Las Vegas Valley Urban Canopy Analysis

2012

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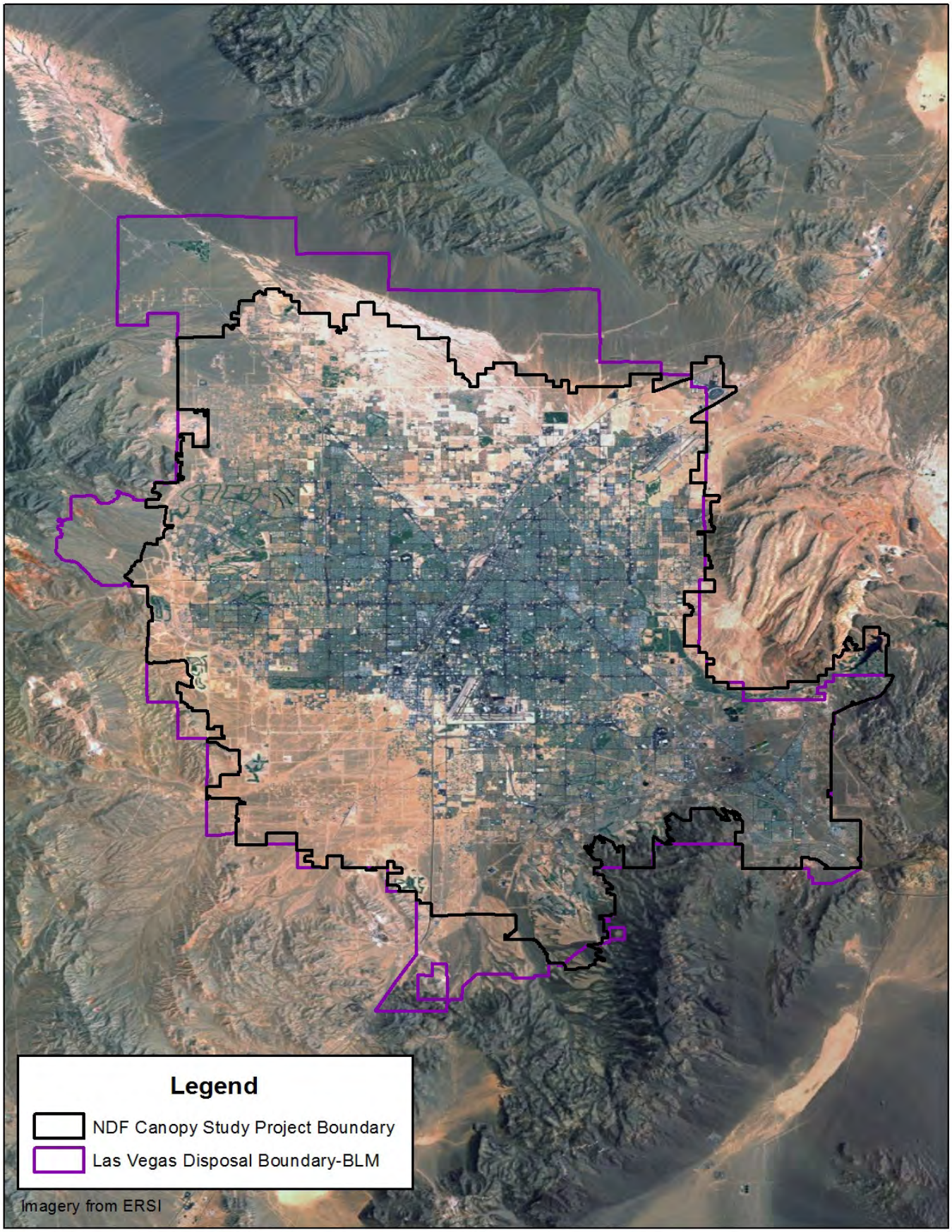


Figure 1. Map showing Project Boundary and the Las Vegas Disposal Boundary.

EXECUTIVE SUMMARY

The Nevada Division of Forestry Urban & Community Forestry Program provides technical assistance, grants, and leadership throughout the State. Several tree inventories and tree canopy cover assessments are underway in Nevada to direct better policy and decision making at the local and regional level for the planning and management of urban natural resources.

The Las Vegas Valley Urban Tree Canopy (UTC) Assessment provides an analysis of current tree canopy extent using geographic information systems (GIS). The Canopy data and GIS data was used to assess some of the environmental and economic benefits of existing and future tree canopy scenarios. This report provides statistical canopy results, current and projected ecosystem benefits, options for setting canopy cover goals, management recommendations for reaching desired goals, and tools for implementation.

The Urban Tree Canopy in the Las Vegas Valley

The area of interest (AOI) for this assessment covered approximately 428 square miles (273,895 acres) of the urbanized areas in the Las Vegas Valley in Clark County, Nevada (Figure 1). This included the incorporated areas in Las Vegas, North Las Vegas and Henderson and the unincorporated urbanized areas of the Las Vegas Valley.

Based on 273,895 acres of land area, the urban portions of Las Vegas Valley have 23,472 acres (8.6%) of tree canopy. Additionally, roughly 25% of the region is covered by impervious surfaces such as pavement and compacted dirt.

Existing UTC within the project boundary was assessed at 12.9% for Las Vegas, 3.1% for North Las Vegas, 7.1% for Henderson and 7.7% for the remaining unincorporated areas. Within the city limits, which extended beyond the project AOI boundary, existing UTC was assessed at 11.3% for the city limits of Las Vegas, 5.5% for North Las Vegas, and 5.4% for Henderson. Assessing UTC by a generalized zoning classification for the AOI revealed that residential areas had a UTC of 10.6%, commercial areas had a UTC of 4.1% and a defined Right of Way has a 2.1% UTC.

Ecosystem Benefits Analysis

Urban trees provide many “ecosystem services” or direct and indirect economic and environmental benefits such as air qulaity improvement, carbon sequestration, and stormwater runoff mitigation, to name a few. Using American Forests’ CITYgreen software, this assessment quantified each of these benefits for city and unincorporated county boundaries and by land use categories. Results demonstrate that the region’s tree canopy provides $8.6M in annual air quality benefit. If tree cover increased to 20% overall, this values would increase to $19.9M.

Setting Canopy Cover Goals

Tree canopy cover is a critical measure of environmental health and sustainability in cities. Setting realistic goals for different land use types and planning scales in a collaborative way creates a shared vision to ensure that resources are allocated effectively and adaptive management can occur over time. Using this top-down approach of assessing the region’s green infrastructure, techniques and tools are presented to evaluate tree canopy goals for urban forest management planning, education and outreach, and policy development.

Using the Results of this Assessment

An assessment report and accompanying GIS data may sit on the shelf underutilized if the information isn't made available in diverse ways to a wide audience. To increase the usefulness of this assessment, a number of tools were provided as part of this project to enable both technical and non-technical application of the data. Showcased in the main body and appendix of this report, these tools include interactive GIS-like Adobe PDFs.

Summary

With just under 9% tree canopy cover for the entire Las Vegas Valley – 13% and 7% for the City of Las Vegas and the City of Henderson, respectively – the region is, on average, similar or a little higher in UTC when compared with other arid areas of the Western U.S. including Albuquerque, NM (6%), Denver, CO (10%), Salt Lake City, UT (10%), and Truckee Meadows (Reno-Sparks) (4.6%).

Over time as development expands and matures in the Las Vegas Valley, the region should expect to see canopy cover increase substantially with proper policy and care. This canopy increase will be accompanied by increased social, environmental and economic benefits of the urban and community forest. Analysis results of tree canopy benefits from this study offer a compelling argument to promote a sustainable urban forest. Reports are provided are available at: http://forestry.nv.gov/forestry-resources/urban-tree-canopy-assessment-projects/.

Figure 2. Tree Planting demonstration.

Introduction

The Las Vegas Valley Urban Tree Canopy assessment is a starting point for understanding, managing and preserving local investments in public and private trees. It provides tools to develop local and regional urban forestry goals, policies, and management plans to sustain and enhance the existing urban forest. To date, street and park tree inventories have been undertaken to gain understanding on the structure and function of public trees.

This assessment examines the area and percent cover for existing tree canopy. The canopies were calculated for the entire study area of interest (AOI), 3 entities (Cities of Las Vegas, Henderson, and North Las Vegas), and the unincorporated areas of Clark County.

The assessment was accomplished using geographic information systems (GIS) and aerial photography. A land cover classification process was performed to map impervious surfaces, grass and open space, bare soil / dry vegetation, and water. Aerial photography from the 2006 National Agricultural Imagery Program (NAIP) was used with additional imagery from ESRI. The NAIP imagery included natural color and color-infrared with "leaf-on" (summer) conditions at 1 meter pixel resolution. The 2010 NAIP was not ready when this project started.

In this report, tree canopy goals are discussed and compared to the results for the Las Vegas Valley. The environmental services provided by trees are described and quantified, for existing and future scenarios.

Innovative methods and tools for setting canopy cover goals based on current data are offered to facilitate this process.

Specific objectives of this assessment were to:

- Map 10 land cover classes across the region
- Calculate environmental and economic benefits of the current tree canopy and model scenarios of increasing canopy cover
- Provide technical and non-technical tools for implementing canopy goals

Las Vegas Valley UTC Assessment

Major Findings

Based on the analysis of aerial imagery, land cover, land use and the resulting GIS mapping data, the following represent the major findings from this study:

- Las Vegas Valley has 8.6% tree canopy and 26% impervious surfaces. Approximately 28% landcover is residential and 6% commercial/business. The other large landcover category is 25% consisting of Western Desert native vegetation including rangeland with 30 to 70% land cover.
- Tree canopy in Las Vegas Valley was estimated to store nearly 1,010,055 tons of carbon and to provide an annual air pollution removal value of $8.5M and a total stormwater runoff mitigation value of approximately $208 M.
- Residential zoning comprises 10.6% of the region's UTC and 4% is commercial property.
- Residential zoning areas average 15.3% UTC in Las Vegas, 6.9% in North Las Vegas, 7.8% in Henderson and 7.1% in unicorporated urban areas of Clark County.

GIS Data Collection

This study included a photo-interpretation land cover classification task, and an ecosystem services analysis using CITYgreen software. The main methods and processes involved are described below. More technical descriptions on the data inputs and land cover methodology are provided in the Appendix.

Land Cover Mapping

Aerial imagery acquired by the National Agricultural Imaging Program during 2006 was used and landcovers of 1) Bladed Ground, 2) Barren Ground, 3) Open Space, 4) Parking lots, 5) Buildings (Residential and Commercial), and 6) Water Features, were mapped. The maps were prepared as an ArcGIS geodatabase containing layers with polygons of these landcover types. In the digitization of landcover classes, necessary QA/QC was performed to assure the accuracy of mapping. The resulting product is furnished with Federal Geographic Data Committee (FGDC) compliant standard metadata.

Acquisition of NAIP Imagery and Preparation of GIS layers

National Agricultural Imaging Program (NAIP) 2006 aerial imagery of Las Vegas was acquired from the University of Nevada Reno Keck library. The data was organized and converted into formats for usage in ArcGIS. ESRI World imagery was used where NAIP imagery is missing data (Northwest Las Vegas area). Figure 1 shows the mosaic of NAIP tiles and ESRI world imagery over the Las Vegas Valley. The Las Vegas disposal boundary was used to define the boundary of the mapping project as shown in Figure 1. Clark County parcel data was used to assist in the identification of boundaries as needed. The area was divided into smaller frames and each frame (quad) was mapped separately. The frames were merged to produce the final map. GIS files were prepared in the UTM Zone 11, NAD83 projection. The FGDC-compliant metadata of the GIS files is completed.

Landcover mapping

The landcover mapping was performed by digitizing the polygons over the NAIP and ESRI world imagery. The Clark County parcel data was utilized where possible to make use of previously digitized boundaries. Adjacent polygons of same landcover type were merged to produce larger polygons. The landcover types have been identified based on the visual representation and context in the NAIP imagery and ESRI world imagery. Figure 2 shows a landcover map produced and Table 1 shows area covered by various classes. The following guidelines were followed in the digitizing process:

1. The whole area was divided into regions based on the NAIP frames and assigned to different personnel for mapping. UNLV students and UNLV personnel were involved in mapping and QA/QC process. In order to assure a high quality of the product, digitizing performed by one individual was quality checked by another individual on the project.
2. When mapping the boundaries, major streets were not included.
3. Aerial imagery was zoomed to appropriate scale to accurately map the boundaries. (very small scale makes it difficult to identify boundary accurately, whereas very detailed large scale tends to result in pixelization causing the boundaries to become fuzzy). It is noted that zoom scale of 2500 to 5000 provides reasonable accuracy.
4. The polygons for which the landcover class type is not clear from the NAIP imagery were flagged. Other sources were consulted to determine the landcover types (e.g., personnel at Nevada Division of Forestry and map resources). Once the class type was confirmed, the QA/QC flag was be updated.

Figure 2. Land use data created by UNLV.

Class	Area (square kilometers)
Bladed Ground	62.61
Barren Ground (Rangeland)	446.48
Open Space	63.66
Parking Lots	85.01
Residential Buildings	388.25
Water Features	2.11
Commercial Buildings	68.51
Total	**1116.64**

Table 1. Area covered by various landcover.

The mapping of various classes is based on following definitions:

- Bladed Ground- This landcover is composed of land that has been bladed for development. Vegetation has been removed from these properties. These areas are usually housing developments that have not been completed.
- Barren Ground (Rangeland)- The surface is composed of undeveloped areas (native vegetation).
- Open Space- This landcover consists of parks, athletic fields, and golf courses (fairways, greens and sand traps).
- Parking lots- This landcover consists of large parking lots adjacent to hotels, malls, larger schools, businesses and universities. It also includes runways and general airport lands.
- Residential Buildings-This layer consists of residential buildings. In residential areas, complete blocks are grouped together where appropriate.
- Commercial Buildings-This layer consists of commercial buildings.
- Water Features- This layer consist of any ponds in parks, water traps on golf courses, some of the large casino water features.

Acquisition of Tree Canopy,Turf Data, Roads (Impervious) Data

Southern Nevada Water Authority (SNWA) provided this project a copy of their tree canopy and turf data from 2006 [1]. The road data came from the Clark County GISMO data set. Major roads where buffered 60 feet and secondary roads where buffered 30 feet. The Urban Western Desert land cover was added to be a catch all for areas that weren't classified and was used in the Citygreen analysis as a replacement land value.

[1]LOCATING TURF AND WATER FEATURES IN THE LAS VEGAS VALLEY, NEVADA, USING REMOTE SENSING TECHNIQUES AND GIS, Pecora 17 – The Future of Land Imaging…Going Operational November 18 – 20, 2008 ♦ Denver, Colorado. Author: Judy Brandt, GIS Analyst, Southern Nevada Water Authority

Zoning Categories Mapping

The Las Vegas Valley zoning map was prepared by merging the landuse maps of the individual cities. In the merging process, careful attention was given to the merging of the different classification schemes used by the cities.

The process for creating the zoning map began with researching available data of designated city land use boundaries and government zone policies. Each city website had PDF's of their zoning map and of the building code which defines land use characteristics. Shapefiles of the zoning maps were accessible at the Clark County GIS Management Office website (GISMO).

The data used for preparing the zoning map is listed below

City of Henderson

- Existing Zoning map by Geographic Information Services created Sept. 2011.
- HDZoning shapefile by Community Development GIS adopted July 20, 2010.

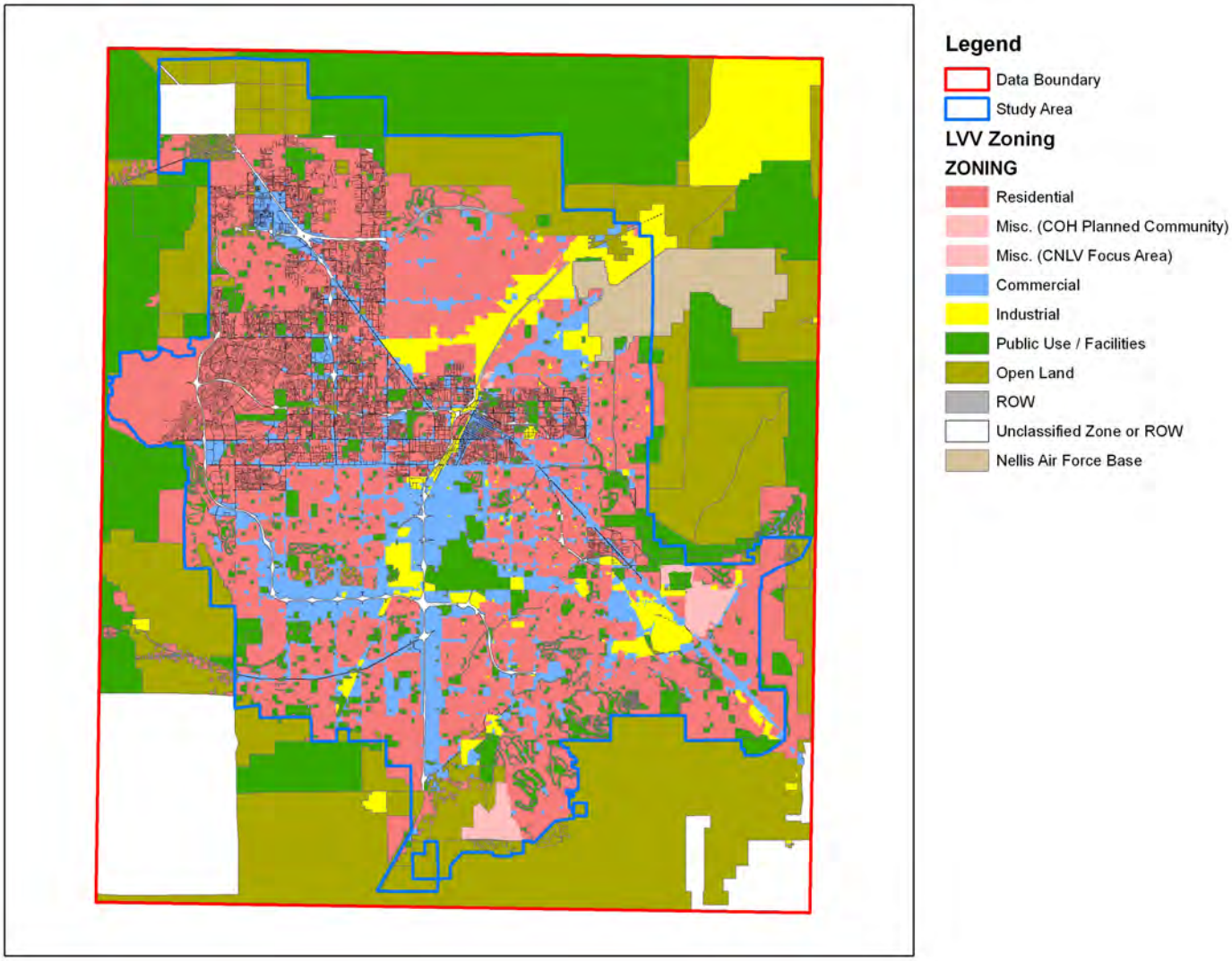


Figure 3. Generalized zoning for the Las Vegas Valley.

City of Las Vegas

- City of Las Vegas Zoning map by Planning & Development Dept. created July 11, 2011.
- CLV_Zoning shapefile – File description does not include publisher and date within metadata information.

City of North Las Vegas

- Zoning map by Community Development Dept. Planning and Zoning Division GIS Services created March 31, 2011
- NLVZONE_P shapefile – File description does not include publisher and date within metadata information.

Clark County (Material created by Comprehensive Planning Dept.)

- Enterprise Planning Area map created Nov. 4, 2009
- CC_ENTPLU_p shapefile created Sept. 2, 2009
- Lone Mountain Planned Land Use map created Oct. 14, 2008
- CC_LMPLU_p shapefile created Sept. 17, 2008
- Northeast County Planned Land Use map created Oct. 4 2006
- CC_NEPLU_p shapefile created Sept. 6, 2006
- Northwest County Planned Land Use map created April 10, 2008
- CC_NWPLU_p shapefile created Nov. 7, 2007
- South County Planned Land Use map created Feb. 8, 2007
- CC_SCPLU_p shapefile created Dec. 6, 1994
- Spring Valley Planning Area map created Nov 4, 2009
- CC_SPVPLU_p shapefile created Dec. 10 2004
- Sunrise Manor Planning Area map created Oct. 11 2010
- CC_SRMPLU_p shapefile created Jan. 18, 2006
- Summerlin South Planned Land Use map created April 18, 2007
- CC_SUMPLU_p shapefile created May 28, 2003
- Whitney Planned Land Use map created May 15, 2007
- CC_WHPLU_p shapefile March 21, 2007
- Winchester and Paradise Planned Land Use map created Sept. 8, 2010
- CC_WPPLU_p shapefile created Aug. 3, 2005

The zoning definitions contained in the building codes are grouped into residential, commercial, industrial, public facilities, open lands, and right of way categories. Any map types not designated within the building codes are classified based on best guess. A table based on this analysis was constructed in Microsoft Excel for future reference.

Shapefiles downloaded from the Clark County website were combined in an ArcGIS map. The map and attribute tables were then compared to zone map PDF's for accuracy. Shapefiles that matched the PDF's the best were selected to build the valley wide planned land use shapefile. The polygons in each shapefile were then exported into separate files based on their zone classification and the constructed excel table. A column labeled 'ZONE_CODE' was added to each attribute table of the exported shapefiles and populated depending on the shapefile zone classification. There were no agricultural (B6) areas identified in the Las Vegas valley study area.

- AFB – Nellis Air Force Base
- B1 – Residential
- B2 – Commercial
- B3 – Industrial
- B4 – Public Use / Facilities
- B5 – Open Land
- B6 – Agricultural
- B7 – ROW
- B8 – City of Henderson Planned Community
- B9 – CNLV Focus Area
- UZ – Unclassified Zone or ROW

All exported files were then combined (merged) into a single file and then clipped to the masking boundary. In the final step, union of zoning shapefile and masking boundary was performed to fill in the unclassified areas. Data was cleaned up by removing the extra columns from the shapefile .

Ecosystem Benefits Analysis

CITYgreen Software

CITYgreen is GIS software extension developed by American Forests and the U.S. Forest Service. Information on the various models and databases included in CITYgreen are provided below. Note that CITYgreen does not model benefits of trees related to energy savings from shade and wind block or aesthetic/property values. Additionally, CITYgreen only operates in ESRI ArcGIS version 9x, it has not been upgraded to run in ArcGIS version 10x.

CITYgreen uses land cover data as an input to quantify some of the ecosystem services provided by urban forest canopy cover in dollars and resource units. Reports estimate benefits of tree canopy cover for air pollution removal capacity for 5 common air pollutants (in lbs./yr.), carbon storage and sequestration (in lbs./yr.), stormwater runoff (volume mitigated) and water quality (percent change in contaminant loading) using event mean concentrations. The model does not estimate urban tree canopy benefits related to energy savings or aesthetic/property values and thus represents only a portion of total urban forest benefits.

