ENVIRONMENTAL ASSESSMENT FOR A MAJOR RENEWAL AND EXTENSION OF THE BARTON SPRINGS SALAMANDER SECTION 10(A)(1)(B) PERMIT

Prepared for

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September 2013

W.O. No. 06141.043.002

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LIST OF ACRONYMS

°	degree
%	percent
$\mu g/m^3$	micrograms per cubic meter
acre-ft	acre-feet
a.m.	ante meridiem
AQCR	Air Quality Control Region
AQI	Air Quality Index
BMPs	best management practices
BP	before present
BSEACD	Barton Springs/Edwards Aquifer Conservation District
C	Celsius
C&D	construction and demolition
CAAA	Clean Air Act Amendments
CAPCOG	Capital Area Council of Governments
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalents
dB	decibels
dB(A)	"A-weighted" decibels
DO	dissolved oxygen
EA	Environmental Assessment
EOR	elemental occurrence representation
ESA	Endangered Species Act
F	Fahrenheit
FHA	Federal Highway Administration
FR	Federal Register
ft	feet
ft^2	square foot

ft^3/s	cubic feet per second
GHG	greenhouse gas
GIS	geographic information system
GWP	global warming potential
HCP	Habitat Conservation Plan
IPCC	Intergovernmental Panel on Climate Change
ITP	Incidental Take Permit
M	meter
m^3/s	cubic meter per second
N	North
NAAQS	National Ambient Air Quality Standards
NE	Northeast
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRHP	National Register of Historic Places
NO_x	nitrogen oxides
NW	Northwest
NYA	National Youth Administration
O_3	Ozone
p.m.	post meridiem
$PM_{2.5}$	particulate matter (equal to or less than 2.5 micrometers in aerodynamic diameter)
PM_{10}	particulate matter (equal to or less than 10 micrometers in aerodynamic diameter)
Ppb	parts per billion
Ppm	parts per million
Psi	pounds per square inch
SE	Southeast
SIP	State Implementation Plan
SO_x	sulfur oxides

SO_2	sulfur dioxide
SPL	sound pressure level
SW	Southwest
TCEQ	Texas Commission on Environmental Quality
THC	Texas Historical Commission
TNRIS	Texas Natural Resources Information System
TPWD	Texas Parks and Wildlife Department
tpy	tons per year
TX	Texas
TXNDD	Texas Natural Diversity Database
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCB	U.S. Census Bureau
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
US Navy	U.S. Department of Defense, Department of the Navy
VOC	volatile organic compound

1. INTRODUCTION AND NEED FOR ACTION

1.1 INTRODUCTION

This Environmental Assessment (EA) has been prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] 4321-4327) regarding the proposed issuance of an renewed Incidental Take Permit (ITP) under Section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (ESA or Act) for maintenance and operations activities proposed by the City of Austin (City) at the Barton Springs Complex in Austin, Texas.

The City has proposed a major amendment to the existing Habitat Conservation Plan (HCP) for the operations and maintenance of the Barton Springs Complex, including the recreational areas associated with the Barton Springs Pool. The existing Barton Springs HCP and permit authorize take and mitigation for the endangered Barton Springs salamander (*Eurycea sosorum*) as a result of operations and maintenance of the Barton Springs Complex. The proposed amendment adds the Austin blind salamander (*Eurycea waterlooensis*), a species recently listed as endangered with designated critical habitat under the Act (USFWS 2013a and 2013b), as a covered species in the HCP and renews the permit for an additional 20 years. The existing permit expires in October 2013. A copy of the amended HCP is located in Appendix A.

Section 9 of the Act prohibits the “take” of federally listed species and defines take as any action that “harass[es], harm[s], pursue[s], hunt[s], shoot[s], wound[s], kill[s], trap[s], capture[s], or collect[s] such a species or to attempt[s] to engage in any such conduct.” The Act defines “incidental” take as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity, and Section 10(a)(1)(B) provides for the issuance of ITPs to authorize such take. Under Section 10(a)(2)(A), any application for an ITP must include a “conservation plan” that details, among other things, the impacts of the incidental take allowed by the ITP on affected species and how the impacts of the incidental take will be minimized and mitigated.

The City has prepared an amended HCP in support of issuance of a renewed ITP for operations, restoration, and maintenance of the Barton Springs Complex. The action under consideration in this EA is therefore the proposed issuance of the renewed ITP, considered in light of the proposed implementation of the amended HCP.

The Barton Springs Complex is the only known habitat for the state and federally listed Barton Springs salamander and the federally listed endangered Austin blind salamander. Additionally the Barton Springs Complex is designated as critical habitat for the Austin blind salamander (USFWS, 2013b). The Barton Springs Pool, within the Barton Springs Complex, is a popular recreational spot operated and maintained by the City as a revenue-generating recreational area. However, maintenance and recreational activities within the complex may take salamanders, which are protected under the ESA. The City's existing United States Fish and Wildlife Service (USFWS) ITP for the incidental take of the Barton Springs salamander will expire in October 2013. The City has updated and amended the existing HCP to apply for a renewed ITP with a proposed term of 20 years from 2013 to 2033. Both the Barton Springs salamander and the Austin blind salamander are included as covered species under the proposed amendment to the HCP. The inclusion of the Austin blind salamander as a covered species under the HCP will ensure the City's ability to continue uninterrupted operations of the Barton Springs Pool while remaining compliant with the ESA for the newly listed Austin blind salamander.

In accordance with NEPA, this EA describes the potential direct, indirect, and cumulative impacts of the proposed action (issuance of a renewed ITP and approval of the proposed amendment to the HCP) and alternatives on the environment, including the impacts of this action on the two covered species. The proposed action is referred to throughout the EA as the Preferred Alternative. A non-renewal of the ITP by USFWS is referred to throughout the EA as the No Action Alternative. These alternatives are discussed in Section 2 of this EA.

1.2 PROJECT STUDY AREA AND LOCATION

The Barton Springs Complex is located within Zilker Park, a 358-acre recreational facility located in Austin, Travis County, Texas (Figure 1-1). The Barton Springs Complex is a network of four hydrologically connected, freshwater springs collectively known as Barton Springs. The plan area covered by the HCP includes a 150-ft buffer around the Barton Springs Complex. The Project Study Area, assessed in this EA, encompasses the plan area covered by the HCP, as well as an additional 100-foot (ft) buffer zone, covering approximately 36 acres of the park (Figure

1.1). The largest surface water body in the Barton Springs Complex is the Barton Springs Pool (30°15'49.76"North latitude, 97°46'13.28"West longitude), a recreational pool fed by Parthenia Springs located in the eastern center of the pool. Barton Creek flows from west to east across the Project Study Area, and the Barton Springs Pool is located within the creek's channel, though the creek does not flow through the pool itself but is instead diverted around it through a bypass culvert under the sidewalk on the north side of the pool. The upstream portion of Barton Creek to the west of the Barton Springs Pool, and Parthenia Springs, is ephemeral as it flows after significant rainfall or during periods of high groundwater levels. Barton Springs Pool discharges into the lower portion of Barton Creek to the east through gates within the downstream concrete dam.

To the west of Parthenia Springs is Upper Barton Spring, the only ephemeral spring in the complex. Upper Barton Spring is located within the bed of Barton Creek, approximately 170 meters (or 558 feet) upstream of Barton Springs Pool. The two remaining springs in the complex, Eliza Spring and Old Mill Spring, are located outside of Barton Creek, to the north and southeast of Parthenia Springs, respectively (Figure 1-1).

The rest of the Project Study Area is composed of maintained lawns, sidewalks and hiking paths, a few areas of undeveloped vegetation, and recreational facilities such as the Barton Springs Pool Bathhouse (to the north of the pool), and a portion of a baseball diamond (to the southeast of the pool). An approximate quarter mile stretch of William Barton Drive to the north of the Barton Springs Pool is also included in the Project Study Area. The boundary of the Project Study Area is confined to property owned by the City and includes areas of historical surface flow and inferred subterranean pathways among all four springs as determined by the City (COA, 2013). However, the area assessed for water quality extended outside the Project Study Area to include potential upstream and downstream impacts. The extent of the area analyzed for water quality impacts is further discussed in Subsection 3.1.

1.3 PROJECT STUDY AREA HISTORY

The Barton Springs area of Barton Creek has been a popular swimming and recreational area since the 1800s. A dam was constructed downstream of the main springs (Parthenia Springs) in the 1920s. Since that time, Barton Springs has remained a popular attraction in Central Texas.

The springs are the main discharge point for the Barton Springs segment of the Edwards Aquifer. Human activity near Barton Springs dates back at least 10,000 years. The springs have served as a source of drinking water, a flour mill, a place for religious activities, a social and family gathering location, a fishing location, and a swimming area. Anthropogenic alterations occurred most prominently in 1920 when the dam was built, followed by the bathhouse, upstream dam, a drain, and finally a bypass that was constructed in the 1970s. All projects were designed to enhance the recreational use of the springs.

Early records of the Barton Springs salamander date back to 1946. The Barton Springs salamander was listed as a federally endangered species in May 1997 (62 Federal Register [FR] 23377-23392). Critical habitat has not been designated for the Barton Springs salamander. In October 1998, the City and the USFWS published the *Final Environmental Assessment and Habitat Conservation Plan for the Issuance of a Section 10 Permit for Incidental Take of the Barton Springs Salamander (Eurycea sosorum) for the Operation and Maintenance of Barton Springs Pool and Adjacent Springs* (USFWS, 1998). The ITP was issued on 28 October 1998 and will expire in 2013. The HCP of 1998 presented details of the maintenance activities allowed within the Barton Springs Complex and provided goals for future activities associated with species conservation and maintenance of the springs. The City prepared the major amendment to the HCP in 2012, with minor changes to the maintenance activities associated with the springs, and with the addition of the Austin blind salamander as a covered species to the plan. The Austin blind salamander was listed as a federally endangered species with designated critical habitat in August 2013 (78 FR 51278-51326; 51328-51379).

1.4 PURPOSE AND NEED FOR THE ACTION

The proposed action is the issuance of a renewed ITP and approval of the proposed amendment to the HCP pursuant to Section 10(a)(1)(B) of the Act (Preferred Alternative). The HCP addresses the effect of activities associated with continued operation and maintenance of Barton Springs Complex, including the recreational areas associated with the pool, on the Barton Springs salamander and the Austin blind salamander. These activities are described in Section 4.0 of the amended HCP. The amended HCP also includes a range of conservation measures and programs designed to minimize and mitigate the effects of take on these salamander species, to monitor the biological effectiveness of the HCP over time, and to allow modification of those measures and programs if necessary. These are described in Section 6.0 of the HCP. The purpose of the action is therefore issuance of a renewed ITP to allow for take of the covered species in the course of otherwise lawful covered activities as provided for by the Act. The purpose of this EA is to evaluate the effects of the action and alternative on the environment. The EA evaluates such effects for the Preferred Alternative and a No Action Alternative.

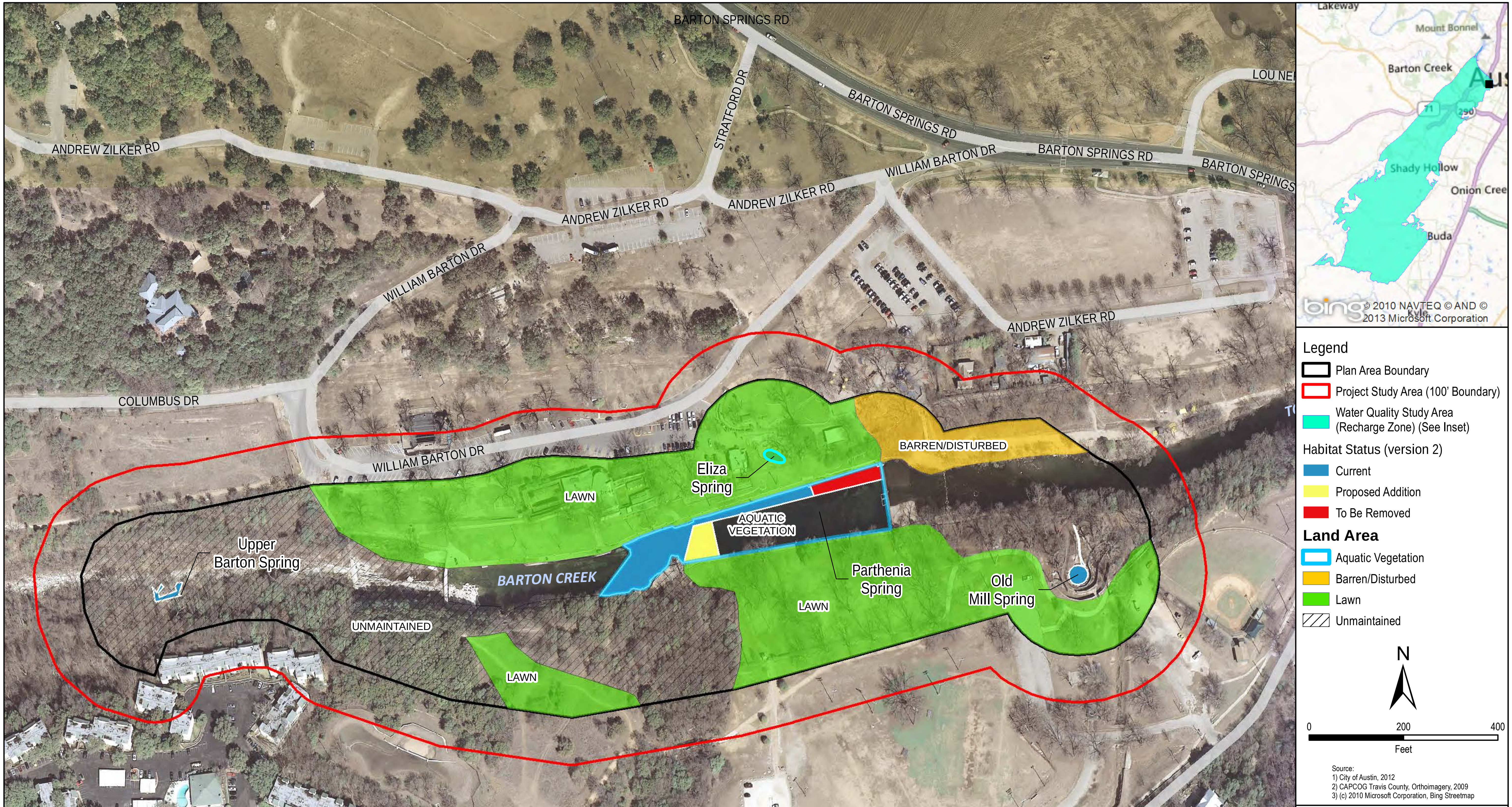

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Figure 1-1
Site Area Map
Environmental Assessment
Barton Springs Salamander
Section 10(a)(1)(B) Permit
Austin, Texas

DATE	PROJECT NO	SCALE
MAY, 2012	06141.043.002.0002	AS SHOWN

FILE: I:\GIS Project Files\06141_City of Austin\043_Barton Springs Salamander\0002_Mapping\mxd\Figure 1 site area map.mxd 9:58:10 AM 8/29/2013 perrint

2. ALTERNATIVES ANALYSIS

2.1 ALTERNATIVE 1: NO ACTION, NO NEW PERMIT

The No Action Alternative describes reasonably foreseeable conditions resulting from the USFWS not issuing a renewed ITP for operation and maintenance of the Barton Springs Pool when the current ITP expires. This alternative provides an environmental baseline against which the impacts of the Preferred Alternative can be compared. This environmental baseline would be the current and anticipated future condition of the environment without the Proposed Action or other alternative actions. Under the No Action Alternative, the City would either cease operations and maintenance responsibilities that could result in take of listed species, or the City would continue these activities without an ITP and consequently would not be afforded protection from violation under the ESA.

2.2 ALTERNATIVE 2: PREFERRED, PERMIT FOR INCIDENTAL TAKE OF BARTON SPRINGS AND AUSTIN BLIND SALAMANDERS

The Preferred Alternative includes the issuance of a renewed ITP for the Barton Springs salamander (*Eurycea sosorum*) and the Austin blind salamander (*Eurycea waterlooensis)* as described in the amended HCP. The renewed ITP would authorize the take of the Barton Springs salamander and the Austin blind salamander resulting from the implementation of the amended HCP. Under this alternative, maintenance activities under the auspices of an amended and revised HCP would continue, and the pool would stay open to the public for recreation.

The proposed amendment to the HCP includes the following operation and maintenance activities. This list includes operations and maintenance activities within the Barton Springs Pool as well as proposed infrastructure improvements to the Barton Springs Complex:

- Public use of Barton Springs Pool and Upper Barton Spring.
- Routine Cleaning: Removal of nuisance algae, excess sediment, and other natural materials from Barton Springs Pool (Parthenia Springs), Eliza Spring, Old Mill Spring, and Upper Barton Spring.
- Drawdowns of water level in Barton Springs Pool and Eliza Spring for routine cleaning.

- Drawdowns of water level in Barton Springs Pool and Eliza Spring for post-flood cleaning.
- Removal of flood-debris from Barton Springs Pool by vacuum dredging.
- Removal of spring water from Barton Springs Pool for irrigation of pool grounds and routine cleaning.
- Maintenance of manicured lawns along riparian corridor of the Barton Springs Pool, Eliza Spring, and Old Mill Spring.
- Maintenance of historic structures and anthropogenic flow regime alterations.
- Salamander habitat reconstruction.

2.3 ALTERNATIVE CONSIDERED, BUT ELIMINATED

Renewal of the Existing Permit. This alternative would have renewed the ITP and HCP for the Barton Springs salamander (*Eurycea sosorum*) only. Under this alternative, as the Austin blind salamander (*Eurycea waterlooensis*) has been listed as endangered, the City would have to avoid take of Austin blind salamander through minimization of operation and maintenance of Barton Springs Complex until an amendment to the HCP to cover take of Austin blind salamander had been completed. As regular and post-flood cleaning is critical to maintaining the Barton Springs Pool for recreational activities, use of the pool would likely be restricted until a renewed ITP could be issued.

3. AFFECTED ENVIRONMENT

This section describes the following: (1) current environmental and socioeconomic conditions within the Project Study Area, (2) resources potentially affected by the Preferred Alternative, which would authorize take as a result of the implementation of the amended HCP, and (3) the baseline information used in Section 4 to identify and evaluate potential impacts resulting from the No Action and Preferred Alternatives. This information has been provided as a baseline for the analysis of effects of the No Action and Preferred Alternatives on the environment and is intended to reduce, but not eliminate, uncertainty regarding these conditions in connection with the property. Conditions are depicted as they currently exist and in accordance with the most recent data available. Resources considered, but determined not to be affected and therefore not analyzed, include:

- Traffic – Impacts to traffic and transportation in and around Zilker Park would be considered less than negligible in comparison to existing conditions for the greater Zilker Park and Downtown Austin region. However, emission levels from transportation are discussed in Section 4.5 for Air Quality;

- Infrastructure and utilities - While the presence of infrastructure would not differ between the No Action and Preferred Alternative, infrastructure maintenance (or lack thereof) could affect City of Austin resources. This discussion is included in Section 4.12 for Socioeconomics; and

- Visual or aesthetic resources – While aesthetics of the Barton Springs Pool could differ from existing conditions under the No Action Alternative (due to debris); these impacts would be considered less than negligible as the Barton Springs Pool would be closed to the public. Under both alternatives the publically accessible areas would continue to be maintained similar to the existing conditions. Therefore, aesthetic resources would not be considered as affected. This discussion is included in Sections 4.8 and 4.9 for Land Use and Vegetative Communities, respectively.

3.1 WATER RESOURCES AND QUALITY

Water resources are sources of water available for human uses, recreation, pumping for agricultural, industrial or municipal purposes, or indirectly through environmental benefits. Water resources available within the Project Study Area include the Barton Springs Pool, Barton Creek (both above and below the pool), as well as the springs (Parthenia, Eliza, Old Mill, and Upper Barton) that make up the Barton Springs Complex. These springs are the primary discharge point for the Barton Springs segment of the Edwards Aquifer. This portion of the aquifer is primarily fed by stormwater runoff on the approximately 98-square-mile Recharge Zone and by surface runoff and stream flow entering the Recharge Zone from the approximately 254-square-mile Contributing Zone (Slade et al., 1986). The Recharge and Contributing zones generally lie to the south and southwest of the springs in Travis, Hays, and Blanco Counties.

Parthenia, Eliza, and Old Mill springs are perennial springs in contrast to Upper Barton Spring, which is ephemeral. Low flows and small storm flows from Barton Creek are diverted around the Barton Springs Pool under normal conditions by the upper dam and a bypass tunnel that discharges below the lower dam. Barton Springs Pool is formed by the lower dam and is fed by Parthenia Spring, which lies in the creek bed below the upper dam. Eliza and Old Mill springs both discharge to Barton Creek below the lower dam. Upper Barton Spring flows directly into Barton Creek above the upper dam, thus bypassing Barton Springs Pool.

The groundwater portion of this system is characterized by high rates of recharge and sometimes rapid, subterranean flows due to the porous nature of the karst material that is the primary geologic feature of the Recharge Zone (BSEACD, 2003). This karst material also allows for significant recharge to occur directly through the bed of Barton Creek and other creeks flowing over the Recharge Zone (Slade et al., 1986). Due to this hydrologic connection, all the creeks within the Recharge Zone typically function as "losing" streams where flows actually decrease downstream due to losses (recharge) to the aquifer. Conversely, during periods of high groundwater levels, increased base flow can be maintained through discharges of groundwater into Barton Creek from these geologic features.

Aquifer levels also strongly influence discharge rates at the springs (Smith and Hunt, 2004). The long-term combined average discharge is 53 cubic feet per second (cfs), while the record low discharge of 9.8 cfs was recorded during the drought of the mid-1950s. Discharge relationships among the springs are complex and dependent not only on aquifer levels, but also water levels in Barton Springs Pool (Asquith and Gary, 2005). Flow is known to cease at Eliza and Old Mill Springs during periods of drought when the Barton Springs Pool level is lowered for maintenance (USFWS, 2005). As noted above, Upper Barton Spring is ephemeral and only flows during periods of high groundwater levels. Aquifer levels are managed by the Barton

Springs/Edwards Aquifer Conservation District (BSEACD), a groundwater district that regulates pumping from the Barton Springs segment of the aquifer. This segment is designated as a sole source aquifer and provides water for approximately 60,000 people, utilizing approximately 7,800 acre-feet (acre-ft)/year through authorized pumping from 94 permit holders (Smith et al., 2007).

Flood flows are another significant feature of the hydrologic system at the Barton Springs Complex. As observed on-site, stream flows that exceed the approximate 500 cfs capacity of the bypass tunnel will overtop the upstream dam, depositing a significant amount of various-sized debris into Barton Springs Pool. Typical debris ranges from leaf litter and trash to masses of tree limbs, boulders, and items of large, dumped refuse (COA, 2010d). Overtopping typically occurs from once to several times per year. It also can lead to displacement of concrete sections from the shallow pool area as well as scouring of plants, sediment, and gravel from other portions of the Barton Springs Pool.

Several factors influence water quality in this system (Johns, 2006; Mahler et al., 2006; USFWS, 2005). More significantly, development in the recharge and contributing zones tends to increase pollutant loads in Barton Creek and at the springs. Impacts of development on water quality include not only increased pollutant loads in stormwater runoff, but also discharges and overflows from septic tanks, wastewater collection systems, and treatment plants (Herrington, 2010). These effects are somewhat mitigated by City and state regulations limiting development and requiring treatment of stormwater runoff. Sediment-laden runoff from construction sites in these zones can also reduce water quality; although, there are increased regulations regarding prevention, control, and treatment of construction runoff in these areas as well. In addition to the deposition of sediment, gravel, and large debris, flooding of the Barton Springs Pool transiently increases turbidity and pollutant loads within the pool.

3.2 SURFACE WATERS INCLUDING WETLANDS

The Barton Springs Complex is the fourth largest spring complex in the State of Texas (USGS, 2012). The surface waters within the Barton Springs Complex include three perennial springs, one ephemeral spring, and Barton Creek. The springs began flowing less than 6 million years ago in the late Miocene (COA, 2013) based on estimations on when the Colorado River first began down-cutting through the Edwards Aquifer beneath what is today South Austin. The Barton Springs Complex is the largest natural discharge point for the Barton Springs segment of the Edwards Aquifer (COA, 2013) and is the fourth largest spring system in the State of Texas (USGS, 2012).

Barton Creek is a tributary of the Colorado River that flows from west to east across Zilker Park. The upstream portion of Barton Creek is ephemeral, only flowing after significant rainfall or during periods of high groundwater levels. The creek is routed around Barton Springs Pool by a bypass system. It flows east into Lady Bird Lake (formerly Town Lake), which then feeds into the Colorado River.

