CITY OF TUCSON
GENERAL SERVICES DEPARTMENT

August 26, 2008

VIA CERTIFIED MAIL

Ms. Tina Le Page
Project Manager, Arizona Department of Environmental Quality
Voluntary Remediation Program Unit, Waste Programs Division
400 W. Congress Street, Suite 433
Tucson, AZ 85701

Re: City of Tucson Central Energy Plant: Site Assessment and Closure Report, ADEQ VRP Site Code: 508392-00

Dear Ms. Le Page:

The City of Tucson-Environmental Services (COT-ES) and Engineering and Environmental Consultants, Inc. conducted soil and groundwater assessment activities in the vicinity of the City of Tucson Central Energy Plant (CEP) located at 265 South Granada Avenue, Tucson, Pima County, Arizona. The facility was accepted into the Voluntary Remediation Program on February 14, 2007, Site Code 508392-00.

The CEP provides heated and cooled water through pipelines to surrounding buildings for the heating, ventilation and air conditioning (HVAC) systems. Buried pipelines convey potable water that was historically mixed with sodium nitrite as a corrosion inhibitor. In the fall of 2006, leaks were detected in several of these buried lines. To correct the problem, the City elected to replace the old lines. Concurrent with the line replacement project, COT-ES collected soil and groundwater samples to assess possible impacts to soil or groundwater by the nitrogen based corrosion inhibitor compound.

The attached report documents the procedures, findings and conclusions of the soil and groundwater assessment associated with the replacement of the HVAC lines.

Should you have any further questions, please contact Richard Byrd or Nancy Petersen at (520) 791-5414.

Sincerely,

R. C. Lewis
Director, General Services Department
City of Tucson

RL/rb/cj

cc: (With CD ROM copy of report)
Mike Letcher, Deputy City Manager
Andrew Quigley, Environmental Services
Nancy Petersen, Environmental Services
Ralph Marra, Tucson Water
Richard M. Byrd, Environmental Services
Central Energy Plant File copy—with all attachments

CITY OF TUCSON

SITE ASSESSMENT and CLOSURE REPORT

CITY OF TUCSON CENTRAL ENERGY PLANT

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
VOLUNTARY REMEDIATION PROGRAM SITE 508392-00

Prepared by
City of Tucson – Environmental Services
August 26, 2008

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LIST OF ACRONYMS

°C	degrees Celsius
A.A.C.	Arizona Administrative Code
A.R.S.	Arizona Revised Statutes
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AZPDES	Arizona Pollutant Discharge Elimination System
CEP	City of Tucson Central Energy Plant
COC	contaminants of concern
CY	cubic yards
ESC	Environmental Science Corporation
LCS	laboratory control sample
mg	milligrams
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m3	milligrams per cubic meter
MS/MSD	matrix spike/matrix spike duplicate
NFA	No Further Action
NOI	Notice of Intent
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbons
PCS	petroleum contaminated soil
PQL	practical quantitation limit
QA/QC	quality assurance/quality control
RAR	Remedial Action Report
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
rSRL	residential soil remediation level
SRL	soil remediation level
SSHP	Site Safety and Health Plan
SWPPP	Storm Water Pollution Prevention Plan
TC	toxicity characteristic
TCC	City of Tucson Convention Center
TCLP	toxicity characteristic leaching procedure
TWA	time-weighted average
USEPA	U.S. Environmental Protection Agency
VRP	Voluntary Remediation Program
WP	Work Plan

Introduction--Site Assessment and Closure Report; City of Tucson Central Energy Plant, ADEQ VRP Site Code: 508392-00

The City of Tucson-Environmental Services (COT-ES) prepared this report summarizing investigation activities conducted by the Engineering and Environmental Consultants Inc (EEC) relating to the release of process water containing sodium nitrite solution from underground heating and cooling loop lines originating from the City's Central Energy Plant (CEP). The City will sending a no further action request for this facility under separate correspondence.

Background

The City of Tucson (COT) CEP is located on the lower level (western side) of the Tucson Convention Center (TCC) at 265 S. Granada Ave. (Figure 1). The CEP and TCC were built in 1969. The plant provides heated and cooled water to the heating, ventilating and air-conditioning (HVAC) systems in surrounding buildings. At the time of the suspected releases, the HVAC distribution system was constructed with a combination of direct burial and interior mounted steel and Transite® piping. The distribution system had three loops: Loop 1 serves the Music Hall, Leo Rich Theater and the Freemont House; Loop 2 serves TCC, Police and Fire Headquarters buildings; and Loop 3 serves the TCC Arena (Figure 2). Each loop included four (4) separate pipelines to make up separate heating and cooling distribution and return lines. The cooling and heating system used process solution that was potable water mixed with small quantities of sodium nitrite (as a corrosion inhibitor) at a concentration of 700 to 800 parts per million (ppm). Optimal concentration for the sodium nitrite in the system was approximately 1,000 ppm. The HVAC Loop locations are illustrated in Figure 2.

The discovery of unexpectedly high volume of system makeup water requirements led to the heating and cooling distribution loops' pressure testing in August 2006. Pressure test results indicated that the chilled water portion of the Loop 2 distribution system was losing an estimated 25,000 to 30,000 gallons of water per month. The City's General Services Department (GSD) notified COT Environmental Services (ES) of this concern on October 23, 2006. GSD conducted additional testing to find the possible source of the leaks. The piping in loops 1 and 3 either tested tight or exhibited very small leakage rates.

ES calculated the system leak discharge rate from Loop 2 of sodium nitrite at approximately 1.3 pounds per day, which is below the threshold for Federal or State emergency release reporting. Because the system was designed and constructed as a "closed loop," and the release was a non-permitted discharge, ES contacted ADEQ on October 27, 2006 to notify them of the system leak. COT subsequently met with ADEQ staff (Sue Keith, Bob Wallin, Bill Ellett and Martin McCarthy) on November 8, 2006 to discuss the release and the COT's planned environmental response. The meeting allowed the City to present a summary of information relevant to the suspected release, and an outline of the City's planned responses.

The site was accepted into the VRP program on **February 14, 2007** for possible impacts to soil and groundwater from nitrate and nitrite. At that time, the Arizona Residential Soil Remediation Levels (RSRLs) for nitrate was 100,000 milligrams per kilogram (mg/Kg) and for nitrite was 6,500 mg/Kg. The Arizona Aquifer Water Quality Standard (AWQS) for nitrate is ten (10) milligrams per liter (mg/L) and one (1) mg/L for nitrite.

The subsequent assessment activities for the leaking heating and cooling loops focused on two primary concerns: 1) Possible sodium nitrite impacts to native soil in the vicinity of the HVAC Loop pipelines, and 2) Possible sodium nitrite impacts to the perched water bearing zone known to exist in the subject area. The investigation included the assessment of the soil and perched groundwater in the pipeline vicinity for possible nitrate and nitrite impacts (chemicals of concern or COC), and establishment of perched groundwater depth, flow direction, and gradient.

Scope of Work

The scope of activities documented in this report includes:

- Well Inventory Search, February 2007
- Meeting with ADEQ Staff on March 7, 2007
- Permitting, Utilities Clearance, Site Access
- Drilling and Installation of Perched Groundwater Monitoring Wells
- Perched Groundwater Monitoring, Sample Collection and Analysis
- Excavation, Removal and Replacement of HVAC lines
- Soil Sample Collection and Analysis (sample locations beneath areas of removed pipelines)
- Community Outreach and Involvement
- January '08 Process-Water Release Assessment

Methodology

Well Inventory Search

In January 2007 ES staff conducted a well inventory search for possible receptor wells within a half mile radius of the CEP pipelines. ES reviewed the April 2004 Arizona Department of Water Resources (ADWR) well inventory report for the Park Euclid WQARF site. The search radius for that report includes the subject area. ES then reviewed all ADWR databases to identify any new wells that may have been installed since 2004. Tucson Water was contacted to acquire any updated information, as well as the Union Pacific Railroad. All known registered wells as of December 2006 within the one-half mile search radius were identified; none were drinking water supply wells. See attached Figure 3.

Meeting with ADEQ

On March 7, 2007 City Environmental Services met with ADEQ's VRP staff. At the meeting the City presented up to date site background information, a status update of the on-going assessment activities, and the proposed assessment activities and goals. See attached meeting agenda (Appendix A).

Permitting and Utilities Clearance

Prior to the initiation of the subsurface assessment activities, public and private utility clearance was coordinated through Arizona Blue Stake and GSD. Boring and well locations were placed in areas where there would be no conflict with above or below grade utilities, but where necessary technical information could be acquired.

In compliance with Arizona Revised Statute (ARS) §45-596, Notice of Intention (NOI) to drill forms for the groundwater monitoring wells were submitted to, and approved by, the Arizona Department of Water Resources (ADWR) prior to initiation of drilling activities (Appendix B).

Drilling and Installation of Groundwater Monitoring Wells

In December 2006 through January 2007, three groundwater-monitoring wells, designated as CEP-518A, CEP-519A, and CEP-520A were drilled in the vicinity of the section of old piping (Loop 2) connecting the Central Energy Plant to the City of Tucson Police and Fire Headquarters complex (Figure 2). These areas were chosen based on information collected by GSD, identifying possible areas of suspected leaks. In June 2007 two additional groundwater-monitoring wells, designated as CEP-527A and CEP-528A were drilled west and northwest of the Central Energy Plant and Loop 1. COT-ES retained Engineering and Environmental Consultants Inc (EEC) to provide oversight of borehole drilling, logging of the drill cuttings, lithologic interpretation, and to provide oversight of the well installation, and development for three groundwater monitoring wells (Figure 2). Layne Christensen Drilling (Layne) was contracted directly by the COT and mobilized a Mobil Drill B-54 hollow stem auger (HSA) drilling rig to the facility for all wells.

Seven additional perched groundwater-monitoring wells were installed in the subject vicinity during 2007 to assess a former leaking underground storage (LUST) facility (ADEQ LUST File #3208.01, ADEQ UST Facility ID#0-005176). The wells associated with the LUST assessment have the prefix "HQUST" Selected analytical test results collected from soil and groundwater samples during the installation and subsequent monitoring of these wells will be referenced later in this report.

All borings were drilled to depths between sixty and seventy-two feet BLS. All five central energy plant wells (and the seven other wells installed as part of a concurrent LUST assessment) encountered a perched water-bearing zone. This zone has been observed at other UST sites in the area, and thought to be present throughout various areas of downtown Tucson. The clay deposits that formed the lower boundary of the perched water zone were not penetrated or compromised.

Each ground water monitoring well was constructed of 4-inch diameter schedule 40 PVC flush thread well casing material. The bottom 20 feet of each well was constructed with PVC well-screen casing with 0.020-inch machine cut slots. The annular space surrounding the screen section was filled with number 10-20 Colorado Silica sand filter pack. The remaining annular space surrounding the upper casing was filled with a hydrated bentonite clay seal. The uppermost 20 feet is sealed with a neat Portland cement mixture. A six-inch diameter by 21-foot long steel sleeve was placed around the PVC well casing in the uppermost 20 feet for wellhead protection.

The surface completion of each well includes the installation of a four-foot by four-foot by six-inch thick concrete slab supporting a flush mount welded steel protective vault. Typical detail illustrating construction of groundwater monitoring wells and surface completions is presented in Appendix C.