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Carbon Storage and Sequestration

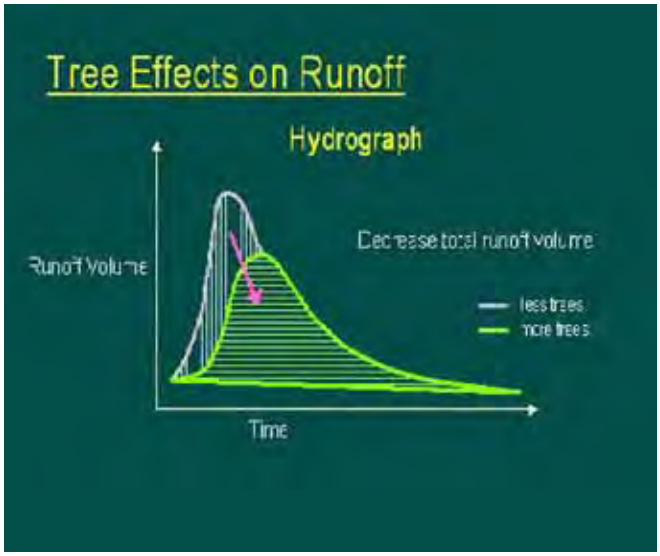
Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was de-

veloped using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Stormwater Runoff Volume

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.



Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

CITYgreen uses the Curve Number (CN) system and hydrologic soil group (HSG) to estimate stormwater runoff potential. CN ranges from 0 to 100 with a higher number indicating more impervious surface and a higher runoff rate. The value of tree canopy is modeled by replacing trees with other cover types such as build-

ings, parking lots and other landscapes, often having a higher CN. To better characterize the hydrologic impact of tree canopy, two cover types were added to the 5-class land cover data: trees with an impervious understory and compacted/bladed urban soils which were sub-classified from bare soil/dry vegetation. Additional information on the air quality, carbon storage, stormwater, and water quality models used in CITYgreen software can be found in the Appendix.

CITYgreen reports were generated for the entire study area, each entity, and by land use and zoning across the study area and for each entity. Additionally, for the project area, City of Las Vegas, City of Henderson and the City of North Las Vegas, reports were created at current canopy cover and 20% canopy cover to model the additional benefits at increased amounts of tree canopy cover. Results are shown in this report and complete CITYgreen reports are included in the appendeix of this report and on line at *http://forestry.nv.gov/forestry-resources/urban-tree-canopy-assessment-projects/las-vegas-urban-tree-canopy-analysis-study/*.

The classes and their corresponding curve numbers (CN) based on C type soils were:

- Barren Ground = Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70% (CN 63)
- Impervious = Impervious Surfaces: Paved (CN 98)
- Impervious = Impervious Surfaces: Paved: Drain to sewer (CN 98)
- Bladed urban soil = Impervious Surfaces: Unpaved: Dirt (CN 87)
- Turf Area = Open Space - Grass/Scattered Trees (CN 79)
- Open Space = Open Space - Grass/Scattered Trees: Grass cover > 75% (CN 74)
- Tree canopy/shrub = Trees: Grass/turf understory: Ground cover > 75% (CN 72)
- Urban: Commercial Business (CN 94)
- Urban: Residential (CN 90)
- Urban: Western Desert (CN 85)
- Water = water area (CN 100)

The following were the parameters used in the CITYgreen modeling:

- Hydrologic Soil Group: “C”
- Air Quality Reference City: Phoenix
- Stormwater Construction: $3/cubic foot
- Slope: 2% average
- Replacement land cover type: Urban: Western Desert: Natural Landscaping (CN 85)

Figure 4. Landcover classification after CityGreen classification.

Results

This section of the report presents the land cover and UTC results, beginning with the entire Las Vegas Valley region followed by results for the Cities of Las Vegas, Henderson, North Las Vegas, and remaining unicorporated Clark County urban areas. These are for the areas that fall within the AOI project boundary. CITYgreen results for current conditions and future canopy scenarios are included by land use type for each entity. Complete analysis can be found in the Appendix.

Las Vegas Valley Urban Tree Canopy by land cover

Land Type	Acres	Percentage
Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	52,449.9	19.1
Impervious Surfaces: Paved	20,420.5	7.5
Impervious Surfaces: Paved: Drain to sewer	34,445.1	12.6
Impervious Surfaces: Unpaved: Dirt	15,750.8	5.8
Open Space - Grass/Scattered Trees	9,549.6	3.5
Open Space - Grass/Scattered Trees: Grass cover > 75%	7,439.1	2.7
Trees: Grass/turf understory: Ground cover > 75%	23,472.5	8.6
Urban: Commercial/Business	16,275.1	5.9
Urban: Residential	77,540.5	28.3
Urban: Western Desert	15,810.1	5.8
Water Area	742.0	0.3
Total	**273,895.1**	**100%**

Las Vegas Valley Ecosystem Benefits

Based on the region's land cover data analyzed in this study, CITYgreen software was used to estimate the benefits of existing and potential tree canopy. Summary results are presented below in the following way:

- For the broad land cover categories
- By the type of ecosystem benefit, including: air pollution removal in dollars and pounds per year, total carbon storage and annual carbon sequestration in tons, and mitigated stormwater runoff in dollars and cubic feet (annually and in total). This is for both current conditions and future scenarios with increased canopy cover of 20% regionally.

Air pollution

The current canopy cover removes 1,099,688 pounds/year for an estimated value of $3,019,799. If the canopy was able to be increased to 20%, 1,944,546 pounds/year of air pollution would be removed with an estimated value of $5,339,821

Carbon Storage

The current canopy cover stores 356,281 tons of carbon with 2,774 tons sequestered annually for an estimated value of $3,019,799. If the canopy was able to be increased to 20%, 630,001 tons stored and 4,905 ton sequestered annually.

Stormwater

Using the current canopy coverage for the City of Las Vegas and if the existing canopy cover was replaced by impervious surfaces consisting of building and structures, Las Vegas would need an additional 31,431,263 cubic feet of storage area to manage stormwater. If you use a construction cost of $3 per cubic feet, the cost would be $94,293,789.

If you increase the canopy cover to 20% citywide, you would reduce the amount of stormwater storage by 5,828,167 cubic feet from the current storage need of 24,889,764. If you factor the cost of building storm water storage, there could be savings up to $17,487,500.

City of Las Vegas Urban Tree Canopy by land cover

Land Type	Acres	Percentage
Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	4,439.7	6.9
Impervious Surfaces: Paved	4,161.3	6.5
Impervious Surfaces: Paved: Drain to sewer	10,171.6	15.9
Impervious Surfaces: Unpaved: Dirt	2,554.1	4.0
Open Space - Grass/Scattered Trees	2,959.2	4.6
Open Space - Grass/Scattered Trees: Grass cover > 75%	1,889.8	2.9
Trees: Grass/turf understory: Ground cover > 75%	8,275.8	12.9
Urban: Commercial/Business	3,478.4	5.4
Urban: Residential	22,194.6	34.6
Urban: Western Desert	3,893.4	6.1
Water Area	125.7	.2
Total	**64,143.6**	**100%**

City of Las Vegas Ecosystem Benefits

Based on the region's land cover data analyzed in this study, CITYgreen software was used to estimate the benefits of existing and potential tree canopy. Summary results are presented below in the following way:

- For the broad land cover categories
- By the type of ecosystem benefit, including: air pollution removal in dollars and pounds per year, total carbon storage and annual carbon sequestration in tons, and mitigated stormwater runoff in dollars and cubic feet (annually and in total). This is for both current conditions and future scenarios with increased canopy cover of 20% regionally.

Air pollution

The current canopy cover removes 1,099,688 pounds/year for an estimated value of $3,019,799. If the canopy was able to be increased to 20%, 1,703,911 pounds/year of air pollution would be removed with an estimated value of $4,679,025.

Carbon Storage

The current canopy cover stores 356,118 tons with 2,772 tons sequestered annually for an estimated value of $3,019,799. If the canopy was able to be increased to 20%, 552,039 tons stored and 4,298 ton sequestered annually.

Stormwater

If the existing canopy cover was replaced by impervious surfaces consisting of building and structures, Las Vegas would need an additional 14,657,366 cubic feet of storage to manage stormwater. If you use a construction cost of $3 per cubic feet, the cost would be $43,972,097.

If you increase the canopy cover to 20% citywide, you would reduce the amount of stormwater storage by 12,372,890 cubic feet from the current storage needs. If you factor the cost of building storm water storage, there could be savings up to $37,118,671.

City of Henderson Urban Tree Canopy by land cover

Land Type	Acres	Percentage
Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	12,654.8	25.2
Impervious Surfaces: Paved	2,260.6	4.5
Impervious Surfaces: Paved: Drain to sewer	5,977.3	11.9
Impervious Surfaces: Unpaved: Dirt	3,091.8	6.2
Open Space - Grass/Scattered Trees	2,020.0	4.0
Open Space - Grass/Scattered Trees: Grass cover > 75%	2,060.9	4.1
Trees: Grass/turf understory: Ground cover > 75%	3,545.1	7.1
Urban: Commercial/Business	2,040.4	4.1
Urban: Residential	12,881.2	25.7
Urban: Western Desert	3,184.5	6.3
Water Area	496.1	1
Total	**50,212.6**	**100%**

City of Henderson Ecosystem Benefits

Based on the region's land cover data analyzed in this study, CITYgreen software was used to estimate the benefits of existing and potential tree canopy. Summary results are presented below in the following way:

- For the broad land cover categories
- By the type of ecosystem benefit, including: air pollution removal in dollars and pounds per year, total carbon storage and annual carbon sequestration in tons, and mitigated stormwater runoff in dollars and cubic feet (annually and in total). This is for both current conditions and future scenarios with increased canopy cover of 20% regionally.

Air pollution

The current canopy cover removes 470,858 pounds/year for an estimated value of $1,292,999. If the canopy was able to be increased to 20%, 1,333,848 pounds/year of air pollution would be removed with an estimated value of $3,662,812

Carbon Storage

The current canopy cover stores 152,550 tons with 1,188 tons sequestered annually for an estimated value of $3,019,799. If the canopy was able to be increased to 20%, 432,144 tons stored and 3,364 ton sequestered annually.

Stormwater

If the existing canopy cover was replaced by impervious surfaces consisting of building and structures, Henderson would need an additional 4,230,804 cubic feet of storage to manage stormwater. If you use a construction cost of $3 per cubic feet, the cost would be $12,692,413.

If you increase the canopy cover to 20% citywide, you would reduce the amount of stormwater storage by 9,456,584 cubic feet from the current storage needs. If you factor the cost of building storm water storage, there could be savings up to $28,369,751.

City of North Las Vegas Urban Tree Canopy by land cover

Land Type	Acres	Percentage
Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	6,009.6	19.6
Impervious Surfaces: Paved	3,097.0	10.1
Impervious Surfaces: Paved: Drain to sewer	4,221.4	13.7
Impervious Surfaces: Unpaved: Dirt	2,232.0	7.3
Open Space - Grass/Scattered Trees	702.3	2.3
Open Space - Grass/Scattered Trees: Grass cover > 75%	627.9	2.0
Trees: Grass/turf understory: Ground cover > 75%	1,685.9	5.5
Urban: Commercial/Business	1,627.5	5.3
Urban: Residential	8,267.3	26.9
Urban: Western Desert	2,231.9	7.3
Water Area	4.2	0.0
Total	**30,707.0**	**100.%**

City of North Las Vegas Ecosystem Benefits

Based on the region's land cover data analyzed in this study, CITYgreen software was used to estimate the benefits of existing and potential tree canopy. Summary results are presented below in the following way:

- For the broad land cover categories
- By the type of ecosystem benefit, including: air pollution removal in dollars and pounds per year, total carbon storage and annual carbon sequestration in tons, and mitigated stormwater runoff in dollars and cubic feet (annually and in total). This is for both current conditions and future scenarios with increased canopy cover of 20% regionally.

Air pollution

The current canopy cover removes 223,916 pounds/year for an estimated value of $614,884. If the canopy was able to be increased to 20%, 815,702 pounds/year of air pollution would be removed with an estimated value of $2,239,958

Carbon Storage

The current canopy cover stores 72,656 tons with 565 tons sequestered annually for an estimated value of $3,019,799. If the canopy was able to be increased to 20%, 264,274 tons stored and 2,057 ton sequestered annually.

Stormwater

If the existing canopy cover was replaced by impervious surfaces consisting of building and structures, North Las Vegas would need an additional 2,526,376 cubic feet of storage to manage stormwater. If you use a construction cost of $3 per cubic feet, the cost would be $7,579,127

If you increase the canopy cover to 20% citywide, you would reduce the amount of stormwater storage by 9,095,035 cubic feet from the current storage. If you factor the cost of building storm water storage, there could be savings up to $27,285,106

Unincorporated Clark County Tree Canopy by land cover

Land Type	Acres	Percentage
Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	29,337.3	22.8
Impervious Surfaces: Paved	10,901.9	8.5
Impervious Surfaces: Paved: Drain to sewer	14,080.6	10.9
Impervious Surfaces: Unpaved: Dirt	7,874.0	6.1
Open Space - Grass/Scattered Trees	3,868.1	3.0
Open Space - Grass/Scattered Trees: Grass cover > 75%	2,860.6	2.2
Trees: Grass/turf understory: Ground cover > 75%	9,966.1	7.7
Urban: Commercial/Business	9,129.0	7.1
Urban: Residential	34,198.6	26.5
Urban: Western Desert	6,499.6	5.0
Water Area	116.1	0.1
Total	**128,831.9**	**100**

Unincorporated Clark County Ecosystem Benefits

Based on the region's land cover data analyzed in this study, CITYgreen software was used to estimate the benefits of existing and potential tree canopy. Summary results are presented below in the following way:

- For the broad land cover categories
- By the type of ecosystem benefit, including: air pollution removal in dollars and pounds per year, total carbon storage and annual carbon sequestration in tons, and mitigated stormwater runoff in dollars and cubic feet (annually and in total). This is for both current conditions and future scenarios with increased canopy cover of 20% regionally.

Air pollution

The current canopy cover removes 1,323,697 pounds/year for an estimated value of $3,634,937. If the canopy was able to be increased to 20%, 3,422,293 pounds/year of air pollution would be removed with an estimated value of $9,397,786

Carbon Storage

The current canopy cover stores 356,281 tons with 2,774 tons sequestered annually for an estimated value of $3,019,799. If the canopy was able to be increased to 20%, 1,108,766 tons stored and 8,632 ton sequestered annually.

Stormwater

If the existing canopy cover was replaced by impervious surfaces consisting of building and structures, unincorporated Clark County would need an additional 31,431,263 cubic feet of storage to manage stormwater. If you use a construction cost of $3 fper cubic feet, the cost would be $94,293,789

If you increase the canopy cover to 20% area, you would reduce the amount of stormwater storage by 31,218,664 cubic feet from the current storage need of 24,889,764. If you factor the cost of building storm water storage, there could be savings up to $93,655,993.

Setting Urban Tree Canopy Goals

There are three underlying assumptions in this type of goal setting, as taken from the American Planning Association's "Planning the Urban Forest: Ecology, Economy, and Community Development" (Planning Advisory Service Report No. 555). These are:

- Current canopy cover is either not adequate, is declining, or could be improved in a way that would benefit the community
- The goal is an increase that's achievable in a projected timeframe
- The outcomes of the goal would result in a positive cost-benefit ratio – that the investment required will yield even greater dividends and value over time

Initially, tree canopy goals from American Forests for the western U.S. were compared to canopy cover in the Las Vegas Valley (see Table 2). Given the large gap between American Forests goals and actual canopy cover in the Las Vegas Valley (25% and 8.6% respectively), these goals are not recommended at this time for the region. Additionally, the land uses provided by American Forests did not directly match the categories assessed in this study.

Category	Canopy Cover
All Land Uses	25%
Suburban	35%
Urban Residential	18%
Central Business Districts	9%

Table 2. American Forest Goals by Land Use in the dry Western U.S.

Recommendations

Based on this assessment and the A.P.A's report guidance, NDF offers the following recommendations for achieving tree canopy goals in the Las Vegas Valley:

1. Using the information gained from this study, form a committee or use existing regional groups to consider land establish local and regional tree cover goals in a collaborative process.

2. Locally and regionally, community forestry advocacy boards should use this report to guide:
   - Determine potential goals to help local and regional stakeholders in envisioning their urban forest and promoting effective use of resources. This could include a regional tree canopy goal
   - Community forestry projects, tree planting ordinances (new development, public street and park trees, tree protection) and;
   - Development or review best management practices (BMPs) such as for low impact development (LID) in parking lot design. There is a BMP book and should be used as a baseline when communities look at their ordinances. A copy of this book is available at http://forestry.nv.gov/forestry-resources/urban-and-community-forest/best-management-practices-additional-information/

3. Conduct an audit of local ordinances to simplify or streamline tree-related policies and identify where codes are working against local tree canopy projects and goals. Additionally:
   - Collaborative planning across entities can reduce costs and provide consistency for developers during-permitting;
   - Explore developing or expanding existing codes to enhance tree canopy cover through Community Develop Standards and Landscaping Requirements.

4. Utilize the information gained from this assessment and other inventories to create a regional urban forest management or master plan.

5. Assess tree canopy every 5 to 10 years to monitor trends and assess the effectiveness of public education & outreach campaigns, policies, codes, and ordinances.

6. Expand upon the ecosystem services analysis from this study by incorporating benefit values from local i-Tree studies into education/outreach campaigns with targeted messages. Make the benefits relevant for residents, businesses and decision-makers.

7. Develope a Public Service Announcement (PSA) from this study to educate the citizens of the Las Vegas Valley.

8. Utilize the land cover data from this project while it is current for other applications such as water supply and water conservation analysis and stormwater modeling.

9. Recommend that UNLV, become a Tree Campus USA, through the Arbor Day Foundation.

10. Explore all potential partnerships to achieve urban forest goals: public/private including corporate and academic sponsors, council representatives, air quality and stormwater associations, volunteers, non-profit organizations, and neighborhood associations.

11. Target specific land use or zoning types in areas most in need of additional tree planting.

12. Promote hardy, drought-tolerant, and long-lived tree species that are appropriate for the environment to insure investments in trees achieve maximum tree benefits.
    - Proper tree selection, planting, irrigation and sufficient soil volume is key to maintaining and increasing canopy cover. Lack of watering trees by private tree owners and those adjacent to the public rights-of way is the most limiting factor to tree longevity in the Las Vegas Valley

13. Understand the limitations of urban tree canopy assessment data:
    - As an example, there may be a substantial amount of right-of way that cannot be planted with trees due to a variety of factors, such as not enough set back, vehicle sight distance issues, and adjacent vacant private land with no landowner to maintain and irrigate trees. This should be discussed when considering canopy cover goal setting, using the goals in this report as a starting point.
    - Additional analysis of priority planting areas should be done using GIS technologies at the local and regional level.

Summary

With just under 9% regional tree canopy cover, it is apparent that the urban forest of the Las Vegas Valley is in its infancy but that development patterns are adding trees and canopy cover to the area. Trees from new development, tree preservation and additional tree planting will be needed to substantially increase canopy cover and associated ecological and economic benefits. This study highlights many opportunities for education, management and planning.

Results show that residential areas comprise an overwhelming portion of all trees, indicating that education and outreach on the benefits of the urban tree canopy will be one of the most cost-effective means to advancing urban forestry in the region. Inventories and assessments such as this one provide information for better management of urban natural resources and should be used to direct policy including ordinances for tree planting, tree preservation, and landscaping.

The climate and soils in the Las Vegas Valley make for a challenging environment for trees, but like any urbanized area, trees are a fabric of the community and can thrive with proper planning, management, education and advocacy. Results from this study offer effective tools and compelling arguments to continue to expand the urban forest.

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Appendix

Included in the Appendix of this report are additional details of the methods and processes used in the analysis, and the different reports created with Citygreen software.

