ADEQ Arizona Department of Environmental Quality

TECHNICAL SUPPORT DOCUMENT

PROPOSED UNDERGROUND STORAGE TANK (UST) RELEASE CASE CLOSURE EVALUATION SUMMARY

LUST Case File #: 4347.01-.02 **Watson Chevron**
Facility ID # 0-000780 **6 South Milton Road**
Coconino County **Flagstaff, Arizona 86001**

***Background*:**
The former Watson Chevron, (the "Site"), is located in Flagstaff. Petroleum product (gasoline) has not been dispensed on the Site since the USTs, and associated piping and dispensers were removed in February 1996. The Site had three USTs for the storage of gasoline (premium unleaded, unleaded and regular [leaded] gasoline) and one UST for the storage of waste oil. The fuel tanks were located south of the service station. The waste oil tank was located within the garage of the service station. The surface area over the tanks was covered with asphalt. The former gasoline tanks supplied dispensers located northwest of the tank basin. The waste oil tank was removed on March 3, 1996. A release adjacent to the waste oil tank was excavated on March 6 and 8, 1996. Leaking UST (LUST) # 4347.01 was assigned to the gasoline USTs, #4347.02 was assigned to the gasoline dispenser area, and #4347.03 was assigned to the used oil UST. LUST #4347.03 was closed in December 2006.

To evaluate groundwater conditions, two monitoring wells (MW-1 and MW-2) were installed in March 2000. Free product was present in MW-1 in August 2000. A third monitoring well (MW-3) was installed in August 2000. The vertical and horizontal extent of the soil and groundwater contamination was defined in 2003. Soil sampling conducted at the Site indicates that soil concentrations were below the soil remediation levels (SRLs). In 2007, three remediation wells (MW-4, MW-5 and MW-6) were installed, and a vapor extraction pilot test was conducted.

The Site was actively remediated from November 21, 2007, to March 20, 2008. In 2009, a Corrective Action Plan (CAP) was submitted and identified monitored natural attenuation (MNA) as the remedial technique. An application to the MNA Program was submitted in February 2010. Both the CAP and the MNA Program application were denied by ADEQ in May 2010. Bio-sparging was operated discontinuously from February 2008 to June 2013.

The Site is zoned commercial and no plans exist to change the zoning. The Site has been used previously as an automotive repair shop and most recently as an automobile brake shop since 1996. Open containers of solvents including small containers of gasoline, idling automobiles, and many other sources of volatile organic compounds (VOCs) were observed during each site visit by the consultant.

***Removal or control of the source of contamination*:**
The UST system was removed in March 1996. An air sparging/vapor extraction system (AS/VES) was installed to remediate the groundwater contamination adjacent to the former tank basin and dispensers. Three monitoring wells (MW-2, MW-5 and MW-6) were directly connected into the remedial system. During system construction, two remediation excavations were advanced to 10 feet below ground surface (bgs) adjacent to the former dispenser islands. The soil was heavily stained and very odorous. The excavated soil was removed and disposed of at the Painted Desert Landfill in Joseph City, AZ, as solid waste based on analytical results of the stockpile soil sample. PVC pipe was placed at the bottom of the excavations, and large cinders were used as backfill to increase the movement of gases in the soil. The VES was installed and started up on November 21, 2007. The system did not operate from November 23 through November 28, 2007. The system was restarted on November 28, 2007. The high temperature controller failed to operate from mid-December 2007 to January 2, 2008. The system was restarted and ran continuously from January 2, 2008, to March 20, 2008. After one to two weeks of operation, there was no detectable hydrocarbons measured at the influent to the VES. The operation of the VES was terminated in March 2008.

The Flagstaff area received relatively high amounts of precipitation in the winter of 2007-2008. This precipitation caused a general increase in groundwater levels at the Site. The rise in groundwater levels (approximately 5 feet below ground surface [bgs]) restricted the volume of soils amenable to vapor extraction.

A small bio-sparging system was installed at the Site on March 20, 2008, to aid in the removal of hydrocarbons. Bio-sparging of MW-5 occurred from March 20, 2008 to June 2010; bio-sparging of MW-1 occurred from June 2010 to June 22, 2013. MW-7 was installed in July 2009 and connected to the bio-sparging system. Both inlet and outlet air samples were collected and analyzed for VOCs by EPA Method 8015 modified, and EPA Method 8260 modified. Between November 2007 and March 2008, the concentrations from both the inlet and outlet dropped to below laboratory reporting limits. The system was operated past this date, however, the compressor failed sometime after June 22, 2013.

Nutrients ([Wort] is an aqueous solution of extract made from grain, intended for fermentation by yeast into beer.) were added to the subsurface (MW-1) on June 14, 2021. The purpose for adding the nutrients was to increase the microbial activity to enhance biodegradation of petroleum VOCs in the groundwater.

Characterization of the groundwater plume:
The groundwater beneath the site is directly influenced by septic system infiltration. The water samples generally have a distinct, fetid odor and are gray in color making the perched aquifer, at least locally, non-potable.

The aquifer at the Site is a perched zone above bedrock. The aquifer is found within recent alluvial and volcanic deposits consisting of clay and sand, gravels, and volcanic cinders/clinker that overlie the impermeable Kaibab Formation limestone. The basalt came from upslope along the Rio de Flag drainage and in this area appears to be a mixture of cinders and clinker rather

than massive basalt. Alluvium deposited along the Rio de Flag floodplain later covered the basalt.

The soils encountered on the Site were dark grayish-brown to black clays and poorly-graded clayey sands to 10 feet bgs. Weathered shale and sandstone of the cream-colored weathered Kaibab Limestone was encountered from 12 to 14 feet bgs.

