URS

IN-SITU BIOREMEDIATION IMPLEMENTATION AND PERFORMANCE MONITORING WORK PLAN - 7^{TH} AVENUE AND BETHANY HOME ROAD WQARF SITE, PHOENIX, AZ

Prepared for:
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Prepared by:
URS CORPORATION

URS Job No. 60513843
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EXPIRES 03-31-2017

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LIST OF ACRONYMS	
ADEQ	Arizona Department of Environmental Quality
btoc	below top of casing
CVOC	chlorinated volatile organic compound
EDS-ER™	electron donor solution – extended release
EPA	U.S. Environmental Protection Agency
ERD	enhanced reductive dechlorination
EVO	emulsified vegetable oil
DTW	depth to water
ft	feet
gpm	gallons per minute
H2SO4	sulfuric acid
HASP	Health and Safety Plan
HCl	hydrochloric acid
HNO3	nitric acid
ID	identification
IDW	Investigation-derived waste
ISB	in situ bioremediation
IW	injection well
mL	milliliter
NTU	nephelometric turbidity unit
OSHA	Occupational Safety and Health Administration
PCE	tetrachloroethene
PPE	personal protective equipment
PRAP	Proposed Remedial Action Plan
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	Quality Assurance and Quality Control
r	radius
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
ROW	right-of-way
SOP	Standard Operating Procedure
TCE	trichloroethene
TD	total depth
URS	URS Corporation
V	casing volume
VOA	volatile organic analysis
VOC	volatile organic compound
WQARF	Water Quality Assurance Revolving Fund
^{o}C	Degrees Celsius

1.0 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

This Work Plan has been prepared by URS Corporation (URS) in order to describe the scope of work and specific field activities that will be required during in situ bioremediation (ISB) carbon substrate injections and performance monitoring for enhanced reductive dechlorination (ERD) of chlorinated volatile organic compounds (CVOCs) in groundwater.

The subject site is the 7th Avenue and Bethany Home Road Water Quality Assurance Revolving Fund (WQARF) Site. This Work Plan has been authorized by the Arizona Department of Environmental Quality (ADEQ) under Contract ADEQ14-077534, Task Order ADEQ14-077534:16, as part of fiscal year 2016 corrective action activities for the Site.

1.2 BACKGROUND

The Site was placed on the ADEQ WQARF Site Registry in 2004 (ADEQ, 2004). The approximate boundaries of the Site are W. Rose Lane to the north, Bethany Home Road to the south, N. 5th Avenue to the east, and N. 8th Avenue to the west. A contaminated groundwater plume with tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride exists at the Site resulting from historic dry cleaning operations at two properties located at the intersection of 7th Avenue and Bethany Home Road (reference **Figure 1**). The two properties identified as the likely sources of groundwater contamination include 1) the Bayless Investment and Trading Company property, (Bayless Property) located at 540 West Bethany Home Road, and 2) the SCI Arizona Funeral Services property (SCI Property) located at 710 West Bethany Home Road. A dry cleaner occupied one of the commercial spaces at the Bayless Property between 1952 and 1992. A dry cleaner also operated at the SCI property from the 1950's until the 1990's on Parcel 2. On Parcel 4 of the SCI Property, a mortuary and parking lot was present that contained two surface drains. One drain led to a septic tank and one to a brick-lined seepage pit.

On behalf of the ADEQ, a Preliminary Remedial Action Plan (PRAP) was prepared by URS and finalized in April 2015 after review and approval by ADEQ (URS, 2015a). The ADEQ provided Public Notice of the PRAP on April 23, 2015. In June 2016, ADEQ issued a Record of Decision (ROD) for groundwater remediation at the Site (ADEQ, 2016). The ROD stipulates that in situ ERD and monitored natural attenuation are the technologies to be implemented for remediation of groundwater at the Site. The period of active ISB is estimated to be approximately 10 years in which periodic injections of substrate to establish and maintain conditions that are conducive to degrade PCE and TCE in the affected aquifer will be performed.

1.3 INJECTION WELL INSTALLATION

In accordance with the selected remedy in the ROD, an In Situ Bioremediation Carbon Substrate Injection System design package was prepared in March 2016 (URS, 2016a). The design includes installation of 7 new nested injection well pairs on the Bayless property (one nested pair and two individual wells previously installed) and eight new nested injection well pairs along West Berridge Lane. One nested well pair will also be installed west of the Bayless Property in the southeast driveway area at the Bethany Bible Church. The ISB injections will ultimately be performed using 18 pairs of permanent injection wells (36 total wells). Well locations for the Bayless Property are provided on **Figure 2**. Proposed injection well locations for Berridge Lane and the Bethany Bible Church property are depicted on **Figure 3**.

- Bayless Property Wells (540 W. Bethany Home Road): IW-1S, IW-1D, IW-2S/D through IW-9S/D
- Berridge Lane Wells (north lane between 552 W. and 600 W. Berridge Lane): IW-10S/D through IW-17S/D
- Bethany Bible Church Well (6060 N. 7th Avenue) ID IW-18S/D

A Groundwater Monitoring and Injection Well Installation Work Plan was prepared in December 2015 and an addendum to the well installation work plan was prepared in August 2016 (URS, 2016b). One new nested injection well (IW-2) and 7 new nested injection wells (IW-3 through IW-9) were installed on the Bayless Property in January and 2016 and August 2016, respectively, in accordance with the Work Plan and the design package as the first phase of remediation. The injection wells located on Berridge Lane and at Bethany Bible Church will be installed in the future as part of a second phase of work.

2.0 ERD INJECTION

2.1 BACKGROUND

A limited Cost/Benefit Analysis of Alternatives to Perform Carbon Substrate Injections for In Situ Bioremediation was prepared by URS in November 2015 (URS, 2015b). The objective of the cost/benefit analysis was to select a recommended alternative for conducting periodic ISB substrate injections over the active ISB groundwater remediation period. An evaluation of the advantages, disadvantages, safety, and costs were used as criteria to compare the alternatives. ADEQ selected Alternative 1 which includes the use of an emulsified vegetable oil (EVO) carbon substrate, and subcontracting an experienced injection contractor to provide all equipment, instrumentation, supplies, and labor to mix and inject the substrate. As such, URS will subcontract a specialty injection contractor to perform all EVO substrate injection activities as outlined in this Work Plan.

2.2 PROPOSED SUBSTRATE

The selected ISB substrate is EDS-ER™ (electron donor solution – extended release) by Tersus Environmental of Wake Forest, North Carolina. EDS-ER™ is an EVO based water mixable oil that self emulsifies on contact with water. EDS-ER™ is 100-percent fermentable and all components are generally recognized as safe. EDS-ER™ contains food grade soybean oil and food grade vegetable oil derived fatty acid esters. It has a neutral pH when mixed with water and contains no preservatives. The benefit of EDS-ER™ is that pH does not have to be adjusted in the field, whereas low pH formulations of other products can inhibit microbial growth.

Tersus' Nutrimens will be mixed with its EDS-ER™ product and water; the formulation will be a slurry-like substrate amended with nutrients for injection to promote enhanced ISB in the subsurface. Nutrimens is an all-natural bio-fermentation product produced during the fermentation of an unmodified strain of botanical classification Saccharomyces cerevisiae. Nutrimens is designed to enhance the kinetics and efficiency of microbial systems. Nutrimens also provides a source of soluble donor and contains over 12% Total Carbon. Nutrimens is expected to reduce the remediation time and the amount of substrates required to meet remediation goals. In addition, Nutrimens has been demonstrated to maintain circumneutral pH.

The complete reductive dechlorination of chlorinated ethenes yields non-toxic ethene as a final product. Absent the right bacteria, an accumulation of vinyl chloride can be observed. It is unknown if the right bacteria are currently established at the site; however, a field test performed by ADEQ in 2013 and subsequent performance monitoring through 2014 demonstrated degradation of PCE and TCE with associated increasing concentrations of cis-1,2-DCE and vinyl chloride followed by decreasing concentrations of these compounds and ethane/ethene production. These concentrations profiles indicate that complete reductive dechlorination is occurring. Thus, bioaugmentation is not proposed at this time. It may be performed in the future pending the results of performance monitoring.

URS will arrange for the delivery of the EDS-ER™ product and Nutrimens to the Bayless Property up to one week in advance of the planned injection activities. The EDS-ER™ liquid will be delivered in 275-gallon polyethylene totes and Nutrimens will be delivered in either polyethylene totes or drums as a liquid, or in bags as granular solid. These injection products will be secured in an area at the north end of the property using temporary fencing. The fencing will have a locked gate and fabric screening to reduce the potential for theft or vandalism of the products.

2.3 REQUIRED PERMITS

Several permits are required prior to implementation of the ISB injections. URS will obtain these permits on behalf of the ADEQ prior to initiation of any injection activities:

- City of Phoenix Temporary Fence Permit
- City of Phoenix Use Permit (one permit required for each of 3 areas[1])
- City of Phoenix Right-of-Way (ROW) Permit (Not required for first phase, only for Berridge Lane)
- City of Phoenix Revocable Permit (currently existing)

2.4 INJECTION SYSTEM CONSTRUCTION

Prior to injection during the first phase of work, URS will hire a construction contractor to install the carbon substrate injection system at the Bayless Property in conformance with the design plans approved by the City of Phoenix Development Services Department (URS, 2016a). The design plans are provided in Appendix A for reference. The main features of the system include installation of:

- New 2-inch diameter polyvinyl chloride (PVC) injection lines (essentially an underground distribution manifold) that will convey the mixed carbon substrate solution into the injection wells;

[1]One Use Permit each for conducting periodic injections on Berridge Lane and the Bethany Bible Church property will be obtained after ADEQ authorizes the second phase of work to include installation and use of new injection wells at those locations.

- An injection port assembly (equipped in a small vault and connected to the underground manifold), that contains a flow control valve, pressure reducing valve, flow meter, and pressure gauge;
- Wellhead vaults for each of the 8 new nested pair injection wells that will be equipped with a shut-off valve, flow control valve, flow meter, and pressure gauge for each well within the vault;
- A new private water supply line and associated backflow preventer. The private water line will originate from an existing City of Phoenix water meter box located on the west side of the Bayless Property;

2.5 INJECTION PROCEDURES

After the ISB injection system at the Bayless Property is installed, a specialty contractor will be hired to perform the injections. The contractor will provide a temporary above ground mixing tank(s), several dosimeter pumps, and all required hoses, valves, and fittings to perform the injections. The specialty contractor's injection hose will be connected to the underground manifold via the injection port assembly. The mixed carbon substrate solution at the prescribed dosage rate will be pumped to the injection wells under pressure not to exceed 25 pounds per square inch (psi) at each of the wellheads. For the eight nested well pairs (IW-2 through IW-9) and two single injection wells (IW-1S and IW-1D), the specialty contractor will utilize the pressure reducing valve, flow control valve, and water meter (within the injection port assembly vault) to establish/monitor a required total flow rate of 27 gallons per minute (gpm) at a pressure that is restricted to no greater than 25 psi at each wellhead. The total flow rate is calculated by 1.5 gpm per well x 18 individual wells = 27 gpm. To the extent that it is possible to do so, the flow control valve and micro flow meter at each individual wellhead will be used to "fine-tune" the feed rate to attain a 1.5 gpm of substrate solution into the well.

The contractor will inject a total of approximately 12,020 gallons of EDS-ER™ solution into each well. The EDS-ER™ solution will be comprised of approximately 10,040 gallons of dilution water, 1,650 gallons of EDS-ER™, and 330 gallons of Nutrimens. The dosimeters, water supply, and mixing tank(s) will be used by the contractor to establish the proper ratio of Tersus' products to water to create the carbon substrate injection solution. For the 18 well screens on the Bayless Property, a total of approximately 216,360 gallons will be injected. A similar volume of solution will be injected in the Berridge Lane wells and the nested well screens to be installed on the Bethany Bible Church property. As described in Section 2.4, each injection wellhead is equipped with a flow totalizer, pressure gauge, and a shutoff valve. During injection, the flow and pressure will be monitored to ensure that the design amount of EDS-ER™ solution is injected into each well.

Assuming the planned continuous 24-hour-per-day injection of all wells simultaneously, the calculated time to complete injection will be 133.6 hours (5.5 days). However, accounting for set-up/break-down time, intermittent short-duration periods to prepare substrate solution, and potential time to trouble-shoot and/or repair injection equipment, the time period to complete an injection event is anticipated to range from 7 to 9 days. This injection time is expected to be required at each of the three separate areas (Bayless Property, Berridge Lane, and Bethany Bible Church) in which the independent injection activities will take place.

2.6 INJECTION FREQUENCY

The anticipated injection frequency is every 2 years for up to a 10 year period (5 total injections). The frequency may be modified based on performance groundwater monitoring of the observed longevity of substrate in the subsurface and the level of observed ERD.

3.0 PERFORMANCE MONITORING

3.1 MONITORING SCHEDULE

Groundwater monitoring will include one round of baseline monitoring followed by periodic performance monitoring. In accordance with the ROD, periodic monitoring will consist of quarterly monitoring for years 1 through 7, followed by semi-annual monitoring for years 8 through 12, followed by annual monitoring for years 13 through 15. The baseline monitoring will be conducted a minimum of 2 weeks in advance of the injection of the substrate at the Bayless Property and no more than 12 weeks in advance of the injection activities. Periodic monitoring will begin within 2 months following the initial injection event. Baseline sampling will be conducted at 19 locations and periodic sampling will be conducted at ten locations as summarized in the table below. All 19 locations will be sampled at least once annually. Monitoring well locations are shown on **Figure 4**.

Baseline and Performance Monitoring Wells

Well Identification	Baseline/Annual Sampling	Periodic Sampling	Screened Interval (ft btoc)	Total Depth (ft btoc)
MW-3	X	X	68-98	98
MW-3R	X	X	80-110	110
MW-4	X	X	70-110	115.5
MW-5	X	X	70-110	115.5
MW-6	X		78.5-118.5	124
MW-7	X	X	78.5-118.5	124
MW-8	X		78.5-118.5	124
MW-9	X		178-218	218
MW-10	X	X	80-120	120
MW-11	X		80-120	125
MW-12	X		80-120	125
MW-14	X	X	80-110	110
MW-15	X		80-110	110
MW-16	X		80-110	110
MW-17	X		79.5-109.5	109.5
MW-18	X	X	80-110	110
MW-19	X	X	80-110	110
MW-20	X		75.5-115.5	120.5
MW-21	X	X	165-210	215
ft - feet btoc - below top of casing				

3.2 GROUNDWATER SAMPLING PROCEDURE

Prior to sampling, the depth to groundwater will be measured in all monitoring wells using an electric, down-hole water level probe in accordance with Standard Operating Procedure (SOP) 3.0 (Appendix B).

The volume of water within the well casing will be calculated as follows:

$$V = (TD - DTW)\ \pi\ r2\ (7.48)$$

Where

V = one casing volume, in gallons
TD = the total depth of the well, in feet
DTW = depth to water, in feet
r = the inner casing diameter, in feet
7.48 = the conversion factor from cubic feet to gallons

Conventional (total well) purging methodology (SOP 4.0) will be used to collect samples from the existing monitoring wells using dedicated pumps equipped in each well. A decontaminated wellhead assembly that consists of PVC threaded piping (including a Tee fitting, pipe nipples, and adapter bushings), a pressure gauge, a flow control valve and a sampling valve, will be used to facilitate purging and sampling the pumped groundwater. During purging, the pump will be operated at a flow rate of up to 5 gallons per minute. A flow control valve will be used to regulate the flow rate. Flow rate may be monitored with a meter or by measuring the volume purged using graduated containers and a stop watch. A YSI 556 multimeter, equipped with a flow-through cell, will be plumbed to the discharge hose or tubing that is connected to the wellhead assembly to monitor the groundwater quality parameters of temperature, pH, specific conductivity, oxidation-reduction potential, and dissolved oxygen). A Hach 2100P Turbidimeter will also be used to monitor turbidity in nephelometric turbidity units (NTUs). These parameters will be monitored until stabilization is achieved (SOP 5.0). Stabilization is achieved when three consecutive readings show the following:

- Temperature - ± 1 degree Celsius
- pH - ± 0.1 pH unit
- Turbidity - ≤ 10 NTU or ± 10%
- Conductivity - ± 5%
- Dissolved Oxygen - ± 10%
- Oxidation-Reduction Potential - ± 10 millivolts

Purging will continue at each well until: (1) at least three casing volumes have been removed; and (2) water quality parameters have stabilized as described above; or (3) five casing volumes have been removed from the well. Should the volume of water removed exceed the well recharge capacity, the well will be purged dry and allowed to recharge to at least 80 percent of the static water level before collecting a sample, if feasible. Wells that require several days or more to recover may be sampled before 80 percent recovery is achieved. Depth to water will be measured prior to, and if necessary to evaluate water level conditions, during purging using a water level probe capable of measuring liquid level to 0.01 feet.

Following purging, the sample will be collected from a sample valve equipped on the wellhead assembly upstream of the discharge hose and flow-through cell. Samples will be collected in pre-preserved laboratory-provided sample containers in accordance with the table presented in Section 3.3. Samples will be placed on ice pending delivery or shipment to the laboratory.

3.3 LABORATORY ANALYTICAL METHODS

All samples for performance monitoring will be submitted to TestAmerica, Inc. of Phoenix, Arizona (Arizona Department of Health Services License Number AZ0728). Samples will be analyzed for the compounds summarized in the following table.

Laboratory Analyses

Analyte(s)	Laboratory Method	Sample Containers / Preservative / Holding Time
VOCs	8260B	3 x 40 mL VOAs / HCl, temperature to <6 ^{o}C / 14 days
Nitrate	300.0	250 mL polyethylene / H2SO4 to pH <2, temperature to <6 ^{o}C / 28 days
Sulfate	300.0	250 mL polyethylene / temperature to <6 ^{o}C / 28 days
Iron, Manganese	200.7 Rev 4.4	500 mL polyethylene / HNO3 to pH<2; temperature to < 6 ^{o}C / 6 months
Methane, Ethane, Ethene	RSK175	3 x 40 mL VOAs / HCL, temperature to < 6 ^{o}C / 14 days
Total Organic Carbon	SM5310B	4 x 40 mL VOAs / H2SO4, temperature to 6 ^{o}C / 28 days

VOCs – volatile organic compounds
mL - milliliter
VOA – volatile organic analysis vial
HCl – hydrochloric acid
H2SO4 – sulfuric acid
HNO3 – nitric acid
^{o}C – degrees Celsius

3.4 SAMPLE IDENTIFICATION

Each sample will be labeled with a unique identifier and recorded in the field logbook at the time of sample collection. Groundwater well samples will be identified by well identification number and date. Labels will be completed with permanent ink and will include the sample identification (ID), date and time of collection, project name, and name of collector, analysis requested, and preservative.

For Quality Assurance/Quality Control (QA/QC) samples, consisting of field duplicate samples, the IDs will follow the same convention, except that they will include a third field, to designate the type of QA/QC sample, as follows:

- Field duplicate samples: -Y

For example, a sample collected from monitoring well MW-3 would be labeled MW-3 and the duplicate would be MW-3-Y. Trip blanks consisting of laboratory prepared samples will also accompany the samples in the cooler with VOC samples. The trip blanks remain unopened throughout the sampling event.

3.5 SAMPLE HANDLING

Samples will be preserved in accordance with the methodology prescribed for the method (see Section 3.3) and in accordance with SOP 18.0. Samples will be managed in accordance with SOP 17.0 and packed and delivered or shipping in accordance with SOP 20.0. A chain-of-custody form will be completed and accompany the samples in accordance with SOP 19.0.

3.6 DATA MANAGEMENT PROCEDURE

The laboratory will provide a Level II Quality Control laboratory data package. Following receipt of the data package from the laboratory, URS will perform data verification to evaluate the reliability and defensibility of the analytical data. This process involves reviewing the data against a known set of criteria to verify data quality prior to URS submitting the data. The laboratory performance will be evaluated for compliance with QA/QC specifications outlined in the analytical methods and the criteria specified in the United States Environmental Protection Agency (EPA) documents: National Functional Guidelines for Superfund Organic Methods Data Review (EPA, 2014). Evaluation of data quality indicators during data verification will be completed as described in Appendix C.

Following data verification, all groundwater elevations and laboratory analytical data will be uploaded to the ADEQ elevation and groundwater quality database.

3.7 HEALTH AND SAFETY

Level D personal protective equipment (PPE) will be worn during sampling activities. Level D consists of disposable protective material used in conjunction with standard work clothing and includes steel-toed boots, hard hats, eye protection, ear protection, and latex/nitrile gloves. All field activities will be conducted in accordance with the Site Health and Safety Plan. Any deviations from measures outlined in the site-specific Health and Safety Plan (HASP) as a result of unexpected field conditions will follow OSHA safety protocols.

3.8 INVESTIGATION DERIVED WASTE

Investigation-derived waste (IDW) will be generated as a result of the activities conducted during this project and will be handled in accordance with SOP 21.0. The types of waste expected to be generated include, but are not limited to, PPE and well purge water. PPE and miscellaneous waste materials will be disposed of as municipal waste. IDW water will be containerized in 55-gallon drums or a rental polyethylene tank and will be sampled. One composite of the purge water will be collected using a sample bailer. It will be submitted for analysis of eight (8) Resource Conservation and Recovery Act (RCRA) metals by SW-846 Method 6010B/6020B/7470A, VOCs by SW-846 Method 8260B, pH, and flashpoint. After the waste has been characterized and approval received from the disposal facility, URS will arrange for the transportation of the water off-site for disposal in accordance with applicable federal, state, and local regulations.

Prior to disposal, waste containers will be staged onsite and clearly labeled using permanent marker and weather-resistant labels with the following information:

- Source of the IDW
- Type of material
- Date the container was filled and sealed
- Contact name and telephone number
- Profiling sampling identification number(s)

4.0 FIELD DOCUMENTATION

A field geologist or engineer will supervise the injection and sampling activities. This individual will be responsible for maintaining the following documentation in a dedicated, bound log book used to record pertinent information:

- General site conditions, daily weather, arrival and departure of subcontractors and visitors, equipment used at the site, equipment problems, and other relevant information;
- Handling and disposal of purge/development water;
- Departures from the field protocol;
- Sample collection procedures, sample IDs, and QA/QC sample information;
- Manufacturer's name and model numbers of the dosimeter pump(s) and other pertinent injection equipment (such as flow meters, gauges, other instrumentation) that the specialty contractor uses to perform the injections.
- Injection activities including flow rates, pressures, and volumes of solution injected, injection equipment setup, and injection process; and
- Health and safety documentation as required by the project HASP.

Performance monitoring activities will also be documented in the log book in accordance with SOP 2.0.

5.0 REPORTING

URS will prepare an Annual O&M and Monitoring Report documenting the field activities described herein. The Annual Report will include the following at a minimum:

- Documentation of the implemented field activities;
- Sampling and purging techniques and procedures;
- A tabulation of analytical results and brief evaluation;
- An evaluation of the remediation progress;
- A Description of IDW management;
- A site map depicting groundwater concentrations and groundwater flow direction;
- Copies of field documentation;
- Copies of laboratory analytical reports; and
- Copies of applicable permits.

The Annual Report will be submitted to the ADEQ for its review and public records.

6.0 REFERENCES

ADEQ, 2004. *Site Registry Report (Final) Water Quality Assurance Revolving Fund (WQARF) Site, 7th Avenue and Bethany Home Road, Phoenix, Maricopa County, Arizona*. August.

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EPA, 2014. *National Functional Guidelines for Superfund Organic Methods Data Review*, Office of Superfund Remediation and Technology Innovation (OSRTI), United States Environmental Protection Agency (EPA), Washington DC 20460. August.

URS, 2015a. *Proposed Remedial Action Plan (PRAP), 7th Avenue and Bethany Home Road WQARF Site, Phoenix, Arizona*. January.

URS, 2015b. *Limited Cost/Benefit Analysis of Alternatives to Perform Carbon Substrate injections for In Situ Bioremediation, 7th Avenue and Bethany Home Road WQARF Site, Phoenix, Arizona.* November.

URS, 2016a. *In Situ Bioremediation Carbon Substrate Injection System, 7th Avenue and Bethany Home Road WQARF Site, Phoenix, Arizona.* March.

URS, 2016b. *Addendum to December 2015 Well Installation and Sampling Work Plan, Installation of Additional Injection Wells at the Bayless Property, 7th Avenue and Bethany Home Road WQARF Site, Phoenix, AZ*. August.

FIGURES

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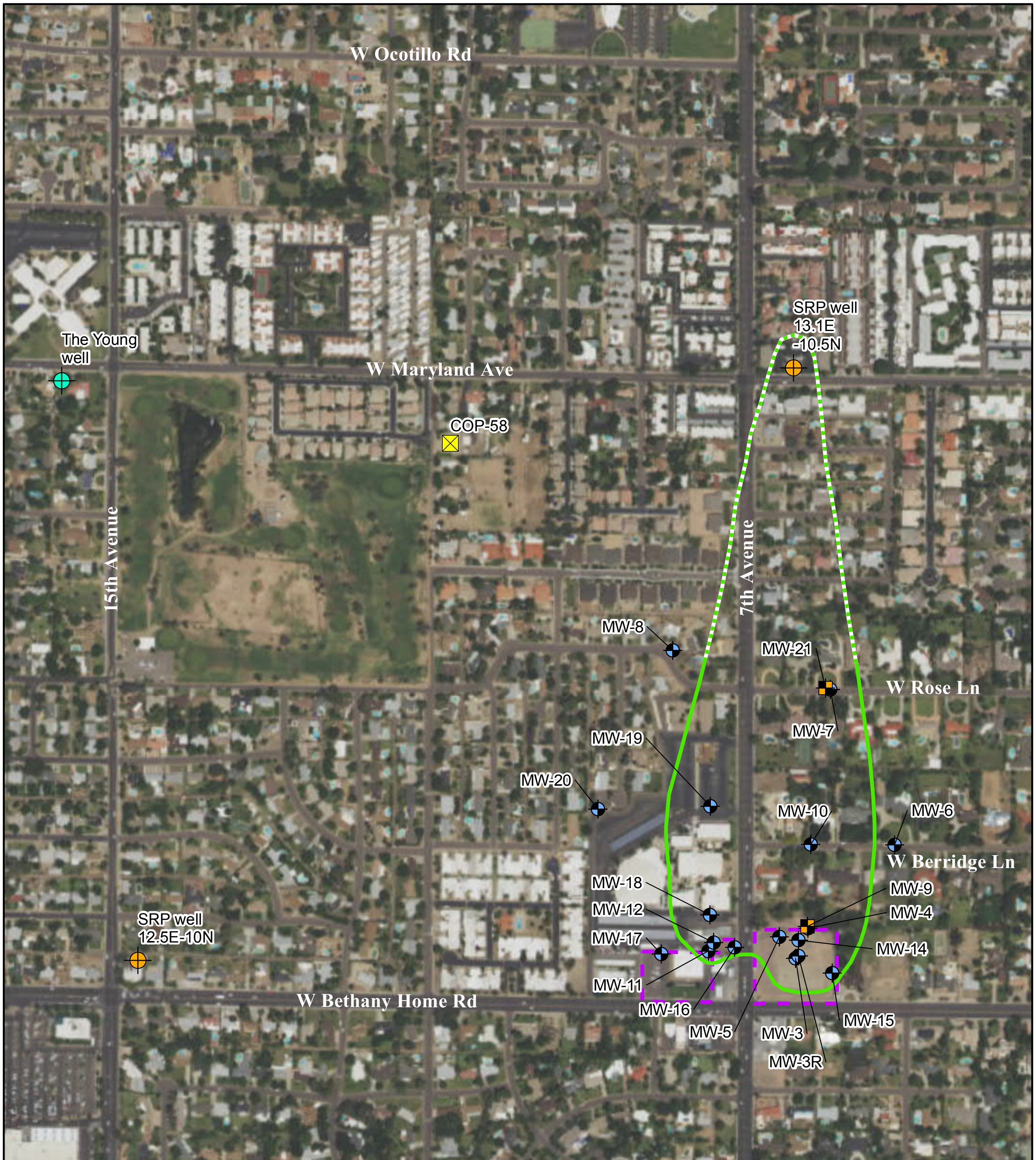


Legend

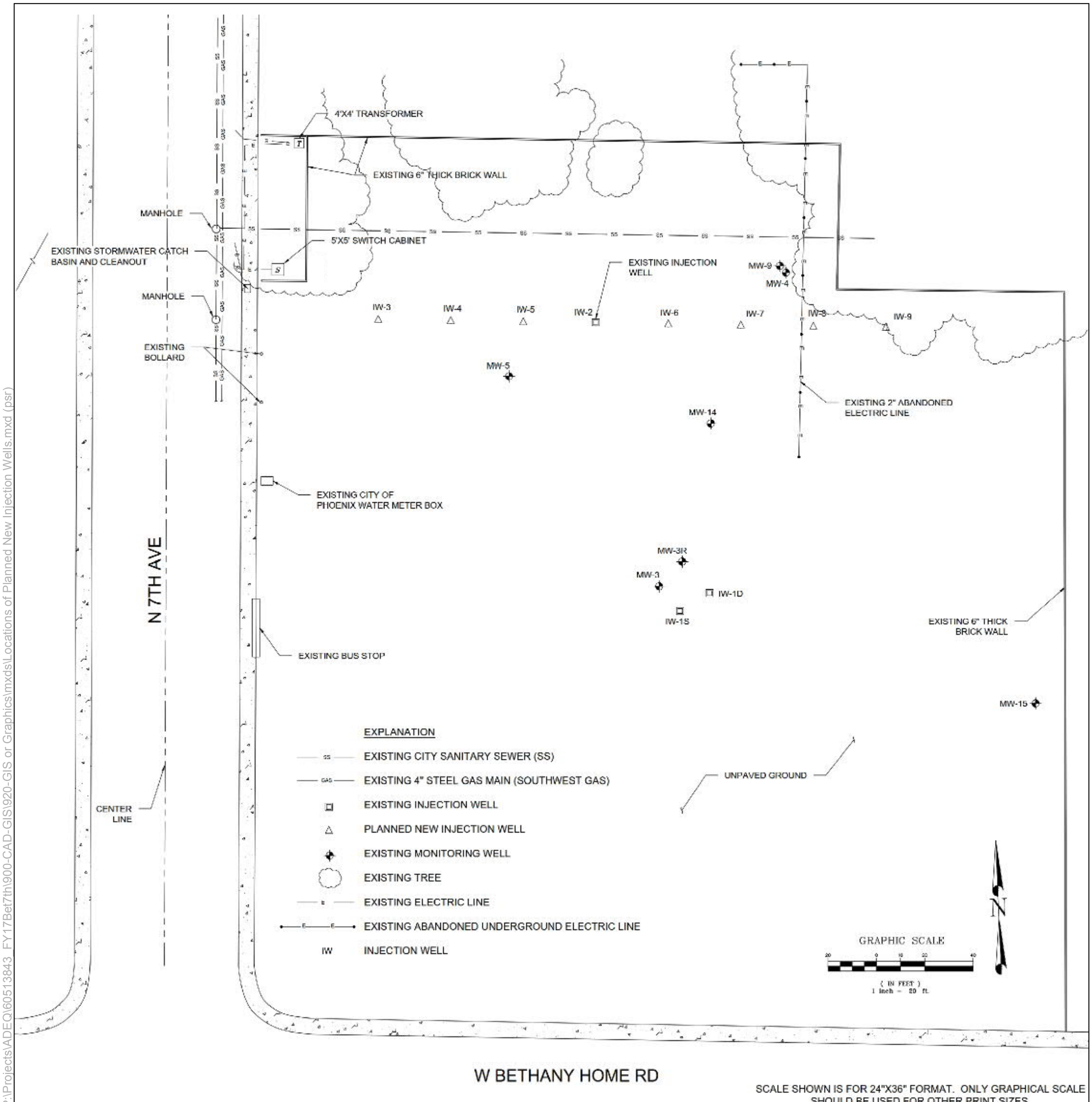
- Shallow Monitoring Well
- Deep Monitoring Well
- SRP Well
- Private Well
- City of Phoenix Well 58 (55-626549)
- Likely Source Property Boundary
- Estimated PCE Plume Boundary
- Dashed Where Inferred

N

0 300 600
Feet
1 in = 600 ft

Source:
Project Features: ARCADIS 2014
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar

Figure 1
Site Map with
Estimated Plume Boundary
7th Ave & Bethany Home Rd
WQARF Site



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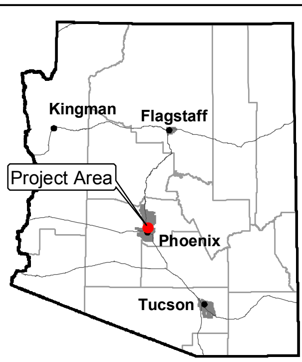

Figure 2

Approximate Locations of Injection Wells (Bayless Property)

7th Ave & Bethany Home Rd WQARF Site

Legend

- Proposed Nested Injection Well
- Existing Nested Injection Well
- Injection Well
- Monitoring Well
- Proposed Injection Transect
- Former Buildings
- General Groundwater Direction

MW-3 1075.20 250 µg/L	Monitor Well Name March 2014 Groundwater Elevation (ft amsl) PCE Concentration (µg/L) 0.00 = Not Sampled (NS)

N

0 250 500
Feet
1 in = 250 ft

Figure 3

Planned and Existing Locations of ISB Injection Wells

7th Ave & Bethany Home Rd WQARF Site

ISB = In-Situ Bioremediation

Source:
Project Features: ARCADIS 2014
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX,

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Legend

- Shallow Monitoring Well
- Deep Monitoring Well
- Injection Well
- Former Buildings

N

0 250 500

Feet

1 in = 250 ft

Figure 4

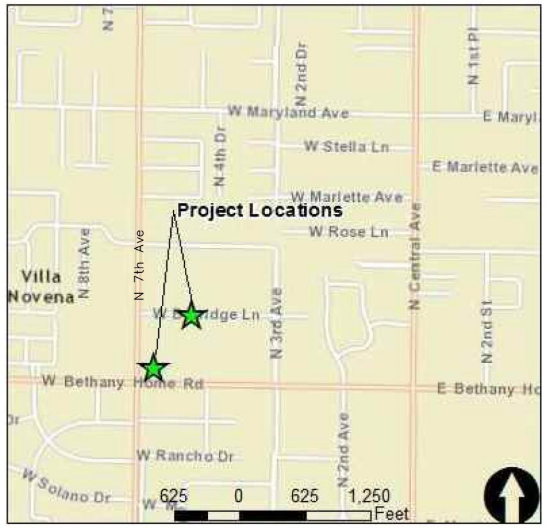
Monitoring Well Location Map

7th Ave & Bethany Home Rd WQARF Site

Source:
Project Features: ARCADIS 2014
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX,

APPENDIX A - DESIGN PLANS FOR ISB CARBON SUBSTRATE INJECTION SYSTEM

LONG, BENJAMIN, 9/14/2016 5:33 PM



VICINITY MAP

IN SITU BIOREMEDIATION
CARBON SUBSTRATE INJECTION SYSTEM

7TH AVENUE AND BETHANY HOME ROAD
WATER QUALITY ASSURANCE REVOLVING FUND SITE
PHOENIX, ARIZONA

PREPARED FOR:
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY - REMEDIAL PROJECTS SECTION
1110 WEST WASHINGTON STREET
PHOENIX, AZ 85007

PREPARED BY:
URS CORPORATION
7720 NORTH 16TH STREET, SUITE 100
PHOENIX, ARIZONA 85020

SITE MAP
NOT TO SCALE

DRAWING LIST	
SHEET NO.	SHEET TITLE
G-1	COVER SHEET
G-2	GENERAL SPECIFICATIONS, LEGENDS, AND ABBREVIATIONS
C-1	ON-SITE INSTALLATION PLAN
C-2	OFF-SITE INSTALLATION PLAN
C-3	WELL, VAULT, AND PIPING DETAILS
C-4	ADDITIONAL PIPING DETAILS
P-1	PROCESS AND INSTRUMENTATION DIAGRAM

SECTION AND DETAIL DESIGNATION

SHEET FROM WHICH DETAIL OR SECTION ORIGINATED — 01 / C-1 C-3 — NUMBER FOR SECTION OR LETTER FOR DETAIL DESIGNATION; SHEET WHERE DETAIL OR SECTION WILL BE SHOWN

SCALE SHOWN IS FOR 24"X36" FORMAT. ONLY GRAPHICAL SCALE SHOULD BE USED FOR OTHER PRINT SIZES.

DRAWING PATH: Q:\Projects\ADEQ\7th and Bethany Design 2015\05_Analysis_and_Engineering\Design_Drawings\Rev's ABC\G-1 COVER SHEET_REVD.dwg

URS

URS Corporation
7720 North 16th Street, Suite 100
Phoenix, AZ 85020
602-371-1100 (phone)
602-371-1615 (fax)

ADEQ
Arizona Department of Environmental Quality

Registered Professional Engineer (Environmental) Certificate No. 34613 JEFFREY W. RACKOW Date Signed 9-13-16 ARIZONA, U.S.A.
Expires: 3-31-18

ISSUED FOR BIDDING 2016-XX-XX XXX (DATE BY)

ISSUED FOR CONSTRUCTION (DATE BY)

REVISIONS

NO.	DESCRIPTION	DATE
△	30% DESIGN	11/6/15
△	95% DESIGN	2/8/16
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△	MODIFY TO INCLUDE COP BUILDING PERMIT ADDITIONS	9/13/16
△		

AECOM PROJECT NO: 60445193
DRAWN BY: PINEDA, REID 2/5/16
DESIGNED BY: RACKOW 2/5/16
CHECKED BY: RACKOW 2/5/16
DATE CREATED: 12/4/15
PLOT DATE: 9/14/16
SCALE: NTS
ACAD VER: 2014

SHEET TITLE

COVER SHEET
IN SITU BIOREMEDIATION
CARBON SUBSTRATE INJECTION SYSTEM

G-1
SHEET 1 OF 7

DRAWING PATH: Q:\Projects\ADEQ\05_Analysis_and_Engineering\Design_Drawings\95% Design\G-2 GENERAL SPECIFICATIONS, LEGENDS, AND ABBREVIATIONS.dwg

REID, LINDSAY, 3/11/2016 9:40 AM

IN SITU BIOREMEDIATION CARBON SUBSTRATE INJECTION SYSTEM

A. GENERAL REQUIREMENTS

1. THE INFORMATION IN THESE PLANS IS SOLELY TO ASSIST THE CONTRACTOR IN ASSESSING THE NATURE AND EXTENT OF THE CONDITIONS THAT MAY BE ENCOUNTERED DURING THE COURSE OF WORK. PRIOR TO BIDDING CONTRACTOR IS ADVISED TO CONDUCT WHATEVER INVESTIGATIONS HE / SHE MAY DEEM NECESSARY TO ARRIVE AT HIS/HER OWN CONCLUSIONS REGARDING THE ACTUAL CONDITIONS THAT WILL BE ENCOUNTERED, AND UPON WHICH HIS/HER BID WILL BE BASED.

2. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH APPLICABLE CITY, COUNTY, STATE, AND FEDERAL RULES, REGULATIONS, ORDINANCES AND LAWS IN EXECUTING WORK. CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING, MAKING NECESSARY ARRANGEMENTS, AND PERFORMING SERVICES REQUIRED FOR MAINTENANCE OF PUBLIC UTILITIES.

3. CONTRACTOR IS RESPONSIBLE FOR PROVIDING DUST CONTROL FOR ALL EARTHWORK AND SOIL LOADING OPERATIONS.

4. CONTRACTOR IS RESPONSIBLE FOR CLEANING THE SITE AND DISPOSING OF ALL CONSTRUCTION WASTE ON A DAILY BASIS.

5. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN AS APPROXIMATE BASED ON THE BEST AVAILABLE INFORMATION AT THE TIME OF PREPARATION OF THESE PLANS.

6. THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ENGINEER WHEN CONFLICTS BETWEEN THE DRAWINGS AND ACTUAL CONDITIONS ARE DISCOVERED.

7. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL SUBMIT TO THE ENGINEER A PROJECT SCHEDULE WITH DATES AND TIMES THAT CONTRACTOR WILL BE ON SITE, DESCRIPTION OF WORK TO BE PERFORMED, AND SCHEDULE OF TESTS THAT WILL BE CONDUCTED BY THE CONTRACTOR OR ANY SUB-CONTRACTORS. A PRE-CONSTRUCTION MEETING AT THE SITE BETWEEN THE CONTRACTOR AND ENGINEER WILL BE REQUIRED BEFORE ANY WORK BEGINS.

8. DURING CONSTRUCTION, THE CONTRACTOR SHALL MAINTAIN A NEAT, ACCURATE, LEGIBLE AS-BUILT (RECORD) DRAWING SET THAT WILL BE SUBMITTED TO THE ENGINEER UPON COMPLETION OF THE WORK.

9. UNLESS OTHERWISE NOTED IN THESE DRAWINGS, THE CONTRACTOR WILL REPLACE ALL EXISTING PAVING, CURB, GUTTERS, SIGNS, GENERAL LANDSCAPING, OR OTHER IMPROVEMENTS WITH THE SAME TYPE OF MATERIAL AND CONFIGURATION THAT WAS REMOVED OR DAMAGED DURING CONSTRUCTION.

10. IN CASE OF SPECIFICATION CONFLICT, NOTIFY ENGINEER AND REFER TO DRAWING SET FOR GUIDANCE.

11. CONTRACTOR SHALL FORMALLY SUBMIT QUESTIONS AS WRITTEN RFI'S. URS WILL PROVIDE A WRITTEN RESPONSE TO DOCUMENT ANY CHANGE IN DESIGN.

12. THE WORDS ENGINEER, URS, OR URS CORPORATION REFER TO THE OWNER'S DESIGN AND ENGINEERING REPRESENTATIVE.

13. ALL MATERIALS USED FOR CONSTRUCTION OF THE SYSTEM SHALL BE NEW.

B. COORDINATION

1. CONTRACTOR SHALL COORDINATE ALL WORK WITH URS.

2. THE CONTRACTOR SHALL CONDUCT UTILITY LOCATING SERVICES AND/OR CONTRACT WITH A PRIVATE UTILITY LOCATING SERVICE AS NECESSARY, AND CONDUCT WORK SO AS NOT TO DAMAGE EXISTING UNDERGROUND OR OVERHEAD UTILITIES OR STRUCTURES.

3. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND SITE CONDITIONS BEFORE STARTING WORK AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES.

4. THE ENGINEER SHALL BE RESPONSIBLE FOR PREPARING AND SUBMITTING ALL CITY OF PHOENIX REQUIRED PERMIT APPLICATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SUBMITTING ALL OTHER REQUIRED PERMIT APPLICATIONS INCLUDING THOSE REQUIRED, BUT NOT NECESSARILY LIMITED TO, MARICOPA COUNTY DUST CONTROL PERMIT(S). THE CONTRACTOR SHALL ALSO BE RESPONSIBLE TO PAY ALL FEES AND PICK UP ALL REQUIRED CONSTRUCTION AND DUST CONTROL-RELATED PERMITS PRIOR TO COMMENCEMENT OF WORK.

C. SAFETY

1. CONTRACTOR SHALL PROVIDE AND INSTALL THE NECESSARY SHORING, TRENCH PLATING, TRENCH BOXES, ORANGE SAFETY FENCING OR BARRICADES, ETC. AS REQUIRED BY FEDERAL AND STATE SAFETY AND OCCUPATIONAL STANDARDS.

2. CONTRACTOR SHALL PROVIDE TRAFFIC CONTROL OPERATED IN ACCORDANCE WITH THE CITY OF PHOENIX BARRICADE MANUAL, LATEST EDITION.

3. CONTRACTOR SHALL CORDON OFF WELLHEAD VAULT EXCAVATIONS AND TRENCH SECTIONS USING TRENCH PLATE OR WITH OTHER CITY-APPROVED METHODS AS NECESSARY TO PROVIDE FOR SAFETY.

4. CONTRACTOR SHALL BE RESPONSIBLE FOR PREPARING A HEALTH AND SAFETY PLAN IN CONFORMANCE WITH OSHA 29 CFR 1910.120. CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING SAFE WORK PRACTICES AT THE PROJECT LOCATION IN ACCORDANCE WITH THE PLAN.

5. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO BE FAMILIAR WITH THE OSHA EXCAVATION SAFETY STANDARDS AND ABIDE BY THEM AT ALL TIMES DURING CONSTRUCTION.

6. CONTRACTOR IS RESPONSIBLE FOR THE SAFE AND HEALTHFUL PERFORMANCE OF WORK BY EACH OF ITS EMPLOYEES, SUBCONTRACTORS, OR SUPPORT PERSONNEL WHO MAY ENTER THE SITE.

7. CONTRACTOR SHALL WEAR AT A MINIMUM OF LEVEL D PPE AT ALL TIMES.

8. ALL CONTRACTOR AND SUBCONTRACTOR PERSONNEL WORKING ON-SITE ARE REQUIRED TO MEET AND FOLLOW THE CONTRACTORS HEALTH AND SAFETY PLAN, REVIEWED AND APPROVED BY URS CORPORATION PRIOR TO COMMENCEMENT OF WORK

9. THE SITE IS A WATER QUALITY ASSURANCE REVOLVING FUND (WQARF) SITE WITH GROUNDWATER CONTAMINATION IMPACTS (>85 FT DEEP). NO CONTAMINANTS ASSOCIATED WITH THE WQARF SITE ARE EXPECTED TO BE ENCOUNTERED DURING CONSTRUCTION

D. EXCAVATION

1. CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE TO EXISTING SUBSURFACE UTILITIES (E.G. ELECTRICAL, WATER, REMEDIATION, ETC.) OR STRUCTURES SUSTAINED DURING TRENCHING/EXCAVATION ACTIVITIES.

2. PRESERVATION OF THE EXISTING INJECTION WELLS (IW'S) SHALL BE THE RESPONSITILITY OF THE CONTRACTOR. ANY DAMAGE TO THE IW'S WELLS OR OTHER EXISTING STRUCTURES SHALL BE REPAIRED TO THE OWNERS SATISFACTION AT THE COST OF THE CONTRACTOR.

E. BACKFILLING

1. NATIVE MATERIAL: NATIVE MATERIAL EXCAVATED AND USED FOR BACKFILL SHALL HAVE A MAXIMUM PARTICLE SIZE OF 2 INCHES (LESS THAN 10% ALLOWED) AND FREE OF DELETERIOUS MATERIAL, IF APPROVED BY ENGINEER. NATIVE MATERIAL TO BE USED AS BACKFILL SHALL BE PLACED IN 8-INCH LOOSE LIFTS, UNLESS OTHERWISE STATED HEREIN. THIS MATERIAL SHALL BE COMPACTED TO WITHIN 95% OF THE MAXIMUM DRY DENSITY AND +/- 3% OF THE OPTIMUM MOISTURE CONTENT ACCORDING TO ASTM D698 SPECIFICATION FOR STANDARD PROCTOR.

2. AGGREGATE BASE COURSE (ABC) MATERIAL: COMMERCIAL AB MATERIAL TO BE USED AS BACKFILL SHALL BE WELL GRADED WITHIN THE FOLLOWING LIMITS:

SIEVE DESIGNATION	PERCENT PASSING
1-1/8 INCH	100
#4	38-65
#8	25-60
#30	10-40
#200	3-12

THIS MATERIAL SHALL BE PLACED IN 12-INCH LOOSE LIFTS, AND SHALL BE COMPACTED TO WITHIN 95% OF THE MAXIMUM DRY DENSITY AND +/-3% OF THE OPTIMUM MOISTURE CONTENT ACCORDING TO ASTM D698 SPECIFICATION FOR STANDARD PROCTOR.

3. CONTRACTOR SHALL PROVIDE FIELD DENSITY TESTS TO URS TO VERIFY COMPACTION REQUIREMENTS AT ORIGINAL GRADE SURFACES, SUBGRADES, AND FINAL GRADES IN CONFORMANCE WITH STANDARD PRACTICES.

URS RESERVES THE RIGHT TO VERIFY COMPACTION AT ANY TIME.

F. TRENCHING

1. TRENCHING MAY BE PERFORMED BY MECHANICAL MEANS FOLLOWING VERIFICATION THAT SUBSURFACE UTILITIES AND STRUCTURES ARE ABSENT.

2. TRENCHING CONFIGURATION SHALL BE IN SUCH A MANNER AS TO ALLOW ADEQUATE INSTALLATION OF THE SUBSTRATE INJECTION, WATER LINE OR ELECTRICAL CONDUIT AND COMPACTION OF BACKFILL. TYPICAL TRENCHING DIMENSIONS ARE SHOWN ON THE CONSTRUCTION DRAWINGS BUT ARE THE CONTRACTOR'S RESPONSIBILITY FOR SAFE AND EFFECTIVE WORK BASED ON SITE SOIL CONDITIONS.

3. INADVERTENT OVEREXCAVATION OF TRENCH BEYOND GRADE LINE SHALL BE BACKFILLED AND COMPACTED WITH NATIVE SOIL TO WITHIN 95% OF THE MAXIMUM DRY DENSITY AND +/-3% OPTIMUM MOISTURE CONTENT ACCORDING TO STANDARD PROCTOR (ASTM D698), AT CONTRACTOR'S SOLE EXPENSE.

4. ALL BACKFILL SHALL BE FIELD INSPECTED AS WELL AS FIELD DENSITY TESTED BY A CONTRACTOR'S REPRESENTATIVE PRIOR TO APPROVAL.

G. CAST-IN-PLACE CONCRETE

1. PLACE CONCRETE DURING HOT AND COLD WEATHER IN ACCORDANCE WITH RECOMMENDED PROCEDURES OF ACI 306.

2. CONCEALED, FORMED CONCRETE SURFACES NEED NOT BE FINISHED. FINISH EXPOSED HORIZONTAL SURFACES OF CONCRETE TO MATCH EXISTING CONDITIONS.

3. REPAIR OR REPLACE REJECTED CONCRETE, AS DIRECTED BY URS ENGINEER.

4. HAND MIXES ARE NOT ALLOWED.

5. COMPACTED BASE MATERIAL MUST BE TESTED BY THE CONTRACTOR AND APPROVED BY THE ENGINEER PRIOR TO PLACING CONCRETE.

H. PIPING

1. UNLESS STATED OTHERWISE, ALL BELOW GRADE INJECTION PIPING SHALL BE NEW POLYVINYL CHLORIDE (PVC) SCHEDULE 80 AND ALL ABOVE GRADE PIPING SHALL BE NEW PVC SCHEDULE 80.

2. ALL JOINTS SHALL BE SOLVENT WELDED UNLESS THREADED WITH THE APPROPRIATE SOLVENTS AND CEMENTS FOR MATERIALS TO BE USED. PROPER CURE TIMES SHALL BE FOLLOWED PER THE MANUFACTURER'S RECOMMENDATIONS.

3. ALL THREADED PIPING AND FITTINGS SHALL HAVE TEFLON TAPED CONNECTIONS.

4. RIGID ABOVEGROUND PIPING SHALL BE INSTALLED SUCH THAT IT IS LEVEL AND SUPPORTED USING UNISTRUT HARDWARE OR OTHER APPROVED METHOD.

5. CONTRACTOR WILL STORE PVC PIPE SUCH THAT IT WILL BE PROTECTED FROM DIRECT EXPOSURE TO SUNLIGHT AT ALL TIMES.

I. BACKFLOW PREVENTER

1. SEE SHEET P-1.

J. WATER PRESSURE REGULATOR

1. SEE SHEET P-1.

K. PRESSURE GAUGES

1. SEE SHEET P-1.

L. VALVES (GATE, GLOBE, AIR BLEED)

1. SEE SHEET P-1.
2. VALVES SHALL CONFORM TO SIZE AND MATERIAL AS SHOWN ON THE CONSTRUCTION DRAWINGS AND MANUFACTURERS CUT SHEETS SHALL BE SUBMITTED TO ENGINEER FOR APPROVAL.

M. FLOW METERS/TOTALIZERS

1. SEE SHEET P-1.

N. PRESSURE TESTING

1. PRESSURE TESTING SHALL BE COMPLETED FOR EACH SECTION OF PIPE. PRESSURE TESTING FOR PVC PIPE IS TO BE CONDUCTED UNDER MODERATE PRESSURE OF 60 PSI FOR A PERIOD OF 20 MINUTES. ANY PRESSURE LOSS DURING 20 MINUTES IS CONSIDERED A FAILURE. CONTRACTOR SHALL FURNISH ALL TESTING EQUIPMENT INCLUDING A PRECISION PRESSURE GAUGE WITH NO GREATER THAN 1 PSI GRADUATIONS. ANY LEAKS SHALL BE REPAIRED AT THE CONTRACTOR'S EXPENSE AND RETESTED PRIOR TO APPROVAL.

2. PRESSURE TESTING OF PIPES MUST BE COMPLETED PRIOR TO BACKFILLING PIPE TRENCHES.

O. PAINTING

1. ALL ABOVE GRADE PIPING SHALL BE PAINTED WITH TWO COATS OF UV-RESISTANT PAINT. COLOR PREFERABLY WHITE.

P. UNDERGROUND FACILITIES

1. THE CONTRACTOR IS NOTIFIED THAT UNDERGROUND FACILITIES (REFERRED TO HEREIN AS SUBGRADE UTILITIES, CONDUITS, DRAINAGE DEVICES, PIPING, VALVES, ETC.) EITHER ARE OR CAN BE LOCATED BENEATH THE SITE OR IN THE VICINITY OF THE PROJECT LOCATION.

2. UNDERGROUND FACILITIES ENCOUNTERED BY THE CONTRACTOR DURING CONSTRUCTION SHALL BE REPORTED TO THE ENGINEER. THE CONTRACTOR SHALL NOT BACKFILL THE AREA WITH THE EXPOSED FACILITY UNTIL A REPRESENTATIVE OF THE FACILITY PROVIDES APPROVAL TO BACKFILL OR COVER IT. ALL REPAIRS, INCIDENTAL COSTS, AND TEMPORARY PROTECTION REQUIRED FOR DAMAGED UNDERGROUND FACILITIES OR UTILITIES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR AT NO ADDITIONAL COST TO THE OWNER OR ENGINEER.

3. UNDERGROUND FACILITIES ENCOUNTERED BY THE CONTRACTOR NOT SHOWN ON THE DRAWINGS SHALL BE REPORTED TO THE ENGINEER. THE CONTRACTOR SHALL MARK THE LOCATION OF THE FACILITY ON THE DRAWINGS FOR REFERENCE AND SHALL PROVIDE THE DEPTH, SIZE, FUNCTION, AND USE OF THE UNDERGROUND FACILITY. THE CONTRACTOR SHALL ALSO REPORT TO THE ENGINEER ANY DISCREPANCIES RELATIVE TO THE UNDERGROUND FACILITIES SHOWN ON THE DRAWINGS.

4. THE CONTRACTOR SHALL NOT DISTURB, SHUT DOWN, COMPROMISE, OR INTERRUPT ANY EXISTING FACILITY WITHOUT AUTHORIZATION FROM THE SPECIFIC UTILITY. THE CONTRACTOR SHALL PROVIDE NECESSARY PROTECTION FOR SHORING OF UTILITIES, IF NECESSARY, AT NO ADDITIONAL COST TO THE OWNER OR ENGINEER.

Q. EQUIPMENT INSTALLATION

1. ALL CONNECTIONS SHOWN ON THESE PLANS, AND/OR REQUIRED TO ENSURE A COMPLETE OPERATING SYSTEM SHALL BE PERFORMED BY THE CONTRACTOR.

2. ALL EQUIPMENT, PLUMBING, AND INSTRUMENTATION SHOWN ON THESE PLANS SHALL BE FURNISHED AND INSTALLED BY THE CONTRACTOR, UNLESS OTHERWISE NOTED.

3. THE NESTED IW'S FOR USE WITH THE REMEDIATION SYSTEM ARE PRESENT AT THE JOB SITE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DEMOLISHING EXISTING SHALLOW, FLUSH-TO-GRADE VAULTS, AND MAKING PIPE CONNECTIONS TO AND INSTALLING VAULTS OVER THE EXISTING WELLHEADS PER THESE PLANS.

VALVES AND ACTUATORS

NORMALLY OPEN	VALVE TYPE
	BALL VALVE
	GATE VALVE
	AIR BLEED VALVE
PR	PRESSURE REGULATOR
	GLOBE VALVE

PIPE SPECIALTIES

SYMBOL	TYPE
	DIRECTION OF FLOW
F	FLOW METER
P	PRESSURE GAUGE
	COMPRESSION UNION
	EXPANSION FITTING
	UNION

PROCESS FLOW DIAGRAM LEGEND

- DIRECTION OF FLOW
- MAJOR PROCESS

ABBREVIATIONS

DIA	DIAMETER
GPM	GALLONS PER MINUTE
IW	INJECTION WELL
MIN	MINIMUM
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
P&I D	PIPING AND INSTRUMENTATION DIAGRAM
PR	PRESSURE REGULATOR
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
SCH.	SCHEDULE
TYP.	TYPICAL
U/G	UNDERGROUND

BENCHMARK:

CITY OF PHOENIX DATUM ELEVATION: 1152.71'
SALT RIVER PROJECT BRASS CAP SET IN TOP SOUTH SIDE OF IRRIGATION STRUCTURE AT SOUTHWEST CORNER 7TH AVENUE & BETHANY HOME ROAD.

C.O.P. QS MAP

REFERENCE CITY OF PHOENIX QUARTER SECTION MAP: 21-27
REVOCABLE PERMIT NUMBER RP-91011-15

CONTRACTING AGENCY:

KEVIN SNYDER, RG
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
1110 W. WASHINGTON STREET
PHOENIX, AZ 85007
602-771-4186

LEGEND

- FIRM UNDISTURBED SOIL
- SILICA SAND (10-20 OR NO. 80)
- NATIVE BACKFILL/ENGINEERED AGGREGATE
- ASPHALT
- CONCRETE
- HYDRATED BENTONITE PELLETS
- CEMENT BENTONITE GROUT
- NEW ABC ROAD BASE
- EXISTING ROAD BASE
- PROPOSED UNDERGROUND PVC PIPING
- E — E: EXISTING UNDERGROUND ELECTRICAL LINE
- E — E: EXISTING ABANDONED UNDERGROUND ELECTRICAL LINE
- G: EXISTING UNDERGROUND GAS LINE
- SS: EXISTING SANITARY SEWER LINE
- DESIGN DIMENSION (DIMENSION MEASURED IN FIELD)

Call at least two full working days before you begin excavation.
ARIZONA 811
Arizona Blue Stake, Inc.
Dial 8-1-1 or 1-800-STAKE-IT (782-5348)
In Maricopa County: (602) 263-1100

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602-371-1615 (fax)

ADEQ
Arizona Department of Environmental Quality

ISSUED FOR BIDDING 2016-XX-XX XXX
DATE BY

ISSUED FOR CONSTRUCTION
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DESIGNED BY: RACKOW 2/5/16
CHECKED BY: RACKOW 2/5/16
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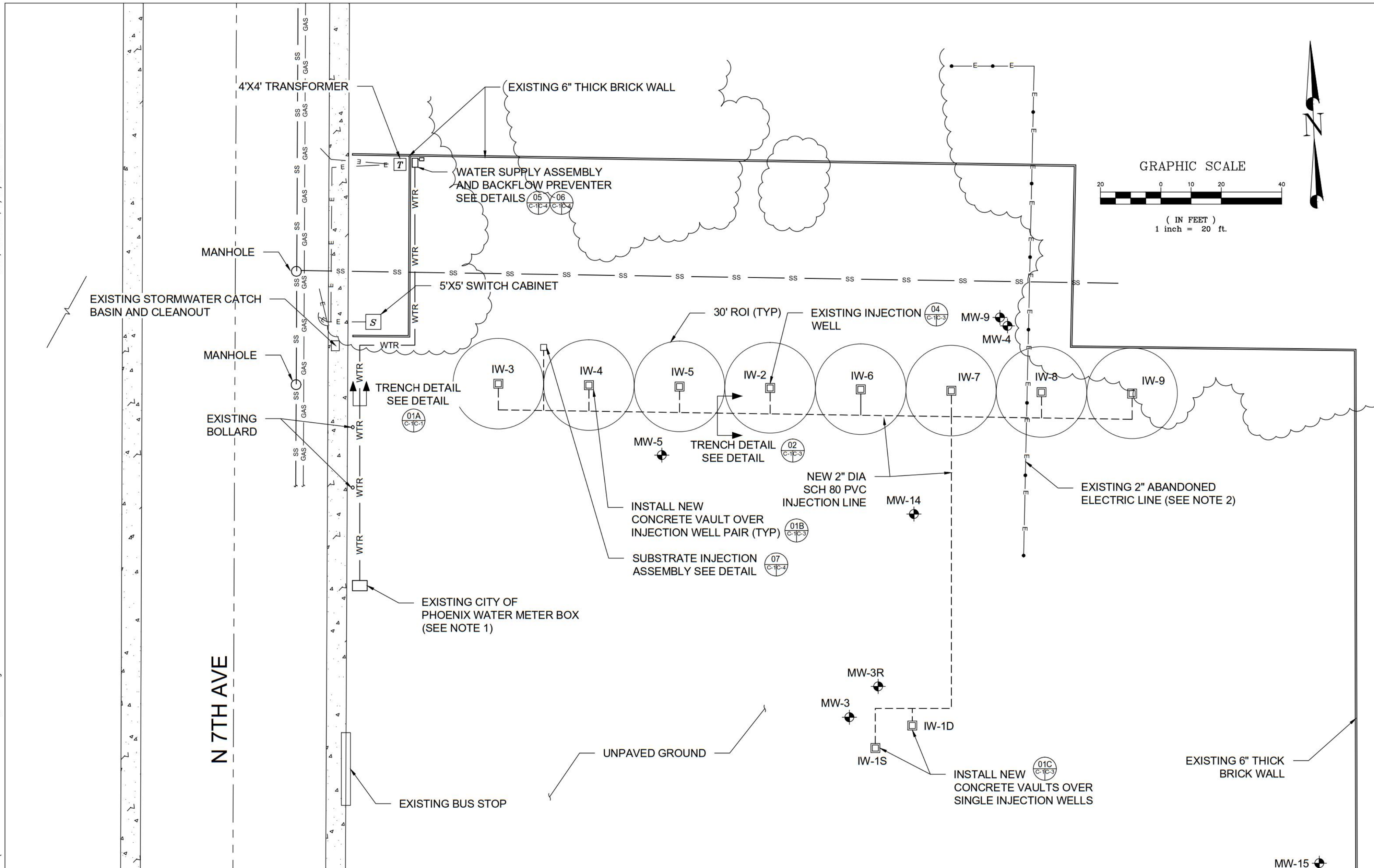
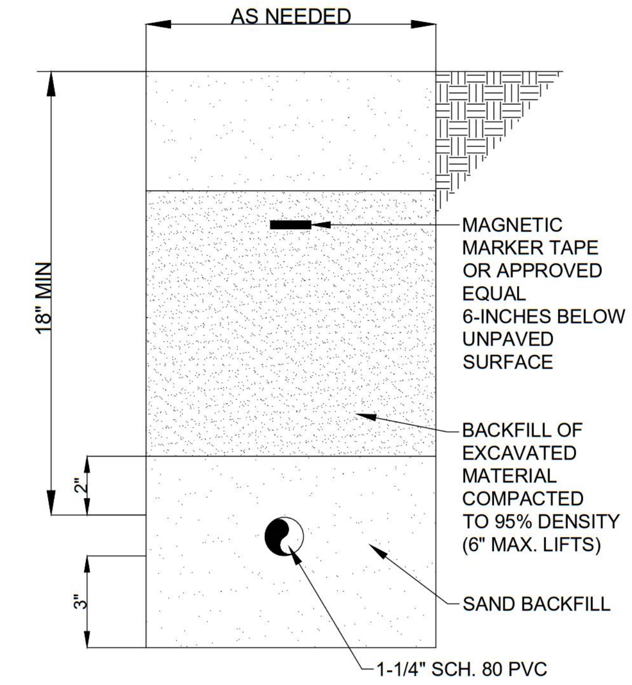
SCALE: NTS
ACAD VER: 2014

SHEET TITLE

**GENERAL SPECIFICATIONS, LEGENDS, AND ABBREVIATIONS
IN SITU BIOREMEDIATION CARBON SUBSTRATE INJECTION SYSTEM**

G-2
SHEET 2 OF 7





01A TRENCH DETAIL
SCALE: NTS

MW-15

CENTER LINE

EXPLANATION

- - - - -	PROPOSED 2" SCH 80 PVC INJECTION LINE
—— WTR ——	PROPOSED 1-1/4" SCH 80 PVC WATER LINE
—— SS ——	EXISTING CITY SANITARY SEWER (SS)
—— GAS —— GAS ——	EXISTING 4" STEEL GAS MAIN (SOUTHWEST GAS)
(symbol)	EXISTING INJECTION WELL
(symbol)	EXISTING MONITORING WELL
(symbol)	EXISTING TREE
—— E ——	EXISTING ELECTRIC LINE
•—— E —— E ——•	EXISTING ABANDONED UNDERGROUND ELECTRIC LINE
ROI	RADIUS OF INFLUENCE (ESTIMATED)
IW	INJECTION WELL

NOTES:

1. CONTRACTOR SHALL FIELD VERIFY THAT CITY 3/4" WATER METER IS EQUIPPED WITH BALL VALVE FOR SHUT OFF OF WATER SUPPLY AND CONNECT TO METER LINE WITH NEW 1-1/4" SCH 80 PVC PRIVATE WATER LINE AS REQUIRED (SEE SHEET P-1).
2. EXISTING UNDERGROUND 2" CONDUIT IDENTIFIED AS ABANDONED ELECTRIC PER ARIZONA PUBLIC SERVICE COMPANY (APS) 2N 3E 17NW MAP DATED ON 01/11/2016. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO CONFIRM WITH APS THAT THE LINE HAS BEEN ABANDONED, AND IF ENCOUNTERED, TO FIELD VERIFY THAT ANY AND ALL CONDUCTORS HAVE BEEN DE-ENERGIZED.
3. WATER SUPPLY CONNECTION AND BACKFLOW PREVENTION SHALL BE INSTALLED IN CONFORMANCE WITH UNIFORM PLUMBING CODE (UPC) 2012.

W BETHANY HOME RD

SCALE SHOWN IS FOR 24"X36" FORMAT. ONLY GRAPHICAL SCALE SHOULD BE USED FOR OTHER PRINT SIZES.

URS
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7720 North 16th Street, Suite 100
Phoenix, AZ 85020
602-371-1100 (phone)
602-371-1615 (fax)

ADEQ
Arizona Department of Environmental Quality

Registered Professional Engineer (Environmental) Certificate No. 34613 JEFFREY W. RACKOW, Date Signed 9-13-16, ARIZONA, U.S.A.
Expires: 3-31-18

ISSUED FOR BIDDING 2016-XX-XX XXX (DATE BY)

ISSUED FOR CONSTRUCTION (DATE BY)

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SHEET TITLE

ON-SITE INSTALLATION PLAN IN SITU BIOREMEDIATION CARBON SUBSTRATE INJECTION SYSTEM

LONG, BENJAMIN, 9/15/2016 12:14 PM

DRAWING PATH: Q:\Projects\ADEQ\7th and Bethany Design 2015\05_Analysis_and_Engineering\Design_Drawings\Rev's ABC\C-1 ON-SITE INSTALLATION PLAN_REVD.dwg

REID, LINDAY, 3/11/2016 9:41 AM

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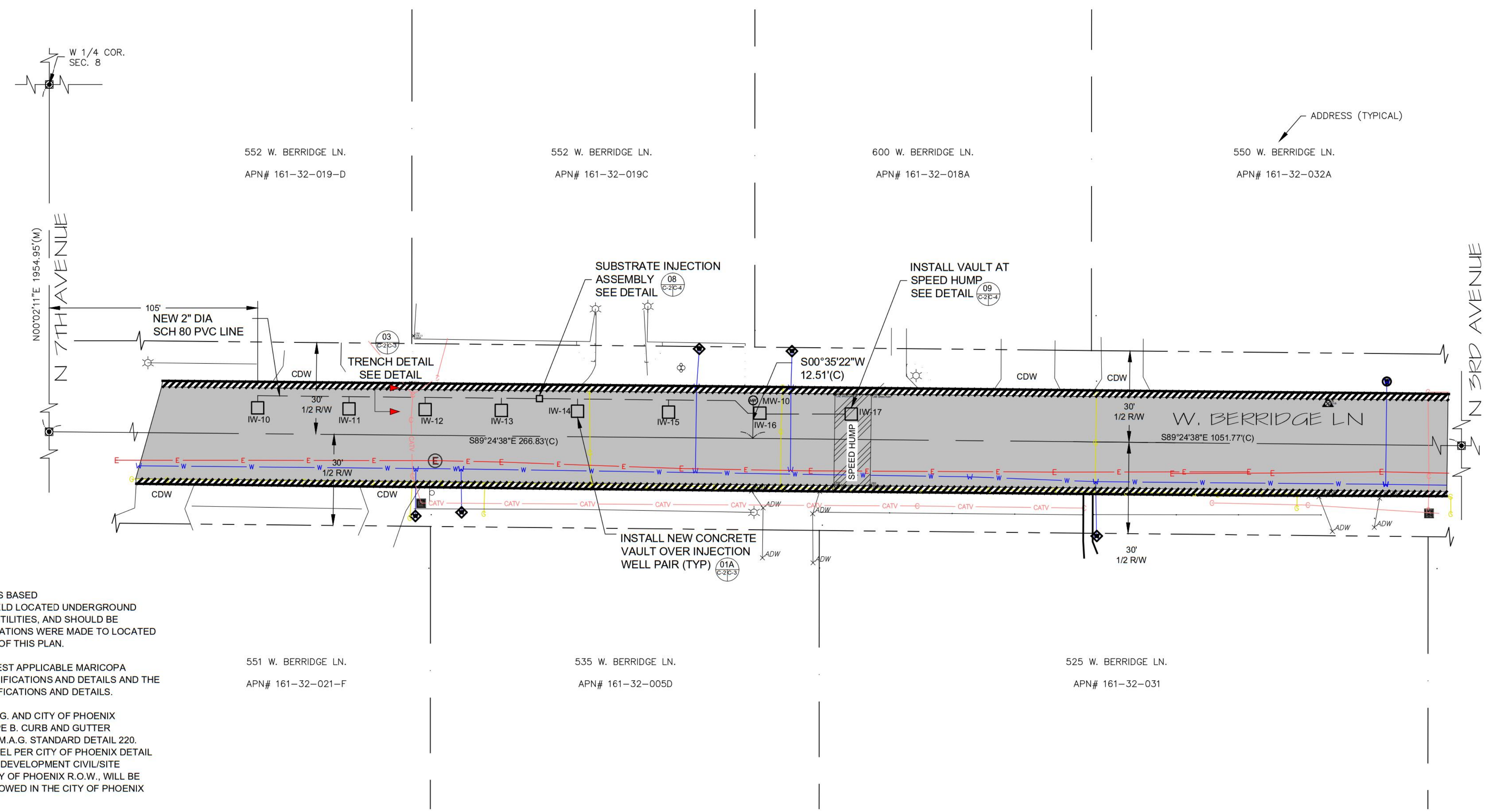
ADEQ
Arizona Department of Environmental Quality

LEGEND

⊙	BRASS CAP IN HANDHOLE
✕	CALCULATED POINT
■	CATV PEDISTAL
▬	CURB AND GUTTER
MW	EXISTING MONITORING WELL
◈	WATER METER
Ⓦ	WATER VALVE
CDW	CONCRETE DRIVEWAY
ADW	ASPHALT DRIVEWAY
SEC	SECTION
MCR	MARICOPA COUNTY RECORDER
(M)	MEASURED DATA
(C)	CALCULATED DATA
APN	ASSESSOR'S PARCEL NUMBER
C.O.P	CITY OF PHOENIX
R/W	RIGHT OF WAY



NOTES:

1. THE LOCATION OF UNDERGROUND UTILITIES AS DEPICTED HEREON IS BASED ON RECORD INFORMATION PROVIDED TO THE ENGINEER, AND OF FIELD LOCATED UNDERGROUND UTILITIES (BLUE STAKE MARKINGS),SURFACE FEATURES OF THOSE UTILITIES, AND SHOULD BE CONSIDERED APPROXIMATE AND POSSIBLY INCOMPLETE. NO EXCAVATIONS WERE MADE TO LOCATED BURIED UTILITIES DURING THE PROCESS OF, OR FOR THE PURPOSE OF THIS PLAN.
2. CONSTRUCTION WITHIN RIGHT OF WAY SHALL CONFORM TO THE LATEST APPLICABLE MARICOPA ASSOCIATION OF GOVERNMENTS (M.A.G.) UNIFORM STANDARD SPECIFICATIONS AND DETAILS AND THE LATEST CITY OF PHOENIX TO THE M.A.G. UNIFORM STANDARD SPECIFICATIONS AND DETAILS.
3. PAVEMENT REPLACEMENT THICKNESS AND TYPE ARE TO BE PER M.A.G. AND CITY OF PHOENIX SUPPLEMENT SECTION 336 AND CITY OF PHOENIX DETAIL P1200-TYPE B. CURB AND GUTTER REPLACEMENT SHALL BE A MINIMUM OF ONE (1) FULL SECTION, PER M.A.G. STANDARD DETAIL 220. SIDEWALK REPLACEMENT SHALL BE A MINIMUM OF ONE (1) FULL PANEL PER CITY OF PHOENIX DETAIL P1230. AT THE DISCRETION OF THE CITY OF PHOENIX PLANNING AND DEVELOPMENT CIVIL/SITE INSPECTOR, TUNNELING UNDER EXISTING CURB AND GUTTER, IN CITY OF PHOENIX R.O.W., WILL BE ALLOWED. TUNNELING UNDER EXISTING SIDEWALK WILL NOT BE ALLOWED IN THE CITY OF PHOENIX R.O.W.
4. THE CITY OF PHOENIX PLANNING AND DEVELOPMENT CIVIL/SITE INSPECTION GROUP, 602-262-7811 VOICE OR 602-534-5500 TTY, SHALL BE NOTIFIED 48 HOURS PRIOR TO ANY CONSTRUCTION WORK WITHIN THE PUBLIC RIGHT-OF-WAY.
5. OBSTRUCTIONS TO PROPOSED IMPROVEMENTS IN THE RIGHT OF WAY SHALL BE REMOVED OR RELOCATED BEFORE BEGINNING CONSTRUCTION OF THE PROPOSED IMPROVEMENTS.
6. THE DEVELOPER OR PERMIT HOLDER SHALL ARRANGE FOR THE RELOCATION AND RELOCATION COSTS OF ALL UTILITIES INCLUDING ANY STREET LIGHTS, WATER METERS, ETC. AND SUBMIT A UTILITY RELOCATION SCHEDULE PRIOR TO THE ISSUANCE OF A CONSTRUCTION PERMIT.
7. EXISTING OR NEWLY AND/OR DISPLACED CONCRETE CURB, GUTTER, SIDEWALK, OR DRIVEWAY SLAB THAT IS WITHIN THE RIGHT-OF-WAY SHALL BE REPAIRED OR REPLACED AS NOTED BY CITY INSPECTORS, BEFORE FINAL ACCEPTANCE OF WORK.
8. TOP OF NEW WELL HEAD VAULTS SHALL BE FINISHED OFF FLUSH WITH THE GROUND SURFACE. RAISED OR DEPRESSED FINISH GRADE WILL NOT BE APPROVED.
9. THE CONTRACTOR SHALL SET VAULT IW-17 AT NORTH SIDE OF SPEED HUMP SUCH THAT ITS STEEL PLATE COVER IS LEVEL. THE CENTER OF THE STEEL PLATE SHALL BE LOCATED AT THE CREST OF THE SPEED HUMP. THE HUMP SHALL BE RECONSTRUCTED TO PROVIDE A SMOOTH, FLUSH, AND SOUND PAVEMENT TRANSITION OVER THE VAULT.
10. ADJACENT PROPERTY OWNERS SHALL BE NOTIFIED 48 HOURS IN ADVANCE OF ANY CONSTRUCTION ACTIVITIES.
11. CONTRACTOR SHALL PROVIDE TRAFFIC CONTROL OPERATED IN ACCORDANCE WITH THE CITY OF PHOENIX BARRICADE MANUAL, LATEST EDITION.
12. A PAVEMENT CUT SURCHARGE SHALL BE ASSESSED ON THIS PROJECT FOR ANY TRENCHING OR POTHOLING IN NEW ASPHALT PAVEMENT THAT IS LESS THAN 30 MONTHS OLD. SURCHARGE FEES ASSESSED ARE IN ADDITION TO THE REGULAR PERMIT FEES AND ARE OVER AND ABOVE ANY SPECIAL BACKFILL, COMPACTION, AND PAVEMENT REPLACEMENT STIPULATIONS THAT MAY BE IMPOSED AS A CONDITION OF PERMITTING. PAVEMENT CUT SURCHARGE FEES ARE ASSESSED IN ACCORDANCE WITH SECTION 31-38 OF THE PHOENIX CITY CODE.
13. PLAN APPROVAL IS VALID FOR 180 DAYS. PRIOR TO PLAN APPROVAL EXPIRATION, ALL ASSOCIATED PERMITS SHALL BE PURCHASED OR THE PLANS SHALL BE RESUBMITTED FOR EXTENSION OF PLAN APPROVAL. THE EXPIRATION, EXTENSION, AND REINSTATEMENT OF CIVIL ENGINEERING PLANS AND PERMITS SHALL FOLLOW THE SAME GUIDELINES AS THOSE INDICATED IN THE PHOENIX BUILDING CONSTRUCTION CODE ADMINISTRATIVE PROVISIONS SECTION 105.3 FOR BUILDING PERMITS.

EXPLANATION

- EDGE OF PAVEMENT
- EASEMENT - AS NOTED
- RIGHT OF WAY
- CATV — CABLE TV LINE
- E — ELECTRIC LINE
- G — GAS LINE
- W — WATER LINE
- NEW 2" SCH 80 PVC INJECTION LINE
- IW-14 — NEW WELLHEAD VAULT

BENCHMARK:

CITY OF PHOENIX DATUM ELEVATION: 1152.71'
SALT RIVER PROJECT BRASS CAP SET IN TOP SOUTH SIDE OF IRRIGATION STRUCTURE AT SOUTHWEST CORNER 7TH AVENUE & BETHANY HOME ROAD.

C.O.P. QS MAP

REFERENCE CITY OF PHOENIX QUARTER SECTION MAP: 21-27
REVOCABLE PERMIT NUMBER RP-91011-15

CONTRACTING AGENCY:

KEVIN SNYDER, RG
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
1110 W. WASHINGTON STREET
PHOENIX, AZ 85007
602-771-4186

GRAPHIC SCALE
20 0 10 20 40
(IN FEET)
1 inch = 20 ft.

N

SCALE SHOWN IS FOR 24"X36" FORMAT. ONLY GRAPHICAL SCALE SHOULD BE USED FOR OTHER PRINT SIZES.

Registered Professional Engineer (Environmental) — CERTIFICATE NO. 34613 — JEFFREY W. RACKOW — ARIZONA, U.S.A. — Signed 3/11/16
Expires: 3/31/2018

ISSUED FOR BIDDING	2016-XX-XX (DATE)	XXX (BY)
ISSUED FOR CONSTRUCTION	(DATE)	(BY)

REVISIONS

NO.	DESCRIPTION	DATE
A	30% DESIGN	11/6/15
B	95% DESIGN	2/8/16
	100% DESIGN	3/9/16

AECOM PROJECT NO:	60445193
DRAWN BY: PINEDA, REID 2/5/16	
DESIGNED BY: RACKOW 2/5/16	
CHECKED BY: RACKOW 2/5/16	
DATE CREATED: 12/4/15	
PLOT DATE: 3/11/16	
SCALE: NTS	
ACAD VER:	2014

SHEET TITLE

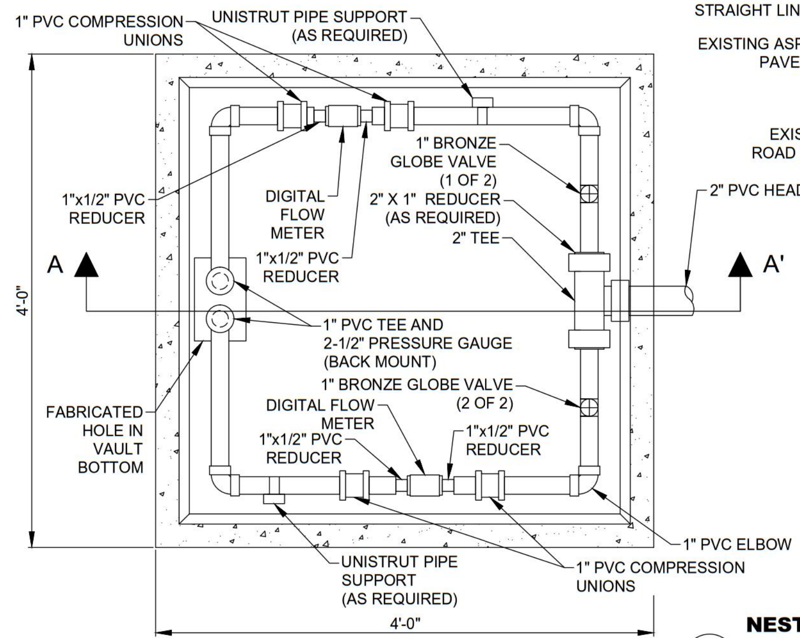
OFF-SITE INSTALLATION PLAN IN SITU BIOREMEDIATION CARBON SUBSTRATE INJECTION SYSTEM

C-2

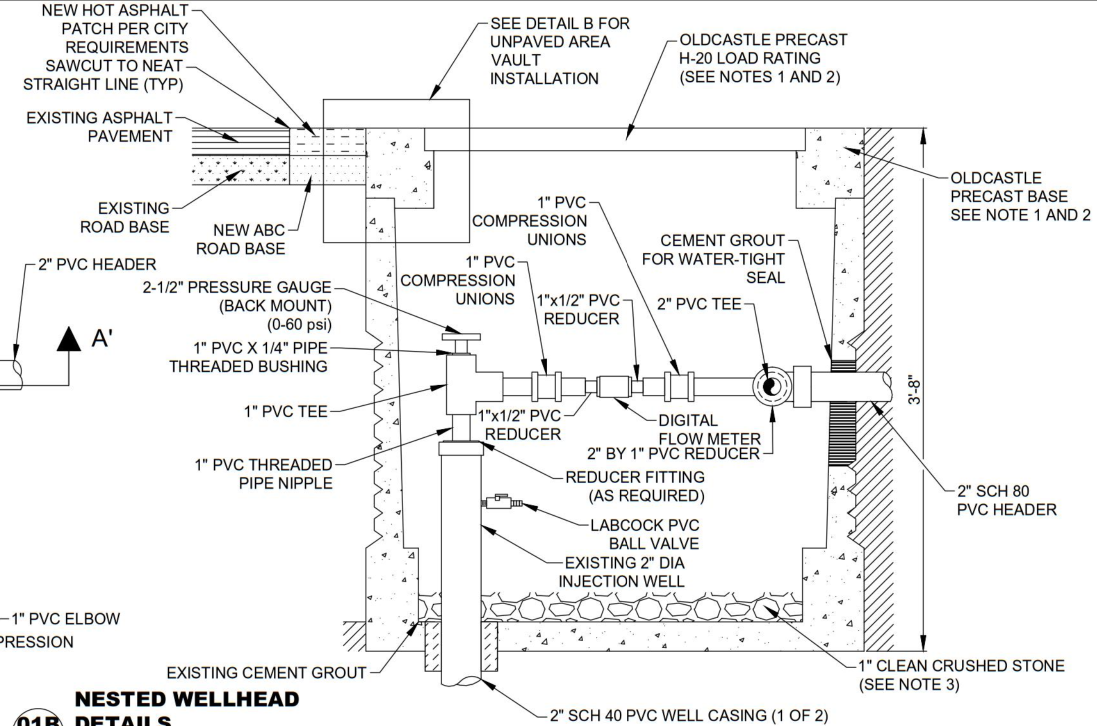
SHEET 4 OF 7

DRAWING PATH: Q:\Projects\ADEQ\05_Analysis_and_Engineering\Design_Drawings\95% Design\C-2 OFF-SITE INSTALLATION PLAN.dwg

LONG, BENJAMIN, 9/15/2016 12:38 PM

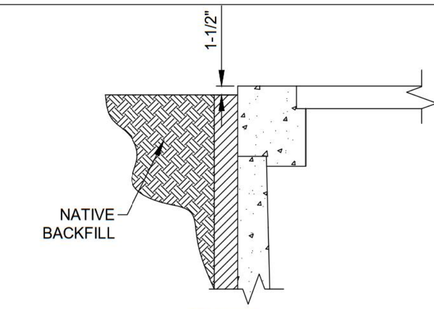


TOP VIEW



01B NESTED WELLHEAD DETAILS
C-1 C-3 SCALE: NTS

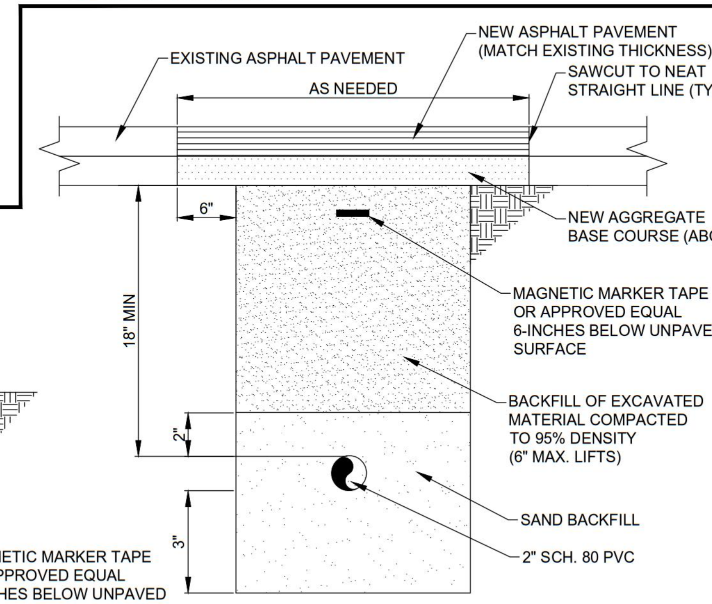
SIDE VIEW
SHOWN FOR PAVED AREA INSTALLATION
SECTION A-A'



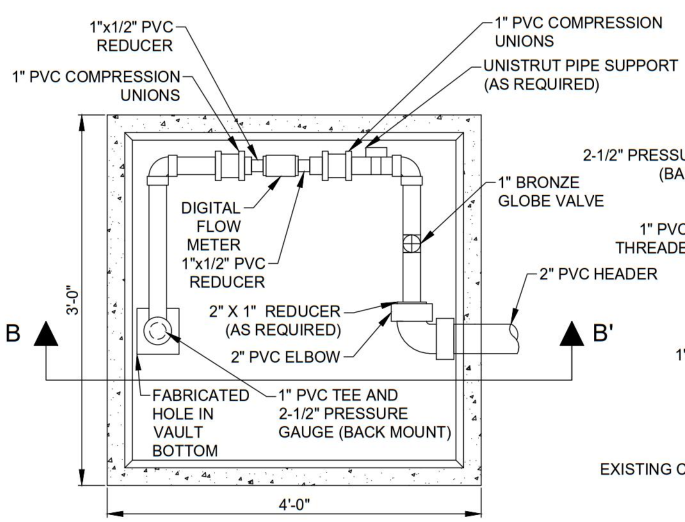
SIDE VIEW
UNPAVED AREA VAULT INSTALLATION
DETAIL B

NOTES:

1. FURNISH AND INSTALL EIGHT (8) OLDCASTLE PRECAST MODEL 444-LA BASE WITH 3636 HATCH, SPRING ASSISTED GALVANIZED DOORS (H-20 LOAD RATED) FOR BERRIDGE LANE INJECTION WELLS.
2. FURNISH AND INSTALL EIGHT (8) OLDCASTLE PRECAST MODEL 233-LA BASE WITH 2436 BOLT DOWN GALVANIZED FRAME AND COVER (H-20 LOAD RATING) FOR NE CORNER VACANT LOT INJECTION WELLS.
3. THE CONTRACTOR SHALL EQUIP ALL NEW BOLT-DOWN VAULTS WITH PENTA-HEAD BOLTS SUPPLIED BY THE MANUFACTURER. THREE (3) PENTA-HEAD SOCKETS SHALL ALSO BE OBTAINED FROM THE MANUFACTURER BY THE CONTRACTOR AND GIVEN TO THE ENGINEER.
4. THE CONTRACTOR SHALL PLACE 1" CLEAN CRUSHED STONE WITHIN EACH BOTTOMLESS VAULT SUCH THAT THE DEPTH FROM THE TOP OF VAULT AT GRADE TO THE TOP OF STONE IS 2'-6".

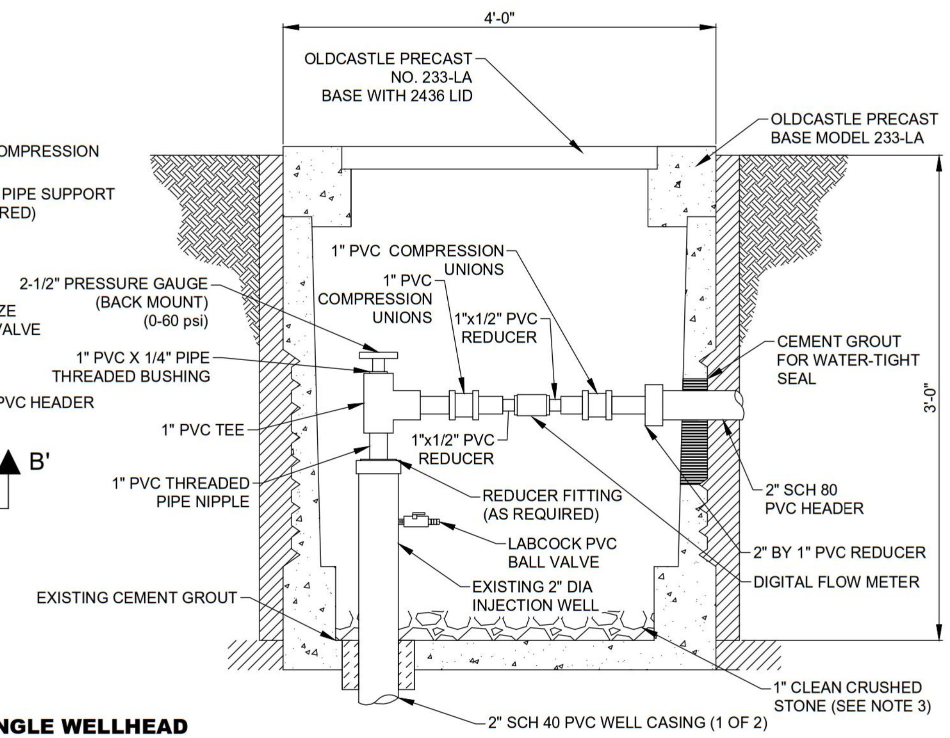


03 TRENCH DETAIL
C-2 C-3 SCALE: NTS

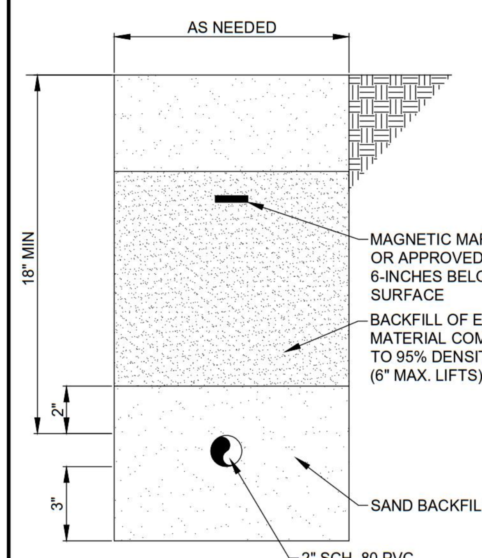


TOP VIEW

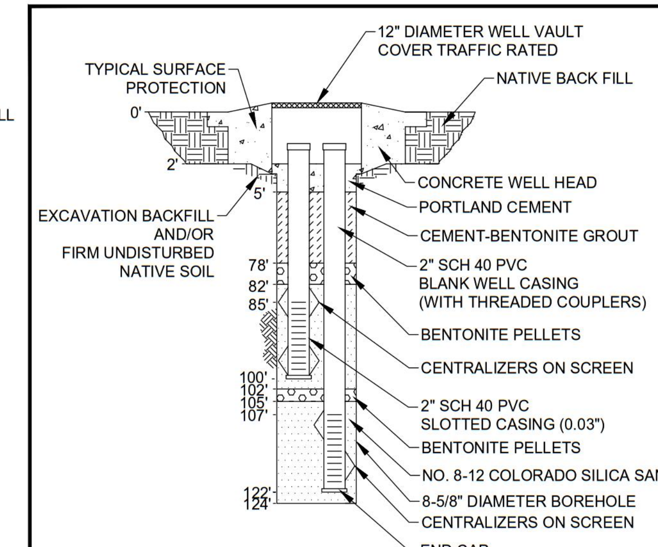
01C SINGLE WELLHEAD DETAILS (IW-1S & IW-1D)
C-1 C-3 SCALE: NTS



SIDE VIEW
SHOWN FOR UNPAVED AREA INSTALLATION
SECTION B-B'



02 TRENCH DETAIL
C-1 C-3 SCALE: NTS



04 TYPICAL EXISTING NESTED INJECTION WELL
C-1 C-3 SCALE: NTS

SCALE SHOWN IS FOR 24"X36" FORMAT. ONLY GRAPHICAL SCALE SHOULD BE USED FOR OTHER PRINT SIZES.

DRAWING PATH: Q:\Projects\ADEQ\7th and Bethany Design 2015\05_Analysis_and_Engineering\Design_Drawings\Rev's ABC\C-3 WELL, VAULT, AND PIPING DETAILS_REVD.dwg

URS
URS Corporation
7720 North 16th Street, Suite 100
Phoenix, AZ 85020
602-371-1100 (phone)
602-371-1615 (fax)

ADEQ
Arizona Department of Environmental Quality

Registered Professional Engineer (Environmental) Certificate No. 34613 JEFFREY W. RACKOW, ARIZONA, U.S.A. Date Signed 9-13-16
Expires: 3-31-18

ISSUED FOR BIDDING 2016-XX-XX XXX
DATE BY

ISSUED FOR CONSTRUCTION
DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
1	30% DESIGN	11/6/15
2	95% DESIGN	2/8/16
3	100% DESIGN	3/9/16
4	MODIFY TO INCLUDE COP BUILDING PERMIT ADDITIONS	9/13/16
5		

AECOM PROJECT NO: 60445193
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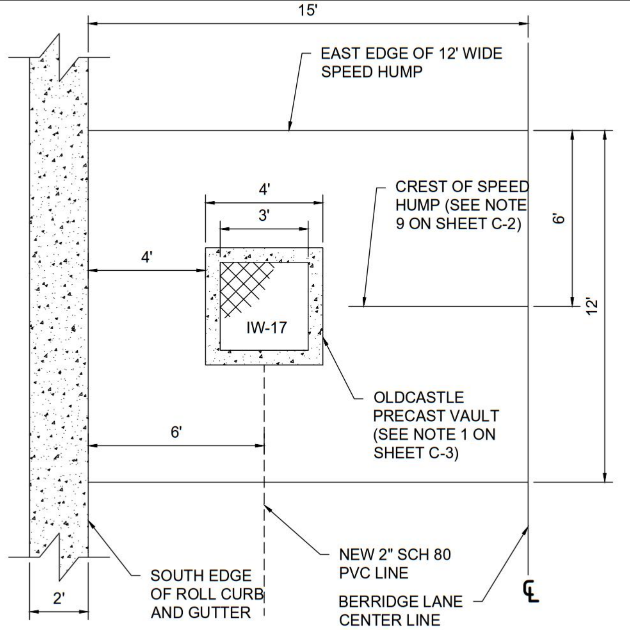
DESIGNED BY: RACKOW 2/5/16
CHECKED BY: RACKOW 2/5/16
DATE CREATED: 12/4/15
PLOT DATE: 9/15/16
SCALE: NTS
ACAD VER: 2014

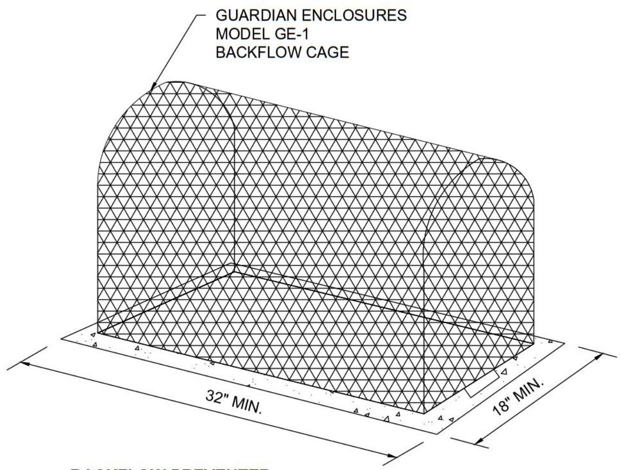
SHEET TITLE

**WELL, VAULT, AND PIPING DETAILS
IN SITU BIOREMEDIATION CARBON SUBSTRATE INJECTION SYSTEM**

C-3
SHEET 5 OF 7

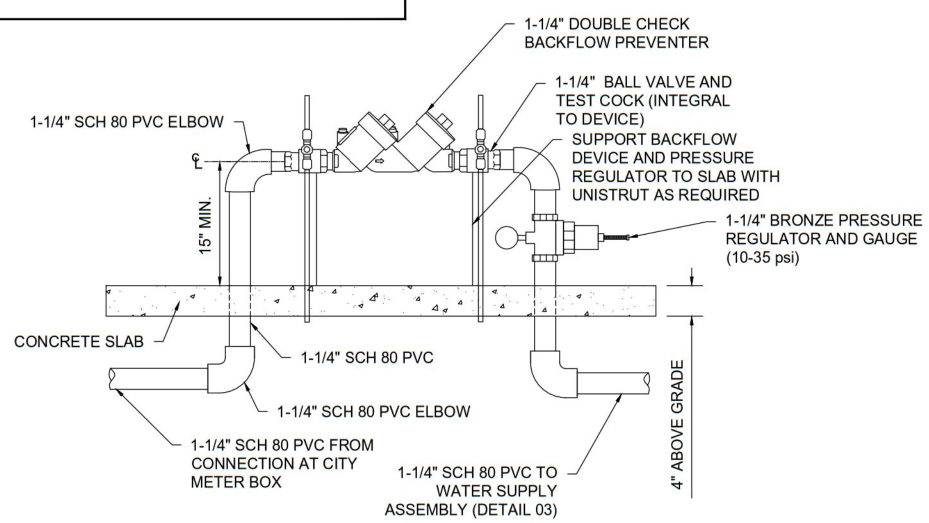


09 VAULT AT SPEED HUMP INSTALLATION PLAN
C-2 | C-4 SCALE: NTS



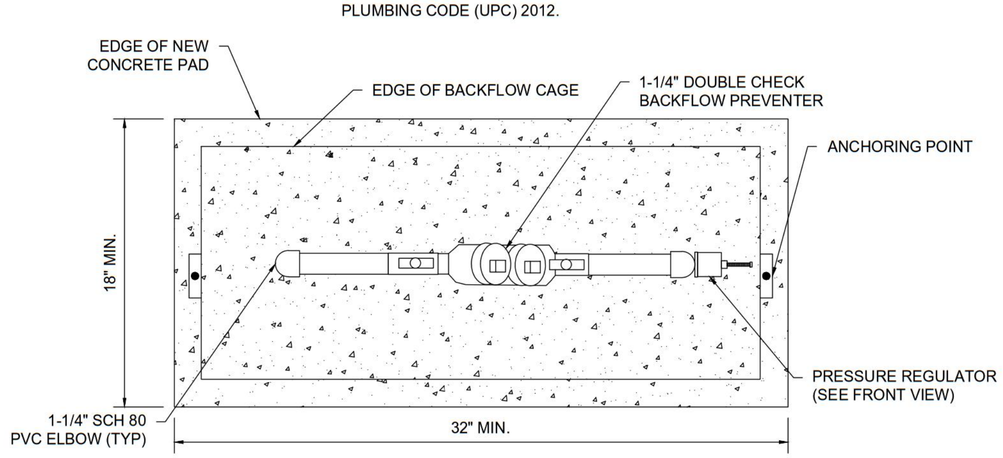
BACKFLOW PREVENTER CAGE (NTS)

NOTE:
1. BOLT CAGE AT EACH END TO CONCRETE SLAB WITH WET OR DRY INSTALLATION PINS/KIT SUPPLIED BY MANUFACTURER.



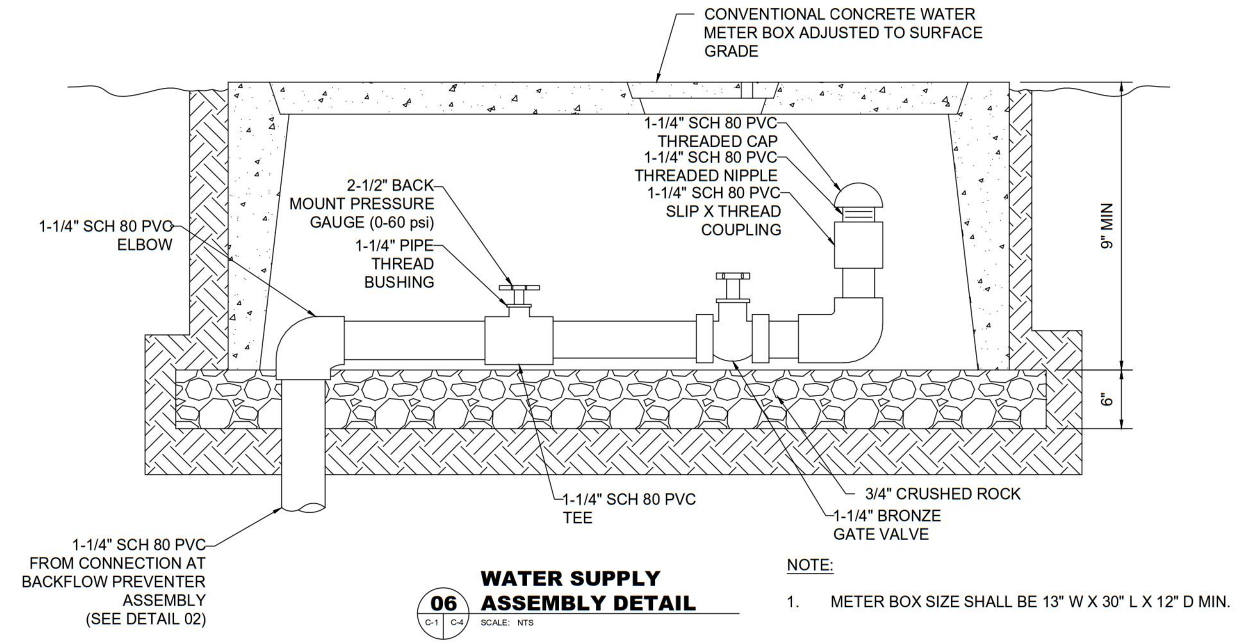
FRONT VIEW (NTS)

NOTE:
1. WATER SUPPLY BACKFLOW PREVENTION SHALL BE INSTALLED IN CONFORMANCE WITH UNIFORM PLUMBING CODE (UPC) 2012.



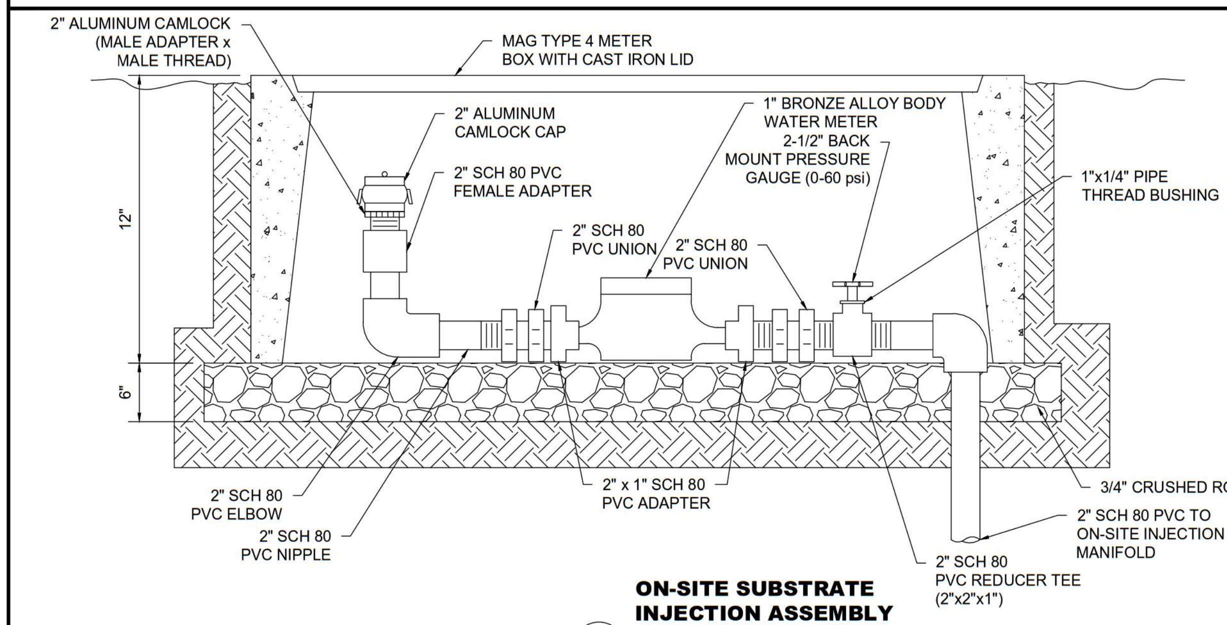
PLAN VIEW (NTS)

05 BACKFLOW PREVENTER ASSEMBLY DETAILS
C-1 | C-4 SCALE: NTS

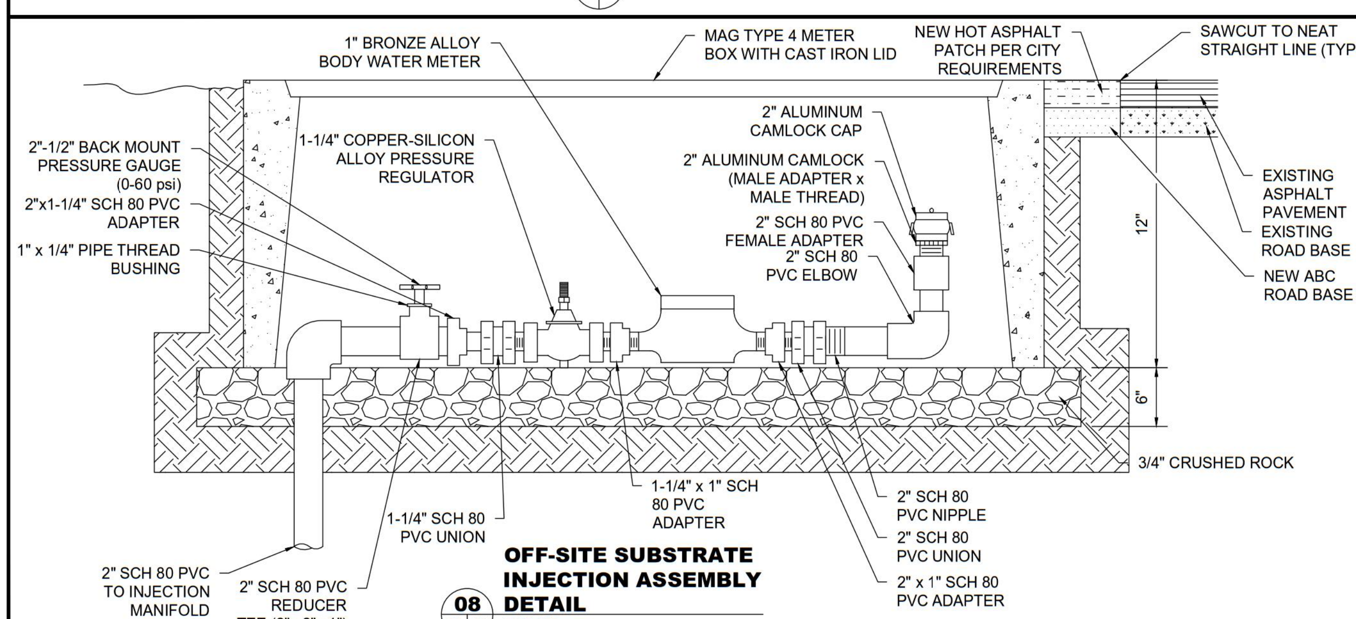


06 WATER SUPPLY ASSEMBLY DETAIL
C-1 | C-4 SCALE: NTS

NOTE:
1. METER BOX SIZE SHALL BE 13" W X 30" L X 12" D MIN.



07 ON-SITE SUBSTRATE INJECTION ASSEMBLY DETAIL
C-1 | C-4 SCALE: NTS



08 OFF-SITE SUBSTRATE INJECTION ASSEMBLY DETAIL
C-2 | C-4 SCALE: NTS

SCALE SHOWN IS FOR 24"X36" FORMAT. ONLY GRAPHICAL SCALE SHOULD BE USED FOR OTHER PRINT SIZES.

URS

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ADEQ Arizona Department of Environmental Quality

Registered Professional Engineer (Environmental) Certificate No. 34613 JEFFREY W. RACKOW Date Signed 9-13-16 ARIZONA, U.S.A.
Expires: 3-31-18

ISSUED FOR BIDDING	2016-XX-XX DATE	XXX BY
ISSUED FOR CONSTRUCTION	DATE	BY

REVISIONS

NO.	DESCRIPTION	DATE
1	30% DESIGN	11/6/15
2	95% DESIGN	2/8/16
3	100% DESIGN	3/9/16
4	MODIFY TO INCLUDE COP BUILDING PERMIT ADDITIONS	9/13/16
5		

AECOM PROJECT NO: 60445193
DRAWN BY: PINEDA, REID 2/5/16
DESIGNED BY: RACKOW 2/5/16
CHECKED BY: RACKOW 2/5/16
DATE CREATED: 1/28/16
PLOT DATE: 9/13/16
SCALE: NTS
ACAD VER: 2014

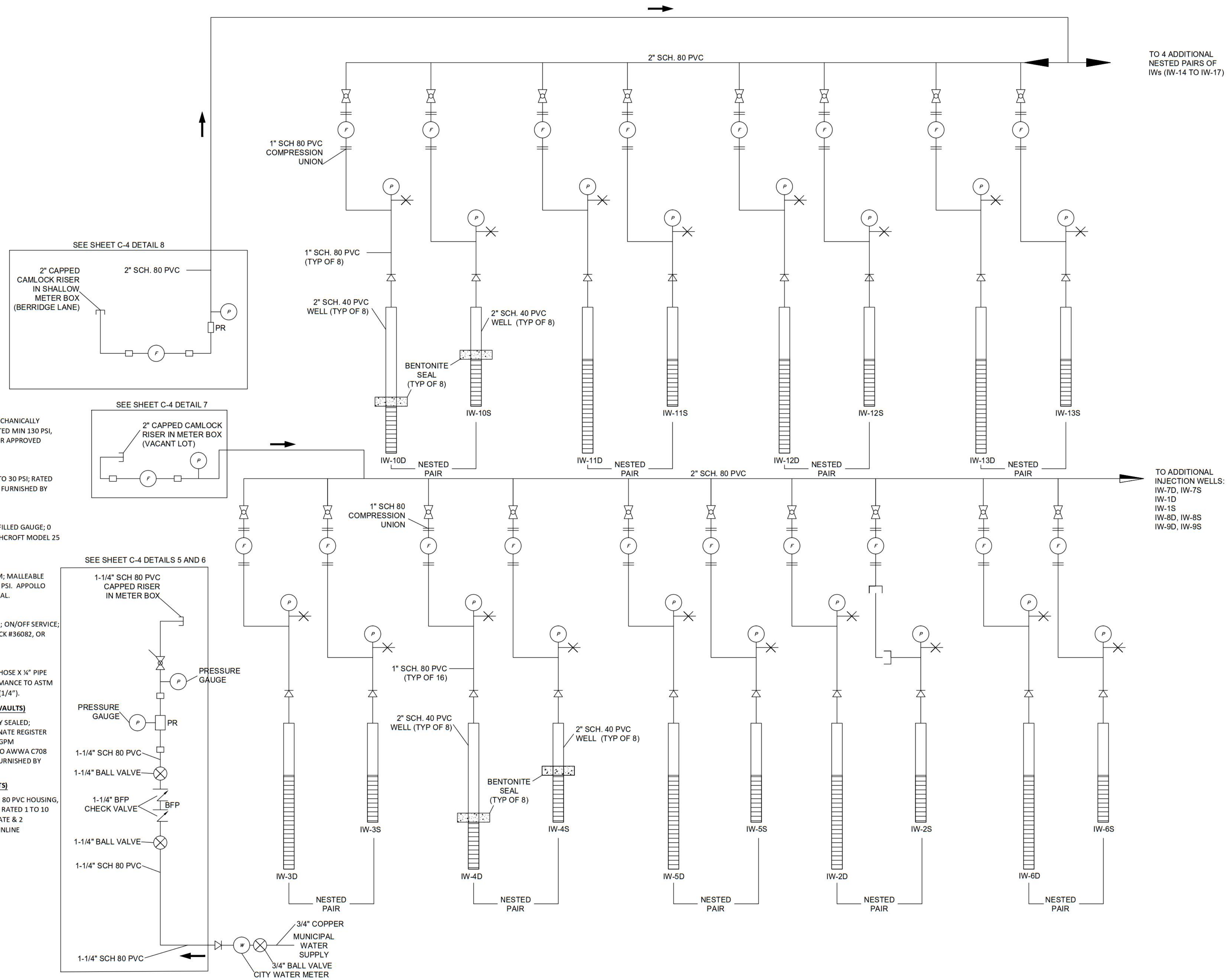
SHEET TITLE

ADDITIONAL PIPING DETAILS IN SITU BIOREMEDIATION CARBON SUBSTRATE INJECTION SYSTEM

C-4
SHEET 6 OF 7

LONG, BENJAMIN, 9/13/2016 10:25 AM

DRAWING PATH: Q:\Projects\ADEQ\7th and Bethany Design 2015\05_Analysis_and_Engineering\Design_Drawings\Rev's ABC\C-4 ADDITIONAL PIPING DETAILS_REVD.dwg



BACKFLOW PREVENTER (SEE SHEET C-4 DETAIL 5)

1-1/4" DOUBLE CHECK TYPE WITH CAST BRONZE BODY; EQUIPPED WITH 2 MECHANICALLY INDEPENDENT, SPRING-LOADED POPPET-TYPE FULL PORT CHECK VALVES; RATED MIN 130 PSI, 130OF. APPOLLO VALVES AS FURNISHED BY USABLUEBOOK STOCK #54911, OR APPROVED EQUAL.

WATER PRESSURE REGULATOR

1-1/4" CAST COPPER-SILICON ALLOY; ADJUSTMENT CAPABILITY IN RANGE 20 TO 30 PSI; RATED MIN 30 GPM AT 20 PSI DIFFERENTIAL PRESSURE. MODEL WATTS LFX65BU AS FURNISHED BY USA BLUEBOOK STOCK #5657 OR APPROVED EQUAL.

PRESSURE GAUGES

2-1/2" DIAL, STAINLESS STEEL CASE, ¼" PIPE THREAD BACK MOUNT, SILICON FILLED GAUGE; 0 TO 60 PSI, ± 1.0% OF SPAN ACCURACY; 316 SS TUBE TIP/BRONZE SOCKET. ASHCROFT MODEL 25 1009AWL (FGS) 02B 60#, OR APPROVED EQUAL.

GLOBE VALVES

1" FEMALE NPT BRONZE VALVE, BRONZE DISC, THREADED BONNET, TOP STEM; MALLEABLE IRON HANDLE; SLOW CLOSING FOR FINE FLOW THROTTLING; RATED MIN 130 PSI. APPOLLO VALVES AS FURNISHED BY USABLUEBOOK STOCK #36093, OR APPROVED EQUAL.

GATE VALVES

1" FEMALE NPT BRONZE VALVE, RISING TOP STEM, MALLEABLE IRON HANDLE; ON/OFF SERVICE; RATED MIN 125 PSI. APPOLLO VALVES AS FURNISHED BY USABLUEBOOK STOCK #36082, OR EQUAL.

AIR BLEED VALVES

INLINE UNIBODY LABCOCK BALL VALVE; PVC BODY, EPDM SEALS; LEVER 3/8" HOSE X ¼" PIPE THREAD; 900 TURN OPERATION; RATED 150 PSI AT 1200F (WATER); CONFORMANCE TO ASTM D1784 CELL CLASSIFICATION 12454A. ASAHI AMERICA LABCOCK BALL VALVE (1/4").

FLOW METERS/TOTALIZERS (ALL UNITS INSTALLED OUTSIDE OF WELLHEAD VAULTS)

1" DIRECT READ MULTI-JET TYPE; MAGNETICALLY DRIVEN AND HERMETICALLY SEALED; LEAD-FREE, BRASS ALLOY BODY, NYLON MEASURING CHAMBER, POLYCARBONATE REGISTER CAN, TEMPERED GLASS REGISTER LENS; FLOW RANGE ¾ TO 50 GPM, MIN 25 GPM CONTINUOUS; RATED MIN 130 PSI OPERATING PRESSURE. CONFORMANCE TO AWWA C708 PERFORMANCE STANDARDS. ZENNER® 1" LEAD-FREE MULTI-JET METER AS FURNISHED BY USABLUEBOOK STOCK #65394, OR EQUAL.

FLOW METERS/TOTALIZERS (ALL UNITS INSTALLED INSIDE WELLHEAD VAULTS)

½" INLINE COMPACT TURBINE, BATTERY-POWERED, ELECTRONIC METER; SCH 80 PVC HOUSING, TUNGSTEN CARBIDE SHAFT CERAMIC BEARINGS, 316 SS RETAINING WASHER; RATED 1 TO 10 GPM, MIN RATED 130 PSI AT 120OF, ACCURACY ± 3% OF READING; LCD W/ RATE & 2 TOTALIZERS (ONE RESETTABLE, ONE CUMULATIVE). MODEL GTM TM SERIES INLINE FLOWMETER/TOTALIZER. AS FURNISHED BY USABLUEBOOK STOCK # 50455.

LEGEND

- DIRECTION OF FLOW
- BALL VALVE
- CHECK VALVE
- GATE VALVE
- GLOBE VALVE
- AIR BLEED VALVE
- FLOW METER/TOTALIZER
- PRESSURE GAUGE
- COMPRESSION UNION
- EXPANSION FITTING
- UNION

BFP	BACKFLOW PREVENTER
BGS	BELOW GROUND SURFACE
ISB	IN SITU BIOREMEDIATION
IW	INJECTION WELL
PR	PRESSURE REGULATOR
PVC	POLYVINYL CHLORIDE
SCH	SCHEDULE
TYP	TYPICAL

SCALE SHOWN IS FOR 24"X36" FORMAT. ONLY GRAPHICAL SCALE SHOULD BE USED FOR OTHER PRINT SIZES.

LONG, BENJAMIN, 9/13/2016 10:23 AM

DRAWING PATH: Q:\Projects\ADEQ\7th and Bethany Design 2015\05_Analysis_and_Engineering\Design_Drawings\Rev's ABC\P-1 PROCESS AND INSTRUMENTATION DIAGRAM_REVD.dwg

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602-371-1100 (phone)
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ADEQ
Arizona Department of Environmental Quality

Registered Professional Engineer (Environmental) Certificate No. 34813 JEFFREY W. RACKOW Date Signed 9-13-16 ARIZONA U.S.A.
Expires: 3-31-18

ISSUED FOR BIDDING	2016-XX-XX (DATE)	XXX (BY)
ISSUED FOR CONSTRUCTION	(DATE)	(BY)

REVISIONS

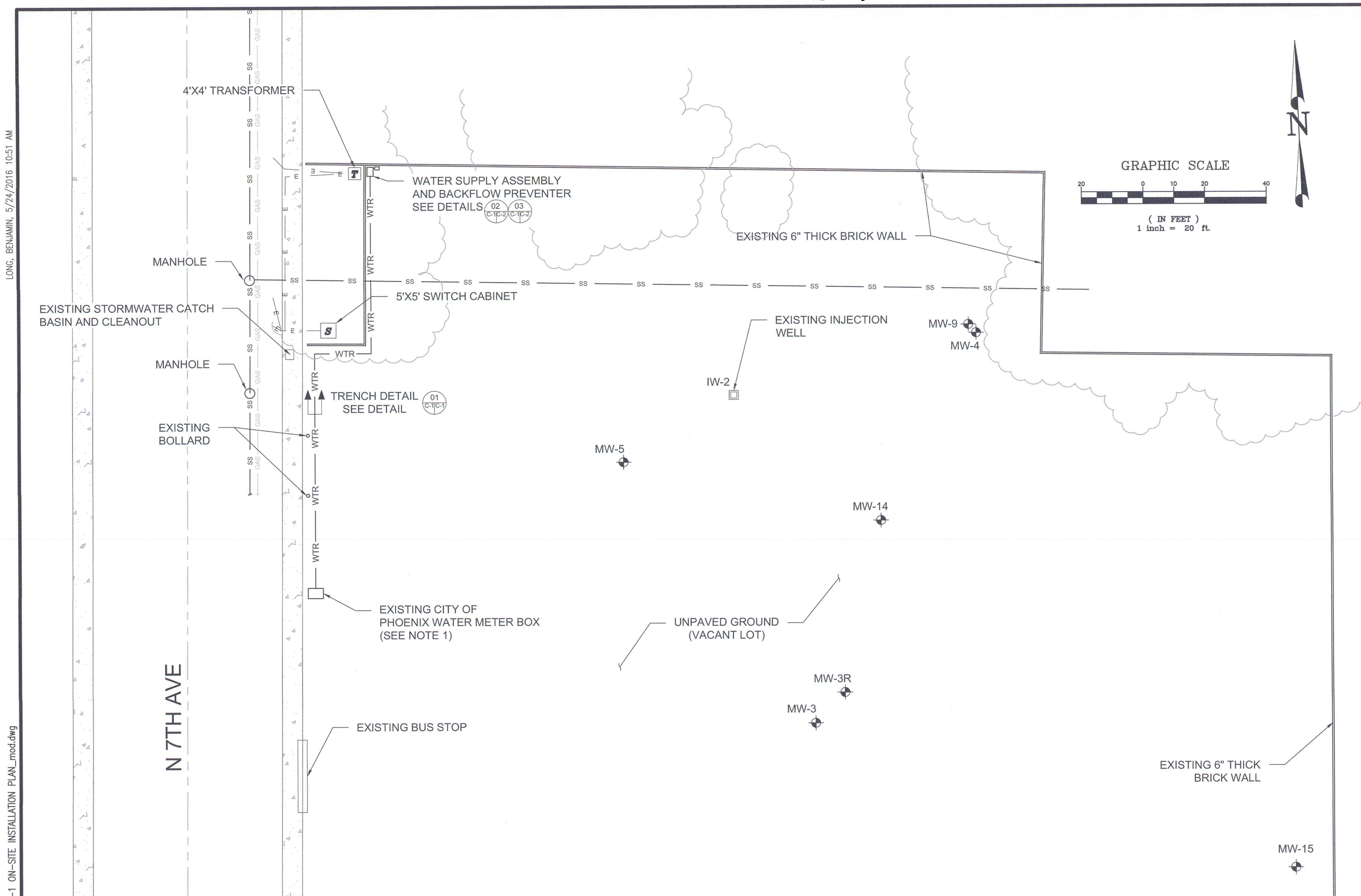
NO.	DESCRIPTION	DATE
A	30% DESIGN	11/6/15
B	95% DESIGN	2/8/16
C	100% DESIGN	3/9/16
D	MODIFY TO INCLUDE COP BUILDING PERMIT ADDITIONS	9/13/16

AECOM PROJECT NO:	60445193
DRAWN BY: PINEDA, REID 2/5/16	
DESIGNED BY: RACKOW 2/5/16	
CHECKED BY: RACKOW 2/5/16	
DATE CREATED: 12/4/15	
PLOT DATE: 9/13/16	
SCALE: NTS	
ACAD VER:	2014

SHEET TITLE

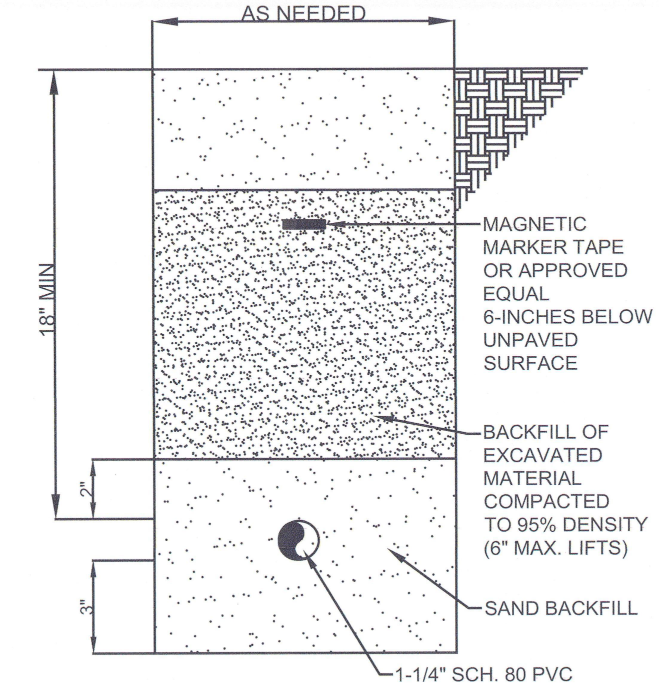
PROCESS AND INSTRUMENTATION DIAGRAM IN SITU BIOREMEDIATION CARBON SUBSTRATE INJECTION SYSTEM

P-1

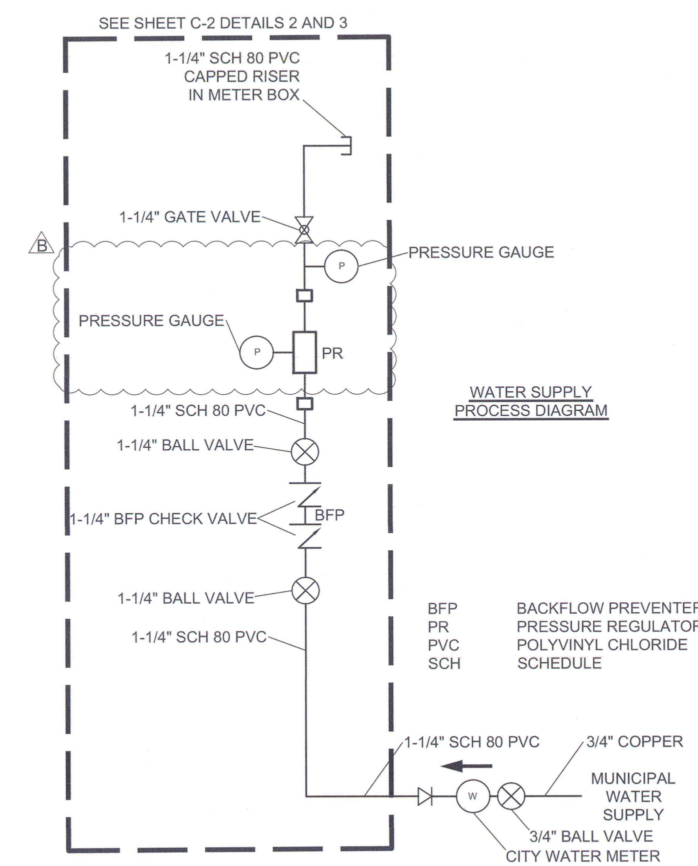


CENTER LINE

W BETHANY HOME RD



01 TRENCH DETAIL (C-1 / C-1)
SCALE: NTS



WATER SUPPLY PROCESS DIAGRAM

BFP	BACKFLOW PREVENTER
PR	PRESSURE REGULATOR
PVC	POLYVINYL CHLORIDE
SCH	SCHEDULE

EXPLANATION

- —WTR— PROPOSED 1-1/4" SCH 80 PVC WATER LINE
- —SS— EXISTING CITY SANITARY SEWER (SS)
- —GAS— EXISTING 4" STEEL GAS MAIN (SOUTHWEST GAS)
- EXISTING INJECTION WELL
- EXISTING MONITORING WELL
- EXISTING TREE
- —E— EXISTING ELECTRIC LINE
- DIRECTION OF FLOW
- WATER METER/TOTALIZER
- EXPANSION FITTING
- UNION

NOTES:

1. CONTRACTOR SHALL FIELD VERIFY THAT CITY 3/4" WATER METER IS EQUIPPED WITH BALL VALVE FOR SHUT OFF OF WATER SUPPLY AND CONNECT TO METER LINE WITH NEW 1-1/4" SCH 80 PVC PRIVATE WATER LINE AS REQUIRED (SEE SHEET P-1).
2. WATER SUPPLY CONNECTION AND BACKFLOW PREVENTION SHALL BE INSTALLED IN CONFORMANCE WITH UNIFORM PLUMBING CODE (UPC) 2012.

BACKFLOW PREVENTER (AT RIGHT AND SEE SHEET C-2 DETAIL 2)

1-1/4" DOUBLE CHECK TYPE WITH CAST BRONZE BODY; EQUIPPED WITH 2 MECHANICALLY INDEPENDENT, SPRING-LOADED POPPET-TYPE FULL PORT CHECK VALVES; RATED MIN 130 PSI, 130OF. APPOLLO VALVES AS FURNISHED BY USABLUEBOOK STOCK #54911, OR APPROVED EQUAL.

WATER PRESSURE REGULATOR

1-1/4" CAST COPPER-SILICON ALLOY; ADJUSTMENT CAPABILITY IN RANGE 20 TO 30 PSI; RATED MIN 30 GPM AT 20 PSI DIFFERENTIAL PRESSURE. MODEL WATTS LFX65BU AS FURNISHED BY USA BLUEBOOK STOCK #5657 OR APPROVED EQUAL.

PRESSURE GAUGE

2-1/2" DIAL, STAINLESS STEEL CASE, ¼" PIPE THREAD BACK MOUNT, SILICON FILLED GAUGE; 0 TO 60 PSI, ± 1.0% OF SPAN ACCURACY; 316 SS TUBE TIP/BRONZE SOCKET. ASHCROFT MODEL 25 1009AWL (FGS) 02B 60#, OR APPROVED EQUAL.

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DRAWING PATH: P:\Projects\ADEQ\60445193_FY167thBet\5_Technical\Building Permit for City Water Connection\C-1 ON-SITE INSTALLATION PLAN_mod.dwg

LONG, BENJAMIN, 5/24/2016 10:51 AM

City of Phoenix
PLANNING & DEVELOPMENT DEPARTMENT

This set of plans has been reviewed by the City of Phoenix Planning & Development Department for compliance with applicable City codes and ordinances and shall be kept at the construction site. Such review shall not prevent the City from requiring correction of errors in the plans where such errors are subsequently found to be in violation of any code, law, ordinance, health, safety, or other design issues.

IBC - David Goodman 602-495-0158

IMC-UPC - Larry Walsh 602-495-0261

URS

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ADEQ
Arizona Department of Environmental Quality

Registered Professional Engineer (Environmental) CERTIFICATE NO. 34613 JEFFREY W. RACKOW Date Signed 5-24-16 ARIZONA, U.S.A.
Expires: 3-31-2018

ISSUED FOR BIDDING 2016-XX-XX XXX (DATE BY)

ISSUED FOR CONSTRUCTION (DATE BY)

REVISIONS

NO.	DESCRIPTION	DATE
A	ADDED UPC NOTE	5/23/16
B	MODIFY PRESSURE GAUGE LOCATIONS	5/23/16

AECOM PROJECT NO:	60445193
DRAWN BY:	PINEDA, REID 2/5/16
DESIGNED BY:	RACKOW 2/5/16
CHECKED BY:	RACKOW 2/5/16
DATE CREATED:	12/4/15
PLOT DATE:	5/24/16
SCALE:	NTS
ACAD VER:	2014

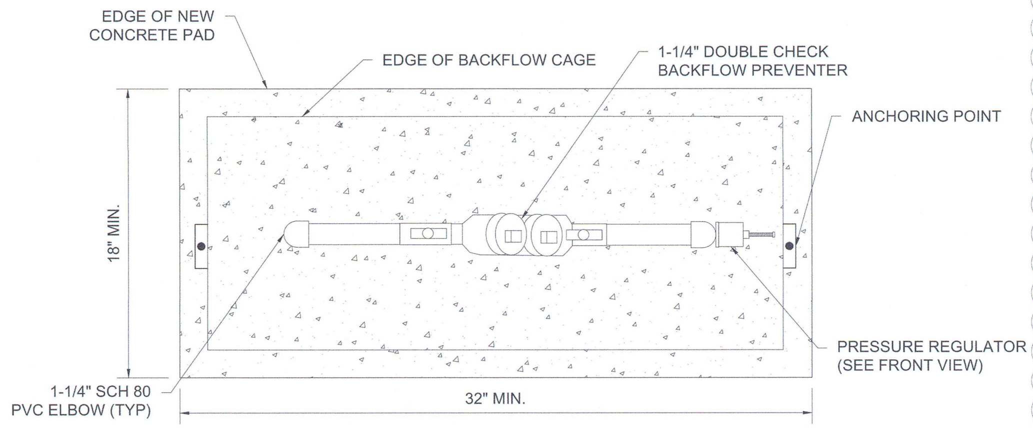
SHEET TITLE

ON-SITE INSTALLATION PLAN FOR NEW WATER SUPPLY

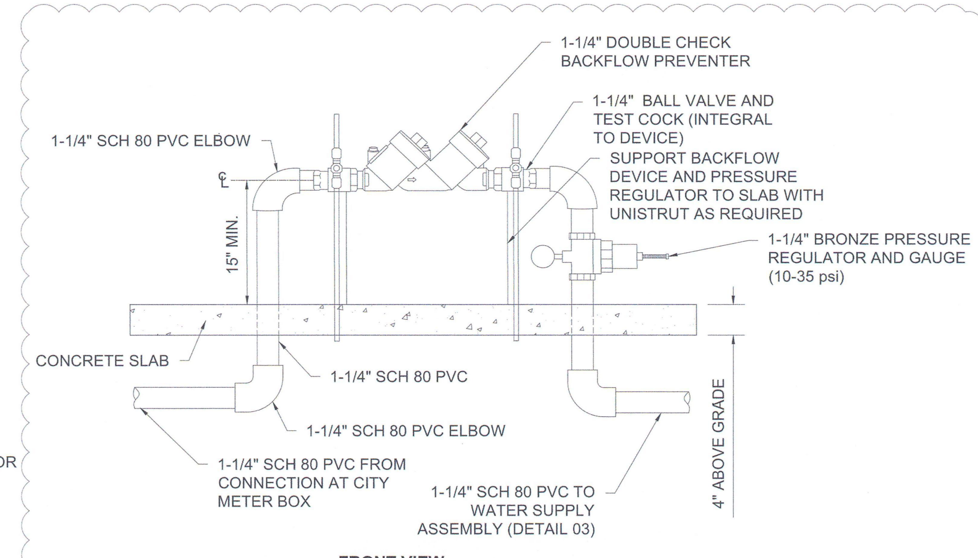
C-1
SHEET 1 OF 2

City of Phoenix Plan #: 1601958-LPRM Date: 05/31/16

City of Phoenix Plan #: 1601958-LPRM Date: 05/31/16



PLAN VIEW
(NTS)



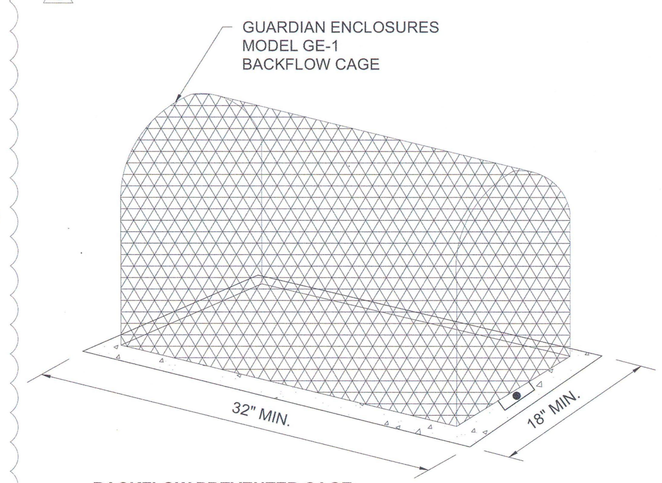
FRONT VIEW
(NTS)

NOTE:
1. WATER SUPPLY BACKFLOW PREVENTION SHALL BE INSTALLED IN CONFORMANCE WITH UNIFORM PLUMBING CODE (UPC) 2012. (D)

02 BACKFLOW PREVENTER ASSEMBLY DETAILS

C-1 C-2 SCALE: NTS

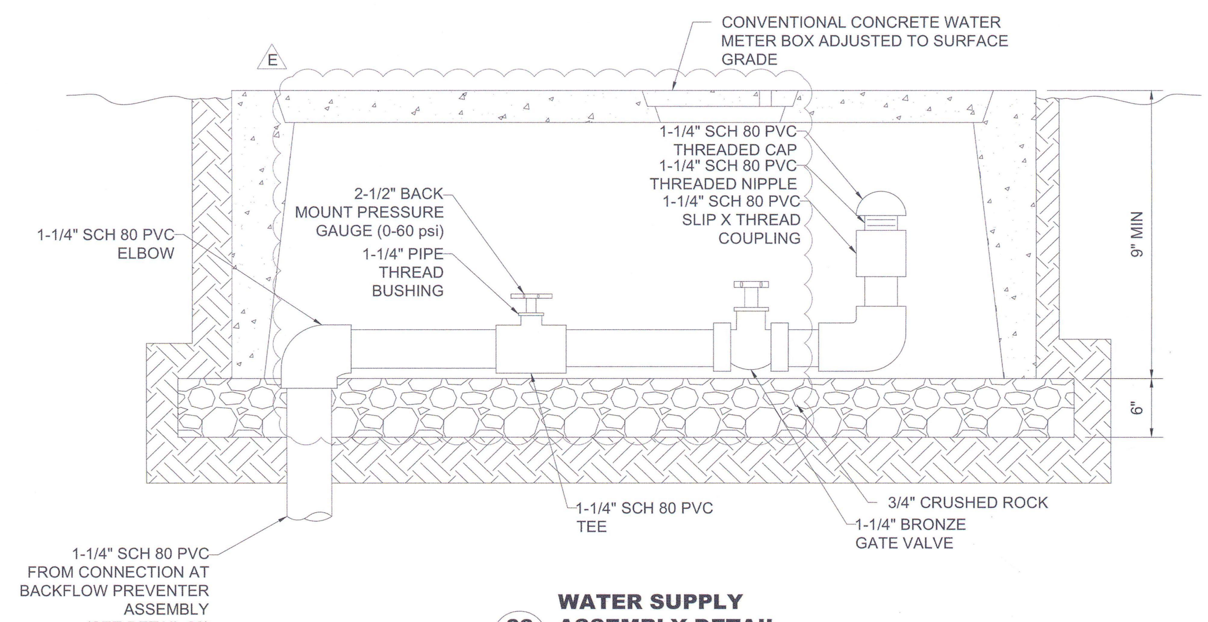
(C)



BACKFLOW PREVENTER CAGE
(NTS)

NOTE:
1. BOLT CAGE AT EACH END TO CONCRETE SLAB WITH WET OR DRY INSTALLATION PINS/KIT SUPPLIED BY MANUFACTURER.

(E)



03 WATER SUPPLY ASSEMBLY DETAIL

C-1 C-2 SCALE: NTS

NOTE:

1. METER BOX SIZE SHALL BE 13" W X 30" L X 12" D MIN.

SCALE SHOWN IS FOR 24"X36" FORMAT. ONLY GRAPHICAL SCALE SHOULD BE USED FOR OTHER PRINT SIZES.

URS

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602-371-1615 (fax)

ADEQ
Arizona Department of Environmental Quality

Registered Professional Engineer (Environmental) Certificate No. 34613 JEFFREY W. RACKOW, Arizona, U.S.A. Date Signed 5-24-16
Expires: 3-31-2018

ISSUED FOR BIDDING 2016-XX-XX XXX (DATE BY)

ISSUED FOR CONSTRUCTION (DATE BY)

REVISIONS

NO.	DESCRIPTION	DATE
C	MODIFIED WITH ADDITION OF ABOVE GROUND PRESSURE REDUCER VALVE AND UNISTRUT SUPPORT	5/23/2016
D	ADDED NOTE FOR UPC 2012	5/23/2016
E	MODIFIED TO REMOVE BELOW GRADE PRESSURE REDUCER VALVE AND ASSOCIATED UNIONS	5/23/2016

AECOM PROJECT NO: 60445193
DRAWN BY: PINEDA, REID 2/5/16
DESIGNED BY: RACKOW 2/5/16
CHECKED BY: RACKOW 2/5/16
DATE CREATED: 1/28/16
PLOT DATE: 5/24/16
SCALE: NTS
ACAD VER: 2014

SHEET TITLE

BACKFLOW AND WATER SUPPLY ASSEMBLY DETAILS

C-2
SHEET 2 OF 2

LONG, BENJAMIN, 5/24/2016 11:01 AM

DRAWING PATH: P:\Projects\ADEQ\60445193_FY16?thBet\5_Technical\Building Permit for City Water Connection\C-2 ADDITIONAL PIPING DETAILS.dwg

City of Phoenix Plan #: 1601958-LPRM Date: 05/31/16

City of Phoenix Plan #: 1601958-LPRM Date: 05/31/16

APPENDIX B – STANDARD OPERATING PROCEDURES

URS Corporation
Standard Operating Procedures

ASRAC Contract No. 14-077534
September 2016

TABLE OF CONTENTS

1.0 LAND SURVEY

1.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide details, specifications, and requirements for establishing the horizontal and vertical position of sampling points and monitoring locations.

1.2 SCOPE

This SOP applies to all professional land-surveying activities in support of environmental investigation.

1.3 METHOD

1.3.1 General

Land surveying services will be required to establish coordinates for sampling points and monitoring locations. These locations will include monitoring wells, soil borings, surface water/sediment sample locations, surface soil sample locations, and reference points used for stream gauging.

1.4 PROCEDURES

To be provided by surveying subcontractor licensed in the State of Arizona.

2.0 FIELD ACTIVITY RECORDS

2.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to set site-wide criteria for content entry and form of field logbooks, and to document procedures employed in recording site activities photographically or using a video camera.

2.2 SCOPE

This SOP applies to all personnel who record information in field logbooks, or employ photographic or video techniques to document site activities.

2.3 METHOD

2.3.1 General

An essential part of the sampling/analytical portion of any environmental project is assuring that proper documentation of all activities is accomplished. The primary document used to record site data is the field logbook. Tasks where analytical data or conclusions based upon analytical data may be used in litigation demand that accountability of the history of a sample be available to demonstrate that the data are a true representation of the environment. The field logbook may be used as evidence in legal proceedings to defend procedures and techniques employed during site investigations. Therefore, it is extremely important that field logbook documentation be factual, complete, accurate, and consistent.

Likewise, when photographic or videographic techniques are used to document site activities, the goal of the records is a true representation of field activities that accurately portrays site conditions or procedures.

2.3.2 Procedures

2.3.2.1 Preparation

New field logbooks will be obtained as needed from the Field Manager/Task Leader. The individual using the field logbook will be responsible for its care and maintenance throughout the field task.

Field logbooks will be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the logbook. The following information will be recorded on the cover, binding, or inside the front cover of the logbook:

- Field document control number;
- Activity;
- Contractor's name;
- Phone number; and
- Site contact (Field Manager/Task Leader).

2.3.2.2 Operation

The following requirements must be followed when using a logbook:

- The date must be recorded at the top of each page.
- If data collection forms are specified by an activity-specific plan or procedure, the information need not be duplicated in the logbook.
- All changes must be made with a single line through the deletion. Changes must be initialed and dated.
- A diagonal line must be drawn through any space left at the bottom of each page.
- The bottom of each page will be signed by the author.
- Do not remove any pages from the logbook.

Entries into the field logbook will be preceded with the time of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged.

At each station where a sample is collected or an observation made, a detailed description of the location is required. If a map is not already available that shows the sample location, a sketch of the location is required. The sketch or diagram should be detailed enough for other individuals to locate the points at future times. A direction indicator or compass direction should be located on the sketch. It is preferred that maps and sketches be oriented so that north is towards the top of each page.

The specific SOPs or project-specific work plans that the work is being conducted in accordance with should be identified in the field logbook.

Events and observations that should be recorded include, but are not limited to:

- Changes in weather that may impact field activities;
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation;
- Problems, downtime, or delays;
- Upgrade or downgrade of personal protective equipment;
- All task members and visitors;
- Actual and background readings of health and safety monitoring equipment;
- Identification of equipment used, including model numbers and/or serial identification numbers;
- Start and end times of sample locations; and
- Decontamination times and methods.

When samples are collected, the following should be recorded:

- Sample location;
- Sample number;
- Sample methodology;
- Sample description;
- Sample collector;
- Sample depth;
- Sample type;
- Sample analyses requested;
- Sample preservation and confirmation; and
- Quality control (QC) sample numbers and types.

2.3.2.3 Visual Recordings

When visual recordings (photographs or video recordings) are made, they will be documented in the associated field logbook. At the start of the day, the weather conditions should be recorded; the weather should also be noted if site conditions change (e.g., weather goes from clear to overcast) throughout the day. For each photograph, the following information must be recorded:

- Location;
- Date and time;
- Photographer;

- Detailed description of subject of photograph;
- Direction of photograph (e.g., “taken facing northwest”);
- Identification of individuals in the photograph and their affiliation;
- Photograph number;
- Mechanical difficulties (if encountered) and corrective actions taken (and results).

A figure, map, or sketch of the site indicating the locations where photographs were taken is useful, especially if before and after photographs are to be taken at different times (potentially by different photographers, although using the same photographer is highly recommended).

For video recordings, the same information should be noted, along with the start and stop times on the recording. If the camera is capable of captioning with date, time, and text information to the recorded image, this is recommended. Such a captioning capability aids in later labeling and identifying the photographs or video recordings.

Photographs and/or video recordings should be taken with a camera-lens system having a perspective similar to that afforded by the naked eye. Telephoto or wide-angle shots are to be avoided unless previously approved by the client.

Most video cameras offer the cameraperson, or an accompanying field technician, audio recording capability that can be used to provide a running commentary on the activities recorded. This information is not a substitute for hard-copy documentation in a logbook (wind blowing across the microphone or technical difficulties may render the sound inaudible). Commentary should be pertinent and succinct.

2.3.2.4 Post-Operation

At the conclusion of a task or when a logbook has been completed, it will be submitted to the Field Manager/Task Leader for filing in the Project File.

Cameras will be returned to the location designated by the field task leader in the field office (the camera and film must be kept in a temperature and humidity controlled environment when not in use; camera batteries may need to be recharged overnight). Film and developed photographs should be protected from unnecessary exposure to light (to avoid fading), and video recordings must be protected from magnetic fields. The video cartridge must be labeled.

After the first day of work and on a regular basis thereafter, the Field Manager/Task Leader will perform a QC content check for compliance with this SOP.

2.4 REFERENCES

U.S. Environmental Protection Agency (USEPA), December 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods*. 2nd Edition, USEPA-600/4-84-076, pp. D1-D11.

USEPA/NEIC, 1982. *Policies and Procedures*. 330/9/78/011-R.

USEPA/National Enforcement Investigations Center (NEIC). *User's Guide to the USEPA Contract Laboratory Program*.

2.5 RECORDS

Documentation will follow all guidelines contained in this SOP.

3.0 STATIC WATER LEVEL AND TOTAL DEPTH MEASUREMENTS

3.1 PURPOSE

The purpose of this Standard Operating Procedure is to describe the equipment and methods used to accurately determine static water level and total depth in a groundwater monitoring well, pumping well, or piezometer.

3.2 SCOPE

This Standard Operating Procedure applies to all personnel who measure water levels and total depths in wells. The procedure is applicable to the sampling of monitoring wells and must be performed prior to any activities, which may disturb the water level, such as purging or aquifer testing.

3.3 METHOD

3.3.1 General

This procedure requires the use of an electronic water level device that employs a battery-powered probe assembly attached to a cable marked in 0.01-foot increments. When the probe makes contact with the water surface, a circuit is closed and energy is transmitted through the cable to sound an audible alarm. This equipment will have a sensitivity adjustment switch that enables the operator to distinguish between actual and false readings. The manufacturer's operating manual should be consulted for instructions on use of the sensitivity adjustment.

3.3.2 Procedures

3.3.2.1 Equipment

- Water level indicator with an audible alarm and a cable marked in 0.01-foot increments. The point on the probe that triggers the alarm corresponds to the zero point.
- If free-phase product is present on the water surface, then an interface probe capable of distinguishing between product and water will be used.

3.3.2.2 Calibration

The water level indicator or interface probe should be calibrated before use. The end of a probe should be placed in a bucket of water to ensure that the audible alarm is in working condition and responds when the electrical contacts encounter water. The marked length units on the probe line should be verified for accuracy by comparing to a standard steel tape measure. If there is any noted discrepancy between the water level indicator and the measuring tape, the difference in length will be noted on the field log and identified on the water level indicator. All subsequent water level measurements will be corrected as necessary.

3.3.2.3 Static Water Level Measurement

Before water level measurements are collected, all equipment will be thoroughly decontaminated as detailed in SOP-12, *Equipment Decontamination Procedures.* The static water level will be measured each time a well is sampled. This must be done before any fluids are withdrawn and before any purging or sampling equipment enters a well.

The measurements of static water level and total depth must be taken at an established reference point, generally from the top of the well casing at the surveyor's mark. The mark should be permanent, such as a notch or mark on the top of the casing. If the surveyor's point is not marked at the time of water level measurement, the north side of the casing should be used and marked. All equipment will be decontaminated before and after introduction of the equipment to the well following procedures in SOP-12, *Equipment Decontamination Procedures.*

If the well is sealed with an air-tight cap, allow time for equilibration of pressures after the cap is removed before water level measurement. Air-tight caps should be replaced by ventilated caps or a hole drilled in the well casing, where feasible, to allow the water to equilibrate to barometric changes.

With the water level indicator switched on, slowly lower the probe until it contacts the water surface as indicated by the audible alarm. Raise the probe out of the water until the alarm turns off. Three or more measurements will be taken on three minute intervals at each well until two measurements agree to within +/- 0.01 feet. Record the reading on the cable at the established reference point to the nearest 0.01 foot.

3.3.2.4 Total Depth Measurement

Slowly lower the water level indicator, with weight attached if necessary, until the cable goes slack. Raise and lower the probe until the precise location of the bottom is determined. Record the reading on the cable at the established reference point to the nearest 0.01 foot. Depending on the type of instrument used, the total depth measurement may need to be adjusted for the offset between the bottom of the probe and the water level sensor. Some instruments have the sensor at the bottom of the probe so the depth reading is accurate without an adjustment. However, the water indicator sensor on some probes is not located at the bottom of the probe. To get a true total depth reading, the distance from the water indicator sensors to the bottom of the probe housing must be added to the depth reading.

If it is not possible to measure the depth of a well in which pumping equipment is installed, then the as-built well construction diagram will provide the total depth.

3.3.2.5 Interface Probe Measurement

If there is the potential for free-phase product to be present on the surface of the water table in a well, then an oil-water interface probe will be used to collect water level measurements. Interface probes are used in the same manner as a water level indicator. The difference is that the interface probes have two different audible signals to differentiate between water and oil. If a layer of free-phase product is present, the probe will emit a different signal than for water. Most probes emit an intermittent beep when product is encountered, as opposed to a constant tone for water. The alarm codes for individual probes are marked on the reel casing. If product is encountered, continue to raise and lower the probe until a precise level (within 0.01 foot) is determined. Record the measurement in the field log and identify it as a product measurement.

Next, slowly lower the probe until the water interface is encountered. Repeat the level measurement process and record the depth to water in the field logbook. Care should be taken during the measurement process to minimize disturbance of the product layer.

3.4 REFERENCES

Driscoll, F.G., 1986. *Groundwater and Wells*, 2nd Edition, Johnson Division, St. Paul, MN, pp. 1089.

Thornhill, J.T., 1989. *Accuracy of Depth to Ground Water Measurements*, from U.S. Environmental Protection Agency (USEPA) Superfund Ground Water Issue, USEPA/540/4-89/002.

U.S. Department of the Interior, 1981. *Groundwater Manual, A Water Resource Technical Publication*, Water and Power Resources Services, U.S. Government Printing Office, Denver, CO, pp. 480.

3.5 RECORDS

All field notes for water level and well depth measurements will be recorded in accordance with SOP-2, *Field Activity Records*.

4.0 GROUNDWATER SAMPLING

This SOP describes the specific protocols necessary for the collection of representative groundwater samples. Groundwater samples will typically include compounds of concern, and geochemical parameters. The monitoring well system for most of the WQARF sites include dedicated monitoring wells, as well as public and private production wells.

4.1 SAMPLE COLLECTION PROCEDURES

Prior to conducting field work, ensure that all meters are properly calibrated and that such calibration is documented in the field log.

As each well is accessed, the condition of the outer well casing, vault, concrete pad, and general site conditions are to be noted in the field log. Plastic sheeting shall be placed around the well prior to access. Field personnel shall wear the appropriate PPE and use new, clean chemical resistant gloves at each measurement/sampling location.

Wells should be monitored and sampled in order from the least contaminated to the most contaminated.

4.1.1 Total Well Volume Purging

Purge each well prior to sampling to ensure that stagnant water from within the well casing has been evacuated and the sample collected is representative of groundwater in the aquifer. Before beginning well evacuation, measure the static water level to the nearest 0.01 foot using an electric water level sounder. The volume of water contained in one casing volume is calculated from the following equation:

$$V = (TD - DTW)\ \pi\ r^2\ (7.48)$$

Where

- V equals one evacuation volume, in gallons
- TD is equal to the total depth of the well, in feet
- DTW is equal to the depth to water in the well, in feet, measured prior to beginning well evacuation
- r is equal to the inner casing diameter, in feet

- 7.48 is the conversion factor from cubic feet to gallons

Evacuate three casing volumes, periodically collecting water quality field parameters and continue purging until parameters have stabilized. Water quality field parameters to be measured include pH, temperature, turbidity, DO, ORP, and conductivity. These parameters will be measured after each casing volume of water has been evacuated, and will be considered to have stabilized if all three readings are within 10 percent of the previous reading. If the readings have not stabilized after three readings, additional casing volumes will be removed until the measurements stabilize. The meters used to measure pH, specific conductance and temperature will be calibrated daily.

If a well is pumped dry during evacuation, allow the well to recover to at least 80 percent of the static water level before collecting a sample, if feasible. Wells that require several days or more to recover may be sampled before 80 percent recovery is achieved.

4.1.2 Well Purging and Sample Collection Equipment

This section describes the methods and types of equipment that will be used to evacuate and collect water quality samples from typical monitoring well systems. The type of evacuation system is site specific.

4.1.2.1 Dedicated Submersible Pumps or Pneumatic Pumps

Monitor wells may be equipped with dedicated pumps. These pumps are used to evacuate the wells prior to sample collection, and to collect the samples. The typical dedicated pump system includes a permanently installed electric or pneumatic submersible pump connected to a drop-tube, a sampling-tee with two spigots, and an electrical power cord or air supply hose. A portable generator is used to provide electricity, and a control box may also be necessary, in order to properly start and operate the electric submersible pump. A compressor is required to operate the pneumatic pump. A flow meter and discharge hose are typically attached to the purge side, and samples are collected directly from the sampling side of the sampling tee. The evacuation and sampling procedure is summarized as follows:

1. Attach the discharge hose to the sampling-tee at the well head.
2. Attach the power cord from the pump to the generator OR attach the compressor to the air hose at the wellhead.
3. Start generator or compressor and initiate pumping.
4. Evacuate the well the required volume of water or until water chemistry stabilizes.

5. Collect samples from sampling-tee.
6. Discontinue pumping and turn off generator or compressor.
7. Disconnect power cord from generator OR disconnect air hose from compressor.
8. Disconnect discharge hose from sampling tee.
9. Secure well and location.

4.1.2.2 Portable Submersible Pumps

Portable submersible pumps are used for evacuation and sample collection from wells that do not have dedicated pumps. The portable submersible pump system includes a Grundfos Redi-Flow 2 or Redi-Flow 3 submersible pump attached to a flexible Teflon-lined discharge hose or rigid PVC pipe connected with stainless steel couplers, a steel cable, and an electrical power cord. A portable generator is used to provide electricity. A flow meter and discharge hose will be attached to the purge side, and samples will be collected directly from the sampling side of the sampling tee. The evacuation and sampling procedure is summarized as follows:

1. Place the thoroughly decontaminated pump in the well at the desired depth by lowering discharge hose assembly.
2. Attach the power cord from the pump reel to the generator.
3. Start generator and initiate pumping.
4. Evacuate the well as required.
5. Collect samples from discharge hose assembly at a decreased flow rate.
6. Discontinue pumping and turn off generator.
7. Disconnect power cord from generator and pump reel.
8. Remove the pump from the casing by raising the discharge hose assembly.
9. Decontaminate (steam clean) pump and discharge hose assembly collecting and containerizing condensate
10. Collect equipment blank from discharge hose (if required).
11. Secure well and location.

4.1.2.3 Turbine Lift Pumps

Turbine lift pumps are currently installed at municipal and private wells, and will be used to evacuate and sample the wells. The well owner or their representative should accompany URS personnel during the sampling process whenever practical. The evacuation and sampling procedure is summarized as follows:

1. Start well pumping, and allow time to stabilize.
2. Evacuate the well as required.
3. Collect samples from hose bib.
4. Secure well and location.

4.1.2.4 Bailer

Often times when there is insufficient water in a well to yield a complete purge volume, or water recovery in a well is slow, a bailer may be necessary to collect the sample. In the event the well is purged dry, a sample will be collected from the monitor well once sufficient water has recharged. For following sampling events, that well will be purged dry approximately one-week prior to collection of samples in order to allow a sufficient recharge period for the well. The evacuation and sampling procedure is summarized as follows:

1. Tie rope to purging bailer, or use dedicated purging bailer, if present.
2. Lower the purging bailer or dedicated bailer to the water table.
3. Evacuate the well as required.
4. Collect samples from the dedicated bailer, or if using a purging bailer, then collect samples by lowering a factory-sterilized, disposable polyethylene bailer.
5. Slowly pour the water into the sample bottles, ensuring an even fill rate.
6. Decontaminate purge bailer, and discard non-dedicated rope and any disposable bailers.
7. Secure well and location.

4.1.2.5 Low-Flow Sampling Protocol

The low flow methodology is also referred to as millipurging, micropurging, or low-stress well sampling (U.S. EPA; July 1996). The method was developed for sampling small diameter wells with short saturated intervals; however, the methodology may prove useful for collecting depth-specific water samples from wells that are not equipped. Using the low-flow purging methodology, the well will be purged until field parameters (e.g., pH, temperature, turbidity, DO, ORP, and conductivity) have stabilized. Readings will be taken at a rate commensurate for the flow involved, but no sooner than every three minutes. Low-flow purging rates on the order of 0.1 - 1.0 L/min will be used depending on the site-specific hydrogeology. Unless otherwise specified in the Field Sampling Plan, the maximum allowable drawdown during low-flow purging is 0.3 feet. If the maximum allowable drawdown limit of 0.3 feet is exceeded and cannot be achieved, then another purge method will be followed.

A submersible pump, such as a Grundfos Redi-Flo 2 or Bennett, is used to purge and sample the wells. The evacuation and sampling procedure is summarized as follows:

1. Remove any dedicated equipment from the well.
2. Decontaminate the down-well sampling equipment (submersible pump and water level indicator).
3. Collect an equipment blank from the sampling pump and discharge tubing prior to placement in the monitor well, in order to verify the efficacy of the decontamination process.
4. Lower the pump and hose assembly into the well in a manner that minimizes agitation of the water column and sediments in the well and adjacent formation.
5. Position the pump intake at the desired sampling depth.
6. Begin purging at a rate no greater than 0.1 gallons per minute (gpm), and ideally purged and sampled at an approximate rate of 100 milliliter per minute (~ 0.03 gpm). Record purging rate.
7. Collect and record periodic water level measurements to ensure that the purge rate is sufficiently low to limit the total water level draw down to less than 5 % of the total saturated interval.
8. Collect periodic measurements of geochemical parameters including temperature, pH, electrical conductivity, and redox potential and record in the field sampling log at three to five minute intervals.
9. Low-flow purging is complete only when all required field parameters have stabilized (e.g., temperature, pH, turbidity, conductivity, DO, and ORP). Stabilization is achieved when three consecutive readings show temperature is within ± one degree Celsius, pH values are within ± 0.1 pH unit, conductivity is within ± 5%, DO is within ± 10%, ORP is within ± 10 millivolts (mV), and turbidity is less than or equal to 15 NTUs or within ± 10% if other conditions of low-flow purging have been met for non-background wells. Background wells must be 10 NTUs or less before sample collection unless a written variance (on a well-specific basis) is acquired. The Site Manager/Field Task Leader has the responsibility of determining if redevelopment of any monitoring well is necessary and appropriate.

10. Disconnect the hose from the inline measurement device, and slowly fill sample containers directly from the hose end.
11. Remove the sampling equipment from the well.
12. Decontaminate sampling and monitoring equipment.
13. Repeat steps 5 through 12 for each sampling interval.
14. Complete final decontamination process, and secure all sampling and monitoring equipment.
15. Secure well and location.

4.1.2.6 Sampling using Multi-Port Sampling Systems

The three dimensional nature of groundwater contamination at many WQARF sites has made the use of groundwater sampling systems capable of collecting samples at multiple depth intervals. FLUTe®, Barcad®, and Westbay® are all proprietary groundwater sampling systems capable of collecting discrete sample from different depth intervals within an aquifer or in different aquifers. Typically these systems operate by using an inert gas (typically nitrogen) to displace a volume of water, which in turn forces a column of water to the surface.

Advantages of these systems include a reduction in the amount of water purged from the well, and highly representative samples of the aquifer in the immediate vicinity of the inlet portal. Disadvantages for these systems are cost, and the fact that they can only collect water from a very limited part of the aquifer, which may not provide data representative of the overall aquifer at that location. The intricacies of each of these systems are too great to provide detail in this SOP, and the user should refer to equipment specific procedures prior to using any of these systems. However, the general process for the evacuation and sampling procedure using these systems is summarized as follows:

1. Attach the manifold/gas supply to the intake portal.
2. Attach the regulator to the (nitrogen) gas tank, and the hose which connects the regulator and the manifold or intake portal.
3. Adjust the regulator according to the manufacturer’s recommendations for the sampling system and the depth of the intake portal.
4. Initiate the fill cycle by opening the regulator at the appropriate pressure.
5. Continue pumping until sufficient fill cycles have been completed to evacuate the sample interval.

6. Collect samples from discharge tube.

7. Shut off flow of gas at the manifold, and at the regulator.

8. Allow the pressure in the lines to bleed off, as required.

9. Disconnect all hoses and tubing.

10. Secure well and location.

4.1.2.7 PDB Sampler Methodology

A PDB sampler is made of low-density polyethylene (LDPE) lay-flat tubing that is closed at both ends. Tubes can be 18 to 24 inches long and from 1 to 1.5 inches in diameter. Prior to deployment, the tube is filled with laboratory grade deionized water (unless filled by the laboratory). Most VOCs diffuse readily from the groundwater into the PDB. After a sufficient period of time has passed to allow the contaminant concentrations in the bag to come into equilibrium with the contaminant concentrations in groundwater (a three-week deployment is recommended), the PDB is removed and the water is analyzed for contaminants using standard procedures. The desired depth that a PDB is to be suspended in a monitoring well (or the depths of multiple tubes that may be deployed for one well) will be specified in the project-specific work plan. The deployment line and PDBs must not contact non-aqueous phase liquid (NAPL) during deployment or retrieval, which could lead to carry-over of contamination and degradation of the polyethylene membrane.

4.1.2.7.1 PDB Sampler Deployment

The following procedures will be performed at each well during PDB sampler deployment:

- The condition of the well completion (outer well casing, concrete well pad, protective posts, well label) and any unusual conditions of the area around the well will be noted on the monitor well purging form (Attachment 1). The well may also be photographed. Any deficiencies encountered will be reported to the Site Manager on the same working day.
- Set up and establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.
- Don PPE as specified in the HASP.

- If elevated VOCs are expected based upon historical analytical results, open the well cap and immediately check for VOC vapors in the well casing. Record this reading on the Monitoring Well Purging Form (Attachment 1).
- Note if the reference point (measuring point) on the well is present. This is usually an indelible mark or V-notch cut in the top of the well casing. If this point is missing, make one on the north side of the well casing.
- The depth of the static water level will be measured with a water level indicator (to the nearest 0.01 foot) in accordance with SOP-3, *Static Water Level and Total Depth Measurement*. If a high concentration of organic vapors are detected in the well, an oil/water interface probe will be used to determine the presence of an immiscible phase (LNAPL or DNAPL).
- The total depth of well will be measured from the same measuring point on the casing with a water level indicator and recorded. It is critical that the distance between the water sensor (zero point) and the end of the water level indicator probe be measured independently and added to each total depth measurement.
- If the PDB tube in not already filled by the laboratory, fill the PDB tube with laboratory grade deionized water.
- Attach the PDB samplers to the customized PDB harness, which has been pre-set for project-specific work plan specifications. Slowly lower the weighted harness into the well with the PDB samplers attached. Suspend the PDB harness at the desired depth interval by attaching the retaining disk that will sit on the top of the well casing opening.
- Close and lock the outer well casing.
- Leave the PDB samplers deployed in the monitoring well for a sufficient period of time to allow the contaminant concentrations in the bag to come into equilibrium with the contaminant concentrations in groundwater (a three-week deployment is recommended).
- To collect the PDB sample follow the steps identified in Section 4.1.2.7.2.

4.1.2.7.2 PDB Sample Collection

PDBs will be used when the groundwater samples are analyzed for VOCs only. After the PDBs have been suspended in the well for the time prescribed in the Field Sampling Plan, the PDB sample will be collected using the following steps:

- The condition of the well completion (outer well casing, concrete well pad, protective posts, well label) and any unusual conditions of the area around the well will be noted on the monitor well purging form (Attachment 1). The well may also be photographed. Any deficiencies encountered will be reported to the Site Manager on the same working day.
- Set up and establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.
- Don PPE as specified in the HASP.
- If elevated VOCs are expected based upon historical analytical results, open the outer well casing and immediately check for VOC vapors in the well casing (the disk suspending the PDB tube will have to be lifted slightly). Record this reading on the Monitoring Well Purging Form (Attachment 1).
- Identification labels for sample bottles will be filled out and attached to sample bottles for each well prior to collecting samples.
- Retrieve the PDB tube by pulling the PDB harness out of the well.
- Open the PDB tube bag (either by uncapping or cutting a small hole in the corner of the bag).
- Slowly pour the contents of the sampler into the sample containers. VOC sample vials should be completely filled so the water forms a convex meniscus at the top, then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles in the vial. If air bubbles are observed in the sample vial, discard the vial and collect another sample.
- After the samples have been collected, they should immediately be placed in an ice-filled cooler until relinquished to the on-site laboratory or shipped to the appropriate laboratory for analysis. Sample bottles may become warm in the field when left in the sun or in a field vehicle; therefore, an effort will be made to ensure that sample containers are kept on ice to prevent warming of the bottles to prevent a loss of volatiles.

- Replace and lock the well cap.

4.1.3 Sample Collection

Samples will be collected using methods to minimize potential volatilization. To accomplish this, the discharge tube of the sampling device will be inserted near the bottom of the container and withdrawn gradually as the container is filled. For VOC samples, the discharge rate will be maintained at a sufficiently low rate so as to not introduce air bubbles into the sample container. The sample container will be filled to slightly overflowing, forming a convex meniscus at the mouth of the container. A drop of water is then placed inside of the cap, and the cap placed upon the convex meniscus and screwed on tightly to seal the container. To check that the sample is air-free, the container will be inverted and gently tapped. The absence of entrapped air indicates a successful seal. If air bubbles are encountered in the container, the sample and container will be discarded and the water sample will be re-collected.

4.2 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Additional quality assurance samples will also be collected during each sampling event. The quality assurance samples collected will by project specific according to the Field Sampling Plan, but may include the following.

- field blanks
- trip blanks
- duplicate/split samples
- equipment blank

4.3 REFERENCES

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

ADEQ, 2002; *Release Reporting & Corrective Action Guidance*, Arizona Department of Environmental Quality UST Program, August, 2002.

ASTM Standard Designation D 5903-96; *Guide for Planning and Preparing for a Groundwater Sampling Event*.

ASTM Standard Designation D 4448-85a (1992); *Guide for Sampling Groundwater Monitoring Wells*.

U.S. EPA, 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures,* Robert W. Puls, and Michael J. Barcelona, EPA/540/S-95/504; United States Environmental Protection Agency, April 996.

5.0 WATER QUALITY MEASUREMENTS USING A MULTIPLE PARAMETER QUALITY METER

5.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for the use of a multiple parameter water quality meter such as the Horiba or U-22 or equivalent. Multiple parameter meters measuring water quality parameters including pH, temperature, salinity, turbidity, dissolved oxygen (DO), oxidation reduction potential (ORP), and specific conductance (conductivity) in water during well purging, well development, and surface water sampling for chemical analysis.

5.2 SCOPE

This SOP applies to all personnel who measure water quality parameters using a multiple parameter water quality meter.

5.3 METHOD

5.3.1 General

Water quality parameters such as pH, temperature, turbidity, DO, conductivity, ORP, and salinity are collected to determine conditions in surface or groundwater at a given location. A series of such determinations can be used to evaluate a variety of situations, from the performance of a groundwater treatment system to the spread of contaminant plume in groundwater. A multiple parameter water quality meter measures each of these parameters digitally. The pH is a primary parameter measured in the field to determine hydrogen-ion activity. It is measured using a glass electrode in combination with a reference potential. Temperature is measured because many water quality parameters vary with temperature. The solubility of oxygen is temperature dependent, as are all electrochemically determined water quality parameters (pH, conductivity).

Turbidity serves as a measure of suspended solids in a water sample. Since these suspended solids might result in elevated apparent concentrations of some contaminants (especially metals) to above levels of concern, the measurement of turbidity is a critical determination before collection of groundwater samples. Turbidity above acceptable levels will typically result in additional efforts to reduce the turbidity of the well water before collecting samples, since samples will be collected unfiltered unless otherwise approved.

DO is an indicator of the oxygen-consuming and oxygen-providing process taking place. It is an indicator of the biochemical processes occurring in the water and is related to the ORP. The most common membrane electrode (ME) meters for determining the DO in water are dependent upon electrochemical reactions. Under steady-state conditions, the current or potential can be correlated with DO concentration. Interfacial dynamics at the ME/sample interface are a factor in probe response and a significant degree of interfacial turbulence is necessary to avoid a "stagnant layer" at the interface and resulting biased determinations. For acceptable precision to be obtained, flow over the DO membrane should be constant, as in the case of a flow-through cell used for groundwater sampling or a flowing stream for stream sampling.

Specific conductance is the ability of a volume of a solution to conduct an electrical current as compared to the same volume of pure water. Chemically pure water has a very low electrical conductance, indicating that it is a good insulator. However, minute amounts of dissolved mineral matter (total dissolved solids, [TDS]) in water increase the electrical conductance of water. In dilute solutions, the specific conductance varies almost directly with the TDS content of the samples. Salinity of the sample is computed from conductivity data.

5.3.2 Procedures

5.3.2.1 Field Determinations Using a Multiple Parameter Water Quality Meter

5.3.2.1.1 Equipment

Equipment that will be used to collect water quality measurements using a multiple parameter water quality meter includes, but is not limited to, the following items:

- Multiple parameter water quality meter with power supply;
- Calibration solutions, as specified by the manufacturer;
- Calibration log form and field logbook for recording calibration;
- Clean sample containers (glass, plastic);
- Distilled or deionized water in wash bottle; and
- Operating manual for the multiple parameter water quality meter.

5.3.2.1.2 Calibration

The multiple parameter water quality meter may be calibrated in the field by using calibration solutions supplied by a commercial laboratory supply house. The specific calibration procedures in the owner's manual for the multiple parameter water quality meter should be followed. Generally, the calibration procedure involves measuring the value of a specific parameter in a standard calibration solution of a known value. The meter is typically calibrated to read the known value to within the acceptance criteria. The instrument should be calibrated prior to each workday of use. The initial instrument response and the final (calibrated) response will be recorded on the calibration log, along with the date and time of calibration. Calibration will be performed in accordance with the manufacturers' instructions.

5.3.2.1.3 Taking Measurements

After the unit is calibrated, it is ready for use. To take measurements, turn the unit on and gently place the probe in the water sample. Typically, a select button can be pressed to toggle between the different parameters, if they are not all displayed on screen simultaneously.

Care should be exercised when handling the probes. The multiple parameter water quality meter should be lowered gently into the sample. The water quality meter should be allowed to stabilize for at least several seconds before collecting water quality parameter data. When conducting groundwater sampling, a flow-through cell should be used whenever possible to minimize wear and tear on the probes, eliminate the need for stabilization (since the electrode is constantly immersed in groundwater flowing over the probes), and improve the consistency of the readings. Multiple determinations as an indication of field precision should be conducted more frequently than every tenth reading if precision problems are apparent.

5.3.2.1.4 Storage

After using the water quality meter, thoroughly wash all probes with analyte free water. The turbidity sensor tube should be periodically washed out with a test tube brush and analyte free water, or according to the manufacturer's instructions. The conductivity guard should be periodically removed to brush away any dirt from the sensor unit. If storing the unit for a week or less, fill the calibration cup with tap water (*not distilled or deionized water, which can damage the probes*) and fit the cap over it. For long-term storage, follow the manufacturer's instructions.

5.3.2.1.5 Additional Considerations

Operators of field equipment should refer to the manufacturer's instructions for step-by-step calibration and usage guidelines. Additional considerations of a general nature include:

- The water quality meter must be checked for mechanical and electrical failures, weak batteries, and cracked or fouled electrodes before field activities.
- Perform calibration using the appropriate solutions as described in the manufacturer's instructions.

- Clean and rinse probes thoroughly using distilled or deionized water in a wash bottle between all samples and at the end of the day. Each time the electrodes are cleaned, they should be examined for damage.

- Some electrodes (e.g., pH and DO electrodes) must NOT be allowed to dry completely, as this may permanently alter the physical or electrochemical properties of the electrode surface.
- Note that oily samples are likely to result in fouling of the electrodes and more aggressive cleaning procedures (such as mild acid washing) will be required, as described in the manufacturer's instruction manual. After such cleaning, a calibration check must be performed; typically such cleaning will necessitate recalibration.

5.4 REFERENCES

American Society for Testing and Materials (ASTM). *Tests for Dissolved Oxygen in Water*. Annual Book of ASTM Standards; Part 31, "Water," Standard D888-92 (A). Philadelphia, PA.

Instruction Manual, Horiba U-10 Water Quality Checker, Horiba Instruments, Inc.

U.S. Environmental Protection Agency (USEPA), 1991. *Environmental Branch Standard Operating Procedures and Quality Assurance Manual*. EPA Region IV, Athens, GA.

USEPA, 1983. *Methods for Chemical Analyses of Water and Wastes.* Environmental Monitoring and Support Laboratory, Cincinnati, OH.

5.5 RECORDS

All field notes will be recorded in accordance with SOP-2, *Field Activity Records.*

5.6 ATTACHMENTS

Not applicable.

6.0 WATER SAMPLING FROM GROUNDWATER TREATMENT SYSTEMS (3.4.4)

This SOP describes the specific protocols necessary for the collection of representative water samples from groundwater treatment systems. The objectives of water sampling from groundwater treatment systems are to:

- Estimate contaminant mass removal from the subsurface by the treatment system;
- Evaluate contaminant removal efficiency of the treatment system; and
- Estimate system life (e.g., granular activated carbon usage rate)

6.1 PROCEDURE SUMMARY

Sampling requirements for groundwater treatment systems will vary based on remediation system design and operating setup. Refer to the site-specific Operations and Maintenance Manual and Monitoring Plan to determine sampling frequency, sample collection points, and required analyses. Typically, water sampling from groundwater treatment systems requires influent and effluent sampling, and may include sampling at intermediate points (e.g., between granular activated carbon vessels, or between primary and secondary treatment technologies).

6.2 EQUIPMENT AND MATERIALS REQUIRED FOR PROCEDURE

The following equipment should be used during sample collection activities:

- Appropriate air monitoring equipment (as per project specific health and safety plan or HASP)
- Appropriate personnel protective equipment (PPE) as per HASP
- Decontamination equipment
- Treatment system keys and/or well keys
- Miscellaneous tools
- Containers for purge water
- Bailer (type specified in the project specific Field Sampling Plan)
- Clean nylon twine or string

- Water quality meter (capable of measuring pH, temperature, conductivity, and turbidity, if specified by the site-specific Field Sampling Plan)
- Polyethylene or glass container to measure field parameters, if required by the site-specific Field Sampling Plan.
- Photoionization detector for air monitoring
- Paper towels
- Waterproof and permanent markers or pens
- Coolers and ice
- Ziploc or similar plastic bags
- Packing material for sample containers
- Field logbook, field sheets, chain-of-custody sheets, sample collection log, air monitoring log, HASP
- System O&M Manual
- Laboratory supplied sample containers, preservatives, and caps

6.3 SAMPLE COLLECTION PROCEDURES

6.3.1 Grab Sampling from Pressurized Lines Via Sampling Ports

Samples will be collected in triplicate from each sample location and placed in sample containers with preservation appropriate to the requested analytical method. The sampler should wear chemical resistant gloves to obtain the sample. New gloves are to be used at each sample location. Samples will be collected from each designated sample collection point as follows:

- Evaluate whether the system is operating prior to sample collection. If the system operates intermittently, ensure that the system has operated for a period of time long enough to purge the system piping.

- Open the valve to the sampling port and allow the water stream to drain through the sampling port into a bucket or container to flush dust or grit from the sampling port.

- Use the valve on the sampling port to reduce the flow rate from the sampling port to prevent aeration of the water stream and/or volatilization of contaminants from the water stream.

- Place the laboratory-supplied sample container beneath the sampling port and into the water stream and fill the sample container. If the sample is to be submitted for VOC analysis, fill the 40 ml VOA until an inverted meniscus is observed at the top of the vial. Carefully seal the vial with a Teflon-lined silicone cap, and check for air bubbles by inverting the vial. If a bubble larger than 1 millimeter is observed, the sample and vial will be discarded, and a new sample will be collected using a new vial.
- Once the sample has been collected, close the valve on the sampling port.

6.3.2 Flow or Time Proportional Sampling

In some cases, flow or time proportional sampling may be required if the treatment system discharges to a POTW and discharge requires an industrial discharge permit. Refer to the requirements of the permit to determine allowable procedures for collection of the proportional sample.

6.3.3 Sampling from Holding Tanks or Bodies of Water

In some cases, sampling must be conducted at discharge points such as a holding tank or body of water. The field sampler should wear chemical resistant gloves to collect the sample. New gloves should be worn at each sample location. Samples will be collected from the designated discharge point as follows:

- Triple rinse the capped sample container with the water being collected.
- Remove the cap and submerge the sample container below the water surface.
- Allow the container to fill completely.
- Remove the submerged sample container.
- Add preservative to the sample container, if required. Place the cap on the container and tighten. Invert VOA containers to check for bubbles. If a bubble larger than 1 millimeter is observed, the sample and vial will be discarded, and a new sample will be collected using a new vial.
- Decontaminate the capped container as required.
- Label the sample with the site name, sampling location, date, and time.
- Place the capped container within a Ziploc or similar bag.
- Store samples on ice, if required.

6.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Additional quality assurance samples will also be collected during each sampling event. The quality assurance samples collected will by project specific according to the Field Sampling Plan, but may include the following.

- field blanks
- trip blanks
- duplicate/split samples
- equipment blank

6.5 REFERENCES

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

7.0 HYDRO-PUNCH GROUNDWATER SAMPLING (3.4.8)

This SOP discusses the procedures used to obtain Hydro-Punch groundwater samples.

7.1 PROCEDURE SUMMARY

Groundwater samples will be collected during the drilling program in order to obtain a vertical profile of the contaminants of concern in groundwater. Samples will be collected using Hydropunch II (hydropunch) technology described below. Hydropunch technology enables groundwater samples to be collected from discrete intervals while minimizing the downward transport of contaminants from one horizon to another.

7.2 SAMPLE COLLECTION PROCEDURES

7.2.1 Drilling

All downhole drilling equipment will be steam-cleaned prior to arrival at the Site. Thereafter, all downhole equipment will be steam-cleaned prior to mobilizing onto each well location. Each site will be prepared by placing heavy plastic sheets beneath the drilling rig to protect the ground surface from oil and hydraulic fluid.

The boring will be advanced to a depth above the zone of interest to allow collection of a sample from an undisturbed area.

7.2.2 Sample Collection

Groundwater samples will be collected using the hydropunch sampling system at depths specified in the project specific sampling plan. When the drill bit reaches the depth just above the sampling depth, the driller will lower the hydropunch sampler on water-tight center rods. Hydropunch samples may be obtained either with the hydrocarbon sampling mode or the water sampling mode.

The hydropunch sampler will be advanced by the direct push method where possible. Where it cannot be hydraulically pushed by the drilling rig, the hydropunch sampler will be driven by the drilling rig's slide hammer. The hydropunch sampler will be driven a minimum of 12 inches and no greater than 3 feet at each sampling interval. The hydropunch sampler then will be retracted no more than 6 inches less than the distance pushed to assist in preventing the sample from being compromised by water from upper intervals already inside the drill pipe. Retraction of the hydropunch sampler will allow groundwater to enter the center rods through a 0.010-inch slotted screen attached to the hydropunch cone. The field geologist will record the inches driven and inches retracted for each hydropunch sample collected.

7.2.2.1 Hydrocarbon Sampling Mode

The hydrocarbon sampling mode will be used when:

- A sample must be collected across the water table interface of an unconfined aquifer;
- A large volume of sample must be collected; or
- The presence of light non-aqueous phase liquid (LNAPL) is suspected.

A small-diameter clean disposable or decontaminated re-usable bailer will be lowered through the casing and body of the Hydropunch II and into the exposed screen to retrieve water samples from the driven hydropunch device. Groundwater samples will be transferred from the bailer to the appropriate sample containers. With the exception of samples collected for volatile organic compound analysis, in cases where splits or duplicates are necessary, the groundwater samples will be transferred from the bailer to a decontaminated 5-gallon Nalgene batch vessel. The appropriate sample containers will then be filled from the batch vessel. Duplicate samples will be collected by filling twice the number of containers.

Conductivity, pH, and temperature parameters will be measured using a separate aliquot taken from one of the hydropunch bailers. Operation, maintenance, and calibration of field water quality instruments will follow specifications and procedures established by the manufacturer.

Samples for analysis of VOCs will be collected using methods to minimize potential volatilization. This will be accomplished by filling a 40-milliliter (mL) volatile organic analysis vial directly from the bailer (or from the Hydropunch device for the water sampling mode) at a rate of approximately 100 mL/minute, until an inverted meniscus is observed at the top of the vial. The vial will be carefully sealed with a Teflon-lined silicone cap, then inverted and rapped firmly on the palm of the hand to check for bubbles. If a bubble larger than 1 millimeter is observed, the sample and vial will be discarded, and another sample will be collected using a new vial. Samples will be submitted to the laboratory under standard Chain-of-Custody procedures.

7.2.2.2 Water Sampling Mode

The water sampling mode will be used when:

- water samples are to be obtained at a minimum of five feet below the surface of the water; or
- a small volume (500 ml to 1,200 ml) of sample is adequate.

The water sampling mode involves directly extracting the water-filled hydropunch device without an intermediate transfer device as described below :

- Upper and lower check valves and the attached filter screen are placed into the tool body in accordance with manufacturer's instructions. The disposable drive cone will be placed into the drive shoe ensuring a seal is made by the O-Ring. The sleeve is placed over the juncture of the drive cone and drive shoe.
- Push or drive the unit to the desired depth and pull back approximately two (2) feet.
- Ground water will flow into the intake screen past the lower check valve, into the sample chamber and finally out the top check valve.
- When full, the tool is pulled to the surface, the hydrostatic head within the tool will close the two check valves.
- At the surface the Hydropunch-II device is inverted and the sample will be decanted through a discharge valve and tubing into the sample containers.

7.3 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Additional quality assurance samples will also be collected during each sampling event. The quality assurance samples collected will by project specific according to the Field Sampling Plan, but may include the following.

- field blanks
- trip blanks
- duplicate/split samples
- equipment blank

7.4 REFERENCES

New Jersey Department of Environmental Protection, Site Remediation Program web page, http://www.state.nj.us/dep/srp/regs/agws/agws_06.htm

8.0 COLLECTION OF SOIL SAMPLES FOR VOLATILE ORGANIC COMPOUNDS (3.4.1)

This SOP describes the specific protocols necessary for the collection of representative soil data for volatile organic compounds (VOCs). Soil samples collected for the submittal of VOCs are often collected during the installation of borings or monitor wells, or during other soil investigations. Because VOCs, by definition, will volatilize, special care should be taken during the sample collection and preservation process. Handling of the soil sample should only be done as necessary, and only while wearing a clean pair of nitrile or latex gloves to minimize the potential for cross-contamination of the soil sample. In Arizona, soil sampling requirements are promulgated under Arizona Revised Statutes (A.R.S.) §49-104 (A).

8.1 PROCEDURE SUMMARY

The EPA Office of Solid Waste promulgated Method 5035, *Closed-System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples* (Attachment 1), in June 1997 in SW-846, Update III. The Arizona Department of Health Services (ADHS) Office of Laboratory Licensure, Certification and Training adopted Method 5035 in May 1998 and Method 5035 became enforceable on March 1, 1999 in Arizona.

When utilizing the field preservation option of the 5035 Method, samples must be preserved immediately after collection with minimal handling to be considered reliable compliance samples. Samples maybe collected and held on ice at 4°C (±2°C) for a maximum of 2 hours before preserving or analyzing the sample. This option of holding samples on ice for up to 2 hours is accepted, but not encouraged, due to the known volatile loss over time. Samples collected and preserved or analyzed after 2 hours will be considered bulk samples and not suitable for compliance purposes.

The collection and storage of soils for VOC analysis using current US EPA methodology has changed since the promulgation of SW846 Method 5035. The EPA has approved of three methods for collecting VOC samples from soil: Methanol Extraction, EnCore™sampler, and Acid-preservation.

URS will typically utilize the methanol preservation method, because of its relative ease. URS will occasionally use the EnCore ™ Sampler as an alternative to the methanol extraction method. This is particularly more appealing if there are no facilities for maintaining the methanol at a controlled temperature, or when the sample or containers require shipment by air, or across state or international borders.

8.1.1 Methanol Preservation.

- Requires coring and weighing 5 gram samples and placing in 40 mL vials preserved with methanol. VOC losses are prevented by both retarding volatilization and preventing biodegradation. However, this method involves use of a hazardous substance and weighing samples in the field. VOC detection limits are elevated 25 to 50 fold. Unused methanol and samples must be disposed of as hazardous waste.

8.1.2 EnCore™ Sampler Preservation.

- Collect EnCore™ Samplers and a dry weight for each sample point. Ship to lab within 48 hours of collection.

8.1.3 Acid Preservation.

- Requires coring and weighing 5 gram samples and placing in 40 mL vials preserved with an acid solution (formed from sodium bisulfate). While this method overcomes the methanol objections and eliminates sub-sampling in the lab, different limitations are presented:
- Acid may be insufficient for preserving soils with high buffering capacity.
- Alkaline soils may react vigorously with the acid and the vials may explode.
- Acid may salt in or salt out contaminants, depending on organic carbon content.
- A high level analysis may be needed in addition to the low level analysis.

8.2 EQUIPMENT AND MATERIALS REQUIRED FOR PROCEDURE

The following equipment should be used during sample collection activities:

- Appropriate air monitoring equipment (as per project specific health and safety plan or HASP)
- Appropriate personnel protective equipment (PPE) as per HASP
- Decontamination equipment

- Paper towels
- Waterproof and permanent markers or pens
- Coolers and ice
- Zip-loc or similar plastic bags
- Packing material for sample containers
- Field logbook, field sheets, chain-of-custody sheets, sample collection log, air monitoring log, HASP
- Contaminant-free magnetic stirring rods (if required by lab)
- Sample containers with preservation reagents (methanol or sodium bisulfate)
- Calibrated balance (balance must be calibrated once per day)
- Syringes or EnCore™ samplers
- Cutting implement

8.3 SAMPLE COLLECTION PROCEDURES

8.3.1 Soil Cores and Bulk Soil Samples

Sample collection vessels will vary depending upon the sample collection apparatus. Typically, URS will collect soil samples for VOC analysis using SimulProbe, Geoprobe or California split-spoon samplers or via a continuous coring process. The sample collection apparatus is immediately opened after retrieval of the sampling device. Once the device is open, the soil is prepared for sub-sampling according to the following methods.

QA/QC sampling requirements for both these methods include the collection of a minimum of one triplicate sample for each day. Particular attention should also be paid to ensure other QA/QC requirements are met, which will typically include the collection of QA/QC samples at a frequency of 5% (minimum) to 10% of the primary samples.

8.3.2 Easy Draw® Syringe/Methanol Extraction

Sample collection procedures are as follows:

- Wear chemical resistant gloves during all handling of the pre-weighed vials
- Weigh the vial with the methanol preservative to the nearest 0.1 gram. If the weight varies by more than 0.2 gram from the original weight recorded on the vial by the laboratory – discard the vial.
- Tare the vial that contains the preservative.
- Collect a 25 or 5 gram sub-sample of the soil core
    - An EasyDraw Syringe® will be inserted into the Powerstop® Handle which is calibrated to accept either 5 or 10 grams (approximately, actual weight will be calculated in the laboratory) of soil.
    - The end cap is then removed from the syringe and the syringe inserted into the soil sub-sample until the syringe has forced the plunger to the stopping point.
    - The syringe is then removed from the handle and inserted into the tared 40-milliliter (ml) vial containing methanol, and the sample is then ejected into the vial by pushing the plunger.
- The 40-ml vial will then be immediately capped, and labeled, placed in a Ziploc bag and then placed into an iced cooler to await delivery to the laboratory for analysis of VOCs by EPA Method 8260. Use the paper towel to remove any soil off the vial threads prior to capping.
- Weight the vial with the soil sample to the nearest 0.1 gram and record on the sample label.
- Fill the dry weight sampling container and label.

Inserting the syringe into soil

Forcing Sample into Syringe

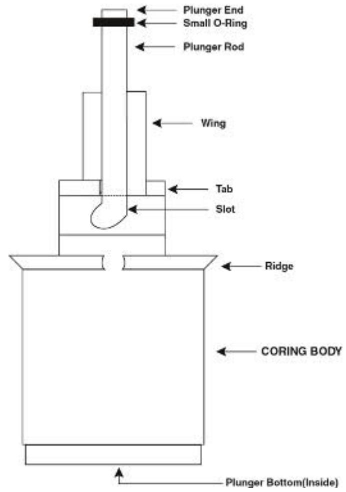
Extruding Sample into Vial

8.3.3 EnCore™ Sampler

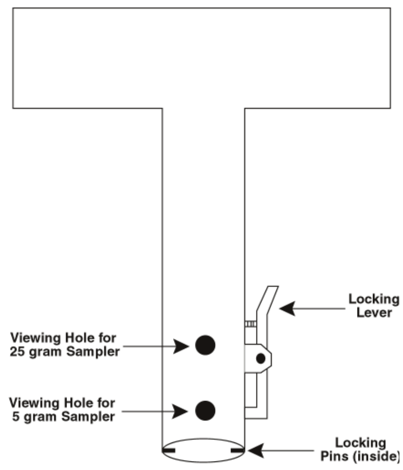
A sub-sample of the soil core or bulk sample will be collected immediately using an EnCore™ Sampling kit. VOC samples will be collected in the following manner:

- Open foil pouch containing the EnCore™ sampler.
- Hold coring body and push plunger rod down until small o-ring rests against tabs. This will assure that plunger moves freely.
- Depress locking lever on EnCore™ T-Handle. Place coring body, plunger end first, into open end of T-Handle, aligning the (2) slots on the coring body with the (2) locking pins in the T-Handle. Twist coring body clockwise to lock pins in slots. Check to ensure Sampler is locked in place. Sampler is ready for use.
- Turn T-Handle with T-up and coring body down. This positions plunger bottom flush with bottom of coring body (ensure that plunger bottom is in position). Using T-Handle, push Sampler into soil until coring body is completely full. When full, small o-ring will be centered in T-Handle viewing hole. Remove Sampler from soil. Wipe excess soil from coring body exterior.
- Cap coring body while it is still on T-handle. Push cap over flat area of ridge. ***Push and twist cap to lock arm in place. Cap must be seated to seal sampler*** (see diagram below).
- Remove the capped Sampler by depressing locking lever on T-Handle while twisting and pulling Sampler from T-Handle.

En Core Sampler™

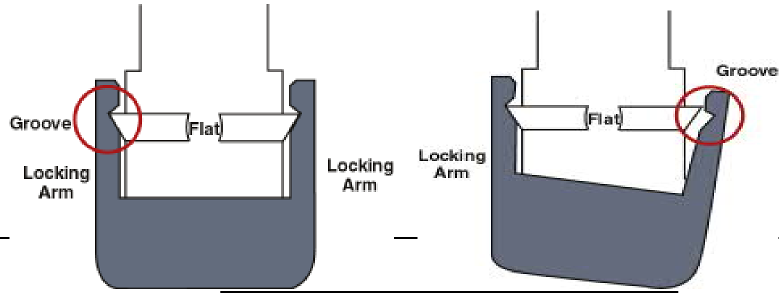


T-Handle

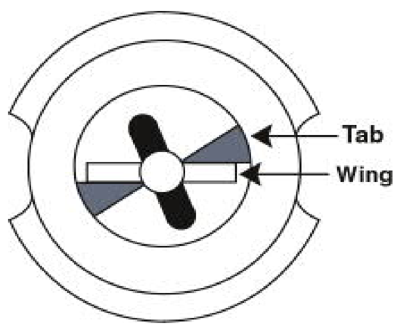


- Lock plunger by rotating extended plunger rod fully counter-clockwise until wings rest firmly against tabs (see plunger diagram at right).
- Attach completed label (from En Core Sampler bag) to cap on coring body.
- Return full En Core Sampler to zipper bag. Seal bag and put on ice.

Capping the Sampler



Locking Wings



8.3.4 Bulk Samples

The rationale for collection of bulk samples must be clearly documented and approved by the appropriate program in a work or sampling plan or other written communication with ADEQ. If samples are not preserved in the field or sub-sampled in EnCore™ Samplers, the reasons for not preserving must be clearly documented and approved by the relevant program. Significant volatile loss occurs when samples are collected in glass jars and transported to a laboratory for analysis. Therefore, **glass jars with Teflon™-lined lids containing no preservative ARE NOT ACCEPTABLE** for the collection of soil for VOC analysis, unless otherwise specified in this policy (Program Specific Requirements) or prior approval has been received from the appropriate program. Bulk sampling methods are typically only used for profiling purposes. Composite soil samples are not acceptable for investigation or remediation confirmation. However, these samples are acceptable for stockpiled soil.

8.4 SAMPLE SHIPPING PROCEDURES, CUSTODY, AND HOLD TIMES

Methanol-extracted or Encore™ Samplers are to be preserved at 4 ^{o}C 62 ^{o}C and shipped to an ADHS certified laboratory for analysis of volatile organic compounds. Shipping containers should be packed with plenty of ice and labeled in accordance with DOT Regulations. For general sample handling and shipping, refer to SOP-17 through SOP-19.

Methanol-extracted samples must be analyzed within 48 hours of collection if stored at 4 ^{o}C 62 ^{o}C. Samples collected using the EnCore™ sampler must be analyzed or preserved within 48 hours of collection if stored at 4 ^{o}C 62 ^{o}C. URS does not typically freeze samples. Approval for freezing samples will be solicited from the ADEQ, if necessary for a specific project.

8.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Field QA/QC samples which may be collected include trip blanks, reagent blanks, rinsate blanks, and field duplicates or split samples. Field QA/QC samples will be determined on a project specific basis based on project data quality objectives.

8.6 REFERENCES

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

ADEQ, 2002; *Release Reporting & Corrective Action Guidance*, Arizona Department of Environmental Quality UST Program, August, 2002.

ASTM Standard Designation D 4547-91; *Practice for Sampling Waste and Soils for Volatile Organics*.

ASTM Standard Designation D 4700-91; *Guide for Soil Sampling from the Vadose Zone*.

ASTM Standard Designation D 1452-80 (1995) Practice for Soil Investigation and Sampling by Auger Borings.

9.0 COLLECTION OF COMPOSITE SOIL SAMPLES FOR COMPLIANCE PURPOSES (3.4.2)

This SOP describes the protocols for sample collection and preparation of composite surface and subsurface soil samples.

9.1 PROCEDURE SUMMARY

Composite soil samples are blended samples collected from two or more discrete sample locations or depths. The purpose of compositing soil samples is to provide analytical cost savings. The composite sample provides a representative or "average" concentration of the soil area of volume that is sampled. The disadvantage to using composites is that information concerning the chemical contaminants is lost. That is, each set of samples generates only one estimate of the concentration of each contaminant, which results in increased standard error and increased "t" values.

Composite samples may be mixed in the field and then split to obtain the appropriate sample volume for laboratory analysis, or the discrete samples may be submitted to the laboratory and mixed by the laboratory prior to analysis.

Composite sampling may be used for most chemical analytes such as semi-volatile organic compounds, most metals, herbicides, pesticides, and PCBs. Composite sampling is not suitable for sampling of soils intended for volatile organic compound (VOC) analysis due to the fact that handling of the samples is likely to result in loss of VOCs through volatilization.

The ADEQ Waste Division does not allow the use of composite samples for site characterization or remediation confirmation.

9.2 EQUIPMENT AND MATERIALS REQUIRED FOR PROCEDURE

The following equipment should be used during sample collection activities:

- Appropriate air monitoring equipment (as per project specific health and safety plan or HASP)
- Appropriate personnel protective equipment (PPE) as per HASP
- Decontamination equipment
- Paper towels

- Waterproof and permanent markers or pens
- Coolers and ice
- Ziploc or similar plastic bags
- Packing material for sample containers
- Field logbook, field sheets, chain-of-custody sheets, sample collection log, air monitoring log, HASP
- Stainless steel bowl, trowel, knife, and spatula
- Plastic sheeting
- Aluminum foil
- Laboratory supplied sample containers and caps

9.3 SAMPLE COLLECTION PROCEDURES

Each sample location will be cleared of vegetation or debris prior to sample collection. Standard utility clearance procedures will be followed prior to collection of subsurface samples. Each sample location will be marked in accordance with the project specific Field Sampling Plan.

9.3.1 Discrete Surface Sample Collection

Surface samples (at depths between zero and six inches) will be collected using a decontaminated stainless steel trowel OR by driving a brass ring or sleeve into the soil at the desired sample location. Personnel will use a clean, chemical resistant pair of gloves for each discrete sampling location to avoid cross-contamination and exposure to contaminants. The sample will be placed in a clean, stainless steel bowl prior to compositing.

Note that if samples are to be collected for VOC analysis, the procedures in Section 1.0 should be followed.

9.3.2 Discrete Subsurface Sample Collection

Subsurface samples will be collected following advancement of a boring by hand augering, a drill rig, or a push-probe rig as determined based on the desired sample depth and site-specific conditions. Following advancement of the boring, the sample will be collected from undisturbed soil in a brass ring/sleeve, or acetate sleeve depending upon the drilling method used and the site-specific Field Sampling Plan.

Collect the sample for compositing at the desired depth interval. Record recovery in the sampler, and any details of interest regarding the recovered sample (e.g., odors, color, lithology, moisture, free product, etc.) The collected sample will be placed in the clean stainless bowl for compositing.

If sampling for VOCs, use the procedures described in Section 1.0. Screen the samples for VOCs using a PID or FID.

9.3.3 Field Compositing of Soil Samples

As each sample is collected for compositing, place the sample in the clean stainless steel bowl. Following collection of the desired samples for the composite, mix the sample thoroughly with the decontaminated trowel and/or spatula. The goal is to achieve as homogeneous a mixture as possible. Following mixing, divide the sample in half and set one half aside (on aluminum foil). Continue dividing the sample until the appropriate volume is achieved to fill the sample containers. The appropriate sample volume will be determined by the analytical method to be performed. Ensure that the filled sample containers will provide the required sample volume. Using a clean stainless steel spoon or the stainless steel trowel, transfer the sample into the container. Cap the container tightly.

Label the sample container(s) using waterproof ink or marker. Each sample should be labeled with the project name or number, Sample ID (which typically includes location and depth information), and date.

Containerize the remaining soil and preserve pending additional analytical needs.

9.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Field QA/QC samples which may be collected include trip blanks, reagent blanks, rinsate blanks, and field duplicates or split samples. Field QA/QC samples will be determined on a project specific basis based on project data quality objectives.

9.5 REFERENCES

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

ADEQ, 2002; *Release Reporting & Corrective Action Guidance*, Arizona Department of Environmental Quality UST Program, August, 2002.

U.S. EPA, SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Revision 4*, Chapter 9, Sampling Methods, December 1996.

10.0 COLLECTION OF SOIL SAMPLES FOR METALS ANALYSIS (3.4.11)

This SOP describes the protocols for sample collection of surface and subsurface soil samples for metals analysis.

10.1 EQUIPMENT AND MATERIALS REQUIRED FOR PROCEDURE

The following equipment should be used during sample collection activities:

- Appropriate personnel protective equipment (PPE) as per HASP
- Decontamination equipment
- Paper towels
- Waterproof and permanent markers or pens
- Sample shipping containers
- Ziploc or similar plastic bags
- Packing material for sample containers
- Field logbook, field sheets, chain-of-custody sheets, sample collection log, air monitoring log, HASP
- Stainless steel bowl, trowel, knife, and spatula
- Plastic sheeting
- Aluminum foil
- Laboratory supplied sample containers and caps OR brass rings, Teflon sheets and end caps

10.2 SAMPLE COLLECTION PROCEDURES

Each sample location will be cleared of vegetation or debris prior to sample collection. Standard utility clearance procedures will be followed prior to collection of subsurface samples. Each sample location will be marked in accordance with the project specific Field Sampling Plan.

10.2.1 Discrete Surface Sample Collection

Surface samples (at depths between zero and six inches) will be collected using a decontaminated stainless steel trowel OR by driving a brass ring or sleeve into the soil at the desired sample location. Personnel will use a clean, chemical resistant pair of gloves for each discrete sampling location to avoid cross-contamination and exposure to contaminants. The sample will be placed in a clean, stainless steel bowl.

Following collection of the sample, mix the sample thoroughly with the decontaminated trowel and/or spatula. The goal is to achieve as homogeneous a mixture as possible. Following mixing, use the clean stainless steel spoon or the stainless steel trowel to transfer the sample into the container. The appropriate sample volume will be determined by the analytical method to be performed. Ensure that the filled sample container will provide the required sample volume. Cap the container tightly.

10.2.2 Discrete Subsurface Sample Collection

Subsurface samples will be collected following advancement of a boring by hand augering, a drill rig, or a push-probe rig as determined based on the desired sample depth and site-specific conditions. Following advancement of the boring, the sample will be collected from undisturbed soil in a brass ring/sleeve, or acetate sleeve depending upon the drilling method used and the site-specific Field Sampling Plan.

The ends of brass rings are to be covered with Teflon sheets, capped, and sealed. Each sample is labeled and placed in a Ziploc or equivalent bag, which is sealed.

10.2.3 Sample

Label the sample container(s) using waterproof ink or marker. Each sample should be labeled with the project name or number, Sample ID (which typically includes location and depth information), and date.

10.3 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Field QA/QC samples which may be collected include trip blanks, reagent blanks, rinsate blanks, and field duplicates or split samples. Field QA/QC samples will be determined on a project specific basis based on project data quality objectives.

10.4 REFERENCES

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

U.S. EPA, SW-846, *Test Methods for Evaluating Solid Waste*, *Physical/Chemical Methods, Revision 4,* Chapter 9, Sampling Methods, December 1996.

11.0 LITHOLOGIC LOGGING (3.4.10)

This SOP describes the specific protocols for lithologic logging, and is intended to provide a consistent and uniform method for describing lithology.

11.1 PROCEDURE SUMMARY

The field geologist will maintain a complete log showing the depth below ground surface at which important changes in formation is encountered. The log shall show the thickness, type, color, and drilling characteristics of rock or soil formation penetrated, the location of water, and the soil classified by the Unified Soil Classification System according to ASTM D 2488. Even though no change in formation is apparent, formations shall be checked and the results entered in the log at intervals not to exceed 10 ft. This log shall be kept up to date with the progress of the drilling, and shall be available for examination at any time during the drilling operation.

The description for the soil should include classification of the soil as well as screening the soil for investigation specific details. Prior to describing lithology, a portion of the soil is placed into a mason jar with a Teflon patch on the lid, or into a plastic bag. This soil is agitated, and allowed to volatilize. A calibrated photoionization detector (PID) is inserted into the container and the total measurement of organic vapors recorded on the lithologic log. Once the PID readings have been recorded the sample sleeve will be opened providing access to undisturbed soil.

11.2 GENERAL SOIL DESCRIPTION

A general description of the soil is typically all that is required for most environmental investigations.

11.2.1 Visual Method

The evaluation of soil using the visual methods discussed below provides the minimum information required to describe the soil.

Determine the angularity of the coarse grained particles (refer to Table 1 and Figure 3)

Determine the shape of the coarse grained particles (refer to Table 2 and Figure 4).

Describe the color of the sample. If more than one color or color is mottled or patchy, describe as such. Include whether the sample is wet or dry.

Describe the odor if organic or unusual. If the soil sample is from a zone of known contamination, PID data may be substituted.

Determine moisture condition of the overall sample (refer to Table 3)

Describe the HCl reaction for the sample (refer to Table 4).

For intact fine-grained soil, describe the consistency (refer to Table 5)

Describe the cementation of intact coarse-grained soils (refer to Table 6).

Describe the structure of intact soils (refer to Table 7).

Describe the range of particle sizes for sand and gravel components.

Describe the maximum particle size for the sample in accordance with the following:

- If the maximum particle size is a sand size, describe as fine, medium, or coarse.
- If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening through which a particle will pass (e.g., maximum particle size is 1½-inch gravel).
- If the maximum particle size is a cobble or boulder size, describe as the maximum dimension of the particle (e.g., maximum boulder dimension is 18-inches).

Describe the hardness of coarse sand and larger particles, or state what happens when the particle is hit by a hammer. “Hard” refers to a particle that will not crumble, crack, or fracture when struck by a hammer blow.

Describe any other descriptors such as the presence of roots or root hole structures, difficulty of drilling or augering, caving of trench or hole, presence of mica, organics, calcareous or carboniferous materials.

Determine whether a local name or geological interpretation of the soil or both may be added if identified as such.

11.2.1.1 Classification as Peat

If the sample is primarily composed of fibrous to amorphous vegetable tissue, is dark brown to black, and has an organic odor, it shall be designated as highly organic soil and identified as peat

(PT), and should not be subjected to any further identification procedure. This identifier is independent of the stage of decomposition.

11.2.2 Manual Methods

In certain instances a qualitative assessment of the soil may be required. The following section provides a summary of the manual test procedures necessary to complete the field classification of a soil sample.

11.2.2.1 Preparation for Identification

1) Remove particles greater than 3-inches in diameter and estimate the percentage by volume of cobbles or boulders.

2) Estimate the percentage by volume of gravel, sand, and fines using jar method, visual method, or wash test method (ASTM D 2488-Appendix X4). Estimate the percentage of each to the nearest 5%. The sum must add up to 100%. If one group is present but <5%, indicate its presence by the term, "trace". The sum of the other groups must still add up to 100%.

11.2.2.1.1 Preliminary Identification

Follow the appropriate identification based upon the determination of whether the soil is fine-grained (>50% fines) or coarse-grained (<50% fines).

Identifying Fine-Grained Soils (>50% Fines)

1) Select a representative sample. Remove particles larger than the #40 sieve.

2) Determine the dry strength by performing the following test:

    - Mold the material into a 1-inch ball, adding water as necessary until the ball has the consistency of putty.
    - Make at least three ½-inch diameter test specimens, and allow to dry slowly (temperature should be less than $60F^o$).
    - Test the dry strength of the balls or lumps by crushing between fingers, using the criteria presented in Table 8.

3) Determine the dilatancy of the soil by performing the following test:

- Mold the material into a ½-inch diameter ball, adding water as necessary until the consistency of the ball is soft but not sticky.
- Smooth the ball in the palm of the hand using a spatula or blade of a knife. Shake horizontally, striking the sides of the hand vigorously against the other hand several times and note the appearance of water. Squeeze the sample back into a ball and note the water disappearing into the soil. Describe the dilatancy of the sample using the criteria presented in Table 9.

4) Determine the toughness of the soil by performing the following test.
    - Following the completion of the dilatancy test, shape the specimen into an elongated pat and roll into a 1/8-inch diameter thread between hand and flat surface or the palm of the other hand.
    - Continue to fold, and re-roll the thread until the plasticity limit is reach, which is when the 1/8-inch diameter thread begins to crumble. Note the pressure required to roll the thread at the plasticity limit.
    - After the thread crumbles, knead the thread into a lump and continue kneading until the lump crumbles. Describe the toughness of the sample during the kneading using the criteria presented in Table 10.
5) Determine the plasticity of the sample based on the observations made during the toughness teat, and describe according to the criteria presented in Table 11.

Classification of Fine-Grained Soils

Once the description of soil is complete and the soil has been identified, the soil is identified and assigned a group name and symbol using. If the soil is inorganic, use the identifiers presented in Table 12. Use the flow charts presented in Figures 1a and 1b to identify fine-grained soil.

- If soil has 15 to 25% sand or gravel, or both, the words "with sand" or "with gravel" shall be added to the group name.
- If the soil has 30% or more or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name.

If the soil contains sufficient organic material to influence the properties of the soil, the soil should be identified as an organic soil, and the symbols OL or OH used, depending upon the properties of the soil.

Identifying Coarse-Grained Soils (<50% Fines)

Use the flow chart presented in Figure 2 to identify coarse-grained soil.

1) The soil is a gravel (G) if the volume of sand is less than the volume of gravel.

The soil is a sand (S) if the volume of gravel is less than the volume of sand.

The soil is considered clean if the volume of fines present in the sample is less than 5%.

The soil is considered well graded (GW or SW) if it has a wide range of particle sizes and substantial amounts of intermediate particles sizes, otherwise it is poorly graded (GP or SP).

If the volume of fines is greater than 15%, the soil is considered a gravel with fines or a sand with fines. Use identification methods for fine-grained soils to determine whether soil is clayey (GC or SC) or silty (GM or SM).

If soil has 10% fines, give dual identification using two symbols with a hyphen "-“ in between.

First symbol for clean gravel or sand (GW, GP, SW, SP).

Second symbol for gravel or sand with fines (GC, GM, SC, SM).

The group name is the name for the first symbol plus the word "with clay" or "with silt".

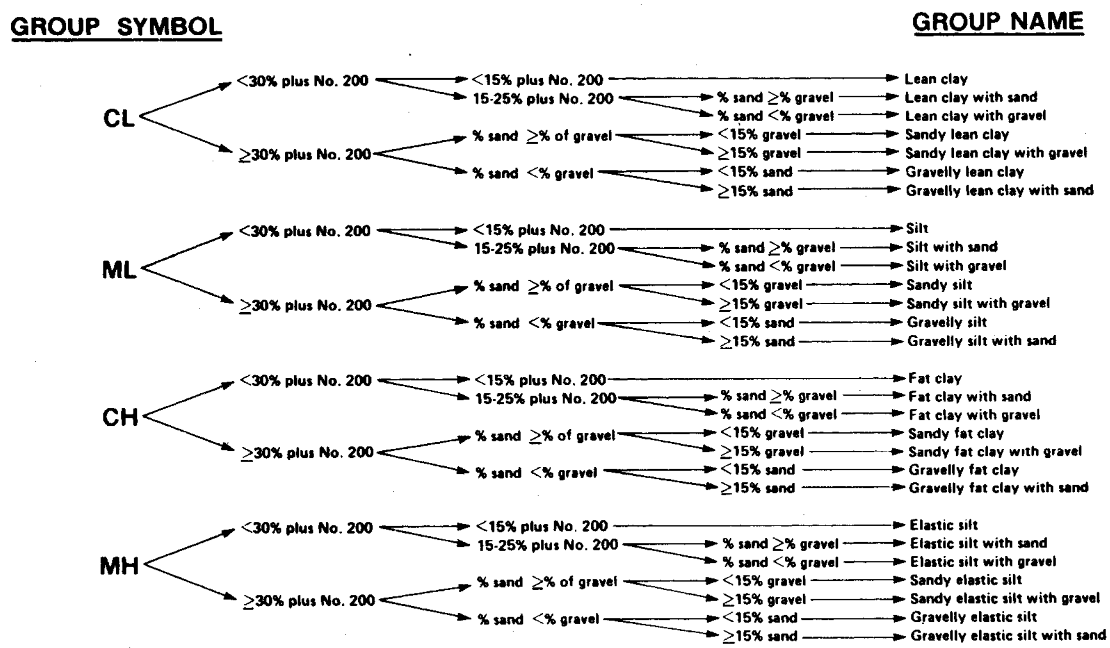
If soil is predominantly sand or gravel but contains ≥ 15% of the other coarse-grained constituent, the word "with gravel" or "with sand" are added to the group name.

Generic Soil Description

Group name (group symbol) - %'s of gravel, sand and fines (with descriptions of hardness and angularity for coarse-grained soils, with descriptions of plasticity, dry strength, dilatancy and toughness for fine-grained soils), color, (odor if unusual), moisture (dry, moist, wet), maximum size.

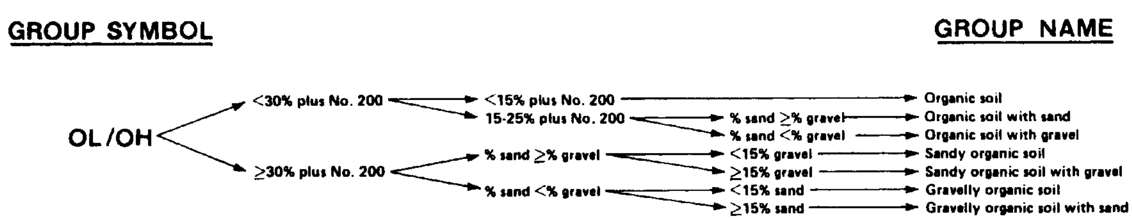
NOTES

- For borderline soils, use a borderline symbol (e.g., CL/CH)
- For intact samples, include a description of the consistency, structure, cementation, layering, etc.



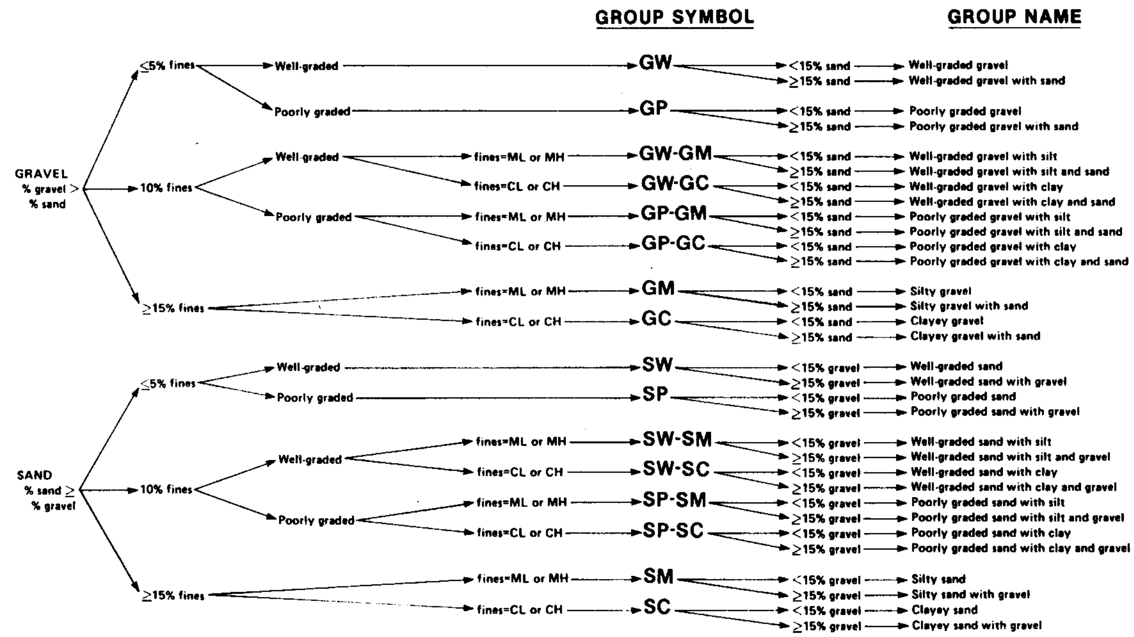
NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

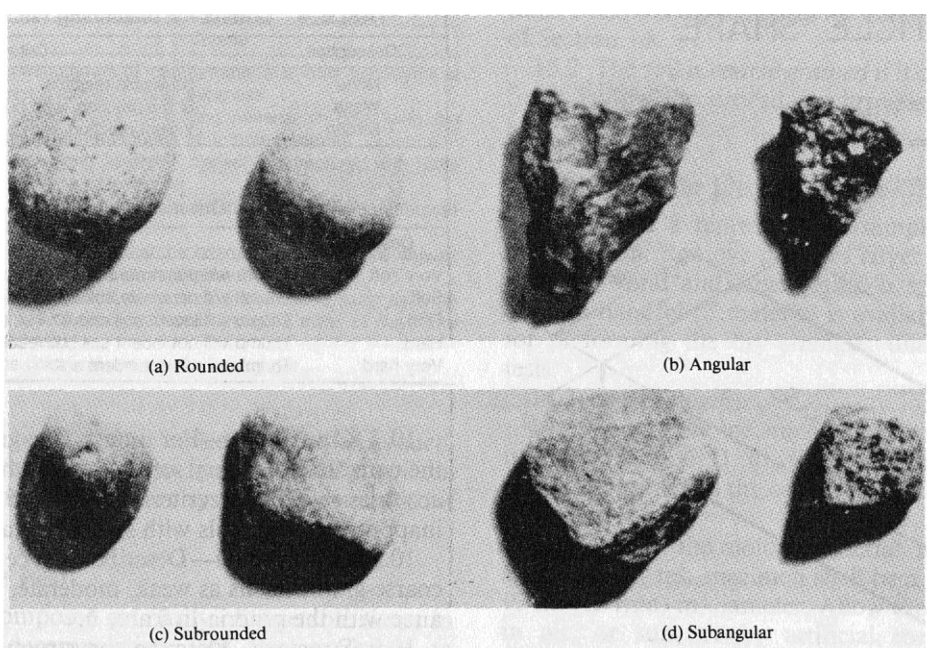


FIG. 3 Typical Angularity of Bulky Grains

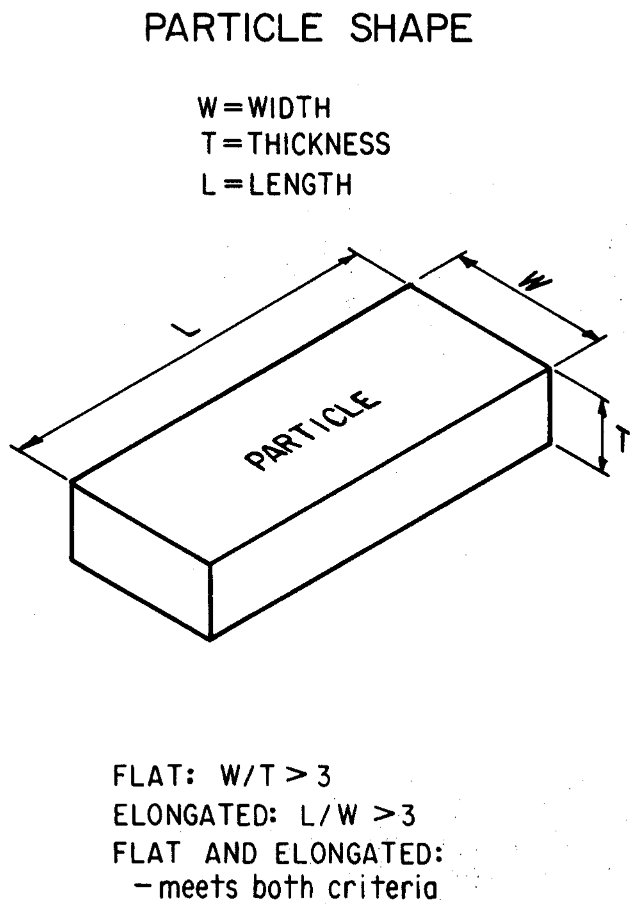


FIG. 4 Criteria for Particle Shape

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

11.3 REFERENCES

ASTM Standard Designation D 5434-93; *Guide for Field Logging of SubsurfaceExploration of Soil and Rock.*

ASTM Standard Designation D 2487-93; *Classification of Soil for Engineering Purposes (Unified Soil Classification System)*.

ASTM Standard Designation D 2488-93; *Practice for Description and Identification of Soils (Visual – Manual Procedure)*.

12.0 EQUIPMENT DECONTAMINATION PROCEDURES

12.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the step-by-step procedures for field decontamination of equipment. Decontamination of equipment and personal protective equipment (PPE) is designed to ensure that the introduction and transfer of contamination is minimized.

12.2 SCOPE

This SOP applies to all personnel collecting environmental samples or operating in environments in which hazardous or contaminating substances are expected to be present.

12.3 METHOD

12.3.1 General

Decontamination consists of physically removing contaminants. To prevent the transfer of harmful materials and unwanted cross contamination, decontamination procedures continue throughout site operations.

A decontamination plan should be based on the worst-case scenario (if information about the site is limited). The plan can be modified if justified by supplemental information obtained as the field program evolves. Initially, the decontamination plan assumes all protective clothing and equipment that leave the exclusion zone are contaminated. Based on this assumption, a system is established to wash and rinse all non-disposable equipment. This SOP will serve as the site decontamination plan.

The type of decontamination procedures and solutions needed at each site should be determined after considering the following project-specific conditions:

- The type of equipment to be decontaminated;
- The type of contaminant(s) present; and
- Extent of contamination.

12.3.2 Procedures

All sampling equipment used at the site must be decontaminated both before activities begin and after each sample is collected. All drilling equipment must be decontaminated both before activities begin and between each location.

12.3.2.1 Decontamination Site

Central decontamination areas for drill rigs and other large equipment will be located within the site. A decontamination area will be chosen so that decontamination fluids and soil wastes can be easily discarded or discharged into controlled areas of accumulation. A full-scale decontamination pad will be constructed. At a minimum, the pad must consist of a bermed liner large enough for equipment, have a nearby source of potable water, have a containment system for rinse water, and be equipped with a steam cleaner. After completion of drilling at a site, signs of gross contamination (if any) will be removed from the drill rig prior to moving the rig.

Smaller decontamination tasks, such as for groundwater, soil, and surface water/sediment sampling equipment, may take place at the sampling locations. In this case, all required decontamination supplies and equipment will be mobilized to the site and all decontamination wastes containerized. Decontamination fluids will be disposed of according to SOP-21, *Investigation-Derived Wastes.*

12.3.2.2 Decontamination Equipment

The following is a list of equipment that may be needed to perform decontamination:

- Bermed concrete or synthetic material-lined decontamination pad;
- Brushes (including long-handled brushes), garden-type water sprayers (without oil-lubricated moving parts), rinse bottles, flat-bladed scrapers;
- Portable steam cleaner;
- Sump or collection system for contaminated liquid;
- Wash tubs and buckets;
- Drums or tanks for containing decontamination fluids and solids; and
- Non-phosphate detergent, American Society for Testing and Materials (ASTM) Type II reagent grade water, isopropanol, methanol, hexane, or nitric acid.

12.3.2.3 Decontamination Procedure

12.3.2.3.1 Sample Bottles and Jars

At the completion of each sampling activity the outside of each sample bottle or jar must be decontaminated as follows:

- Be sure that the bottle or jar lids are snug; and
- Wipe the outside of the bottle with a paper towel, if necessary to remove visible sample material from the bottle or jar.

12.3.2.3.2 Personnel and Personal Protective Equipment

Review the project Health and Safety Plan (HASP) for appropriate personnel decontamination requirements.

12.3.2.3.3 Sampling Equipment

Note: See Section 12.3.2.3.6 for groundwater sampling pump decontamination.

The following steps will be used to decontaminate small sampling equipment:

- Decontamination personnel will wear the appropriate personal protective equipment as required by the contractor specific HASP.
- The sequence of actual decontamination will be as follows:
  - Gross contamination on equipment will be scraped off at the sampling site.
  - Water-resistant equipment is placed in a washtub containing Liquinox, or equivalent laboratory-grade detergent with potable water, and scrubbed with a bristle brush or similar utensil.
  - Equipment will be thoroughly rinsed with potable water in a second washtub, and then rinsed using distilled water.
  - Rinse with pesticide-grade methanol if visible oil is present.
  - Rinse with pesticide-grade hexane if visible oil is present.
  - If methanol and hexane are used, rinse twice again with tap water and then rinse using a deionized or distilled grade water.

- Depending on site conditions and the number of samples collected at each location, rinse and detergent water may be replaced with new solutions between boreholes or sample locations.
- Following decontamination, equipment will be placed in a clean area to prevent contact with contaminated soil. All equipment should be allowed time to dry before re-use. If the equipment is not used immediately, it will be covered or wrapped in aluminum foil after drying to minimize potential airborne contamination.

12.3.2.3.4 Measurement Devices/Monitoring Equipment

Any delicate instrument that cannot be decontaminated easily should be protected while it is being used. These instruments can be covered with plastic sheeting, plastic bags, or aluminum foil to minimize contamination of the instrument. Openings can be made in the wrapping for sample intake.

12.3.2.3.5 Bailers

New bailers and nylon rope which are dedicated for each well and not used for well purging will only require an deionized or distilled water rinse prior to sample collection. If disposable bailers are used for purging, they will be discarded after purging. If non-disposable bailers are used, both end caps will be removed and decontaminated as outlined for sampling equipment before they are used for groundwater sample collection. Decontamination will include a complete wash and rinse using a long-handled brush to clean inside the bailer. This procedure will be followed to ensure that any contaminants associated with the stagnant water present in the casing prior to purging do not impact the groundwater sample through retention on the bailer. Similarly, if bailers come in contact with the ground or any other potential source of contamination, they will be decontaminated according to the procedure outlined for sampling equipment. Nylon cord used for bailing will be replaced if it comes into contact with the ground surface.

12.3.2.3.6 Groundwater Sampling Pumps

Proper pump decontamination between wells is essential for sample integrity. The following steps will be adhered to during decontamination:

- Potable water with a non-phosphate detergent such as Liquinox will be flushed through the pump and over the outside of the hoses. A minimum of three pump tubing volumes of soapy water will be purged through the pump.
- Potable water will then be flushed through the pump and over the outside of the hoses. A minimum of three pump tubing volumes of potable water will be purged through the pump to assure that all of the detergent solution has been removed.
- At least two pump tubing volumes of deionized or distilled water will then be flushed through the pump. When applicable, the pump may then be used for the collection of an equipment blank.
- The pump is then allowed to dry and stored in the equipment area.

12.3.2.3.7 Drilling and Subsurface Soil Sampling Equipment

Drilling equipment, including the rig, augers, drill rods, and split-spoon samplers will be decontaminated by the drilling contractor prior to any drilling operations and between borings. Decontamination will take place at the fixed decontamination pad. All external surfaces of all drilling equipment, rigs, tools, drill bits, drilling stem, hoses, and all other appurtenant equipment will be thoroughly cleaned after each hole is completed. All tools used for soil sampling (i.e., split-spoon, split-barrel, Hydropunch samplers) will be decontaminated as specified in Section 12.3.2.3.3 prior to the collection of each sample. When collecting samples for geotechnical analysis only, soil sampling equipment will be decontaminated in the same manner as other drilling tools.

All drilling rigs and tools will be steam cleaned prior to commencement of drilling activities. All fluids will be contained and managed. Decontamination begins by completely removing all soil and visible contamination (i.e., soil, mud, hydraulic fluid) from the equipment with a high pressure steam cleaner, and thoroughly flushing the interior and exterior of all downhole tools, including drill pipes, collars, bits and tremie pipe with fresh, clean, potable water.

Decontamination will take place at the decontamination pad where all rinse water will be containerized for disposition.

12.3.2.3.8 Decontamination of Heavy Equipment

Heavy equipment (e.g., drill rigs, bulldozers, backhoes, and trucks) is generally washed with water under pressure, if possible. Portable steam cleaners and handwashing with a brush and detergent, followed by a potable water rinse, can also be used. Decontamination of heavy equipment will be conducted at the decontamination pad where all rinse water can be containerized for treatment. Particular care must be given to the components in direct contact with contaminants, such as tires and buckets. Wipe sampling may be utilized to establish effectiveness of decontamination procedures.

12.3.3 Investigative Derived Material

All materials and wastes generated during decontamination will be managed as described in SOP-21, *Investigation-Derived Waste*.

12.4 REFERENCES

U.S. Environmental Protection Agency (EPA). *A Compendium of Superfund Field Operations Methods.* Vols. I and II. USEPA/540/P 87/001a and b.

12.5 RECORDS

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded in the field logbooks as per SOP-2, *Field Activity Records*. The information entered in the field logbook concerning decontamination should include the following:

- Date, start and end times;
- Decontamination personnel;
- Decontamination solutions used;
- Equipment identification numbers; and
- General decontamination methods and observations.

13.0 SOIL VAPOR SAMPLING FOR SOIL VAPOR SURVEYS (3.4.5)

This SOP describes the typical protocol used to perform soil gas surveys.

13.1 PROCEDURE SUMMARY

The performance of soil vapor surveys can provide significant information about the site, soil, and groundwater. There are generally two types of soil gas surveys to consider, active and passive. Passive soil gas surveys are usually used to assess large areas for the presence of VOCs, and certain semi-VOCs. The analytical data is quantitative relative to the other survey data, but can usually only be used qualitatively, to assess the presence and relative location of hotspots at a site. Active soil gas surveys, on the other hand, provide real data that can be compared to other locations, or to air quality standards. Several proprietary methods are available for collecting soil gas data, and the inclusion of any proprietary method in this SOP does not constitute an endorsement of such equipment.

13.2 SAMPLE COLLECTION PROCEDURES

13.2.1 Passive Soil Gas Surveys

The passive soil gas survey using GORE-Sorbers is an EPA accepted screening method. The passive soil gas survey consists of the installation of GORE-Sorber® screening modules. The quantity and approximate locations of the soil gas sampling points are determined prior to going into the field. Another important consideration is identifying the target analyte list. A complete list of analytes is available from W.L. Gore Associates.

The exact location of the samples are modified in the field, based upon the presence of obstructions, but will generally be within 10 feet of the proposed locations. A private utility location service will be used to locate buried utilities. The location of some of the sample points may be altered based upon the presence of buried utilities. The actual sample location will be marked and recorded.

The modules are placed in the ground to an approximate depth of 3 feet and remain in the ground for a 14-day period. After 14 days, the modules are removed and prepared for shipping to the W.L. Gore & Associates' (GORE) Screening Module Laboratory for analysis of VOCs by modified EPA Method 8260. The analytical results are tabulated and presented on isoconcentration maps, which are included with the final report from GORE.

13.2.1.1 Mobilization

Prior to deploying the GORE-Sorber® Screening Modules, the site-specific health and safety plan is reviewed and revised if necessary. Arizona Blue Stake is contacted to locate buried utilities. A licensed utility location service should be subcontracted to locate buried private utilities, if necessary.

13.2.1.2 Deployment and Retrieval

The GORE- Sorber® Screening Modules are deployed by constructing a ¾- to 1-inch boring to a depth of approximately 2 to 3 feet below ground surface (bgs). Care should be taken to ensure that the pilot holes are of uniform diameter and depth. After the pilot hole is completed, the modules are tied to a section of retrieval cord, and inserted using a stainless steel insertion rod. The retrieval cord is tied to a cork, which is used to seal the boring. At locations where duplicates are deployed, the duplicate collector will be inserted in the same pilot hole as the primary sample collector. Following insertion of collectors, the cork is tamped flush with the ground surface and then the location is marked to assist in locating it during retrieval. Property owners and/or on-site managers should be notified of the sample locations to ensure that they are not damaged or covered up by ongoing site operations.

Once the modules have been exposed for the 14-day period, field personnel will locate the modules, remove the cork, grasp the cord, and manually pull the module assembly from each location. The cork and cord are then detached and disposed of, and the GORE-Sorber® Screening Modules are resealed in their respectively designated shipping vials. The sealed vials are returned to the supplied shipping boxes and returned along with Chain-of-Custody (COC) forms to the GORE Screening Module Laboratory for analysis. The pilot holes are sealed with bentonite once the modules have been removed.

13.2.1.3 Analytical Methodology

When the modules arrive at the laboratory, the shipping boxes are opened, the samples are logged, and the Chain of Custody (COC) documents inspected. Samples are then transferred to a temporary holding chamber with a positive pressure, zero-air supply to await analysis. The samples are prepared by simply cutting the module and removing a sorbent container (sorber). The primary sorber is then opened and placed into a desorption tube and the replicate sorbers are returned to the zero-air chamber. The primary sorber is then prepared for analysis by placing the sorbant material from the primary sorber into a desorption tube. The desorption tube is then placed into an automatic thermal desorption unit, which traps the desorbed vapors for analysis by gas chromatography and mass spectroscopy (GC/MS).

The standard analytical screening method uses a modified EPA method 8260A. Quality assurance for the screening method includes manufacturing, instrument, and method blanks as well as tuning checks and calibration standards. Prior to each sample run sequence, two instrument blanks, a sorber containing 5 micrograms (μg) of bromofluorobenzene, and a method blank are analyzed. These blanks and control samples must meet with set criteria prior to introducing standards into the system. Once the instrument has met the set criterion, standards containing target compounds at three calibration concentrations (5, 20, and 50 μg) are introduced into the instrument. Once all of the quality assurance criteria have been met, the samples can be introduced into the instrument. The positive identification of the individual target compounds is determined by the presence of the target ion, at least two secondary ions, retention time versus reference standard, and the analyst's judgment, and is reported as mass of analyte (in micrograms) per sample.

13.2.1.4 Reporting

A final report is prepared by GORE, once the analytical results have been validated. The analytical results are tabulated and presented on a map or maps of the property. URS will also prepare a drawing of the site depicting all buildings, utilities (which potentially may affect migration and distribution of soil gasses), and sample locations. An electronic copy of the drawing is forwarded to GORE for their use in constructing the isoconcentration maps.

13.2.2 Active Soil Gas Surveys

The active soil gas survey provides quantitative data, which can be used for characterization purposes. The use of subsurface investigative equipment for collecting the soil gas data will generally result in higher investigative costs for each sampling location than the passive soil gas survey. For this reason, URS will generally recommend collection of passive soil gas data to identify hotspots, prior to performing an active survey. In situations where source information is available, or a detailed depth profile is required, then the active survey should be used.

The active soil gas survey can be two or three dimensional, depending on the data objectives. The survey includes installation of a boring or borings, the collection of soil gas samples, and then backfilling the boring for abandonment. The borings can be installed using a variety of methods, including direct push, GeoProbe® (either manual or mechanical), as well as using conventional drilling techniques. The method for sample collection will vary depending on the method of boring installation. URS is very familiar with a variety of active soil gas surveying methods, but has provided general details for collecting samples using conventional drilling methods and the SimulProbe® sampler, which is capable of simultaneously collecting soil and soil gas samples from the same interval.

13.2.2.1 Planning

The proposed borings locations should be assessed based on previous sampling data or areas where operational activities may have caused a release. The total depth of the borings, and the number of sampling intervals should also be determined, unless the investigation objective is to delineate contamination laterally or horizontally. Once the locations and total depths are determined, drilling permits are prepared and submitted, as necessary (e.g., when anticipating encountering groundwater or if the total depth of the boring exceeds 99-feet).

Prior to mobilizing, the site-specific Health & Safety Plan will be reviewed and modified. Arizona Blue Stake will be contacted to locate buried utilities. In addition, a licensed utility location service will be subcontracted to locate buried private utilities, if necessary. The final location of the proposed boring may be modified based upon the location of utilities.

Laboratory coordination should also be completed in the planning stages, to ensure compatibility of sampling equipment, sample containment, and analytical methods, including whether to use a mobile laboratory or a fixed base laboratory. Advantages of the mobile laboratory are rapid turnaround of results, which can be used to assess the extent of contamination. The value of having a mobile laboratory becomes less when the results are not needed immediately, when the sample collection time reduces the number of samples collected during a day to less than approximately 10 samples, or when a lower detection limit and full QA/QC packages are necessary.

13.2.2.2 Boring Installation

The borings may be installed using a variety of drilling or direct push methods. When selecting the drilling method, one must consider the total depth of the boring, and the lithology that is anticipated to be encountered.

13.2.2.3 Sampling Methodologies

This SOP describes the sample collection process using the SimulProbe® sampler, which is capable of simultaneously collecting depth specific soil and soil gas samples in advance of the drill casing. The SimulProbe sampling tool is attached to the leading probe rod and driven into the ground. Additional probe rods are attached as necessary to reach depth. The sampler is advanced using an uphole slide hammer. This is a hydraulically powered percussion method for driving sampling tools into the subsurface. This method relies on a relatively small amount of static weight combined with percussion as the energy for advancement of the sampling tool.

The SimulProbe sampler has a screen that is covered until the sampler is retracted. Polyethylene tubing (¼-inch) is attached to the discharge outlet of the sampler. Once driven to the desired depth, the rod and SimulProbe will be lifted approximately six inches to expose the screened section. The ¼-inch tubing is then attached to a sampling apparatus located on the ground surface. A vacuum pump connected to the apparatus will be used to evacuate the tubing. Three to five tubing volumes of air will be removed before the sample is collected. The evacuation time will be adjusted with respect to the flow rate to assure the proper sample volume is extracted. The flow rate is dependent on resistance to vapor movement in subsurface soils and is indicated by the vacuum gauge on the pump.

After evacuation of the desired volume of air, the gate valve will be closed to prevent the introduction of ambient air to the sample stream. A laboratory-supplied, one-liter negative pressure canister labeled with a unique identification number will then be connected to the sampling apparatus. The canister will be opened to allow for the collection of the soil gas sample. Once the vacuum has decreased to approximately (–3) inches of mercury, the valve is closed and the sampling is complete.

13.2.2.4 Analytical Methodologies

URS will submit the soil vapor samples to the selected on-site or off-site laboratory for analysis of VOCs. Soil gas samples may be analyzed by EPA Method TO-15 or U.S. EPA 8260.

13.2.2.5 Quality Control

All laboratory analytical data and QA/QC data compiled as part of this investigation will be carefully reviewed to evaluate if any inconsistencies exist and if quality control criteria have been met. In the event that a QA/QC problem exists, URS will immediately contact the laboratory to investigate the problem and, if necessary, initiate corrective actions. QA/QC problems and solutions will be documented in the report.

Duplicate samples that are collected from the same location in the field and sent to the laboratory as two separate samples. Duplicate samples are used to check the precision of the field collection or laboratory analysis. Duplicate samples will be collected at a frequency of 10% or one per sampling event, whichever is greater.

13.2.2.6 Boring Abandonment

Each boring will be abandoned once the final sample has been collected. The borehole will be abandoned using a high solids bentonite grout.

13.2.2.7 IDW Management

All IDW will be managed as described in SOP-021, *Investigation-Derived Waste*.

13.3 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Additional quality assurance samples will also be collected during each sampling event. The quality assurance samples collected will by project specific according to the Field Sampling Plan, but may include the following.

- field blanks
- trip blanks
- duplicate/split samples
- equipment blank

13.4 REFERENCES

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

ASTM Standard Designation D 5466-95; Test Method for Determination of Volatile Organic Chemicals in Atmospheres (Canister Sampling Methodolog).

PRC, 1997; *Final Demonstration Plan For The Evaluation Of Soil Sampling And Soil Gas Sampling Technologies*, Prepared For U.S. Environmental Protection Agency National Exposure Research Laboratory by PRC Environmental Management, Inc.

US EPA, 1991, *Site Characterization For Subsurface Remediation*, Epa/625/4-91/026; U.S. Environmental Protection Agency, November 1991.

14.0 SAMPLING SOIL VAPOR MONITORING WELLS (3.4.6)

This SOP describes the specific protocols necessary for the collection of representative samples from soil vapor monitor wells. The designs of soil vapor monitoring points vary from site to site. This SOP addresses site specific sampling protocols for a simple nested soil vapor monitor wells constructed of tubing bundles or piping buried inside of sand filter packs, with bentonite seals segregating the sampling intervals

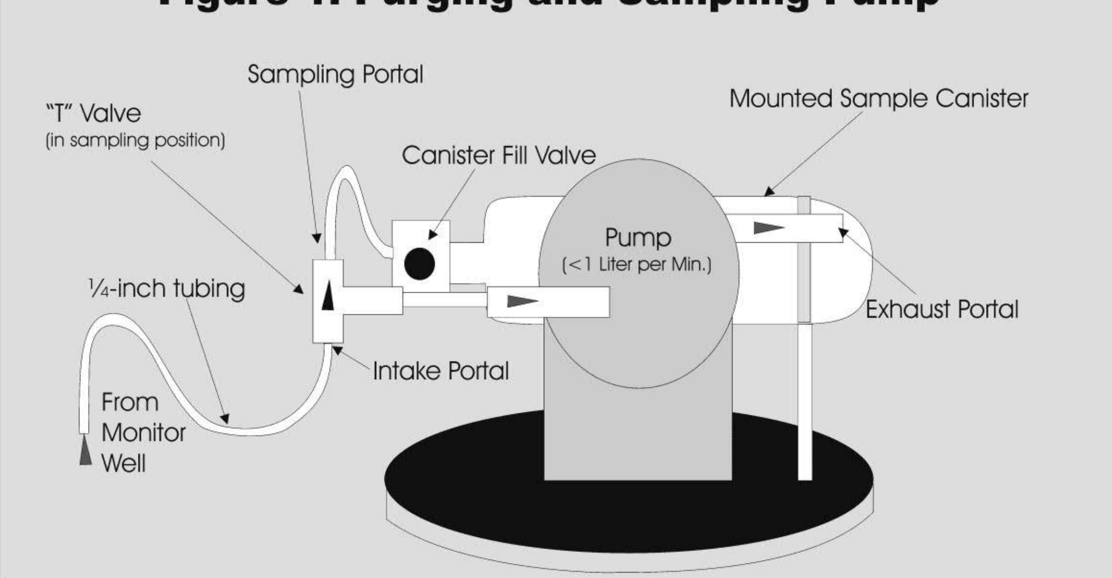
Special care should be taken when collecting samples from enclosed areas, especially if the area is considered a confined space. The site-specific Health and Safety Plan should address safe operating procedures during sampling activities.

14.1 EVACUATION AND SAMPLING EQUIPMENT

This section describes the methods and types of equipment that will be used to evacuate and collect soil vapor samples from typical nested monitoring well systems. The capacity of evacuation system is a function of casing/tubing diameter and depth, type of constituent selected for analysis, and objective of the particular sampling task.

URS typically utilizes a purging and sampling pump to evacuate the casing and tubing, and to collect the sample. The standard purging and sampling pump capacity is approximately 1 liter per minute, and the higher capacity pump can evacuate at a rate of up to 10 liters per minute.

Figure 1. Purging and Sampling Pump



The purging and sampling pump is set up to accept a ¼-inch inner diameter tubing, which connects directly to the intake portal. The air flow is then directed through a “T” valve into the pump and exits from the pump at the exhaust portal. The other side of the “T” valve is the sampling portal. A sample canister can be mounted on the side of the pump, and is connected to the sampling portal.

14.2 SAMPLE COLLECTION PROCEDURES

14.2.1 Planning

Prior to mobilization, sampling personnel should review the site-specific Health and Safety Plan. The laboratory and property owners should also be notified.

14.2.2 Soil Gas Screening

If the well is constructed with casing larger than ½”inch diameter, then a purge pump should be used to first evacuate the well casing. Once the well casing has been evacuated, a length of tubing that will reach the screened section should then be lowered into the well. This tubing can be dedicated, or disposable, depending on the duration of the sampling program. URS recommends that Teflon®-lined tubing be used if more than three sampling events are needed, the tubing can be dedicated to the individual well if this is the case. Once the well casing is evacuated, the tubing can also be evacuated, using the purging and sampling pump. The purging and sampling pump utilizes quick-connects, or can accept open ended tubing as well.

The intricacies of each of these systems are too great to provide detail in this SOP, and the user should refer to equipment specific procedures prior to using any of these systems. However, the general process for the evacuation and sampling procedure using these systems is summarized as follows:

1. Assess historic data, if available, to ensure the order of sample collection shall be from the least contaminated well to the mot, and from the least contaminated sampling interval to the interval with the highest contamination.
2. Assess the tubing bundles to ensure that individual tubes are correctly labeled according to the interval they are monitoring.
3. Determine the well interval to be sampled, and identify on the field log.
4. Attach the tubing to the purging and sampling pump’s intake portal.
5. Ensure that nothing is blocking the exhaust or sampling portals.

6. remove the red plastic end cap from the Silonite coated sampling canister, and connect the sampler to the Silonite coated sampling canister.
7. Connect the Silonite-coated sampling canister to the sampling portal.
8. Record the serial number for the sample canister on the chain of custody, and on the field record.
9. Turn the “T” valve and open the sampling portal side, then open the sample canister valve and record the pressure in the canister on the chain of custody, on the sample canister tag, and in the field notes
10. Close the sample canister valve.
11. Turn the “T” valve away from the sampling portal and ensure that the valve is open toward the purge pump.
12. Calculate and record the tubing volume based on the inner diameter and total length of the tubing.
13. Determine the total purge volume, and record on field log.
14. Measure and record the flow rate and compare to the purge volume
15. Determine the time required for purging the tubing and record.
16. Start the purging and sampling pump, and record the time.
17. Continue pumping until the tubing is purged, and record the elapsed time.
18. Shut the purging and sampling pump off
19. Turn the “T” valve to divert the airflow to the sampling portal.
20. Open the valve on the sampling canister.
21. After waiting appropriate time (typically two to three minutes, but depends on several factors) shut off the fill valve on the sampling container.
22. Disconnect the sampling container and all hoses and tubing.
23. Disconnect the sampler from the Silonite coated sampling canister, and replace the red plastic end cap onto the canister.
24. Secure well and location.

14.2.3 Soil Vapor Sample Collection, Handling, and Documentation

14.2.3.1 Well Casing and Tubing Evacuation

Purge each well prior to sampling to ensure that stagnant air from within the well/tubing casing has been evacuated and the sample collected is representative of soil gas in the vicinity of the sampling interval. Before beginning evacuation, calculate the volume of air contained in one casing/tubing volume using the following equation:

$$V = (TL)\ \pi\ r^2\ (28.316\ L/ft^3)$$

Where

- V equals one evacuation volume, in liters
- TL is equal to the total length of the tubing or the total depth of the well casing, in feet
- π is equal to 3.14159
- r is equal to the inner casing/tubing diameter, in feet
- 28.316 L/ft^3 is the conversion factor from cubic feet to liters

For standard ¼-inch inner diameter tubing, this simple approximation can be used

$$V = (TL)\ 0.03861\ L/ft^2$$

Where

- V equals one evacuation volume, in liters
- TL is equal to the total length of the tubing or the total depth of the well casing, in feet
- 0.03861 L/ft2 is the approximation of the surface area in Liters per square feet

Evacuate three volumes from casings and/or tubing using the purging and sampling pump. If the casing is greater than ½ inch diameter a higher capacity pump should be used for purging the larger volume. Once the casing has been evacuated use the purging and sampling pump to evacuate the sample tubing.

14.2.3.2 Sample Collection

The sample is collected immediately following purging of the sample tubing (and well casing, if present). Once the tubing is purged, the pump is turned off, and the “T” Valve is opened to the sample portal side. The valve on the sample canister is then opened.

After evacuation of the desired volume of air, the gate valve will be closed to prevent the introduction of ambient air to the sample stream. The laboratory-supplied, negative pressure canister labeled with a unique identification number will be opened to allow for the collection of the soil gas sample. Once the vacuum has decreased to approximately (–3) inches of mercury, the valve is closed and the sampling is complete.

For characterization or compliance monitoring, additional quality assurance samples will also be collected. The quality assurance samples may include duplicate/split samples and equipment blanks.

14.3 SAMPLE PRESERVATION AND HANDLING

The canisters used to collect and store the soil gas sample will depend on the laboratory analyses required for the sample. The analytical laboratory will provide all canisters required for sampling, and all samples will be collected according to the requirements for each analysis.

All samples will be placed in their respective shipping boxes, after ensuring that all data has been recorded on the container tag. A completed chain-of-custody form will accompany the sample containers during transport. Samples will be transported from the field to a central shipping location for shipment to the analytical laboratory.

14.4 DOCUMENTATION

14.4.1 Soil Gas Monitoring Sample Collection Record

A field record will be completed for each well site and will follow the procedures outlined in SOP-2, *Field Activity Records* along with the following information:

- Well ID and/or portal ID
- Sampler's name(s)
- Weather conditions
- Minimum purge volume
- Sample date and time
- Canister serial number
- Flow rate information
- Purge Time in minutes
- Beginning pressure
- Ending pressure

- Sample ID number
- Other significant field observations pertinent to sample collection

14.4.2 Sample Labels

The analytical laboratory will provide Chain-of-Custody seals and sample labels, which are filled out by the field technician. The sample label will include the job number, sample ID (comprised of a six-digit date code and a sequentially numbered, 2-digit sample ID), date and time of sample collection, type of analysis requested and the final pressure in the canister. A Chain-of-Custody seal will be placed over the cap of each sample container, and will include the sample collection date and the signature of the field technician.

14.4.3 Chain of Custody

Each Chain-of-Custody form will follow the procedures outline in SOP-19, *Chain of Custody Form* and include the following information:

- consultant name, address, phone number
- project manager
- project name and/or number
- sample ID (eight digit code)
- canister ID
- final pressure in canister
- date sample was collected
- time sample was collected
- Size of sampling canister
- analysis to be performed on the sample
- signature of the sampler
- date/time relinquished by sample technician
- signature of sample recipient
- signature of the person at the lab who accepted the samples
- date and time the sample was received by the laboratory

- final remarks about the samples after acceptance by the laboratory

A copy of the Chain-of-Custody records will be submitted to the project office on a daily basis; an additional copy will be included with the analytical results from the laboratory.

14.5 REFERENCES

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

ASTM Standard Designation D 5466-95; Test Method for Determination of Volatile Organic Chemicals in Atmospheres (Canister Sampling Methodolog).-

US EPA, 1991, *Site Characterization For Subsurface Remediation*, Epa/625/4-91/026; U.S. Environmental Protection Agency, November 1991.

15.0 SOIL VAPOR SAMPLING FOR REMEDIATION SYSTEMS (3.4.7)

This SOP describes the specific protocols necessary for the collection of representative water samples from groundwater treatment systems. The objectives of water sampling from groundwater treatment systems are to:

- Estimate contaminant mass removal from the subsurface by the remediation system;
- Evaluate contaminant removal or destruction efficiency of the remediation system; and
- Estimate system life (e.g., granular activated carbon usage rate)

15.1 PROCEDURE SUMMARY

Sampling requirements for remediation systems will vary based on system design and permit requirements. Refer to the site-specific Operations and Maintenance Manual, Monitoring Plan, and/or Air Quality Permit to determine sampling frequency, sample collection points, and required analyses. Typically, vapor sampling for remediation systems requires influent and effluent sampling, and may include sampling at intermediate points (e.g., between granular activated carbon vessels, or between primary and secondary treatment technologies).

Samples may be collected in either new, unused Tedlar bags or laboratory-certified clean Summa® canisters from each sample location. Please note that 1-liter canisters are typically used for “source” testing, while 3-liter canisters are typically used for low vapor concentrations (i.e., in the parts per billion by volume range). If Summa® canisters are used, check the Summa® canisters vacuum gauge. Canisters that decrease in vacuum over time indicate that the inlet valve may be leaking jeopardizing the integrity of the sample.

15.2 EQUIPMENT AND MATERIALS REQUIRED FOR PROCEDURE

The following equipment should be used during sample collection activities:

- Appropriate air monitoring equipment (as per project specific health and safety plan or HASP)
- Appropriate personnel protective equipment (PPE) as per HASP
- Decontamination equipment
- Treatment system keys and/or well keys
- Miscellaneous tools

- Vacuum or air sampling pump with integral air meter
- Vacuum gauges
- Teflon tubing of appropriate size (typically ¼-inch)
- Portable generator or other power source
- Paper towels
- Waterproof and permanent markers or pens
- Packing material for sample containers
- Field logbook, field sheets, chain-of-custody sheets, sample collection log, air monitoring log, HASP
- System O&M Manual and As-built drawings
- Laboratory supplied sample containers (i.e., Tedlar bags or Summa® canisters)
- Shipping container

15.3 SAMPLE COLLECTION PROCEDURES

15.3.1 Grab Sampling from Pressurized Lines Via Sampling Ports

Samples will be collected from each designated sample collection point as follows:

- Ensure that the remediation system has been operational a suitable period of time to provide representative vapor samples.
- Connect new, clean Teflon tubing to the sampling port. Open the valve to the sampling port and allow the pressurized air/vapor stream to flush the air out of the Teflon tubing. Ensure that the vapor stream does not contain condensate which may effect the sample. Should the vapor stream contain condensate, a moisture trap must be installed in-line.
- Following the flushing of the Teflon tubing, immediately connect the inlet port of the Tedlar bag or Summa® canister to the discharge side of the Teflon tubing. Do not allow air to enter the tubing prior to connection to the sampling container.
- Open the valve on the sampling container.
    - Allow the Tedlar bag to fill such that the bag is about three quarters full. Do not fill the bag completely. A bag that has been filled completely may burst during shipping.

    - Allow the Summa® canister to fill for the prescribed time on the sampling valve. Most canisters have a 1-minute or 2-minute fill time. (In special cases, an 8-hour or 24-hour sampling valve may be used. These longer sampling times are typically used for ambient air sampling rather than grab sampling of remediation systems.)

- When the sample container is filled, close the valve on the sampling container and remove the container from the tubing.
- Close the valve on the sampling port, remove the sampling tubing and discard.

15.3.2 Grab Sampling from Vacuum Lines

It is recommended to use Summa® canisters to sample locations that are under vacuum. Samples will be collected from each designated sample collection point using an air sampling pump as follows:

- Ensure that the air sampling pump has been decontaminated prior to each use.
- Connect new, clean Teflon tubing from the valved sampling port (Valve A) to the air sampling pump. The sampling pump must be capable of pulling a vacuum greater than the vacuum at the sample location. A tee is to be installed in the tubing between the sample port and the pump. The tee is connected to the valve on the Summa® canister (Valve B) using a short length of new, clean Teflon tubing.
- Turn on the air sampling pump and open the valve to the sampling port (Valve A) and allow the air/vapor stream to flush the air out of the Teflon tubing. Ensure that the vapor stream does not contain condensate which may affect the sample. Should the vapor stream contain condensate, a moisture trap must be installed in-line.
- Following the flushing of the Teflon tubing using the air sampling pump, open the valve on the Summa® canister (Valve B). Allow the Summa® canister to fill for the prescribed time on the sampling valve. Most canisters have a 1-minute or 2-minute fill time.
- At the conclusion of sampling, close the valve on the canister (Valve B).
- Disconnect the air sampling pump and allow ambient air to flush the pump for decontamination purposes. Use a field instrument (e.g., photoionization detector) to monitor the discharge from the sampling pump to monitor decontamination.
- Close the sampling port valve (Valve A).

15.3.3 Stack Sampling – EPA 25A

Typically, grab samples are used to demonstrate remediation system performance and are also sufficient for reporting required within air quality permits. Occasionally, formal performance monitoring of a remediation system is requested to be conducted by an air quality agency. Should formal performance monitoring be required, URS will prepare a work plan for review by the air quality agency.

15.4 SAMPLE SHIPPING PROCEDURES, CUSTODY, AND HOLD TIMES

Required sample containers and recommended maximum holding times for samples submitted to the laboratory will vary with the source of the sample and the analytical method to be performed. In the field, each sample container will be marked with the sampling location ID, and date and time of sample collection. Samples will be stored at room temperature. It is important to keep Tedlar bags out of direct sunlight to avoid VOC destruction as a result of UV light. Samples will be transported directly from the field or shipped to the laboratory for analysis. Tedlar bags will be shipped to the analytical laboratory within 24 hours of sample collection. Samples collected within Summa® canisters will be shipped within the hold time for the sample as indicated by the analytical method.

Each Chain-of-Custody form will follow the procedures outline in SOP-19, *Chain of Custody Form* and in section 13.4.3 in SOP-13, *Sampling Soil Vapor Monitoring Wells*.

15.5 REFERENCES

ADEQ, 2000; Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan, Arizona Department of Environmental Quality SPS, May 22, 2000.

16.0 MAXI AND MINI SIMULPROBE SAMPLING FOR SOIL, SOIL VAPOR, AND GROUNDWATER (3.4.9)

This SOP describes the specific protocols necessary for the collection of representative soil, soil vapor, and groundwater samples using SimulProbe technology.

16.1 PROCEDURE SUMMARY

Simulprobe™ technology enables samples to be collected from discrete intervals while minimizing the downward transport of contaminants from one horizon to another. The Simulprobe™ Sampler (the Sampler) is decontaminated at the surface, then pressurized with an inert gas to prevent fluid entrance during down hole positioning of the Sampler. When the drill bit reaches the sampling depth, the driller will lower the pressurized Sampler on steel center rods. The Sampler will be advanced by the direct push method where possible. In conditions where the drilling rig cannot push the Sampler, the Sampler can be driven by the drilling rig's slide hammer. The Sampler will be driven a minimum of 12 inches and no greater than 24 inches at each sampling interval. The Sampler then will be retracted no more than 5 inches to expose a 4-inch screened section of the inner tool. The field geologist will record the inches driven and inches retracted for each sample collected. The pressure in the Sampler will be released, which allows fluid from the sampling depth to enter the Sampler chamber. After sample collection, the Sampler is re-pressurized and retrieved to the ground surface. Re-pressurizing the Sampler prevents any borehole fluids from mixing with the groundwater sample during recovery of the Sampler, and preserves samples containing volatile organic compounds.

The Sampler can retrieve approximately 2 liters of sample, which allows for adequate volumes of water to be collected for primary samples, split samples, and duplicates where necessary. Laboratory-provided sampling containers having appropriate preservatives will be filled directly from the Sampler chamber.

16.2 SAMPLE COLLECTION PROCEDURES

Sample collection procedures are detailed in the attached Simulprobe documents.

16.3 SAMPLE SHIPPING PROCEDURES, CUSTODY, AND HOLD TIMES

Sample hold times will vary depending upon the sample matrix and the analytical method to be employed. Refer to the site-specific Field Sampling Plan to determine the hold times. Refer to groundwater sampling, soil sampling, and soil vapor sampling SOPs for appropriate containers and handling and Chain of Custody requirements. For general Chain of Custody requirements, refer to SOP-19, *Chain of Custody Form*.

16.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Additional quality assurance samples will also be collected during each sampling event. The quality assurance samples collected will by project specific according to the Field Sampling Plan, but may include the following.

- field blanks
- trip blanks
- duplicate/split samples
- equipment blank

17.0 FIELD SAMPLE MANAGEMENT

17.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to assure representative environmental sample data by documenting the management of samples from time of collection through analysis and final disposition.

17.2 SCOPE

This SOP applies to all personnel who collect and/or handle environmental samples.

17.3 METHOD

17.3.1 General

An essential part of the sampling/analytical portion of any environmental project is assuring the integrity of the sample from collection to data reporting. Projects where analytical data or conclusions based upon analytical data may be used in litigation demand that accountability of the history of a sample be available to demonstrate that the data are a true representation of the environment. The chain of custody (COC) form is used as evidence in legal proceedings to demonstrate that a sample was not tampered with or altered in any way that may skew the analytical accuracy of the laboratory results. Therefore, it is extremely important that COC forms be complete, accurate, and consistent.

Assuring sample integrity and accountability requires strict adherence to the proper use of the following six essential sampling components:

- Sampling and Analysis Plans (SAPs);
- Sample labels;
- Sample logs;
- Sample custody seals;
- Field logbooks; and
- COC forms.

Successful implementation of these components requires a thorough understanding of sample custody requirements. A sample is under an organization's custody if:

- It is in an employee's physical possession;
- It is in view of an employee, after being in their physical possession;
- It was in an employee's physical possession and then locked up so no one could tamper with it; and
- It is in a designated and identified secure area, controlled and restricted to authorized personnel (or individuals accompanied by authorized personnel) only.

A sample remains in an organization's custody until relinquished in writing to another person or organization that is authorized to take custody of the sample.

17.3.2 Procedures

17.3.2.1 Sample Labels

Sample labels are required to prevent misidentification of samples. Sample labels will generally be pre-printed by a database technician and taken to the field.

The sample label will be affixed to the proper sample container at the time of the sampling event by the field sampler. The labels will contain the following pre-printed information:

- Sample identification number (ID);
- Site ID;
- Event ID (if applicable);
- Location ID;
- Analyses requested;
- Receiving laboratory;
- Type of sample container;
- Preservatives used;
- Sample matrix; and
- Matrix spike/matrix spike duplicate (MS/MSD) if required.

During a sampling event, the field sampler will write the following information on the label:

- Field sampler's initials;
- Date (mm/dd/yy or m/d/yy, i.e., 04/03/98 or 4/3/98 is April 3, 1998); and
- Time of sample collection (military format).

Custody seals are narrow strips of adhesive paper used to document that no sample tampering has occurred during transport from the time of collection to laboratory receipt. Custody seals will be signed, dated, and attached to all coolers so they tear if the cooler is opened.

17.3.2.2 Field Logbooks

All samples collected will be documented in field logbooks. All field documentation will follow SOP-2, *Field Activity Records.*

17.3.2.3 Chain-of-Custody Form

Every person involved with sample collection and handling will know and understand the COC form, discussed in detail in SOP-19, *Chain-of-Custody Form*. These procedures will be made available to all field personnel.

The sample shipper will complete the COC form while preparing the samples for shipment. This individual or other authorized person will sign the "Relinquished By" box and enter the shipper's name in the "Received By" box prior to sealing a sample shipping container for courier pickup after ensuring that samples and COC forms match (in other words, only samples identified on the enclosed COC(s) are in the container and all samples enclosed are listed on the COC(s) enclosed). The "Received By" box will be signed by the laboratory sample receipt staff. As long as COC forms are sealed inside the sample shipping container, commercial carriers are not required to sign the COC form.

Distribution of the COC form will be:

- Original and one copy - sealed in plastic bag and taped inside the top of the shipping container;
- One copy - file in appropriate Field Office project file; and
- One copy - submit to Data Management staff.

All changes to a COC form will be made by striking the incorrect information with a single line, initialing and dating the strike, and inserting the correct information. If changes are made to a COC form after the original distribution, the following steps will be taken:

- Make the change by striking the incorrect information with a single line, initialing and dating the strike, and inserting the correct information (in black or blue indelible ink). Add a comment as to why the change was made, as appropriate.
- Distribute copies of the corrected COC form as specified above.

Whenever a sample is split with a second party (e.g., client, agency) a separate COC form must be prepared for those samples.

17.4 REFERENCES

US Environmental Protection Agency (US EPA), December 1984, *Characterization of Hazardous Waste Sites - A Methods Manual*: Vol. II. Available Sampling Methods, 2nd Edition, USEPA-600/4-84-076, p. D1-D11.

US EPA/NEIC, *User's Guide to the EPA Contract Laboratory Program*.

US EPA/NEIC, 1982. *Policies and Procedures*, 330/9/78/001-R.

17.5 RECORDS

Procedures for maintaining COC forms are described in SOP-19, *Chain-of-Custody Form.*

18.0 PRESERVING ENVIRONMENTAL SAMPLES IN THE FIELD

18.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that the chemical integrity of a sample is maintained from time of collection until chemical analysis.

18.2 SCOPE

This SOP applies to all personnel involved with the collection, shipping, and chemical analysis of environmental samples. The SOP documents the protocols and chemicals to be used for the preservation of field samples. The environmental media addressed in this SOP include soils, sediments, Investigation-Derived Waste (IDW), and aqueous samples.

18.3 METHOD

18.3.1 General

Most chemical and biological reactions and many physical processes are slowed by lowering the temperature. Therefore, all samples except solids samples for volatile organic compounds (VOC) analysis need to be cooled at the time of collection and maintained slightly above freezing until preparation for final analysis. Solid VOC samples are extracted within 48 hours of collection and the extract kept chilled.

Non VOC soil samples and other solid samples, including sediments, sludges and solid waste, will be preserved by cooling to ≤ 6°C. Soil and solid samples require no other preservatives, except for special conditions outlined in SOP-8, *Soil Sampling_VOC*, SOP-9, *Soil Sampling_Composite*, and SOP-10, *Soil Sampling_Metals*. However, analysis must be performed within the method-specific holding time requirements.

Aqueous samples may be presumed to be homogenous and amenable to chemical preservation as applicable. In addition to keeping such samples cold, the following general approaches are employed depending on the analyte(s):

- Volatile acids (hydrogen cyanide, hydrogen sulfide) are rendered involatile in the presence of strong base (sodium hydroxide (NaOH), pH > 12).
- Volatile bases (ammonia) are rendered involatile in the presence of strong acid (sulfuric acid [H_2SO_4], pH < 2).

- Biodegradation of organic compounds is retarded under strongly acidic conditions (hydrochloric acid [HCl] or H_2SO_4, pH < 2).
- Dehydrohalogenation (loss of HCl) of chlorinated solvents is counteracted in the presence of acid (HCl, pH $\leq$ 2).
- Oxidation of target analytes by the chlorine found in drinking water is eliminated by destroying the chlorine with a reducing agent such as sodium thiosulfate.
- Many soluble metal salts tend to plate out on the walls of the container or form precipitates with time. This can be prevented by the addition of nitric acid to a pH of < 2, which maintains the metals as soluble nitrate salts.

18.3.2 Procedures

18.3.3 General

All sample containers and disposable soil syringes for VOC sample collection will be supplied in advance by the subcontracting laboratories.

The required chemical preservatives for aqueous samples will normally be added to the appropriate containers by the subcontracting laboratories prior to delivery to the field. Pre-preserved sample containers are preferable so that the laboratory scheduled to do the analysis maintains control over sample integrity and container cleanliness. Sample preservatives should be identified on the sample label and the sample log form.

18.3.3.1 Soil, Sediment, and Solid IDW

Following collection, solid samples, except for volatiles in any type of container, will be labeled and then immediately placed in an ice chest containing sufficient ice to maintain a temperature range of 0 - ≤ 6°C throughout the day. Ice chests with samples collected at the sampling site will be transported to the field sample control area in a timely fashion.

Samples are maintained in ice or in refrigerators, within a range of 0 - ≤ 6°C, from the time they are collected until the samples are packed for shipment and relinquished to the shipper or other transport agent.

All soil and sediment samples are shipped in ice chests packed with sufficient ice to maintain a temperature range of ≤ 6°C for at least 24 hours (refer to Standard Operating Procedure SOP-20, *Packing and Shipping of Environmental Samples*). The receiving laboratory will measure the temperature within the ice chest and then place the VOC samples in a freezer with a temperature between –7°C and –20°C immediately upon assuming custody of a shipment of samples. The temperature of all ice chests will be noted on the chain-of-custody form or addenda to the form.

Temperatures in excess of 6°C will be reported immediately to the Project Chemist. After consultation with the Project Chemist and QA Manager, the Project Manager will determine if resampling is necessary.

18.3.3.2 Aqueous Samples

With respect to procedures for maintaining a temperature range of 0 - ≤ 6°C, aqueous samples will be treated the same as solid samples as described in Section 3.2.2.

The amount of acid preservative provided by the laboratory may not suffice to lower the pH to ≤ 2 in the case of highly buffered waters. The pH of such samples should be monitored on a regular basis (see SOP-4, *Groundwater Purging and Sampling*). A small amount should be poured from each container with preservative (except zero headspace samples) directly onto the pH strip. For volatile organic compounds, this is best accomplished by filling an extra vial during collection, ensuring it is not overfilled, then using pH strips or probe to check that the sample is at or below the maximum pH allowed. This vial would then be disposed of as IDW. Similar remarks apply to aqueous samples preserved with NaOH where the pH should be > 12. With the exception of VOCs, if the pH of a sample is not at the required level, the appropriate chemical preservative will be added in the field until the required level is achieved. For VOCs, the sample containers cannot be reopened once the sample has been collected; therefore, the laboratory will be notified of all VOC samples that do not meet the target preservation pH. Those VOC samples will be prioritized by the laboratory so that the analyses are completed within the unpreserved holding time limits.

18.3.3.3 Reagents

Reagent-grade inorganic chemicals conforming to specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS) will be used as preservatives, including:

- Analyte-free reagent water, prepared per page 26 of Chapter One of *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, 1985) or purchased high pressure liquid chromatography-grade water;
- Nitric Acid, ACS grade, 16N;
- NaOH, ACS grade, pellets;

- H_2SO_4, ACS grade, 37N;
- HCl, ACS grade, 12N;
- Sodium Thiosulfate, ACS grade crystals; and
- Zinc Acetate.

18.4 REFERENCES

American Public Health Association, 1985. *Standard Methods for the Examination of Water and Wastewater*, 16th Edition.

Code of Federal Regulations (CFR), 1990, 40 CFR 136.

U.S. Environmental Protection Agency (EPA), June 1991. *Statement of Work for Organics Analysis*, Document No. OLMO1.0, Contract Laboratory Program.

EPA, November 1990. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, 3rd Edition, Final Update I, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, March 1990. *Statement of Work for Inorganics Analysis*, Document No. ILMO1.0, Contract Laboratory Program.

EPA, December 1982. *Methods for Chemical Analysis of Water and Wastes*, USEPA-600/4-82-055.

State of California, 1989. *Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure*, Leaking Underground Fuel Tank Task Force.

18.5 RECORDS

A record of reagents used with corresponding lot control numbers will be maintained in the sample control area by the Sample Shipper/Controller.

19.0 CHAIN OF CUSTODY FORM

19.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for use of the chain of custody (COC) form.

19.2 SCOPE

This SOP applies to all personnel responsible for collecting, shipping, and analyzing environmental samples.

19.3 METHOD

19.3.1 General

COC forms are used to legally track samples from time of collection through completion of laboratory analysis.

19.3.2 Procedures

The following information will be preprinted on the COC form when possible:

- Project name;
- Name and address of laboratory; and
- Potential analysis and method numbers.

The following information will be written on the COC form by the sample controller/shipper:

- Site name;
- Name of receiving laboratory;
- Sample IDs for all samples in a particular cooler/shipping container;
- Sample matrix or matrix code (e.g., SO for soil);
- Sample type (environmental, trip blank, equipment blank, etc.), which is encrypted in the sample ID code;
- Analysis requested by method number unless other arrangements are made with

the receiving laboratory;

- Number of containers;
- Quality Control (QC) required (to indicate the sample is to be used for matrix spike/matrix spike duplicate analyses);
- Date of collection (mm/dd/yy or m/dd/yy: 04/03/98 or 4/3/98 is April 3, 1998);
- Time of collection (military format);
- Signature of individual who prepares the COC form;
- Cooler identification (ID);
- Carrier service and airbill number; and
- Signature of individual relinquishing samples along with the date and time of relinquishment.

Upon completion of the form, retain two copies and affix the original and one copy to the inside of the sample cooler (in a Ziploc® bag to protect from moisture), to be sent to the designated laboratory.

19.4 REFERENCES

U.S. Environmental Protection Agency (EPA), December 1990. *Sampler's Guide to the Contract Laboratory Program*, USEPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C.

EPA, January 1991. *User's Guide to the Contract Laboratory Program*, USEPA/540/0-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, Washington, D.C.

EPA, *Guidelines and Specifications for Preparing Quality Assurance Project Plans.*

19.5 RECORDS

Distribution of the COC record will be:

- Original and one copy - sealed in plastic bag with a custody seal (initialed and dated) and taped inside the top of the shipping container;
- One copy - file in Project File; and
- One copy - submit to URS Database Manager.

20.0 PACKING AND SHIPPING OF ENVIRONMENTAL SAMPLES

20.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide guidance for the packing and shipping of environmental samples with the appropriate chain-of-custody (COC) forms. This is in accordance with all applicable transportation regulations, analytical requirements, and proper COC forms.

20.2 SCOPE

This SOP applies to all personnel involved in the packing and shipping of environmental samples. Samples determined to be hazardous will be managed in accordance with the requirements of the U.S. Department of Transportation (DOT) and the International Air Transportation Association (IATA) for shipping hazardous/dangerous goods by land or air.

20.3 METHOD

20.3.1 General

Environmental samples and quality control samples are collected, labeled, and sealed in the field, and COC is maintained, as defined in SOP-17, *Field Sample Management.*

40 Code of Federal Regulations (CFR) Part 261.4 describes sample shipping requirements. It states that:

> "... a sample of solid waste or a sample of water, soil, or air, which is collected for the sole purpose of testing its characteristics or composition, is not subject to any requirements of this part (hazardous materials shipping requirements)... when:
>
> (i) The sample is being transported to a laboratory for the purpose of testing; or
>
> (ii) The sample is being transported back to the sample collector after testing.
>
> In order to qualify for the(se) exemption(s)..., a sample collector shipping samples to a laboratory and a laboratory returning samples to a sample collector must:
>
> (i) Comply with DOT, U.S. Postal Service (USPS), or any other applicable shipping requirements; or

(ii) Comply with the following requirements if the sample collector determines that DOT, USPS, or other shipping requirements do not apply to the shipment of the sample:

(A) Assure that the following information accompanies the sample:

(1) The sample collector's name, mailing address, and telephone number;

(2) The laboratory's name, mailing address, and telephone number;

(3) The quantity of the sample;

(4) The date of shipment; and

(5) A description of the sample.

(B) Package the sample so that it does not leak, spill, or vaporize from its packaging. The URS Hazardous Materials Shipping Hotline can be reached at 1.800.381.0664. Shipping experts are available via the hotline to answer any shipping questions you may have.

Samples will be assessed to determine potential hazard. Potentially hazardous samples are required by law to be properly handled and labeled.

PID readings greater than 1,000 parts per million will be used to identify a sample as hazardous. These measurements should be made on the sample headspace or directly over the sample as it is being collected. Good judgment on the part of the sample coordinator is also necessary to identify hazardous samples. Samples collected from chemical or fuel drums and tanks, stained or otherwise obviously contaminated soil, free product from a well, leachates, sludges, and samples with headspace readings noted above are all hazardous samples. Hazardous waste samples will be shipped according to DOT and IATA regulations.

Samples determined to be non-hazardous by the Sample Coordinator are environmental samples. They are to be labeled, packaged, documented, and shipped as described in Section 4.3.

20.3.2 Procedures

Determine the maximum allowable weight of each cooler (Federal Express limit for Priority Overnight shipping is 150 pounds).

Place each container in a Ziploc® bag and seal, squeezing as much air as possible from the bag before closing. Glass bottles and jars will be wrapped in bubble wrap.

Tape the cooler's drain plug shut on the inside and the outside, unless using dry ice in shipment.

Place a large size plastic bag (trash bag) in the cooler to contain samples.

Place the bottles upright in the plastic bag, with enough room for ice bags to be placed among and around the containers, and insulate with enough bubble wrap to deter breakage.

Place ice (double-bagged) among the containers along the walls and top of each cooler in a manner to ensure uniform cooling. When shipping soil samples, place one bag of ice along the bottom of the cooler as well. For water samples, it is possible to place the bottles upright in absorbent material to provide additional stability. Do not use Blue Ice, as its heat capacity is lower than regular ice. If the Sample Shipper/Controller is informed by the laboratory that the samples are not being chilled sufficiently, additional ice may be required. Note that in summer months, more ice may be needed to ensure the samples arrive cold at the laboratory.

If shipping via commercial carrier (e.g., Federal Express), write the carrier's airbill number on the COC form, place the appropriate pages of the COC form inside a Ziploc® bag, and seal the bag with a signed, dated custody seal. The COC form has three pages. The original and one copy are sealed inside the Ziploc® bag and placed inside the cooler. One copy goes to project data management, and one copy (made by the Field Manager) is placed in field files. The COC form sent to the laboratory must be completed with all designated information, the pages must be originals (not photocopies), and the COC must be unique to the samples contained in the cooler.

If a courier from the laboratory is collecting the samples and delivering them to the laboratory, have the courier confirm that all samples listed are present, and then sign the COC form.

Tape the Ziploc® bag with the COC form to the inside lid of the cooler, and close and latch the cooler.

Wrap strapping tape completely around the cooler on both sides of the latch.

Affix the shipping label with the address and telephone number of the laboratory and the contractor.

Affix signed custody seals on the front right and back left of the cooler across the lid, so as to tear if the cooler is opened during shipping.

The laboratory should be notified if the samples are being delivered via courier. They should be prepared to receive and check the samples and sign the COC form as the sample receiver.

20.4 REFERENCES

40 CFR 261.4, July 1990. Identification and Listing of Hazardous Waste. Federal Register, Chapter 1, p. 35.

Environmental Resource Center, 1992. *Hazardous Waste Management Compliance Handbook*. Van Nostrand Reinhold, New York.

EPA, 1987. *A Compendium of Superfund Field Operation Methods*. Office of Solid Waste and Emergency Response, Directive 9355.0-14.

EPA, 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*.

EPA, 1985. *Characterization of Hazardous Waste Sites: A Method Manual, Vol. I, Site Investigation.*

20.5 RECORDS

Completed COC form.

21.0 INVESTIGATION-DERIVED WASTE

21.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that Investigation-Derived Waste (IDW) generated as the result of environmental investigations is managed:

- In a manner consistent with the federal and state applicable or relevant and appropriate requirements (ARARs) to the extent practical;
- To ensure that the potential of further contamination to the site from IDW is eliminated;
- To ensure the quantity of generated IDW is minimized;
- To provide labeling, tracking, and inventory of IDW; and
- To reduce health and safety concerns by reducing the potential for exposure.

21.2 SCOPE

This SOP applies to all contractor personnel and subcontractors generating, transporting, and handling IDW during environmental investigations and monitoring programs at the site. This SOP describes the minimum acceptable practices.

21.3 METHOD

21.3.1 General

The IDW generated should be considered part of the site that is being investigated and should be managed with other wastes from the site. The IDW should be managed in a protective manner and should comply with Arizona Department of Environmental Quality (ADEQ) and Resource Conservation Recovery Act (RCRA) requirements.

21.3.2 Procedures

21.3.2.1 Materials

The following materials may be used to comply with this SOP:

- Ring-top 55-gallon drums (DOT-17-H);
- 20-yard (or similar capacity) roll-off boxes with tarps to cover;

- Roll-off liners;
- Drum labels;
- Field supplies such as pallets, Visqueen, rope, drum liners, paint pens, tape, and hand tools;
- Sampling and shipping supplies such as bottles, coolers, plastic bags, vermiculite, self-closing plastic bags, labels, tapes, and bubble wrap;
- Health and safety equipment such as personal protective equipment (PPE), first aid supplies from sites and vehicles, and eye wash stations;
- 250-gallon truck tank(s);
- Submersible pump(s);
- Hoses and clamps; and
- Spill kit that contains absorb booms or pads, vermiculite, hand tools, spill-related PPE.

21.3.2.2 Equipment

The following equipment will be needed to comply with this SOP:

- Boom truck;
- Flat bed truck;
- Soil sampling equipment such as hand auger, trowels, bowls, sieves, drum thieves, disposable bailers, funnels, and bottles;
- Drum forks or clamps;
- Health and safety equipment and monitoring equipment (photoionization detector [PID], flame ionization detector [FID]);
- First aid supplies, eye wash station, splash protection PPE;
- Water polishing system, if applicable (Project-Specific Basewide Sampling
- Analysis Plan [SAP] should contain the plans, designs, and equipment list for this system);
- Bulk tank(s); and
- Roll-off boxes.

21.3.2.3 Solid Investigation-Derived Waste

All waste that is generated, stored, processed, transported or disposed of in the state must be classified according to Arizona Revised Statutes (ARS) Title 49, Chapter 4, Solid Waste Management, and Chapter 5, Hazardous Waste Disposal.

Non-Indigenous Solid IDW such as disposable sampling equipment or tools will be disposed at a licensed landfill. Used PPE such as Tyvek® or Saranac® suits; latex, nitrile, or rubber gloves or booties; and spent respirator filters will be disposed as hazardous, non-hazardous, or radioactive waste in an appropriate designated drum/container/dumpster based on its generation. PPE generated from coming into contact with listed or characteristic hazardous waste will be disposed in a separate drum/container/dumpster designated for hazardous waste and shipped to an approved facility. However, PPE generated during the investigation from non-hazardous waste areas will be placed in a separate container and will be managed as non-hazardous waste.

Grossly contaminated PPE will be put into a ring-top 55-gallon drum lined with plastic bag drum liner. When the drum is full, the liner bag will be sealed, the lid closed, and the drum will be numbered, labeled, and moved to the secured site drum holding area.

Indigenous Solid IDW Any solids generated during an investigation will be collected and placed in appropriate designated drums/containers/dumpsters and manifested off-site for disposal based on its nature and characteristics as either hazardous waste, non-hazardous waste, or a radioactive waste. For solids where nature of contamination is not known, the contractor must first determine whether the waste is hazardous or non-hazardous using either historical information or sampling. Waste such as drill cuttings, and excess soil samples or other solid media that may be generated, will be stored at the sampling location and/or a designated location at the site. As the IDW is generated, it will be placed into clean ring-top 55-gallon drums or lined roll-off boxes. The drums to be used for the collection of wastes will be placed in new or reconditioned containers carrying the Department of Transportation (DOT) United Nations "performance oriented packaging standard" symbol. Containers storing hazardous waste must be marked using a yellow "Hazardous Waste" label with the name, address, city, state, zip code, EPA ID number, EPA waste number, accumulation start date, manifest document number, and DOT proper shipping name.

21.3.2.3.1 Solid Waste Sampling and Characterization

Generators who characterize waste using analytical methods to classify their waste must follow all state requirements. Where required by the disposal facilities, additional samples from each drum/container may be required. The solid samples will be collected using either a trier or an auger (SW-846, Chapter 9, Sampling Plans, 1986). For each drum/container, the analytical data associated with the samples collected for characterization of the waste will be evaluated to determine if the IDW is hazardous waste. To determine the characteristic of the IDW, the analytical results will be compared to the Toxicity Characteristic Leaching Procedure (TCLP) regulatory limit (40 CFR 261.24).

The field sampler will accurately record field-screening data on the waste accumulation log. IDW at each site will be containerized, managed, and sampled as a single waste stream. The non-segregated IDW may be bulk containerized with other non-hazardous solid IDW as necessary for efficient management of the waste.

Grossly contaminated non-indigenous IDW will be characterized as special or hazardous waste. The drums will be labeled, manifested, transported, and disposed of at a licensed RCRA hazardous/special waste landfill.

Indigenous solid IDW will be classified after analytical data are available.

If the IDW is found to be either a special waste or a hazardous waste, then the container will be labeled, manifested, transported, and disposed of at a licensed RCRA hazardous/special waste landfill, or a municipal solid waste (MSW) landfill that can accept Special Wastes. The landfill will be certified according to 40 CFR 300.440, also known as the off-site rule.

21.3.2.3.2 Analytical Methods

The hazardous waste characteristics are defined in 40 CFR 261 Subpart C. Those characteristics include ignitability, corrosivity, reactivity, and TCLP levels. In the TCLP procedure, samples are extracted by Method 1311, further analyzed for TCLP metals, TCLP volatile and semivolatile organic compounds. All waste streams shipped off-site for disposal will be analyzed for RCRA characteristics in accordance with 40 CFR 261 Subpart C. For purposes of determining accurate waste classification, any commercial laboratory capable of performing SW-846 analytical method, using internally derived quality control limits, are adequate to meet the Data Quality Objectives (DQOs) for off-site disposal. Typically, the laboratory will be associated with the disposal company and will provide relevant information such as bottle sizes, holding times, and sample preparation.

All samples analyzed for IDW characterization will be performed in compliance with the project-specific plans.

21.3.2.4 Liquid Investigation-Derived Waste

It is expected that during sampling activities at the site, liquids will be generated. The liquid IDW generated at each location, such as groundwater from the purging and development of monitoring wells and wastewaters from the decontamination of equipment will be characterized to determine types of contaminants present and management process required to handle the waste. Liquid IDW may at the Project Manager and Arizona Department of Environmental Quality (ADEQ) direction be combined from several sites if the IDW is determined to be non-hazardous. Historical results may be used to make this determination. Disposal options for purge water include surface discharge or discharge back to the well from which the water was removed (in accordance with the Aquifer Protection General Permit Type A 1.04), or transport and disposal at a permitted treatment facility. The selected disposal option will be project dependent.

21.3.2.4.1 Liquid Waste Characterization

Before any data gathering activity occurs, the presence of a water-immiscible phase will be determined visually or using an oil/water interface probe. If a water-immiscible phase is present, then the IDW generated from that location will be pumped into 55-gallon drums. The drums, which will be sealed, numbered, labeled, and recorded on log sheets, will be left on pallets at the location. A composite sample will be taken and analyzed for hazardous waste characteristics. Before sampling, the drums of water with an immiscible layer will be inspected.

If the IDW is found to be a special or hazardous waste as defined in ARS 49-851 to 868, or 40 CFR 261, Subpart D, or ARS Title 49, Chapter 5, then the container will be labeled, manifested, stored in a secured area with temporary berms, until it can transported for disposal at a licensed RCRA hazardous/special waste disposal facility.

If analytical results from liquid samples demonstrate the IDW is non-hazardous but contains constituents at levels above City of Phoenix guidelines, the wastes must be containerized and disposed at an offsite facility.

If the analytical results from liquid samples show the IDW to be hazardous, the drummed IDW will be managed and disposed of as a hazardous waste.

Empty drums will be decontaminated and if structurally sound, will be reused. If the drum is not structurally sound, the drum will be decontaminated, crushed, and recycled as scrap.

21.3.2.4.2 Sampling Liquid IDW

Representative composite samples will be collected and analyzed to characterize the liquid IDW generated at each site and accumulated in bulk storage tanks, drums or other containers using a Coliwasa tube. The samples will be labeled, sealed, recorded on the chain of custody, packaged, and shipped to the laboratory for analysis.

21.3.2.4.3 Analytical Methods

The hazardous waste characteristics are defined in 40 CFR 261 Subpart C. Those characteristics include: Toxicity, ignitability, corrosivity, reactivity, and TCLP levels by Method 1311, further analyzed for TCLP metals, TCLP volatile and semivolatile organic compounds. For purposes of determining accurate waste classification, any commercial laboratory capable of performing SW-846 analytical method, using internally derived QC control limits, are adequate to meet the DQOs for offsite disposal. Typically, the laboratory will be associated with the disposal company and will provide relevant information such as bottle sizes, holding times, and sample preparation.

21.3.2.5 IDW Management Procedures

21.3.2.5.1 Drum Specifications

The drums to be used for the collection of wastes will be placed in new or reconditioned containers carrying the DOT UN "performance oriented packaging standard" symbol. Drums should be selected on their ability to hold hazardous, radioactive, and non-hazardous liquids and solids without damage to drum integrity. Special care should be taken in the selection of drums in areas where wastes will be collected and that are known to be reactive, corrosive, or contain organic solvents. The drums will be marked with weather proof indelible ink showing the sampling location (associated with the waste), and an identification number which will represent the location in the storage building where the drum is housed. These markings will be located on the top and side of the drum. Each drum will be stored in a manner so that the drum and attached labels can be inspected without moving the drum or surrounding drums.

21.3.2.5.2 Waste Tracking Labels

Container labels will be placed on the side and top of each container and will include the following information: Waste tracking number; generator; contents; the estimated depth collected (if solid); date the waste was first put in the container; date the container was closed; estimated quantity; and the name, address, and phone number of an emergency Point of Contact for additional information concerning the containers, and the words "Waste Solids or Waste Liquids". The drums will comply with DOT regulations outlined in 40 CFR.

21.3.2.5.3 Transport of Drums and Rolloff Boxes

All drums will be placed on a flat bed truck or trailer using a forklift or Bobcat and transported to the designated central IDW staging area. Roll-off boxes will be transported on a flatbed trailer to the central IDW staging area when two-thirds full or after the roll-off box is no longer needed. Straps will be used to secure the drums when they are placed on the flat bed and while being transported to the central IDW staging area.

21.3.2.5.4 Drum Inspections

The drums will be stored at the sampling location and/or designated location at the site. The drums will rest directly on a gravel/soil substrate with a secondary containment. Any spills will be reported immediately to the Field Manager and the Project Manager. If drum integrity is compromised, it will be immediately corrected. All drums will remain closed at all times except during accumulation or when waste is being sampled or removed.

Drums will be inspected at least monthly by the Field Manager or his designee who will document in the field logbook or on a checklist the condition of each drum. Initiation of any necessary corrective actions will be the responsibility of Field Manager and coordinated with the ADEQ. Any corrective actions will be discussed with the ADEQ and it contractor's project management personnel.

21.3.2.5.5 Storage Time Limitations

Potential RCRA hazardous IDW generated at each site(s) will be temporarily stored for no longer than 90 days from beginning date of collection. According to 40 CFR 262.34(a), a generator may accumulate hazardous waste on-site for 90 days or less without a permit or without having interim status provided that the requirements in 40 CFR 262.34(a) are met. The storage unit will conform to 40 CFR 262.34(a), having a secondary containment system lined with 10-mil plastic. All non-hazardous waste will be stored at the central IDW staging area no longer than one year.

21.4 REFERENCES

40 Code of Federal Regulations (CFR) 261, Subpart D.

Arizona Revised Statutes (ARS) Title 49, Chapters 4 and 5.

21.5 RECORDS

The following records will be maintained by the Field Administrator and retained as project documents and included as appropriate in the Waste Management Report for client deliverables.

- Hazardous Waste Weekly Inspection Forms;
- IDW Inventory Sheet;
- Field log books;
- Certificates of Disposal;
- Water treatment logs, sample collection data sheets, and discharge records; and
- Receipts for material being recycled.

APPENDIX C – ASSESSMENT USING DATA QUALITY INDICATORS

C.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions.

For metals analysis, laboratory analytical precision will be assessed through the analysis of laboratory duplicate (D) samples. Precision will be measured as the relative percent difference (RPD) between these replicate measurements. The QA requirement for laboratory precision is an RPD of less than 35% for soil samples if both results are greater than five times the laboratory reporting limit. If either result is less than or equal to five times the reporting limit, the QA requirement will be agreement within three times the reporting limit for soil samples.

Field sampling and analysis precision will be assessed through the analysis of homogenized field duplicate (FD) samples submitted blind to the laboratory. Concentration dependent evaluation criteria will be used to evaluate overall sampling and analysis precision. For analytes where both the sample and field duplicate results are greater than 5 times the higher of the detection limit or the reporting limits, precision will be evaluated by means of RPD. Acceptable agreement will be indicated by an RPD of less than or equal to 50%. For analytes where either result is less than 5 times the greater of the two reporting limits, field duplicate results are evaluated by comparing the absolute difference between the results to a factor of the higher reporting limit. Acceptable agreement will be indicated by an absolute difference of less than or equal to 3 times the higher reporting limit.

RPD will be calculated in accordance with the following formula:

$$RPD (\%) = (| S-D |)/((S+D)/2) \times 100$$

Where S = First Measured Value

D = Second Measured Value

C.2 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. The accuracy of the laboratory performance in conducting analyses will be assessed through analysis of laboratory control samples (LCS); clean matrices spiked with known amounts of all target analytes. The accuracy will be measured as the percent recovery (%R) of a given target analyte relative to its known concentration. The QA objective for laboratory accuracy on LCS analyses is a %R within the range specified by the manufacturer of the LCS solution.

The accuracy of the laboratory analysis on the site-specific matrix will be assessed through analysis of matrix spike (MS) samples. The accuracy will be measured as the %R of a given target analyte relative to the level spiked into the sample.

%R will be calculated in accordance with the following formula for MS and LCS results:

$$\%R = X/T \times 100$$

Where X = Measured Value

T = True Value

C.3 Completeness

The analytical completeness QA requirement for work under this SAP will be 80%. If any data are rejected, all parties will be notified and a determination made of whether or not the rejected data are critical in meeting project objectives. If the data are considered critical, additional sampling and analysis may be required.

Analytical completeness will be calculated as the ratio of acceptable analytical results (including those qualified as estimated during data verification) to the total number of analytical results requested from the laboratory (expressed as a percentage). Completeness will be calculated by the following formula:

% Completeness = (Number of Acceptable Analytical Results) / (Total Number Analytical Results Requested) x 100

C.4 Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness will be maintained during the sampling effort by completing all sampling in compliance with the procedures described or specified in this Work Plan.

C.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision as these quantities are measures of data reliability. Data are considered comparable if siting considerations, collection techniques, measurement procedures, methods, and reporting are of equivalent quality for the samples within a given sample set. All analyses will be conducted using standard analytical methods and all samples will be collected following standard operating procedures in order to maximize the comparability of data to be collected under this Work Plan.

C.6 Sensitivity

Sensitivity is a measure of the analytical detection or quantification limits. A detection is the minimum amount of analyte that can be consistently measured, and reported with a high degree of confidence that the analyte concentration is above background response. A quantification limit is that amount that can be consistently quantified with acceptable precision and accuracy. This is also referred to as a practical quantitation limit (PQL).

The laboratory quantitation limits required for this project must be at or below the applicable regulatory standard.