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Las Vegas Valley (Project AOI)

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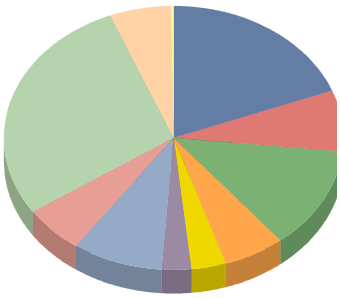
Analysis Report
for
Las Vegas Valley



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	52,449.9	19.1%
Impervious Surfaces: Paved	20,420.5	7.5%
Impervious Surfaces: Paved: Drain to sewer	34,445.1	12.6%
Impervious Surfaces: Unpaved: Dirt	15,750.8	5.8%
Open Space - Grass/Scattered Trees	9,549.6	3.5%
Open Space - Grass/Scattered Trees: Grass cover > 75%	7,439.1	2.7%
Trees: Grass/turf understory: Ground cover > 75%	23,472.5	8.6%
Urban: Commercial/Business	16,275.1	5.9%
Urban: Residential	77,540.5	28.3%
Urban: Western Desert	15,810.1	5.8%
Water Area	742.0	0.3%
Total:	273,895.1	100.0%

Tree Canopy: 23,472.5 acres (8.6%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	188,312	$92,419
Ozone:	899,714	$3,178,736
Nitrogen Dioxide:	481,243	$1,700,254
Particulate Matter:	1,506,498	$3,553,601
Sulfur Dioxide:	41,847	$36,115
Totals:	**3,117,615**	**$8,561,126**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**1,010,055**
Tons Sequestered **(Annually)**:	**7,864**

Stormwater Management

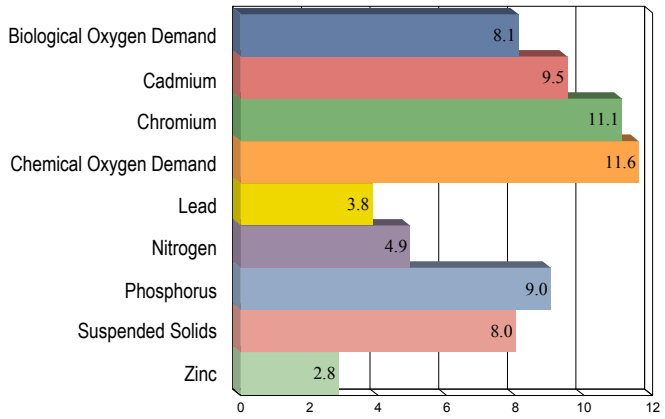
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	84
Curve Number of replacement land cover:	86
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Impervious Surfaces: Buildings/ structures	
Additional cu. ft. storage needed:	**69,368,919**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$208,106,758**
Annual Stormwater Value:	**$18,143,696**

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

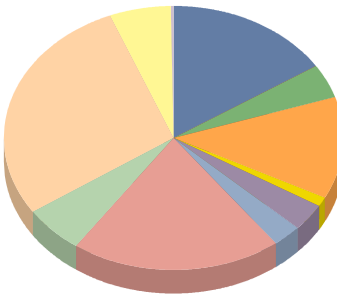
Percent change in contaminant loadings



Analysis Report

for

Las Vegas Valley: Project Area Increase to 20% Canopy



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	43,549.3	15.9%
Impervious Surfaces: Buildings/ structures	0.0	0.0%
Impervious Surfaces: Paved	10,955.8	4.0%
Impervious Surfaces: Paved: Drain to sewer	34,510.8	12.6%
Impervious Surfaces: Unpaved: Dirt	2,739.0	1.0%
Open Space - Grass/Scattered Trees	9,586.3	3.5%
Open Space - Grass/Scattered Trees: Grass cover > 75%	7,395.2	2.7%
Trees: Grass/turf understory: Ground cover > 75%	54,779.0	20.0%
Urban: Commercial/Business	16,159.8	5.9%
Urban: Residential	77,512.3	28.3%
Urban: Western Desert	15,885.9	5.8%
Water Area	821.7	0.3%
Total:	273,895.1	100.0%

Tree Canopy: 54,779.0 acres (20.0%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	439,475	$215,683
Ozone:	2,099,713	$7,418,394
Nitrogen Dioxide:	1,123,102	$3,967,978
Particulate Matter:	3,515,799	$8,293,235
Sulfur Dioxide:	97,661	$84,285
Totals:	**7,275,751**	**$19,979,574**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**2,357,222**
Tons Sequestered **(Annually)**:	**18,352**

Stormwater Management

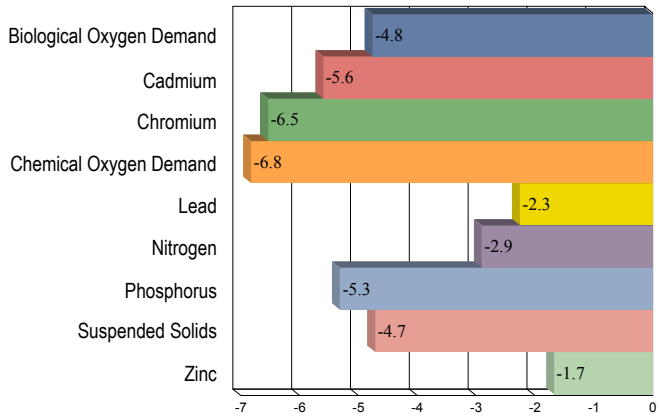
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	84
Curve Number of replacement land cover:	83
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Impervious Surfaces: Buildings/ structures	
Additional cu. ft. storage needed:	**-35,530,743**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$-106,592,228**
Annual Stormwater Value:	**$9,293,196**

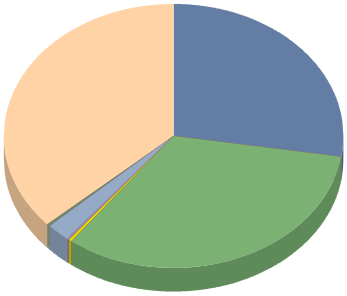
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Right of Way



Tree Canopy: 19.1 acres (2.3%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	226.4	27.4%
Impervious Surfaces: Paved	0.4	0.0%
Impervious Surfaces: Paved: Drain to sewer	270.7	32.8%
Impervious Surfaces: Unpaved: Dirt	0.6	0.1%
Open Space - Grass/Scattered Trees	1.5	0.2%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2.6	0.3%
Trees: Grass/turf understory: Ground cover > 75%	19.1	2.3%
Urban: Commercial/Business	0.3	0.0%
Urban: Residential	0.6	0.1%
Urban: Western Desert	303.7	36.8%
Water Area	0.0	0.0%
Total:	825.8	100.0%

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	153	$75
Ozone:	732	$2,587
Nitrogen Dioxide:	392	$1,384
Particulate Matter:	1,226	$2,892
Sulfur Dioxide:	34	$29
Totals:	**2,537**	**$6,967**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**822**
Tons Sequestered **(Annually)**:	**6**

Stormwater Management

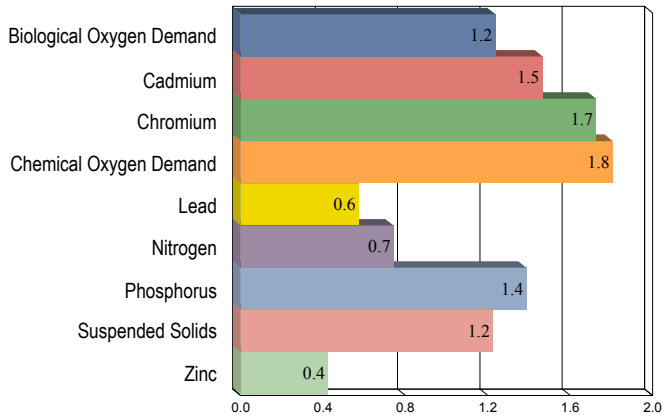
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	83
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**26,032**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$78,097**
Annual Stormwater Value:	**$6,809**

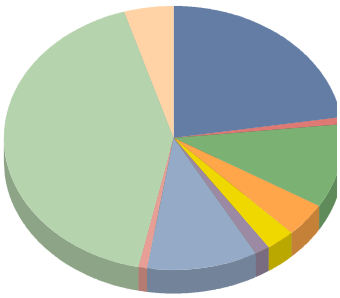
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	38,926.3	22.4%
Impervious Surfaces: Paved	1,385.9	0.8%
Impervious Surfaces: Paved: Drain to sewer	17,909.3	10.3%
Impervious Surfaces: Unpaved: Dirt	7,391.6	4.3%
Open Space - Grass/Scattered Trees	4,611.3	2.7%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2,604.3	1.5%
Trees: Grass/turf understory: Ground cover > 75%	18,367.0	10.6%
Urban: Commercial/Business	1,275.6	0.7%
Urban: Residential	72,816.4	41.9%
Urban: Western Desert	8,152.8	4.7%
Water Area	191.8	0.1%
Total:	173,632.3	100.0%

Tree Canopy: 18,367.0 acres (10.6%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	147,353	$72,317
Ozone:	704,019	$2,487,336
Nitrogen Dioxide:	376,568	$1,330,435
Particulate Matter:	1,178,823	$2,780,664
Sulfur Dioxide:	32,745	$28,260
Totals:	**2,439,509**	**$6,699,012**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**790,360**
Tons Sequestered **(Annually)**:	**6,153**

Stormwater Management

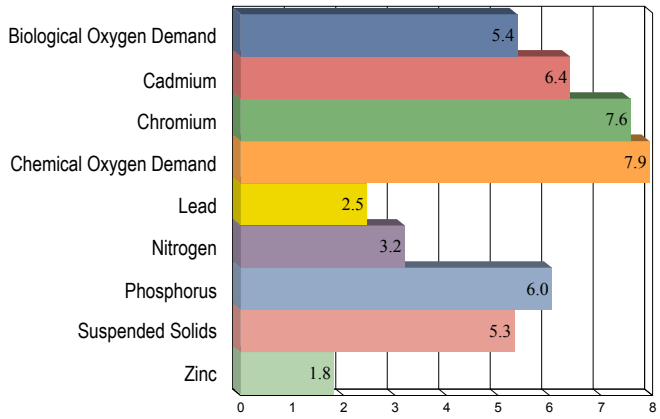
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	82
Curve Number of replacement land cover:	83
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**22,897,294**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$68,691,882**
Annual Stormwater Value:	**$5,988,871**

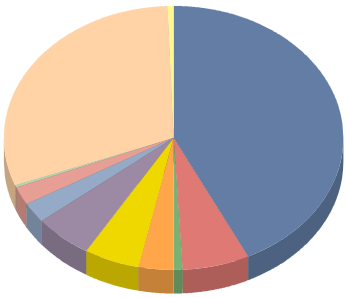
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Public Use-Facilities



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	33,387.7	42.8%
Impervious Surfaces: Paved	4,871.6	6.2%
Impervious Surfaces: Paved: Drain to sewer	638.6	0.8%
Impervious Surfaces: Unpaved: Dirt	2,719.9	3.5%
Open Space - Grass/Scattered Trees	4,205.0	5.4%
Open Space - Grass/Scattered Trees: Grass cover > 75%	4,134.9	5.3%
Trees: Grass/turf understory: Ground cover > 75%	1,966.3	2.5%
Urban: Commercial/Business	1,829.8	2.3%
Urban: Residential	272.8	0.3%
Urban: Western Desert	23,492.4	30.1%
Water Area	490.3	0.6%
Total:	78,009.4	100.0%

Tree Canopy: 1,966.3 acres (2.5%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	15,775	$7,742
Ozone:	75,368	$266,280
Nitrogen Dioxide:	40,313	$142,429
Particulate Matter:	126,198	$297,682
Sulfur Dioxide:	3,506	$3,025
Totals:	**261,160**	**$717,158**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**84,611**
Tons Sequestered **(Annually)**:	**659**

Stormwater Management

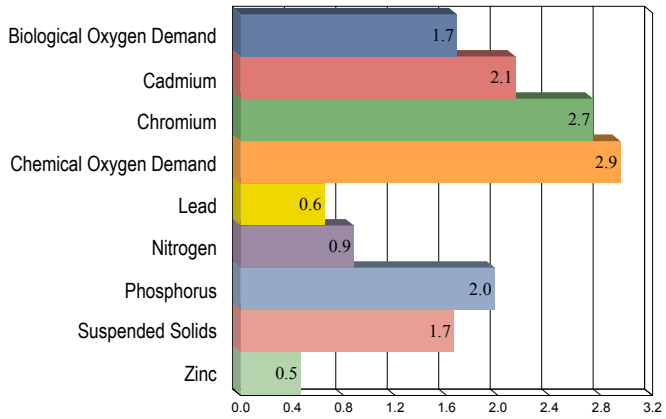
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	76
Curve Number of replacement land cover:	76
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**1,365,605**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$4,096,814**
Annual Stormwater Value:	**$357,179**

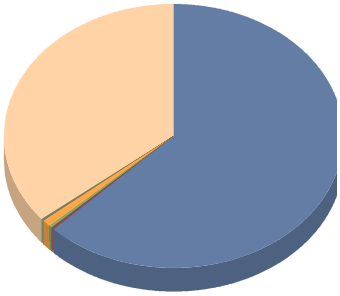
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Open Land



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	72,999.5	62.6%
Impervious Surfaces: Paved	116.3	0.1%
Impervious Surfaces: Paved: Drain to sewer	301.3	0.3%
Impervious Surfaces: Unpaved: Dirt	1,063.7	0.9%
Open Space - Grass/Scattered Trees	31.6	0.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	52.0	0.0%
Trees: Grass/turf understory: Ground cover > 75%	59.4	0.1%
Urban: Commercial/Business	30.4	0.0%
Urban: Residential	94.7	0.1%
Urban: Western Desert	41,913.9	35.9%
Water Area	0.0	0.0%
Total:	116,662.7	100.0%

Tree Canopy: 59.4 acres (0.1%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	476	$234
Ozone:	2,276	$8,040
Nitrogen Dioxide:	1,217	$4,301
Particulate Matter:	3,810	$8,988
Sulfur Dioxide:	106	$91
Totals:	**7,885**	**$21,654**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**2,555**
Tons Sequestered **(Annually)**:	**20**

Stormwater Management

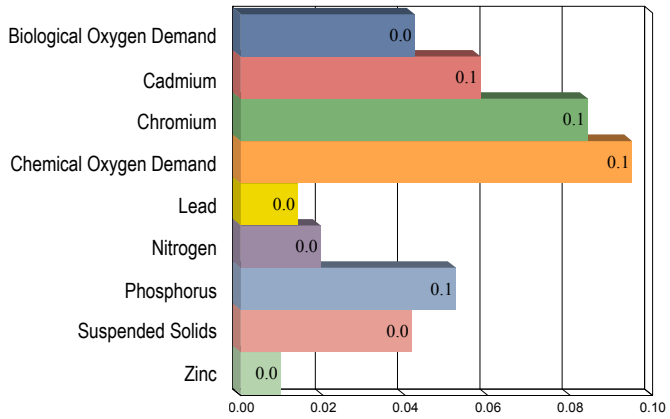
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	71
Curve Number of replacement land cover:	71
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**25,158**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$75,474**
Annual Stormwater Value:	**$6,580**

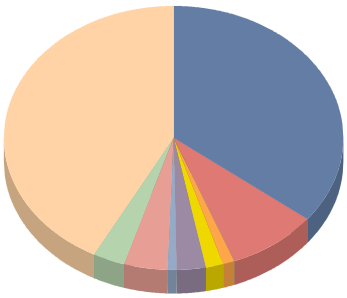
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
NELLIS AFB



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	4,929.7	35.6%
Impervious Surfaces: Paved	1,167.1	8.4%
Impervious Surfaces: Paved: Drain to sewer	27.8	0.2%
Impervious Surfaces: Unpaved: Dirt	147.6	1.1%
Open Space - Grass/Scattered Trees	245.4	1.8%
Open Space - Grass/Scattered Trees: Grass cover > 75%	361.6	2.6%
Trees: Grass/turf understory: Ground cover > 75%	112.0	0.8%
Urban: Commercial/Business	574.4	4.1%
Urban: Residential	424.8	3.1%
Urban: Western Desert	5,856.8	42.3%
Water Area	0.0	0.0%
Total:	13,847.1	100.0%

Tree Canopy: 112.0 acres (0.8%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	898	$441
Ozone:	4,292	$15,162
Nitrogen Dioxide:	2,295	$8,110
Particulate Matter:	7,186	$16,950
Sulfur Dioxide:	200	$172
Totals:	**14,871**	**$40,835**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**4,818**
Tons Sequestered **(Annually)**:	**38**

Stormwater Management

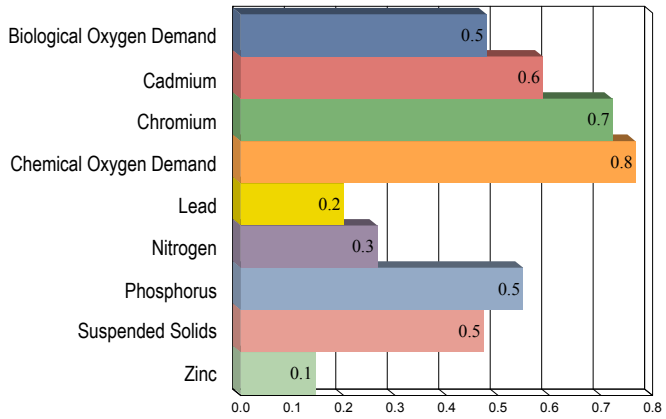
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	78
Curve Number of replacement land cover:	78
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**98,273**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$294,818**
Annual Stormwater Value:	**$25,704**

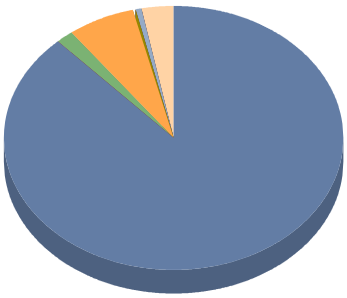
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
MISC_COH



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	3,685.4	88.1%
Impervious Surfaces: Paved	0.3	0.0%
Impervious Surfaces: Paved: Drain to sewer	64.4	1.5%
Impervious Surfaces: Unpaved: Dirt	275.9	6.6%
Open Space - Grass/Scattered Trees	4.4	0.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2.7	0.1%
Trees: Grass/turf understory: Ground cover > 75%	23.6	0.6%
Urban: Commercial/Business	0.3	0.0%
Urban: Residential	5.4	0.1%
Urban: Western Desert	122.7	2.9%
Water Area	0.2	0.0%
Total:	4,185.3	100.0%

Tree Canopy: 23.6 acres (0.6%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	189	$93
Ozone:	903	$3,192
Nitrogen Dioxide:	483	$1,707
Particulate Matter:	1,513	$3,568
Sulfur Dioxide:	42	$36
Totals:	**3,130**	**$8,596**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**1,014**
Tons Sequestered **(Annually)**:	**8**

Stormwater Management

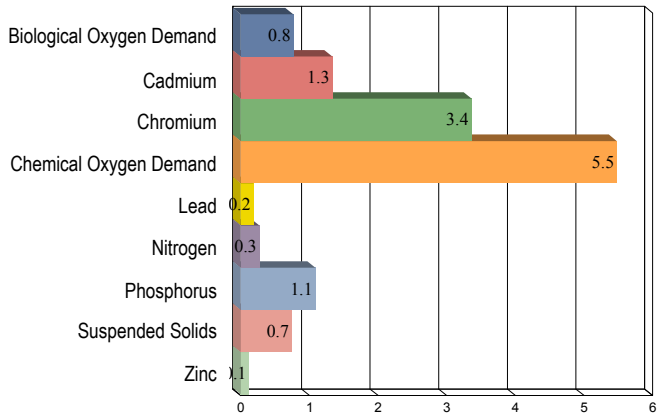
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	66
Curve Number of replacement land cover:	66
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**4,585**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$13,756**
Annual Stormwater Value:	**$1,199**

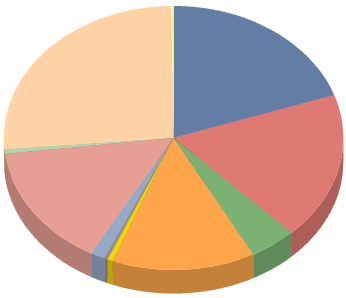
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Industrial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	4,613.8	19.8%
Impervious Surfaces: Paved	4,166.4	17.9%
Impervious Surfaces: Paved: Drain to sewer	1,052.2	4.5%
Impervious Surfaces: Unpaved: Dirt	3,178.0	13.7%
Open Space - Grass/Scattered Trees	92.4	0.4%
Open Space - Grass/Scattered Trees: Grass cover > 75%	50.8	0.2%
Trees: Grass/turf understory: Ground cover > 75%	326.3	1.4%
Urban: Commercial/Business	3,534.6	15.2%
Urban: Residential	107.4	0.5%
Urban: Western Desert	6,089.6	26.2%
Water Area	40.3	0.2%
Total:	23,251.8	100.0%

Tree Canopy: 326.3 acres (1.4%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	2,618	$1,285
Ozone:	12,506	$44,184
Nitrogen Dioxide:	6,689	$23,633
Particulate Matter:	20,940	$49,395
Sulfur Dioxide:	582	$502
Totals:	**43,335**	**$118,999**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**14,040**
Tons Sequestered **(Annually)**:	**109**

Stormwater Management

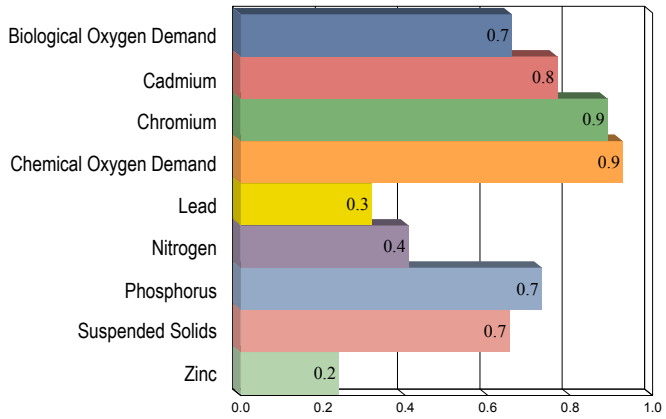
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	85
Curve Number of replacement land cover:	85
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**502,557**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$1,507,672**
Annual Stormwater Value:	**$131,446**

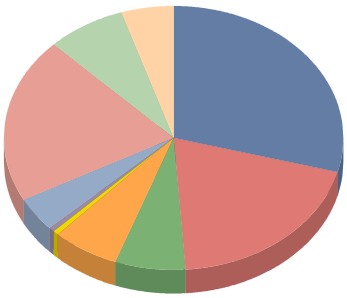
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Commercial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	12,885.7	29.1%
Impervious Surfaces: Paved	8,761.7	19.8%
Impervious Surfaces: Paved: Drain to sewer	2,906.6	6.6%
Impervious Surfaces: Unpaved: Dirt	2,801.4	6.3%
Open Space - Grass/Scattered Trees	299.2	0.7%
Open Space - Grass/Scattered Trees: Grass cover > 75%	236.0	0.5%
Trees: Grass/turf understory: Ground cover > 75%	1,805.3	4.1%
Urban: Commercial/Business	9,016.8	20.4%
Urban: Residential	3,368.9	7.6%
Urban: Western Desert	2,147.0	4.9%
Water Area	16.1	0.0%
Total:	44,244.8	100.0%

Tree Canopy: 1,805.3 acres (4.1%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	14,483	$7,108
Ozone:	69,198	$244,481
Nitrogen Dioxide:	37,013	$130,769
Particulate Matter:	115,867	$273,312
Sulfur Dioxide:	3,219	$2,778
Totals:	**239,780**	**$658,448**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**77,685**
Tons Sequestered **(Annually)**:	**605**

Stormwater Management

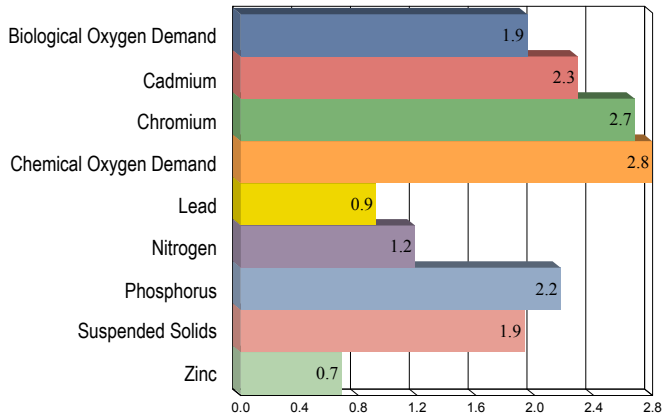
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	84
Curve Number of replacement land cover:	84
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**2,475,833**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$7,427,500**
Annual Stormwater Value:	**$647,563**

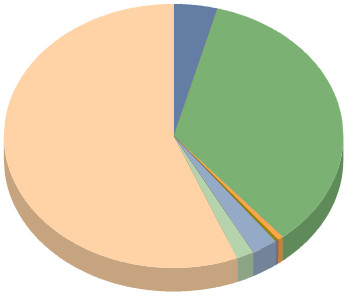
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Unclassified Zoning or ROW