Depth to groundwater at the Site varies from approximately 4 feet to 14 feet bgs. The water levels in the monitoring wells have consistently correlated with the amount of rain and snow-melt in the Flagstaff area. A prolonged drought from August 2000 to November 2004 apparently attenuated groundwater below historic levels. The Flagstaff area experienced relatively high precipitation in the winter of 2007-2008, and the winter of 2008-2009.

Seven monitoring wells are located at the Site. ADEQ requested an additional well to be installed because the water level in MW-1 was above the top of the well screen. Well MW-7 was installed on July 23, 2009. The well was sampled as the replacement to MW-1 on August 8, 2009. This well was interfaced with the existing remediation system. The well was used for bio-sparging remediation until system failure occurred in 2014/2015.

The perched aquifer was visually observed when performing remediation actions at a facility (former Trejo Oil Service Station – Facility ID# 0-006182, LUST File # 5014.01-.02) located immediately east the Site. An excavation was advanced to approximately 30 feet square by 14 feet deep. An inspection of the cross-section of the excavation indicated a thin (1-foot thick) water-bearing zone meshed between the uniform black clay above and a white weathered Kaibab Formation limestone below the water-bearing unit. The water-bearing unit was composed of sand and small gravels. This unit produced water very slowly during the excavation activities.

The shallow perched groundwater below the Site is heterogeneous, therefore, based on the water levels in the monitoring wells at the Site, it is difficult to determine the direction of groundwater flow. Based on observations during excavation performed on the adjacent property, it is believed that the degraded limestone is likely acting as an aquitard at the Site.

Groundwater flow direction calculations are only considered valid in isotropic and homogeneous aquifers. This aquifer is heterogeneous and hydraulic conductivity likely varies many orders of magnitude from clayey sands and gravels to porous volcanic cinders and clinker. Wells MW1, MW-2, and MW-3 are screened across these heterogeneous zones. Therefore, groundwater level measurements give only a rough estimate of the down gradient flow direction. Flow directions were calculated for two high water table events, September 2006 (N86E) and April 2017 (S39E). The down gradient direction of the Rio de Flag is roughly in a southeasterly direction. Variations in the seasonal recharge rate were easily observed. On several occasions (multiple years), a well was bailed and left idle. No recharge was observed after several hours.

Through 2015, water samples were submitted to Trans West Analytical Laboratories for analysis. Water samples were analyzed for volatile hydrocarbons using Environmental Protection Agency (EPA) Method 8260B. The 2017-2021 water samples were submitted to ESC Lab Sciences for laboratory analysis using EPA Methods 8260B for volatile organic compounds (VOCs), 8270C

SIM for polycyclic aromatic hydrocarbons (PAHs), and periodically for nitrates, sulfates, phosphates, ferrous iron, and manganese, as indicators of natural attenuation.

As of May 2021, benzene is the only VOC present in groundwater at concentrations that exceed Aquifer Water Quality Standards (AWQS) in wells MW-1, MW-2, MW-4 and MW-6. Benzene has not been detected above laboratory method reporting limits in samples collected from MW-3 and MW-5 since August 2007 and April 2020, respectively.

***Groundwater plume stability*:**
Trend analysis was performed using the GIS Mann-Kendall Tool Kit for constituent analysis. The analyses were done on sample results from MW-1, MW-2, MW-3, MW-4, MW-5, and MW-6 to examine trends in contaminant concentrations. Because the plots are on a logarithmic scale, values of <1, <2, < 200 etc. are replaced with 0.5 ug/L so that the non-detect data can be plotted on the graph. Different values of the non-detect level were not used to avoid spurious results. Note that analytical results that are mainly or entirely non-detect will be shown to be stable or no trend. The trend analysis results for benzene in the six wells were either decreasing or stable.

Groundwater plume stability is assessed based on groundwater flow directions and gradient. Based on the trend analysis it appears that the contaminant plume is stable or decreasing for all contaminants. The data suggests that the combination of vapor extraction bio-sparging remediation along with natural attenuation appears to have contributed to the predominantly downward trend in contaminant levels in all monitor wells.

***Natural Attenuation*:**
There may be several factors that control natural attenuation of contaminant concentration levels seen in the monitor wells. Non-destructive reduction of contaminants occurs by dispersion, sorption on various substrates, and to a lesser degree, volatilization. What is also likely, based on changes to the water levels observed in many of the monitor wells, is that the groundwater flow through the aquifer beneath the Site appears to be roughly balanced by infiltration into the shallow aquifer causing dilution. Biological attenuation is occurring to some extent because the nutrient additions in the summer of 2020 did reduce contaminant levels. This degradation could be occurring by either aerobic metabolism utilizing oxygen receptors or by anerobic pathways. At this Site, observations of dissolved oxygen (DO) concentrations in MW-1, the area of greater contamination, are generally lower than in the other monitor wells. This suggests that anerobic degradation of the contaminants is a likely biological attenuation pathway.

When sufficient DO is present in groundwater, biodegradation of hydrocarbons proceeds aerobically (with oxygen as the electron acceptor). As oxygen becomes less available, anaerobic microorganisms consume electron acceptors in the following order of preference: nitrate, manganese (IV), iron (III), sulfate, and carbon dioxide.

In 2009, 2015 and 2017, Burge presented a VOC concentration ratios table of xylenes/benzene and toluene/benzene which indicated that the bacteria were metabolizing the xylene and toluene faster than benzene. Between 2009 and 2018, in MW-1 the xylene/benzene ratio dropped from

5.53 to 0.5, and the toluene/benzene ratio dropped from 3.0 to 0.029. Within a distance of 18 feet (distance from MW-1 to MW-6), the toluene, ethylbenzene and xylene concentrations have attenuated to below AWQS.

In April 2017, DO concentrations indicated aerobic conditions. Groundwater was sampled for nitrates, sulfates, phosphates, ferrous iron, and manganese, as indicators of natural attenuation in 2017 and 2018. The September 2018 data indicates that no nitrate is present, but the other electron receptors for anaerobic degradation were present.

In April 2020, DO concentrations still represented aerobic conditions. Benzene degrades faster in aerobic conditions.

Threatened or impacted drinking water wells:
Burge and Associates conducted a review of registered wells in the Arizona Department of Water Resources (ADWR) well database. Forty-seven registered wells are located within 0.5 mile of the Site. Two wells are registered as 'exempt' wells. There are no registered 'non-exempt' wells. Thirty-two wells are registered as monitor, and thirteen wells are registered as other. The two 'exempt' wells are located between ¼ and ½ mile from the LUST site. One well (#55-630476) located at 311 W. Cherry, is registered to the City of Flagstaff. The imaged record indicates the well was previously used for irrigation. The other well (#55-648994) is associated with a private residence. The ADWR imaged record indicates that the well was used prior to 1968.

Drinking water comes from Upper Lake Mary, springs in the Inner Basin of the San Francisco Peaks, and groundwater, which is pumped from the Lake Mary and Woody Mountain well fields, the Inner Basin wells, and local "in-city" wells. Plans are underway to install up to five additional "in-city" wells over the next 10 years. The City maintains 24 wells (excluding the shallow Inner Basin wells). The newest addition is the McAllister Well which is 2,480 feet bgs in the C Aquifer, and supplies up to 430,000 gallons of water per day. The treatment process for the water varies depending on the source. Groundwater from wells is disinfected with chlorine. Surface water is treated at one of the City's two water treatment plants. Flagstaff water wells near the city are pumping from the C-aquifer (Coconino Sandstone) with the depth to groundwater at more than 900 feet at the closest well (Skunk Canyon). The City of Flagstaff operates a regulated public water system (AZ04-03008). According to the 2020 Consumer Confidence Report, no VOCs were detected in samples collected during the February 2019 sampling event.

According to ADWR, any new or replacement well located at or near the LUST site would need to meet the criteria of A.A.C. R12-15-1302 (B) (3).

***Other exposure pathways*:**
Shallow (1-2 feet bgs) soil vapor samples were collected in November 2009, according to the Soil Gas Investigation Report dated 8, 2009. Four of the soil vapor samples (SG-1, SG-2, SG-3, SG-4) were collected under or adjacent to the cement floor of the automotive brake shop. VOC

concentrations in these locations were indicative of shop operations. SG-5 was placed near the former dispenser island. Soil vapor sample SG-6 was placed near MW-1 in native soil. SG-7 was installed at a piping joint along the piping run connecting the dispenser island and the former USTs. SG-8 was placed near the former tank basin in fill material. The analytical results were compared to applicable EPA Regional Screening Levels – Resident Air (April 2009), and none exceeded those values. Therefore, there was no unacceptable inhalation risk. The soil vapor survey and interpretation were done according to guidance provided by ADEQ's Risk Assessor in November 2009.

Open containers of solvents including small containers of gasoline, idling automobiles, and many other sources of VOCs were observed during each site visit. In November 2019, soil vapor samples were collected. SV-1 was collected near the former dispenser island, SV-2 was collected at the former UST tank basin, and SV-3 was collected near MW-6. Locations SV-1 and SV-2 had no VOC concentrations reported over laboratory reporting limits. SV-3 is the only location were a VOC concentration met the criteria to be evaluated using the screening level Johnson & Ettinger (J&E) model. ADEQ evaluated the ethylbenzene concentration, and the cancer risk and non-cancer risk is 6×10^{-8} and 6×10^{-5} which are below the target risk values of 1×10^{-6} and 1, respectively.

The surface areas of the Site and surrounding areas are covered with concrete or asphalt.

Commercial and mixed-use properties are located adjacent to three sides of the Site with Northern Arizona University to the east. The groundwater contamination is limited to on-site, so it does not pose a threat to any off-site receptors. There also is no unacceptable soil vapor intrusion risk based on data collected from the soil vapor surveys and J&E modeling. A previously mentioned, the water samples collected on-site generally have a distinct, fetid odor and are gray in color making the perched aquifer, at least locally, non-potable.

No surface water bodies are located within ¼ of a mile of the Site.

Requirements of A.R.S. §49-1005(D) and (E):
The results of the corrective action completed at the site assure protection of public health, welfare and the environment, to the extent practicable, the clean-up activities competed at this site allow for the maximum beneficial use of the site, while being reasonable, necessary and cost effective.

Other information that is pertinent to the LUST case closure approval:
The facility and LUST files were reviewed for information regarding prior cleanup activities, prior site uses and operational history of the UST system prior to removal.

Groundwater tables:

MW-1 (dispenser area)
Total Depth: 20.5 feet bgs Screened Interval: 10.5-20.5 feet bgs

Date	Depth to Water (feet)	Benzene AWQS is 5.0 µg/L	Ethyl benzene AWQS is 700 µg/L
March 2000	7.98	**7,500**	**2,800**
November 2004	8.52	**Free Product**	**Free Product**
August 2007	10.72	**Free Product**	**Free Product**
VE System Operated November 2007-March 2008			
June 2008	4.93	**1,900**	**1,700**
April 2009	5.45	**2.270**	**2,330**
Bio-sparge start 2010			
May 2011	4.77	**379**	566
June 2012	6.63	**461**	550
June 2013	8.14	**333**	132
Bio-sparge ended 2013			
June 2015	6.54	**518**	275
April 2017	4.37	**628**	38.9
September 2018	10.54	**1,840**	371
November 2019	12.75	**1,380**	160
April 2020	7.75	**628**	38.9
September 2020	12.48	**1,790**	**819**
May 2021	9.45	**1,630**	**1,310**

MW-7 (adjacent to MW-1) installed in 2009
Used as a sparge well 2009-2014/2015
Total Depth: 15 feet bgs Screened Interval: 3 – 15 feet bgs

Date	Depth to Water (feet)	Benzene AWQS is 5µg/L
July 2009 install		
August 2009	7.61	**1,390**
April 2017	4.83	Not reported

MW-2 (UST basin)
Total Depth: 20.5 feet bgs Screened Interval: 10.5-20.5 feet bgs

Date	Depth to Water (feet)	Benzene AWQS is 5.0 µg/L
March 2000	8.18	**2,300**
November 2004	8.74	**2,200**
August 2007	11.53	**1,200**
VE system operated		

November 2007 to March 2008		
June 2008	5.13	**1,100**
April 2009	5.40	**869**
June 2012	6.72	**504**
June 2013	8.25	**131**
June 2015	6.59	**56.6**
April 2017	5.11	1.58
September 2018	10.31	<1.00
November 2019	13.89	**7.42**
April 2020	7.99	1.58
September 2020	13.52	**18.8**
May 2021	10.16	**9.61**

MW-3 (up gradient)
Total Depth: 20 feet bgs Screened Interval:5-20 feet bgs

Date	**Depth to Water (feet)**	**Benzene AWQS is 5.0 µg/L**
August 2000	13.79	<1.0
November 2004	9.89	2.3
August 2007	11.98	<0.05
VE System Operated November 2007- March 2008		
May 2011	5.60	<1.0
June 2012	7.30	<0.50
June 2013	8.82	Not sampled
June 2015	7.12	<0.50
April 2017	6.08	<1.0
September 2018	14.8	<1.00
November 2019	17.88	<1.0
April 2020	10.72	<1.0
September 2020	16.30	<1.0
May 2021	12.16	<1.0

MW-4 (Dispenser area)
Total Depth: 15 feet bgs Screened Interval: 5 – 15 feet bgs

Date	**Depth to Water (feet)**	**Benzene AWQS is 5.0 µg/L**
February 2006 installed		
August 2007	10.71	**1,500**
VE System Operated November 2007 to March 2008		
June 2008	5.55	**620**

April 2009	5.99	**221**
May 2011	5.45	**89.7**
June 2012	7.42	**137**
June 2013	8.51	**284**
June 2015	7.16	**132**
April 2017	4.74	**49.2**
September 2018	10.56	**339**
November 2019	12.66	**138**
April 2020	8.19	**88.2**
September 2020	11.59	**513**
May 2021	9.62	**83.6**

MW-5 (dispenser area)
Total Depth: 15 feet bgs Screened Interval: 5 – 15 feet bgs

Date	**Depth to Water (feet)**	**Benzene AWQS is 5.0 µg/L**
February 2006 installed		
August 2007	11.98	FP
VE System Operated November 2007-March 2008		
Bio-sparge start March 2008		
June 2008	Not measured	Not sampled
April 2009	6.09	**86.3**
Bio-sparge end June 2010		
May 2011	5.49	**5.54**
June 2012	8.13	**19.7**
June 2013	9.43	**81.5**
June 2015	7.88	**19.0**
April 2017	4.69	**14.5**
September 2018	12.22	**14.5**
November 2019	14.33	**10.9**
April 2020	9.21	<1.0
September 2020	14.55	<1.0
May 2021	11.84	<1.0

MW-6 (product line area)
Total Depth: 15 feet bgs Screened Interval: 5 – 15 feet bgs

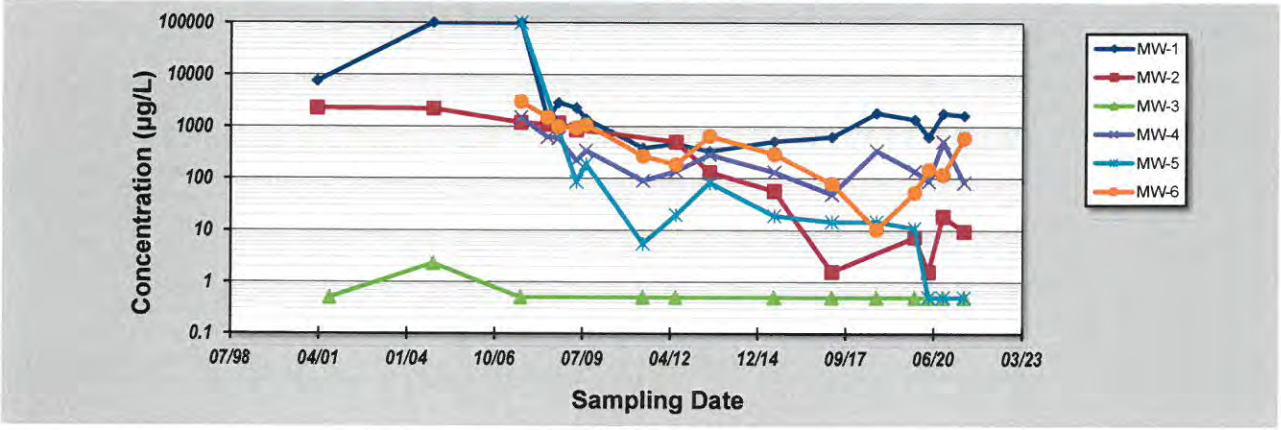
Date	Depth to Water (feet)	Benzene AWQS is 5.0 µg/L
February 2006 installed		
August 2006	10.21	**Not sampled**
August 2007	11.97	**3,000**
VE System operated November 2007 to March 2008		
June 2008	5.44	**1,500**
April 2009	5.88	**938**
May 2011	5.22	**267**
June 2012	7.09	**185**
June 2013	8.35	**647**
June 2015	6.88	**291**
April 2017	6.47	**79.0**
September 2018	11.32	**10.4**
November 2019	13.48	**53.8**
April 2020	7.96	**150**
September 2020	12.22	**120**
May 2021	9.03	**602**

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 13-Jul-21
Facility Name: Watson Underpass Chevron
Conducted By: Lee Amoroso

Job ID: 96-013
Constituent: Benzene
Concentration Units: µg/L

Sampling Point ID:		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	
Sampling Event	Sampling Date	BENZENE CONCENTRATION (µg/L)						
1	30-Mar-01	7500	2300					
2	21-Aug-01			0.5				
3	5-Nov-04	100000	2200	2.3				
4	1-Aug-07	100000	1200	0.5	1500	100000	3000	
5	1-Jun-08	1400	1100		620		1500	
6	2-Oct-08	2870	1180		595		989	
7	24-Apr-09	2270	869		221	86.3	938	
8	8-Aug-09	1390			340	188	1080	
9	24-May-11	379		0.5	89.7	5.54	267	
10	1-Jun-12	461	504	0.5	137	19.7	185	
11	22-Jun-13	333	131		284	81.5	647	
12	27-Jun-15	518	56.6	0.5	132	19	291	
13	18-Apr-17	628	1.58	0.5	49.2	14.5	79	
14	5-Sep-18	1840	<1.00	0.5	339	14.5	10.4	
15	13-Nov-19	1380	7.42	0.5	138	10.9	53.8	
16	21-Apr-20	628	1.58	0.5	88.2	0.5	150	
17	29-Sep-20	1790	18.8	0.5	513	0.5	120	
18	26-May-21	1630	9.61	0.5	83.6	0.5	602	
19								
20								
Coefficient of Variation:		2.47	1.19	0.80	1.09	3.59	1.20	
Mann-Kendall Statistic (S):		-42	-74	-9	-49	-58	-63	
Confidence Factor:		95.4%	>99.9%	70.4%	99.2%	>99.9%	99.9%	
Concentration Trend:		Decreasing	Decreasing	Stable	Decreasing	Decreasing	Decreasing	



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

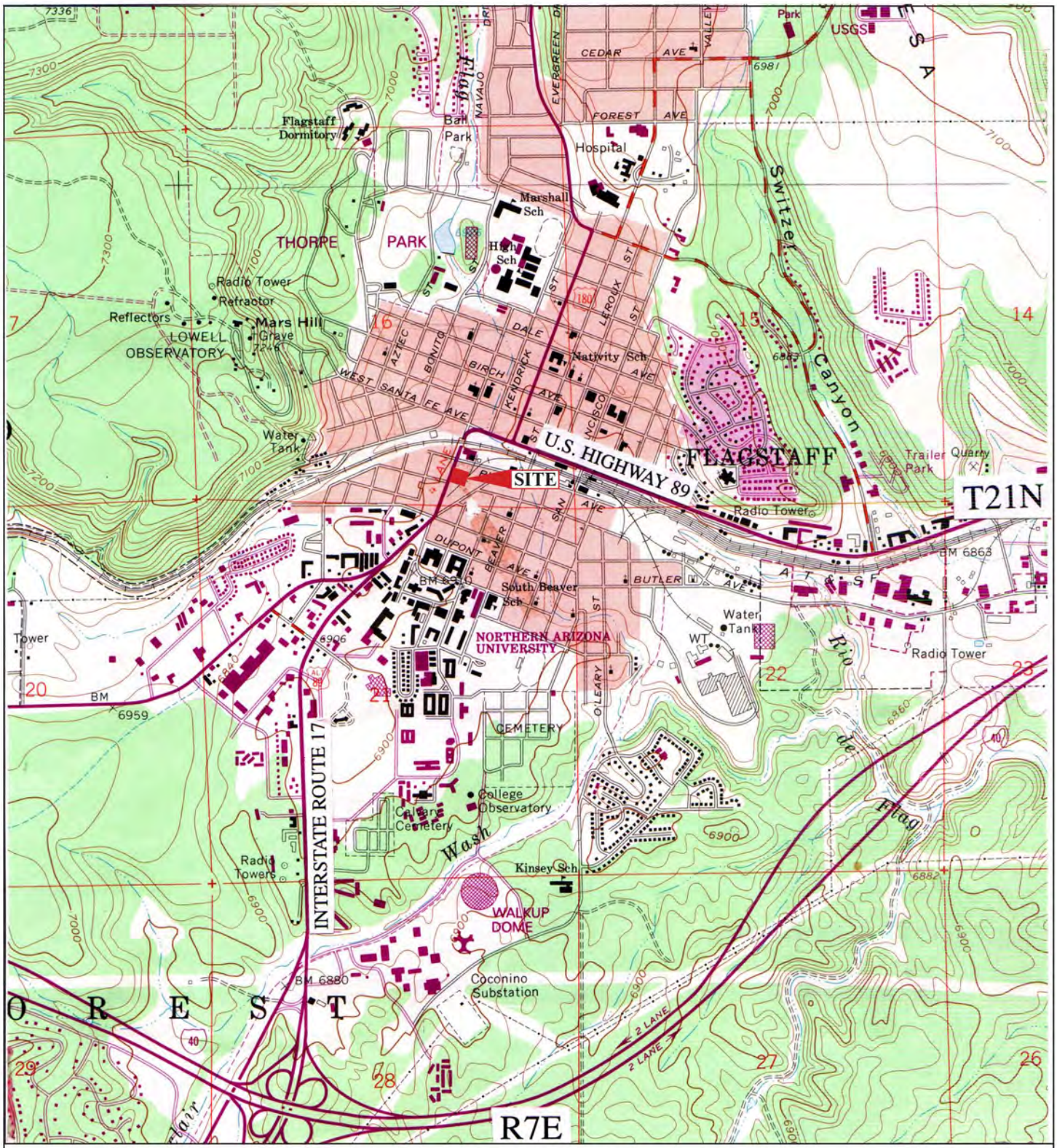
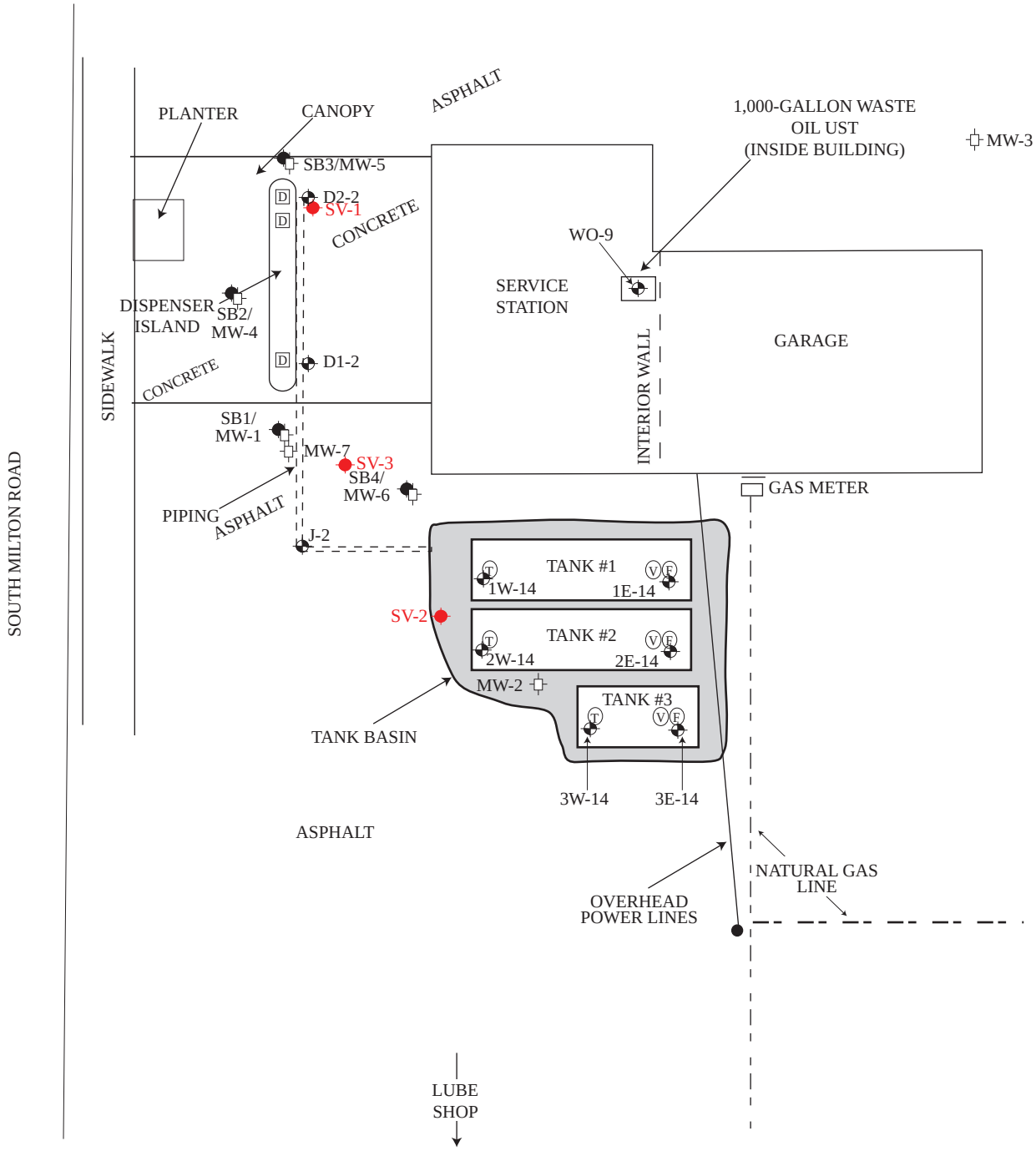


FIGURE 1
SITE LOCATION
WATSON UNDERPASS CHEVRON
6 South Milton Road • Flagstaff, Arizona

Burge & Associates
96-013

Prepared from U.S.G.S. Topographic Map Series, Flagstaff West, Arizona
Quadrangle: 1:24,000, Photorevised, 1983



North

FIGURE 2

SITE MAP

WATSON UNDERPASS CHEVRON

6 South Milton Road

Flagstaff, Arizona

0 Feet 20

Approximate Scale

- (F) FILL
- (T) TURBINE
- SOIL SAMPLE
- SOIL BORING
- (V) VENT
- [D] DISPENSER
- MONITORING WELL
- SOIL VAPOR SAMPLE

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96-013

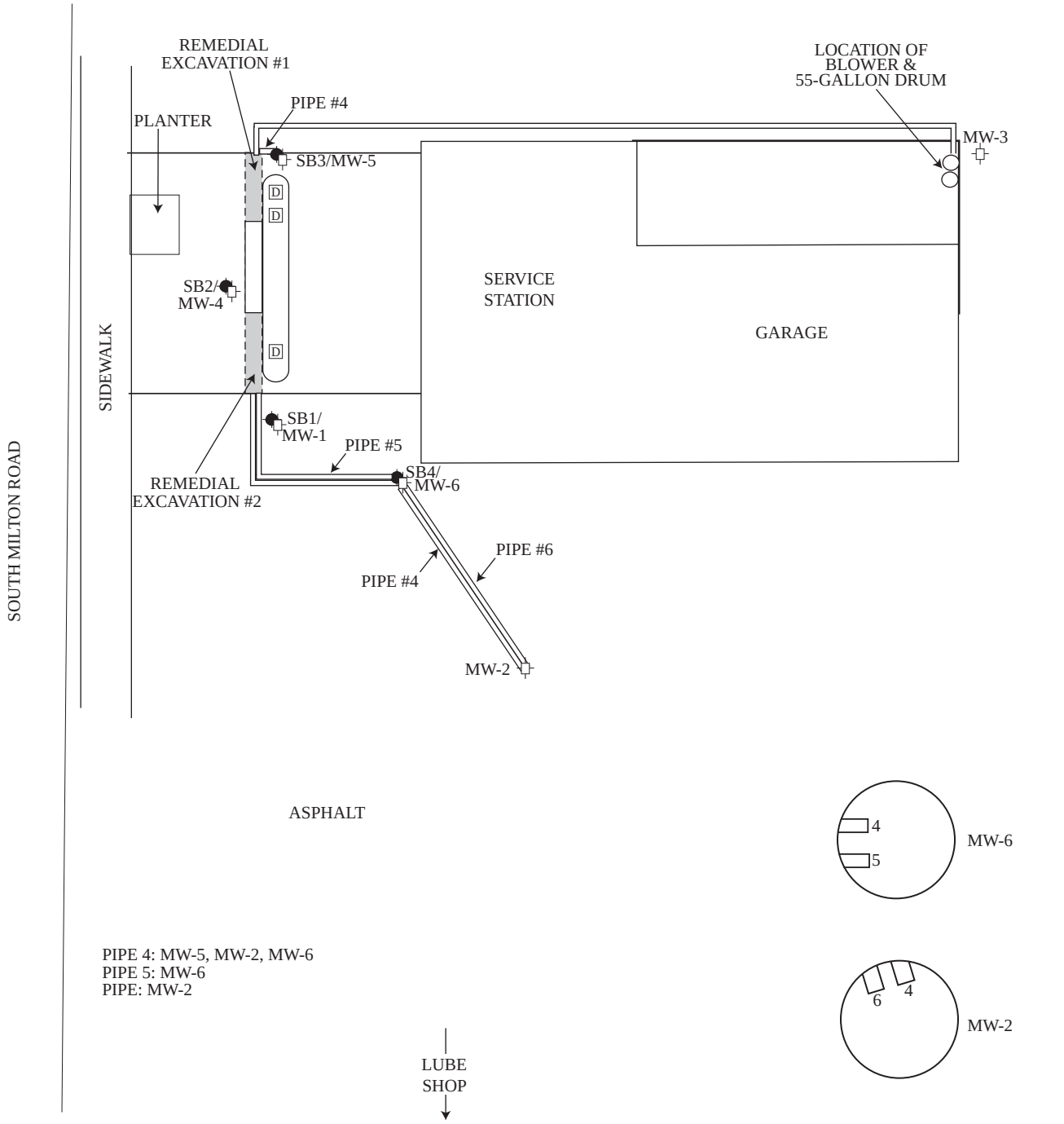

FIGURE 5

REMEDIAL EXCAVATION

WATSON UNDERPASS CHEVRON

6 South Milton Road

Flagstaff, Arizona

0 Feet 20

Approximate Scale

REMEDIAL EXCAVATION

SOIL BORING

D DISPENSER

MONITORING WELL

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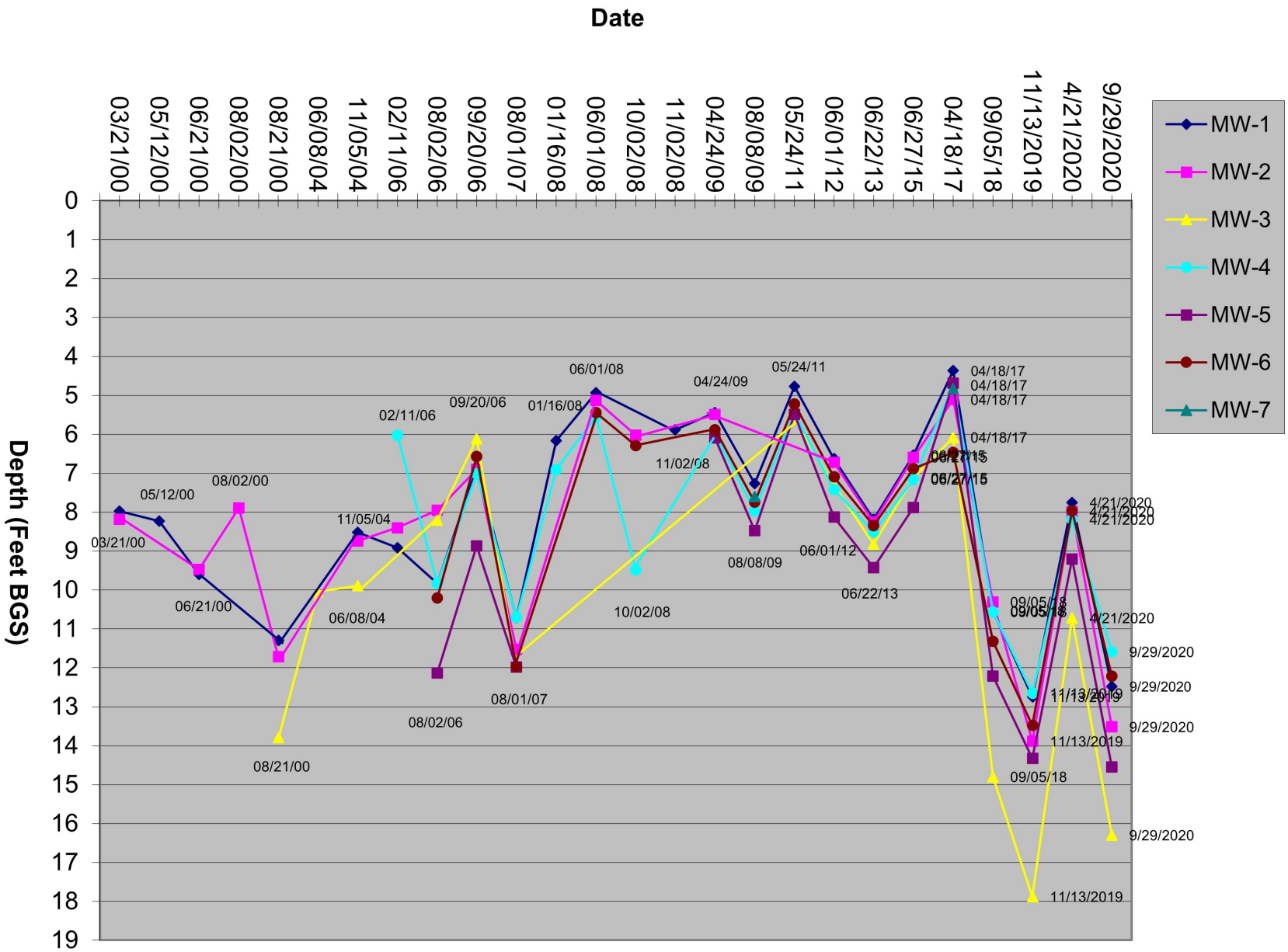
FIGURE 6
Groundwater Levels 2000-2018
WATSON UNDERPASS CHEVERON
6 South Milton Road • Flagstaff, Arizona



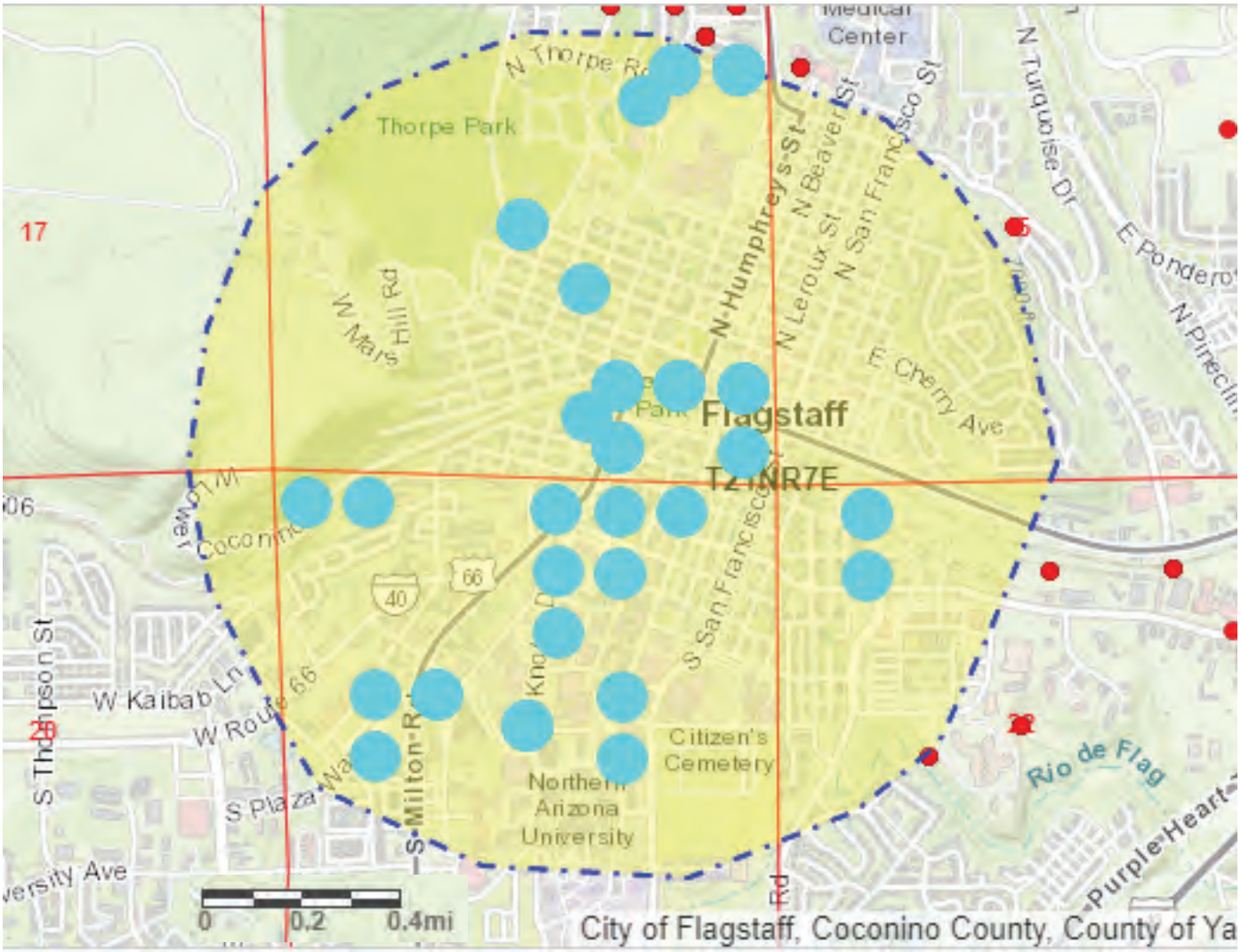


FIGURE 1A

WELL LOCATION MAP - 1/2 MILE RADIUS

WATSON UNDERPASS CHEVRON

6 South Milton Road

Flagstaff, Arizona

Burge & Associates

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