The largest spring in the Barton Springs Complex is Parthenia Spring within the Barton Springs Pool (COA, 2013). The spring is located inside the Barton Creek channel, which is a part of the Colorado River Basin. Eliza Spring is located north of Barton Creek. The habitat of Eliza Spring has been heavily altered by anthropogenic activities that have occurred since the 1920s; these have included the installation of a concrete floor in the spring pool and a surrounding stone amphitheater (COA, 2013). Eliza Spring discharges its outflow into a buried pipe connected to the bypass tunnel. Ultimately, this outflow travels through the bypass tunnel downstream to Barton Creek. Eliza Spring is the most hydrologically interconnected spring to Parthenia Spring and Barton Springs Pool. When water levels in Barton Springs Pool have dropped during severe drought or past drawdowns to clean the pool, the Eliza Spring water level has decreased to below the altered surface of the spring pool and appeared to have gone dry. However, the current HCP and the proposed amendment to the HCP include measures to ensure that Eliza Spring no longer appears to go dry during drawdowns. Old Mill Spring is located south of Barton Creek. Similar to Eliza Spring, the habitat of Old Mill Spring has been heavily altered since the early 1900s through the construction of stone walls around the spring and its pool (COA, 2013). This has allowed the accumulation of litter and detritus in the spring pool, covering any natural underlying substrate. Old Mill Spring retains an overland outflow stream that flows through an outlet in the stone wall surrounding the pool and discharges directly into Barton Creek downstream of Barton Springs Pool and Parthenia Spring. Upper Barton Spring, the smallest and only ephemeral spring, is located along the south margin of the Barton Creek channel upstream of Barton Springs Pool (COA, 2013).

Barton Springs Pool is classified as a palustrine, open water, permanently flooded, impounded wetland (USFWS, 2012b). The upstream area of Barton Creek to the west of the Barton Springs Pool and the downstream area to the east of the pool are classified as riverine, lower perennial wetlands. All of the surface waters of the Baron Springs Complex are considered jurisdictional Waters of the United States (U.S.) per the Clean Water Act Section 404, and as such are regulated under the U.S. Army Corps of Engineers (USACE) permitting programs for development or construction activities and by the U.S. Coast Guard (USCG) under Section 10 of the Rivers and Harbors Act of 1899 for boating or potential impacts to navigation.

3.3 SOILS / GEOLOGY

The soils of the Project Study Area are derived primarily from the weathering and residuum of Cretaceous limestone, and secondarily from alluvial deposits of both Barton Creek and the Colorado River. The U.S. Department of Agriculture (USDA) shows six unique soil types within the Project Study Area (Figure 3-1). The depth to limestone varies from bare rock to greater than 203 centimeters (cm) or 80 inches. The ground slope is between 0 and 50 degrees (°), with the highest values on the southwestern edge of the boundary buffer. All of the soils within the boundary buffer are classified as well-drained (Table 3-1).

Table 3-1
Soils of the Barton Springs Complex Project Study Area

Soil Name	Soil Abbrev.	Depth to rock	Surface Slope	Drainage Class
Altoga and Urban	AlD	>203 cm (80 inches)	2-8°	well drained
Bergstrom and Urban	Bh	>203 cm (80 inches)	0-2°	well drained
Hardeman and Urban	HdE	>203 cm (80 inches)	3-12°	well drained
Mixed Alluvial	Md	0-122 cm (0-48 inches)	0-1°	well drained
Tarrant-Rock	TdF	15-51 cm (6-20 inches)	18-50°	well drained
Volente and Urban	VuD	>203 cm (80 inches)	1-8°	well drained

Source: USDA, 2012

3.3.1 Hydrogeologic Setting

The surface geology overlying the Edwards Aquifer includes Cretaceous limestone and Quaternary alluvial terrace deposits (Blome et al., 2005). A stratigraphic section of the

Cretaceous rocks (Figure 3-2) includes limestone of the Edwards Aquifer, confining units above and below the primary water-bearing units of the Edwards Group and Georgetown Formation, and a bar showing the formations that crop out in the Project Study Area. Other significant aquifer units in the region include the Trinity Aquifer, consisting of older Cretaceous limestone, primarily in the Glen Rose Formation, and to a lesser extent some usable groundwater found in the Austin Chalk in rocks younger than the Edwards Group (Maclay and Small, 1986). In areas with significant surface water streams, alluvial terrace and associated clastic sediments provide a thin cover over the limestone (Maclay and Small, 1986).

3.3.2 Regional Geologic History

The pre-Cretaceous geologic history includes deposition of about 1,500 meters (m), or 4,921 ft, of Paleozoic carbonates, sandstone, and shale during the Early Cambrian (Flawn, 1956). These sedimentary rocks were intensely uplifted, faulted, and folded during the Ouachita orogeny, peaking in the Late Pennsylvanian through Early Permian (Rose, 1972). A wide, shallow sea formed and was uplifted and aerially exposed by the end of the Paleozoic Era (Rose, 1972). During the Triassic and Jurassic periods, most of central and west Texas was exposed to erosion as the Llano uplift created a topographic high in central Texas (Rose, 1972). The surrounding basin filled with Triassic sediments (Rose, 1972). By the end of the Jurassic, a large sea prograded westward and eventually covered most of central and much of west Texas (Rose, 1972).

The primary groundwater-bearing geologic units in the area are Cretaceous age limestone and include Lower Cretaceous (Glen Rose Ls., Edwards Group) and Upper Cretaceous (Del Rio Clay, Buda Ls., Eagle Ford Gp., Austin Chalk) (Maclay and Small, 1986). These carbonate rocks were deposited in a series of cycles where shallow oceans covered the region then regressed seaward (southeast) and transgressed back to submerge the area (Maclay and Small, 1986). Thick sequences of limestone formed as a result of this process, and provide the primary framework for present day aquifers (Maclay and Small, 1986).

In the early Cenozoic time, these rocks were heavily faulted as the ancestral Gulf of Mexico to the southeast subsided. This high angle normal faulting produced as much as 365 m (1,200 ft) of vertical displacement in the area now referred to as the Balcones Fault Zone (Rose, 1972).

Development of secondary porosity along fault planes heavily altered the diagenetic processes occurring throughout the Cenozoic and into the Quaternary, including extensive karstification (Barker et al., 1994). In areas of streams and rivers, there has been some deposition of alluvial sediments, mostly silt, sand, and gravel that thinly cover the eroded limestone surface. A more detailed explanation of the regional geologic history can be found in Rose (1972), Maclay and Small (1986), and Barker et al (1994).

3.3.3 Edwards Aquifer Structure

The Edwards Aquifer is one of the most productive groundwater reservoirs in the country (Sharp and Banner, 1997). It is confined by the Upper Glen Rose Formation (below) and by Del Rio Clay (above) (Maclay and Small, 1986). It can be divided into three zones, from west to east, the Contributing Zone, Recharge Zone, and Confined Zone (TCEQ, 2000 and Collins & Hovorka, 1997). The Contributing Zone is relatively impermeable catchment area where rainfall drains to streams that lead to the Recharge Zone. Within the Recharge Zone, the Edwards Group becomes exposed at the surface and large fractures and faults allow for large amounts of surface water to recharge the aquifer. Farther southeast is the Confined Zone, where the units above the Edwards Group become exposed at the surface and the Edwards Aquifer becomes bounded by low permeability units of the Glen Rose below and Del Rio above (Ferrill et al., 2004). Barton Springs Complex lies along the eastern edge of the Recharge Zone. The surface geology surrounding the Project Study Area is shown in Figure 3-3.

3.3.4 Recharge and Groundwater Movement

Approximately 80 percent (%) of recharge into the Edwards Aquifer occurs in losing streams where surface water flows over faults, fractures, and karst features that have been solutionally enhanced (Sharp and Banner, 1997). Periods of recharge are intermittent, as most streams in central Texas are ephemeral; however, the recharge capacity of surface water into the aquifer is extremely efficient due to the karstic nature of the system. Water typically flows over the Contributing Zone (Glen Rose outcrop), where little recharge occurs, and onto the Recharge Zone, where major fault zones are exposed. Heavily karstified Edwards Group limestone rapidly transfers water to the aquifer with little filtration.

The geologic mechanisms that form karst are complex, and many factors affect how karst is expressed in current settings. These factors control the way the groundwater flow system evolves, and ultimately how groundwater is recharged, transmitted, and naturally discharged through the aquifer system. A great deal of literature exists that presents current perspectives on karst development in the Edwards Aquifer region (Hovorka et al., 1998; Palmer and Palmer, 2009; Schindel et al., 2008; Sharp and Banner, 1997).

3.3.5 Hydrogeology of the Barton Springs Segment of the Edwards Aquifer

The Project Study Area is located on the most downgradient edge of the Barton Springs segment of the Edwards Aquifer. Dye tracing studies and potentiometric data show that groundwater in the Barton Springs segment generally flows from the southwest to northeast toward a few focused discharge points including Cold Springs and four other springs (Parthenia Spring, Eliza Spring, Old Mill Spring, and Upper Barton Spring) that are collectively known as the Barton Springs Complex (Figure 3-3). These studies also indicate that groundwater flow paths are complex, can differ with hydrologic conditions (i.e., drought stage vs. flood stage), and flow paths are greatly influenced by local geology, particularly faulting. Groundwater flowpaths in the Barton Springs segment can generally be grouped into three major basins: the Cold Springs Basin, the Sunset Valley Basin, and the Manchaca Basin (Hauwert et al., 2004, Figure 3-4). Dye tracing shows that groundwater within the Cold Springs Basin discharges at Cold Springs, located on the Colorado River, and that groundwater within the Sunset Valley and Manchaca Basin discharges at one or more of the springs that are collectively known as the Barton Springs Complex (Hauwert et al., 2004).

Dye tracing highlights the complexity of groundwater flowpaths in the Barton Springs segment. The four springs collectively known as the Barton Springs Complex are all located within 600 m (0.37 miles) of one another (Figure 3-3), yet have distinct source areas that vary based on flow conditions (Hauwert et al., 2004).

Dye tracing shows that groundwater velocity differs between high and low-flow conditions. For example, dye was injected in a sinkhole located in Barton Creek just downstream from the MoPac Expressway bridge during low and high-flow conditions. During low-flow conditions, dye reached Cold Springs (approximately 4.83 kilometers [3 miles] from the injection site) approximately 5 days after injections, whereas during high-flow conditions, dye reached Cold Springs approximately 19 hours after injection (Hauwert et al., 2004).

3.3.6 Karst Features in Project Study Area

The geologic site map (Figure 3-3) shows the surface geology of the Project Study Area as mapped by the U.S. Geological Survey (USGS) (Blome et al., 2005), as well as the Geologic Atlas of Texas published by the Texas Natural Resources Information System (TNRIS). The USGS mapping and geographic information system (GIS) data were generated specifically for documentation of the Edwards Aquifer outcrop and are restricted to those geologic units within the Edwards Group and immediate underlying and overlying confining units.

A review of geological assessments near Barton Springs Complex revealed that no significant geologic features were documented within the Project Study Area.

3.3.7 Barton Springs Structures

As discussed in Subsection 3.12 (history of development), the springs have been modified to control flow and flood conditions. The current condition includes upper and lower dams on Barton Creek, which enclose Parthenia Spring, all located downstream of the Upper Spring, which has not been altered. Enclosures or retaining wall structures were created around the original surface expressions (orifices) of Eliza and Old Mill Springs. In addition, pipes or channels have been installed to direct flow from Eliza Spring into the Barton Springs Pool bypass and to direct Old Mill Spring directly into Barton Creek. The result of this hydrologic manipulation has been a moderately elevation-controlled recreational pool between the dams (Barton Springs Pool) and minimization of sedimentation from upstream flows that were redirected around the pool predominantly maintained by spring flow (COA, 2013).

3.4 AIR QUALITY

3.4.1 Air Quality Standards and Regulations

State and local air pollution control agencies are required to adopt federally approved control strategies to minimize concentrations of criteria air pollutants by Section 110 of the Clean Air

Act (42 USC §7410). These federally approved plans are referred to as State Implementation Plans (SIPs) and establish best management practices (BMPs) to minimize emissions of criteria air pollutants. Federal air quality standards are currently established for six criteria pollutants of concern, which include carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), commonly measured as sulfur dioxide [SO_2]), lead, particulate matter (equal to or less than 10 micrometers in aerodynamic diameter [PM_{10}] and equal to or less than 2.5 micrometers in aerodynamic diameter [$PM_{2.5}$]), and ozone (O_3). Although ozone is considered a criteria pollutant and is measurable in the atmosphere, it is often not considered as a pollutant when reporting emissions from specific sources, because ozone is not typically emitted directly from most emissions sources. Ozone is formed in the atmosphere from its precursors, nitrogen oxides (NOx) and volatile organic compounds (VOCs) that are directly emitted from various sources. Thus, emissions of NOx and VOCs are commonly reported instead of ozone. Thus, emissions of NO_x and VOCs are monitored to control the formation of ground level ozone (USEPA, 2011a). Ozone is discussed in further detail in the sections of this report relating to climate change.

Additionally, the U.S. Environmental Protection Agency (USEPA) has established primary and secondary National Ambient Air Quality Standards (NAAQS) for each criteria air pollutant under the Clean Air Act Amendments (CAAA) of 1990. Primary standards define levels of air quality necessary to protect public health, including the health of sensitive populations such as people with asthma, children, and the elderly. Secondary standards define levels of air quality necessary to protect against decreased visibility and damage to animals, crops, vegetation, and buildings. Any area under USEPA jurisdiction, which violates these NAAQS between one and four times per year over a 3-year span of time is classified as a “non-attainment area.”

USEPA classifies the air quality within an Air Quality Control Region (AQCR) according to whether the region meets federal primary and secondary air quality standards. An AQCR or portion of an AQCR may be classified as attainment, nonattainment, or unclassified with regard to the air quality standards for each of the criteria pollutants. “Attainment” describes a condition in which standards for one or more of the six pollutants are being met in an area. An area is considered an attainment area for only those criteria pollutants for which the NAAQS are being met. “Nonattainment” describes a condition in which standards for one or more of the six pollutants are not being met in an area. “Unclassified” indicates that air quality in the area cannot be classified, and the area is treated as attainment. An area may have all three classifications for different criteria pollutants.

Travis County and the Project Study Area are located within the Austin-Waco Intrastate Air Quality Control Region (AQCR, 212) and the Texas Commission on Environmental Quality (TCEQ) NAAQS Monitoring Region 11. There are two state air quality monitoring sites for TCEQ Region 11, which take hourly readings of air pollutant levels to calculate an Air Quality Index (AQI) for each criteria pollutant to determine whether the area is in attainment. Closest to Barton Springs Complex is the Austin Northwest Monitoring Station (USEPA Site 48-453-0014), located in Travis County approximately 6 miles north of the Project Study Area. The Audubon monitoring station (USEPA Site 48-453-0020) is located in Williamson County approximately 16 miles northwest of the Project Study Area.

The maximum monitored concentrations are listed in Table 3-2 below, along with the current NAAQS for the criteria pollutant (USEPA, 2011d). In the case of ozone, the 2011 maximum exceeds the NAAQs for that single year, but to be classified as non-attainment the annual fourth-highest daily maximum 8-hr concentration averaged over 3 years is compared to the NAAQS. In the case of $PM_{2.5}$, to be classified as non-attainment the 98^{th} percentile concentration averaged over 3 years would have to exceed the NAAQS.

Table 3-2
Current NAAQS for Criteria Air Pollutants

Pollutant	Primary / Secondary	Averaging Period	National Ambient Air Quality Standard[a]	Maximum Monitored Concentration[b]
Carbon monoxide	Primary	8-hour	9 ppm	N/A
		1-hour	35 ppm	0.7 ppm
Lead	Primary and Secondary	Quarterly Mean (Rolling 3 month average)	0.15 $\mu g/m^3$	N/A
Nitrogen oxide	Primary	1-hour	100 ppb	47.1 ppb
	Primary and Secondary	Annual	53 ppb	N/A
Ozone	Primary and Secondary	8-hour	0.075 ppm	0.088 ppm

Pollutant	Primary / Secondary	Averaging Period	National Ambient Air Quality Standard[a]	Maximum Monitored Concentration[b]
Particular Matter ($PM_{2.5}$)	Primary and Secondary	Annual	15 $\mu g/m^3$	N/A
		24-hour	35 $\mu g/m^3$	42.42 $\mu g/m^3$
Particulate Matter (PM_{10})	Primary and Secondary	24-hour	150 $\mu g/m^3$	N/A
Sulfur dioxide	Primary	1-hour	75 ppb	N/A
	Secondary	3-hour	0.5 ppm	N/A

Source: (a) USEPA 2011d, (b) TCEQ 2012a&b

Notes:
NAAQS values current as of October 2011
$PM_{2.5}$ = particulate matter equal to or less than 2.5 micrometers in aerodynamic diameter
PM_{10} = particulate matter equal to or less than 10 micrometers in aerodynamic diameter
ppb = parts per billion
ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
Measured values for ozone range from 75 to 88 ppb. Ozone levels in this range are considered moderate (TCEQ, 2012a&b)

The CAAA requires federal actions to conform to any applicable SIP. USEPA has promulgated regulations implementing this requirement. A SIP must be developed to achieve the NAAQS in non-attainment areas (i.e., areas not currently attaining the NAAQS for any pollutant) or to maintain attainment of the NAAQS in maintenance areas (i.e., areas that were non-attainment areas, but are currently attaining that NAAQS). There are no SIPs required in Travis County.

General conformity refers to federal actions other than those conducted according to specified transportation plans (which are subject to the Transportation Conformity Rule). Therefore, the General Conformity Rule applies only to non-transportation actions in non-attainment or maintenance areas. The Transportation Conformity Rule is not applicable to this project.

Travis County is currently classified as within attainment for all six criteria pollutants (USEPA, 2012). Therefore, this action is not subject to General Conformity Regulations (40 CFR Parts 6, 51 and 93).

3.4.2 Greenhouse Gases

The six greenhouse gases (GHGs) covered by the Kyoto Protocol include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The emissions of each GHG are calculated separately and then converted to CO_2 equivalents (CO_{2e}) on the basis of their global warming potential (GWP), the universal unit of measurement expressed in terms of one unit of carbon dioxide. GWP is used to evaluate the release of different GHGs against a common basic measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is a relative scale that compares the gas in question to that of the same mass of carbon dioxide (whose GWP is by definition one). Table 3-3 lists the GWP (USEPA, 2011a) of the six GHGs regulated under the Kyoto Protocol.

Table 3-3
Global Warming Potential of Kyoto Protocol GHGs

Gas	Chemical Formula	GWP[a]
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbons	HFCs	Various
Perfluorocarbons	PFCs	Various
Sulfur hexafluoride	SF_6	23,900

Source: USEPA, 2011a

Only one of the Kyoto GHGs is considered in the emissions from the Preferred Alternative. Project-related CO_2 emissions represent the only CO_{2e} associated with activities in the Preferred Alternative. The other Kyoto GHGs were not considered in the potential emissions from the Proposed and Alternative Actions, as they are not anticipated to be emitted. Specifically, methane is typically emitted from natural-gas-generating facilities and landfills; nitrous oxides are generally associated with the agricultural and industrial activities; HFCs are most commonly used in refrigeration and air conditioning systems; and PFCs and SF_6 are predominantly emitted from various industrial processes, including aluminum smelting, semiconductor manufacturing, electric power transmission and distribution, and magnesium casting, none of which are part of the Proposed and Alternative Actions (USEPA, 2011a).

Direct emissions of CO_2 occur naturally to the atmosphere, but human activities have increased global GHG atmospheric concentrations. The most recent 2009 total U.S. GHG emissions were 6,639,700,000 metric tons of CO_{2e} (USEPA, 2011a). U.S. total GHG emissions have risen 7.4 % from 1990 to 2009 (USEPA, 2011a). Direct project-related emissions of CO_2 from existing maintenance activities at Barton Springs Pool result in a total CO_{2e} of 12.40 metric tons per year (see emissions estimates associated with routine pool maintenance in Appendix B). Direct project-related emissions of CO_2 from vehicles visiting the pool result in a total CO_{2e} of 5,246 metric tons per year. This is based on the total number of adult entries to the Barton Springs Pool during the 2010-2011 season and on a conservative assumption that each adult drives 10 miles each way to the pool in separate vehicles (COA, 2012c). See Appendix B for detailed emission calculations.

3.5 NOISE

Noise is generally defined as unwanted or disturbing sound. If loud enough, noise can induce hearing loss or is otherwise undesirable because it can interfere with daily activities, such as sleeping or conversation, and can diminish one's quality of life (USEPA, 2011c). Ambient noise is measured in decibels (dB) and is defined as the level of acoustic noise existing at a given location. The USEPA defines noise levels that interfere with activities and cause annoyance as 55 dB for outdoor areas and 45 dB for indoor areas (USEPA, 2011c). A noise level of 70dB or above in either an indoor or outdoor setting can cause damage to hearing.

When describing sound levels in relation to humans, a weighted sound level is used to characterize the sound levels to which the human ear responds especially well by emphasizing mid-frequencies and de-emphasizing the low and high frequencies. Sound levels weighted in this manner are referred to as "A-weighted" decibels or dB(A) (USEPA, 2011c).

Noise associated with the operation of machinery on construction sites is typically short-term, intermittent, and highly localized. Table 3-4 lists noise levels associated with the types of equipment expected to be utilized during maintenance and construction activities. As shown in Table 3-4, the equipment produces peak sound pressure levels (SPLs) ranging from 55-88 dB(A) at 50 ft from the source, which decreases by 6 dB(A) with every doubling of the distance from the source. It is important to note that the peak SPL range for construction equipment noise does not take into account the ability of sound to be reflected/absorbed by nearby objects, which would further reduce noise levels.

Table 3-4
Construction Equipment Peak Sound Pressure Level

Equipment	Generated Noise[1] dBA				
	50 ft	100 ft	200 ft	400 ft	800 ft
Air Compressor	80	75	69	63	57
Backhoe	80	74	68	62	56
Generator	81	75	69	63	57
Jack Hammer	88	82	76	70	64
Crane	85	79	73	67	61
Pickup Truck	55	49	43	37	31
Haul/Gravel Truck	88	82	76	70	64

Source: USDOT, 2006
[1] Noise from a single source.
dBA - "A-weighted" decibel
ft – feet

A noise-sensitive receptor is commonly defined as the occupants of any facility where a state of quietness is a basis for use such as a residence, hospital, or church (USDOT, 2006). The Project Study Area is located in park area close to downtown Austin, Texas, and is bounded by neighboring homes, Barton Creek, Town Lake, and Zilker Park. The closest residence is approximately 500 ft from the construction project area at Eliza Spring and approximately 400 ft from Barton Springs Pool where seasonal use (including personal vehicle traffic, which is anticipated to have per vehicle noise levels less than or equivalent to the pickup truck described in Table 3-4 above) and ongoing routine maintenance activities would occur.

3.6 HAZARDOUS MATERIALS

Hazardous materials associated with the Project Study Area include general household-type cleaning products. The products are generally used for cleaning of Barton Springs Pool amenities including restrooms and showers. Some equipment used for pool cleaning activities at the Barton Springs Complex are powered by gasoline or diesel and include pressure washers (blaster), fire hoses, and a small rubber wheeled front-end loader (Bobcat). Such equipment is generally used during the spring-cleaning activities and is not used on a daily basis. According to the amended HCP, fueling of maintenance equipment occurs at least 25 ft away from the water to avoid the chance of detrimental impacts on the spring habitat or aquatic life (COA, 2013). Additionally, absorbent pads are used underneath or around all equipment during fueling, operating, and maintenance activities. Gas containers, power washers, and fire hoses are currently stored in the Blaster Room, a storage room located inside the Barton Springs Pool bathhouse. The salamander habitat is cleaned with spring water at pressures not to exceed 30 pounds per square inch (psi). The diesel-powered Bobcat is stored in the barn in the maintenance yard west of the playscape area and is outside of the Project Study Area (COA, 2008a).

The current HCP requires City personnel to provide annual spill and response training for all employees that perform maintenance activities in and around the springs in Zilker Park. The HCP also requires completion of an inventory of containment and remediation equipment each year and following use of any equipment. Under the current HCP, a Catastrophic Spill Response Plan was completed to address spill prevention, containment, remediation, and salamander rescue procedures (see Appendix A).

Waste currently generated within the Project Study Area consists primarily of municipal solid waste and is disposed of at a City landfill. The majority of the waste is generated within the Barton Springs Pool facility (pool, restrooms, office, and parking lot). Areas surrounding Eliza Spring and Sunken Garden have restricted entry to the public and do not contain waste receptacles. However, trash and debris are occasionally disposed illicitly afterhours at Old Mill Spring (COA, 2008b).