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	1,349.2	4.1%
Impervious Surfaces: Paved	55.3	0.2%
Impervious Surfaces: Paved: Drain to sewer	11,554.1	34.7%
Impervious Surfaces: Unpaved: Dirt	123.3	0.4%
Open Space - Grass/Scattered Trees	62.9	0.2%
Open Space - Grass/Scattered Trees: Grass cover > 75%	27.0	0.1%
Trees: Grass/turf understory: Ground cover > 75%	832.4	2.5%
Urban: Commercial/Business	45.4	0.1%
Urban: Residential	517.9	1.6%
Urban: Western Desert	18,682.1	56.2%
Water Area	3.3	0.0%
Total:	33,252.9	100.0%

Tree Canopy: 832.4 acres (2.5%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	6,678	$3,278
Ozone:	31,908	$112,733
Nitrogen Dioxide:	17,067	$60,299
Particulate Matter:	53,427	$126,027
Sulfur Dioxide:	1,484	$1,281
Totals:	**110,565**	**$303,617**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**35,821**
Tons Sequestered **(Annually)**:	**279**

Stormwater Management

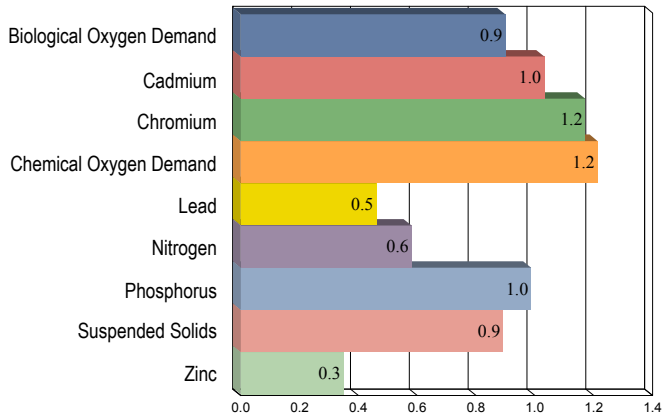
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	89
Curve Number of replacement land cover:	89
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**1,462,405**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$4,387,216**
Annual Stormwater Value:	**$382,497**

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



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City of Las Vegas

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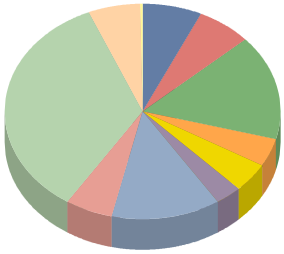
Analysis Report

for

LAS VEGAS WITHIN PROJECT



Tree Canopy: 8,275.8 acres (12.9%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	4,439.7	6.9%
Impervious Surfaces: Paved	4,161.3	6.5%
Impervious Surfaces: Paved: Drain to sewer	10,171.6	15.9%
Impervious Surfaces: Unpaved: Dirt	2,554.1	4.0%
Open Space - Grass/Scattered Trees	2,959.2	4.6%
Open Space - Grass/Scattered Trees: Grass cover > 75%	1,889.8	2.9%
Trees: Grass/turf understory: Ground cover > 75%	8,275.8	12.9%
Urban: Commercial/Business	3,478.4	5.4%
Urban: Residential	22,194.6	34.6%
Urban: Western Desert	3,893.4	6.1%
Water Area	125.7	0.2%
Total:	64,143.6	100.0%

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	66,394	32,584
Ozone:	317,215	$1,120,736
Nitrogen Dioxide:	169,673	$599,463
Particulate Matter:	531,150	$1,252,903
Sulfur Dioxide:	14,754	$12,733
Totals:	**1,099,186**	**3,018,420**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**356,118**
Tons Sequestered **(Annually)**:	**2,772**

Analysis Report

for

LAS VEGAS WITHIN PROJECT

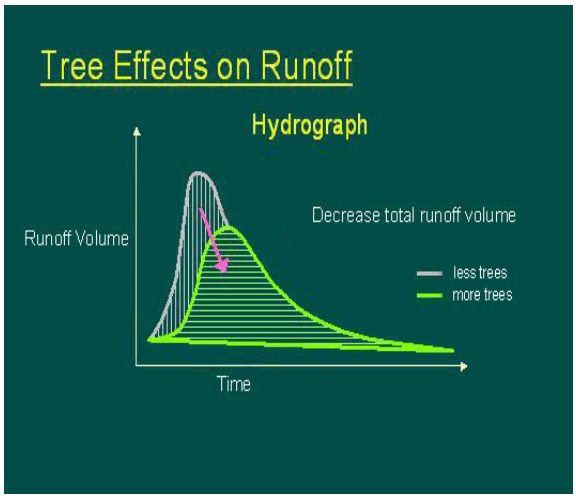
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

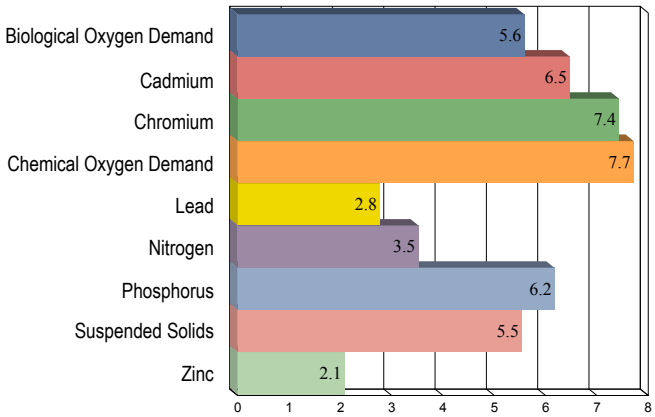
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	86
Curve Number of replacement land cover:	88
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**14,657,366**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$43,972,097**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$3,833,688**



Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

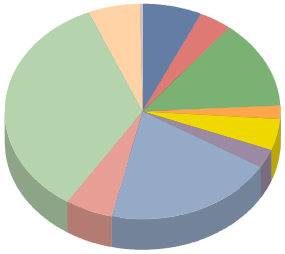
Percent change in contaminant loadings



Analysis Report

for

LAS VEGAS WITHIN PROJECT: increase 20% canopy



Tree Canopy: 12,828.7 acres (20.0%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	4,425.9	6.9%
Impervious Surfaces: Paved	2,565.7	4.0%
Impervious Surfaces: Paved: Drain to sewer	8,531.1	13.3%
Impervious Surfaces: Unpaved: Dirt	1,282.9	2.0%
Open Space - Grass/Scattered Trees	2,950.6	4.6%
Open Space - Grass/Scattered Trees: Grass cover > 75%	1,860.2	2.9%
Trees: Grass/turf understory: Ground cover > 75%	12,828.7	20.0%
Urban: Commercial/Business	3,463.8	5.4%
Urban: Residential	22,193.7	34.6%
Urban: Western Desert	3,912.8	6.1%
Urban: Western Desert: Natural Landscaping	0.0	0.0%
Water Area	128.3	0.2%
Total:	64,143.6	100.0%

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	102,921	50,511
Ozone:	491,733	$1,737,317
Nitrogen Dioxide:	263,020	$929,262
Particulate Matter:	823,366	$1,942,196
Sulfur Dioxide:	22,871	$19,739
Totals:	**1,703,911**	**4,679,025**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**552,039**
Tons Sequestered **(Annually)**:	**4,298**

Analysis Report

for

LAS VEGAS WITHIN PROJECT: increase 20% canopy

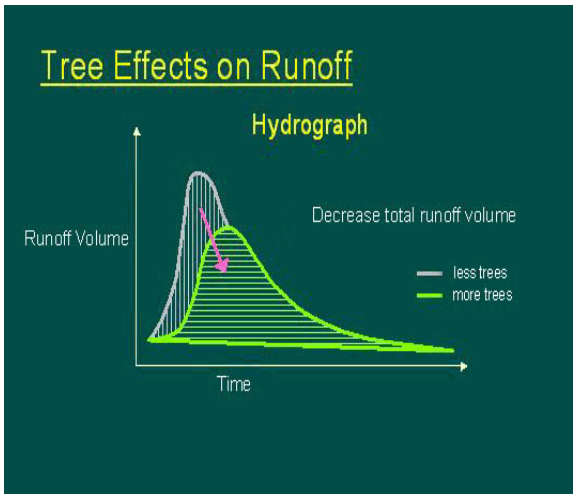
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

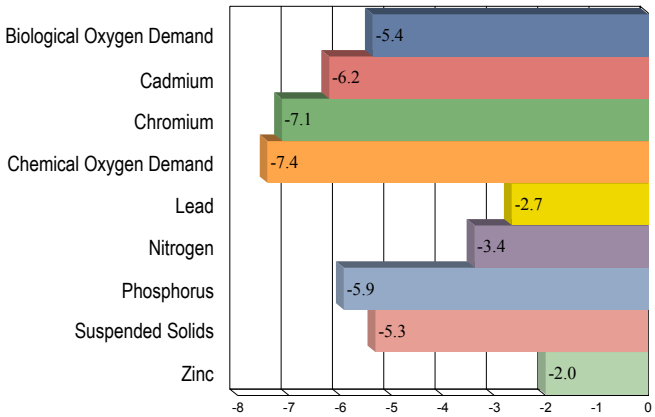
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	86
Curve Number of replacement land cover:	85
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**-12,372,890**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$-37,118,671**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$3,236,175**



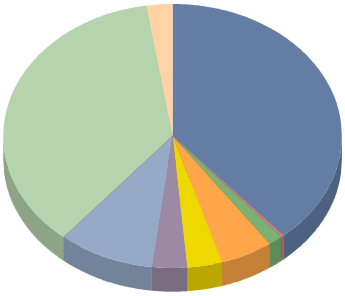
Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	3,726.6	38.7%
Impervious Surfaces: Paved	18.9	0.2%
Impervious Surfaces: Paved: Drain to sewer	124.0	1.3%
Impervious Surfaces: Unpaved: Dirt	497.0	5.2%
Open Space - Grass/Scattered Trees	321.2	3.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	320.1	3.3%
Trees: Grass/turf understory: Ground cover > 75%	874.2	9.1%
Urban: Commercial/Business	6.5	0.1%
Urban: Residential	3,512.7	36.5%
Urban: Western Desert	234.8	2.4%
Water Area	0.8	0.0%
Total:	9,636.8	100.0%

Tree Canopy: 874.2 acres (9.1%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	7,013	$3,442
Ozone:	33,508	$118,384
Nitrogen Dioxide:	17,923	$63,322
Particulate Matter:	56,106	$132,345
Sulfur Dioxide:	1,558	$1,345
Totals:	**116,108**	**$318,837**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**37,617**
Tons Sequestered **(Annually)**:	**293**

Stormwater Management

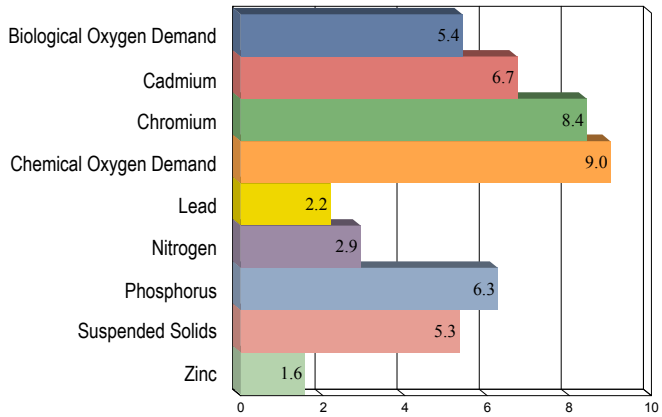
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	77
Curve Number of replacement land cover:	78
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**683,638**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$2,050,913**
Annual Stormwater Value:	**$178,808**

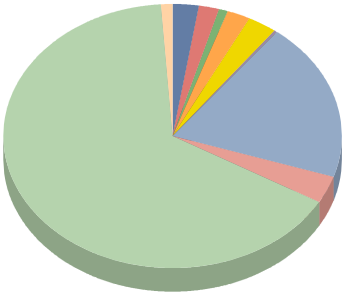
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	262.6	2.5%
Impervious Surfaces: Paved	188.4	1.8%
Impervious Surfaces: Paved: Drain to sewer	107.2	1.0%
Impervious Surfaces: Unpaved: Dirt	211.4	2.0%
Open Space - Grass/Scattered Trees	304.0	2.9%
Open Space - Grass/Scattered Trees: Grass cover > 75%	27.6	0.3%
Trees: Grass/turf understory: Ground cover > 75%	2,016.6	19.5%
Urban: Commercial/Business	345.3	3.3%
Urban: Residential	6,783.0	65.5%
Urban: Western Desert	107.4	1.0%
Water Area	0.0	0.0%
Total:	10,353.5	100.0%

Tree Canopy: 2,016.6 acres (19.5%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	16,179	$7,940
Ozone:	77,299	$273,100
Nitrogen Dioxide:	41,346	$146,077
Particulate Matter:	129,430	$305,307
Sulfur Dioxide:	3,595	$3,103
Totals:	**267,849**	**$735,527**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**86,779**
Tons Sequestered **(Annually)**:	**676**

Stormwater Management

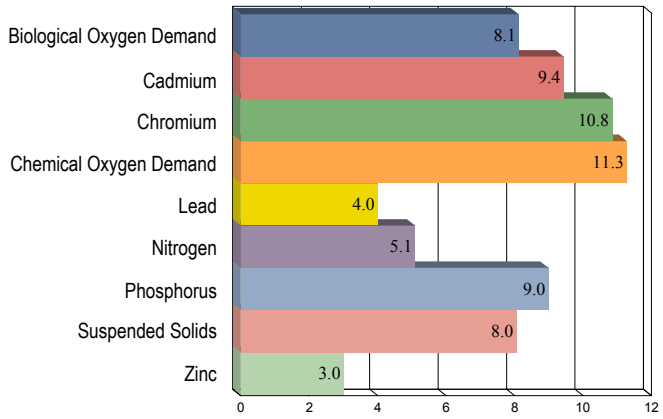
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	86
Curve Number of replacement land cover:	88
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**3,381,425**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$10,144,276**
Annual Stormwater Value:	**$884,424**

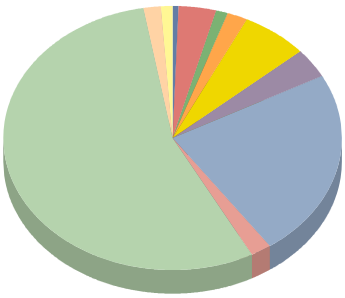
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	42.2	0.6%
Impervious Surfaces: Paved	235.4	3.5%
Impervious Surfaces: Paved: Drain to sewer	75.0	1.1%
Impervious Surfaces: Unpaved: Dirt	132.5	2.0%
Open Space - Grass/Scattered Trees	439.7	6.5%
Open Space - Grass/Scattered Trees: Grass cover > 75%	233.5	3.5%
Trees: Grass/turf understory: Ground cover > 75%	1,549.7	23.0%
Urban: Commercial/Business	123.0	1.8%
Urban: Residential	3,707.3	55.1%
Urban: Western Desert	117.2	1.7%
Water Area	70.1	1.0%
Total:	6,725.6	100.0%

Tree Canopy: 1,549.7 acres (23.0%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	12,433	$6,102
Ozone:	59,402	$209,871
Nitrogen Dioxide:	31,773	$112,257
Particulate Matter:	99,464	$234,621
Sulfur Dioxide:	2,763	$2,384
Totals:	**205,836**	**$565,235**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**66,687**
Tons Sequestered **(Annually)**:	**519**

Stormwater Management

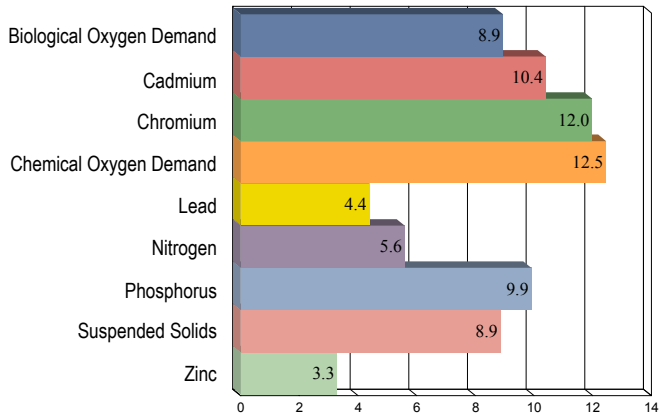
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	86
Curve Number of replacement land cover:	88
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**2,377,111**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$7,131,333**
Annual Stormwater Value:	**$621,742**

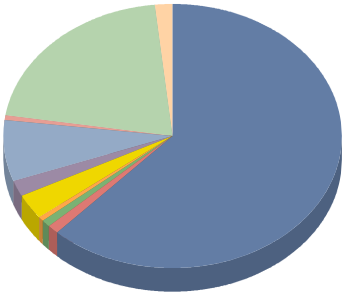
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	2,553.7	62.0%
Impervious Surfaces: Paved	43.4	1.1%
Impervious Surfaces: Paved: Drain to sewer	29.7	0.7%
Impervious Surfaces: Unpaved: Dirt	24.1	0.6%
Open Space - Grass/Scattered Trees	129.2	3.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	80.7	2.0%
Trees: Grass/turf understory: Ground cover > 75%	311.4	7.6%
Urban: Commercial/Business	14.9	0.4%
Urban: Residential	859.5	20.9%
Urban: Western Desert	66.6	1.6%
Water Area	3.2	0.1%
Total:	4,116.3	100.0%

Tree Canopy: 311.4 acres (7.6%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	2,498	$1,226
Ozone:	11,936	$42,171
Nitrogen Dioxide:	6,384	$22,557
Particulate Matter:	19,986	$47,144
Sulfur Dioxide:	555	$479
Totals:	**41,360**	**$113,577**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**13,400**
Tons Sequestered **(Annually)**:	**104**

Stormwater Management

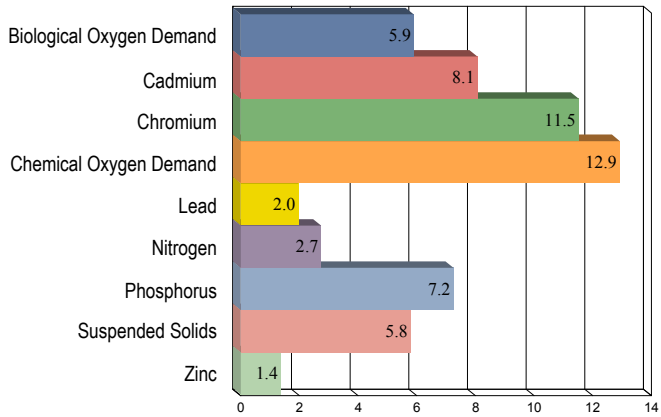
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	72
Curve Number of replacement land cover:	73
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**137,887**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$413,660**
Annual Stormwater Value:	**$36,065**

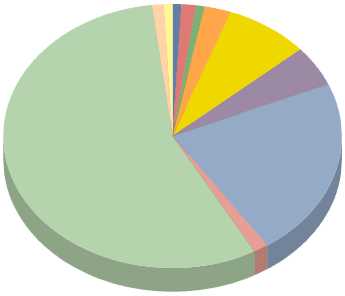
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	38.3	0.7%
Impervious Surfaces: Paved	74.5	1.4%
Impervious Surfaces: Paved: Drain to sewer	57.9	1.1%
Impervious Surfaces: Unpaved: Dirt	121.8	2.3%
Open Space - Grass/Scattered Trees	438.1	8.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	278.2	5.2%
Trees: Grass/turf understory: Ground cover > 75%	1,177.6	21.9%
Urban: Commercial/Business	72.6	1.3%
Urban: Residential	3,020.4	56.1%
Urban: Western Desert	60.6	1.1%
Water Area	40.5	0.8%
Total:	5,380.6	100.0%

Tree Canopy: 1,177.6 acres (21.9%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	9,448	$4,637
Ozone:	45,140	$159,480
Nitrogen Dioxide:	24,144	$85,304
Particulate Matter:	75,583	$178,288
Sulfur Dioxide:	2,100	$1,812
Totals:	**156,414**	**$429,520**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**50,676**
Tons Sequestered **(Annually)**:	**395**

Stormwater Management

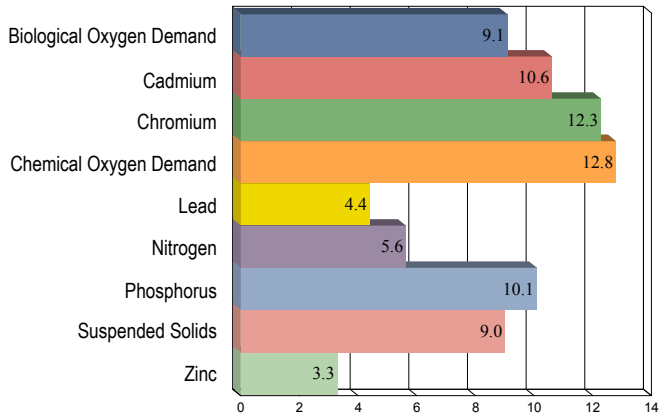
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	85
Curve Number of replacement land cover:	88
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**1,783,951**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$5,351,852**
Annual Stormwater Value:	**$466,599**

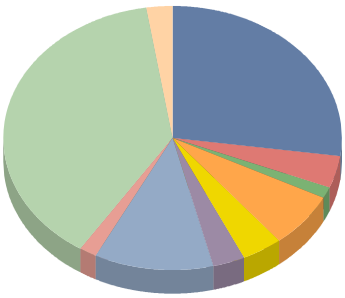
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	636.5	27.3%
Impervious Surfaces: Paved	91.5	3.9%
Impervious Surfaces: Paved: Drain to sewer	32.6	1.4%
Impervious Surfaces: Unpaved: Dirt	153.8	6.6%
Open Space - Grass/Scattered Trees	86.6	3.7%
Open Space - Grass/Scattered Trees: Grass cover > 75%	70.6	3.0%
Trees: Grass/turf understory: Ground cover > 75%	267.1	11.5%
Urban: Commercial/Business	43.2	1.9%
Urban: Residential	889.3	38.2%
Urban: Western Desert	59.5	2.6%
Water Area	0.0	0.0%
Total:	2,330.8	100.0%

Tree Canopy: 267.1 acres (11.5%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	2,143	$1,052
Ozone:	10,239	$36,175
Nitrogen Dioxide:	5,477	$19,349
Particulate Matter:	17,144	$40,441
Sulfur Dioxide:	476	$411
Totals:	**35,480**	**$97,429**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**11,495**
Tons Sequestered **(Annually)**:	**89**