During the installation of each boring, soil samples were collected at five to ten foot intervals where possible to assess subsurface conditions. Samples were collected with a 2-inch diameter by 2-foot long split-spoon sampling tube. The tube was fitted with brass sample collection sleeves. Immediately after sample collection, the brass sleeves were sealed with Teflon® sheeting, end-caps and tape. The samples were then labeled, placed on ice, and transported under chain of custody protocols to a state certified laboratory. A general application of "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), ASTM Designation D 2488" was followed to create the lithologic descriptions for each of the borings. Soil samples were collected in general accordance to ASTM procedures D-1586 and D-4700. Boring Logs are presented in Appendix C.

Subsequent to monitoring well installation, each well was developed to enhance the groundwater movement between the surrounding formations and the well's screened interval. Development also removes any sediment that had been deposited in the well during the construction process. The development process included bailing and swabbing until the water was clear, indication that all of the sand or fine-grained material had been removed from the well and surrounding annulus. Next, a decontaminated electric pump was placed into the well at multiple depths along the screened interval, and pumped until the discharged groundwater was clear, and free of visible suspended solids. This process was repeated at each new well as it was installed.

Groundwater Monitoring

In January 2007, the COT initiated groundwater assessment of the pipeline vicinity by collecting groundwater quality samples from the first three new wells (CEP-518A, CEP-519A, and CEP-520A).

COT-ES monitors the on site groundwater wells on a quarterly basis, or as new wells have been installed. Prior to groundwater sample collection, the depth to groundwater is measured with a calibrated well "Sounder" (electronic measuring device) to establish the distance from a surveyed measuring point on the well casing or concrete pad to the perched groundwater water surface. The sounder

measures the depth to groundwater to the nearest 0.01 foot. Depth to groundwater measurements are summarized on Table 1.

After gauging, monitoring wells were purged with a decontaminated down-hole electric pump. When possible, purged water is monitored for physical parameters including total flow in gallons, pH, specific conductivity (SpC), temperature (Temp), dissolved oxygen (DO), and oxidation reduction potential (ORP). When these parameters stabilize, discrete samples were collected for laboratory analysis. Due to the limited ability of this perched water-bearing unit to recharge some wells, several wells are purged almost dry, and allowed to recover to 90% volume prior to sample collection. All groundwater samples are labeled, placed on ice, and transported to a state certified laboratory under chain of custody protocols.

When the wells were initially installed, groundwater samples are analyzed for alkalinity, ammonia, hardness, anions (nitrate, sulfate, fluoride, and chloride); metals (aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, potassium, selenium, silver, sodium, and zinc) and volatile organic compounds (VOCs) to establish basic groundwater quality conditions. Subsequent sample collection events will have a smaller list of analytes focusing on the compounds of concern. No groundwater samples were collected from wells containing light non-aqueous phase liquids (LNAPL).

The Federal government defines LNAPL as liquids that are sparingly soluble in water and less dense than water. For example, oil is an LNAPL because it "floats" on top of water and does not mix with water. Hydrocarbons, such as oil and gasoline, are other examples of LNAPLs.

Excavation, Removal and Replacement of HVAC lines

Starting in December 2006 and running through the end of 2007, the COT implemented a phased replacement process for the heating and cooling loop lines connected to the CEP. Due to the potential environmental concerns, the pipelines with the largest loss rates were taken out of service first. Loop 2 was addressed first, then Loop 1, and lastly Loop 3. See Figure 2 for Loop pipeline locations.

The western section of Loop 2 between the TCC and headquarters buildings was uncovered, excavated, and replaced during the first quarter of 2007. The eastern end of Loop 2 was abandoned in place due to conflicts with numerous sub-grade utilities. COT-ES retained Engineering and Environmental Consultants Inc (EEC) to provide oversight and sample collection services. When a section of the old pipeline was uncovered, it was inspected for possible sources of leakage. Soil samples were collected from native soil beneath joint or suspect areas when sections of old pipe were removed. New pipelines were installed in the open trenches where old piping had been removed. New pipes were also installed above grade and in new excavations in areas were old piping had been abandoned.

Most of Loop 1 was abandoned in place, with new sections of pipelines being installed in new, adjacent trenches. Old Loop 1 lines were exposed at only one location and soil samples were collected from native material at that location. The Loop 1 activities occurred during the last half of 2007.

Loop 3 was abandoned in place and replaced with new above grade piping. Figure 2 identifies the old and new pipeline locations, and respective soil sample collection points.

During the pipeline replacement process, EEC observed no holes or leak points in the pipelines. No sub-grade saturation or erosion pockets were observed. The pipeline may have had seepage points near joints or elbows, and no impacts to the surrounding soil stability for subsidence potential were encountered.

Soil Sample Collection and Analysis

Seventeen soil samples were collected from native soil beneath the pipeline routes at locations were the old pipelines were removed. Twenty-four soil samples were collected from soil borings during the groundwater monitoring well installation process. Eleven soil samples were collected from borings at a nearby off-site location to establish background soil conditions. All fifty-two soil samples were collected and analyzed following all federal state and local regulations. A State of Arizona certified laboratory conducted all laboratory analysis. The analyte list for the soil samples collected as part of this assessment included nitrates, nitrites, and sodium. Additional analysis not pertaining to this investigation may also have been performed on selected soil samples. Copies of the analytical test results are presented in Appendix D.

Community Outreach and Involvement

Beginning in the last quarter of 2006 and continuing through 2008, City staff from Environmental Services (ES), Tucson Water (TW), and General Services Department (GSD) has attended monthly neighborhood association meetings for the Barrio Viejo and Barrio Santa Rosa neighborhoods. Monthly large scale mailing of informational letters or cards has been distributed to the neighborhoods in the vicinity of the TCC. The mailers have provided a brief overview and update of the City projects associated with the HVAC loop line replacement project. The presentations by City staff at the neighborhood meetings have provided detailed project updates along with question and answer sessions regarding the progress of the HVAC Loop line replacement, the soil and groundwater assessment for nitrates, and for the soil and groundwater assessment of the adjacent LUST site. A sign was also posted near the location of the Loop 2 lines near Church Avenue as a public notice of the environmental assessment activities. The City will continue to provide updates to the neighborhoods, and answer questions as the project proceeds. See Appendix E for copies of the mailers and photographs of the sign. The following table provides a summary of outreach activities:

Date	Summary Of Activities
10/30/06	Public Meeting sponsored by Council Member Trasoff – Notification of leak and environmental investigation. Residents were notified of meeting with a flyer that was distributed door to door. *City staff in attendance: Council Member Nina Trasoff, Deputy City Manager Mike Letcher, Asst. City Manager Karen Masbruch, GSD Director Ron Lewis, ES Deputy Director Nancy Petersen, Tucson Water Deputy Director Marie Pearthree, Ralph Marra, TW Administrator, Tony Larrivee, GSD Facilities Manager*
11/13/06	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff attended the neighborhood meeting to provide an update.
11/14/06	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa. (Department of Neighborhood Resources provided mailing list.)
12/8/06	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa.
12/11/06	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report.
1/8/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – Presented progress report. Discussed well search in vicinity of Tucson Convention Center and application to ADEQ's Voluntary Remediation Program (VRP).
1/22/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa.
2/12/07	Meeting requested by ES –Met with neighborhood representatives at NW corner of Cushing St. and Church Ave., discussed soil and groundwater sampling results and detection of dissolved petroleum compounds in the perched aquifer.
2/13/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report.
2/26/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa.
3/13/07	Barrio Viejo Neighborhood Meeting – GSD and ES staff provided progress report.
3/19/07	Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report.
4/09/07	Copy of "Tucson Central Energy Plant Well Installation and Sampling Report dated March 13, 2007: mailed to Barrio Viejo Neighborhood Association
4/10/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – ES was requested not to attend meeting as agenda was focused on association business.
5/4/07	Newsletter update mailed each resident in Barrio Viejo and Barrio Santa Rosa.
5/8/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report. Notified residents of request to ADEQ to re-open and assess the closed underground storage tank (UST) site at Police and Fire headquarters.
6/11/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa.
6/12/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – ES did not attend meeting because location was changed for summer and no notification was received. ES has been added to the meeting mailing list for future notifications.
7/10/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report.

Date	Summary Of Activities (continued)
7/12/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa.
8/10/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa.
9/07/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa
9/11/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report.
10/05/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa
11/09/07	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa.
11/13/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report.
12/11/07	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report.
01/04/08	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa
01/08/08	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – GSD and ES staff provided progress report
02/12/08	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – ES staff provided progress report
03/11/08	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – ES staff provided progress report
04/08/08	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – ES staff provided progress report
05/09/08	Postcard update mailed to each resident in Barrio Viejo and Barrio Santa Rosa
05/13/08	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – ES staff provided progress report
06/10/08	Barrio Viejo/Barrio Santa Rosa Neighborhood Meeting – ES staff provided progress report

January '08 Process-Water Release

On Saturday, January 5, 2008, during testing of the new HVAC Loop line system, 13,000 gallons of cooling process water was released to the soil near (south of) Tucson Fire Headquarters. A valve connecting the old, abandoned Loop 2 cooling line to the active cooling system had been accidentally left open. Sections of the old line had been left in place, and had an open end terminating in the soil. As the cooling system was refilled for testing, potable water with no added corrosion inhibitors escaped through the open valve, and seeped into the soil, south of the TFD headquarters building. The active HVAC system and a portion of the abandoned loop line may have contained some residual amount of sodium nitrite.

GSD notified ES of this concern on Tuesday, January 8, 2008. ES notified ADEQ of the possible release as soon as they had been notified. On Wednesday, January

9, 2008 ES staff recovered a grab water sample of the leaked process water which had pooled in a sub-grade vault. This sample was analyzed for concentrations of sodium nitrite.

Analytical results by Tucson Water Quality Laboratory indicated that neither nitrite nor nitrate was detected above analytical method detection limits in the Loop 2 water sample. Since makeup water from the Tucson Water distribution system has been added periodically to the lines since 2006, there does not appear to be a measurable concentration of residual sodium nitrite in the process water. A letter report summarizing the release and test results was sent to ADEQ in March 2008.

Results

Geology

The TCC and CEP are located in downtown business district of Tucson (Figure 1). The subject area is located in the western portion of the Tucson Basin, a structural valley in southeastern Arizona, which is in the Sonoran section of the Basin and Range Physiographic Province.

The principal geologic units of interest in the Tucson Basin are recent alluvium related to modern streams and washes, the Fort Lowell Formation of Quaternary age, and the Tinaja beds of Tertiary age. These units are classified as basin-fill deposits and are underlain by older sedimentary rocks of the Pantano Formation and by a basement bedrock complex.

The shallow vadose-zone in the vicinity of the CEP pipelines extends from the top of the perched water table (saturated zone) to land surface. This zone extended to a depth of about 62 feet BLS. Geologic units comprising the vadose zone are recent alluvium from about 0 to 20 feet BLS; and the Fort Lowell Formation which is present from about 20' BLS, to beyond the total depth of this assessment (assessment depth approximately 70 feet BLS).

The lithology of the vadose zone in each boring consisted of inter-bedded layers of moderately fine and medium-grained sands and gravels. During drilling of the groundwater monitoring wells at the site, COT-ES observed inter-bedded layers of silty sand, clayey sand, sandy clay, sandy silt, silty gravel with sand, well-graded gravel with sand, and well graded sand with gravel and silts. The perched water-bearing zone consists predominantly of medium brown sandy clay with some gravels. Immediately beneath the water-bearing unit is dense, dark brown, cemented, dry clay layer. This clay unit exhibits very low permeability and transitivity, acting as an aquitard, and causes the water to accumulate above it, forming the perched saturated zone.

Hydrogeology

Depth to initial perched groundwater contact during the drilling process was approximately 62 feet BLS in the eastern wells (CEP-518A, 519A & 520A), and 42 feet BLS in the two western wells (CEP-527A & 528A), see Figure 2. Static depth to perched groundwater (after well installation and development) at the site ranges from approximately 42 feet to 72 feet BLS. The saturated thickness of this

perched water-bearing zone is generally three to eight feet thick. Although groundwater flow directions in perched zones can sometimes vary, flow direction in the project area is toward the northwest and has been stable for the monitoring period (over one year). Potentiometric perched groundwater surface elevations in the vicinity of the TCC has ranged from approximately 2320 feet above mean sea level (amsl) to 2313 feet (amsl). Depths to perched water measurements are presented in Table 1. Information provided by Tucson Water indicates depth to the regional groundwater surface is approximately 150 feet BLS.

Wells CEP-520A, CEP-528A, HQUST-532A, HQUST-533A, HQUST-525A and CEP-518A are all screened into the perched water bearing zone. The alignment between HQUST-532A and HQUST -533A, CEP-520A and CEP-528A and HQUST-525A and CEP-518A are all southeast to northwest, which is parallel to the flow direction. None of the six wells contain free phase petroleum product. These physical conditions allow the use of a simple calculation to determine the hydraulic flow gradient.

The *hydraulic gradient* is a vector gradient between two or more hydraulic head measurements over the length of the flow path. It is also called the *Darcy slope*, since it determines the quantity of a *Darcy flux*, or discharge. A dimensionless hydraulic gradient can be calculated between two piezometers or wells as:

Where $i = dh / dl = h2\text{-}h1 / length$

i is the hydraulic gradient (dimensionless),
dh is the difference between two hydraulic heads (Length, usually in m or ft), and
dl is the flow path length between the two piezometers or wells (Length, in m or ft)

Wells HQUST-525A and CEP-518A, (measurements in November 2007)

Groundwater surface elevation of HQUST-525A= 2319.67 feet above sea level (*h*2).
Groundwater surface elevation of CEP-518A= 2319.28 feet above sea level (*h*1).
Distance between wells (parallel to flow direction) = 340 feet (*dl)*

i = 0.39/340 ***=0.0012***

Wells HQUST-532A and HQUST-533A, (measurements in November 2007)

Groundwater surface elevation of HQUST-532A= 2320.40 feet above sea level (*h*2).
Groundwater surface elevation of HQUST-533A= 2319.04 feet above sea level (*h*1).
Distance between wells (parallel to flow direction) = 498 feet (*dl)*

i = 1.071/498 ***=0.0021***

For Wells CEP-520A and CEP-528A, (measurements in June 2007)

Groundwater surface elevation of CEP-520A = 2319.14 feet above sea level (*h*2).

Groundwater surface elevation of CEP-528A = 2313.72 feet above sea level (*h*1).
Distance between these two wells (parallel to flow direction) = 1185 feet (*dl)*
i = 5.421/1185 ***=0.0046***

The **average hydraulic gradient** calculated from measurements collected from these three sets of perched groundwater wells, is ***0.0026*** *[(0.0012 + 0.0021 +0.0046) divided by 3]***.**

No aquifer characterization tests have been performed on the perched aquifer beneath the subject site. Aquifer parameters can be estimated from reference documents based on boring log observations. The saturated zone is relatively thin, between 3 and 8 feet in thickness. The saturated soils vary from fine grain sandy clay to poorly sorted fine grained sand. The saturated zone is heterogenic and would appear to exhibit anisotropic conditions. Ignoring dispersion, the average linear velocity of flow through a porous medium can be calculated through the equation: ***V= -K/n * i***

Where: *V* is the average linear velocity,
i is the hydraulic gradient (*dh / dl*) (which for this area is estimated to be 0.0026)
K is the Hydraulic Conductivity of the soil
n is the effective porosity of the soil

Using estimated values found in *Groundwater and Wells, Second Edition*, by Fletcher G. Driscoll, PhD; the hydraulic conductivity (*K*) of sandy silt and sand in a medium dense soil is estimated to range from 12 to 365 millimeters (mm) per day. The effective porosity (*n*) of sandy silt and sand is estimated to ranges from 25% to 50%.

Based on these estimates, the **average linear velocity** in the water bearing unit beneath the site would **range from 0.063 mm/day to 3.8 mm/day (0.02 to 1.4 meters per year),** in a down gradient direction (towards the northwest).

During 2007, perched groundwater elevations dropped in the wells located in the eastern portion of the site, but rose on the western side. Water levels dropped 0.42 feet at well CEP-518A, and rose 0.24 feet at well CEP-527A. Groundwater elevations in a shallow perched aquifer can vary in response to localized surface water infiltration. Free product was being removed through hand bailing, this may also have had a local impact on water levels..

Potentiometric Groundwater Surface Map is presented in Figure 3. Hydrographs of the three eastern CEP wells is presented on Figure 4. Hydrographs of the two western CEP wells is presented on Figure 5.

Surface Water Hydrology

Surface water flow in the Tucson basin occurs in response to precipitation. Flow events are observed in channels, washes, and some sheet flow. The surface water flow in the vicinity of the TCC has been highly altered by cultural features including buildings, parking lots and roadways. Cushing Street Wash and TCC Wash are located just west of the subject site, and are the major receptors for

surface water running from the TCC facility. Both of these washes are tributaries of the Santa Cruz River, which is the major drainage feature in the western part of the Tucson Basin. Surface water generally flows in a west- northwesterly direction in most this area. The flow direction of the perched water-bearing unit roughly mirrors surface water flow in this vicinity.

Soil Sample Analysis

The compounds of concern associated with releases from pipeline are nitrates and nitrites. Nitrates and nitrites are nitrogen-oxygen chemical units, which combines with various organic and inorganic compounds. Nitrite was the compound used in the Loop HVAC lines. Nitrite is not stable in the environment, and will change into nitrate. Primary sources of organic nitrates include human sewage and livestock manure. The greatest source of man-made nitrates is fertilizer (*US Environmental Protection Agency Consumer Fact sheet on: NITRATES/NITRITES*).

The subject vicinity is an older area of Tucson. During the excavation of Loop 2, the remains of a residential "out-house" from Tucson's pioneer days was unearthed. Archeologists were brought in and surveyed the site. The barrio residential homes that were located on the property prior to the construction of the TCC were originally serviced by out-houses, septic tanks and leach fields, and finally sanitary sewer systems. Pima County maintains the sanitary sewer system in this vicinity. Sections of the sewer system in this vicinity are of advanced age, have suffered leaks, and according to Pima County have gone through numerous up-grades and repairs. All of these waste treatment facilities are potential sources of nitrogen impacts to soil and groundwater.

Eleven soil samples collected to establish background conditions from an off-site location (Tax Parcel 117-13-069E) near the intersection of Cushing and Clark streets, approximately 1,500 feet southwest from the suspected Loop 2 releases. Soil sample depths ranged from six inches to sixty feet below current land surface (BLS). Nitrate concentrations of 46 mg/Kg were identified in a twenty-foot BLS sample, and 8.4 mg/Kg was detected in a fifteen-foot BLS sample. Nitrates were not identified above analytical method detection limits (5.0 mg/Kg) in any of the other background samples. There were no nitrite concentrations detected above analytical method detection limits (0.20 mg/Kg) in any background samples

Seventeen soil samples were collected from native soil at locations underneath the old Loop 2 pipelines as they were removed. Nitrate concentrations ranged from 1,200 mg/Kg to below analytical method detection limits (5.0 mg/Kg). Nitrite concentrations ranged from 2.9 mg/Kg to below analytical method detection limits (0.20 mg/Kg).

Twenty-four soil samples were collected from the soil borings drilled to install the monitoring wells in the vicinity of the Loop lines. Sample depths ranged from ten to sixty feet below land surface. Nitrate concentrations ranged from 130 mg/Kg to below analytical method detection limits (5.0 mg/Kg). Nitrite concentrations ranged from 0.31 mg/Kg to below analytical method detection limits (0.20 mg/Kg).

The analytical test results for the soil samples are summarized in Table 2. The City's characterization of the site began in late 2006 and early 2007, prior to May 2007. The City adopted the then existing Arizona residential soil remediation standards (RSRLs) as the site specific clean up standards. None of the soil analytical test results exceeded the RSRLs for nitrate (100,000 mg/Kg) or nitrite (6,500 mg/Kg).

Groundwater Quality

Background

The compounds of concern associated with the pipeline leakage are *nitrate*s and *nitrites*. These compounds could be present from the sodium nitrite corrosion inhibitor that was used in the HVAC process water. Most nitrogenous materials in natural waters tend to be converted to nitrate, so all sources of combined nitrogen, particularly organic nitrogen and ammonia, should be considered as potential nitrate sources. Since nitrogen-oxygen compounds are very soluble and do not bind to soils, nitrates have a high potential to migrate to ground water. Because they do not readily evaporate, nitrates/nitrites are likely to remain in water (*US Environmental Protection Agency Consumer Fact sheet on: NITRATES/NITRITES*).

During 2006, groundwater wells located west of the TCC were sampled and analyzed for nitrogen compounds. These wells are located within 600 yards of the CEP and were previously installed and are associated with a nearby Leaking Underground Storage Tank site (LUST site 0912). Samples collected from four perched, and three regional monitoring wells were submitted to the University of Arizona-Department of Geosciences for laboratory analysis of nitrogen (N) isotopes to evaluate possible sources of nitrogen (as nitrate) in groundwater. According to Chapelle (2001), "Nitrogen occurs as two stable isotopes, ^{15}N and ^{14}N". Ratios of these isotopes are commonly referred to a standard and reported as $\delta^{15}N$.

Results are presented on the table below:

Stable Nitrogen Isotopes in Groundwater – Sample Dates Nov 20-21, 2006

Well	**Aquifer**	**$\delta^{15}N$ (parts per thousand)**	**Source (according to Chappelle, 2001)**
WR-251A	Perched	22.8	Human-animal waste
WR-249A	Regional	11.2	"
WR-249 Dupe	Regional	11.1	
WR-271B	Regional	9.7	"
WR-248A	Regional	9.7	"
WR-252A	Perched	5.8	Organics in soil, possibly fertilizer
WR-250A	Perched	2.9	Fertilizer
WR-269A	Perched	1.3	Fertilizer

In general, $\delta^{15}N$ for fertilizer sources is approximately +2 to -2.5 Naturally-occurring organic sources in soil have $\delta^{15}N$ of +4 to +9. Human and animal waste sources have $\delta^{15}N$ of +9 to +18 and above.

Fractionation and denitrification in the vadose zone and in groundwater result in increases of $\delta^{15}N$, but generally not above +10, according to Chappelle. It is reasonable to assume that $\delta^{15}N$ greater than 10 is from an animal waste source while $\delta^{15}N$ less than 2 is from a fertilizer source. Identifying a nitrogen source when $\delta^{15}N$ is between 10 and 2 can be problematic. Based on the results in the table above, the source of nitrogen in WR-249A and WR-251A is human or animal wastes (i.e. feedlots, livestock farming, septic systems etc). Low $\delta^{15}N$ in WR-250 A and WR-269A appears to be due to a fertilizer source of nitrogen. Nitrogen in WR-271B and WR-248A appears to be due to animal waste, but it is possible that denitrification or fractionation from a naturally-occurring organic material in soil is the source.

All three regional aquifer wells at the nearby LUST site appear to have nitrogen sources from animal wastes, while the perched wells had fertilizer sources. An exception is perched well WR-251A, which had the highest $\delta^{15}N$ characteristic of an animal waste source. This is the same well that had 15 mg/L nitrate in September 2006 and no detection of nitrate in November 2006. Surface water runoff into the well may be contributing to these anomalous results. While $\delta^{15}N$ in these wells can be quantified, nitrate does not exceed the AWQS.

Given certain environments, denitrification can take place. Denitrification is the process by which nitrate-nitrogen is converted to nitrogen gas by microorganisms when oxygen is low or absent. This reaction is the mechanism for removal of nitrogen from water, wastewater or soil. During the denitrification process, the nitrates become nitrite, nitrous oxide, ammonia, or elemental nitrogen. Most commonly, the nitrates are converted into the pure nitrogen element. The natural denitrification process may be occurring in areas of the perched aquifer where nitrogen compounds are present.

CEP Perched Wells Results

Of the compounds which were detected in the CEP well samples above the analytical method practical quantitative limits (PQL's), several VOC's, nitrates and nitrites have been detected at concentrations exceeding the Arizona Aquifer Water Quality Standards (AWQS). The wells with VOC exceedences are in an area where an underground storage tank (UST) system was formerly located, and are part of a separate and on-going UST assessment (ADEQ LUST File #3208.01, ADEQ UST Facility ID#0-005176).

In January 2007 the first three groundwater-monitoring wells (CEP-518A, 519A & 520A) were completed into the perched water-bearing unit beneath the subject area. A total of twelve groundwater-monitoring wells have been completed into the perched water-bearing unit beneath the facility. Thirty-seven groundwater samples have been collected from the twelve monitoring wells in the vicinity of the leaking pipelines. Five of the wells were focused on just the pipeline, the other seven are dual purpose, and are used to assess the pipeline release and the

former UST site (ADEQ LUST File #3208.01, ADEQ UST Facility ID#0-005176).

Five wells had sample results exceeding the AWQS for *nitrate*. All five of these wells are located on COT property. Results from CEP-518A indicate nitrate concentrations ranging from 46 mg/L to 7.6 mg/L. Results from CEP-527A indicate nitrate concentrations ranging from 94 mg/L to 51 mg/L. Results from CEP-528A indicate nitrate concentrations ranging from 18 mg/L to 15 mg/L. Results from HQUST-525A indicate nitrate concentrations of ranging from 14 mg/L to 7.7 mg/L. Results from HQUST-533A indicate nitrate concentrations of ranging from 43 mg/L to 33 mg/L. The remaining monitoring well samples indicated no nitrates or nitrites at concentrations above the AWQS.

Two well's samples exceeded the AWQS for *nitrite*. CEP-518A samples have nitrite concentrations ranging from 21 mg/L to 1.9 mg/L. HQUST-533A has nitrite concentrations of 36 mg/L to 6.4 mg/L. The remaining well samples had concentrations below the AWQS. These two wells are located on COT property. Due to the minimal horizontal gradient, the potential for off-site migration of the elevated nitrite concentrations is minimal.

Samples from the new perched groundwater monitoring wells were collected and submitted to the University of Arizona-Department of Geosciences for nitrogen isotope analysis as they were installed in 2007. Results are presented on the following table:

Stable Nitrogen Isotopes in Groundwater – CEP Vicinity Wells

Well	**Aquifer**	**$\delta^{15}N$**	**Source (according to Chappelle, 2001)**
CEP-518A	Perched	6.7	Organics in soil, possibly fertilizer
CEP-519A	Perched	13.8	Human-animal waste
CEP-520A	Perched	23.4	Human-animal waste
CEP-520A/dupe	Perched	21.1	Human-animal waste
HQUST-523A	Perched	19.1	Human-animal waste
HQUST-525A	Perched	11.4	Human-animal waste
HQUST-526A	Perched	5.9	Organics in soil, possibly fertilizer
CEP-527A	Perched	14.2	Human-animal waste
CEP-528A	Perched	13.5	Human-animal waste
HQUST-531A	Perched	20.5	Human-animal waste
HQUST-532A	Perched	11.3	Human-animal waste
HQUST-533A	Perched	21.5	Human-animal waste
Sodium Nitrite Product	NA	2.3	Anti Corrosion Compound

Based on the results from the nitrogen isotope analysis summarized in the table above, the sources of nitrogen compounds observed in the perched wells are as follows:

- CEP-519A, CEP-520A, HQUST-523A, HQUST-525A, CEP-527A, and CEP-528A samples have sources of nitrogen compounds from human or animal wastes (i.e. feedlots, livestock farming, leaking sewers, septic systems etc.
- Intermediate levels of $\delta^{15}N$ in wells CEP-518A and HQUST-526A appears to be due to organics in soil, possibly fertilizer source of nitrogen. Well samples from CEP-518A, HQUST-526A may also have nitrogen compounds that came from the former leaking HVAC pipelines.
- Four of the five wells with samples exceeding the AWQS for nitrate (CEP-527A, CEP-528A, HQUST-525A and HQUST-533A) appear to have been impacted with nitrogen compounds originating from human or animal waste. Their impacts do not appear to be associated with releases from the HVAC pipelines.

Wells CEP-519A, HQUST-523A, & 524A all contain LNAPL (free phase gasoline) as of December 2007. Figure 3 illustrates the perched groundwater monitoring well locations. Table 3 summarizes the groundwater sample test results. Figure 6 indicates the average nitrate and nitrite concentrations detected in the groundwater monitoring wells from January 2007 through May 2008. Figure 7 illustrates the concentration of nitrites and nitrates in well CEP-518A.

Copies of groundwater analytical test results for samples collected from on-site wells are presented in Appendix F. All of the soil and groundwater samples (except for the samples analyze for $\delta^{15}N$) were analyzed by laboratories certified by the State of Arizona, and comply with normal quality assurance and quality control requirements.

January 8, 2008 Process Water Release

The process water released from the HVAC system in January 2008 was sampled, and analyzed by a State certified laboratory. The analytical test results indicated there were no residual sodium nitrite concentrations above analytical method detection limits. A copy of the March 28, 2008 report to ADEQ is presented in Appendix G.

Conclusions

Based on the information presented herein, the following conclusions can be made:

- The results of the well inventory search indicate no drinking water wells are located within ½ mile of the subject site.
- Geologic units comprising the vadose-zone include recent alluvium from about 0 to 20 feet BLS and the Fort Lowell Formation from about 20 feet BLS to the bottom of the boring (approximate 70 feet BLS). The majority

of the soils encountered during the drilling were fine-grained deposits including clays, silts, sands, and some larger grain-sized gravel.

- A perched water bearing zone was identified under the assessment area. The perched water-bearing zone consists predominantly of medium brown sandy clay with some gravels. This "perched groundwater" is not utilized for a source of drinking water. There is no drinking water wells located in this vicinity.
- Potentiometric groundwater surface elevations indicate perched groundwater is encountered approximately 42 to 72 feet below land surface, and flow direction is northwest. The perched groundwater under the site moves at a very slow velocity. The on-going monitoring results collected over the last year continue to indicate a northwesterly flow. The average horizontal gradient is calculated to be 0.0026. The average linear velocity beneath the site is estimated to range from 0.063 mm/day to 3.8 mm/day (0.02 to 1.4 meters per year).
- Based on soil analytical test results, there are no nitrate or nitrite impacts to soil above Arizona Residential Soil Remediation Levels (in effect February 2007 at time of VRP acceptance). Any historic releases of process water containing sodium nitrite from the HVAC pipelines do not appear to have adversely impacted shallow soil. The vadose zone soil does not appear to be adversely impacted by nitrates or nitrites.
- Based on perched groundwater analytical test results, the water quality in the perched saturated zone in the vicinity HVAC pipelines has been degraded by multiple sources, including petroleum compounds and nitrogen-based compounds.
- The petroleum impacts to the perched water-bearing zone are being addressed as part of a separate and on going UST assessment (ADEQ LUST File #3208.01, ADEQ UST Facility ID#0-005176).
- Based on analytical test results from on-site, and nearby wells, the perched water bearing zone in this vicinity has elevated nitrate and nitrite concentrations. The elevated nitrogen compounds have many possible sources including historic use of fertilizer, human and/or livestock wastes, or naturally occurring nitrogen. Based on analytical test results, only two perched wells, CEP-518A, and HQUST-533A exceed AWQS for nitrite and nitrate. Both wells are located in close proximity to the original Loop-2 pipelines.
- Based on nitrogen isotope analysis, monitoring well CEP-518A appears to have been impacted by releases from the CEP pipelines. The elevated nitrogen levels seen in well HQUST-533A are attributable to human or animal waste. This is also supported by the nearby discovery of an historic out-house (just south or HQUST-533A).

- Based on nitrogen isotope test results, AWQS exceedences of nitrate in vicinity monitoring wells (CEP-527A, CEP-528A, HQUST-525A, and HQUST-533A) appear to be due to septage or animal wastes (historical uses), and are not due to sodium nitrite releases from the CEP pipeline.
- The nitrite impacts associated with the CEP to the perched groundwater either meet AWQS, or are confined to one well (CEP-518A) which is located on property owned by the COT. The presence of fine grained soils in the borings, low hydraulic gradient and low flow velocities in the perched water bearing zone, all combine to indicate a very low probability of off-site migration of the nitrite/nitrate impacted groundwater. The impacted groundwater would likely remain on City property long enough to allow natural attenuation. Figure 8 illustrates that nitrogen concentrations in groundwater from well CEP-518A have been declining since the source was shut off and removed.
- The potential sources for nitrites and nitrates (sodium nitrite leakage from the old HVAC lines) have been eliminated through the replacement of the old HVAC loop lines, and the discontinued use of the sodium nitrite compounds in the new pipelines. These actions took place in 2007.
- There are no known conduits for human contact to the perched water-bearing zone (with the exception of the City's secured monitoring wells).

ES has demonstrated the sodium nitrite released from the former HVAC pipelines has not impacted the native soil above residential soil remediation standards. The nitrite and nitrate impacts to the perched groundwater exceeding the AWQS and are attributable to releases from the CEP pipelines are isolated at one City owned well CEP-518A, and will not likely migrate off-site.

Other monitoring wells showing *nitrate* impacts exceeding the AWQS (CEP-527A, CEP-528A, HQUST-525A, and HQUST-533A) have nitrogen sources associated with historical uses; human or animal wastes, and are not due to sodium nitrite releases from the pipelines.

Pursuant to Arizona Revised Statutes Title 49, section 175B-4, the City will request a no further action designation for this site. An official "No Further Action" letter from the City will follow this report.

Tables

Table 1

Perched Groundwater Elevations-CEP and HQUST Site							
Well	DATE	TOC elevation (ft)	DTW (ft)	DTP (ft)	Product Thickness (ft)	Corrected DTW	Corrected GW Elevation
CEP-518A	1/31/2007	2385.52	65.82			65.82	2319.70
CEP-518A	6/27/2007	2385.52	66.18		0.00	66.18	2319.34
CEP-518A	11/13/2007	2385.52	66.24		0.00	66.24	2319.28
CEP-519A	6/27/2007	2381.67	62.75	62.10	0.65	62.23	2319.44
CEP-519A	11/9/2007	2381.67	62.53	62.10	0.43	62.19	2319.48
CEP-519A	11/16/2007	2381.67	62.54	62.25	0.29	62.31	2319.36
CEP-519A	11/21/2007	2381.67	62.56	62.29	0.27	62.34	2319.33
CEP-519A	11/30/2007	2381.67	62.51	62.24	0.27	62.29	2319.38
CEP-519A	12/7/2007	2381.67	62.54	62.25	0.29	62.31	2319.36
CEP-519A	12/14/2007	2381.67	62.53	62.25	0.28	62.31	2319.36
CEP-519A	12/21/2007	2381.67	62.53	62.25	0.28	62.31	2319.36
CEP-519A	12/27/2007	2381.67	62.47	62.25	0.22	62.29	2319.38
CEP-519A	1/4/2008	2381.67	62.41	62.18	0.23	62.23	2319.44
CEP-520A	1/31/2007	2379.40	59.87		0.00	59.87	2319.53
CEP-520A	6/27/2007	2379.40	60.26		0.00	60.26	2319.14
CEP-520A	11/13/2007	2379.40	60.25		0.00	60.25	2319.15
CEP-527A	6/27/2007	2357.48	42.30		0.00	42.30	2315.19
CEP-527A	7/2/2007	2357.48	42.31		0.00	42.31	2315.17
CEP-527A	8/1/2007	2357.48	41.36		0.00	41.36	2316.12
CEP-527A	Nov-07	2357.48	nm	nm	nm	nm	
CEP-527A	1/3/2008	2357.48	42.05		0.00	42.05	2315.43
CEP-528A	6/27/2007	2359.78	46.06		0.00	46.06	2313.72
CEP-528A	7/2/2007	2359.78	46.04		0.00	46.04	2313.74
CEP-528A	8/1/2007	2359.78	45.61		0.00	45.61	2314.17
CEP-528A	Nov-07	2359.78	nm	nm	nm	nm	
CEP-528A	1/3/2008	2359.78	45.89		0.00	45.89	2313.89
HQ-UST-523A	6/27/2007	2382.85	63.32		0.00	63.32	2319.53
HQ-UST-523A	8/1/2007	2382.85	63.41		0.00	63.41	2319.44
HQ-UST-523A	11/14/2007	2382.85	63.94	63.21	0.73	63.36	2319.49
HQ-UST-523A	12/21/2007	2382.85	63.42	63.40	0.02	63.40	2319.45
HQ-UST-523A	12/27/2007	2382.85	63.42	63.41	0.01	63.41	2319.44
HQ-UST-523A	1/4/2008	2382.85	63.36	63.35	0.01	63.35	2319.50
HQ-UST-524A	6/27/2007	2382.21	62.93	62.68	0.25	62.73	2319.48
HQ-UST-524A	8/17/2007	2382.21	63.20	62.67	0.53	62.78	2319.43
HQ-UST-524A	8/21/2007	2382.21	63.29	62.61	0.68	62.75	2319.46
HQ-UST-524A	8/30/2007	2382.21	63.09	62.77	0.32	62.83	2319.38
HQ-UST-524A	9/5/2007	2382.21	63.15	62.75	0.40	62.83	2319.38
HQ-UST-524A	9/11/2007	2382.21	63.10	62.70	0.40	62.78	2319.43
HQ-UST-524A	9/17/2007	2382.21	63.16	62.72	0.44	62.81	2319.40
HQ-UST-524A	9/20/2007	2382.21	63.12	62.72	0.40	62.80	2319.41
HQ-UST-524A	9/26/2007	2382.21	63.19	62.75	0.44	62.84	2319.37
HQ-UST-524A	9/28/2007	2382.21	63.16	62.72	0.44	62.81	2319.40
HQ-UST-524A	10/1/2007	2382.21	63.14	62.72	0.42	62.80	2319.41
HQ-UST-524A	10/3/2007	2382.21	63.10	62.76	0.34	62.83	2319.38
HQ-UST-524A	10/11/2007	2382.21	63.15	62.69	0.46	62.78	2319.43
HQ-UST-524A	10/16/2007	2382.21	63.15	62.62	0.53	62.73	2319.48
HQ-UST-524A	11/2/2007	2382.21	nm--pump	nm	nm	nm	
HQ-UST-525A	6/26/2007	2391.50	71.74		0.00	71.74	2319.76
HQ-UST-525A	8/1/2007	2391.50	71.84		0.00	71.84	2319.66
HQ-UST-525A	11/13/2007	2391.50	71.83		0.00	71.83	2319.67
HQ-UST-526A	6/25/2007	2379.57	60.42		0.00	60.42	2319.15
HQ-UST-526A	8/13/2007	2379.57	60.55		0.00	60.55	2319.02
HQ-UST-526A	11/14/2007	2379.57	60.46		0.00	60.46	2319.11
HQ-UST-531A	11/15/2007	2378.36	59.08		0.00	59.08	2319.28
HQ-UST-532A	11/15/2007	2382.75	62.35		0.00	62.35	2320.40
HQ-UST-533A	11/15/2007	2379.29	60.25		0.00	60.25	2319.04

nm = not measured

Table 2

Central Energy Plant Pipeline Release- Soil Sample Analytical Test Results				
		Analytes (mg/Kg)		
Sample Name/Location	**Date**	**Nitrate**	**Nitrite**	**Sodium**
TCC-1	1/18/2007	39	1.9	3500
TCC-2	1/18/2007	100	0.89	5400
TCC-3	1/18/2007	33	2	1800
TCC-4	1/18/2007	<10	2.9	380
TCC-5	1/18/2007	110	2.3	1100
TCC-6	1/18/2007	440	<0.20	810
TCC-7	1/18/2007	110	<0.20	1700
TCC-8	1/18/2007	240	<0.20	930
TCC-9	2/14/2007	<5.0	<0.20	140
TCC-10	2/14/2007	<5.0	1.1	180
TCC-11	2/14/2007	33	<0.20	640
TCC-12	2/15/2007	1200	<0.20	3400
TCC-13	2/15/2007	89	<0.20	1100
TCC-14	3/2/2007	<5.0	<0.20	<100
TPD-S	9/11/2007	<5.0	<0.40	140
MH-SE-1	9/11/2007	15	<0.20	380
MH-SE-2	9/11/2007	9.8	<0.20	360
*TCC-PLD-1-60'	9/18/2006	<5.0	<0.20	<100
*TCC-PLD-4-20'	9/14/2006	46	<0.20	2700
*TCC-PLD-4-25'	9/14/2006	<5.0	<0.20	<100
*TCC-PLD-5-40'	9/14/2006	<5.0	<0.20	280
*TCC-PLD-6-30'	9/14/2006	<5.0	<0.20	<100
*TCC-PLD-6-40'	9/14/2006	<5.0	<0.20	230
*TCC-PLD-7-15'	9/20/2006	8.4	<0.20	700
*TCC-PLD-7-40'	9/20/2006	<5.0	<0.20	190
*TCC-PLD-7-60'	9/20/2006	<5.0	<0.20	150
**SS-B-0.5'	11/28/2006	<5.0	<0.20	160
**SS-B-2.5'	11/28/2006	<5.0	<0.20	350
****CEP-518A-15'	12/12/2006	<5.0	<0.20	<100
****CEP-518A-30'	"	11	<0.20	1,900
****CEP-518A-40'	"	6.9	<0.20	1,300
****CEP-519A-25'	12/19/2006	36	<0.20	370
****CEP-519A-40'	"	130	<0.20	810
****CEP-519A-60'	"	8.5	0.31	120
****CEP-520A-20'	12/13/2006	35	<0.20	460
****CEP-520A-40'	12/14/2006	5.8	<0.20	430
****CEP-520A-60'	"	<5.0	<0.20	260
****CEP-527A-10'	6/18/2007	7.7	<0.40	900
****CEP-527A-20'	"	<5.0	<0.20	990
****CEP-527A-30'	"	<5.0	<0.20	<100
****CEP-527A-40'	"	<5.0	<0.20	120
****CEP-528A-10'	6/19/2007	22	<0.20	850
****CEP-528A-20'	"	53	<0.20	620
****CEP-528A-30'	"	<5.0	<0.20	370
****CEP-528A-41'	"	<5.0	<0.20	120
****HQUST-525A-10'	6/5/2007	<5.0	<0.20	200
****HQUST-525A-20'	"	<5.0	<0.20	250
****HQUST-525A-40'	"	<5.0	<0.20	760
****HQUST-525A-60'	"	<5.0	<0.20	530
****HQUST-526A-20'	5/31/2007	<5.0	<0.20	110
****HQUST-526A-40'	"	<5.0	<0.20	200
****HQUST-526A-60'	6/1/2007	<5.0	<0.20	310
***AZ SRLs**		**100,000**	**6,500**	

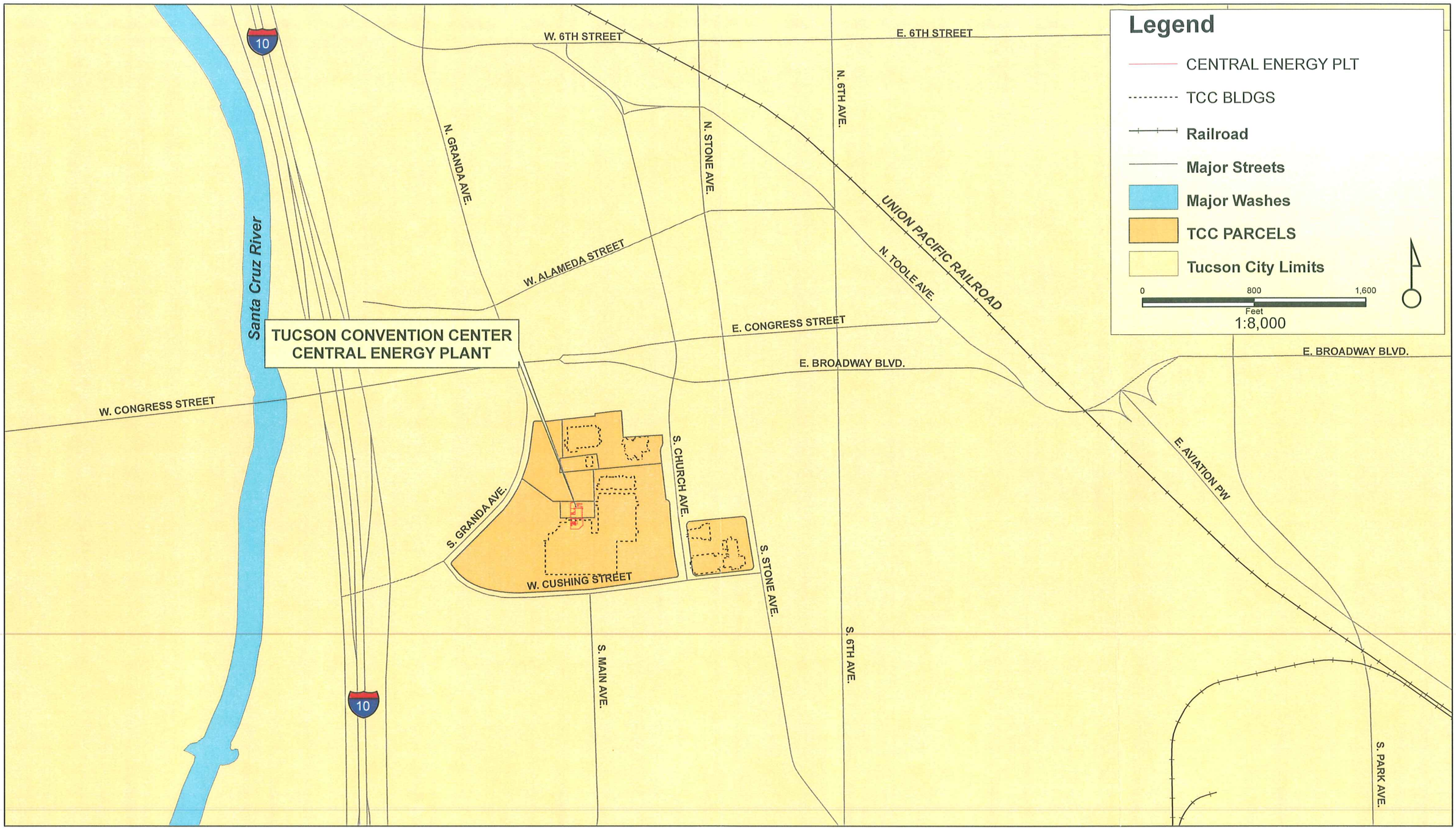
NOTE:
Samples TCC-1 through 14, TPD-S, MH-SE-1 & 2 were collected in native soil beneath pipeline during removal.
* = Samples TCC-PLD-1-60' through TCC-PLD-7-60' collected from soil from borings at 495 W. Cushing St.
** = Samples SS-B-0.5' and SS-B-2.5' collected from shallow native soil at 495 W. Cushing St.
*** = Arizona Soil Remediation Levels (SRLs) at time of assessment activities
**** = Soil samples collected from soil borings during monitoring well installation
(* and **) Soil samples collected to establish background concentrations (Approx. 1,500' Away)
Milligrams per Kilogram = mg/Kg

Table 3

Central Energy Plant Pipeline Release- Perched Groundwater Sample Results					
	Analytes (mg/L as N)				
Sample Location	**Date**	**Nitrate/Nitrite**	**Nitrite (NO2)**	**Average NO3**	**Average NO2**
CEP-518A	1/31/2007	***46***	***21***		
CEP-518A	6/25/2007	***32***	***8.5***		
CEP-518A(Dup)	6/25/2007	***30***	***8.4***		
CEP-518A	11/13/2007	***18***	***3.9***		
CEP-518A	2/26/2008	***16***	***4.3***		
CEP-518A	5/28/2008	*7.6*	***1.9***	***24.9***	**8**
CEP-519A	1/31/2007	3.1	0.21		
	Well Contains Free Phase Gasoline, N/A				
CEP-520A	1/31/2007	9.6	0.18		
CEP-520A (Dup)	1/31/2007	9.7	0.18		
CEP-520A	6/26/2007	8.4	0.97		
CEP-520A	2/27/2008	6.6	<0.5		
CEP-520A	5/29/2008	6.7	0.14	8.2	0.37
CEP-527A	7/2/2007	***51***	0.032		
CEP-527A	2/27/2008	***88***	0.046		
CEP-527A(Dup)	5/27/2008	***94***	0.037		
CEP-527A	5/27/2008	***93***	0.037	**81.5**	0.038
CEP-528A	7/2/2007	**18**	0.044		
CEP-528A	2/26/2008	**16**	<0.02		
CEP-528A(DUP)	2/26/2008	**16**	<0.02		
CEP-528A	5/27/2008	**15**	<0.010	**16.3**	0.044
HQUST-523A	6/26/2007	6	0.072		
	Well Contains Free Phase Gasoline, N/A				
HQUST-524A	**Well Contains Free Phase Gasoline, N/A**				
HQUST-525A	6/26/2007	7.7	0.056		
HQUST-525A	2/26/2008	8.4	<0.02		
HQUST-525A	5/28/2008	**14**	<0.010	**10.0**	0.056
HQUST-526A	6/25/2007	<0.50	<0.02		
HQUST-526A	2/27/2008	<0.50	<0.02		
HQUST-526A	5/29/2008	<0.50	<0.02		
HQUST-531A	11/15/2007	9.1	0.74		
HQUST-531A	2/27/2008	7.7	<1.0		
HQUST-531A	5/28/2008	8.2	0.58	8.3	0.66
HQUST-532A	11/15/2007	7.8	<0.01		
HQUST-532A	2/28/2008	7.3	<0.02		
HQUST-532A	5/28/2008	6.8	<0.01	7.3	N/D
HQUST-533A	11/15/2007	***43***	***6.4***		
HQUST-533A	2/28/2008	***33***	***36***		
HQUST-533A	5/29/2008	***35***	***14***	***37***	**18.8**
AWQS		**10**	**1**		

NOTE:
Arizona Water Quality Standard = AWQS
No Analysis = N/A, Test Results Below Laboratory Method Detection Levels=N/D
Bolded Analytical Test Results Indicate Concentrations Above AWQS
Milligrams per Liter = mg/L

Figures

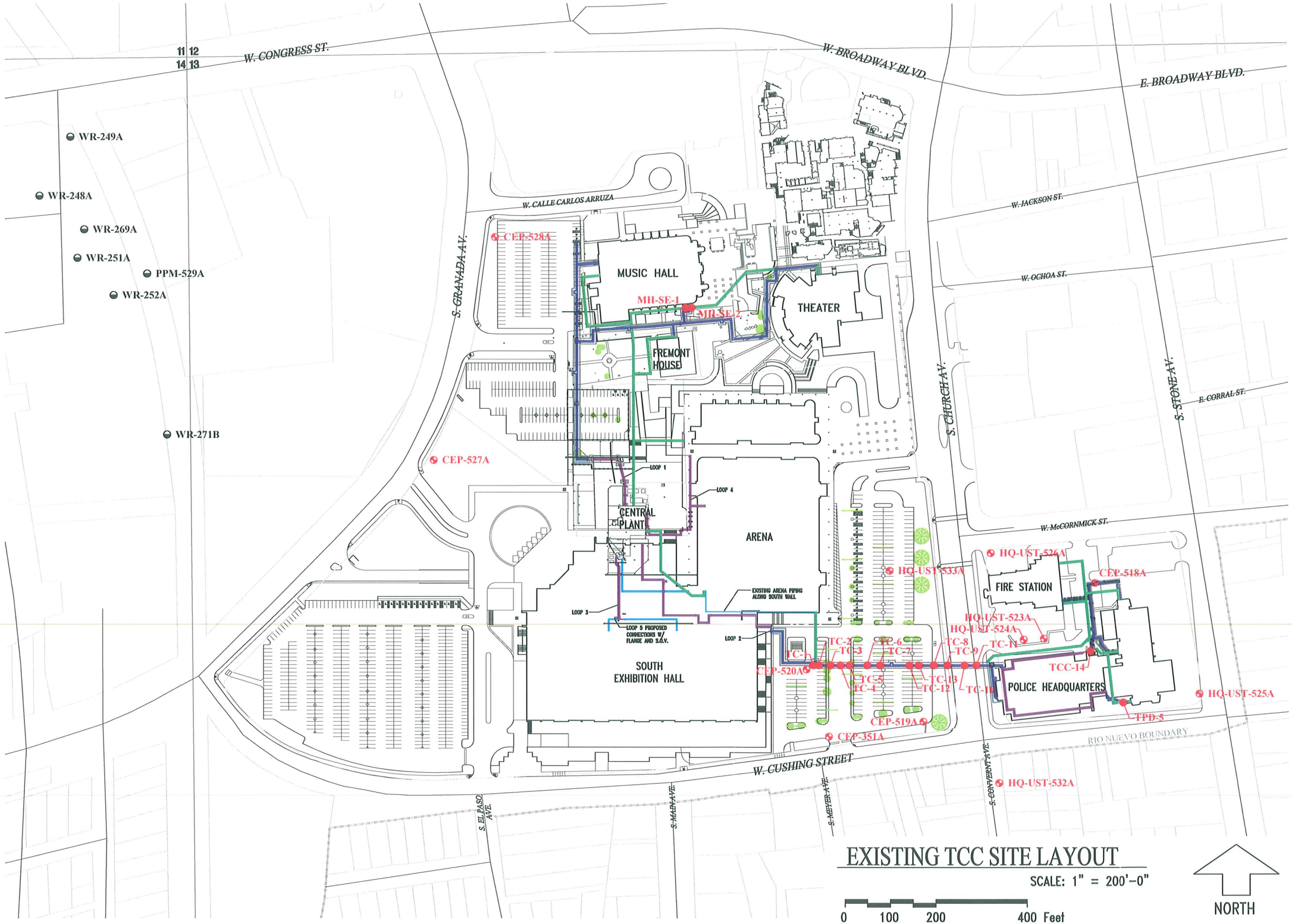


CITY OF TUCSON
ENVIRONMENTAL SERVICES

Figure 1
Central Energy Plant Closure Report
ADEQ VRP Site 508392-00
Vicinity Map

Drawn By:	AGR
Checked:	RB
Approved:	RB
Date:	2/12/2008
File:	See Below

J://GIS/TCC/GIS/TCC Vincity Map.mxd



General Notes

LEGEND

- ABANDONED UNDERGROUND PIPING
- UNDERGROUND PIPING NEW
- ABOVE GROUND PIPING (NEW)
- ABOVE GROUND PIPING
- HQ-UST-526A — MONITORING WELLS
- TCC-1 — SOIL SAMPLE LOCATIONS (BENEATH FORMER PIPELINE)
- MW-248A — PIONEER PAINT WELLS

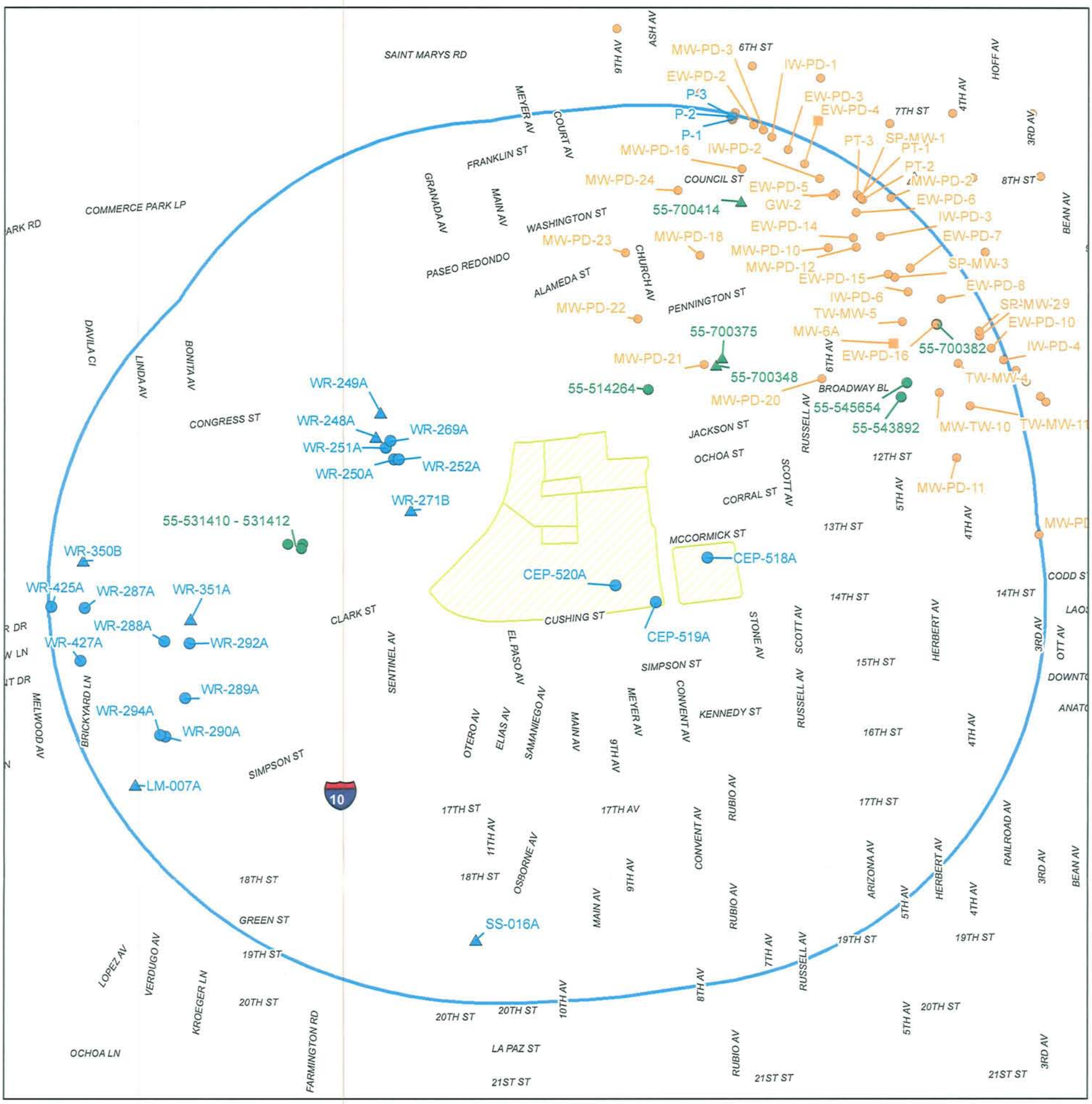
No.	Revision/Issue	Date

CITY OF TUCSON
ENVIRONMENTAL SERVICES

PREPARED FOR:
CITY OF TUCSON
ENVIRONMENTAL SERVICES
100 N Stone Ave
2nd Floor
Tucson, Arizona 85712
(520) 791-5414
(520) 791-5417 Fax

Drawing Title:
Well Location and Soil Sample Collection Sites

Project: Tucson Convention Center	Sheet: 2
Date: February 6, 2008	
Scale: 1"=200'-0"	



Explanation

Parcels of Project Area

Half-Mile Buffer

Well Location Provided by UPRR

- Perched Well
- Regional Well
- Unknown Depth

ADWR Located Groundwater Well

- Perched Well
- Regional Well

Well Location Provided by COT

- Perched
- Regional

Notes:
NO KNOWN DRINKING WATER PRODUCTION WELLS ARE WITHIN THIS BUFFER AREA.

Union Pacific Railroad (UPRR) well locations provided by UPRR consultant, Environmental Resources Management (ERM).

Arizona Department of Water Resources (ADWR) well locations provided by Wells 55 Database (September 2006). Data supplemented by the Park-Euclid and 7th Street & Arizona Avenue Water Quality Assurance Revolving Fund (WQARF) Sites April 2004 Well Inventory.

City of Tucson (COT) well locations provided by the City of Tucson - Tucson Water and Environmental Services.

0 875 1,750 3,500 Feet

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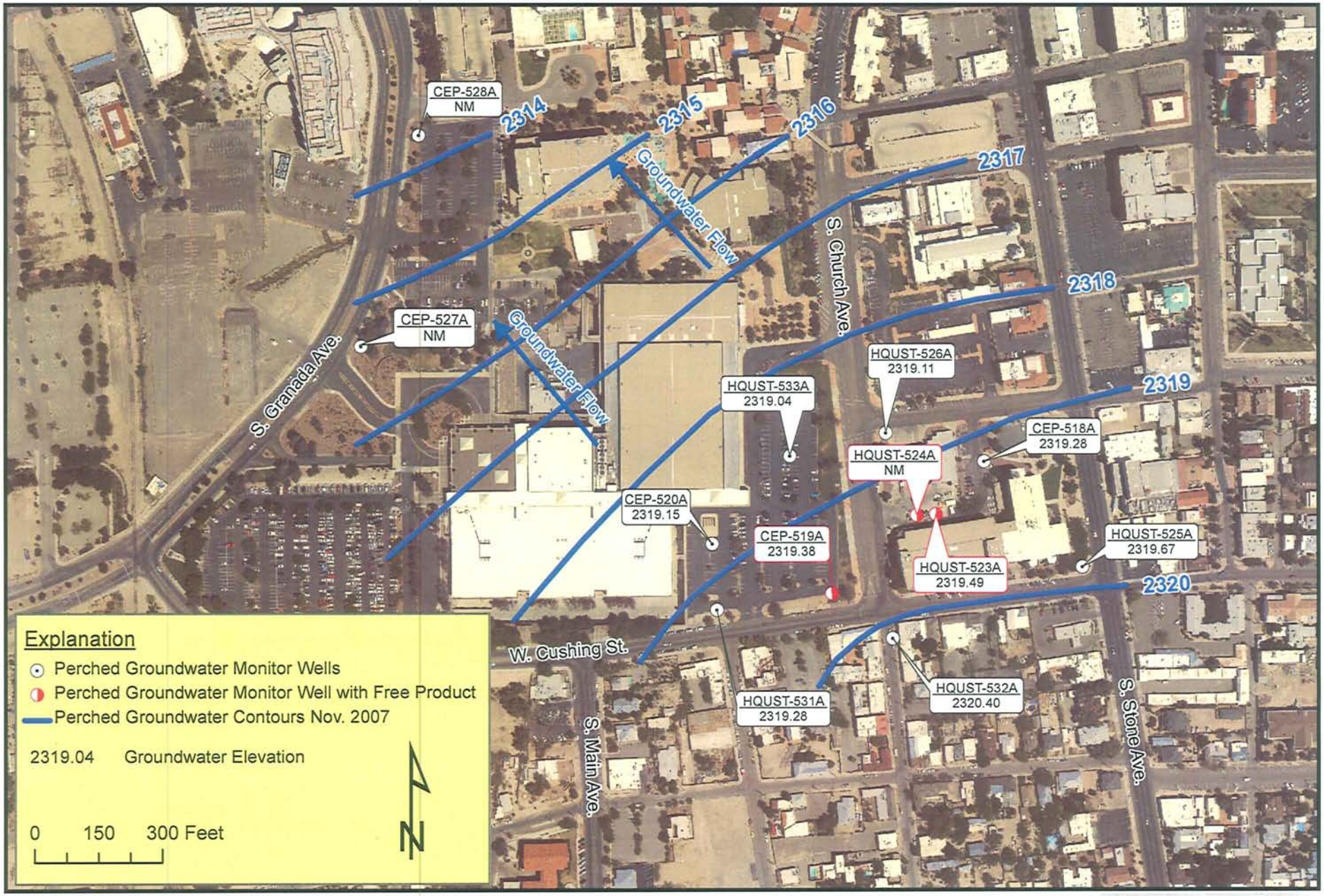
Figure 3
Well Inventory Map
Central Energy Plant

Drawn By:	LE
Checked:	AJ
Approved:	AJ
Date:	2/6/2007
File:	See Below

GIS\TCC\WellMap_INVENTORY.mxd



CITY OF TUCSON
ENVIRONMENTAL SERVICES

FIGURE 4
Potentiometric Groundwater Surface Map
November 2007

Drawn By:	AGR
Checked:	RB
Approved:	RB
Date:	3/20/2008
File:	See Below

J:GIS\TCC\2008\Potentiometric GW Surface Map.mxd

Figure 5
TCC East Wells--Hydrograph

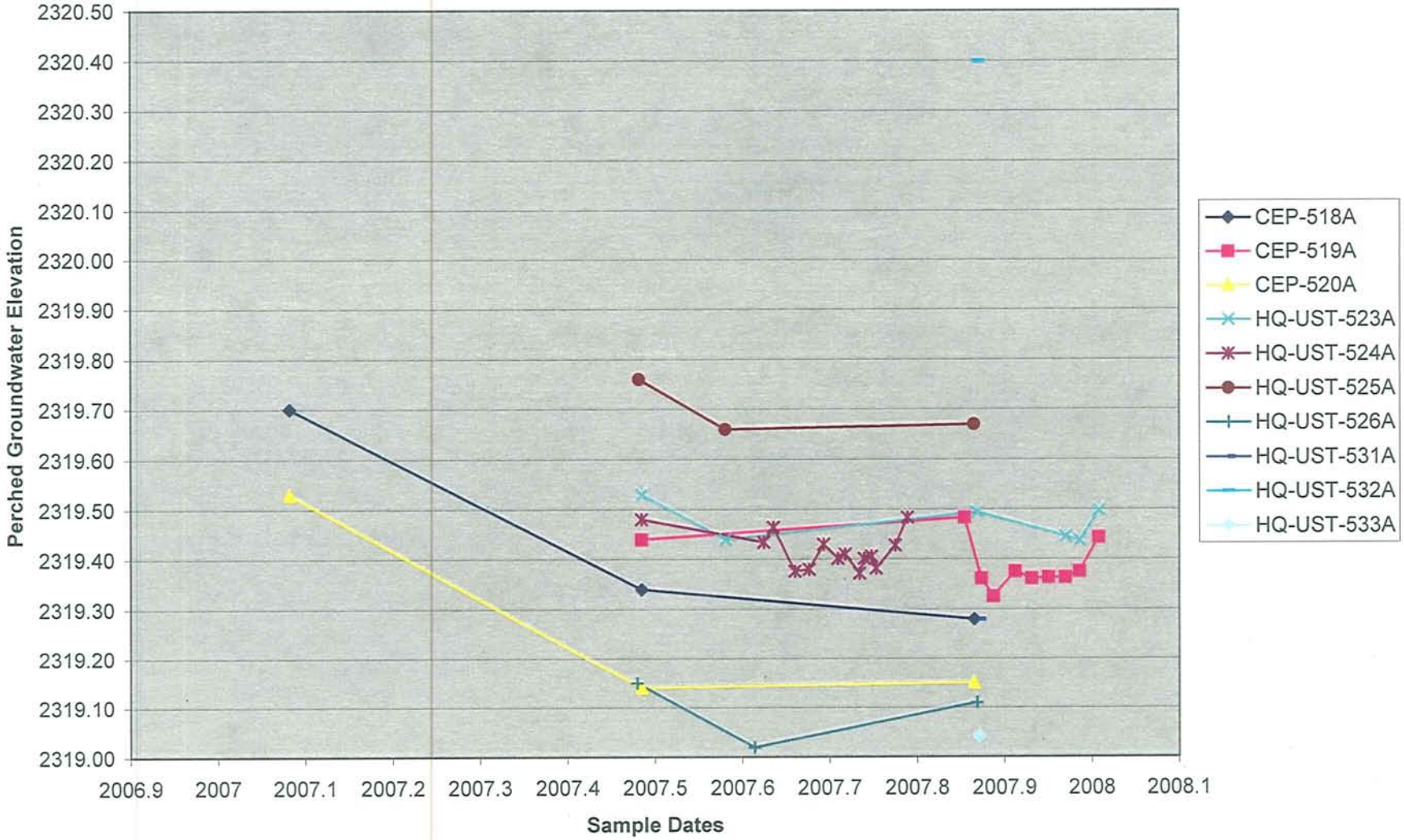
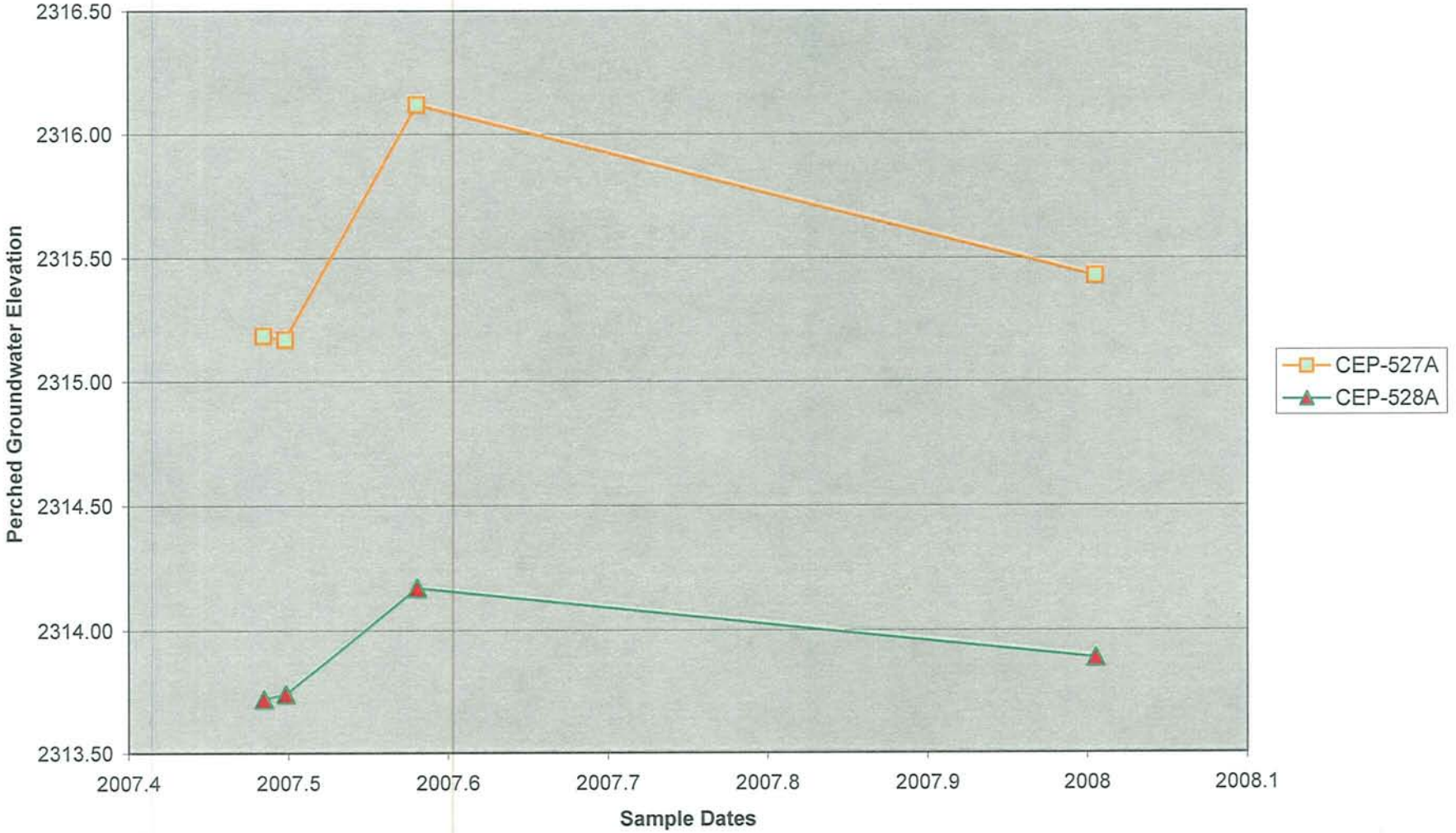
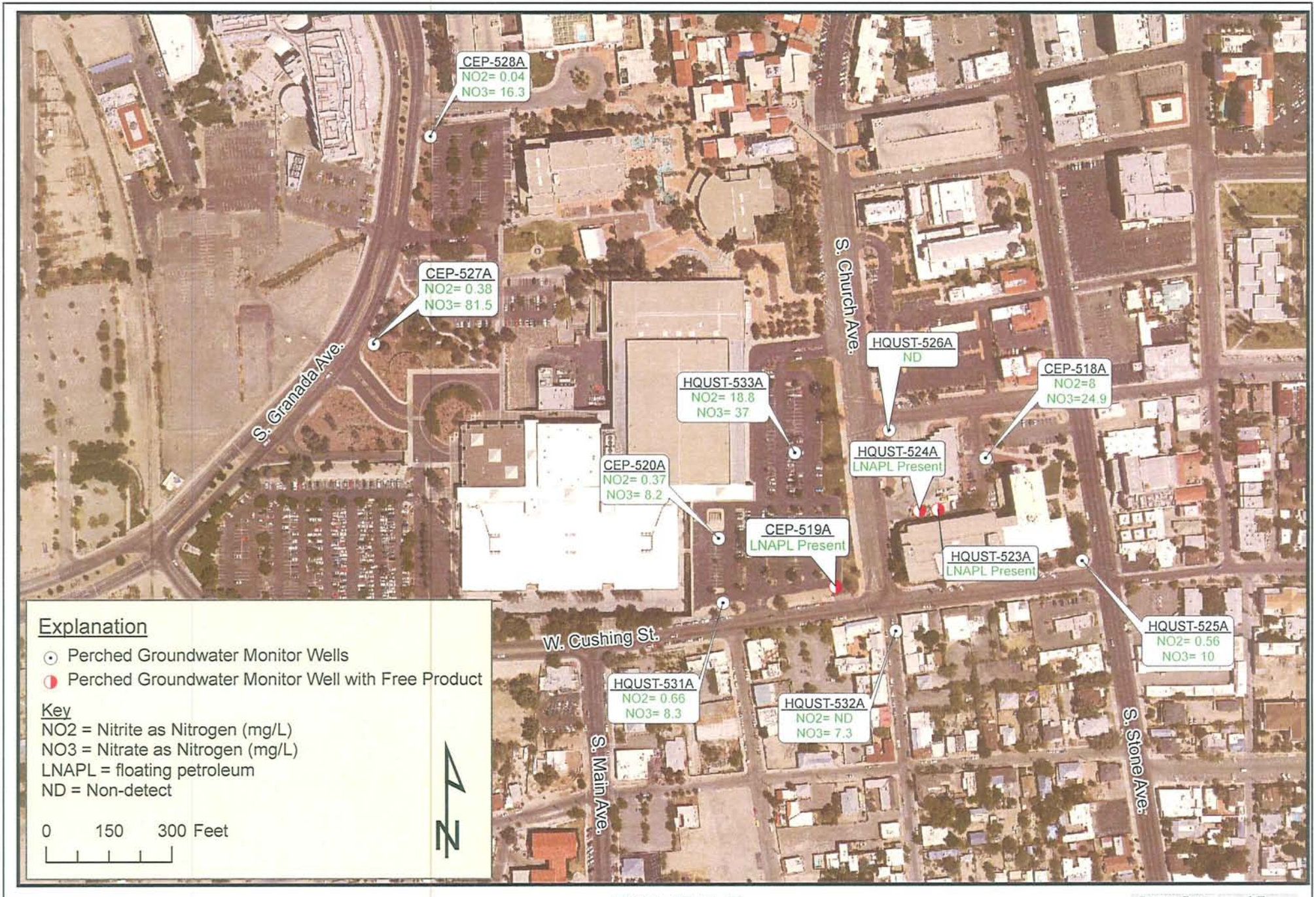


Figure 6
TCC West Wells--Hydrograph





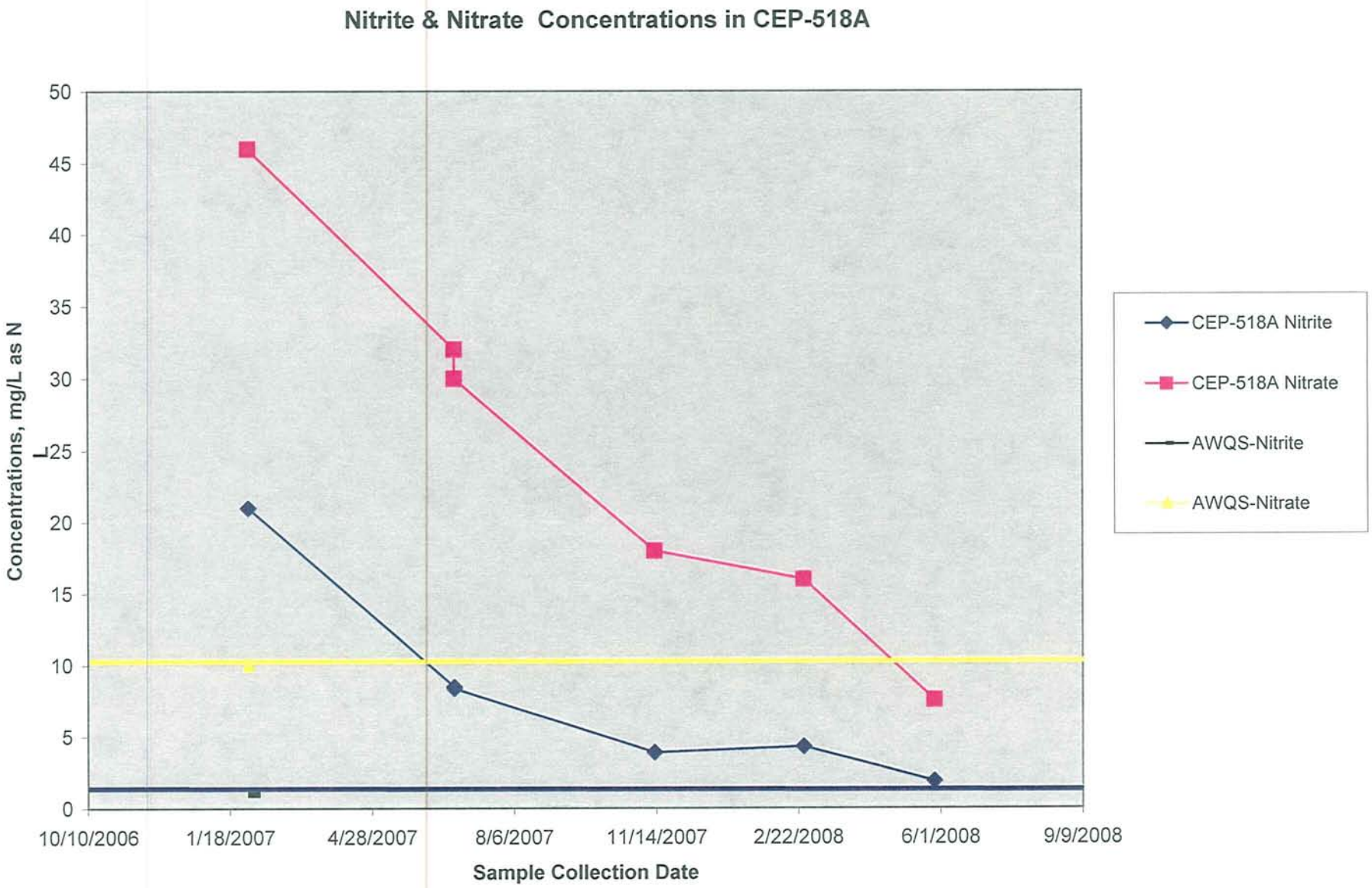
CITY OF TUCSON
ENVIRONMENTAL SERVICES

FIGURE 7
Average Nitrate and Nitrate Concentration in Perched Groundwater (January 2007 - May 2008)

Drawn By:	LE
Checked:	RB
Approved:	RB
Date:	7/30/2008
File:	See Below

J:\GIS\TCC\2008\Nitrate and Nitrate Concentration In Perched GW .mxd

Figure 8


Nitrite & Nitrate Concentrations in CEP-518A
Concentrations, mg/L as N
50
45
40
35
30
25
20
15
10
5
0
10/10/2006
1/18/2007
4/28/2007
8/6/2007
11/14/2007
2/22/2008
6/1/2008
9/9/2008
Sample Collection Date
CEP-518A Nitrite
CEP-518A Nitrate
AWQS-Nitrite
AWQS-Nitrate