3.7 LAND USE

Land use refers to the human use of land including residential, commercial, industrial, and recreational classifications. The majority of the Project Study Area is located within public, City-of-Austin-owned property that has a Land Use Classification of Parks/Greenbelts (COA, 2006b). The property has been continuously used as public park land since the early 1900s (USFWS, 1998). A small portion of the southwest corner of the Project Study Area is within an area zoned for multi-family residential use. Additionally, a small portion on the north side of the Project Study Area is within an area used for streets and roads (William Barton Dr). These areas are outside the boundary of the Barton Springs Complex, but within the 100-ft buffer considered the Project Study Area. A small portion of the western corner of the Project Study Area is located within the Land Use Classification of Preserves, and a small portion on the eastern corner is water. Land use in the adjacent and surrounding areas consists of parks and open space to the north, west, and east. Parks and open space and mixed residential development are south of the Project Study Area (Figure 3-5).

Zilker Metropolitan Park hosts several recreation attractions for residents and visitors including the annual Zilker Park Kite Festival, the Zilker Botanical Gardens, the Austin Nature and Science Center, the Zilker Hillside Theatre, the Umlauf Sculpture Garden and Museum, the Austin Sunshine Camp, and Barton Springs Pool (COA, 2012a). Amenities associated with the park include a baseball field, 10 soccer fields, one multi-purpose field, 5 volleyball courts, 18 disc golf baskets, 2.46 trail-miles, playground amenities, 158 picnic tables, a picnic shelter, and several parking areas (COA, 2010a).

Barton Springs Pool is open year round to the public and offers recreation activities including swimming, sun bathing, and an educational exhibit informing patrons of the Edwards Aquifer. A total of 706,592 guests visited the pool during 2010-2011 (COA, 2012c). Of the total number of guests, 141,996 guests visited the pool during the non-charging season (November through March), which equates to approximately 28,400 guests per month (COA, 2012c). During the charging season (April through October), approximately 80,700 guests visited the pool per month. Fees and revenue generated from the recreation and land use designations is included in Subsection 3.11. Visitation demographics for Barton Springs Pool are included in Table 3-5 on the following page.

Table 3-5
Barton Springs Pool Visitation

Entries and Passes Sales	Visitation
Adult (18-61 yr)	430,718
Junior (12-18 yr)	50,220
Child (1-11 yr)	60,894
Senior (62+ yr)	15,189
Medical Pass Entries	388
Punch Cards	1,209
Family Season Passes	52
Employee Entries	5,926
Non-Charging Times*	141,996
Total	**706,592**

Source: COA, 2012c
*Entries during Non-charging times are not categorized by age.

Barton Springs Pool is one of seven municipal pools in the City of Austin and 1 of 10 City of Austin operated pool facilities located in the South Austin area. Municipal pools operated by the City are shown in Table 3-6 and on Figure 3-6. City of Austin operated pools and facilities located in the South Austin area are shown in Table 3-7 and Figure 3-7.

Table 3-6
City-Operated Municipal Pools in Austin

General Location	Municipal Pool Facilities	Approximate Distance from Proposed Project Study Area
North	Beverly S Sheffield NW	6 miles north (N)
	Walnut Creek	10 miles northeast (NE)
East	Bartholomew	5 miles NE
	Mabel Davis	3 miles southeast (SE)
South	Barton Springs Pool	within proposed Project Study Area
	Garrison	4 miles southwest (SW)
West	Deep Eddy	< 1 mile northwest (NW)

Source: COA, 2012d.

Table 3-7
South Austin Pool Facilities and Types

South Austin Pool Facility	Facility Type
Barton Springs Pool	Municipal
Big Stacy	Neighborhood
Dick Nichols	Neighborhood
Dittmar	Neighborhood
Dove Springs	Neighborhood
Garrison	Municipal
Gillis	Neighborhood
Little Stacy Wading	Wading
Odom Wading	Wading
Ricky Guerrero Splash Pad	Splash Pad

Source: COA, 2012d.

The closest pool to Barton Springs Pool is the City-of-Austin-operated Deep Eddy Pool, located in the West Austin area. Deep Eddy Pool is located within the 8-acre Eilers Park, within 1 mile north of the proposed Project Study Area (COA, 2012e). The pool is a man-made, spring-fed pool. A total of 190,997 guests visited Deep Eddy Pool in the last year (COA, 2012c). Additional water recreation opportunities in the vicinity of the proposed Project Study Area include boating amenities along Lady Bird Lake, privately operated by Austin Rowing Club, Rowing Dock, Texas Rowing Center, and Zilker Park Boat Rentals (COA, 2012f).

3.8 VEGETATION COMMUNITIES

The Barton Springs Complex is located between two ecoregions: the Edwards Plateau to the west and the Blackland Prairie to the east. The Edwards Plateau ecoregion is characterized by steep canyons, rolling hills, and natural springs (TPWD, 2011a). Historical habitats for this region were open grasslands and savannahs, but suppression of fire and extirpation of native grazers such as bison (*Bison bison*) allowed the widespread encroachment of oak/juniper woodlands into much of the region (TPWD, 2011a). The Blackland Prairie ecoregion is characterized by deep, fertile black soils, which historically supported prairie dominated by tall-growing grass species such as big bluestem (*Andropogon geradii*), little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) (TPWD, 2011a). Today, much of this habitat has been plowed for agricultural use. Similar to the Edwards Plateau, suppression of fire and extirpation of native species have also allowed woodlands to encroach into this region.

Terrestrial habitat within Zilker Park, home to the Barton Spring Complex, is typified by highly maintained, manicured lawns with few unaltered areas. Typical species found within the park are live oak (*Quercus virginiana*), Ashe juniper (*Juniperus ashei*), pecan (*Carya illinoensis*), elm (*Ulmus americana*), and eastern cottonwood (*Populus deltoides*). Cottonwoods and pecans are especially abundant in lowland areas close to Barton Springs Complex with oaks, junipers, and elms more abundant in upland areas. Lawn and turf areas of the park are covered with Bermuda grass (*Cynodon sp.*) and zoysia grass (*Zoysia sp.*). Most areas of Zilker Park lack an understory due to regular mowing and maintenance of public areas (COA, 2013). Approximately 10 acres of the Project Study Area are composed of less maintained areas with an understory primarily composed of non-native invasive species such as Chinese privet (*Ligustrum sinense*), nandina (*Nandina domestica*), Chinese tallow (*Sapium sebiferum*), and Japanese honeysuckle (*Lonicera japonica*) (COA, 2013).

In 2008, the City conducted a tree survey of the Barton Springs Complex area (COA, 2009). Of the 46 trees assessed, 22 of them were found to be very high risk, meaning that if issues related to the trees are not addressed within a reasonable period of time, there is a chance of complete failure of the tree. Based on this information, the City has begun the process of removing the 22 highest risk trees, along with two additional trees judged to be at risk based on survey results, and replacing them with new, native trees.

The majority of aquatic vegetation within the Barton Springs Complex is found within the Barton Springs Pool. Diversity of species here is likely due to variable flow regimes and maintenance of pool areas by City staff as well as the disturbed nature of the habitat present within Eliza and Old Mill Springs (COA, 2013). The upper portion of Barton Creek is ephemeral and does not support aquatic vegetation during most times of the year. Lower Barton Creek immediately east of the Barton Springs Pool is a popular recreational area with highly disturbed substrates that support little, if any, aquatic vegetation. Farther away from the Barton

Springs Complex, the creek begins to support a greater abundance of aquatic species of vegetation.

Within Barton Springs Pool, the aquatic vegetation is most abundant and diverse in the area fed by Parthenia Spring near the eastern, deeper end of the pool (COA, 2013). The eastern end of the Barton Springs Pool is heavily vegetated with delta arrowhead (*Sagittaria platyphylla*), Carolina fan wort (*Cabomba caroliniana*), and creeping primrose willow (*Ludwiga repens*) due to decreased flow rate. Portions of this area are currently designated as salamander habitat (COA, 2013). Aquatic moss (*Amblystegium riparium*) is common in the shallower Parthenia Springs area of Barton Springs Pool.

The habitat of Eliza Spring and Old Mill Spring has undergone more extensive disturbance historically than Barton Springs Pool (COA, 2013). Aquatic moss and algae are the only species of vegetation present in both springs. Attempts to revegetate both springs with native macrophytes have met with varying degrees of success. Currently, the floor of Eliza Spring is composed of concrete covered with a more natural spring substrate, making re-vegetation difficult. As a part of the existing HCP, temporary populations of primrose willow and water hyssop (*Bacopa monnieri*) have been established, and aquatic moss continues to grow without outside intervention. Another aspect of the existing HCP is the removal of the highly disturbed substrate of Old Mill Spring with the intent of unearthing more natural substrate beneath it. However, these efforts make it difficult to establish populations of aquatic species in the spring other than the naturally occurring aquatic moss. To-date, populations of primrose willow, water hyssop, and American water-willow (*Justicia americana*) have been established around the edge of Old Mill Spring (COA, 2013).

3.9 WILDLIFE

The Edwards Aquifer region of the Edwards Plateau is renowned for the number of its endemic species (COA, 2013). Subterranean karst formations form habitat for vertebrate and invertebrate species not found anywhere else (TPWD, 2003). Several species of endemic karst aquatic fauna are found in spring-fed streams throughout the region (COA, 2013), including a species of fish endemic to Edwards Plateau springs that is only found in the Guadalupe and Nueces River drainages. Outside of the Edwards Plateau region, the Colorado River basin has few endemic, resident species (COA, 2013). Most fauna observed in the area are transitional. The Colorado River basin is located within the Central Flyway migratory route, bringing a diversity of transitioning species of avifauna throughout the year (USFWS, 2012a).

3.9.1 Fish

Twenty species of fish have been documented within the Barton Springs Complex (COA, 2013). Native fish species commonly observed in Barton Springs Pool (or Parthenia Spring) include green sunfish (*Lepomis cyanellus*), bluegill sunfish (*Lepomis macrochirus*), longear sunfish (*Lepomis megalotis*), spotted sunfish (*Lepomis punctatus*), largemouth bass (*Micropterus salmoides*), Guadalupe bass (*Micropterus treculi*), mosquito fish (*Gambusia affinis*), and greenthroat darter (*Etheostoma lepidum*). Non-native species of fish observed in Barton Springs Pool include redbreast sunfish (*Lepomis auritus*) and Rio Grande cichlid (*Cichlasoma cyanogutatum*) (COA, 2013). A single Asian grass carp (*Ctenopharyngodon idella*) was observed in Barton Springs Pool during the 1990s, but was subsequently removed. Mexican tetras (*Astyanax mexicanus*) have also historically been observed in Barton Springs Pool, but observations have ceased in recent years (COA, 2013).

Due to their hydrological interconnectedness, several species of fish commonly transition between Barton Springs Pool (Parthenia Spring) and Barton Creek. Native species of fish that primarily live in Barton Creek but occasionally migrate in and out of Barton Springs Pool (Parthenia Spring) include America eel (*Anguilla rostrata*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictus olivaris*), gray redhorse (*Moxostoma congestum*), Texas log perch (*Percina carbonaria*), dusky darter (*Percina sciera*), orangethroat darter (*Etheostoma spectabile*), red shiner (*Cyprinella lutrensis*), blacktail shiner (*Cyprinella venusta*), Texas shiner (*Notropis amabilis*), central stoneroller (*Campostoma anomalum*), and blackstripe topminnow (*Fundulus notatus*) (COA, 2013).

Other springs within the Barton Springs Complex are more sparsely populated (COA, 2013). Eliza Springs has one major resident species of fish, the mosquitofish, but tadpole madtom (*Noturus gyrinus*) have also been observed. Old Mill Spring has no resident species of fish, but species of sunfish have been observed migrating in and out of the spring. When Upper Barton

Spring is flowing, an abundance of bullhead minnows (*Pimephales vigilax*) are typically observed.

3.9.2 Invertebrates

Over 100 species of macroinvertebrates have been observed in the Barton Springs Complex (COA, 2013). Non-insect invertebrates reported within the springs include aquatic earthworms (*Dugesia* sp.), triclad flatworms, glossiphoniid leeches, water mites, and hydra. Crustacean species observed in the springs include crayfish (*Procambrus clarkii*), ostracods, copepods, the amphipod species *Hyalella azteca*, three species of blind amphipods (*Stygobromus* sp.), and one species of blind isopod (*Lirceolus hardeni*) (COA, 2013). These species all typically live within the springs themselves and are rarely seen at the surface.

Families of gastropods that have been documented within the springs include Physidae, Lymnaeidae, Planorbidae, Pleuroceridae, Ancylidae, and Hydrobiidae (COA, 2013). A species of small, aquatic hydrobiid snail (*Stygopyrgus bartonensis*) has been described based on the characteristics of an empty shell found in Eliza Springs, but to date no additional specimens have been found in the complex.

At least 10 groups of aquatic insects have been identified in the complex, including 8 genera from the order Ephemeroptera, 14 genera from Trichoptera, 18 genera from Coleoptera, 5 families from Odonata, 1 genus from Plecoptera, one aquatic moth species from Lepidoptera, 3 species from Diptera, and 6 species from Hemiptera, Megaloptera, and Collembola (COA, 2013).

Two non-native species of invertebrates have been identified within the complex. Shells of invasive mussel *Corbicula fluminea* have been found in Parthenia Springs (COA, 2013). Red-rimmed melania (*Melanoides tuberculata*) illegally introduced into Old Mill Spring were removed (COA, 2013).

3.9.3 Reptiles and Amphibians

Other than the two species of endangered aquatic salamander found within the Barton Springs Complex, four species of turtles and several species of frogs and toads have been observed in and around the springs (COA, 2013). Turtle species observed are the red ear slider (*Trachemys scripta*), Texas cooter (*Pseudemys texana*), common snapping turtle (*Chelydra serpentina*), and smooth softshell turtle (*Apalone mutica*) (COA, 2013). Frog and toad species commonly observed in the area are the gulf coast toad (*Bufo valliceps*), Woodhouse's toad (*Bufo woodhouseii*), Blanchard's cricket frog (*Acris crepitan*), spotted chorus frog (*Pseudacris clarkii*), southern leopard frog (*Rana sphenocephala*), and the Rio Grande leopard frog (*Rana berlandieri*) (COA, 2013).

A comprehensive list of snake and lizard species observed in and around the springs was not available at the time of this report. Species of snakes and lizards common to the area around the Barton Springs Complex include green anole lizard (*Anolis carolinensis*), little brown skink (*Scincella lateralis*), Texas rat snake (*Elaphe obsolete lindheimerii*), diamondback water snake (*Nerodia rhombifer rhombifer*), garter and ribbon snakes (*Thamnophis* sp.), western cottonmouth/water moccasin (*Agkistrodon piscivorus leucostoma*), and southern copperhead (*Agkistrodon contortrix contortrix*) (TPWD, 2009).

3.9.4 Birds

Due to the disturbed nature of the urban habitat around the Barton Springs Complex, there are few resident species of birds in the area. A species list of avifauna within Zilker Park is not available as of the date of this report. Based on observations and species life histories, common native bird species which can be observed in the Zilker Park area throughout the year include common grackle (*Quiscalus quiscula*), great-tailed grackle (*Quiscalus mexicanus*), white-winged dove (*Zenaida asiatica*), mourning dove (*Zenaida macroura*), northern mockingbird (*Mimus polyglottos*), blue jay (*Cyanocitta cristata*), house finch (*Carpodacus mexicanus*), Carolina wren (*Thyrothorus ludovicianus*), and Carolina chickadee (*Poecile carolinensis*) (Cornell, 2012). Zilker Park is also utilized by some species of raptors, including red-tailed hawk (*Buteo jamaicensis*), that vary in abundance throughout the year. Great horned owls (*Bubo virginianus*) could also utilize the more heavily wooded areas of the park for habitat. Great blue heron (*Ardea herodias*) is a native species of wading bird present in the area throughout the year that could also use the springs as habitat (Cornell, 2012). Common non-native species of avifauna include the rock pigeon (*Columba livia*), European starling (*Sturnus vulgaris*), and house sparrow (*Passer domesticus*).

Austin, Texas is located within the Central Flyway avian migratory route (USFWS, 2012a). The composition of the avian community in Zilker Park can change throughout the year based on which migrations are moving through the area at the time. A comprehensive list of bird species observed within the Project Study Area was not available at the time of this report, but based on observations and species life histories, migratory passerine species common to the area around the Barton Springs Complex include ruby-crowned kinglet (*Regulus calendula*), white-eyed vireo (*Vireo griseus*), eastern phoebe (*Sayornis phoebe*), western kingbird (*Tyranus verticalis*), and American goldfinch (*Spinus tristis*) (Cornell, 2012). Common species of migratory waterfowl that may use surface water in the Barton Springs Complex as habitat include wood ducks (*Aix sponsa*), American coots (*Fulica Americana*), blue-winged teal (*Anas dicors*), green-winged teal (*Anas crecca*), ring-necked duck (*Aythya collaris*), lesser scaup (*Aythya affinis*), and northern pintail (*Anas acuta*) (Cornell, 2012). Several species of migratory wading bird common to the area around the Barton Springs Complex that may also use the surface waters of the springs, include green heron (*Butorides virescens*), snowy egret (*Egretta thula*), and great egret (*Ardea alba*). Osprey (*Pandion haliaetus*) are a migratory species of raptor that have been observed in the Zilker Park area during their migration (Cornell, 2012).

3.9.5 Mammals

As with bird species, the highly urbanized and maintained nature of the habitat around the Barton Springs Complex results in few resident species of mammals present in the area (McKinney, 2008). Eastern grey squirrels (*Sciurus carolinensis*) and eastern fox squirrels (*Sciurus niger*) are commonly observed throughout the lawn areas and unmaintained areas of the Barton Springs Complex. Eastern cottontail rabbits (*Sylvilagus floridanus*) can also be found grazing on the lawn areas and unmaintained areas around the springs (TPWD, 2005). Raccoons (*Procyon lotor*) have also been observed around the springs. White-tailed deer (*Odocoileus virginianus*), while not abundant, have been known to transit across park grounds and browse in unmaintained areas (TPWD, 2005). Domestic dogs (*Canis lupus familiaris*) are common throughout Zilker Park, both on- and off- leash. Barton Springs Pool (Parthenia Spring), Eliza Spring, and Old Mill

Spring are all closed to dogs, but Upper Barton Spring is commonly used as a recreational area for people and their dogs when the spring is both dry and running.

Nutria (*Myocastor coypus*), a non-native invasive species of semi-aquatic rodent, have been observed in Barton Creek. This species is incredibly destructive due to its foraging and burrowing habits in wetland areas (TPWD, 2010). According to City personnel, nutria have never been observed inside the springs themselves.

3.10 THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONSERVATION CONCERN

Of the 21 federally protected or candidate species listed for Travis County, Texas, there are only two that occur within the Project Study Area, the Barton Springs salamander (*Eurycea sosorum*) and the Austin blind salamander (*Eurycea waterlooensis*). The Barton Springs Complex is designated as critical habitat for the Austin blind salamander (USFWS, 2013b). There are no terrestrial karst features within the Project Study Area, and the bracted twistflower (*Streptanthus bracteatus*) has not been reported or observed within the confines of Zilker Park where the Barton Springs Complex is located. Known occurrences and breeding territories of the Golden-cheeked Warbler (*Dendroica* [*Setophaga*] *chrysoparia*) are found within the Barton Creek Greenbelt; however, *S. chrysoparia* have not been observed on greenbelt land that is adjacent to and inside the Project Study Area, and it is not a known occupied habitat. Additionally, the Project Study Area is out of the known range of the candidate mollusk and fish species. Other than the two aquatic salamander species found within the Project Study Area, there is no known or suspected habitat present of the remaining 19 federally listed or candidate species at this location (Table 3-8).

The remaining species in Table 3-8 include state-listed and species of conservation concern as documented by Texas Parks and Wildlife (TPWD, 2011b). Of these species, potential habitat for the Texas garter snake (*Thamnophis sirtalis annectens*) does occur in the riparian corridor surrounding the upper Barton Spring Complex. There is no known or observed habitat in the Project Study Area for the remaining state-listed species and species of conservation concern.

Table 3-8
Rare, Threatened, and Endangered Species of Travis County, Texas

Common Name	Scientific Name	USFWS	TPWD
Amphibians			
Austin blind salamander	*Eurycea waterlooensis*	LE	--
Barton Springs salamander	*Eurycea sosorum*	LE	E
Jollyville Plateau salamander	*Eurycea tonkawae*	LT	--
Pedernales River springs salamander*	*Eurycea sp 6*	--	--
Arachnids			
Bee Creek Cave harvestman	*Texella reddelli*	LE	--
Bone Cave harvestman	*Texella reyesi*	LE	--
Tooth Cave pseudoscorpion	*Tartarocreagris texana*	LE	--
Tooth Cave spider	*Neoleptoneta myopica*	LE	--
Warton Cave meshweaver	*Cicurina wartoni*	C	--
Bandit Cave spider*	*Cicurina bandida*	--	--
Birds			
Black-capped vireo	*Vireo atricapilla*	LE	E
Golden-cheeked warbler	*Setophaga chrysoparia*	LE	E
Whooping crane	*Grus americana*	LE	E
Interior least tern*	*Sterna antillarum athalassos*	--	E
Mountain plover*	*Charadrius montanus*	--	--
Sprague's pipit*	*Anthus spragueii*	C	--
Western burrowing owl*	*Athene cunicularia hypugaea*	--	--
Crustaceans			
An amphipod*	*Stygobromus russelli*	--	--
Balcones Cave amphipod*	*Stygobromus balconies*	--	--
Bifurcated Cave amphipod*	*Stygobromus bifurcates*	--	--
Fishes			
Guadalupe bass*	*Micropterus treculii*	--	--
Smalleye shiner*	*Notropis buccula*	C	--
Insects			
Kretschmarr Cave mold beetle	*Texamaurops reddelli*	LE	--
Leonora's dancer damselfly*	*Argia leonorae*	--	--
Rawson's metalmark*	*Calephelis rawsoni*	--	--
Tooth Cave blind rove beetle*	*Cylindropsis sp 1*	--	--

Common Name	Scientific Name	USFWS	TPWD
Tooth Cave ground beetle	*Rhadine Persephone*	LE	--
Mammals			
Cave myotis bat*	*Myotis velifer*	--	--
Plains spotted skunk*	*Spilogale putorius interrupta*	--	--
Red wolf*	*Canis rufus*	LE	E
Mollusks			
Creeper (squawfoot)*	*Strophitus undulates*	--	--
False spike mussel*	*Quadrula mitchelli*	--	T
Smooth pimpleback*	*Quadrula houstonensis*	C	T
Texas fatmucket*	*Lampsilis bracteata*	C	T
Texas fawnsfoot*	*Truncilla macrodon*	C	T
Texas pimpleback*	*Quadrula petrina*	C	T
Plants			
Basin bellflower*	*Campanula reverchonii*	--	--
Bracted twistflower*	*Streptanthus bracteatus*	C	--
Correll's false dragon-head*	*Physostegia correllii*	--	--
Texabama croton*	*Croton alabamensis var texensis*	--	--
Warnock's coral-root*	*Hexalectris warnockii*	--	--
Reptiles			
Spot-tailed earless lizard*	*Holbrookia lacerate*	--	--
Texas garter snake*	*Thamnophis sirtalis annectens*	--	--
Texas horned lizard*	*Phrynosoma cornutum*	--	T

** species of conservation concern documented by Texas Parks and Wildlife Department (TPWD), Travis County, Texas Annotated County List of Rare Species on 12/15/2011*

Source: TPWD, 2011b

E = Endangered

T = Threatened

LE = Federally Listed Endangered

LT = Federally Listed Threatened

C = Candidate Species for Listing as Threatened or Endangered

Texas Natural Diversity Database (TXNDD) elemental occurrence representations (EORs) that were reviewed during this analysis included all records within a 5-mile radius of the Project Study Area (TXNDD, 2012). These included federally and state-listed species as well as species of conservation concern (Table 3-9). These records are updated with the last known documented occurrence and can represent from one occurrence to an accumulation of many. Known locations of *E. sosorum* and *E. waterlooensis* are documented with a 3-second radius accuracy, meaning a 0.3 kilometer (~1,000 ft) radius margin-of-error from the original mapped point source. Based on references for these species in the Project Study Area and the mapped EORs, it is inferred that the source records occur within the spring complex itself. Other elemental occurrence records for most of the species listed in Table 3-9 are within a 3-second to 1-minute radius, which is approximately a 2-kilometer (1.24 miles) radius margin-of-error from either point or polygon source features. These EORs are not within the Project Study Area, and the closest approximate known occurrences are listed in Table 3-9. The Texas garter snake (*Thamnophis sirtalis annectens*) EOR is accurate to an 8-kilometer (4.97 mile) radius margin-of-error. Elemental occurrence representations that are labeled as general are considered imprecise and are mapped at the scale of locale, quad, or place name only (TXNDD, 2012).

Table 3-9
Texas Natural Diversity Database Element Occurrence Representation Records within a 5-Mile Radius of the Project Study Area

No.[1]	Scientific Name	Approximate Distance from Project Study Area kilometers (miles)
1	*Eurycea sosorum*	within Project Study Area boundary
1	*Eurycea waterlooensis*	within Project Study Area boundary
4	*Invertebrate cave*	0.95 (0.59)
1	*Juniperus ashei-quercus spp. series*	5.13 (3.19)
2	*Micropterus treculi*	within Project Study Area boundary
1	*Notropis buccula*	2.43 (1.51)
1	*Physostegia correllii*	7.63 (4.74)
1	*Schizachyrium scoparium-sorghastrum nutans series*	2.40 (1.49)
15	*Setophaga chrysoparia*	2.66 (1.65)
5	*Streptanthus bracteatus*	3.72 (2.31)
4	*Texella reddelli*	0.98 (0.61)
1	*Thamnophis sirtalis annectens*	within Project Study Area boundary
2	*Vireo atricapilla*	5.07 (3.15)

TXNDD, 2012

3.10.1 Texas Garter Snake

Based on TXNDD (2012) records of the state-listed or species of conservation concern documented in Table 3-8, only the Texas garter snake is known to occur within the Project Study Area. This uncommon species is found in a wide variety of habitats near water such as along the margins of streams, rivers, ponds, lakes or marshes, or in damp soil (Werler and Dixon, 2000). It is most commonly found utilizing ground cover of grass, weeds, or other brushy streamside vegetation (Werler and Dixon, 2000). This species hibernates underground or in or under surface cover (TPWD, 2011b).

3.10.2 Aquatic Salamander Species

The Barton Springs and Austin blind salamanders are dependent on outflow from the Barton Springs Complex. This spring system consists of subterranean water-filled caverns that are part of the Edwards Aquifer. As is typical of karst systems, this spring-fed water falls within a neutral pH range and an average temperature of 21.1º Celsius (C) with little variation (18-22ºC) and is clean and transparent, exhibiting high visibility conditions (COA, 1997; Mahler et al., 2006; Pierce, 1985).

Both species occur in the same habitat, show similar reproductive strategies, exhibit preference for the same food items, and are even known to prey on one another. Little is known on how much, if any, interspecific competition may be present, especially when resources such as water quantity become limited (Dries, 2012; Pianka, 2000; Vrijenhoek, 1979).

Since both species are dependent on their aquatic habitats, they are both affected by water quality. It has been documented that as the percent of embeddedness, sediment deposition, conductivity, oxygen depleting wastes, and excessive nutrient loading increase, salamander abundance declines (COA, 2006a; Woods et al., 2010). Excessive nutrients and pollutants can contribute to a decrease in the dissolved oxygen (DO) that is available to living organisms. It is common practice for scientists to use DO as a primary indicator of aquatic health (Venkiteswaran et al., 2008). The quantity of water is important because DO and outflow from the springs are positively correlated (COA, 1997). Low DO has been shown to cause increased mortality and reduced growth rates for both juvenile and adult *E. sosorum and Eurycea nana* salamanders (Woods et. al., 2010).

3.10.2.1 Barton Springs Salamander

The Barton Springs salamander, *Eurycea sosorum*, is neotenic and aquatic and more closely related to the San Marcos salamander (*Eurycea nana*) than the Austin blind salamander (*E. waterlooensis*) (Hillis et al., 2001). It is seen reaching the surface more often than *E. waterlooensis*, and therefore considered more highly adapted to the spring habitat than the aquifer habitat (Chippindale et al., 1993; USFWS, 1997). *Eurycea sosorum* is lungless, exhibiting perennibranchiate characteristics, which include red feathery gills, for its entire life cycle (Chippindale et al., 2000; Hillis et al., 2001; Sweet, 1982; USFWS, 2005 Chippindale, 1995; Hillis et al., 2001). As formally described by Chippindale et al. (1993) and again by Chippendale (1995) and Hillis et al. (2001), *Eurycea sosorum* exhibits the following characteristics:

- Reduced limbs.
- Reduced eyes with image-forming lenses.
- Truncated snout.
- Finned tails.
- Dark melanophores along with silvery-white iridophores that create a pale to dark brown, salt-and-pepper appearance on the dorsal side and a cream colored, translucent ventral side.
- Short tail that typically exhibits some orange to yellow pigmentation.
- From 13-16 costal grooves.
- Typically it is found under rocks and boulders, and in gravel and cobble substrates that are free of sediment.

Eurycea sosorum will utilize macrophytes, algae, aquatic moss, and leaf litter for foraging and cover from predators (Chamberlain and O’Donnell, 2003; Chippindale et al., 1993; Sweet, 1984). *Eurycea sosorum* feed on amphipods, leeches, snails, copepods, ostracods, chironomid larvae, isopods, mayfly larvae, planarians, and adult riffle beetles (Chamberlain and O’Donnell, 2002; Chippindale et al., 1993; Hillis et al., 2001). *Eurycea sosorum* sightings have occurred at Eliza, Sunken Garden, and Upper Barton as well as the spring run and confluence of Sunken Garden and Barton Creek. There are no known *E. sosorum* occurrences at other springs in the Barton Springs segment including Campbell's Hole and Backdoor springs (Chippendale, 1995).

The primary listed threat to the *E. sosorum* is degradation in water quality and quantity (USFWS, 1997). This threat is a noted side-effect of urbanization, urban growth, and surface habitat modification over the watershed. The USFWS (1997, 2005) lists other threats as follows:

- Lack of a comprehensive plan.
- Lack of adequate regulatory mechanisms to protect the Barton Springs watershed from increased threats.
- The Salamander's restricted range makes it vulnerable to various forms of environmental degradation.
- Groundwater contamination, including hazardous spills.
- Water depletion caused by withdrawals from the Edwards Aquifer.
- Detrimental impacts to terrestrial habitat.

Extensive monitoring efforts by City biologists provide a robust estimate of the present status of *E. sosorum* in the Project Study Area (COA, 2004; COA, 2005; COA, 2006a; COA, 2007). City biologists collected monthly quantitative data starting in 1993 with Parthenia Spring. Salamander abundance ranged from over 1,000 specimens with densities of 0-1.5 salamanders per square foot (ft^2) (Bendik and Turner, 2011; Dries, 2012). The monitoring reports indicate that the biggest influence of salamander abundance is flow regime, specifically tied to DO, flow velocity, and discharge. Population data from 2004 to 2011 show this species was stable during the examined time period (Bendik and Turner, 2011; Dries, 2012).

3.10.2.2 Austin Blind Salamander

The Austin blind salamander (*Eurycea waterlooensis)* is found in some of the same spring sites as the Barton Spring salamander (*E. sosorum)* and has a similar natural history; however, it is more closely related to the Texas blind salamander (*E. rathbuni)* (Hillis et al., 2001). This species is rarely seen reaching the surface and is considered to be more subterranean than *E.*

sosorum. It differs in appearance from *E. sosorum* by having dark eyespots that are covered by skin, overall pale to dark lavender coloration, less costal grooves (12), narrower head at the eyespots, weakly developed tail fins, and a longer snout (Hillis et al., 2001; USFWS, 2005). This species is found in Old Mill Spring with minimal sightings in both Eliza Spring and Barton Springs Pool (Parthenia Springs), and with no known occurrences in Upper Barton Spring (Chippindale, 1995). Hillis et al. (2001) documented, through fecal analysis and observation, that *E. waterlooensis* will take the same type of prey items as *E. sosorum* when near the surface and readily accepts small aquatic invertebrates in captivity.

This species was federally listed as endangered with designated critical habitat in August 2013 based on the same primary threats as *E. sosorum* (USFWS, 2013a and 2013b). Degradation in water quality due to increased urban growth is listed as the primary threat to the species (USFWS, 2010).

According to USFWS (2010) other threats include the following:

- Alteration of the hydrologic regime.
- Increased impervious cover over the watershed.
- Increased stormwater flows.
- Stream warming.
- Increased sedimentation.
- An entirely aquatic lifestyle and limited range that make it vulnerable to various forms of environmental degradation.
- Groundwater contamination including hazardous spills, contaminated runoff, and subterranean water flow.
- Lack of a comprehensive plan.
- Lack of adequate regulatory mechanisms to protect the Austin blind salamander.
- Collection of specimens for study, captivity, or commercial sale beyond the City captive breeding program.

Little is known about the life history of the Austin blind salamander because this species spends most of its life in the subterranean habitat of Eliza, Old Mill, and Parthenia Springs (Hillis et al., 2001). Information on this species is limited as a result. What is known comes from City monthly surface habitat surveys, starting in 1998, which do not encompass any subterranean surveying efforts. Taking all four sites into account, their abundance has ranged from 0-43 specimens with a mean density of 0.001 per ft^2 (Dries, 2012).

3.11 SOCIOECONOMIC

Socioeconomic characteristics include demographic traits (population, housing, income, etc.) and economic factors for the local area. The socioeconomic resources evaluated for this assessment include the City of Austin and Travis County.

3.11.1 Demographics

In 2010, the population of Austin was 790,390, as comprised from 354,241 housing units, with an average of 2.35 persons per household. Since 2000, the total population has increased by 20.4% (USCB, 2012a). A comparison of socioeconomic data for the Project Study Area is provided in Table 3-10.

Table 3-10
Summary of Socioeconomic Data for the Project Study Area

	City of Austin	Travis County
Total Population (2010)	790,390	1,024,266
Housing Units	354,241	441,240
Persons per household	2.35	2.45
Median household income ($)	50,520	54,074
Persons below poverty level (%)	18.4	16.2

Source: USCB, 2012a; USCB, 2012b.

The reported 2010 median household income for Austin ($50,520) is slightly above the State of Texas average ($48,646) (USCB, 2012a). The Hispanic population comprises approximately 35% of the city population, though the total minority population is just over 50% of city population. Population demographic information for the Project Study Area is provided in Table

3-11. The age demographics for the city of Austin and Travis County are presented in Table 3-12.

Table 3-11
Population Demographics of the Project Study Area

	City of Austin	Travis County
White (%)	68.3	69.3
Black (%)	8.1	8.5
American Indian and Alaskan Native (%)	0.9	0.8
Asian (%)	6.3	5.8
Native Hawaiian and Other Pacific Islander (%)	0.1	0.1
Persons reporting two or more races (%)	3.4	3.3
Persons of Hispanic or Latino origin (%)	35.1	33.5
White persons (not Hispanic) (%)	48.7	50.5

Source: USCB, 2012a; USCB, 2012b.

Table 3-12
Age Demographics of the Project Study Area

	City of Austin	Travis County
Age under 5	57,982	75,774
Age 5 to 19	144,617	201,684
Age 20 to 59	502,465	631,051
Age over 60	85,326	115,757
Median Age	31	31.9

Source: USCB, 2012c; USCB, 2012d.

3.11.2 Local Economy

The 2010-2011 City budget included $650.2 million to provide public safety, recreation, culture, and other needed services to Austin through the general fund, approximately 23% of the overall City-approved budget. For budgetary purposes, the City of Austin further classifies public recreation as a business-type activity, as function-related user fees or charges are intended to recover all or a significant portion of operational costs. Expenses associated with public recreation as a business-type activity for the 2010-2011 fiscal year was $9,715,000, while program revenues were $12,809,000, resulting in a net of $3,094,000 and representing a profit of approximately 32% (COA, 2010b).

The total fee-based revenue generated from Barton Springs Pool entry fees for the 2010-2011 season was $1,412,377.33. Revenue generated from Barton Springs Pool operations is significantly greater than revenue generated from the nearby Deep Eddy Pool ($296,919.77) due to the fewer number of visitors (COA, 2012c). Entry fees to Barton Springs Pool are provided in Table 3-13. Profit from the Barton Springs Pool is approximately 37%, with operation costs of $52,209.68 for contractual and commodity expenses and $838,528.20 in salaries (COA, 2012g). Parking amenities adjacent to Barton Springs Pool are available within Zilker Park for $3.00 per day per car. Additionally, an independently operated concession is located immediately adjacent to the Barton Springs Pool, within Zilker Park. While not operated by the City, the concession operator maintains permits with the City that include a percentage of the generated revenues. The revenue provided to the City from concession operations for the 2010-2011 fiscal year was $138,024.00 (COA, 2012h). Although, the City does not track what percentage of concession revenue is directly attributable to the Barton Springs Pool, it is reasonable to assume that a portion of this revenue is generated by visitors to the pool. Therefore, total revenue for the 2010-2011 fiscal year generated by the City of Austin related to the Barton Springs Pool ranged from $1,412,377.33 to $1,550,401.33 (COA, 2012c; COA, 2012h). The City currently employs six full-time, year-round employees. Additionally, the City employs 20-30 temporary/seasonal employees for Barton Springs Pool during the winter months and increases employment to 40 to 50 during the summer open season (COA, 2012g).

Table 3-13
Barton Springs Pool Entry Fees

Fee Type	Day	Summer Pass (Memorial Day - Labor Day)
Senior	$1	$60
Adult	$3	$180
Junior (12-17)	$2	$120
Child (Under 11)	$1	$60
Family of Four	N/A	$350
Parking Fee*	$3	N/A

*Parking charges apply to weekends in March through September.
Source: COA, 2012b.

According to the 1998 HCP, the City deposits $45,000 annually to a conservation and research fund for the Barton Springs salamander. The funds were obtained from revenues generated by Barton Springs Pool and any donation from a group or individual. In addition to the $45,000 annual deposit, the City contributed an additional $10,000 to the fund under the requirements outlined in the 1998 HCP (USFWS, 1998).

3.12 CULTURAL RESOURCES

Cultural resources include archeological sites, historical buildings, structures and objects, as well as historic districts, cultural landscapes, and traditional cultural places. The cultural resources at the Barton Springs Complex and in the immediately surrounding vicinity are subject to the provisions of the Antiquities Code of Texas (Texas Natural Resource Code, Title 9, Chapter 191), which requires state agencies and political subdivisions of the state to notify the Texas Historical Commission (THC) of ground-disturbing activity on public land. Counties, municipalities, and other local government agencies must notify the THC prior to commencing any project on public land that will involve 5 or more acres of ground disturbance; 5,000 or more cubic yards of earth moving; will occur in a historic district; or will affect a recorded archeological site. State agencies must also notify the THC prior to making modifications to or demolishing any building 50 years old or older. The THC issues antiquities permits for archeological studies or work at designated buildings and structures. An archeological permit may be issued only to a professional archeologist as defined in Rules of Practice and Procedure for the Antiquities Code of Texas.

The THC is also the state agency responsible for conducting reviews authorized under the National Historic Preservation Act of 1966 (Public Law 89-665; 16 USC 470 et seq). Any federally funded, assisted, or approved project must undergo a review to consider the effects of the project on historic or cultural resources that are listed or are eligible for listing on the National Register of Historic Places (NRHP).

Within the City of Austin, alterations to any building or structure designated as a City of Austin Historic Landmark requires review by the City of Austin Historic Landmark Commission (City of Austin Land Development Code Ch. 25-11-212).

3.12.1 Historical Overview

Humans have occupied the area at and around the Barton Springs Complex for at least 10,000 years, as is evidenced by archeological excavations (Nickels et al., 2010). The first recorded occupation of the area was in 1730 when the Spanish established a mission near the Colorado River (Nickels et al., 2010). The area at and around the Barton Springs Complex was included in a league of land that was granted to Henry P. Hill in 1835, a colonist of Empresario Benjamin R. Milam. In the late 1830s, William Barton settled near the springs and may have operated a sawmill in 1839 (Nickels et al., 2010). After Barton's death in 1840, the property around the springs had no permanent settlers until Ashford B. McGill began purchasing property in the area in 1855 (Nickels et al., 2010). McGill built a ranch house on the property but sold the property in 1860 to Phineas de Cordova, who later sold the property to William C. Walsh in 1867 (Nickels et al., 2010). The heirs of William C. Walsh eventually sold the land to Andrew J. Zilker in 1901 (Nickels et al., 2010). During the time between McGill and Zilker's ownership of the property, several people sought to use the water power of Barton Creek for mills. G. T. Rabb, who owned the land on the south side of the creek, leased the power rights to Michael Paggi to operate an ice factory and grist mill on the creek sometime in the 1870s (Nickels et al., 2010). Rabb eventually sold this mill to Jacob Stern, and it was operated under the name of Barton Springs Feed Mill (Nickels et al., 2010). In 1879, Messrs. English, and Darr built a flour mill at the creek (Nickels et al., 2010). The springs at Barton Creek also attracted visitors from

Austin as early as the 1840s due to its appeal as a recreation spot (Nickels et al., 2010). In 1901, Austin entrepreneur Andrew J. Zilker purchased the property around the springs from the Walsh family. Zilker began acquiring adjacent land, and by 1913 he owned several hundred acres surrounding the Barton Springs Complex (Nickels et al., 2010). Zilker farmed this property on a limited basis, and also leased the land for industrial and recreational purposes (Nickels et al., 2010). In 1918, Zilker deeded 35 acres of land that included the Barton Springs Complex and adjacent to properties to the City of Austin (COA, 2011).

3.12.2 Archeological Sites

Archaeological deposits around Barton Creek were identified as early as 1928, when J. E. Pearce conducted archaeological investigations on the south side of Barton Creek. The site he investigated is now known as 41TV2. Originally, this designation encompassed areas on both banks of the creek, but in 1986 the portion on the north bank of Barton Creek was re-designated as site 41TV1364 (the Vara Daniel Site). Today, site 41TV2 delineates about 7 acres on the south side of the creek, and site 41TV1364 delineates about 60 acres between the creek and the Colorado River (THC, 2012). Site 41TV1364 has been intensively investigated, beginning in 1986 when a study was conducted in advance of the South Austin Outfall Relief Main project. That study consisted of 22 backhoe trenches dug to a depth of 11.5 ft and documented stratified archaeological components representing the Late Paleoindian through Historic periods (Nickels et al., 2010). Follow-up surveys in 1989 and 1992 excavated seven exploratory trenches and 14 auger holes reaching a maximum depth of 21.3 ft. Through radiocarbon dating and artifact recovery, this investigation confirmed the presence of stratified buried deposits representing the Paleoindian through Historic period (Nickels et al., 2010). In 2003, the City of Austin sponsored additional survey level investigations consisting of 21 cores, and three large diameter (43-inch) holes up to 27.9 ft deep. Recovered items included lithic artifacts and bone fragments, plus fire–cracked rocks and a charcoal sample. The work confirmed the earlier studies and concluded that the site contained significant, highly stratified archeological deposits dating to the Paleoindian period through the present. In 2003 and 2006, test excavations were conducted to refine the placement of the proposed South Austin Outfall Relief Main (Nickels, et.al, 2010). Additional auger holes were excavated to a depth of 21.3 ft below ground surface, yielding abundant stone artifacts including projectile point and other stone tools. Samples yielded dates ranging from about 1,000 BC to about 11,000 BC (Nickels, et.al, 2010).

The Paleoindian deposits in the vicinity of the Barton Springs Complex are of great archaeological interest. Such deposits can be especially valuable cultural resources because they contain information about the very earliest human occupation of North America. Paleoindian deposits are often found in association with natural springs, and their presence in association with Barton Springs Complex has been confirmed (Nickels, et.al, 2010). Due to their great age, Paleoindian deposits are rare and have an inherently greater chance of being destroyed, severely disturbed, or obscured than do younger deposits, both through natural processes (erosion, deep burial) as well as anthropogenic processes (development, landscape modifications) (Nickels, et.al, 2010). The THC agreed to allow construction of the South Austin Outfall project with the stipulation that the City of Austin would sponsor an archaeological data recovery excavation (Nickels et al., 2010). That work was conducted in 2009 and targeted the Paleoindian component under the Zilker Park Rugby Fields. The investigation mechanically removed 48 cubic meters of sediment and manually excavated 32 cubic meters of sediment between 9.8 ft and 16.4 ft below the modern ground surface. Recovered material included 1,328 pieces of chipped stone; 50 pieces of burned rocks; more than 20,000 snails; and over 300 mussel shell pieces. Five buried features were discovered including two burned rock hearths, an occupation surface, a chipped stone concentration, and a stain. After completion of field work, dating was accomplished using 14 radiocarbon assays of bulk sediment and isotope assays on mussel shells. Analysis of the chipped stone assemblage identified an early Paleoindian, Clovis-like, occupation dating to about 10,905-9,840 before present (BP) at the deepest level. Above this, a Late Paleoindian occupation dating to about 9,634-9,230 BP is seen and an Early Archaic occupation was identified above this depth. A paleoenvironmental reconstruction suggests that from about 10,480 to 9,840 BP, the site area transitioned from a gravel point bar to a lower flood basin, then to an upper flood basin with terrace accretion deposits by around 9,600 BP. Finally, generally finer terrace deposits covered the immediate area through about 8,600 BP and later (Nickels et al., 2010).

Comparable excavations have not been conducted on site 41TV2. Although the underlying geology and Holocene stratigraphy is different on the south bank of Barton Creek (not being as heavily influenced by the Colorado River), the several springs were undoubtedly the most important natural resource tethering prehistoric populations to the general location, and comparable Paleoindian deposits are likely (Nickels et al., 2010).

3.12.3 Historic Districts

During the 19th and 20th centuries, the industrial and later recreational uses of springs at the Barton Springs Complex resulted in construction of a variety of buildings and structures. Recognizing these, the Barton Springs Historic District was listed on the National Register of Historic Places in 1985. In addition to the archeological elements discussed above at 41TV2 and 41TV1364, historic elements included within the district are the bathhouse, the pool and dams, the surrounding springs, plus masonry walls and associated structures. In 1997, the much larger Zilker Park Historic District was listed on the NRHP. This district encompasses the Barton Springs District as well as all of Zilker Park, including several hundred acres between Barton Creek and the Colorado River. Elements of the districts that are in immediate proximity to the actions proposed or which may be affected by the proposed alternatives are discussed below; elements that are not in proximity and/or will not be affected (such as the Zilker Ponds) are not discussed.

3.12.3.1 Parthenia Spring and Barton Springs Pool

The Barton Springs Pool, fed by Parthenia Spring, is defined upstream and downstream by concrete dams across Barton Creek. Prior to construction of these permanent dams in 1930, temporary rock dams were built across each spring to form the pool (COA, 2008b). Parthenia Spring, located on the south bank across from the diving boards, feeds directly into the Barton Springs Pool and is currently the primary source of water for the pool, except when flooding overtops the upstream dam. The bottom of the Barton Springs Pool is largely natural bedrock, except where natural fissures have been filled with concrete in the 1980s. The current Barton Springs bathhouse was built in 1947, replacing an earlier wood frame bathhouse. The Barton Springs Pool, bathhouse, and dams are all identified as contributing elements in the 1985 listing of the Barton Springs Historic District, and in 1990 the Barton Springs Pool and Bathhouse were designated as City of Austin Historic Landmarks (COA, 2008b). Today, the Parthenia Spring and Barton Springs Pool are key elements in a cultural landscape that is unique to the City of Austin (COA, 2008b).

3.12.3.2 Eliza Spring

On the north bank of the creek, Eliza Spring was largely unaltered in character until 1903 when Andrew Zilker enclosed the spring by a large, stepped masonry amphitheater for use as a meeting place for the Benevolent and Protective Order of Elks, Austin Lodge #201 (COA, 2008b). The spring originally drained through a slot in the southeast wall and then flowed unobstructed to the main Barton Springs Pool. In 1975, this outflow was diverted into a bypass tunnel and the slot was partially blocked with new masonry. In addition, the original amphitheater walls have been raised several times with poured concrete and cut limestone construction. The amphitheater is identified as a contributing element in the 1985 listing of the Barton Springs Historic District. After the 1997 listing of the salamander, the amphitheater was surrounded by a chain-link fence intended to restrict public access to the salamander habitat (COA, 2008b).

3.12.3.3 Old Mill Spring

Located on the south bank of the creek, the Old Mill Spring is named for the grist mill that was constructed and operated by Michael Paggi in the early 1870s. The first dam across the spring outflow was constructed of limestone with wooden gates to control the water flow. About that time, the spring was described as a pool approximately 15 ft deep and 200 ft in circumference (COA, 2008b). The mill experienced a series of owners and operators, but was destroyed by fire in 1886. The property was acquired by Andrew Zilker in 1907 who donated it to the City in 1917. In 1938, the National Youth Administration (NYA) constructed a series of terraced flagstones and concentric retaining walls around the spring. As a result, the spring became known as the Sunken Gardens and became a locale for gathering and picnicking. The Sunken Gardens is identified as a contributing element in the 1985 listing of the Barton Springs Historic District. Following the 1997 listing of the Barton Springs salamander, the innermost rock wall was surrounded by a steel fence intended to restrict public access to the salamander habitat (COA, 2008b).

3.12.3.4 Upper Barton Spring

The Upper Spring is located in a natural environment upstream from the Barton Springs Pool. No construction has been attempted here, and no cultural resources are known in association with the Upper Barton Spring (THC, 2012).