Stormwater Management

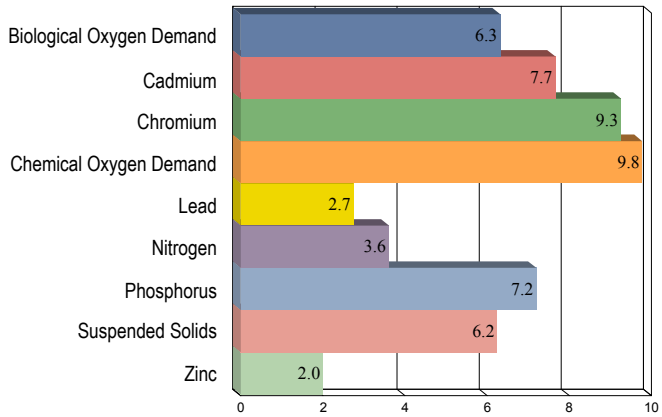
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	80
Curve Number of replacement land cover:	81
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**278,461**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$835,383**
Annual Stormwater Value:	**$72,833**

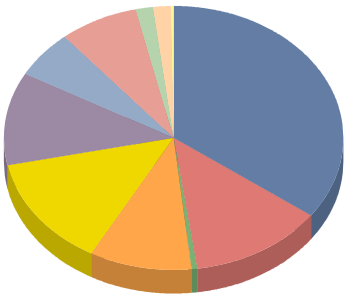
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Public Use-Facilities



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	2,371.3	34.9%
Impervious Surfaces: Paved	868.3	12.8%
Impervious Surfaces: Paved: Drain to sewer	45.3	0.7%
Impervious Surfaces: Unpaved: Dirt	649.7	9.6%
Open Space - Grass/Scattered Trees	935.9	13.8%
Open Space - Grass/Scattered Trees: Grass cover > 75%	765.8	11.3%
Trees: Grass/turf understory: Ground cover > 75%	392.2	5.8%
Urban: Commercial/Business	515.9	7.6%
Urban: Residential	118.8	1.8%
Urban: Western Desert	112.1	1.7%
Water Area	11.1	0.2%
Total:	6,786.5	100.0%

Tree Canopy: 392.2 acres (5.8%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	3,147	$1,544
Ozone:	15,034	$53,114
Nitrogen Dioxide:	8,041	$28,410
Particulate Matter:	25,173	$59,378
Sulfur Dioxide:	699	$603
Totals:	**52,093**	**$143,050**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**16,877**
Tons Sequestered **(Annually)**:	**131**

Stormwater Management

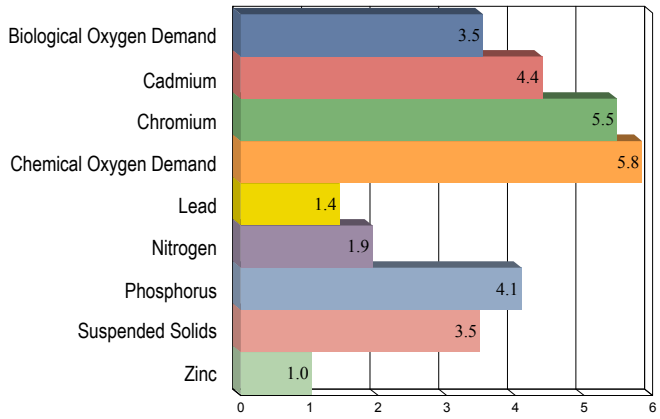
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	77
Curve Number of replacement land cover:	78
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**319,121**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$957,362**
Annual Stormwater Value:	**$83,467**

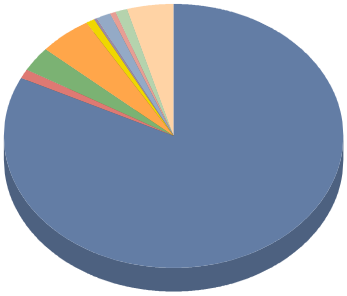
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Open Land



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	2,242.1	82.3%
Impervious Surfaces: Paved	30.6	1.1%
Impervious Surfaces: Paved: Drain to sewer	84.6	3.1%
Impervious Surfaces: Unpaved: Dirt	136.0	5.0%
Open Space - Grass/Scattered Trees	21.4	0.8%
Open Space - Grass/Scattered Trees: Grass cover > 75%	9.3	0.3%
Trees: Grass/turf understory: Ground cover > 75%	33.1	1.2%
Urban: Commercial/Business	17.2	0.6%
Urban: Residential	31.2	1.1%
Urban: Western Desert	119.8	4.4%
Water Area	0.0	0.0%
Total:	2,725.3	100.0%

Tree Canopy: 33.1 acres (1.2%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	265	$130
Ozone:	1,268	$4,479
Nitrogen Dioxide:	678	$2,396
Particulate Matter:	2,123	$5,007
Sulfur Dioxide:	59	$51
Totals:	**4,393**	**$12,064**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**1,423**
Tons Sequestered **(Annually)**:	**11**

Stormwater Management

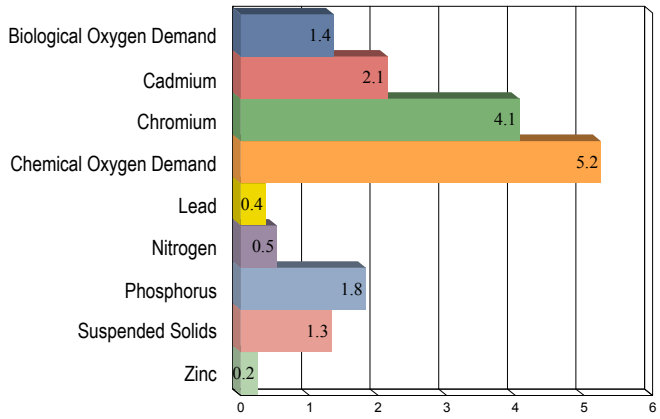
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	68
Curve Number of replacement land cover:	68
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**8,429**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$25,286**
Annual Stormwater Value:	**$2,205**

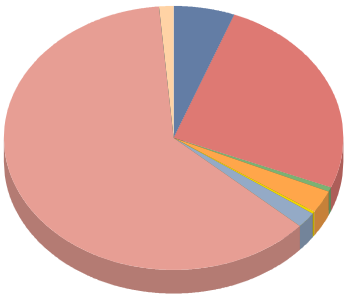
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Industrial



Tree Canopy: 15.0 acres (2.1%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	41.3	5.7%
Impervious Surfaces: Paved	183.3	25.4%
Impervious Surfaces: Paved: Drain to sewer	4.4	0.6%
Impervious Surfaces: Unpaved: Dirt	19.8	2.7%
Open Space - Grass/Scattered Trees	1.1	0.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	0.0	0.0%
Trees: Grass/turf understory: Ground cover > 75%	15.0	2.1%
Urban: Commercial/Business	445.5	61.8%
Urban: Residential	1.0	0.1%
Urban: Western Desert	9.7	1.3%
Water Area	0.0	0.0%
Total:	721.0	100.0%

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	120	$59
Ozone:	576	$2,034
Nitrogen Dioxide:	308	$1,088
Particulate Matter:	964	$2,273
Sulfur Dioxide:	27	$23
Totals:	**1,995**	**$5,477**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**646**
Tons Sequestered **(Annually)**:	**5**

Stormwater Management

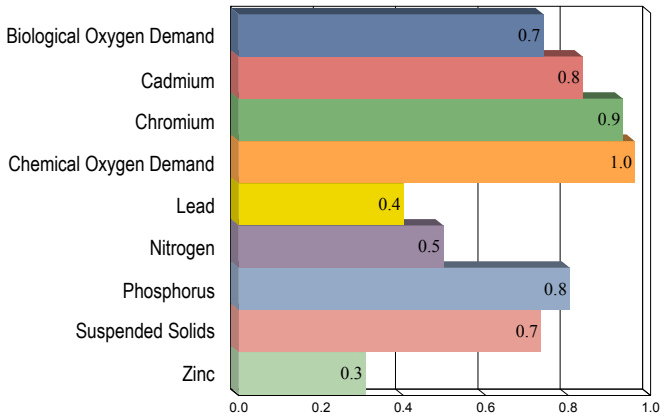
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	92
Curve Number of replacement land cover:	93
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**40,484**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$121,453**
Annual Stormwater Value:	**$10,589**

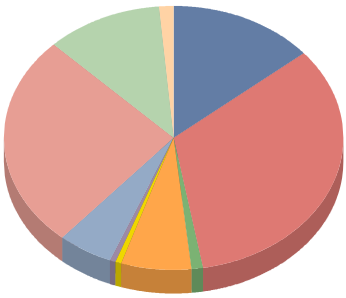
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Commercial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	995.3	13.9%
Impervious Surfaces: Paved	2,372.9	33.2%
Impervious Surfaces: Paved: Drain to sewer	79.0	1.1%
Impervious Surfaces: Unpaved: Dirt	475.4	6.7%
Open Space - Grass/Scattered Trees	48.2	0.7%
Open Space - Grass/Scattered Trees: Grass cover > 75%	32.2	0.5%
Trees: Grass/turf understory: Ground cover > 75%	375.0	5.3%
Urban: Commercial/Business	1,859.4	26.0%
Urban: Residential	796.3	11.2%
Urban: Western Desert	104.5	1.5%
Water Area	0.0	0.0%
Total:	7,138.2	100.0%

Tree Canopy: 375.0 acres (5.3%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	3,008	$1,476
Ozone:	14,373	$50,779
Nitrogen Dioxide:	7,688	$27,161
Particulate Matter:	24,066	$56,767
Sulfur Dioxide:	668	$577
Totals:	**49,803**	**$136,760**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**16,135**
Tons Sequestered **(Annually)**:	**126**

Stormwater Management

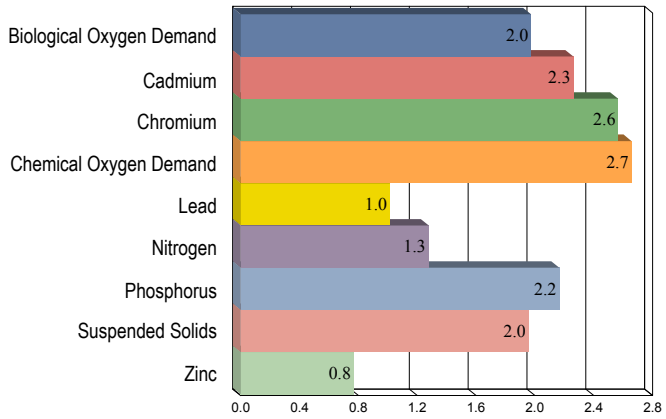
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	89
Curve Number of replacement land cover:	89
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**714,554**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$2,143,661**
Annual Stormwater Value:	**$186,894**

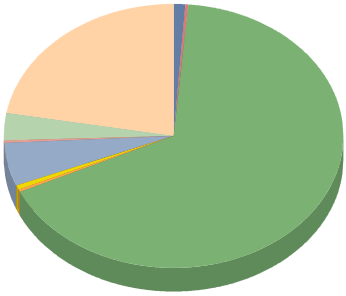
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Unclassified Zoning or ROW



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	151.8	1.1%
Impervious Surfaces: Paved	40.1	0.3%
Impervious Surfaces: Paved: Drain to sewer	9,563.2	66.6%
Impervious Surfaces: Unpaved: Dirt	75.1	0.5%
Open Space - Grass/Scattered Trees	55.5	0.4%
Open Space - Grass/Scattered Trees: Grass cover > 75%	22.5	0.2%
Trees: Grass/turf understory: Ground cover > 75%	763.2	5.3%
Urban: Commercial/Business	30.6	0.2%
Urban: Residential	452.1	3.1%
Urban: Western Desert	3,209.0	22.3%
Water Area	0.0	0.0%
Total:	14,363.2	100.0%

Tree Canopy: 763.2 acres (5.3%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	6,123	$3,005
Ozone:	29,256	$103,362
Nitrogen Dioxide:	15,648	$55,286
Particulate Matter:	48,986	$115,551
Sulfur Dioxide:	1,361	$1,174
Totals:	**101,374**	**$278,378**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**32,844**
Tons Sequestered **(Annually)**:	**256**

Stormwater Management

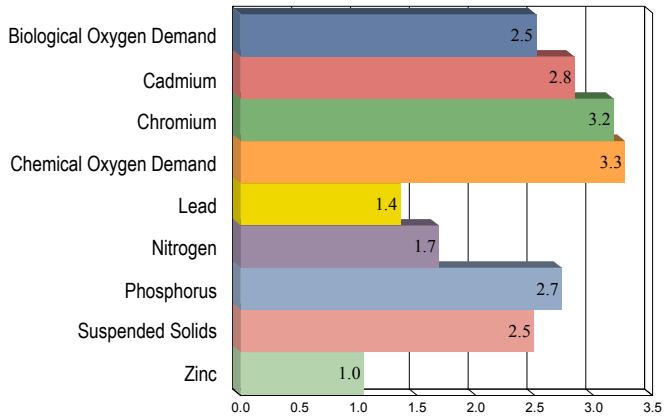
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	92
Curve Number of replacement land cover:	93
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**2,765,348**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$8,296,044**
Annual Stormwater Value:	**$723,287**

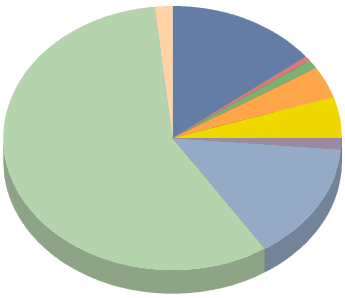
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	505.9	14.6%
Impervious Surfaces: Paved	13.8	0.4%
Impervious Surfaces: Paved: Drain to sewer	44.8	1.3%
Impervious Surfaces: Unpaved: Dirt	126.7	3.6%
Open Space - Grass/Scattered Trees	178.0	5.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	47.1	1.4%
Trees: Grass/turf understory: Ground cover > 75%	499.1	14.4%
Urban: Commercial/Business	6.4	0.2%
Urban: Residential	1,991.7	57.3%
Urban: Western Desert	60.7	1.7%
Water Area	0.0	0.0%
Total:	3,474.0	100.0%

Tree Canopy: 499.1 acres (14.4%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	4,004	$1,965
Ozone:	19,129	$67,583
Nitrogen Dioxide:	10,232	$36,149
Particulate Matter:	32,030	$75,553
Sulfur Dioxide:	890	$768
Totals:	**66,284**	**$182,019**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**21,475**
Tons Sequestered **(Annually)**:	**167**

Stormwater Management

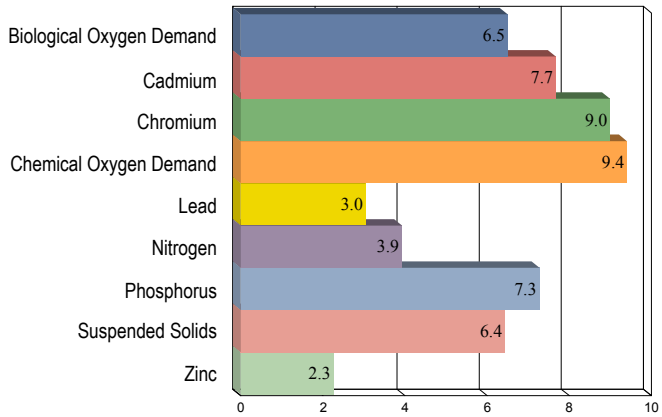
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	85
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**647,500**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$1,942,499**
Annual Stormwater Value:	**$169,356**

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



City of Henderson

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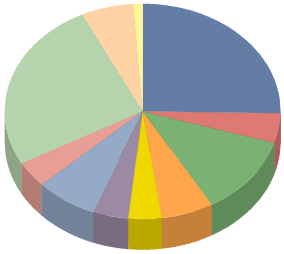
Analysis Report

for

HENDERSON WITHIN PROJECT



Tree Canopy: 3,545.1 acres (7.1%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	12,654.8	25.2%
Impervious Surfaces: Paved	2,260.6	4.5%
Impervious Surfaces: Paved: Drain to sewer	5,977.3	11.9%
Impervious Surfaces: Unpaved: Dirt	3,091.8	6.2%
Open Space - Grass/Scattered Trees	2,020.0	4.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2,060.9	4.1%
Trees: Grass/turf understory: Ground cover > 75%	3,545.1	7.1%
Urban: Commercial/Business	2,040.4	4.1%
Urban: Residential	12,881.2	25.7%
Urban: Western Desert	3,184.5	6.3%
Water Area	496.1	1.0%
Total:	50,212.6	100.0%

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	28,441	13,958
Ozone:	135,885	$480,089
Nitrogen Dioxide:	72,683	$256,792
Particulate Matter:	227,529	$536,705
Sulfur Dioxide:	6,320	$5,455
Totals:	**470,858**	**1,292,999**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**152,550**
Tons Sequestered **(Annually)**:	**1,188**

Analysis Report

for

HENDERSON WITHIN PROJECT

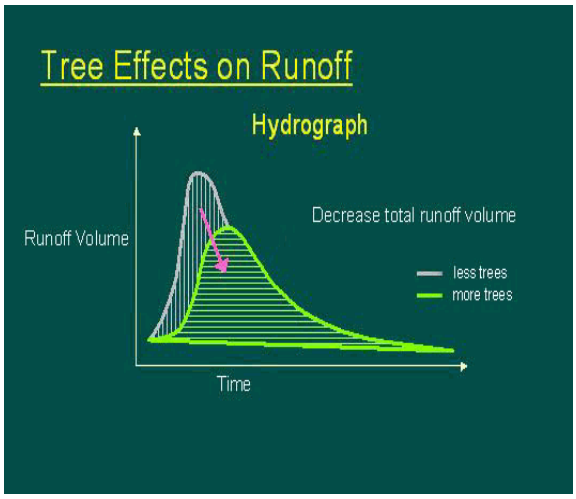
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

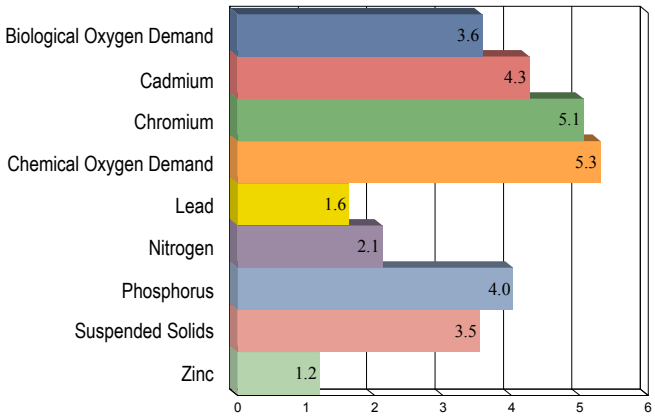
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	82
Curve Number of replacement land cover:	83
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**4,230,804**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$12,692,413**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$1,106,582**



Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

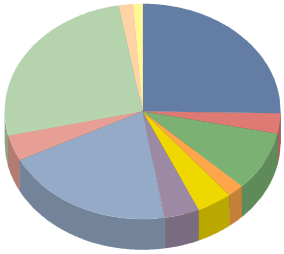
Percent change in contaminant loadings



Analysis Report

for

HENDERSON WITHIN PROJECT: 20% Canopy Increase



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	12,653.6	25.2%
Impervious Surfaces: Paved	1,506.4	3.0%
Impervious Surfaces: Paved: Drain to sewer	4,468.9	8.9%
Impervious Surfaces: Unpaved: Dirt	1,104.7	2.2%
Open Space - Grass/Scattered Trees	2,008.5	4.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2,058.7	4.1%
Trees: Grass/turf understory: Ground cover > 75%	10,042.5	20.0%
Urban: Commercial/Business	2,058.7	4.1%
Urban: Residential	12,904.6	25.7%
Urban: Western Desert	903.8	1.8%
Water Area	502.1	1.0%
Total:	50,212.6	100.0%

Tree Canopy: 10,042.5 acres (20.0%)

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use "externality" costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state's Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	80,568	39,541
Ozone:	384,936	$1,359,998
Nitrogen Dioxide:	205,896	$727,441
Particulate Matter:	644,544	$1,520,381
Sulfur Dioxide:	17,904	$15,452
Totals:	**1,333,848**	**3,662,812**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree's dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**432,144**
Tons Sequestered **(Annually)**:	**3,364**

Analysis Report

for

HENDERSON WITHIN PROJECT: 20% Canopy Increase

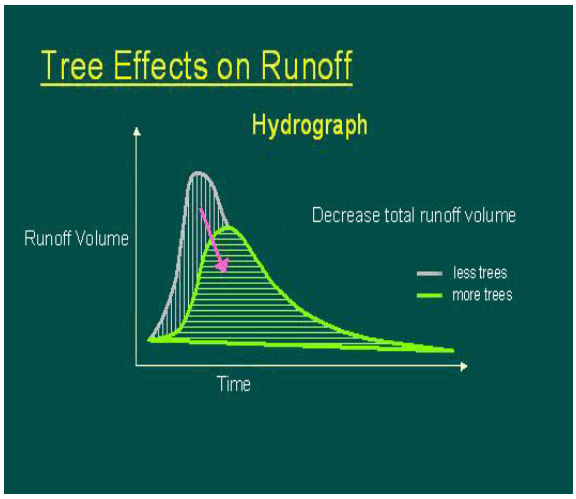
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

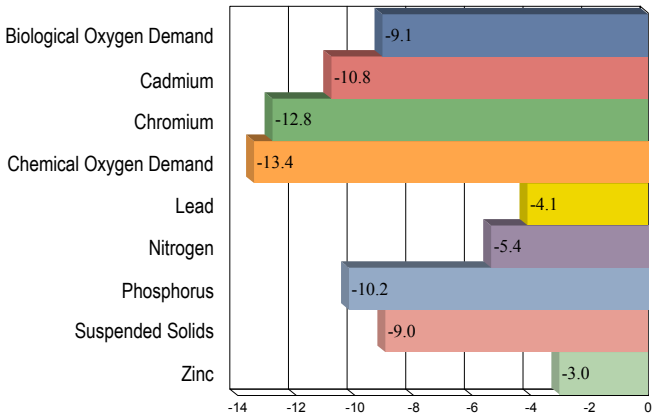
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	82
Curve Number of replacement land cover:	80
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**-9,456,584**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$-28,369,751**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$2,473,404**



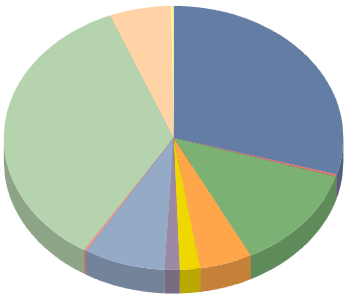
Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	10,676.0	29.5%
Impervious Surfaces: Paved	69.2	0.2%
Impervious Surfaces: Paved: Drain to sewer	4,703.3	13.0%
Impervious Surfaces: Unpaved: Dirt	1,787.1	4.9%
Open Space - Grass/Scattered Trees	655.7	1.8%
Open Space - Grass/Scattered Trees: Grass cover > 75%	530.2	1.5%
Trees: Grass/turf understory: Ground cover > 75%	2,829.7	7.8%
Urban: Commercial/Business	114.1	0.3%
Urban: Residential	12,696.5	35.0%
Urban: Western Desert	2,097.3	5.8%
Water Area	75.6	0.2%
Total:	36,234.6	100.0%

Tree Canopy: 2,829.7 acres (7.8%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	22,702	$11,141
Ozone:	108,464	$383,209
Nitrogen Dioxide:	58,016	$204,972
Particulate Matter:	181,614	$428,400
Sulfur Dioxide:	5,045	$4,354
Totals:	**375,840**	**$1,032,076**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**121,766**
Tons Sequestered **(Annually)**:	**948**

Stormwater Management

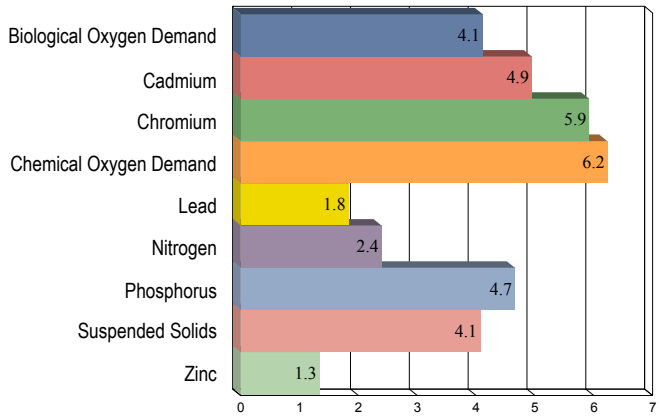
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	81
Curve Number of replacement land cover:	82
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**3,121,121**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$9,363,363**
Annual Stormwater Value:	**$816,341**

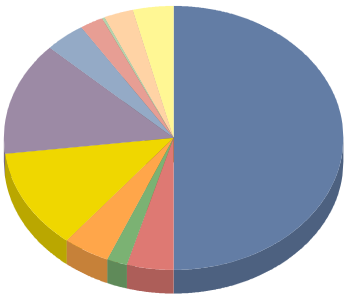
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Public Use-Facilities



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	5,318.6	49.9%
Impervious Surfaces: Paved	467.4	4.4%
Impervious Surfaces: Paved: Drain to sewer	212.1	2.0%
Impervious Surfaces: Unpaved: Dirt	491.1	4.6%
Open Space - Grass/Scattered Trees	1,307.0	12.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	1,453.2	13.6%
Trees: Grass/turf understory: Ground cover > 75%	414.0	3.9%
Urban: Commercial/Business	238.9	2.2%
Urban: Residential	46.7	0.4%
Urban: Western Desert	286.7	2.7%
Water Area	417.3	3.9%
Total:	10,653.1	100.0%

Tree Canopy: 414.0 acres (3.9%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	3,321	$1,630
Ozone:	15,868	$56,061
Nitrogen Dioxide:	8,487	$29,986
Particulate Matter:	26,569	$62,672
Sulfur Dioxide:	738	$637
Totals:	**54,983**	**$150,987**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**17,814**
Tons Sequestered **(Annually)**:	**139**

Stormwater Management

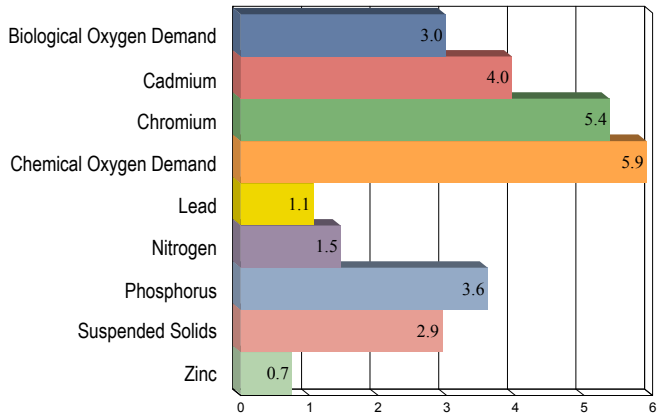
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	73
Curve Number of replacement land cover:	74
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**227,745**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$683,234**
Annual Stormwater Value:	**$59,567**

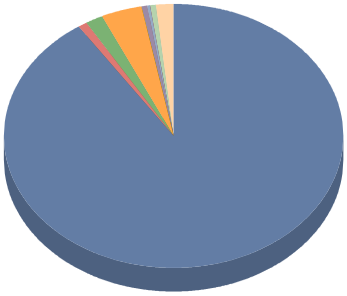
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Open Land



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	6,420.4	90.5%
Impervious Surfaces: Paved	54.0	0.8%
Impervious Surfaces: Paved: Drain to sewer	118.8	1.7%
Impervious Surfaces: Unpaved: Dirt	282.3	4.0%
Open Space - Grass/Scattered Trees	6.1	0.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	32.1	0.5%
Trees: Grass/turf understory: Ground cover > 75%	17.0	0.2%
Urban: Commercial/Business	9.1	0.1%
Urban: Residential	41.9	0.6%
Urban: Western Desert	113.1	1.6%
Water Area	0.0	0.0%
Total:	7,094.8	100.0%

Tree Canopy: 17.0 acres (0.2%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	136	$67
Ozone:	651	$2,300
Nitrogen Dioxide:	348	$1,230
Particulate Matter:	1,090	$2,572
Sulfur Dioxide:	30	$26
Totals:	**2,256**	**$6,196**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**731**
Tons Sequestered **(Annually)**:	**6**

Stormwater Management

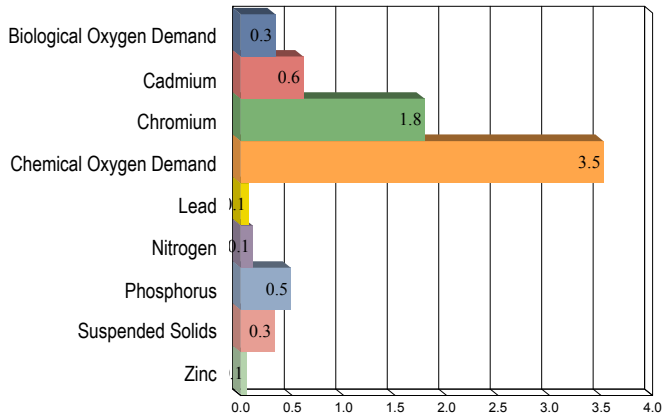
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	65
Curve Number of replacement land cover:	66
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**2,857**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$8,572**
Annual Stormwater Value:	**$747**

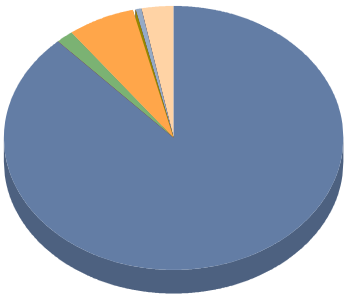
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
MISC_COH



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	3,685.4	88.1%
Impervious Surfaces: Paved	0.3	0.0%
Impervious Surfaces: Paved: Drain to sewer	64.4	1.5%
Impervious Surfaces: Unpaved: Dirt	275.9	6.6%
Open Space - Grass/Scattered Trees	4.4	0.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2.7	0.1%
Trees: Grass/turf understory: Ground cover > 75%	23.6	0.6%
Urban: Commercial/Business	0.3	0.0%
Urban: Residential	5.4	0.1%
Urban: Western Desert	122.7	2.9%
Water Area	0.2	0.0%
Total:	4,185.3	100.0%

Tree Canopy: 23.6 acres (0.6%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	189	$93
Ozone:	903	$3,192
Nitrogen Dioxide:	483	$1,707
Particulate Matter:	1,513	$3,568
Sulfur Dioxide:	42	$36
Totals:	**3,130**	**$8,596**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**1,014**
Tons Sequestered **(Annually)**:	**8**

Stormwater Management

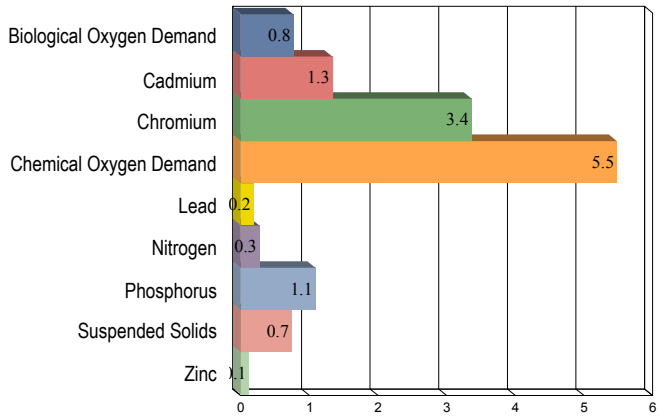
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	66
Curve Number of replacement land cover:	66
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**4,585**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$13,756**
Annual Stormwater Value:	**$1,199**

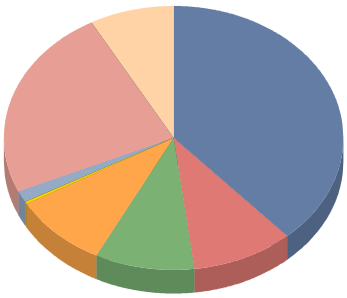
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Industrial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	1,169.0	38.3%
Impervious Surfaces: Paved	300.1	9.8%
Impervious Surfaces: Paved: Drain to sewer	287.0	9.4%
Impervious Surfaces: Unpaved: Dirt	285.3	9.3%
Open Space - Grass/Scattered Trees	4.6	0.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	1.3	0.0%
Trees: Grass/turf understory: Ground cover > 75%	43.2	1.4%
Urban: Commercial/Business	722.6	23.6%
Urban: Residential	0.6	0.0%
Urban: Western Desert	242.4	7.9%
Water Area	0.0	0.0%
Total:	3,056.1	100.0%

Tree Canopy: 43.2 acres (1.4%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	347	$170
Ozone:	1,657	$5,854
Nitrogen Dioxide:	886	$3,131
Particulate Matter:	2,774	$6,544
Sulfur Dioxide:	77	$67
Totals:	**5,741**	**$15,766**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**1,860**
Tons Sequestered **(Annually)**:	**14**

Stormwater Management

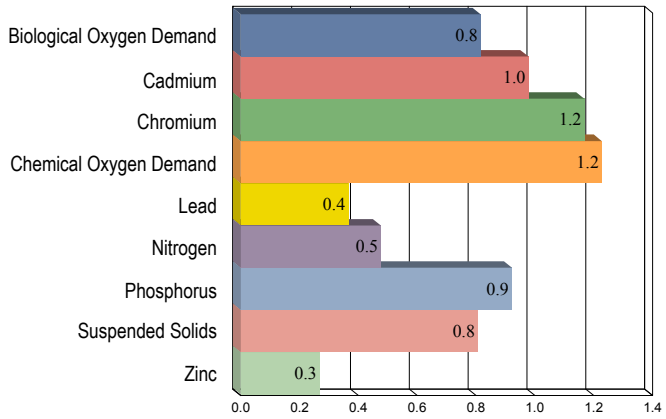
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	81
Curve Number of replacement land cover:	81
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**52,173**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$156,520**
Annual Stormwater Value:	**$13,646**

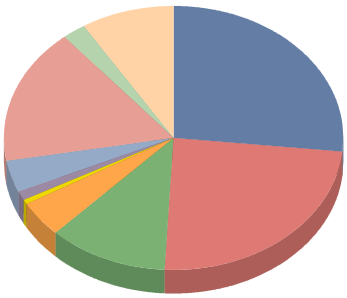
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Commercial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	1,550.2	26.6%
Impervious Surfaces: Paved	1,414.6	24.3%
Impervious Surfaces: Paved: Drain to sewer	663.1	11.4%
Impervious Surfaces: Unpaved: Dirt	253.3	4.3%
Open Space - Grass/Scattered Trees	44.0	0.8%
Open Space - Grass/Scattered Trees: Grass cover > 75%	56.4	1.0%
Trees: Grass/turf understory: Ground cover > 75%	233.2	4.0%
Urban: Commercial/Business	957.0	16.4%
Urban: Residential	130.6	2.2%
Urban: Western Desert	521.5	8.9%
Water Area	3.2	0.1%
Total:	5,827.2	100.0%

Tree Canopy: 233.2 acres (4.0%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	1,871	$918
Ozone:	8,940	$31,584
Nitrogen Dioxide:	4,782	$16,894
Particulate Matter:	14,968	$35,308
Sulfur Dioxide:	416	$359
Totals:	**30,976**	**$85,063**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**10,036**
Tons Sequestered **(Annually)**:	**78**

Stormwater Management

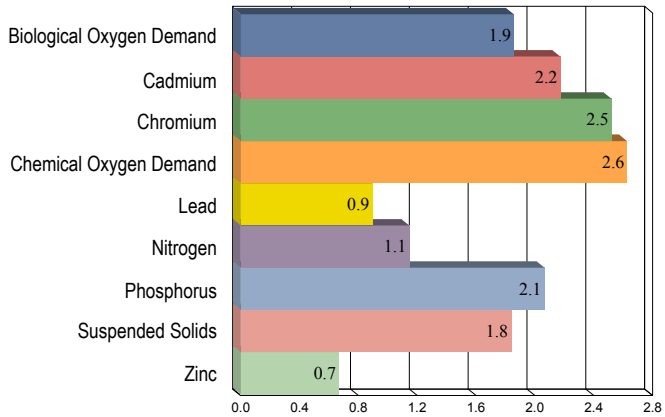
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	85
Curve Number of replacement land cover:	85
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**349,407**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$1,048,220**
Annual Stormwater Value:	**$91,389**

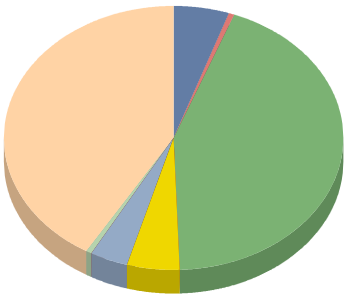
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Unclassified Zoning or ROW



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	1.5	5.2%
Impervious Surfaces: Paved	0.2	0.7%
Impervious Surfaces: Paved: Drain to sewer	12.1	43.4%
Impervious Surfaces: Unpaved: Dirt	0.0	0.1%
Open Space - Grass/Scattered Trees	1.4	4.9%
Open Space - Grass/Scattered Trees: Grass cover > 75%	0.0	0.1%
Trees: Grass/turf understory: Ground cover > 75%	1.0	3.7%
Urban: Commercial/Business	0.0	0.1%
Urban: Residential	0.1	0.5%
Urban: Western Desert	11.5	41.3%
Water Area	0.0	0.0%
Total:	27.8	100.0%

Tree Canopy: 1.0 acres (3.7%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	8	$4
Ozone:	39	$137
Nitrogen Dioxide:	21	$73
Particulate Matter:	65	$154
Sulfur Dioxide:	2	$2
Totals:	**135**	**$370**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**44**
Tons Sequestered **(Annually)**:	**0**

Stormwater Management

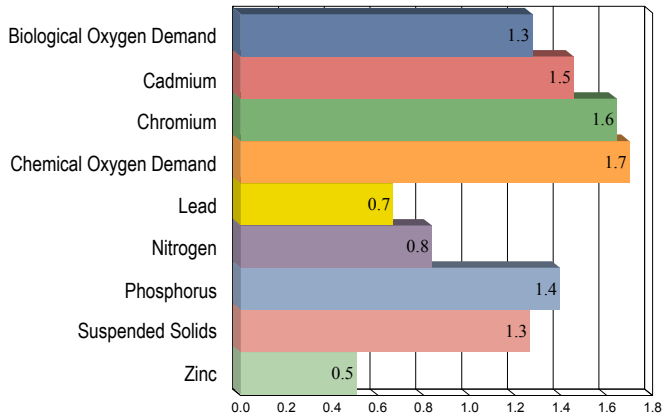
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	90
Curve Number of replacement land cover:	90
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**2,003**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$6,008**
Annual Stormwater Value:	**$524**

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



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City of North Las Vegas

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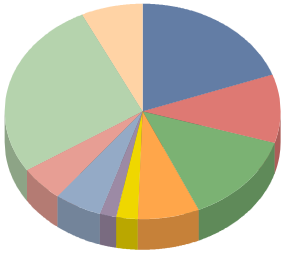
Analysis Report

for

NORTH LAS VEGAS WITHIN PROJECT



Tree Canopy: 1,685.9 acres (5.5%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	6,009.6	19.6%
Impervious Surfaces: Paved	3,097.0	10.1%
Impervious Surfaces: Paved: Drain to sewer	4,221.4	13.7%
Impervious Surfaces: Unpaved: Dirt	2,232.0	7.3%
Open Space - Grass/Scattered Trees	702.3	2.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	627.9	2.0%
Trees: Grass/turf understory: Ground cover > 75%	1,685.9	5.5%
Urban: Commercial/Business	1,627.5	5.3%
Urban: Residential	8,267.3	26.9%
Urban: Western Desert	2,231.9	7.3%
Water Area	4.2	0.0%
Total:	30,707.0	100.0%

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	13,525	6,638
Ozone:	64,620	$228,306
Nitrogen Dioxide:	34,564	$122,117
Particulate Matter:	108,201	$255,229
Sulfur Dioxide:	3,006	$2,594
Totals:	**223,916**	**614,884**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**72,545**
Tons Sequestered **(Annually)**:	**565**

Analysis Report

for

NORTH LAS VEGAS WITHIN PROJECT

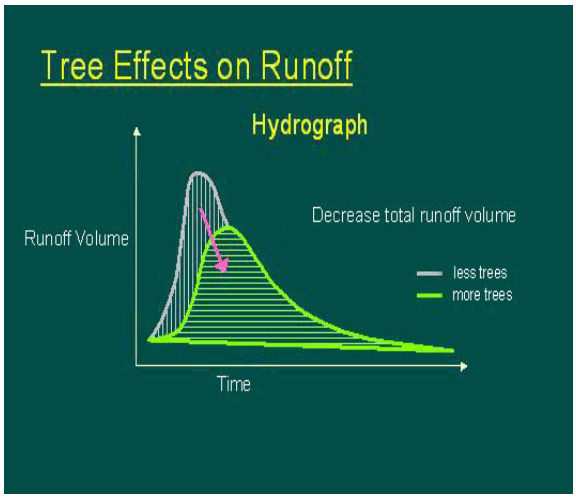
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

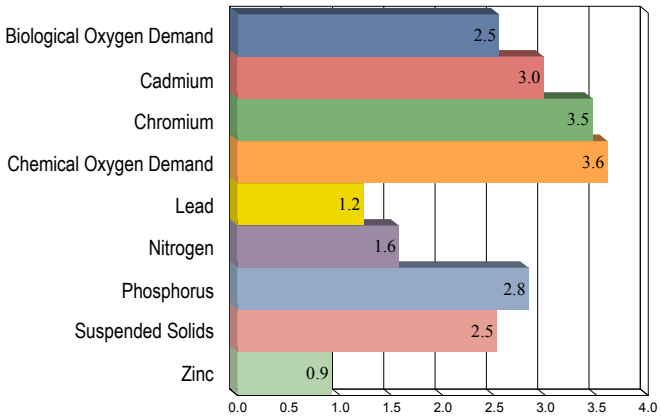
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	85
Curve Number of replacement land cover:	85
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**2,526,376**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$7,579,127**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$660,783**



Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

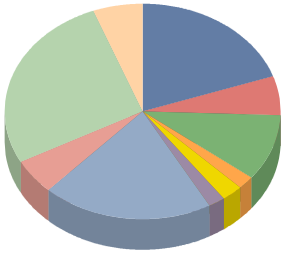
Percent change in contaminant loadings



Analysis Report

for

NORTH LAS VEGAS WITHIN PROJECT: 20% increase in canopy-north las vegas



Tree Canopy: 6,141.4 acres (20.0%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	6,018.6	19.6%
Impervious Surfaces: Paved	1,842.4	6.0%
Impervious Surfaces: Paved: Drain to sewer	3,070.7	10.0%
Impervious Surfaces: Unpaved: Dirt	614.1	2.0%
Open Space - Grass/Scattered Trees	706.3	2.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	614.1	2.0%
Trees: Grass/turf understory: Ground cover > 75%	6,141.4	20.0%
Urban: Commercial/Business	1,627.5	5.3%
Urban: Residential	8,260.2	26.9%
Urban: Western Desert	1,781.0	5.8%
Water Area	30.7	0.1%
Total:	30,707.0	100.0%

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	49,271	24,181
Ozone:	235,404	$831,694
Nitrogen Dioxide:	125,914	$444,860
Particulate Matter:	394,165	$929,774
Sulfur Dioxide:	10,949	$9,449
Totals:	**815,702**	**2,239,958**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**264,274**
Tons Sequestered **(Annually)**:	**2,057**

Analysis Report

for

NORTH LAS VEGAS WITHIN PROJECT: 20% increase in canopy-north las vegas

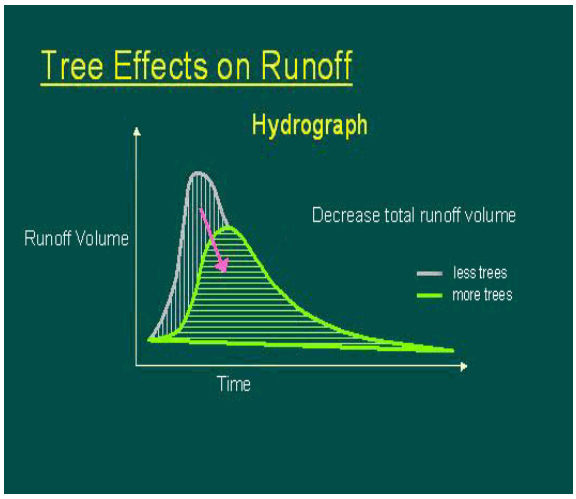
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

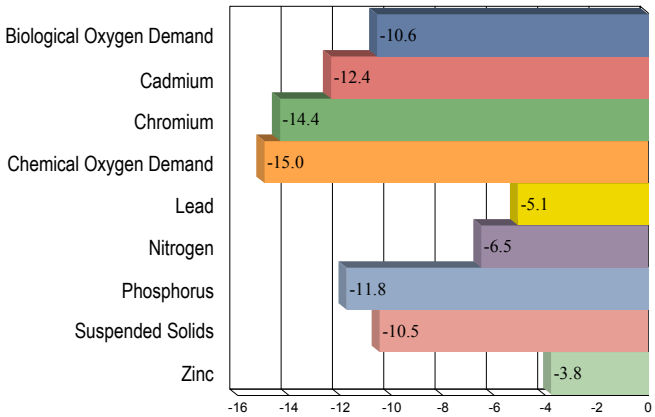
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	85
Curve Number of replacement land cover:	82
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**-9,095,035**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$-27,285,106**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$2,378,840**