3.13 CLIMATE

The Project Study Area is located in Travis County, which has a climate characterized by hot summers and mild winters. The county receives an average of 34.51 inches of rain a year. July is the hottest month of the year, with an average high temperature of 96° Fahrenheit (F), whereas January is the coldest month of year with an average low temperature of 37.3°F (NOAA, 2011).

GHGs are components of the atmosphere that trap heat relatively near the surface of the earth, and therefore contribute to the greenhouse effect and global warming. Most GHGs occur naturally in the atmosphere, but increases in their concentrations result from human activities such as the burning of fossil fuels. Global temperatures are expected to continue to rise as human activities continue to add carbon dioxide, methane, nitrogen oxide, and other greenhouse (or heat-trapping) gases to the atmosphere. Since 1900, the Earth's average surface air temperature has increased by about 1.2ºF to 1.4ºF. The warmest global average temperatures on record have all occurred within the past 10 years, with the warmest year being 2005 (USEPA, 2011a). Most of the U.S. is expected to experience an increase in average temperature. Precipitation changes, which are also very important to consider when assessing climate change effects, are more difficult to predict. Whether or not rainfall will increase or decrease remains difficult to project for specific regions (IPCC, 2007; USEPA, 2011b). The extent of climate change effects, and whether these effects prove harmful or beneficial, will vary by region over time, and with the ability of different societal and environmental systems to adapt to or cope with the change. Human health, agriculture, natural ecosystems, coastal areas, and heating and cooling requirements are examples of climate-sensitive systems. Rising average temperatures are already affecting the environment. Some observed changes include shrinking of glaciers, thawing of permafrost, later freezing and earlier break-up of ice on rivers and lakes, lengthening of growing seasons, shifts in plant and animal ranges, earlier flowering of trees, larger fluctuations in temperature, and possible prolonged periods of extensive precipitation or drought (IPCC, 2007; USEPA, 2011b).

Impacts of climate change on karst systems is a relatively new area of study. Simulations of climate change on the Edwards Balcones Fault Zone aquifer indicated that climate change could exacerbate water shortages in the aquifer zone, even if pumping of water by humans remains at present average levels (Loaiciga et al., 2000). Studies conducted in other karst systems have shown similar detrimental results. A simulation conducted in the United Kingdom indicated that climate change could influence three key aspects of karst geomorphology: hydrology, dissolution rates, and the operation of other geomorphological processes such as mass movements (Viles, 2004).

The effects of climate change are particularly important for the scope of this project, as the Barton Springs Complex and associated salamander habitat are susceptible to drought conditions. During past times of extreme drought, water levels in the springs have dropped and Eliza and Old Mill Springs have both gone dry, resulting in exposure of salamander habitat and an increase in salamander mortality rate (COA, 2013).

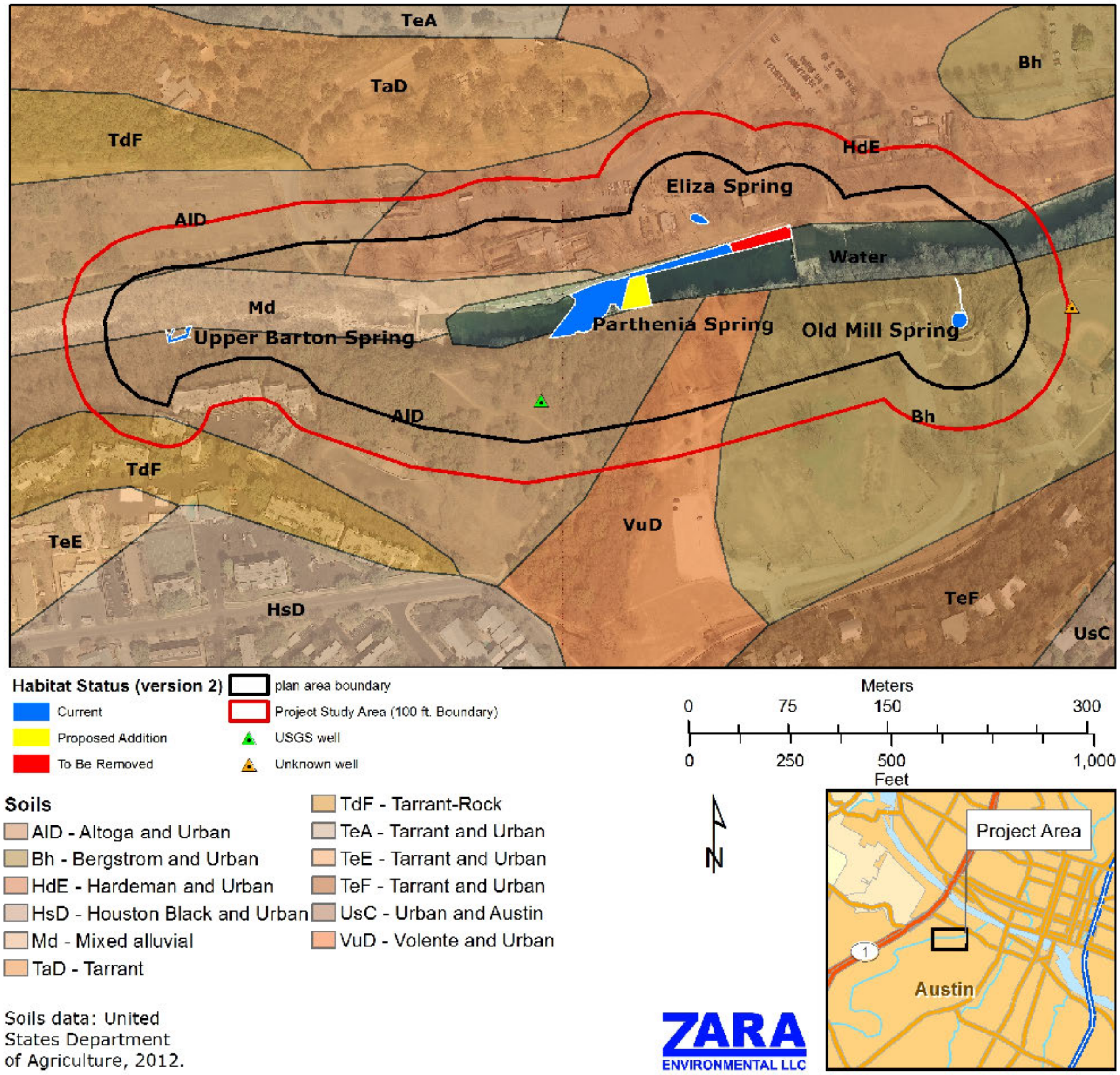
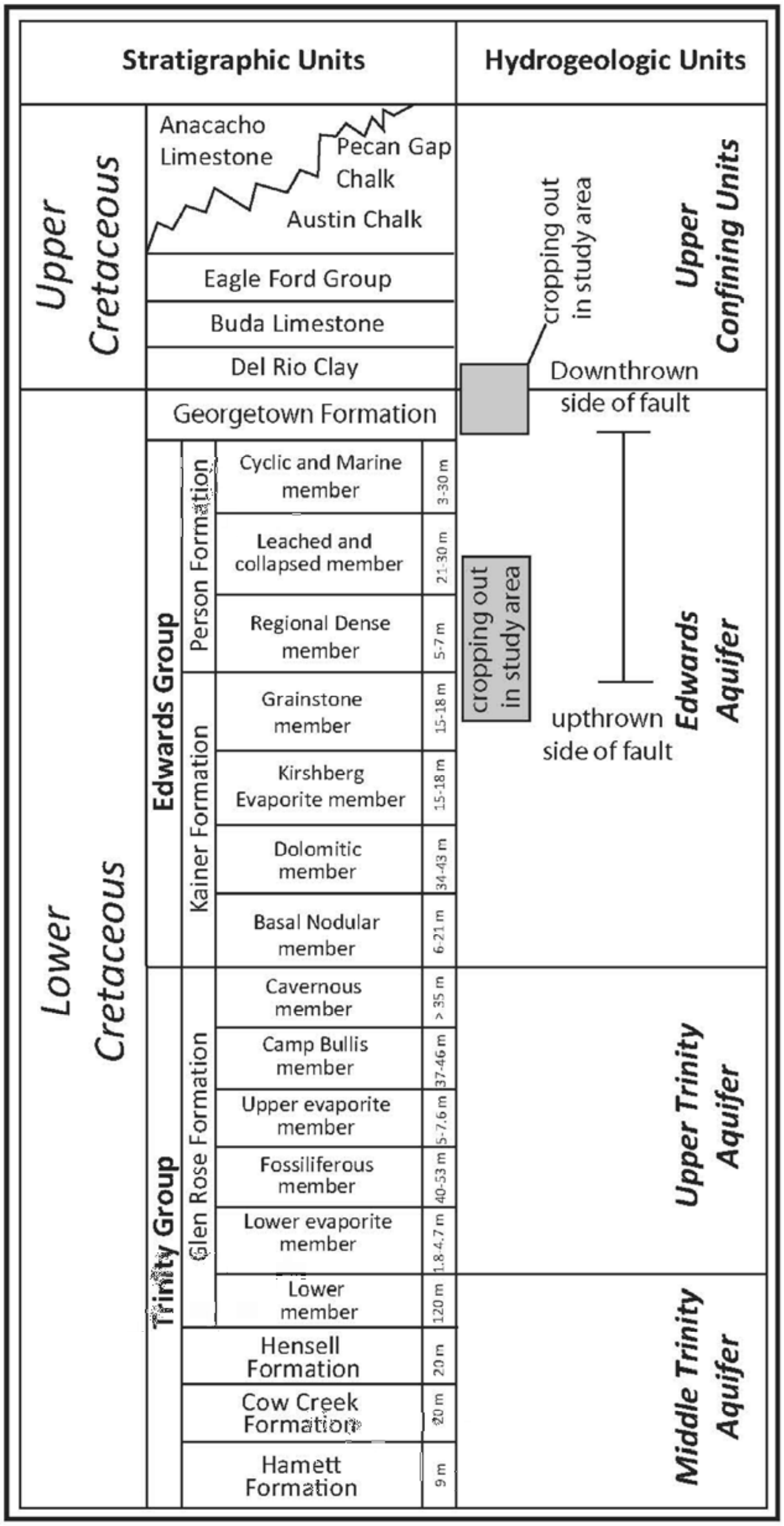


Figure 3-1
Soil Types within the Project Study Area
Barton Springs Salamander HCP
City of Austin - Zilker Park
Travis County, Texas

DATE	PROJECT NO	SCALE
SEPTEMBER, 2012	06141.043.002.0007	AS SHOWN

SOURCE: Zara Enviromental LLC.

FILE: I:\GIS Project Files\06141_City of Austin\043_Barton Springs Salamander\0002_Mapping\mxd\Figure 3-1.mxd 9:53:01 AM 9/7/2012 Herrinm



SOURCE: Zara Enviromental LLC.

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Figure 3-2
Stratigraphic Section
of the Cretaceous Rocks
Barton Springs Salamander HCP
City of Austin - Zilker Park
Travis County, Texas

DATE	PROJECT NO	SCALE
MAY, 2012	06141.043.002.0007	AS SHOWN

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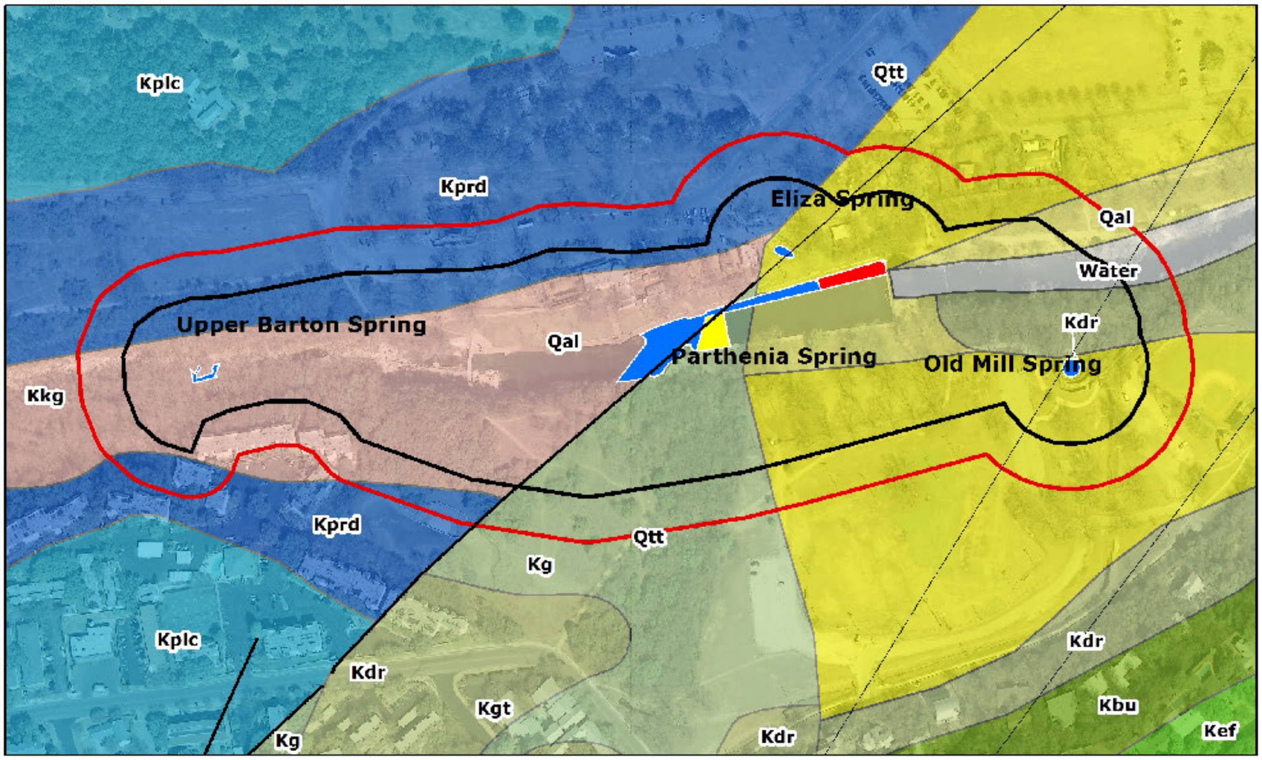


Habitat Status (version 2)
- Current
- Proposed Addition
- To Be Removed

- plan area boundary
- Project Study Area (100 ft. Boundary)

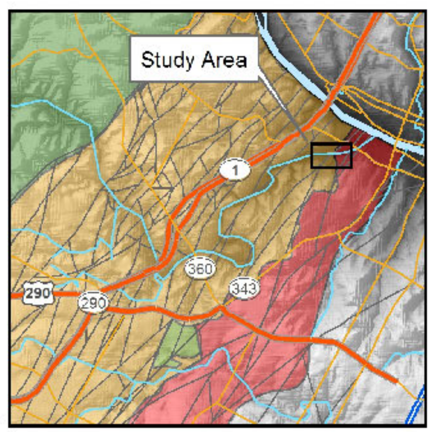
N

Meters: 0, 75, 150, 300
Feet: 0, 255, 510, 1,020

- fault-certain
- fault-certain (outside recharge zone)
- Qt - Qal - Qtt -Fluviatile Terrace
- Kef - Eagle Ford Formation
- Kbu/Kb - Buda Limestone
- Kdr - Del Rio Clay
- Ked - Edwards undivided
- Kdr - Del Rio Clay
- Kg - Georgetown Formation
- Kpcm - Person Formation - Cyclic and Marine Member
- Kplc - Person Formation - Leached and Collapsed Member
- Kprd - Person Formation - Regional Dense Member
- Kkg - Kainer Formation - Grainstone Member

Geology sources: TNRIS, Geologic Atlas of Texas, 2010. USGS SIM, 2873,2005

Edwards Aquifer zones
- Contributing Zone
- Contributing Zone within the Transition Zone
- Recharge Zone
- Transition Zone



data source: TCEQ Edwards Aquifer zones, 2000.

Figure 3-3
Surface Geology of Project Study Area
Barton Springs Salamander HCP
City of Austin - Zilker Park
Travis County, Texas

DATE	PROJECT NO	SCALE
SEPTEMBER, 2012	06141.043.002.0007	AS SHOWN

SOURCE: Zara Enviromental LLC.

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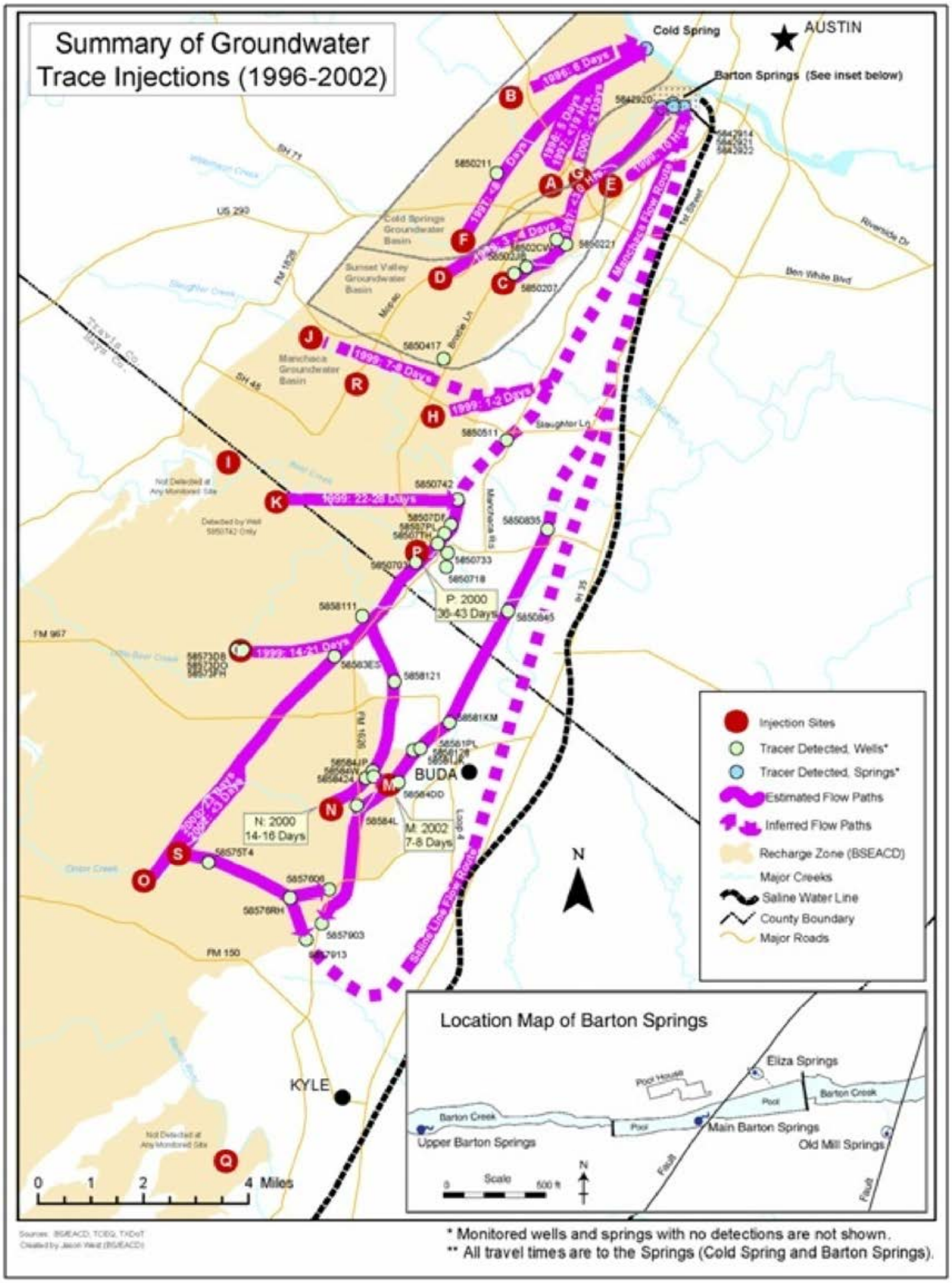

Figure 3-4
Groundwater Flowpaths in the Barton Springs Segment
Barton Springs Salamander HCP
City of Austin - Zilker Park
Travis County, Texas

DATE	PROJECT NO	SCALE
MAY, 2012	06141.043.002.0007	AS SHOWN

SOURCE: Zara Enviromental LLC.

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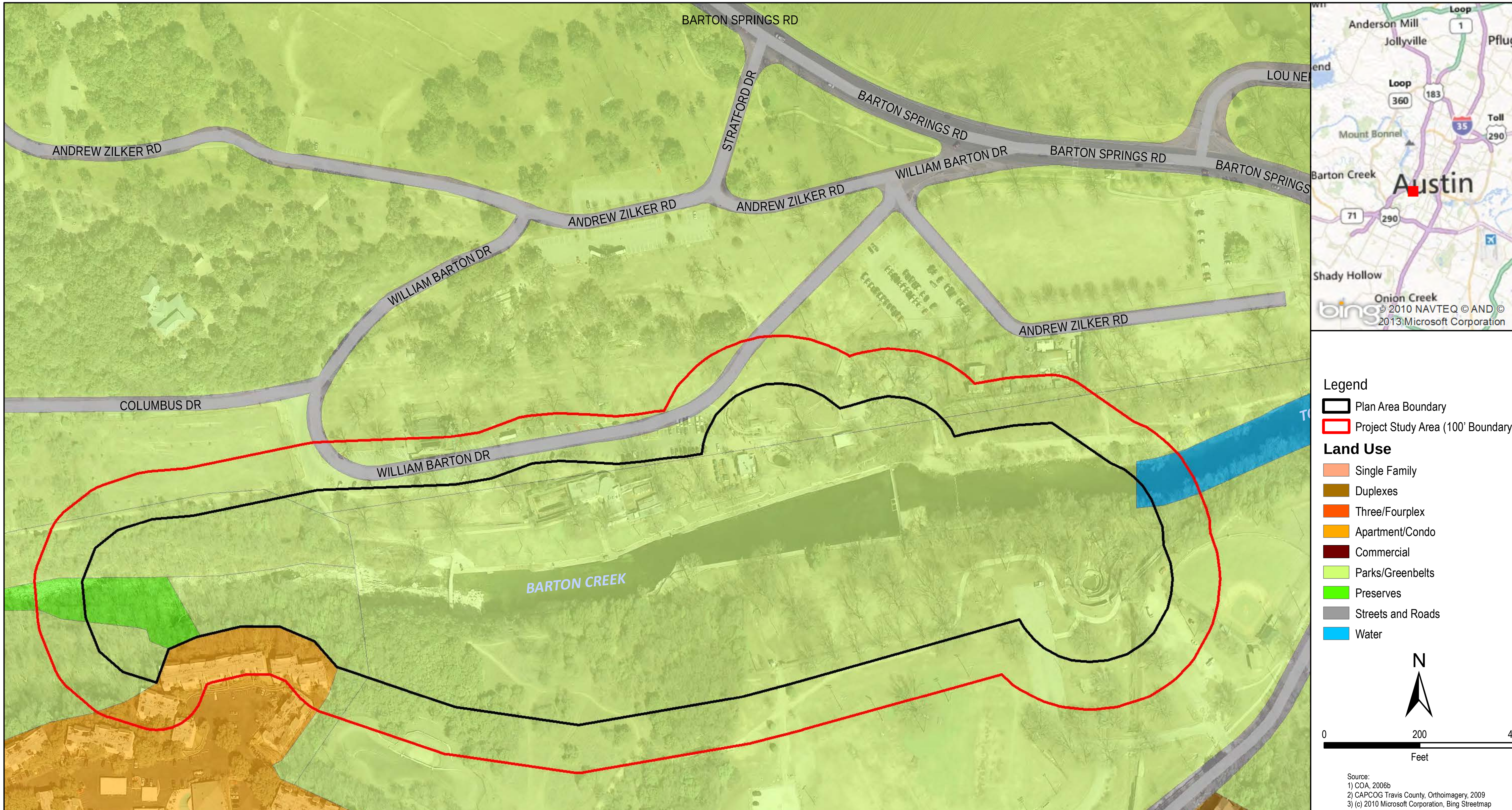
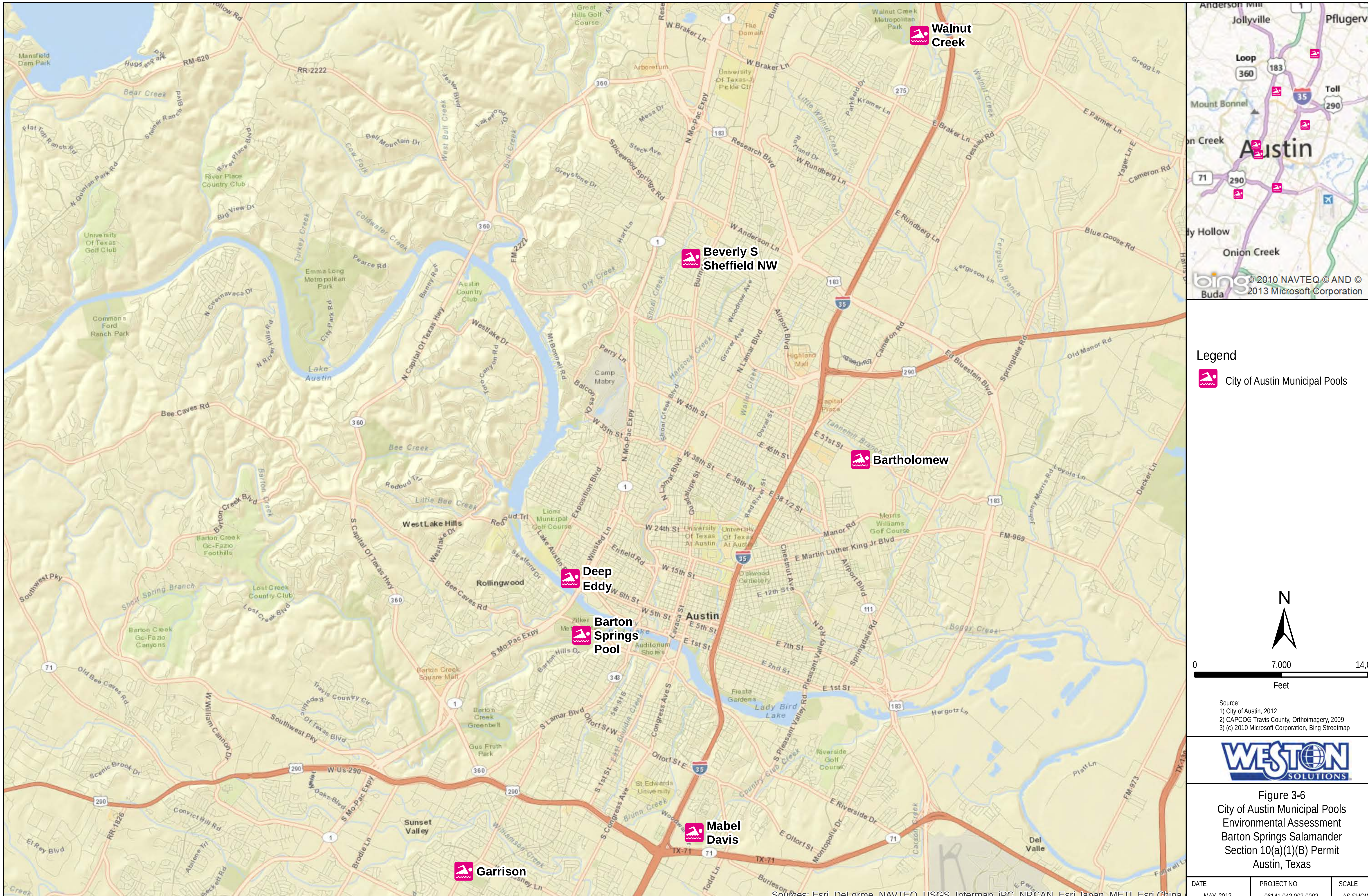


Figure 3-5
Land Use Map
Environmental Assessment
Barton Springs Salamander
Section 10(a)(1)(B) Permit
Austin, Texas

DATE	PROJECT NO	SCALE
MAY, 2012	06141.043.002.0002	AS SHOWN

FILE: I:\GIS Project Files\06141_City of Austin\043_Barton Springs Salamander\0002_Mapping\mxd\Figure 3-5 Land Use Map.mxd 10:02:06 AM 8/29/2013 perrint



Legend

City of Austin Municipal Pools

N

0 7,000 14,000

Feet

Source:
1) City of Austin, 2012
2) CAPCOG Travis County, Orthoimagery, 2009
3) (c) 2010 Microsoft Corporation, Bing Streetmap

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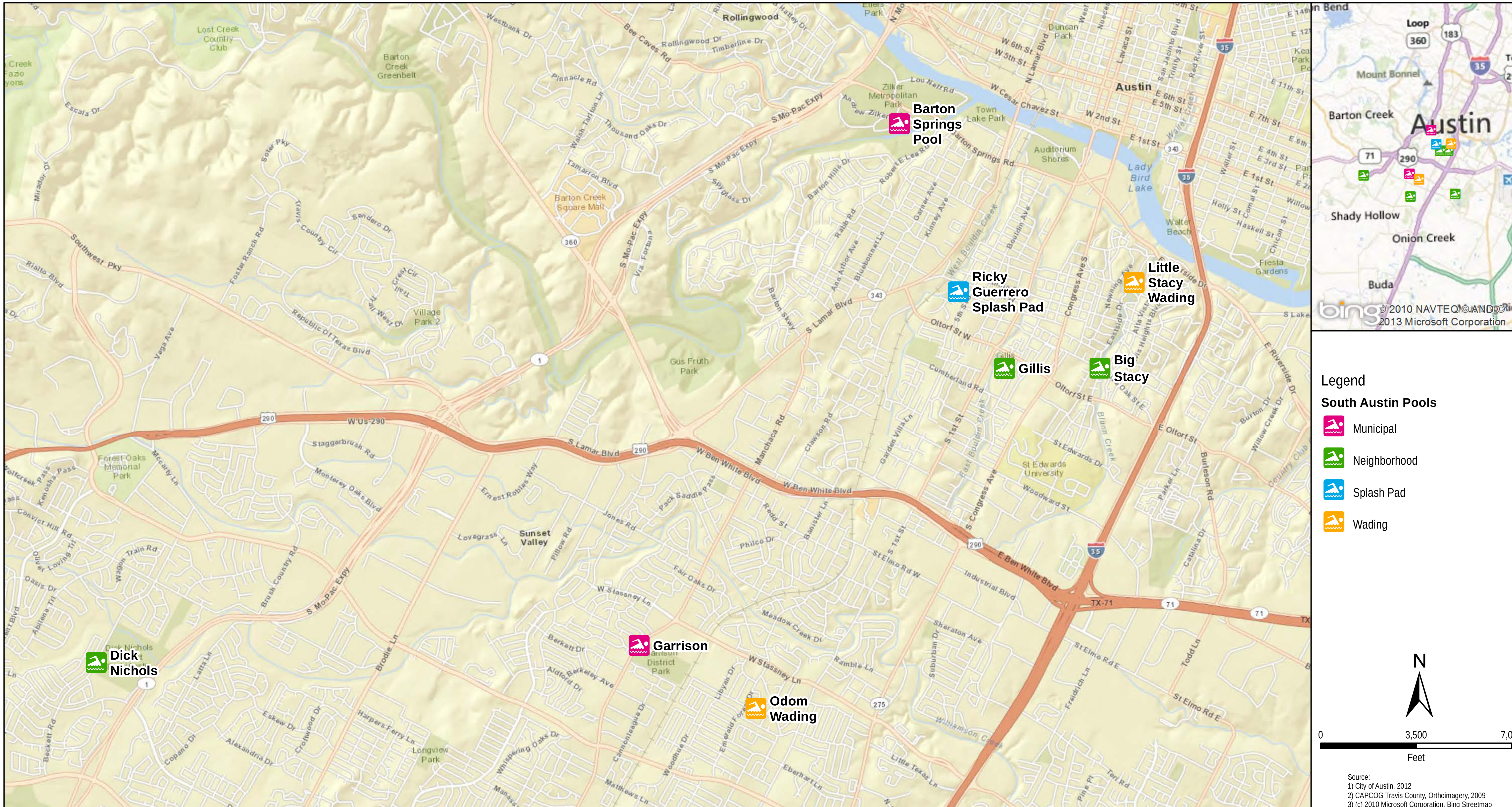
Figure 3-6
City of Austin Municipal Pools
Environmental Assessment
Barton Springs Salamander
Section 10(a)(1)(B) Permit
Austin, Texas

DATE	PROJECT NO	SCALE
MAY, 2012	06141.043.002.0002	AS SHOWN

FILE: I:\GIS Project Files\06141_City of Austin\043_Barton Springs Salamander\0002_Mapping\mxd\Figure 3-6 City of Austin Municipal Pools.mxd 10:05:47 AM 8/29/2013 pentint



WESTON SOLUTIONS

Figure 3-7
South Austin Pool Facilities
Environmental Assessment
Barton Springs Salamander
Section 10(a)(1)(B) Permit
Austin, Texas

DATE	PROJECT NO	SCALE
MAY, 2012	06141.043.002.0002	AS SHOWN

FILE: I:\GIS Project Files\06141_City of Austin\043_Barton Springs Salamander\0002_Mapping\mxd\Figure 3-7 South Austin Pool Facilities.mxd 10:08:43 AM 8/29/2013 permit

4. ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This section describes the environmental effects of each alternative identified in Section 2. The No Action Alternative would result in the expiration of the existing permit, and no new permit would be issued. Maintenance of the Barton Springs Pool would only continue until the current permit expires. Alternative 2, the Preferred Alternative, includes the issuance of a renewed ITP for the Barton Springs salamander (*Eurycea sosorum*) and the potential future take of the Austin blind salamander (*Eurycea waterlooensis)*, as described in the major amendment to the HCP.

The alternatives were evaluated for direct and indirect effects that may occur upon implementation of the proposed action. Further clarification of the terms and procedures specific to the NEPA process are defined and described below.

<u>Definition of an Impact</u> – The term impact and effect are considered synonymous in this EA. An impact, or effect, is defined as a modification to the environment, as it presently exists (or if describing a past effect as it existed at the time of that action), that is brought about by an outside action. Impacts can vary in significance from no change or slight discernible change, to a full modification or elimination of the environmental condition.

<u>Types of Impacts</u> – Impacts may be major, minor, negative, or beneficial and may apply to the full range of natural, aesthetic, historic, cultural, and economic resources to the Barton Springs Complex and the surrounding area. They may be further classified as short-term or long-term, direct or indirect, and evaluated in terms of intensity or severity (40 CFR and 30 CFR):

- Short-term impacts are considered to be 1 year or less, are anticipated to dissipate over time, and may not contribute to cumulative impacts.
- Long-term impacts are considered to be those that last beyond 1 year and have the potential to continue into perpetuity.
- Direct impacts are caused by an action and occur at an immediate time and place.
- Indirect impacts are caused by the Proposed Action and occur later in time or farther in distance, but are reasonably foreseeable. Indirect impacts may include induced changes in the pattern of land use, population density, or growth rate, and related effects on air, water, and other natural resources and social systems.

4.2 WATER RESOURCES AND QUALITY

An impact to water resources and water quality would be considered major in that it significantly increases or decreases stream flow or spring flows at the site, or significantly decreases surface water or groundwater quality.

4.2.1 No Action Alternative

Under the No Action Alternative, maintenance at the Barton Springs Pool and springs would cease, leading to accumulation of sediment, leaf litter, trash, and other debris. Water quality at the Barton Springs Pool would be especially affected due to continued uncontrolled flooding and subsequent accumulation of sediment, gravel, and large flood debris. This accumulation would result in a decrease in depth and volume of the Barton Springs Pool, likely leading to increased water temperature and turbidity, along with growth of algae and macrophytes. The resulting safety issues caused by debris and plant and algal matter would require permanent closure of the Barton Springs Pool to the public, as described in Section 7.1 of the HCP (Appendix A), resulting in a long-term, direct impact to the recreational use of the pool as a water resource.

4.2.2 Preferred Alternative

Under the Preferred Alternative, availability of water resources for human use will be maintained through the actions outlined in Subsections 6.1.3 and 6.1.4 of the HCP (Appendix A). These actions include infrastructure improvements and revised Barton Springs Pool operations and maintenance procedures that are designed to restore and/or maintain, as much as is feasible, the natural flow regime. Changes to the flow regime will reinforce the “stream-like” character of the Barton Springs Pool, which will in turn reduce algae and sediment levels in the pool and foster diversity of aquatic species (Appendix A, see Appendix E of the HCP – “Justification for Proposed Conservation Measures”). Overall, these efforts will generally provide a small benefit to water quality as well as improved recreational use of these water resources.

The Preferred Alternative will reduce impacts to water quality through the actions identified in Subsection 6.1.2 of the HCP. These actions include enhanced stormwater BMPs and spill response required by the City Stormwater Management Plan. Water quality in the Barton Springs Pool will be further maintained by management of flood flows through the pool as identified in Subsection 6.1.3.2 of the HCP. The bypass tunnel would continue to be operated, while flood waters in excess of the approximate 500 cfs capacity of the bypass tunnel would overtop the upstream dam and enter the Barton Springs Pool. Gates on the Lower Dam will be opened when flooding is imminent to allow floodwater to pass through the Barton Springs Pool in a manner and velocity similar to more natural creek flood flow. The velocity of the floodwater with the gates open will limit sedimentation and, for some flood events, scour a degree of sediment and vegetation from the Barton Springs Pool.

There are no significant negative impacts to water resources and water quality from human use of water resources as described in the amended HCP. No changes in the Parthenia Spring's flow, Barton Creek flow, or flow downstream of the Barton Springs Pool will occur related to the proposed actions. Proposed use of Barton Springs Pool (Parthenia Spring) as a source for irrigation water will have no impact on levels in the pool. The proposed maximum rate of pumping of 100 gallons per hour (0.22 cfs) is approximately 0.2% of the historic recorded low discharge from Parthenia Spring (9.8 cfs). For comparison purposes, this temporary drawdown roughly equates approximately 1.2 inches, which would not be sufficient to affect riparian zone habitat.

Maintenance impacts to Eliza and Old Mill Springs will be minimized by the Drawdown Plan developed as part of the HCP (Subsections 6.1.3.4 through 6.1.3.10). Transient increases in sediment load may result in a short-term, direct negative impact to water quality for some construction projects associated with implementation of the HCP. All projects will be developed and constructed with specific measures to limit increases in sediment load. Examples of such measures from prior projects include the use of coffer dams and sediment curtains to isolate the construction area from salamander habitat. The construction activities are regulated by both City and state environmental rules and criteria.

4.3 SURFACE WATERS INCLUDING WETLANDS

An impact to surface waters, including wetlands, would be considered significant in that it removes or adds surface water acreage to the Project Study Area. An adverse impact would involve the loss or disturbance of aquatic habitat, especially salamander habitat. A beneficial impact would improve salamander habitat.

4.3.1 No Action Alternative

Under the No Action Alternative, moderate, negative impacts to surface water would be expected. All management of the springs would cease, including removal of litter, sediment deposits, and debris within the spring, as discussed in Subsection 4.1.1 of this EA. There could be a short-term minor beneficial effect of reduced salamander mortality due to cessation of Barton Springs Pool recreational use and maintenance activities that have potential to cause incidental take. However, in the long-term, with maintenance of the Barton Springs Pool and springs discontinued and with the dams and other anthropogenic structures remaining in place, silt and sediment would build up within Barton Springs Pool (Parthenia Spring), Eliza Spring, and Old Mills Spring, making the habitat inappropriate for salamander use. Events such as flooding and droughts would result in moderate changes to the water bodies associated with the springs. Water levels and flow rates would not be maintained (using manual water releasing methods), and therefore would vary greatly due to the weather and groundwater conditions, potentially negatively impacting salamander habitat. Without management of the Barton Springs Pool structures, long-term impacts include the deterioration of anthropogenic features, including the dams, concrete beaches along Barton Springs Pool, and the amphitheaters around Eliza and Old Mill Springs. This would result in slow modification of the pool area and springs, resulting in the eventual return of the Barton Springs Pool to the natural flow of Barton Creek. Under the No Action Alternative, removal of the substrate from Old Mill Spring would also cease, allowing sedimentation and debris to build up and potentially change the surface water structure within the springs. This alternative would result in major, long-term impacts to surface water associated with the springs.

4.3.2 Preferred Alternative

Under the Preferred Alternative, impacts to surface water would be minor and beneficial. Flow regimes within and between the springs would continue to be managed to establish conditions beneficial to both species of salamander (COA, 2013). Barton Creek flow would be managed during flooding events to prevent excessive sedimentation within the Barton Springs Pool area which could otherwise cover salamander habitat. Flow would be managed by manual water releasing methods located within the dams. The surface water of the Barton Springs Pool would not change under this alternative. The underground pipe that currently connects Eliza Spring to Barton Creek would be removed. The water from Eliza Spring would flow above ground in a stream, providing a hydrologic connection from the spring to the creek that mimics the historic flow regime, adding surface water acreage and aquatic habitat to the Barton Springs Complex. The removal of debris from Old Mill Spring would continue under this alternative, resulting in the increase of surface water and flow from the spring via a surface stream.

4.4 SOILS / GEOLOGY

4.4.1 No Action Alternative

Under the No Action Alternative, maintenance activities would end at the expiration of the current permit and recreation activities in the Barton Springs Pool would likely be discontinued. A detailed account of the potential effects of the No Action Alternative on the hydrogeology in the Project Study Area is provided in Table 4-1. If no maintenance was performed on the dams forming Barton Springs Pool or the structures surrounding Eliza and Old Mill springs, these structures would begin to deteriorate and eventually fail. Failure of the structures surrounding Eliza and Old Mill springs would likely have minimal impact on the hydrogeology of the Barton Springs Complex other than to lower or completely dewater the spring pools at Eliza and Old Mill Spring, and this impact might be more severe under low flow conditions. A failure of the Barton Springs Pool dams could have a greater impact on the hydrogeology of the Barton Springs Complex.

If failure of the Barton Springs Pool downstream dam were catastrophic, it could result in rapid but short-term and localized flooding along Barton Creek downstream of the pool. This type of event may cause a temporary, but significant, increase in turbidity and suspended sediments and could cause significant erosion of the alluvial soils along the banks of Barton Creek. Failure (whether catastrophic or functional) of the upstream and downstream dams could return Parthenia Spring to a more natural flow regime that is characterized by perennial spring discharge and periodic flooding events due to heavy rainfall in the Barton Creek watershed. The absence of the dams may cause sediments to be flushed down Barton Creek rather than accumulating behind the dams during flood events.

The draining of Barton Springs Pool would cause a decrease in hydrostatic pressure at the orifice of Parthenia Spring that would result in a lowering or dewatering of the Eliza Spring Pool (COA, 2010c) and potentially Old Mill Spring Pool as well (Hauwert, 2012). The hydraulic connection between Parthenia and Eliza springs is strong and well supported by the nearly simultaneous arrival of dye at both springs during groundwater dye tracing experiments, and the nearly simultaneous arrival of stormwater constituents at Parthenia and Eliza springs.

During low flow, when discharge is less than 1.53 cubic meters per second (m^3/s), or 54 cubic feet per second (ft^3/s), flow in Eliza Spring will cease (e.g., during pool drawdowns) (COA, 2010c). When discharge is between 1.53 m^3/s (54 ft^3/s) and 2.27 m^3/s (80 ft^3/s), there will be a decrease in the water level in Eliza Spring Pool during drawdowns (COA, 2010c). Above 2.27 m^3/s (80 ft^3/s), there will be no detectable decrease in the water level of Eliza Spring (COA, 2010c).

Table 4-1
Potential Effects of the No Action Alternative on the Hydrogeology in the Project Study Area

Event		Potential Effect
Failure of Structures due to Lack of Maintenance	Failure of structures at Old Mill or Eliza springs	Lowering or dewatering of Old Mill and/or Eliza springs Pools
	Catastrophic failure of Barton Springs Pool downstream dam	Short-term localized flooding of Barton Creek, temporary increase in turbidity and total suspended solids, erosion of Barton Creek banks.
	Failure of both Barton Springs Pool dams	More frequent stream flood pulses at Parthenia Spring, less sediment trapped in Barton Springs Pool during floods.
	Draining of Barton Springs Pool	Decrease in hydrostatic pressure at the orifice of Parthenia Spring, dewatering of the Eliza Spring Pool at less than 1.53 m^3/s (54 ft^3/s) discharge, lowering of the Eliza Spring Pool between 1.53 m^3/s (54 ft^3/s) and 2.27 m^3/s (80 ft^3/s) discharge, no effect on Eliza Spring Pool over 2.27 m^3/s (80 ft^3/s) discharge, potential lowering or dewatering of Old Mill Spring Pool.

4.4.2 Preferred Alternative

4.4.2.1 Soils

Habitat improvements at Old Mill and Eliza springs include the construction of spring streams or alteration of existing streams that flow from the springs into Barton Creek. These alterations could disturb soils and alter erosion patterns slightly. If the streams are poorly designed, they could contribute to increased localized erosion and sedimentation. These changes will likely be insignificant when compared to the profound anthropogenic impacts to soils and hydrology associated with the original construction of Barton Springs Pool and facilities beginning in the early 1900s (COA, 2013).

4.4.2.2 Geology

A search of TCEQ records shows that no recharge features have been identified in the Project Study Area; thus, project activities are unlikely to affect any recharge features. The Preferred Alternative includes several activities that could affect the hydrogeology of Parthenia Spring, Eliza Spring, Old Mill Spring, and Upper Barton Spring (collectively referred to as Barton Springs). Most of the direct effects will be a result of maintenance associated with recreational use of Barton Springs Pool and maintenance and improvement of salamander habitat. The most significant habitat improvements, and effects on the hydrogeology of Barton Springs, may result from modifications of the dams that form Barton Springs Pool and the restoration of Eliza and Old Mill springs to flowing spring pools with overland stream outlets. Activities associated with the Preferred Alternative and the effects of those activities on the hydrogeology in the Project Study Area are detailed in Table 4-2.

If recreational use of Barton Springs Pool is continued, the water level of the Pool will likely remain similar to the current level. This artificially elevated water level above Parthenia Spring increases hydrostatic pressure at the spring orifices, likely resulting in decreased discharge at Parthenia Spring and increased discharge at Eliza Spring, and potentially Old Mill Spring. Increased hydrostatic pressure associated with filling Barton Springs Pool may reduce discharge at the Barton Springs, resulting in a slower draining of the aquifer during low-flow conditions.

Barton Springs Pool will be drawn down multiple times each year for planned cleaning, planned habitat maintenance, and for storm debris removal when required. These drawdowns are known to affect the flow at Parthenia, Old Mill and Eliza springs, and these effects vary based on spring discharge (Hauwert, 2012). A hydraulic connection exists between Parthenia, Old Mill and Eliza springs. The existence of this connection is supported by the nearly simultaneous arrival of dye during groundwater dye tracing experiments, and the nearly simultaneous arrival of stormwater constituents at Parthenia and Eliza springs (COA, 2010c). The Barton Springs Fault is the likely conduit connecting the springs.

During low flow, when discharge is less than 1.53 m^3/s (54 ft^3/s), the Pool will not be drawn down (COA, 2010c). When discharge is between 1.53 m^3/s (54 ft^3/s) and 2.27 m^3/s (80 ft^3/s) there is a decrease in the water level in Eliza Spring Pool during drawdowns (COA, 2010c). Above 2.27 m^3/s (80 ft^3/s), there is no detectable decrease in the water level of Eliza Spring Pool during drawdowns (COA, 2010c). During drawdowns, water velocity in Barton Springs Pool likely increases as the cross section area through which the water flows has been reduced by the drawdown while the spring discharge has likely remained the same or increased slightly (COA, 2010c).

Because the total discharge of Parthenia, Old Mill and Eliza springs is measured by a USGS reference well, the actual change in discharge (if any) at each spring is not directly measured; therefore, discussions of spring discharge and Barton Springs Pool water velocity response to drawdowns are based on water level observations and basic principles of hydrogeology. When Barton Springs Pool is filled, the column of water above the spring orifice exerts pressure (hydrostatic pressure) likely causing more water to flow to Eliza Spring, and potentially Old Mill Spring, than would flow to them during times when the pool is drawn down. When Barton Springs Pool is drawn down, less water flows to Eliza and potentially Old Mill spring and likely more water flows to Parthenia. This is supported by decreases in the water level at Eliza Spring Pool during times when Barton Springs Pool is drawn down and subsequent increases in the water level when Barton Springs Pool is drawn up.

Cleaning of Barton Springs Pool also entails the removal of sediment and debris that has accumulated in salamander habitat. Removal is accomplished by using submersible pumps that recirculate spring water through garden hoses that are used to wash sediment and debris away from habitat areas. The pumps produce 1.4-2.1 kg/cm^2 (20-30 psi) of pressure, which is enough to dislodge any cobble that is less than 4 inches in diameter. Washing of sediments will result in decreased embeddedness and may cause a temporary increase in turbidity and total suspended solids in Barton Springs Pool.

Barton Springs Pool is bound by two dams, one at the upstream end of the pool and one at the downstream end of the pool. These dams serve two purposes: creating an impoundment for recreation purposes, and minimizing flood impacts to the Barton Springs Pool in Barton Creek. Barton Creek is currently diverted through a bypass culvert that runs along the northwest side of the Barton Springs Pool. The dams and culvert are capable of diverting floodwaters less than 14.16 m^3/s (500 ft^3/s) past the Barton Springs Pool and Parthenia Springs (COA, 2013). Flows 4.16 m^3/s (500 ft^3/s) or greater overtop the upstream dams and move through Barton Springs Pool depositing a large amount of sediment and debris. Potential modifications to the upstream and downstream dams might include reconfiguration of gated openings or addition of openings (COA, 2013). Additional gates in both dams might allow flood flows to pass through the Barton Springs Pool area less impeded, resulting in less deposition of sediment and debris in the pool area. These types of flows would be more like the natural flood pulses experienced in central Texas.

Cobble substrate may be added to create more suitable salamander habitat (COA, 2013). If the material is not composed of limestone, water chemistry may be affected. Limestone has the ability to buffer carbonic acid that is created when carbon dioxide mixes with water. If non-limestone substrate is introduced, acid buffering could be diminished and the water may become more acidic. Although this effect is likely to be negligible, it could be more pronounced during low flow periods when residence time in the Barton Springs Pool (and thus contact with the substrate) is likely greater. A detailed study would be needed to determine the extent that non-limestone cobble could alter the Barton Springs Pool chemistry (if at all).

As previously described, Eliza Spring is located on the north bank of Barton Creek adjacent to Barton Springs Pool. Currently, the elevation of water in Eliza Spring is maintained at 132.2 m (433.6 ft) above mean sea level for salamander habitat, and the elevation of water in Barton

Springs Pool is maintained at 132.1 m (433.4 ft) above mean sea level (SAM, 2009). The Preferred Alternative calls for the removal of concrete from Eliza Spring and the reconstruction of a spring run that flows into Barton Creek (COA, 2013). The removal of concrete may decrease the lower aquifer discharge threshold required for groundwater discharge at Eliza Spring. This may increase discharge at Eliza Spring and potentially reduce discharge at Parthenia Spring as more water may be diverted to Eliza Spring. If water in the spring pool is maintained at its current depth, water velocity may increase due to increased discharge. Increased water velocity may reduce sediment embeddedness.

Old Mill Spring is located on the northeast bank of Barton Creek where there are two historical structures, remnants of a mill and an amphitheater, that currently impound the spring creating a deep pool that has been filled with rubble and sediment. A constructed streambed now flows from the spring to Barton Creek. Plans include lowering of the constructed streambed to the natural stream level and removal of a concrete plug that impounds water in the spring pool. These modifications would decrease the water depth of the pool and restore a more natural flow regime to the spring than is currently afforded by the increased hydrostatic pressure and lower flow velocities caused by the deep pool impoundment. Increased water velocity may reduce sediment embeddedness. Greater discharge from the aquifer due to reduced hydrostatic pressure may lead to less conserved aquifer water during low-flow periods.

Table 4-2
Potential Effects of the Preferred Alternative on the Hydrogeology in the Project Study Area

Activity		Potential Effect
Recreation activities at Barton Springs Pool	Filling Barton Springs Pool	Increased hydrostatic pressure at Parthenia Spring orifices; greater discharge at Eliza and Old Mill Spring; slower dewatering of aquifer during low-flow conditions.
Habitat cleaning	Drawing down Barton Springs Pool under high-flow conditions	Flow velocity increases in Barton Springs Pool; discharge from Parthenia Spring may increase due to decreased hydrostatic pressure.
	Drawing down Barton Springs Pool under normal flow conditions	Flow velocity increases in Barton Springs Pool; discharge from Parthenia Spring may increase due to decreased hydrostatic pressure; water level in Eliza Spring Pool decreases; flow in Old Mill Spring may decrease.

Activity		Potential Effect
	Sediment and debris cleaning in habitat areas	Decreased embeddedness; temporary increase in turbidity and total suspended solids.
Habitat improvement	Modification of Barton Springs Pool dams to allow flood water pass-through	Higher flow velocity and decrease in sedimentation and debris accumulation in Barton Springs Pool.
	Addition of cobble substrate to habitat areas	If non-limestone, potential decrease in pH due to decreased acid buffering ability, more study needed.
	Sediment and debris cleaning in habitat areas	Decreased embeddedness contributes to improved habitat.
	Concrete removal in Eliza Spring pool	Decrease in head at Eliza Spring orifice; lower head required for groundwater discharge at Eliza Spring; increase discharge at Eliza Spring, potentially reducing discharge at Parthenia Spring; and a lower discharge threshold at which Eliza Spring stops flowing. Water velocity in the spring pool may increase due to increased discharge, which may reduce sediment embeddedness. Greater discharge may lead to less conserved aquifer water during low-flow conditions
	Constructing spring run from Eliza Spring Pool	Create spring run with increased velocity and lower embeddedness, stream erosion if improperly engineered
	Old Mill streambed lowering and concrete plug removal	Decreased pool water depth; increased water velocity, reduced sediment embeddedness; greater discharge may lead to less conserved aquifer water during low-flow, potential increased stream erosion.

4.5 AIR QUALITY

The following factors were considered in evaluating air quality: (1) the short- and long-term air emissions generated from construction and maintenance activities; (2) the type of emissions generated; and (3) the potential for emissions to result in ambient air concentrations that exceed one of the NAAQS requirements. Impacts to air quality are considered significant if emissions from the alternatives would be considered regionally significant by the USEPA. The air emission calculations for the alternatives included in the section below are detailed in Appendix B.

4.5.1 No Action Alternative

There would be no short-term or long-term negative impacts to air quality associated with the No Action Alternative. Once the current permit expires, air emissions would be expected to decrease due to lack of regular maintenance activities at the Barton Springs Pool and reduced emissions from visitor vehicular traffic. However, the decreased emissions would only be minimal due to continued visitation to Zilker Park, as described in the socioeconomic section of this document. Additionally, it is expected that the impacts from emissions associated with vehicular traffic would be similar, considering Barton Springs Pool patrons are likely to visit other area pools for recreation. The emissions would be displaced to other areas in the regional airshed, and while it is safe to assume a small percentage of those Barton Springs Pool patrons are tourists and less likely to visit other pools, the overall vehicular traffic emissions would stay the same due to increasing population trends for the Austin area. Therefore, there would be a minor beneficial, long-term indirect impact to air quality as a result of the No Action Alternative.

4.5.2 Preferred Alternative

A short-term minor increase in emissions from equipment and vehicles would occur during the Eliza Spring construction project described in the HCP (COA, 2013) as well the routine Barton Springs Pool maintenance activities associated with the Preferred Alternative. Emissions released as a result of the construction and maintenance projects are expected to include NAAQS criteria pollutants CO, O_3, NOx, and SO_2 due to the combustion of fossil fuels used in the construction equipment; particulate matter, which could be released into the air during excavation activities; and GHG as discussed below in Subsection 4.5.3. Fugitive dust and particulate matter would be emitted into the air from access roads, stockpiles, the pool bottom, and/or other work areas. Watering of the disturbed area and stockpiles would be the preferred method of controlling fugitive dust. Heavy equipment exhaust, concrete removal operations, and stockpile dust emissions would affect the immediate project area due to the removal of the bottom of Eliza Spring. Direct impact from these emissions would be temporary (short term) and would return to pre-construction levels once the construction was completed. Any detrimental effects to air quality in the vicinity of the proposed project area would be temporary and insignificant. There would be no long-term impacts to air quality as a result of the proposed construction activities identified in the HCP (COA, 2013) or routine maintenance project.

A minor long-term increase in vehicular emissions due to visitor traffic to Barton Springs would also be expected with the Preferred Alternative. However, this increase should be minimal and mainly due to increasing population trends in the Austin area. No short-term negative impact from emissions due to vehicular traffic in the project area should be expected. Regional traffic should be expected to increase with increasing population regardless of the continued operation of Barton Springs Pool. There would be no significant increase in long-term negative impacts to air quality of the regional airshed as a result of the continued visitation to Barton Springs Pool.

A conformity determination would not be required, as the total emissions from construction activities at the site of the Preferred Alternative would be below *de minimis* thresholds specified in 40 Code of Federal Regulations (CFR) 93.153(b)(1) and the project area is in attainment for all six criteria pollutants. Table 4-3 shows the total projected air emissions from the Preferred Alternative over the expected duration of construction and maintenance activities, while detailed air emission calculations can be found in Appendix B. Significant air emissions would be those that represent 10% or more of the *de minimis* threshold for each pollutant in an area of nonattainment. Travis County is in attainment for all six criteria pollutants, so comparison to these numbers is a conservative approach since actual emissions inventory data is not available for the project area. As such, all projected annual air emissions for the Preferred Alternative are less than the significant levels as presented in Table 4-3.

Table 4-3
Projected Air Emissions from Preferred Action and *de minimis* Thresholds

	Total Projected Emissions (tons per year [tpy])					
	CO	**VOC**	**NOx**	**SO_2**	**PM_{10}[a]**	**CO_{2e}[b]**
One-Time Demolition Project-Eliza Springs	<0.01	0.01	0.07	0.01	0.03	41.61
Routine Pool Maintenance-Barton Springs	<0.01	<0.01	0.01	<0.01	<0.01	12.4
Annual Debris Removal-Barton Springs	<0.01	<0.01	<0.01	<0.01	<0.01	3.15
Annual Visitor Traffic-Barton Springs	N/A	N/A	N/A	N/A	N/A	5,246
de minimis threshold[c,d]	100	50	50	100	70	N/A

Notes: calculations based on fuel efficiencies from RITA, 2012

CO=carbon monoxide
CO_2=carbon dioxide
tpy=tons per year
SO_2=sulfur dioxide
NO_x=nitrogen oxides
$PM_{2.5}$=particulate matter equal or less than 2.5 micrometers in aerodynamic diameter
PM_{10}=particulate matter equal or less than 10 micrometers in aerodynamic diameter
CO_{2e}=carbon dioxide equivalent

[a] $PM_{2.5}$ emissions assumed to be the same as PM_{10} emissions.
[b] CO_{2e} emissions given in US (short) tons per year, except for annual visitor traffic emissions, which is given in metric tons per year.
[c] No *de minimis* threshold exists for CO_2. For purposes of Greenhouse Gas emissions, CO_{2e} is equivalent to 1 x CO_2.
[d] *de minimis* thresholds as specified in 40 CFR 93.153(b) for serious non-attainment designations to be conservative.

4.5.2.1 Greenhouse Gases

The passenger vehicles from visitor traffic to the Barton Springs Pool and the vehicles and equipment used during construction-related and maintenance activities would emit CO_2 in the Project Study Area. The CO_2 emissions were estimated using current USEPA methodologies (USEPA, 2008) (see Appendix B for detailed emission calculations). Under the Preferred Alternative, approximately 5,303 metric tons of CO_{2e} would be released, including emissions from the one-time demolition project at Eliza Springs, the routine Barton Springs Pool maintenance, and the annual visitor traffic to Barton Springs (refer to Table 4-3 above). The amount of CO_{2e} released under the Preferred Alternative represents less than $8x10^{-9}$% of the 2009 U.S. anthropogenic emissions of CO_{2e} as described in Subsection 3.4 of this document (USEPA, 2011a). This is a limited amount of emissions that would not contribute significantly to global warming, but any emission of GHGs represents an incremental increase in global GHG concentrations.

Activities under the Preferred Alternative are not one of the source categories listed in 40 CFR 98, and therefore would not be subject to the requirements of the USEPA National Greenhouse Gas Reporting Rule.

4.6 NOISE

The following factors were considered in evaluating potential noise impacts: (1) the degree to which noise levels generated by construction activities would be higher than the ambient noise levels; (2) the degree to which there is annoyance and/or interference with activity as a result of the alternative; and (3) the proximity of noise-sensitive receptors to the noise source.

Noise naturally dissipates by atmospheric attenuation as it travels through the air. Factors that can affect the amount of attenuation are ground surface, foliage, topography, and humidity. Assuming that noise from the construction equipment radiates equally in all directions, the sound intensity would diminish inversely as the square of the distance from the source. Therefore, in a free field (no reflections of sound), the SPL decreases 6 dB with every doubling of the distance from the source. Impacts from noise would be considered significant if they reached 65 dB at nearby residences (US Navy, 2005).

4.6.1 No Action Alternative

There would be no short-term or long-term negative effect on ambient noise levels associated with the No Action Alternative. Once the current permit expires, noise levels would be expected to decrease due to lack of regular maintenance activities at the Barton Springs Pool and reduced vehicular traffic from visitors to the Barton Springs Complex area. Therefore, there would be a beneficial, long-term direct and indirect impact to noise as a result of the No Action Alternative.

4.6.2 Preferred Alternative

The Preferred Alternative would involve the excavation and backfill of the concrete bottom of Eliza Springs. It is anticipated that during construction of the project, noise from trucks, excavators, and related operations would temporarily affect the project area. It should be noted that these noise levels are conservative estimates, as attenuation from air absorption, ground effect, and shielding were not included in the calculations (USDOT, 2006).

There are no anticipated long-term effects to area noise levels as a result of the Eliza Springs construction project. Noise levels generated from ongoing maintenance activities at Barton Springs Complex under the Preferred Alternative would not be expected to change from current conditions. The primary source of noise would result from construction activities at Eliza Springs, which would be generated by truck traffic and the operation of heavy machinery. Construction activities would be expected to occur between 7:00 ante meridiem (a.m.) and 6:00 post meridiem (p.m.), which are normal City of Austin working hours. It is important to note that construction sound levels within nearby buildings would be diminished because of sound transmission loss through building walls and windows. A building provides 20 dB of outdoor-to-indoor noise level reduction, depending on the type of walls and windows; therefore, housing near the construction site would only be subject to a short-term minor increase in sound levels during construction hours (US Navy, 2005). Considering the nearest residence is 400 ft from the project area and accounting for a 20 dB noise-level reduction, the loudest construction-related equipment (70 dB) would not reach the 65 dB significance threshold at neighboring houses (US Navy, 2005). Nearby residences and persons utilizing the Barton Springs Pool and park area during construction hours could be subject to a short-term minor increase in noise levels.

Construction signs would be posted near the project area alerting visitors of potential noise disturbances.

Construction activities could pose a risk of hearing loss to construction workers if adequate hearing protection is not used. There is a possibility of short-term minor, localized speech interference or annoyance near construction zones. Implementation of the Preferred Alternative would generate short-term minor direct impacts to noise throughout the construction phase of the Eliza Spring bottom removal project. Post-construction noise levels surrounding the project areas would remain at or near pre-construction levels and would include noise generated from routine Barton Springs Complex maintenance and visitor traffic. Because construction activities are temporary, no long-term increase in noise impacts would occur.

4.7 HAZARDOUS MATERIALS

4.7.1 No Action Alternative

Under the No Action Alternative, management of the Barton Springs Complex would cease. The Barton Springs Pool would not be cleaned or lowered for cleaning. The pool would be closed to recreation for safety reasons. Since the pool would close under the No Action Alternative, no solid or hazardous wastes would be generated. The maintenance of the Barton Springs Complex would be severely limited. Basic maintenance of the vegetation and lawn would likely be the only maintenance conducted. Therefore, the use of potentially hazardous materials would decrease significantly under the No Action Alternative.

4.7.2 Preferred Alternative

- Under the Preferred Alternative, management of the Barton Springs Complex would continue as is currently being managed (COA, 2013); specifically: Some of the equipment used during cleaning and maintenance activities requires the use of fuel or oils. Specific areas for vehicle fueling and equipment maintenance will be located away from the springs to avoid potential impacts to the spring habitats. Absorbent pads will be used during all operations, fueling and maintenance activities (COA, 2013).
- A catastrophic spill response plan will be developed to address spill prevention, containment, remediation, and salamander rescue (COA, 2013).

- Sediment and debris that is collected during routine cleaning of the Barton Springs Pool will not be disposed of in, allowed to settle in, or otherwise adversely affect the habitat (COA, 2013).

- Removal of woody debris is occasionally needed after a rain event. The debris will be inspected for salamanders before and after removal (COA, 2013).

- Improvements will be made to control surface water runoff around the Barton Springs Complex, including Eliza Spring, Old Mill Spring, and Upper Barton Spring. Temporary silt fencing and other erosion control measures will be implemented until permanent improvements can be made.

- Under the Preferred Alternative, more natural flow regimes will be restored and/or maintained in the Barton Springs Complex, specifically Eliza Spring, and Old Mill Spring (Sunken Garden), to the maximum extent feasible by modifying, replacing, or removing some of the existing infrastructure. Restoration of the spring pools and overland streams at Eliza Spring and Old Mill Spring (Sunken Garden) are expected to improve and enlarge the surface salamander habitat and to improve the quality of habitat. Restoration and infrastructure improvement projects planned at Eliza Springs and Old Mill Spring would be expected to temporarily generate construction and demolition (C&D) wastes.

According to the amended HCP, the following is a list of proposed infrastructure improvements to the Barton Springs Complex that have potential to generate waste (COA, 2013):

- Removal of the concrete floor of Eliza Spring - The floor of Eliza Spring currently consists of approximately 12 inches of concrete overlying substrate, which elevates the surface habitat approximately 1 ft. Under the Preferred Alternative, the removal of the concrete floor and restoration of the substrate elevation and composition would result in wetted surface habitat during drawdown.

- Removal of existing underground pipe that currently connects Eliza Spring and Barton Springs Pool (Parthenia Spring).

- Enhancement of the bottom substrate with clean cobble and gravel at Eliza Spring and Old Mill Spring.

- Modification of the existing gate system for the drawdowns of the Barton Springs Pool.

- Installation of a pump system to provide spring water for Barton Springs Pool maintenance.

- Modification of the Old Mill Spring to restore the natural surface flow into Barton Creek.

At this time, detailed plans have not been developed. Plans for the improvements or modifications to the infrastructure will be submitted to the service for approval prior to being implemented. The schedule of these activities will be staged over time and will be designed to minimize potential impacts to habitats. As a result, volumes of C&D waste generated will be minimized. All C&D waste will be disposed in accordance to the City policy. Since the restoration and infrastructure improvement projects would be implemented over a period of time, existing landfill capacity is adequate to accept any waste that would be generated (COA, 2012g).

4.8 LAND USE

4.8.1 No Action Alternative

No impacts to the land use designation under the No Action Alternative would be expected. The Project Study Area would remain within Zilker Park, an area designated for parks/greenbelts, as outlined in Section 3.7.

Significant, direct, long-term impacts to the recreational use of the Project Study Area would be expected under the No Action Alternative. Under the No Action Alternative, while the related facilities would remain intact, the ongoing maintenance of the Barton Springs Pool would cease. Due to the lack of maintenance, the Barton Springs Pool would be closed to recreation activities and public entrance would not be permitted. Therefore, the approximate 700,000 annual visitors would be displaced from swimming activities at Barton Springs Pool. It is reasonable to assume that the closure of Barton Springs Pool and displacement of these visitors may also potentially result in a reduction of overall visitation to Zilker Park, including the nearby concession amenities. Closure of the Barton Springs Pool under the No Action Alternative would likely increase visitation to other municipal or neighborhood pools in Austin, such as the nearby Deep Eddy Pool.

4.8.2 Preferred Alternative

No impacts to the land use designation of the proposed project would be expected under the Preferred Alternative. The Project Study Area would remain within Zilker Park, an area designated for parks/greenbelts, as outlined in Section 3.7. Annual visitation to Zilker Park and use of the Barton Springs Pool would be unaffected and anticipated to remain similar to the current visitation rates of the facilities. However, due to the approximate 20% population growth experienced in Austin from 2000-2010 (USCB, 2012a), continued population growth of the area is expected and may result in increased use of the Barton Springs Pool.

4.9 VEGETATION COMMUNITIES

Much of the vegetation within the boundaries of the Project Study Area is altered through human intervention. Few areas are left undisturbed by human activities. Under these conditions, a major impact to vegetation would be any activity or cessation of activity due to a change in the existing management programs that would result in the modification of the vegetative community within the Project Study Area. A negative impact would result in a loss of diversity or abundance of plant species, especially those species essential to salamander habitat. A beneficial impact would benefit salamander habitat and increases the diversity and abundance of native species.

4.9.1 No Action Alternative

Under the No Action Alternative, significant long-term adverse and beneficial impacts to aquatic or riparian vegetation would be expected. Management of the Barton Springs Complex would cease, including the re-vegetation of Eliza and Old Mill springs with native aquatic flora. Although maintenance of the Barton Springs Pool and springs would cease, the dams and other anthropogenic structures would remain in place, resulting in silt and sediment build up within Barton Springs Pool (Parthenia Spring), Eliza Spring, and Old Mills Spring, altering existing and potential salamander habitat. Events such as flooding, droughts, algae blooms, increased silt and sediment, and changes in aquatic population levels (crayfish, fish, etc.) would result in major changes in the habitat and vegetative species assemblage and biomass associated with the Barton Springs Complex and currently existing salamander habitat. Without anthropogenic intervention, it is anticipated the populations of native flora established in these springs would change over time due to the lack of invasive species, sediment, and debris removal or control. Conversely, without management of the Barton Springs Pool structures, long-term impacts include the deterioration of the anthropogenic features including the dam structures. This is anticipated to result in slow modification of the pool area and springs, resulting in the eventual return of the Barton Springs Pool to the natural flow regime of Barton Creek, and eventually the vegetation within the pool area is anticipated to be similar to the surrounding creek habitat, and presumably, over time, to the native water regime and habitat of the creek and springs. Under the No Action Alternative, removal of the substrate from Old Mill Spring would also cease, allowing sedimentation and debris to build up. This would result in an impact to the aquatic plant community in the spring (COA, 2013). This alternative would result in major, long-term impacts to vegetation associated with the springs.

Under the No Action Alternative, terrestrial/upland vegetative species would continue to be maintained similar to the existing conditions. Grasses and lawns would be mowed regularly based on the existing Zilker Park maintenance plan. Invasive species control and native revegetation throughout the Project Study Area would continue based on the existing invasive species and native species management plans.

4.9.2 Preferred Alternative

Under the Preferred Alternative, moderate long-term beneficial impacts to vegetative species would be expected. Management of the Barton Springs Complex would continue under the existing maintenance plan, including the revegetation of Eliza and Old Mill Springs and the Barton Springs Pool (Parthenia Spring) with native aquatic flora and replacement of the constructed and altered substrates of the springs with natural substrates.

The Preferred Alternative would allow for great control over fluctuating water levels and water quality parameters, allowing for temporary restoration of a low depth, high velocity water regime to the Barton Springs Complex during drawdowns. These changes in water level would be beneficial to species that require ephemeral variability in water level to thrive and detrimental to those species that prefer constant water levels (COA, 2013). Currently the majority of species in the Barton Springs Complex are those that are well adapted to both alternatives (COA, 2013)."

4.10 WILDLIFE

The impacts to wildlife within the scope of this EA would be limited to changes in the way habitat within the Project Study Area is managed. A significant impact would affect a species population or habitat. An adverse impact would reduce diversity and abundance of native wildlife species; a positive impact would improve the abundance and diversity of native wildlife species.

4.10.1 No Action Alternative

Under the No Action Alternative, moderate long-term impacts to non-listed wildlife species within the Barton Springs Complex would be expected. The Barton Springs Complex would be closed off to the public. All maintenance activities that could impact either species of salamander protected by the HCP would cease, including cleaning algae, sedimentation, and debris from the springs which would have a major, potentially long-term impact on salamander habitat and mortality rate. These changes within the springs could also impact the habitat of invertebrate species that the salamanders prey upon. Anthropogenic revegetation of the springs with native species would also cease, which would halt management of essential parts of salamander habitat.

The cessation of management could have a moderate to major impact on wildlife species associated with the Barton Spring Complex. Changes in the habitat available within the Barton Springs Pool (Parthenia Spring), Old Mills Springs, and Eliza Springs due to the cessation of maintenance activities would have a moderate effect on the wildlife species currently present within the springs and associated water bodies. The Barton Springs Pool would be expected to become shallower due to sedimentation, and more highly variable in water quality due to drastically changing algae levels and flood events, in addition to the lack on anthropogenic modification in the native and invasive vegetative species. These changes would likely impact the assemblages of wildlife species that use the Barton Springs Pool, Eliza Spring, and Old Mill Spring as habitat. There is no reasonably foreseeable way to predict the long-term effect of no action on all wildlife habitat and assemblage within the Project Study Area under an eventually re-asserted (albeit different) flow regime and stream/spring geomorphologies due to sedimentation and probable altered spring flow rates and locations.

The No Action Alternative would have no appreciable impact on wildlife species not within or associated with the springs. The available habitat within the Project Study Area that is not part of the Barton Springs Complex would continue to be maintained similar to the existing conditions, and therefore would not be expected to impact wildlife species.

4.10.2 Preferred Alternative

Under the Preferred Alternative, minor long-term impacts to the wildlife associated with the springs would be expected. The Barton Springs Complex would continue to be managed for salamander habitat, while the Barton Springs Pool (Parthenia Spring) and Upper Barton Spring would remain open to the public. The current management plan, and those modifications to the management plan presented in the HCP, would continue to provide improved spring habitat, managed along with the needs of the recreational community, and would continue to benefit the wildlife species (COA, 2013). Impacts to wildlife associated with the current (and future) management of the springs include the following:

- Drawdown of the Pool for cleaning can strand wildlife species.
- Physical maintenance activities can strike, scare, or disturb natural behaviors of wildlife species.
- Recreational activities within the Barton Springs Complex can injure or disturb wildlife.
- Lowering of water level to prepare for flooding can strand wildlife species.

Negative impacts to wildlife species would be temporary and minor under the existing and future management plan and the amended HCP. Wildlife will continue to inhabit the Barton Springs Complex and surrounding Project Study Area.

4.11 THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN

4.11.1 No Action Alternative

It is anticipated that the No Action Alternative may impact the Texas garter snake. Riparian biological community management activities associated with the HCP consist primarily of protection and repatriation of native vegetation as well as non-native vegetation removal (COA, 2013). Without these activities, the riparian area immediately adjacent to Barton Springs will likely become invaded by non-native vegetation. An increase in non-native vegetation would alter the vegetation composition of those areas, potentially altering the amount of brushy cover available for the snake. Additionally, public access to areas immediately surrounding Eliza and Old Mill springs would become less restrictive under the No Action Alternative (COA, 2013), increasing the likelihood of disturbance to the snake by humans. Other than the effects on the aquatic salamanders discussed below, it is anticipated that the No Action Alternative will have no effect on the remaining threatened or endangered species or species of conservation concern known to occur in Travis County.

Under the No Action Alternative, the Barton Springs Pool would close, and the management activities listed under the Preferred Alternative would not occur. Potential incidental take from drawdown events and authorized recreation activities in the Barton Springs Pool would also cease to occur; however, unauthorized use of the area might still result in take of some individuals. Due to lack of maintenance, habitat areas in the Barton Springs Pool are anticipated to become embedded with sediment which will reduce the amount of available habitat for the salamanders. Existing structures could fail or cease functioning, leading to dewatering of spring pools and sediment deposition, subsequently affecting the long-term viability of both species.

4.11.2 Preferred Alternative

Maintenance of the existing native riparian community surrounding Barton Springs and access restrictions to areas around Eliza and Old Mill springs are anticipated to impact the Texas garter snake, as previously discussed. Other than effects to the two aquatic salamander species discussed below, the Preferred Alternative will have no effect on the remaining federally protected species, candidate species, or species of conservation concern known to occur in Travis County.

The Preferred Alternative involves several activities and conservation measures that will likely directly affect both salamander species. A summary of these potential effects are provided in Table 4-4. The most significant effects to the long-term viability of the species are anticipated to result from restoring a more natural flow regime of the creek and springs, continued scientific research, and continued community outreach as discussed below.

Table 4-4
Potential Effects of Preferred Alternative on Aquatic Salamander Species

Activity	Potential Effect*
Human recreation	Minor mortality increase from rocks being stepped on around Upper Barton Spring and the Barton Springs Pool beach area or rocks being moved and/or dropped around Parthenia Spring; major benefit from outreach efforts paid for with the Barton Springs Pool entrance fees and increased community support; overall positive.
Pool Maintenance	Minor mortality increase from being stranded during drawdowns; minor disturbance from noise associated with Barton Springs Pool cleaning; major benefit from decreased sedimentation and embeddedness in salamander habitat and increased community support; overall positive.
Modification of Existing Infrastructure	Minor mortality increase from being crushed or stranded during construction events; temporary habitat impacts from increased sedimentation during construction events; major benefit from long-term improvement of salamander habitat; overall positive.
Monitoring program	Minor mortality increase from rocks being stepped on by observers; major benefit from long-term point count data; overall positive.
Captive Breeding program	Minor mortality increase associated with salamanders that are captured and don't survive in tanks; potential population rescue in the case of a contaminant spill and major die-off in the spring; overall positive.

*includes Potential effects taken from COA, 2013.

Many positive impacts will likely result from actions under the Preferred Alternative. Habitat for *E. sosorum* and *E. waterlooensis* will be restored to natural conditions as much as possible and maintained by the City of Austin (COA, 2013). The natural flow regime of the creek and springs that both species inhabit will be restored to the greatest extent feasible, given the constraints of recreational use by modifying, replacing, or removing existing infrastructure at Barton Springs Complex (COA, 2013). These restoration efforts will result in the improvement and enlargement of surface salamander habitat and improved habitat quality (COA, 2013). Restoration of the native aquatic species community and maintenance of a healthy, native riparian community will result in improved predator-prey balance and stream habitat quality. Maintenance of a captive breeding population will thwart the threat of extinction in case there are events outside of the City's control that greatly threaten one or both species, such as extreme drought or a catastrophic spill. Using artificial selection for adaptations to future environmental conditions in the captive breeding and wild salamander populations will help protect the evolutionary potential of both species. Also under the Preferred Alternative, the City will continue to gather and maintain data on both species and their habitats and share that information with the scientific community (COA, 2013). Community outreach programs, paid for by entrance fees into the Barton Springs Pool, will likely result in greater community support for strict water quality regulations and development ordinances.

Potential negative impacts as a result of covered activities associated with the Preferred Alternative include the minimal likelihood of increased mortality to individual salamanders as a result of being stranded during drawdowns for cleaning and/or preparation for flooding events; physical disturbance, including a low level of mortality, resulting from recreation activities at Upper Barton Spring and Barton Springs Pool; physical disturbance, including a low level of mortality, a temporary increase in sedimentation during modification of existing infrastructure; and harassment from noise associated with cleaning the Pool (COA, 2013). While a minimal amount of mortality is expected from activities conducted under the Preferred Alternative, the level of mortality is expected to be low and not expected to adversely affect the long-term viability of either species.

4.12 SOCIOECONOMIC

4.12.1 No Action Alternative

No significant impact to the City or Travis County demographics is expected under the No Action Alternative. The No Action Alternative is not anticipated to result in adverse impacts related to Environmental Justice. The proposed project is not located in a low-income area or in an area with a minority population comprising over half of the population (FHA, 2012a and FHA, 2012b). Therefore, a disproportionate burden is not expected to fall upon low-income or minority communities as a result of the proposed project.

Long-term, direct, adverse impacts to the local economy would be expected under the No Action Alternative. Under the No Action Alternative, Barton Springs Pool would no longer operate and recreation would no longer be permitted. This closure would result in the loss of revenue and profit generated from entry fees, parking fees, and the sale of concessions related to Barton

Springs Pool. Additionally, closure of the Barton Springs Pool may also reduce the overall visitation to Zilker Park, resulting in less revenue generated from parking charges and concession sales, and representing a loss in revenue to the City of Austin. Additionally, the closure of the Barton Springs Pool would also result in the loss of 40 to 50 seasonal jobs and 6 year-round, full-time positions. Additionally, the loss of jobs and the lack of ongoing maintenance (debris removal) of the Barton Springs Pool may result in increased instances of infrastructure (e.g. fencing, dam, outfall structures) damage and required replacement. Increased instances of replacement would also increase the City of Austin's maintenance costs of the closed facility. While the closure of the Barton Springs Pool would represent a loss in revenue, it can be assumed that the displacement of the Barton Springs Pool visitors to other municipal pools in the area may increase revenues generated by those facilities. However, it is assumed that this increase in revenue at other facilities is not anticipated to offset the overall loss due to Barton Springs Pool.

4.12.2 Preferred Alternative

Under the Preferred Alternative, no significant impact to the City of Austin or Travis County demographics would be expected. Additionally, the Proposed Action is not anticipated to result in adverse impacts related to Environmental Justice. The proposed project is not located in a low-income area or in an area with a minority population comprising over half of the population (FHA, 2012a and FHA, 2012b). Therefore, a disproportionate burden is not expected to fall upon low-income or minority communities as a result of the proposed project.

Under the Preferred Alternative, direct, beneficial impacts to the local economy would be expected. While continued operation of Barton Springs Pool would be estimated to cost over $890,737.88 per year as discussed in Section 3.11.2, fees received from visitors to the Barton Springs Pool would be expected to generate revenue that would cover all operational costs. Revenue generated from the recreational use of the Barton Springs Pool would be expected to be similar to revenue currently generated, and would range from $1,412,377.33 to $1,550,401.33, as described in Section 3.11. Additionally, under the Preferred Alternative, the amended HCP would require the City to increase the amount of money deposited to a conservation and research fund for the Barton Springs salamander from $45,000 to $53,000, a 17.8% increase from the amount outlined in the current HCP. Additionally, the amended HCP would increase the amount of City-allocated funds for the development and maintenance of the Barton Springs salamander captive breeding program. Revenue not allocated to expenses or conservation and breeding would go into the City Parks budget, and therefore is anticipated to provide a benefit to the community through increased funding available for City services and programs.

4.13 CULTURAL RESOURCES

Cultural resources include archeological sites, historical buildings, structures and objects, as well as historic districts, cultural landscapes, and traditional cultural places. The THC is the state agency responsible for conducting reviews authorized under the National Historic Preservation Act of 1966 (Public Law 89-665; 16 USC 470 et seq). Any federally funded, assisted, or approved project must undergo a review to consider the effects of the project on historic or cultural resources that are listed or are eligible for listing on the NRHP. As detailed in Section 3.12, the cultural resources at Barton Springs Complex subject to the THC review include two archeological sites (41TV2 and 41TV1364), the Barton Springs Historic District (including the Barton Springs Pool, bathhouse, dams, amphitheater and construction conducted by NYA in 1938) and the much larger Zilker Park Historic District.

4.13.1 No Action Alternative

The No Action Alternative would result in the closing to the public of the Barton Springs Pool (Parthenia Spring). These are key elements in the cultural landscape, and lack of access to them by the public would be an adverse effect.

At Eliza Spring, the No Action Alternative would possibly result in an adverse effect; reduced maintenance could result in long-term deterioration to the historic amphitheater.

At Old Mill Spring, the No Action Alternative would possibly result in an adverse effect on the rock walls of the Sunken Garden; reduced maintenance could result in long-term deterioration of the feature.

At the Upper Barton Spring, the No Action Alternative would have no effect on cultural resources.

4.13.2 Preferred Alternative

4.13.2.1 Parthenia Spring and Barton Springs Pool

At the Barton Springs Pool (Parthenia Spring), the Preferred Alternative will have no effect on cultural resources. Removal of the concrete infilling of the bedrock fissures will not affect the character of the Barton Springs Pool. No mitigation measures are warranted at this location.

4.13.2.2 Eliza Spring

At Eliza Spring, the Preferred Alternative will have a net positive effect on the historic structure. The action will include removal of recent construction that is blocking the natural outflow to Barton Creek and removal of the concrete floor. These actions will serve to partially restore the original architectural aspect of the Eliza Spring amphitheater.

However, excavation of an outflow channel from the pool to Barton Creek has the potential to encounter and adversely affect buried archeological deposits. The area is within archeological site 41TV1364, which is a State Archeological Landmark and is also listed on the NRHP. Such deposits could potentially include significant Paleoindian deposits as have been demonstrated by excavations at the Rugby Fields. The excavation of an outflow channel between Eliza Spring and Barton Creek should be monitored by an archeologist under a permit issued by the THC. If archeological remains are unearthed, these should be recorded by the archeologist as relating to site 41TV1364. If such remains are observed to be contained within intact and undisturbed sediments, then further excavation of the outflow channel should be postponed until the extent and significance of the archeological deposits can be evaluated in consultation with the THC. If the deposits are determined by the THC to be significant, possible mitigative actions could consist of controlled archeological excavation in the vicinity of Eliza Spring and/or the outflow channel. The City has committed to coordinate restoration activities at all sites with the City's Historic Preservation Officer and the Texas Historical Commission.

4.13.2.3 Old Mill Spring

At Old Mill Spring, the Preferred Alternative will have a net positive effect on cultural resources. Stabilization and maintenance of the rock walls immediately surrounding the spring will prevent further deterioration. Any restoration or reconstruction of masonry, dating to either the 1938 NYA constructions or to the earlier grist mill period, will be coordinated with and planned in consultation with the THC (CoA, 2012i). In the 10 July 2012 letter THC concurred with the COA that routine scientific studies and debris removal will not require a permit or mitigation (Appendix C).

4.13.2.4 Upper Barton Spring

The Preferred Alternative will have no effect on cultural resources at the Upper Barton Spring. No mitigation measures are warranted at this location.

4.14 CLIMATE CHANGE

4.14.1 No Action Alternative

Under the No Action Alternative, maintenance and recreational activities at the Barton Springs Complex would cease. Based on the values in Table 4-3, this would result in a negligible, potentially long-term decrease in the amount of GHGs released, as all equipment used to maintain the springs would no longer be run and traffic to the Project Study Area would decrease. Under this alternative, maintenance and operation of the dams and other mechanical means used to control water levels in Barton Springs Pool would cease. This would leave populations of salamanders and other wildlife in Barton Springs Pool susceptible to the effects of low precipitation levels during droughts or high precipitation levels during floods caused by global climate change. City of Austin staff would no longer be able to maintain elevated water levels during times of drought.

4.14.2 Preferred Alternative

Under the Preferred Alternative, maintenance and recreation activities in and around the springs would continue as usual. Based on the values in Table 4-3, overall annual emissions of GHGs would see a small increase around the Barton Springs Complex mainly due to the one-time construction activity at Eliza Spring. There is no *de minimis* threshold for CO_2, but based on current observable activities in and around the Barton Springs Complex, the levels of CO_2 released with the Preferred Alternative would be very low. Impacts to the springs are anticipated to be minor and short-term. Under this alternative, maintenance of the dam and other mechanical means of controlling water levels in Barton Springs Pool would continue, allowing City of Austin staff to potentially mitigate the impact of extreme precipitation levels due to droughts and floods caused by global warming on the salamander population and their associated habitat by controlling water levels in Barton Springs Pool.

4.15 CUMULATIVE EFFECTS

The Council on Environmental Quality (CEQ) defines cumulative impacts as the incremental impacts of multiple actions (in the past, present, and future), that can be individually minor, but collectively may have significant effects. Cumulative effects can be further defined as the total effects of the multiple developments and their interrelationships on the environment. This section considers the effects of past, present, and future developments and activities that have been authorized, are under review, or can reasonably be anticipated within the Project Study Area. Developments or projects are considered concurrently with the effects of the issuance of a renewed ITP and the subsequent implementation of the amended HCP. All proposed actions may contribute to the cumulative effects of such activities not only on special status species, but also on society and the human environment within the Project Study Area. Cumulative effects of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource, no matter what entity (federal, non-federal, or private) is taking the action.

The No Action Alternative and/or the Preferred Alternative are not expected to significantly contribute to cumulative impacts to air quality, noise, climate, cultural resources, land use, and/or socioeconomics.

Activities covered under the Preferred Alternative would contribute to water resources in the Project Study Area, as described in Section 4.1 above. The cumulative effects of a managed flow regime (including flood flows) are expected to be primarily beneficial. The most significant activity not covered by the HCP that may impact water resources is pumping of groundwater from the Barton Springs segment of the Edwards Aquifer. Groundwater pumping and aquifer levels are regulated by the BSEACD through their Drought Management and Permitting programs, which represent reasonably foreseeable actions by others which might contribute to a net negative effect on available water levels or surface area within the Project Study Area; therefore the overall net cumulative effect may be positive during non-drought years and negative during drought.

Activities covered under the Preferred Alternative would also affect the water levels or surface area in the Project Study Area. Potential temporary negative impacts due to increased sediment during construction activities would be mitigated by project-specific BMPs. Additionally, the effects of implementation of the City of Austin Stormwater Management Plan along with State and County regulation are expected to be beneficial in protecting the water quality and quantity of the stormwater that recharges the aquifer. However, continued development over the Recharge and Contributing zones in areas not covered by the HCP could potentially reduce water quality over time. Therefore, the cumulative effect on water quality due to the proposed alternative and the reasonably foreseeable actions of others is locally beneficial, but may not affect any change in the region/aquifer's overall water quality trends. Specifically, the effects related to the Preferred Alternative on the hydrogeology of the Barton Springs Complex include the actions of the COA and those undertaken by other entities that may or may not be related to the Preferred Alternative. The hydrogeology of Barton Springs Complex is affected by activities relating to urbanization, discussed below, in the Contributing, Recharge, and Confined zones of the Barton Springs segment of the Edwards Aquifer, of which only 28% falls within City jurisdiction.

Urbanization within the Barton Springs segment is a likely cause of many changes to the hydrogeology and chemistry of the Barton Springs Complex (BSEACD, 2011). As human populations move into undeveloped areas, the amount of impervious cover and anthropogenic pollutants introduced increases (Van Metre et al., 2000), and karst aquifers are particularly sensitive to this type of contamination (Veni, 1999). Anthropogenic contaminants are routinely detected at the Barton Springs Complex (Mahler et al., 2006), and in creeks that recharge the Barton Springs segment and contribute significantly to flow at the Barton Springs Complex (Mahler and Massei, 2007). Although degradation of water quality at the Barton Springs Complex (Mahler et al., 2006) cannot be traced to one building, road, or development, an overall decrease in water quality can be attributed to the cumulative impact of urbanization in the Barton Springs Zone of the Edwards Aquifer. Additional cumulative effects might include changes in groundwater use and flood patterns, and therefore recharge, due to impervious cover and development as well as global climate change, the actual effects of which are unknown in Central Texas. Continued implementation of City's Stormwater Management Plan and the Save Our Spring Ordinance (which limits impervious cover over the Recharge Zone to 20%) may help mitigate the cumulative impacts of urbanization in the Barton Springs Zone.

Cumulative effects to *Eurycea sosorum* and *Eurycea waterlooensis* from activities outside of City control, such as increased impervious cover and sediment deposition within salamander habitat (associated with urbanization within the Barton Springs segment and additional permitting by the TCEQ for surface-supplied wastewater effluent in the Recharge and Contributing zones), would likely reduce habitat quality for both species, potentially affecting their long-term viability. Also, additional permitting by the Barton Springs Edwards Aquifer Conservation District for groundwater withdrawal, alone or in conjunction with worsening drought conditions potentially associated with global climate change, could reduce surface habitat for *E. sosorum*, forcing them underground where interspecific competition could result in reduced long-term viability of one or both salamander species.

5. PUBLIC INVOLVEMENT

In October 1998, the City and the USFWS published the *Final Environmental Assessment and Habitat Conservation Plan for the Issuance of a Section 10 Permit for Incidental Take of the Barton Springs Salamander (Eurycea sosorum) for the Operation and Maintenance of Barton Springs Pool and Adjacent Springs* (USFWS, 1998). The ITP was issued on 28 October 1998 and will expire in 2013. The HCP of 1998 presented details of the maintenance activities allowed within the spring complex and provided goals for future activities associated with the species conservation and maintenance of the springs.

The October 1998 Final Environmental Assessment included a total of 271 public comments broken down into 15 categories based upon the type of concern. The public comment period was July 15, 1998 through August 14th, 1998. The following Table 5-1 illustrates the public's concern by topic and the number of comments by topic.

Table 5-1
FEA October 1998 Public Comments

Concern Title	Number of Comments
Watershed Concerns	36
Experimental Pool Cleaning	4
Incidental Take	23
Salamander Biology	12
Education	15
HCP and Proposed Measures	26
Pool Cleaning and Management	4
Impacts of Recreational Activities	39
Beach Modifications	21
Deep End Pool Lowering Four Times Per Year	8
Pool Lowering- Partial Drawdowns	9
Sediment Management/Aquatic Vegetation	13
Sunken Garden , Eliza, and Upper Springs	16
Economic Concerns	15
General	30
Total Comments	**271**

The City began preparation of the major amendment to the HCP in 2011, with minor changes to the maintenance activities associated with the springs, and with the addition of the Austin blind salamander as a covered species to the plan. On 11 October 2011, the City held a public information meeting at Barton Springs Pool to discuss the proposed major renewal and extension of the existing Section 10(A)(1)(B) Permit. Representatives from the City and USFWS were available to answer questions from the public about the renewal process. Approximately 25 people attended the meeting. A copy of the promotional flyer for this meeting can be found in Appendix D. Public participation is an important part of the project development process. Public involvement occurred early in the process and continued through the project development process. It is important that project stakeholders understand the community values in order to avoid, minimize, and mitigate impacts, as well as to narrow the field of alternatives appropriately. The community should be informed regarding the constraints and potential compromises that are realized during the project planning and project development process. The community should completely understand the project process and support the project needs and purpose. Community outreach by the City has been extensive on their website, the Austin American Statesman, and on local radio stations just to name a few. Outreach included but was not limited to airing on the KXAN, YNN, KTBC, KEYE and KVUE television networks. Radio interviews were aired on KLBJ-AM and KUT-FM.

5.1 AGENCY INVOLVEMENT

This EA was developed with input from the USFWS Austin Ecological Services Office and the USFWS Region 2 Office in Albuquerque, New Mexico.

5.2 PUBLIC REVIEW

The draft of this document along with the major amendment to the HCP and the application for renewal of the ITP was made available for public review during a 60-day public review period, beginning 23 April 2013 and lasting through 21 June 2013. The Notice of Availability was posted to the Austin Ecological Services Office website (http://www.fws.gov/southwest/es/AustinTexas/) and published in the Federal Register, Volume

78, Number 77 on 22 April 2013. Copies of both Notices of Availability are located in Appendix D.

The City briefed the City of Austin Environmental Board on 1 May 2013 and also held an informational meeting at Barton Springs on 18 May 2013 to present information to the public regarding both documents and encourage the submittal of comments thorough the Federal Register notice. The meeting was attended by two members of the public. This meeting was covered by YNN and KVUE. Additionally, the publication of the HCP was also covered in two other news articles, InFact Daily on 7 May 2013, "City staff working with feds to renew Barton Springs conservation plan" by Charlotte Moore; and an article by April Reese in Greenwire on 22 April 2013 entitled "Endangered species: Austin, Texas, seeks changes to salamander's habitat plan."

The Service received comments from two non-government organizations (NGOs) and four members of the general public during the 60-day public review and comment period. Commenting NGOs included the Save our Springs Alliance (SOS) and the Barton Springs Polar Club (BSPC). Substantive reviews raised by the commenters included concerns regarding the usage of sunscreens at Barton Springs Complex, the inclusion of a candidate species into the HCP, and the implementation and management of SOS ordinances by the City of Austin. All comments are included in Appendix D.

NEPA requires that the Service consider all comments received during the public review and comment period, and provide a response to all comments that are considered substantive. All comments received and the applicable response to all substantive comments received during the public comment and review period are provided in Appendix D. Any revisions based on substantive comments received during the public comment period are incorporated into this EA and the HCP, and are detailed in Appendix D.

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7. GLOSSARY OF TERMS

Cumulative Impacts — The Council on Environmental Quality (CEQ) defines cumulative impacts as the incremental impacts of multiple actions, both present and future, that can be individually minor, but collectively may have significant effects. Cumulative effects can be defined as the total effects of the multiple developments and their interrelationships on the environment. This section considers the effects of past, present, and future developments and activities that have been authorized, are under review, or can reasonably be anticipated within the Project Study Area.

Direct Impacts — are caused by an action and occur at an immediate time and place.

Long-Term Impacts — are considered to be those that last beyond 1 year and have the potential to continue into perpetuity.

Indirect Impacts — are caused by the Proposed Action and occur later in time or farther in distance, but are reasonably foreseeable. Indirect impacts may include induced changes in the pattern of land use, population density, or growth rate, and related effects on air, water, and other natural resources and social systems.

Impact — The term impact and effect are considered synonymous in this EA. An impact, or effect, is defined as a modification to the environment, as it presently exists (or if describing a past effect as it existed at the time of that action), that is brought about by an outside action. Impacts can vary in significance from no change or slight discernible change, to a full modification or elimination of the environmental condition.

Impacts may be major, minor, negative, beneficial, or adverse and may apply to the full range of natural, aesthetic, historic, cultural, and economic resources to Barton Springs and the surrounding area. They may be further classified as short-term or long-term, direct or indirect, and evaluated in terms of intensity or severity (40 CFR and 30 CFR).

Project Study Area — The Project Study Area encompasses the Barton Springs Complex, as well as a 100 feet buffer zone around the complex, covering approximately 36 acres of the park. This Environmental Assessment addresses the impacts in the Project Study Area.

Short-Term Impacts — are considered to be 1 year or less, are anticipated to dissipate over time and may not contribute to cumulative impacts.

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APPENDIX A

HABITAT CONSERVATION PLAN

APPENDIX B

AIR EMISSION CALCULATIONS

APPENDIX C

TEXAS HISTORICAL COMMISSION CORRESPONDENCE

APPENDIX D

PUBLIC INVOLVEMENT

D-1: City of Austin New Release for Scoping Public Meeting

D-2: Federal Register Notice of Availability

D-3: USFWS News Release and Notice of Availability

D-4: City of Austin City Council (Environmental Board) Agenda

D-5: City of Austin Public Meeting Notice

D-6: Public Comments and Responses