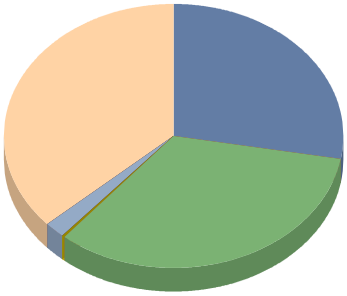
Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

Percent change in contaminant loadings



Analysis Report
for
Right of Way



Tree Canopy: 16.0 acres (2.0%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	225.8	27.8%
Impervious Surfaces: Paved	0.4	0.1%
Impervious Surfaces: Paved: Drain to sewer	270.8	33.3%
Impervious Surfaces: Unpaved: Dirt	0.4	0.1%
Open Space - Grass/Scattered Trees	0.6	0.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	0.6	0.1%
Trees: Grass/turf understory: Ground cover > 75%	16.0	2.0%
Urban: Commercial/Business	0.4	0.0%
Urban: Residential	0.5	0.1%
Urban: Western Desert	296.8	36.5%
Water Area	0.0	0.0%
Total:	812.4	100.0%

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	129	$63
Ozone:	614	$2,170
Nitrogen Dioxide:	328	$1,160
Particulate Matter:	1,028	$2,425
Sulfur Dioxide:	29	$25
Totals:	**2,128**	**$5,843**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**689**
Tons Sequestered **(Annually)**:	**5**

Stormwater Management

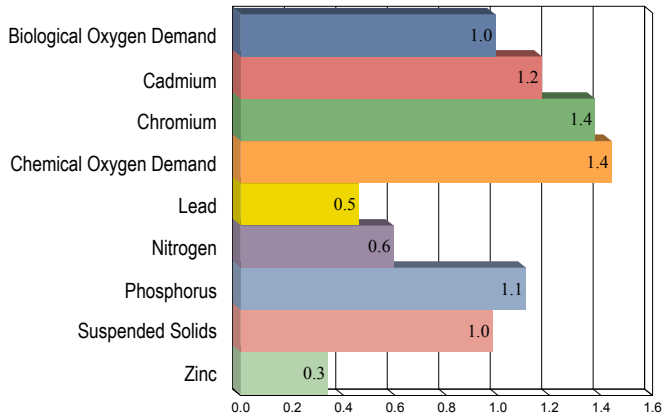
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	83
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**20,616**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$61,847**
Annual Stormwater Value:	**$5,392**

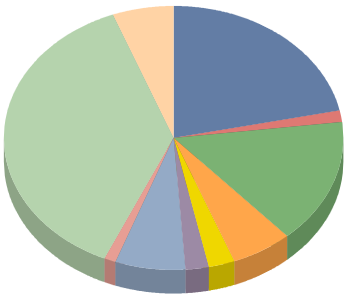
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	4,662.9	21.6%
Impervious Surfaces: Paved	335.8	1.6%
Impervious Surfaces: Paved: Drain to sewer	3,266.2	15.1%
Impervious Surfaces: Unpaved: Dirt	1,302.1	6.0%
Open Space - Grass/Scattered Trees	529.0	2.4%
Open Space - Grass/Scattered Trees: Grass cover > 75%	445.1	2.1%
Trees: Grass/turf understory: Ground cover > 75%	1,483.4	6.9%
Urban: Commercial/Business	218.6	1.0%
Urban: Residential	8,111.4	37.5%
Urban: Western Desert	1,257.8	5.8%
Water Area	1.3	0.0%
Total:	21,613.8	100.0%

Tree Canopy: 1,483.4 acres (6.9%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	11,901	$5,841
Ozone:	56,859	$200,887
Nitrogen Dioxide:	30,413	$107,451
Particulate Matter:	95,206	$224,577
Sulfur Dioxide:	2,645	$2,282
Totals:	**197,024**	**$541,038**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**63,833**
Tons Sequestered **(Annually)**:	**497**

Stormwater Management

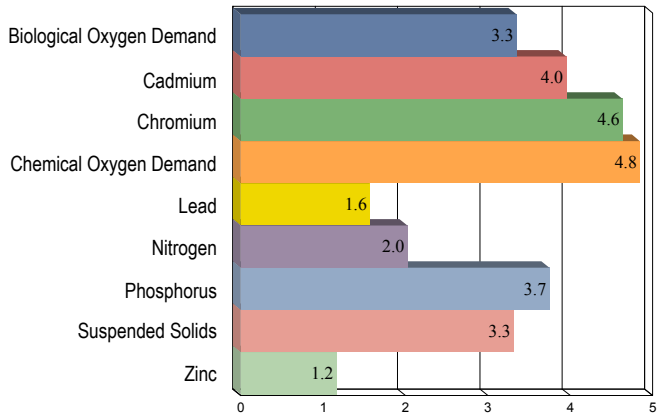
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	84
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**1,996,566**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$5,989,699**
Annual Stormwater Value:	**$522,209**

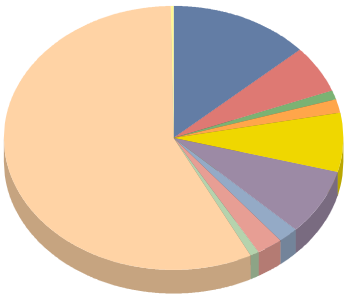
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Public Use-Facilities



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	255.3	13.3%
Impervious Surfaces: Paved	109.4	5.7%
Impervious Surfaces: Paved: Drain to sewer	21.0	1.1%
Impervious Surfaces: Unpaved: Dirt	33.8	1.8%
Open Space - Grass/Scattered Trees	140.5	7.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	155.0	8.1%
Trees: Grass/turf understory: Ground cover > 75%	35.3	1.8%
Urban: Commercial/Business	48.8	2.6%
Urban: Residential	12.9	0.7%
Urban: Western Desert	1,099.2	57.4%
Water Area	2.9	0.2%
Total:	1,914.1	100.0%

Tree Canopy: 35.3 acres (1.8%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	283	$139
Ozone:	1,353	$4,780
Nitrogen Dioxide:	724	$2,557
Particulate Matter:	2,266	$5,344
Sulfur Dioxide:	63	$54
Totals:	**4,689**	**$12,875**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**1,519**
Tons Sequestered **(Annually)**:	**12**

Stormwater Management

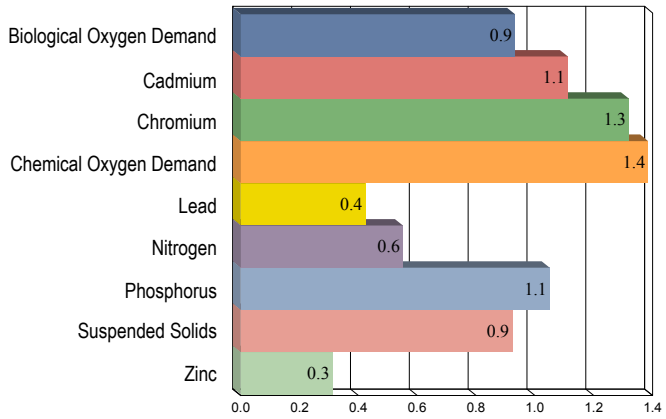
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	82
Curve Number of replacement land cover:	82
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**40,575**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$121,725**
Annual Stormwater Value:	**$10,613**

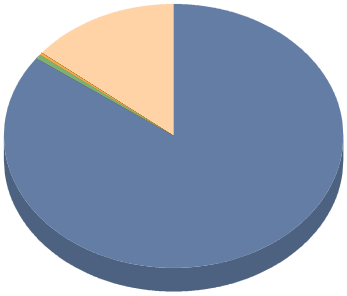
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Open Land



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	15,808.6	84.9%
Impervious Surfaces: Paved	31.3	0.2%
Impervious Surfaces: Paved: Drain to sewer	69.3	0.4%
Impervious Surfaces: Unpaved: Dirt	63.5	0.3%
Open Space - Grass/Scattered Trees	3.9	0.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	10.1	0.1%
Trees: Grass/turf understory: Ground cover > 75%	4.9	0.0%
Urban: Commercial/Business	4.0	0.0%
Urban: Residential	5.1	0.0%
Urban: Western Desert	2,612.9	14.0%
Water Area	0.0	0.0%
Total:	18,613.6	100.0%

Tree Canopy: 4.9 acres (0.0%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	39	$19
Ozone:	187	$662
Nitrogen Dioxide:	100	$354
Particulate Matter:	314	$740
Sulfur Dioxide:	9	$8
Totals:	**649**	**$1,783**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**210**
Tons Sequestered **(Annually)**:	**2**

Stormwater Management

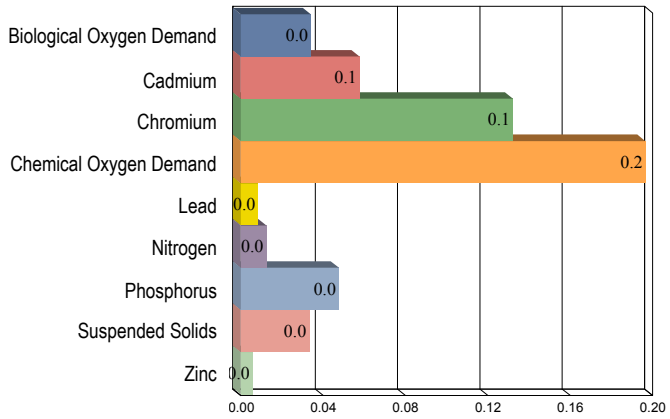
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	66
Curve Number of replacement land cover:	66
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**1,024**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$3,073**
Annual Stormwater Value:	**$268**

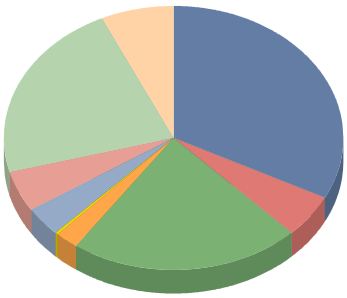
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
MISC_CNLV



Tree Canopy: 3.5 acres (3.5%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	31.7	32.5%
Impervious Surfaces: Paved	5.1	5.2%
Impervious Surfaces: Paved: Drain to sewer	21.5	22.0%
Impervious Surfaces: Unpaved: Dirt	2.1	2.2%
Open Space - Grass/Scattered Trees	0.3	0.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	0.1	0.2%
Trees: Grass/turf understory: Ground cover > 75%	3.5	3.5%
Urban: Commercial/Business	4.8	4.9%
Urban: Residential	21.9	22.4%
Urban: Western Desert	6.7	6.9%
Water Area	0.0	0.0%
Total:	97.8	100.0%

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	28	$14
Ozone:	132	$467
Nitrogen Dioxide:	71	$250
Particulate Matter:	222	$523
Sulfur Dioxide:	6	$5
Totals:	**458**	**$1,259**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**149**
Tons Sequestered **(Annually)**:	**1**

Stormwater Management

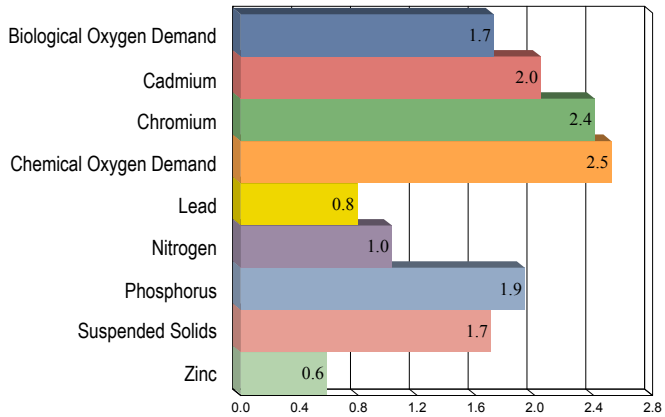
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	83
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**4,192**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$12,576**
Annual Stormwater Value:	**$1,096**

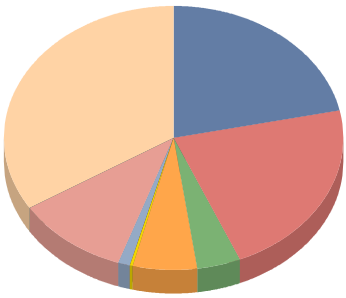
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Industrial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	2,084.1	21.7%
Impervious Surfaces: Paved	2,106.5	21.9%
Impervious Surfaces: Paved: Drain to sewer	406.8	4.2%
Impervious Surfaces: Unpaved: Dirt	576.3	6.0%
Open Space - Grass/Scattered Trees	24.5	0.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	12.7	0.1%
Trees: Grass/turf understory: Ground cover > 75%	100.3	1.0%
Urban: Commercial/Business	1,053.0	11.0%
Urban: Residential	4.0	0.0%
Urban: Western Desert	3,245.3	33.8%
Water Area	0.0	0.0%
Total:	9,613.3	100.0%

Tree Canopy: 100.3 acres (1.0%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	805	$395
Ozone:	3,844	$13,582
Nitrogen Dioxide:	2,056	$7,265
Particulate Matter:	6,437	$15,183
Sulfur Dioxide:	179	$154
Totals:	**13,321**	**$36,579**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**4,316**
Tons Sequestered **(Annually)**:	**34**

Stormwater Management

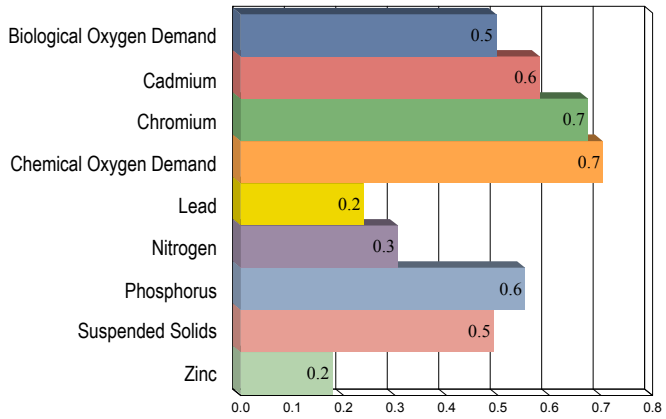
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	85
Curve Number of replacement land cover:	85
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**148,914**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$446,741**
Annual Stormwater Value:	**$38,949**

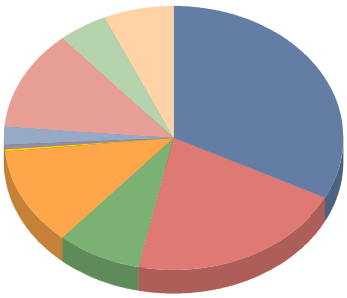
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Commercial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	791.2	32.4%
Impervious Surfaces: Paved	508.6	20.8%
Impervious Surfaces: Paved: Drain to sewer	194.6	8.0%
Impervious Surfaces: Unpaved: Dirt	295.4	12.1%
Open Space - Grass/Scattered Trees	5.1	0.2%
Open Space - Grass/Scattered Trees: Grass cover > 75%	12.6	0.5%
Trees: Grass/turf understory: Ground cover > 75%	57.2	2.3%
Urban: Commercial/Business	298.0	12.2%
Urban: Residential	111.3	4.6%
Urban: Western Desert	165.5	6.8%
Water Area	0.0	0.0%
Total:	2,439.6	100.0%

Tree Canopy: 57.2 acres (2.3%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	459	$225
Ozone:	2,193	$7,747
Nitrogen Dioxide:	1,173	$4,144
Particulate Matter:	3,671	$8,660
Sulfur Dioxide:	102	$88
Totals:	**7,598**	**$20,864**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**2,462**
Tons Sequestered **(Annually)**:	**19**

Stormwater Management

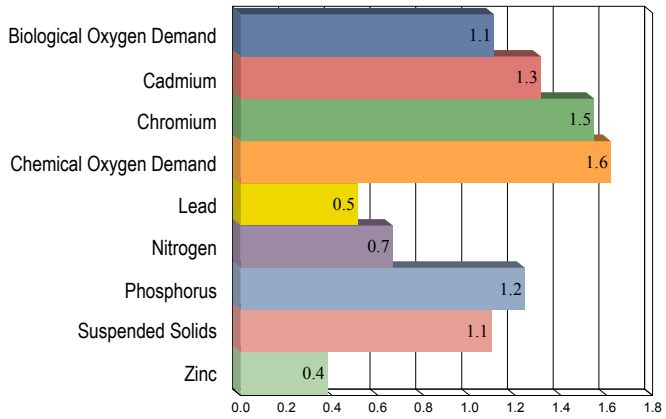
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	83
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**68,483**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$205,449**
Annual Stormwater Value:	**$17,912**

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

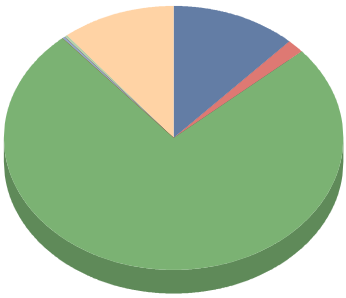
Percent change in contaminant loadings



Analysis Report

for

Unclassified Zoning or ROW



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	4.1	11.8%
Impervious Surfaces: Paved	0.6	1.7%
Impervious Surfaces: Paved: Drain to sewer	26.0	74.9%
Impervious Surfaces: Unpaved: Dirt	0.0	0.1%
Open Space - Grass/Scattered Trees	0.0	0.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	0.0	0.0%
Trees: Grass/turf understory: Ground cover > 75%	0.1	0.3%
Urban: Commercial/Business	0.0	0.1%
Urban: Residential	0.1	0.3%
Urban: Western Desert	3.7	10.7%
Water Area	0.0	0.0%
Total:	34.7	100.0%

Tree Canopy: 0.1 acres (0.3%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	1	$0
Ozone:	4	$14
Nitrogen Dioxide:	2	$7
Particulate Matter:	7	$16
Sulfur Dioxide:	0	$0
Totals:	**14**	**$37**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**4**
Tons Sequestered **(Annually)**:	**0**

Stormwater Management

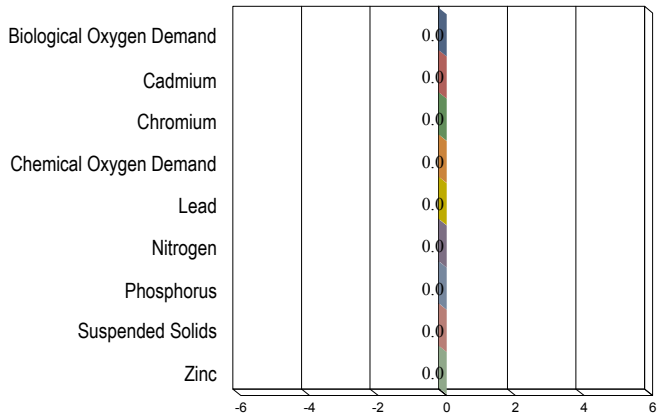
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	91
Curve Number of replacement land cover:	91
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**0**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$0**
Annual Stormwater Value:	**$0**

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Unincorporated Clark County

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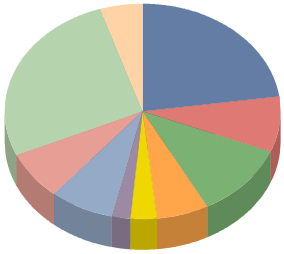
Analysis Report

for

CLARK COUNTY WITHIN PROJECT



Tree Canopy: 9,966.1 acres (7.7%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	29,337.3	22.8%
Impervious Surfaces: Paved	10,901.9	8.5%
Impervious Surfaces: Paved: Drain to sewer	14,080.6	10.9%
Impervious Surfaces: Unpaved: Dirt	7,874.0	6.1%
Open Space - Grass/Scattered Trees	3,868.1	3.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2,860.6	2.2%
Trees: Grass/turf understory: Ground cover > 75%	9,966.1	7.7%
Urban: Commercial/Business	9,129.0	7.1%
Urban: Residential	34,198.6	26.5%
Urban: Western Desert	6,499.6	5.0%
Water Area	116.1	0.1%
Total:	128,831.9	100.0%

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	79,955	39,240
Ozone:	382,006	$1,349,648
Nitrogen Dioxide:	204,329	$721,905
Particulate Matter:	639,639	$1,508,810
Sulfur Dioxide:	17,768	$15,334
Totals:	**1,323,697**	**3,634,937**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**428,856**
Tons Sequestered **(Annually)**:	**3,339**

Analysis Report

for

CLARK COUNTY WITHIN PROJECT

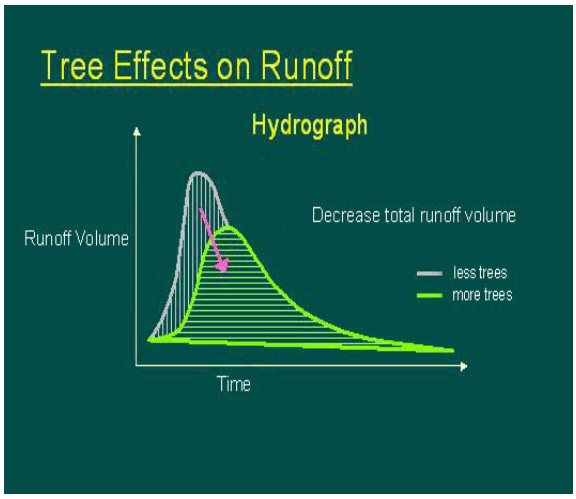
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

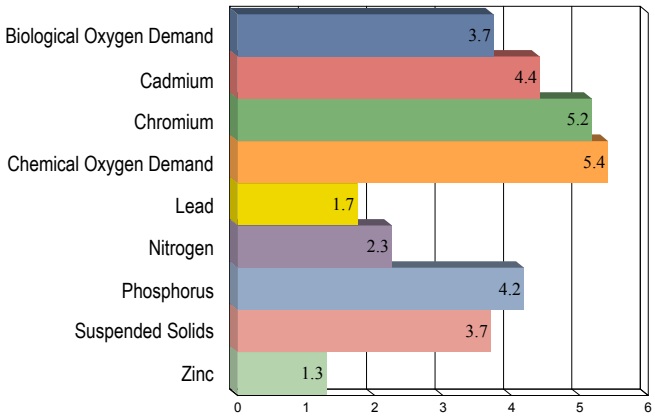
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	84
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**13,251,982**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$39,755,945**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$3,466,104**



Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

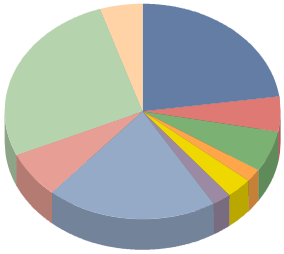
Percent change in contaminant loadings



Analysis Report

for

CLARK COUNTY WITHIN PROJECT: 20% Canopy Increase



Tree Canopy: 25,766.4 acres (20.0%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	29,373.7	22.8%
Impervious Surfaces: Paved	6,828.1	5.3%
Impervious Surfaces: Paved: Drain to sewer	7,729.9	6.0%
Impervious Surfaces: Unpaved: Dirt	2,576.6	2.0%
Open Space - Grass/Scattered Trees	3,865.0	3.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2,834.3	2.2%
Trees: Grass/turf understory: Ground cover > 75%	25,766.4	20.0%
Urban: Commercial/Business	9,147.1	7.1%
Urban: Residential	34,140.5	26.5%
Urban: Western Desert	6,441.6	5.0%
Urban: Western Desert: Natural Landscaping	0.0	0.0%
Water Area	128.8	0.1%
Total:	128,831.9	100.0%

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state’s Public Services Commission.

Nearest Air Quality Reference City: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	206,716	101,451
Ozone:	987,642	$3,489,388
Nitrogen Dioxide:	528,273	$1,866,417
Particulate Matter:	1,653,725	$3,900,887
Sulfur Dioxide:	45,937	$39,645
Totals:	**3,422,293**	**9,397,786**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree’s dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**1,108,766**
Tons Sequestered **(Annually)**:	**8,632**

Analysis Report

for

CLARK COUNTY WITHIN PROJECT: 20% Canopy Increase

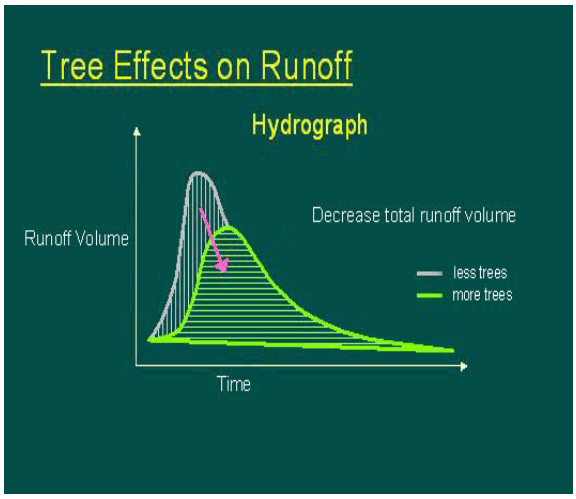
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

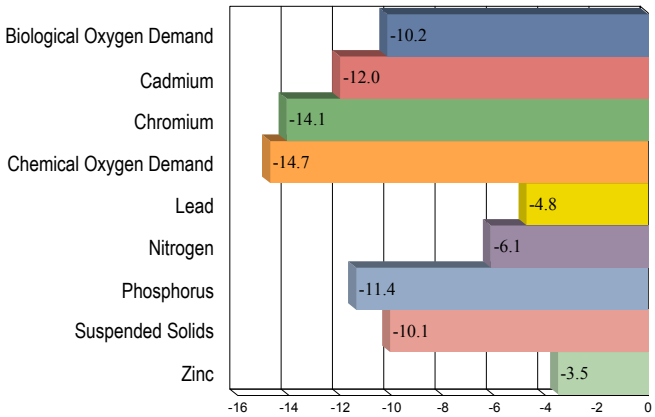
2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	80
Dominant soil type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**-31,218,664**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$-93,655,993**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$8,165,356**



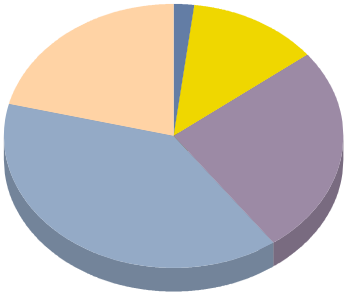
Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

Percent change in contaminant loadings



Analysis Report
for
Right of Way



Tree Canopy: 3.1 acres (38.8%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	0.2	2.0%
Impervious Surfaces: Paved	0.0	0.0%
Impervious Surfaces: Paved: Drain to sewer	0.0	0.0%
Impervious Surfaces: Unpaved: Dirt	0.0	0.0%
Open Space - Grass/Scattered Trees	1.0	12.4%
Open Space - Grass/Scattered Trees: Grass cover > 75%	2.0	25.5%
Trees: Grass/turf understory: Ground cover > 75%	3.1	38.8%
Urban: Commercial/Business	0.0	0.0%
Urban: Residential	0.0	0.0%
Urban: Western Desert	1.7	21.2%
Water Area	0.0	0.0%
Total:	7.9	100.0%

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	25	$12
Ozone:	118	$417
Nitrogen Dioxide:	63	$223
Particulate Matter:	198	$466
Sulfur Dioxide:	5	$5
Totals:	**409**	**$1,122**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**132**
Tons Sequestered **(Annually)**:	**1**

Stormwater Management

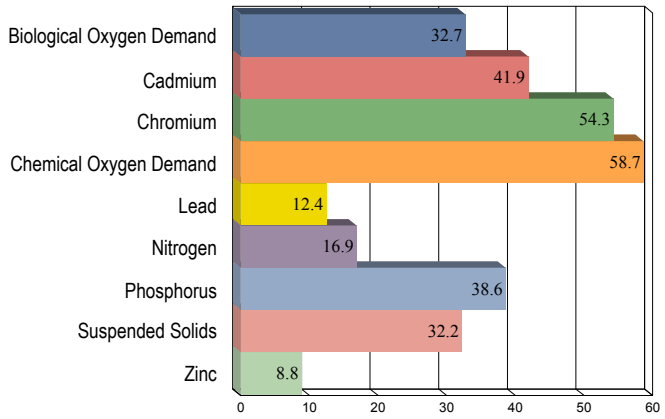
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	75
Curve Number of replacement land cover:	81
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**3,255**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$9,765**
Annual Stormwater Value:	**$851**

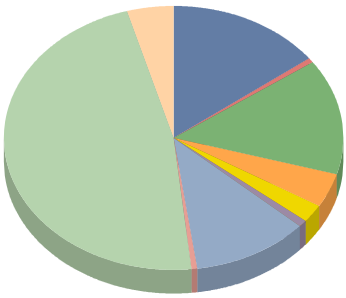
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Residential



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	9,780.5	14.8%
Impervious Surfaces: Paved	270.2	0.4%
Impervious Surfaces: Paved: Drain to sewer	9,387.3	14.2%
Impervious Surfaces: Unpaved: Dirt	2,691.7	4.1%
Open Space - Grass/Scattered Trees	1,532.1	2.3%
Open Space - Grass/Scattered Trees: Grass cover > 75%	566.4	0.9%
Trees: Grass/turf understory: Ground cover > 75%	7,363.6	11.2%
Urban: Commercial/Business	312.3	0.5%
Urban: Residential	31,234.5	47.3%
Urban: Western Desert	2,844.8	4.3%
Water Area	0.4	0.0%
Total:	65,983.6	100.0%

Tree Canopy: 7,363.6 acres (11.2%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	59,076	$28,993
Ozone:	282,250	$997,204
Nitrogen Dioxide:	150,971	$533,388
Particulate Matter:	472,605	$1,114,803
Sulfur Dioxide:	13,128	$11,330
Totals:	**978,030**	**$2,685,718**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**316,865**
Tons Sequestered **(Annually)**:	**2,467**

Stormwater Management

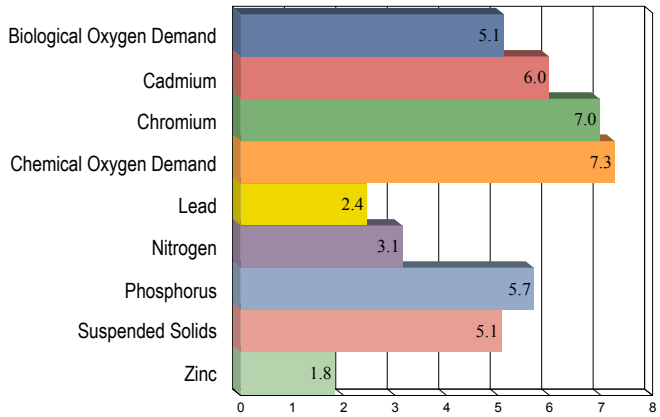
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	84
Curve Number of replacement land cover:	86
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**10,892,806**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$32,678,417**
Annual Stormwater Value:	**$2,849,053**

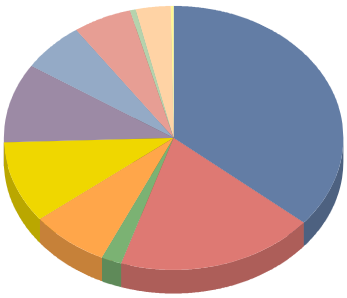
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Public Use-Facilities



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	6,582.0	36.2%
Impervious Surfaces: Paved	3,413.4	18.8%
Impervious Surfaces: Paved: Drain to sewer	357.0	2.0%
Impervious Surfaces: Unpaved: Dirt	1,373.0	7.6%
Open Space - Grass/Scattered Trees	1,819.7	10.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	1,756.3	9.7%
Trees: Grass/turf understory: Ground cover > 75%	1,116.2	6.1%
Urban: Commercial/Business	1,018.1	5.6%
Urban: Residential	91.5	0.5%
Urban: Western Desert	586.9	3.2%
Water Area	59.0	0.3%
Total:	18,173.2	100.0%

Tree Canopy: 1,116.2 acres (6.1%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	8,955	$4,395
Ozone:	42,785	$151,163
Nitrogen Dioxide:	22,885	$80,855
Particulate Matter:	71,641	$168,989
Sulfur Dioxide:	1,990	$1,717
Totals:	**148,256**	**$407,119**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**48,033**
Tons Sequestered **(Annually)**:	**374**

Stormwater Management

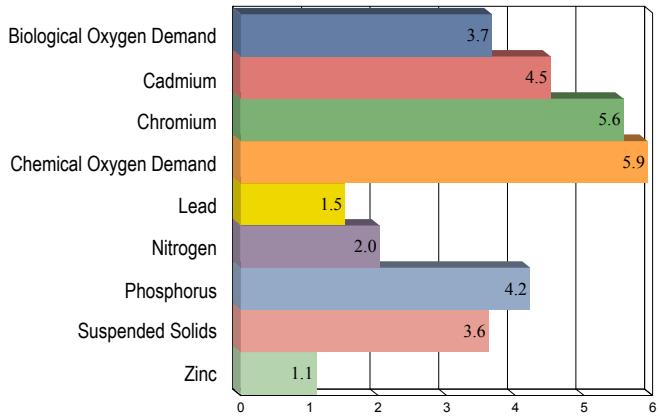
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	78
Curve Number of replacement land cover:	79
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**979,973**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$2,939,918**
Annual Stormwater Value:	**$256,315**

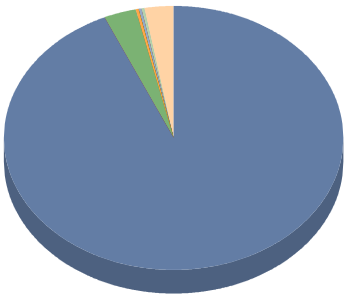
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Open Land



Tree Canopy: 2.1 acres (0.2%)

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	840.0	93.4%
Impervious Surfaces: Paved	0.0	0.0%
Impervious Surfaces: Paved: Drain to sewer	26.5	2.9%
Impervious Surfaces: Unpaved: Dirt	2.4	0.3%
Open Space - Grass/Scattered Trees	0.1	0.0%
Open Space - Grass/Scattered Trees: Grass cover > 75%	0.0	0.0%
Trees: Grass/turf understory: Ground cover > 75%	2.1	0.2%
Urban: Commercial/Business	0.0	0.0%
Urban: Residential	3.7	0.4%
Urban: Western Desert	24.3	2.7%
Water Area	0.0	0.0%
Total:	899.1	100.0%

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	17	$8
Ozone:	82	$288
Nitrogen Dioxide:	44	$154
Particulate Matter:	136	$322
Sulfur Dioxide:	4	$3
Totals:	**282**	**$776**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**91**
Tons Sequestered **(Annually)**:	**1**

Stormwater Management

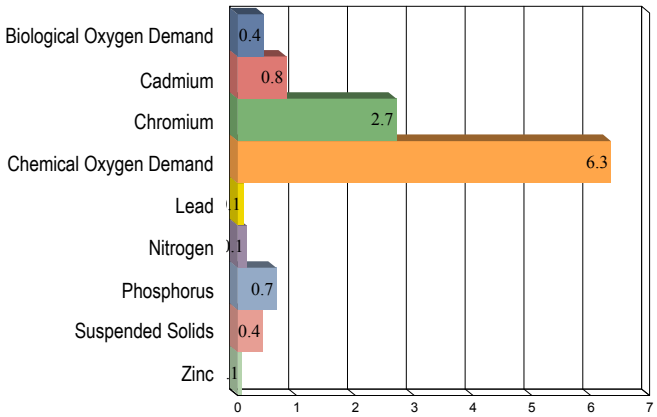
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	65
Curve Number of replacement land cover:	65
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**440**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$1,320**
Annual Stormwater Value:	**$115**

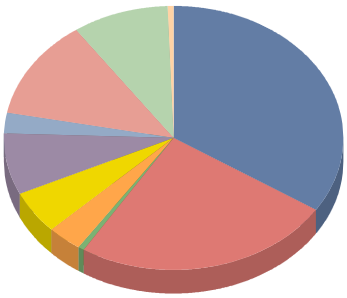
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
NELLIS AFB



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	1,600.0	34.1%
Impervious Surfaces: Paved	1,167.1	24.9%
Impervious Surfaces: Paved: Drain to sewer	27.3	0.6%
Impervious Surfaces: Unpaved: Dirt	147.8	3.1%
Open Space - Grass/Scattered Trees	245.4	5.2%
Open Space - Grass/Scattered Trees: Grass cover > 75%	361.8	7.7%
Trees: Grass/turf understory: Ground cover > 75%	110.5	2.4%
Urban: Commercial/Business	574.2	12.2%
Urban: Residential	425.2	9.1%
Urban: Western Desert	32.3	0.7%
Water Area	0.0	0.0%
Total:	4,691.5	100.0%

Tree Canopy: 110.5 acres (2.4%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	886	$435
Ozone:	4,234	$14,960
Nitrogen Dioxide:	2,265	$8,002
Particulate Matter:	7,090	$16,724
Sulfur Dioxide:	197	$170
Totals:	**14,672**	**$40,290**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**4,754**
Tons Sequestered **(Annually)**:	**37**

Stormwater Management

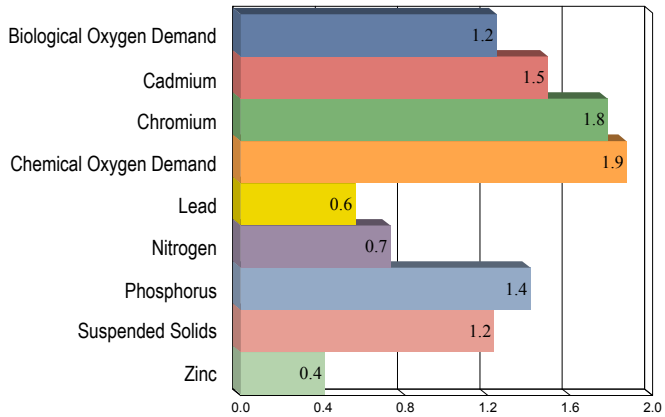
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	81
Curve Number of replacement land cover:	81
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**122,122**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$366,367**
Annual Stormwater Value:	**$31,942**

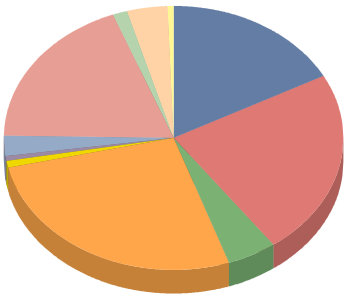
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Industrial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	1,204.7	17.3%
Impervious Surfaces: Paved	1,577.2	22.7%
Impervious Surfaces: Paved: Drain to sewer	337.4	4.8%
Impervious Surfaces: Unpaved: Dirt	1,850.9	26.6%
Open Space - Grass/Scattered Trees	62.2	0.9%
Open Space - Grass/Scattered Trees: Grass cover > 75%	37.0	0.5%
Trees: Grass/turf understory: Ground cover > 75%	167.1	2.4%
Urban: Commercial/Business	1,313.5	18.9%
Urban: Residential	101.1	1.5%
Urban: Western Desert	268.9	3.9%
Water Area	40.3	0.6%
Total:	6,960.3	100.0%

Tree Canopy: 167.1 acres (2.4%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	1,340	$658
Ozone:	6,404	$22,624
Nitrogen Dioxide:	3,425	$12,101
Particulate Matter:	10,722	$25,292
Sulfur Dioxide:	298	$257
Totals:	**22,189**	**$60,932**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**7,189**
Tons Sequestered **(Annually)**:	**56**

Stormwater Management

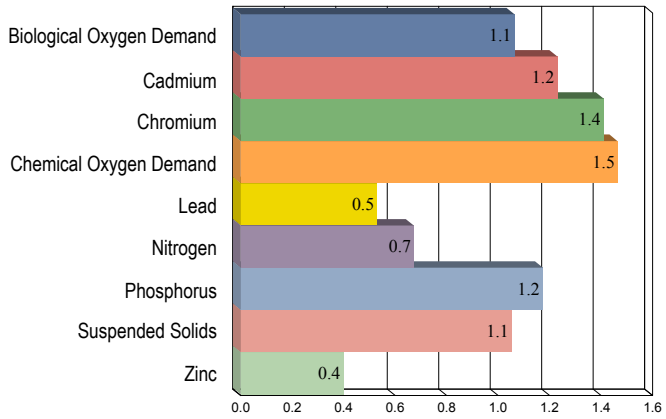
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	87
Curve Number of replacement land cover:	87
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**295,698**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$887,095**
Annual Stormwater Value:	**$77,341**

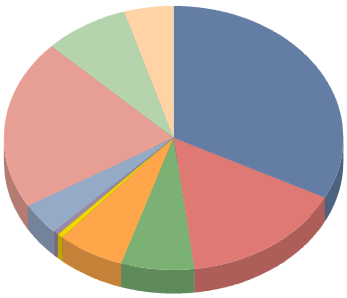
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Commercial



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	9,218.1	32.4%
Impervious Surfaces: Paved	4,464.4	15.7%
Impervious Surfaces: Paved: Drain to sewer	1,970.5	6.9%
Impervious Surfaces: Unpaved: Dirt	1,764.8	6.2%
Open Space - Grass/Scattered Trees	201.9	0.7%
Open Space - Grass/Scattered Trees: Grass cover > 75%	134.4	0.5%
Trees: Grass/turf understory: Ground cover > 75%	1,138.6	4.0%
Urban: Commercial/Business	5,901.5	20.8%
Urban: Residential	2,326.5	8.2%
Urban: Western Desert	1,292.9	4.5%
Water Area	12.9	0.0%
Total:	28,426.7	100.0%

Tree Canopy: 1,138.6 acres (4.0%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	9,135	$4,483
Ozone:	43,644	$154,197
Nitrogen Dioxide:	23,345	$82,477
Particulate Matter:	73,079	$172,381
Sulfur Dioxide:	2,030	$1,752
Totals:	**151,232**	**$415,291**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored **(Total)**:	**48,997**
Tons Sequestered **(Annually)**:	**381**

Stormwater Management

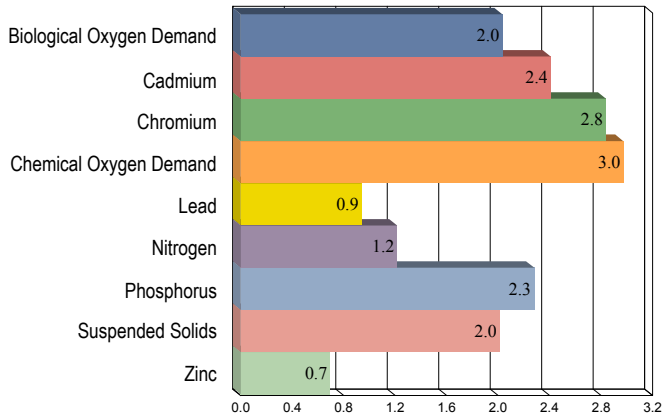
Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	83
Curve Number of replacement land cover:	83
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**1,464,359**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$4,393,077**
Annual Stormwater Value:	**$383,008**

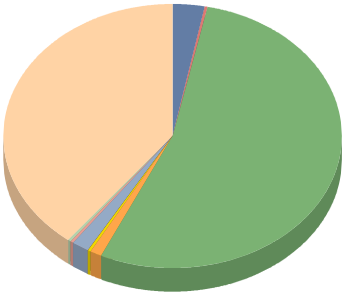
(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Analysis Report
for
Unclassified Zoning or ROW



Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	116.0	3.1%
Impervious Surfaces: Paved	10.8	0.3%
Impervious Surfaces: Paved: Drain to sewer	1,973.5	53.4%
Impervious Surfaces: Unpaved: Dirt	43.8	1.2%
Open Space - Grass/Scattered Trees	5.7	0.2%
Open Space - Grass/Scattered Trees: Grass cover > 75%	3.0	0.1%
Trees: Grass/turf understory: Ground cover > 75%	64.7	1.8%
Urban: Commercial/Business	9.4	0.3%
Urban: Residential	14.2	0.4%
Urban: Western Desert	1,449.4	39.2%
Water Area	3.4	0.1%
Total:	3,693.9	100.0%

Tree Canopy: 64.7 acres (1.8%)

Air Pollution Removal

Nearest air quality reference city: ***Phoenix***

	Lbs. Removed/yr	Dollar Value/yr.
Carbon Monoxide:	519	$255
Ozone:	2,481	$8,765
Nitrogen Dioxide:	1,327	$4,688
Particulate Matter:	4,154	$9,798
Sulfur Dioxide:	115	$100
Totals:	**8,596**	**$23,606**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

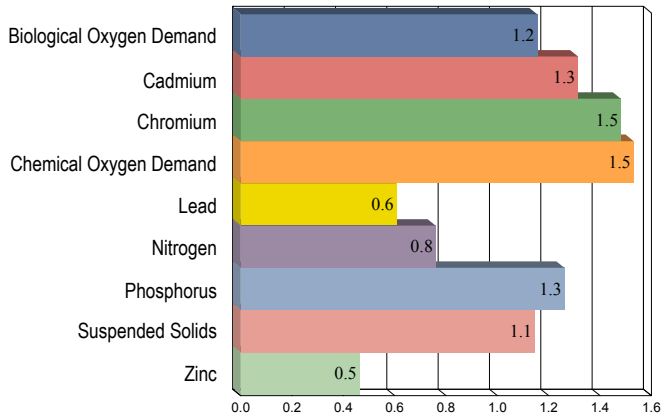
Tons Stored **(Total)**:	**2,785**
Tons Sequestered **(Annually)**:	**22**

Stormwater Management

Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	1.25
Curve Number reflecting existing conditions:	90
Curve Number of replacement land cover:	91
Dominant Soil Type: **C**	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	**254,219**
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$762,657**
Annual Stormwater Value:	**$66,492**

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings