AMENDMENT NO. 2
TO THE 1988 RECORD OF DECISION FOR THE
DELAWARE SAND & GRAVEL LANDFILL SUPERFUND SITE
NEW CASTLE, DELAWARE

Prepared by:

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TABLE OF CONTENTS

FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BCEE	bis(2-chloroethyl)ether
BRA	bioremediation area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	Conceptual Site Model
DDA	Drum Disposal Area
DNREC	Department of Natural Resources and Environmental Control
DRBC	Delaware River Basin Commission
DRGHW	Delaware Regulations Governing Hazardous Waste
DS&G	Delaware Sand & Gravel Landfill
eLFExS	enhanced low flow groundwater extraction system
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ESD	Explanation of Significant Differences
ft-msl	feet above mean sea level
HI	hazard index
HQ	hazard quotient
LFExS	low flow groundwater extraction system
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDL	method detection limit
MNA	monitored natural attenuation
NAPL	nonaqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	non-detect result
NPL	National Priorities List
O&M	operation and maintenance
PFAS	perfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PHE	Public Health Evaluation
PRG	preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
PRM	Potomac Raritan Magothy aquifer system
RAO	remedial action objective
ROD	Record of Decision
RSL	Regional Screening Level
SSDS	sub-slab depressurization system

SVOC	semi-volatile organic compound
SWFT	slurry-wall flood test
TR	target risk
THQ	target hazard quotient
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
UCL	upper confidence limit
UPCU	Upper Potomac Confining Unit
UPCUTZ	Upper Potomac Confining Unit Transition Zone
USACE	United States Army Corps of Engineers
VOC	volatile organic compound

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NEW CASTLE, DELAWARE

1.0 DECLARATION

1.1 SITE NAME AND LOCATION

The Delaware Sand & Gravel Landfill (DS&G) Superfund Site (Site or DS&G Site) is located two miles south of the City of New Castle in New Castle County, Delaware. The Site is located along Grantham Lane, east of U.S. Highway 13 (Dupont Highway) and west of Delaware Route 9 (River Road) (see Figure 1). It consists of approximately 27 acres in an area of residential and light-industrial land use and is bounded to the north and northeast by the Norfolk Southern Railroad tracks and to the west by Army Creek which discharges into the Delaware River less than one mile east of the Site. The Army Creek Landfill Superfund Site (Army Creek Landfill) is located immediately west of the Site on the opposite bank of Army Creek.

The National Superfund Database Identification Number for the Site is DED000605972.

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document (ROD Amendment No. 2 or Amendment) modifies the remedy for the Site selected in the April 22, 1988 Record of Decision (1988 ROD), as modified by the September 30, 1993 Amendment to the ROD (ROD Amendment No. 1) and the July 2003 Explanation of Significant Differences (ESD). The U.S. Environmental Protection Agency (EPA) is modifying the remedy for the Site in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C. § 9601 et seq. and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, as amended.

The information supporting ROD Amendment No. 2 is contained in the Administrative Record file for the Site which has been developed in accordance with Section 113(k) of CERCLA, 42 U.S.C. § 9613(k). The Administrative Record is available for review online at http://go.usa.gov/xWFuh, at the EPA Region III Records Center located at 1650 Arch Street in Philadelphia, Pennsylvania, and at the Department of Natural Resources and Environmental Control (DNREC) located at 391 Lukens Drive in New Castle, Delaware.

The State of Delaware (State), through DNREC, concurs with modifying the remedy for the Site through ROD Amendment No. 2.

1.3 ASSESSMENT OF THE SITE

The remedy selected in 1988 ROD, as previously amended and as amended by this ROD Amendment No. 2 (Selected Remedy), is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment and

actual or threatened release of pollutants or contaminants which may present an imminent and substantial endangerment to public health or welfare.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The Selected Remedy will address 1) contaminated groundwater in the Upper Potomac Aquifer, including groundwater in the Upper Potomac Confining Unit Transition Zone (UPCUTZ) and groundwater pumped from Artesian Water Company's (Artesian) Llangollen well field; 2) contaminated soil and groundwater within the slurry wall surrounding the former Drum Disposal Area (DDA); and 3) potential vapor intrusion at new construction adjacent to the Inert Area and the Grantham South Area. It does not include response actions that address waste and contaminated soil at the Grantham South Area and the Inert Area, which have already been implemented at the Site as described in the 1988 ROD, ROD Amendment No. 1 and the ESD.

The Selected Remedy consists of components of the remedial action for the Site, which are categorized as follows:

1) Remedial components that were previously selected in the prior decision documents referenced above, but which are not being modified by this ROD Amendment No. 2 (each identified below as an "Existing Component");

2) Remedial components that were previously selected in the prior decision documents, but which are being modified by this ROD Amendment No. 2 (each identified below as a "Modified Component"); and

3) New remedial components that were not previously selected in the prior decision documents (each identified below as a "New Component").

Specifically, the Selected Remedy consists of the following components:

1. Existing Components
   - Slurry-wall system;
   - A composite barrier cap to minimize infiltration of precipitation through contaminated soil contained within the slurry wall surrounding the DDA, and
   - Institutional controls to prevent direct contact with contaminated soil, the installation of drinking water wells on the Site property and other future uses of the Site property which could compromise the effectiveness of the Selected Remedy.

2. Modified Components
   - Hydraulic control of contaminated groundwater within the slurry-wall enclosure using an enhanced low-flow groundwater extraction system (eLFExS);
   - Installation and operation of extraction wells in areas determined to optimize capture and remove contaminant mass from the more highly-impacted areas of the Upper Potomac Aquifer, including the UPCUTZ; and
   - Discharge of groundwater pumped from the DS&G extraction wells to the Wilmington Wastewater Treatment Plant.

3. New Components
    - Pre-design investigations to develop supplemental information regarding source and extent of contamination in the Upper Potomac Aquifer and hydraulic connections between hydrostratigraphic units within the Upper Potomac Aquifer, and confirm target capture zones within the Upper Potomac Aquifer;
    - Continued groundwater extraction at Artesian's Llangollen well field with treatment utilizing existing systems for bis(2-chloroethyl)ether (BCEE) and 1,4-dioxane and, if necessary, additional treatment systems targeting other contaminants of concern (COCs) such as manganese;
    - A groundwater monitoring program to ensure that the remedial action is meeting the short-term goal of plume containment and will meet the long-term goal of aquifer restoration within a reasonable time frame; and
    - Institutional controls to prevent potential future exposure to Site contaminants in indoor air.

The estimated cost of the Selected Remedy is $46,100,000.

1.5 STATUTORY DETERMINATION

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The Selected Remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

Because this Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be continue to be conducted every five years to ensure that the Selected Remedy is, or will be, protective of human health and the environment. The last five-year review for the Site was conducted in 2015.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this Amendment:

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD Amendment No. 2.

- Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factors that led to selecting the remedy (i.e., a description of how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

Additional information can be found in the Administrative Record file for this Site.

1.7 AUTHORIZING SIGNATURE

This ROD Amendment No. 2 documents the components of the Selected Remedy for contaminated soil and groundwater remaining at the former DDA, contaminated groundwater in the Upper Potomac Aquifer and potential future vapor intrusion associated with the migration of landfill gas from the Inert Area and Grantham South Area, and is based on the Administrative Record for the Site. EPA selected these components with the concurrence of DNREC. The Director of the Hazardous Site Cleanup Division for EPA Region III has approved and signed this ROD Amendment No. 2.

Karen Melvin, Director
Hazardous Site Cleanup Division
EPA Region III

DEC 12 2017
Date

2.0 DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

The Site is located two miles south of the City of New Castle, New Castle County, Delaware. The Site property is located along Grantham Lane, east of U.S. Highway 13 (Dupont Highway) and west of Delaware Route 9 (River Road) (see Figure 1). It consists of approximately 27 acres in an area of residential and light-industrial land use and is bounded to the north and northeast by the Norfolk Southern Railroad tracks and to the west by Army Creek which discharges into the Delaware River less than one mile east of the Site. Artesian's Llangollen well field is located approximately three quarters of a mile southwest of the Site.[1]

The Site property is a former sand and gravel quarry that was later operated as a permitted landfill from 1968 until 1976. It includes four waste disposal areas (see Figure 2). Three of these – the Grantham South Area, the Drum Disposal Area (DDA) and the Inert Area – were unlined gravel pits into which waste materials, including hazardous substances, were disposed. The fourth area, known as the Ridge Area, was used for temporary storage of chemical waste and was impacted by the spillage of hazardous substances. Approximately 550,000 cubic yards of industrial and municipal wastes and construction rubble were disposed of at the Site, including approximately 15,000 drums containing liquids and sludge from chemical production, manufacturing and petroleum refining processes.

The Army Creek Landfill Superfund Site (Army Creek Landfill) is located immediately west of the Site on the opposite bank of Army Creek. The 50-acre Army Creek Landfill is an abandoned sand and gravel quarry that was operated as an unlined landfill for the disposal of 1.9 million cubic yards of municipal and industrial waste from 1960 through 1968. In September 1986, EPA issued a Record of Decision (ROD) for the Army Creek Landfill, selecting a source control and aquifer restoration remedy; in June 1990, EPA issued a ROD for Operable Unit 2 at the Army Creek Landfill, which called for treatment to remove iron from recovered groundwater prior to its discharge to Army Creek.

In addition to the Site property, the Site includes areas to the south and southwest where hazardous substances have been transported in groundwater.

The CERCLA identification number for the Site is DED000605972.

EPA is the lead agency for Site activities, and DNREC is the support agency. The United States, on behalf of EPA, and the State of Delaware, on behalf of DNREC, have reached prior settlements with potentially responsible parties (PRPs) under which the PRPs have performed, and are performing, the response actions selected in the 1988 ROD and ROD Amendment No. 1.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Local officials first discovered groundwater degradation in the Upper Potomac Aquifer in 1971 when landfill leachate constituents were detected in a residential well near the Army Creek

[1] The production wells in Artesian's Llangollen well field are shown in Figure 8 of this ROD Amendment No. 2.

Landfill. In 1973, Army Creek Landfill owner and operator, New Castle County (County), installed groundwater recovery wells in the Upper Potomac Aquifer between the Army Creek Landfill and Artesian's Llangollen well field to intercept and contain the contaminant plume emanating from the Army Creek Landfill. Subsequently, the County modified its groundwater recovery well network, moving pumping locations closer to the Army Creek Landfill to improve system performance.

In 1975, the State installed several monitoring wells at the Site and initiated enforcement action against the Delaware Sand & Gravel Company, owner and operator of DS&G, for violations of the State solid waste permit. In 1976, the State Attorney General's office ordered DS&G closed.

In 1980, the State reduced and capped the permitted groundwater withdrawal rate from Artesian's Llangollen well field, and Artesian extended public water supply lines to residences along Grantham Lane and the Llangollen Estates subdivision south of the Site.

EPA placed the Site on the National Priorities List (NPL) on September 8, 1983. In 1984, EPA and DNREC performed an emergency removal of more than 1,600 drums from the surface of the DDA and Ridge Area. DNREC conducted a remedial investigation and feasibility study at the Site from 1984 to 1987. In April 1988, EPA issued a ROD selecting on-site incineration of contaminated soil and waste materials at the DDA and the Ridge Area, construction of a Resource Conservation and Recovery Act (RCRA) Subtitle C (composite barrier) cap over the Grantham South Area, installation of a RCRA Subtitle D (single barrier) cap over the Inert Area, and collection and treatment of contaminated groundwater with discharge of treated water to Army Creek.

From 1989 to 1991, the United States Army Corps of Engineers (USACE), on behalf of EPA, constructed the landfill cap over the Grantham South Area. The State of Delaware assumed responsibility for monitoring and maintenance of the Grantham South Area in October 1992.

In 1991, 18 PRPs entered into a Consent Decree under Sections 106 and 107 of CERCLA with the United States, on behalf of EPA, and the State, on behalf of DNREC, concerning the adjacent Army Creek Landfill (1991 Consent Decree). Under the 1991 Consent Decree, the County agreed to install and operate a groundwater treatment plant and continue to operate groundwater recovery wells to 1) control the migration of contaminants released from the Army Creek Landfill and DS&G Sites into the Upper Potomac Aquifer and 2) restore groundwater quality downgradient of the Army Creek Landfill property boundary to primary drinking water standards. The additional signatories to the 1991 Consent Decree installed a multilayer cap at the Army Creek Landfill from 1992 to 1993.[2]

Between 1991 and 1993, USACE conducted pre-design investigations at the Site which showed that contamination at the DDA was more widespread and heterogeneous than previously recognized. In 1992, EPA determined that buried drums at the DDA posed an imminent threat

[2] Although the County and the other PRPs agreed in the 1991 Consent Decree to undertake separate tasks, the PRPs therein agreed that they were jointly and severally liable to comply with all of the requirements of the 1991 Consent Decree, including operation and maintenance of the groundwater treatment plant and maintenance of the Army Creek Landfill cap.

and entered into an Administrative Order on Consent under Section 106 of CERCLA with 22 PRPs who agreed to design and construct a subsurface slurry wall around the DDA as an interim removal action.

Based on the results of the pre-design investigations performed by USACE, EPA reassessed the remedy selected in the 1988 ROD and issued ROD Amendment No. 1 in September 1993. ROD Amendment No. 1 upgraded the selected cover system for the Inert Area to a RCRA Subtitle C cap and changed the selected remedy for contaminated soil at the DDA and the Ridge Area from excavation and on-site incineration to enclosure within a slurry wall containment system, including a RCRA Subtitle C cap, with *in-situ* treatment by soil vapor extraction and bioventing.

In 1994, the PRPs installed a three-foot-thick soil-bentonite slurry wall, ranging in depth from 17 to 57 feet and keyed into the underlying clay stratum, around a three-acre area encompassing the DDA and the surrounding soils affected by historical releases from the DDA. EPA accepted the PRPs' certification of completion of slurry wall construction in February 1995.

In June 1995, 31 PRPs, referred to as the DS&G Remedial Trust, agreed in a Consent Decree (1995 Consent Decree) entered under Sections 106, 107 and 113 of CERCLA with the United States, on behalf of EPA, and the State of Delaware, on behalf of DNREC, to implement the modified response actions selected in the 1993 ROD Amendment and to monitor and maintain the Grantham South Area.

From 1996 to 1997, under the 1995 Consent Decree, the DS&G Remedial Trust constructed a RCRA Subtitle C landfill cap over the Inert Area. EPA accepted the Remedial Action Report documenting completion of cap construction in September 1997.

From 1995 to 1997 the DS&G Remedial Trust completed remedial action and construction activities at the DDA and the Ridge Area. Approximately 5,000 tons of PCB-contaminated soil, drum carcasses, contaminated solids, asbestos containing materials and hazardous liquids were excavated or removed and transported to permitted facilities for disposal. The remainder of the soil excavated from the Ridge Area and the DDA was combined with woodchips, sand and di-ammonium phosphate to encourage bioremediation of the soil contaminants and placed in a bio-cell within the slurry wall surrounding the DDA. A dewatering system and a bioventing system were installed to enable circulation of oxygen-enriched air throughout the contaminated soil within the slurry wall, and a temporary cap was constructed over the bioremediation area (BRA). EPA issued a Preliminary Close Out Report documenting the completion of construction activities for all cleanup actions at the Site in August 1997.

The DS&G Remedial Trust began operating the dewatering and bioventing systems at the BRA in 1997. In 1998, the DS&G Remedial Trust's consultant, McLaren/Hart, Inc., noted that upward seepage from the Potomac Aquifer into the Columbia Aquifer due to artesian pressure would likely preclude the complete dewatering of the soil at the BRA.

In 1999, BCEE, a Site-related COC, was detected in groundwater at the Llangollen well field. In 2000, Delaware's Department of Health and Social Services proposed an interim health advisory level for BCEE (0.096 micrograms per liter [µg/L]), and Artesian installed a granular activated

carbon system to remove BCEE from groundwater pumped from the Llangollen well field prior to its distribution to customers.

EPA issued an ESD in July 2003 to clarify and modify the land and groundwater use restrictions previously selected for the Site. EPA then issued Unilateral Administrative Orders (UAOs) under Section 106 of CERCLA to the three separate owners of the Site property in 2004, 2006 and 2008, respectively, requiring the respondents of the respective UAOs to provide Site access and implement institutional controls in order to establish those land and groundwater use restrictions. Respondents to the 2006 and 2008 UAOs have complied with the terms of their respective UAO. EPA is working to secure full compliance from the former operator and current owner of DS&G with the requirements of the 2004 UAO. Toward that end, on September 22, 2017, the United States Department of Justice, on behalf of EPA, filed a complaint to compel the former operator and current owner of DS&G to comply with the 2004 UAO.

In May 2004, the dewatering of the BRA was suspended with EPA approval to allow water levels within the slurry wall to rise during the course of a six-month pilot study proposed by the DS&G Remedial Trust. The primary purpose of the "slurry-wall flood test" (SWFT) was to evaluate the impacts, following several years of bioventing, of the remaining soil contamination on shallow groundwater at the BRA. Groundwater monitoring performed during the SWFT suggested that the soil contamination remaining at the BRA was continuing to impact shallow groundwater.

In July 2004, EPA approved the County's related pilot study proposal to suspend operation of the Army Creek Landfill groundwater recovery and treatment system for one year and refocus groundwater recovery efforts in the area immediately downgradient of the former DDA where the highest BCEE concentrations had been observed. One objective of the pilot study was to determine whether rebounding groundwater elevations in the Upper Potomac Aquifer and the Columbia Aquifer would cause new releases of hazardous substances to groundwater or Army Creek. An additional objective was to evaluate focused source control measures as an alternative to the high-volume groundwater extraction required to maintain a groundwater divide between the two Superfund sites and the Llangollen well field. The County shut down the Army Creek Landfill groundwater recovery wells in October 2004 and began pumping groundwater from extraction well PW-1 to capture releases from the DDA and discharging the groundwater to the City of Wilmington's wastewater treatment plant. The County did so through a cost-sharing agreement with the DS&G Remedial Trust.

During the SWFT and the County's pilot study, groundwater elevations were monitored in the Columbia and Upper Potomac Aquifers in the vicinity of the DDA/BRA. Based on the observed hydraulic connection between the Upper Potomac Aquifer and the Columbia Aquifer, which prevented dewatering of the soil within the slurry wall and resulted in ongoing releases of dissolved-phase contaminants from the DDA/BRA into the Upper Potomac Aquifer, EPA concluded that the remedial action at the DDA was not performing as intended. EPA's Third Five-Year Review Report for the Site, issued in 2005, recommended that the DS&G Remedial Trust reassess the response actions at the DDA/BRA.

In June 2006, DNREC established a groundwater management zone in the vicinity of the Site which placed restrictions and conditions on the installation of new public or domestic water supply wells to prevent potential exposure to contaminated groundwater.

EPA approved several extensions of the County's pilot study and the SWFT through early May 2009. Groundwater monitoring during this period showed that maximum contaminant levels (MCLs) for primary drinking water contaminants promulgated pursuant to the Safe Drinking Water Act, 42 U.S.C. §§ 300f et seq., and codified at 40 CFR Part 141, had been met at the Army Creek Landfill property boundary and that the BCEE groundwater plume originated at the DDA and not the Army Creek Landfill. On May 4, 2009, EPA notified the County that renewed operation of the Army Creek Landfill groundwater collection and treatment system would not be required, consistent with the terms of the 1991 Consent Decree. In order to capture BCEE and other contaminants released from the DDA into the Upper Potomac Aquifer, the County continued to operate extraction well PW-1 until October 15, 2012, when the DS&G Remedial Trust assumed hands-on responsibility for the operation of the well and began implementing measures to maintain more consistent extraction rates. Since October 2012, EPA has provided funding for the operation of extraction well pursuant to a Disbursement Agreement between EPA and the DS&G Remedial Trust and New Castle County. Under the terms of the Disbursement Agreement, EPA reimburses the DS&G Remedial Trust and the County for costs incurred in operating PW-1 with funds from site-specific special accounts for both the Army Creek Landfill and the Site.

In 2008, EPA requested that the DS&G Remedial Trust implement additional response actions at the DDA to provide hydraulic containment of the source area. In May 2009, the DS&G Remedial Trust began operating a low flow groundwater extraction system (LFExS) within the slurry wall to mitigate the release of contaminants from the DDA into the Upper Potomac Aquifer. Groundwater from the system is discharged to the City of Wilmington's wastewater treatment plant in Wilmington, Delaware. Because the LFExS utilizes components of the BRA bioventing system, it was necessary to terminate bioventing operations to implement this interim source control measure. Vertical head differences observed between the Columbia Aquifer and the Upper Potomac Aquifer in the vicinity of the DDA indicate that the LFExS has generally induced an upward gradient across the most impacted portions of the slurry-wall containment area since October 2012 and, as such, has mitigated the release of contaminated groundwater from the DDA into the Upper Potomac Aquifer.

In April 2010, EPA notified the DS&G Remedial Trust of the need to perform additional Site characterization and a feasibility study to evaluate additional response actions for the DDA source area and the impacted Upper Potomac Aquifer, including the Llangollen well field.

2.3 COMMUNITY PARTICIPATION

The Proposed Remedial Action Plan (Proposed Plan) for the Site and supporting documents were made available to the public in September 2016. These documents, including the *Supplemental Site Characterization Report – Revision 2* (Golder Associates, 2016), the *Development of Site-Specific Remediation Goals – Revision 2* (Golder Associates, 2014), the *Final Feasibility Study – Revision 1* (Golder Associates, 2016) (Feasibility Study) and other documents which formed the basis of EPA's remedy selection are located in the Administrative Record file which can be

viewed at http://go.usa.gov/xWFuh and the information repositories maintained at the U.S. EPA Region III office located at 1650 Arch Street in Philadelphia, Pennsylvania, and the DNREC office located at 391 Lukens Drive in New Castle, Delaware. The notice of the availability of these documents was published in the *Delaware News Journal* on September 7, 2016. In addition, EPA sent a fact sheet summarizing EPA's preferred remedial alternative to residences and businesses near the Site in September 2016. From September 7, 2016, to October 7, 2016, EPA held a 30-day public comment period to accept public comment on the remedial alternatives presented in the Feasibility Study and the Proposed Plan and the other documents contained within the Administrative Record file for the Site. On September 21, 2016, EPA held a public meeting to discuss the Proposed Plan and accept comments. A transcript of this meeting is included in the Administrative Record file. The summary of significant comments received during the public comment period and EPA's responses are included in the Responsiveness Summary in Section 3 of this ROD Amendment No. 2.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

Previously implemented response actions addressing groundwater and the DDA have not performed as expected. The response action selected in this ROD Amendment No. 2 modifies the remedy selected for groundwater in the 1988 ROD and the remedy selected for the DDA in the 1993 ROD Amendment, and adds requirements to mitigate potential vapor intrusion due to the migration of landfill gas for habitable new construction.

The Selected Remedy would restore contaminated groundwater in the Upper Potomac Aquifer to beneficial use within a reasonable time frame, prevent exposure to Site contaminants in drinking water, effectively mitigate the release of contaminants from the DDA into the Upper Potomac Aquifer, prevent exposure to contaminated soil at the DDA and eliminate potential future exposure to Site-related contaminants in indoor air.

2.5 SITE CHARACTERISTICS

2.5.1 Surface Features, Land Use, Drainage, Geology and Hydrogeology

Surface Features and Land Use

The Site topography is generally characterized as flat to gently rolling with small isolated areas of steeper slopes which are generally remnants of prior quarrying activities. The elevation at the Site and the surrounding areas vary from about 44 feet above mean sea level (ft-msl) to 4 ft-msl with elevations typically between 20 and 30 ft-msl. Regionally, the area generally slopes to the south and east toward the Delaware River. The majority of the Site is covered by grasses as a result of prior excavation, filling and capping activities. Wooded areas surround the perimeter of the Site in the areas where no prior excavation activities occurred.

The current land use around the Site is residential, light industrial, and commercial in nature. Based on New Castle County's zoning map, the surrounding areas are zoned for mixed residential, commercial, and/or industrial uses; therefore, the current land use is anticipated to continue for the foreseeable future. There are multiple residential developments within one mile of the Site, the closest of which is the Llangollen Estates development located less than a mile

southwest of the Site, between DuPont Parkway and River Road. Commercial and/or industrial properties are located to the east and south of the Site along Grantham Lane and River Road.

Drainage

There are many natural and man-made features at the Site that govern surface water drainage patterns. The Site drainage is dominated by Army Creek, which generally runs west to east and drains into the Delaware River about one mile east of the Site. Tide gates are in place to prevent the tidal surge in the Delaware River from entering Army Creek and Army Pond. Multiple man-made drainages branch off from Army Creek to the north and northwest. The man-made drainages were created during previous Site activities and generally consist of shallow, grassed channels.

Regional Geology and Hydrogeology

The geologic formations present beneath the Site are the Quaternary-age Columbia Formation and the Upper Cretaceous-age Potomac Formation. The Columbia Formation is a narrow, linear upper valley fill and a broader lower valley fill of sands and gravel deposited during the Pleistocene Epoch. The narrow valley fill deposits were transported to the southwest into Delaware along the ancestral channel of the Delaware River as distal glacial outwash. These deposits occur parallel with, and to the west of, the Delaware River in the northern Coastal Plain of Delaware.

The Columbia Formation ranges in thickness from about 10 feet to as much as 100 feet in deeply incised areas. Near the base of the formation, the sands may be fine- to coarse-grained with variable amounts of coarse to fine gravels; the basal section of the gravels may be cemented by iron oxides. In the vicinity of the Site, the base of the lowest gravel horizons resting on the underlying Potomac Formation ranges from elevations of about 12 feet above mean sea level to as much as 25 feet below mean seal level. These varying elevations correspond to the undulating surface of the eroded top of the Potomac Formation. The near surface deposits of the Columbia Formation represent the surficial, water table aquifer in the northern Coastal Plain of Delaware and are referred to as the Columbia Aquifer.

The Potomac Formation is the uppermost hydrogeologic formation of the regional Potomac Raritan Magothy aquifer system (PRM) in the Site area. The PRM dips southeast and east at about 100 feet per mile. The Potomac Formation is several hundred feet thick east and down-dip of the Site, and is further divided into the “upper,” “middle” and “lower” sand deposits separated by intervening and finer grained silty clays and clays. Its stratigraphy is represented by proximal, stream-deposited sands, silts, clays and gravels accumulated in an estuarine, marginal marine basin. The uppermost portion of the Potomac Formation consists of a stiff, red to grey, reddish-grey and occasionally brick red, variegated clay or silty clay overlying proximal, grey to light tan and pale brown sands and gravels. This horizon is highly variable, not only in its depositional thickness, but also because of erosion and incision by channels active during the Pleistocene Columbia Formation time. Site investigations have focused on the upper sand deposit of the Potomac Formation which is referred to as the Upper Potomac Aquifer in Site documents.

Regionally, there are two aquifer units used for water supply, the Columbia Aquifer and the Upper Potomac Aquifer. The Columbia Aquifer is a water table aquifer underlain and separated from the Upper Potomac Aquifer by the Upper Potomac Confining Unit (UPCU), a regionally thick, competent clay unit.

Site-Specific Geology and Hydrogeology

In the Site area, the Columbia Aquifer rests unconformably upon the upper portion of the Potomac Formation. The Site is located in the up-dip feather-edge of the Potomac Formation and its stratigraphy is represented by proximal, stream-deposited sands, silts, clays and gravels accumulated in an estuarine, marginal marine basin. Given these depositional conditions, the lateral and vertical distribution of sand, silt, clay and gravel is quite varied. In the area of the Site, the Upper Potomac Aquifer is generally separated from the overlying Columbia Formation by the UPCU. The top of the UPCU generally slopes to the north and northwest beneath the Site. Subcrop zones (zero-clay areas) where the UPCU has been eroded away and replaced by sands, gravels and cobbles have been identified at and near the Site, as evidenced by the presence of the Columbia basal gravel unit in areas where paleochannels exist. In the subcrop zones, the Columbia Aquifer is in direct contact with the generally fining-upward sequence that is present between the UPCU and the top of the Upper Potomac Aquifer upper sand (discussed below). This key hydrostratigraphic unit, referred to as the UPCUTZ at the Site, displays evidence of bedding/discontinuous sandy layers. Beneath the UPCUTZ, the Upper Potomac Aquifer is approximately 75 to 100 feet thick in the area of the Site. Within the Upper Potomac Aquifer there is an intermittent clay unit, referred to in Site documents as the Upper Potomac Dividing Clay (UPDC), which separates the Upper Potomac Aquifer into two sand units, the upper sand of the Upper Potomac Aquifer and lower sand of the Upper Potomac Aquifer.

In the area of the Site, Columbia Aquifer groundwater is recharged by precipitation, except in areas at the DS&G and Army Creek Landfill Sites where landfill caps reduce infiltration. The groundwater flow direction in the Columbia Aquifer at the Site is generally to the northwest toward Army Creek which discharges to the Delaware River to the northeast of Site. The Upper Potomac Aquifer receives recharge directly from a subcrop zone immediately north and west of the Site and indirectly as vertical leakage from the overlying Columbia Aquifer and the underlying Middle Potomac Aquifer and/or Lower Potomac Aquifer. Groundwater in the Columbia Aquifer at the Site, outside the slurry-wall enclosure at the DDA, drains through the subcrop zone (zero-clay area) into the Upper Potomac Aquifer. The Upper Potomac Aquifer is a confined aquifer except in areas near the zero-clay areas where the Upper Potomac Aquifer is semi-confined. Artesian operates public water supply wells in the Upper Potomac Aquifer at its Llangollen well field located to the south and southwest of the Site. The general groundwater flow direction in the Upper Potomac Aquifer is to the south/southeast or southwest toward Artesian's Llangollen well field. Prior to the groundwater withdrawals in this area, the natural groundwater flow was probably from the Columbia Aquifer through the zero-clay areas, into the Upper Potomac Aquifer and toward the Delaware River located to the east of the Site.

The head differences measured between wells screened in the Columbia Aquifer and the Upper Potomac Aquifer generally indicate a downward vertical gradient between the Columbia Aquifer and the Upper Potomac Aquifer, except where the operation of the LFExS is creating upward vertical gradients within the slurry-wall containment area at the DDA. Due to extraction

predominantly from the Upper Potomac Aquifer lower sand at Artesian's Llangollen well field, there is typically a downward vertical gradient from the Upper Potomac Aquifer upper sand to the Upper Potomac Aquifer lower sand between the well field and the DS&G and Army Creek Landfill Sites.

2.5.2 Previously Implemented and Ongoing Remedial Measures

Several remedial measures have been undertaken at the Site, some of which have been incorporated into, or modified by, the Selected Remedy. As discussed in Section 2.2, herein, EPA and DNREC removed drummed chemical wastes from the surface of the DDA and the Ridge Area in 1984 and disposed of this material at a permitted off-site facility. From 1989 to 1991, EPA installed a landfill cap at the Grantham South Area.

In 1991, New Castle County agreed to operate the groundwater recovery wells it had installed to capture releases from the Army Creek Landfill so that contaminants released from the DS&G Site into the Upper Potomac Aquifer would also be captured. In 1994, the DS&G Remedial Trust installed a slurry wall, which is keyed into the underlying UPCU, around the DDA.

From 1995 to 1997, the DS&G Remedial Trust conducted the following additional response actions at the Ridge Area and the DDA: excavation of buried wastes and highly contaminated soil and disposal of the material at permitted off-site facilities; excavation of additional contaminated soil from the Ridge Area and consolidation of this material with the contaminated soil remaining at the DDA; installation of dewatering and bioventing systems within the slurry-wall enclosure; and construction of a temporary cap above the area contained within the slurry wall. From 1996 to 1997, the DS&G Remedial Trust installed a landfill cap above the Inert Area. The DS&G Remedial Trust operated the bioventing system within the slurry-wall enclosure from 1997 until 2009. When the bioventing system was shut down in 2009, the DS&G Remedial Trust began operating the LFExS to provide hydraulic containment at the DDA.

In 2004, New Castle County shut down the Army Creek Landfill groundwater recovery wells and began pumping groundwater from extraction well PW-1 at the DS&G Site and discharging the groundwater to the City of Wilmington's wastewater treatment plant (through the cost-sharing agreement with the DS&G Remedial Trust); in 2012, the DS&G Remedial Trust assumed hands-on responsibility for the operation and maintenance of extraction well PW-1.

From July to September 2017, the DS&G Remedial Trust installed a landfill gas mitigation system along the perimeter of those sections of the Inert Area and the Grantham South Area that are adjacent to existing habitable structures, to prevent the migration of landfill gas toward potential receptors.

The slurry wall, LFExS and groundwater extraction well PW-1 are components of the Selected Remedy.

2.5.3 Supplemental Site Characterization

Summary and Findings of Recent Investigations

Additional Site characterization was performed in accordance with Golder Associates' October 2011 *Feasibility Study Work Plan – Revision 2*, submitted on behalf of the DS&G Remedial Trust, to support the evaluation of additional response actions for the DDA and the impacted Upper Potomac Aquifer. Toward that end, the following activities were performed from 2011 through 2013:

- Soil borings were advanced at five locations within the slurry-wall containment area and soil samples were collected and analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Soil samples were also collected and visually inspected to evaluate the micro-stratigraphy of the UPCU beneath the DDA.
- A new monitoring well was installed in the Columbia Aquifer between the northern section of the slurry wall and the railroad track. A soil sample collected from the well borehole was analyzed for VOCs and SVOCs.
- 25 new monitoring wells were installed in the Upper Potomac Aquifer at and downgradient of the DDA. Borings were advanced using rotosonic drilling with vertical aquifer profiling to assist in the selection of screened intervals. Soil samples were collected from the UPCUTZ and analyzed for VOCs and SVOCs to evaluate the potential for contaminants to leach into the upper sand and the potential presence of non-aqueous phase liquid (NAPL). Well screens were set across the UPCUTZ (11 wells) and the upper (11 wells) and lower (3 wells) sand units of the Upper Potomac Aquifer.
- Groundwater samples were collected from new and previously existing monitoring wells and analyzed for VOCs, SVOCs and metals.
- Aquifer testing was performed to determine aquifer hydraulic properties.

The results and findings of the field activities and data evaluations are described in detail in the *Supplemental Site Characterization Report - Revision 2* and are summarized below:

- Contaminants, including benzene, ethylbenzene, xylenes and BCEE, are present in both saturated and unsaturated soil within the slurry-wall containment area.[3] The maximum concentrations of these contaminants detected in soil samples collected in 2011 are 1,100 micrograms per kilogram (µg/kg), 12,000 µg/kg, 59,000 µg/kg and 330 µg/kg, respectively. Benzene, ethylbenzene and xylenes were also found in the soil sample collected between the slurry wall and the railroad track, but the concentrations were one to two orders of magnitude lower than the concentrations within the slurry-wall containment area.
- Contaminants, including benzene, ethylbenzene, xylenes and BCEE, are present in soil in the UPCUTZ at concentrations that are lower than those detected in soil at the DDA. The

[3] Analytical results for 1,4-dioxane in soil samples collected within the slurry-wall containment area are not available because 1,4-dioxane was not included on the target analyte list when the samples were collected. The presence of 1,4-dioxane in groundwater within the containment area suggests that 1,4-dioxane is also present in the soil.

maximum concentrations of these contaminants detected in UPCUTZ soil samples collected in 2012 and 2013 are 1,000 µg/kg, 120 µg/kg, 400 µg/kg and 12 µg/kg, respectively. 1,4-dioxane is also present in soil in the UPCUTZ (up to 390 µg/kg).

- A plume of groundwater contaminants extends from the DDA through the Upper Potomac Aquifer to the Llangollen well field, nearly one mile downgradient.[4] The primary organic COCs are BCEE and 1,4-dioxane.[5] EPA's Integrated Risk Information System (IRIS) characterizes BCEE as a B2 probable human carcinogen and 1,4-dioxane as likely to be carcinogenic to humans. BCEE and 1,4-dioxane are particularly mobile in the subsurface because they are highly soluble in water and do not readily adsorb to soil. The highest BCEE concentrations are found in the UPCUTZ immediately downgradient of the DDA (up to 690 µg/L) and in the upper sand of the Upper Potomac Aquifer (180 µg/L at monitoring well P-6). The highest 1,4-dioxane concentrations are also found in the UPCUTZ immediately downgradient of the DDA (up to 2,800 µg/L) and in the upper sand (390 µg/L at monitoring well P-6). BCEE (160 µg/L) and 1,4-dioxane (850 µg/L) are also found in the UPCUTZ near monitoring well P-6 which is located immediately east of the Grantham South Area.[6] The highest concentrations of BCEE and 1,4-dioxane detected in the lower sand of the Upper Potomac Aquifer are 36 µg/L and 150 µg/L, respectively, at monitoring well UPA-03D. BCEE and 1,4-dioxane concentrations in groundwater in the Upper Potomac Aquifer in 2013 are depicted in Figures 3A - D and 4A - D, respectively. The minimum and maximum detected concentrations of all of the groundwater COCs is included in Table 1 in Appendix A[7] of this Amendment.
- Elevated concentrations of dissolved metals, particularly iron, manganese, arsenic and cobalt, in groundwater within a portion of the Upper Potomac Aquifer have resulted from redox conditions in the aquifer caused by releases from both DS&G and the Army Creek Landfill. The extent to which each site is contributing to elevated redox-sensitive metals concentrations in areas of the Upper Potomac Aquifer has not been confirmed. The highest concentrations of these metals observed in the Upper Potomac Aquifer, excluding the UPCUTZ, are as follows: iron at 31,000 µg/L at monitoring well DDA-01; manganese at 12,800 µg/L at monitoring well DDA-03; arsenic at 6.6 µg/L at monitoring well MW-28; and cobalt at 180 µg/L at monitoring well DDA-03.[4]
- Manganese concentrations in the downgradient portion of the plume (monitoring wells UPA-02D and MW-26N) have been generally increasing since 2011, and manganese was detected at 1,900 µg/L in the sample collected from monitoring well MW-26N in April 2016. Dissolved manganese concentrations in groundwater in the Upper Potomac Aquifer in 2013 are depicted in Figures 5A - B.
- Concentrations of certain contaminants (e.g., ethylbenzene, 1,2,4-trimethylbenzene and xylenes) in soil and/or groundwater suggest the potential presence of residual NAPL in

[4] Unless otherwise noted, reported concentrations are for samples collected during the March/April 2013 groundwater monitoring event.

[5] In 2014, Artesian installed an ultraviolet/hydrogen peroxide treatment system to remove 1,4-dioxane from groundwater pumped from the Llangollen well field.

[6] The reported concentrations were detected in groundwater samples collected from monitoring well UPA-101-TZ in December 2013.

[7] Appendix A includes Tables 1-7 of Golder Associates' *Revised Addendum to Development of Site-Specific Preliminary Remediation Goals – Revision 2*, October 2017.

the Columbia Aquifer at the DDA. In addition, xylene concentrations in groundwater suggest the potential for residual NAPL in the UPCUTZ in the immediate vicinity of the DDA.

Groundwater Modeling

A groundwater flow model was developed for the Site to further evaluate the conceptual site model (CSM), which is discussed in Section 2.5.4, below, and to support the development and analysis of remedial alternatives for the Feasibility Study. The groundwater flow simulations were performed using MODFLOW-NWT and particle tracking was performed with MODPATH Version 5. The model was used for two purposes. First, it was used to evaluate key aspects of the CSM, such as groundwater flux through the UPCUTZ and contaminant migration from the Upper Potomac Aquifer upper sand unit to the Upper Potomac Aquifer lower sand unit. Second, the model was used to predict capture zones for potential future groundwater extraction scenarios to optimize capture and containment and provide mass removal within the more highly contaminated areas of the UPCUTZ and the Upper Potomac Aquifer. A detailed description of the groundwater flow model can be found in Golder Associates' April 2015 *Detailed Analysis of Alternatives* which can be found in Appendix K in the Feasibility Study.

Aquifer restoration time frames for the remedial alternatives evaluated in the Feasibility Study were also estimated based on particle tracking using the Site-specific groundwater flow model and the application of modifying factors based on pore volume exchanges calculated with the assistance of simplified one- or two-dimensional transport models which accounted for retardation, dispersion and initial concentrations of contaminants. A detailed description of the methodology for estimating restoration time frames can be found in Appendix O of the Feasibility Study.

Vapor Intrusion Investigation

Vapor intrusion is the migration of VOCs from the subsurface into overlying buildings. Soil and groundwater contaminated with VOCs can emit vapors that may migrate through subsurface soil and eventually enter buildings through cracks or other conduits in basement floors, walls or foundations. In 2006, the DS&G Remedial Trust evaluated the potential for contaminated groundwater at the DS&G Site to adversely affect indoor air quality at buildings in the immediate vicinity of the Site. The study concluded that contaminated groundwater within the Upper Potomac Aquifer did not present unacceptable risks, due to potential vapor intrusion, to residents or workers in buildings near the Site. In August of 2006, the DS&G Remedial Trust expanded the scope of the vapor intrusion investigation: their consultant collected soil gas samples from shallow vapor probes and landfill gas monitoring wells near buildings in proximity to the Site and analyzed the samples for VOCs. VOC concentrations in indoor air were modeled based on VOC concentrations in the soil gas, and the estimated indoor air levels were used in a risk assessment.[8] The study concluded that VOCs in soil gas did not present an unacceptable risk, as a result of potential vapor intrusion, to residents or workers in the buildings near the Site. However, conditions encountered in the field during the investigation (shallow groundwater at

[8] Indoor air concentrations were estimated with Version 3.1 of the Johnson and Ettinger vapor intrusion model.

depths of 4 to 5 feet below ground surface) precluded collection of sub-slab soil gas samples at an office building adjacent to the Inert Area. In addition, the presence of shallow groundwater prevented the collection of soil gas samples from vapor probes installed between the office building and the Inert Area.

In April and June 2013, the DS&G Remedial Trust collected indoor and outdoor ambient air samples at the office building adjacent to the Site when the low levels of methane detected in the building's basement during quarterly monitoring of the Inert Area exceeded the threshold for additional monitoring established by EPA. The samples were submitted to a laboratory for analysis of VOCs. The following VOCs were detected at concentrations above EPA's industrial screening levels in one or both indoor air samples which were collected from the basement of the office building: benzene, 1,4-dichlorobenzene, ethylbenzene, trichloroethene, 1,1,2,2-tetrachloroethane, 1,2,4-trimethylbenzene, 1,2-dibromoethane, 1,2,3-trichloropropane and xylenes. 1,4-dichlorobenzene was also found in the outdoor air sample at a concentration above the screening level. It was not determined whether the VOCs detected in the indoor air samples were caused by landfill gas migration from the Inert Area into the basement of the building, other potential sources within or near the building, or a combination of the two. However, due to the persistent detection of methane at 100 percent of the lower explosive limit along the perimeter of the Inert Area near the building, and the detection of methane outside the building near the window wells, it was evident that landfill gas migration was occurring.

In November 2014, the DS&G Remedial Trust installed and began operating a sub-slab depressurization system (SSDS) in the office building and the adjoining automotive repair shop to mitigate the potential for migration of vapors, including methane, into the building. Confirmatory indoor air samples and an ambient air sample were collected in December 2014, 30 days following installation of the SSDS. The indoor air samples were collected from both the unfinished basement and the first floor of the office building, as well as the office space in the repair garage.

EPA reviewed the confirmatory sample analytical results and found that the VOCs detected in the indoor air while the system was in operation were within EPA's acceptable risk range. Based on EPA's evaluation of the performance testing results, the SSDS is operating as designed and is inducing vacuum conditions beneath the slab to mitigate the potential for sub-slab vapors to enter the building.

The DS&G Remedial Trust is sampling indoor air at the office building and adjoining repair shop every five years during the heating season in accordance with the operation and maintenance (O&M) plan for the Inert Area.

Additional Groundwater Monitoring Performed by EPA

In October 2013 and April 2015, EPA obtained groundwater samples from selected Site monitoring wells and analyzed the samples for perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS) and other perfluoroalkyl substances (PFAS). PFOA was detected in these samples at concentrations up to an estimated 273 nanograms per liter (ng/L). PFOS was detected at concentrations up to an estimated 26.8 ng/L. The DS&G Remedial Trust began monitoring groundwater for PFAS in fall 2016. EPA will oversee the monitoring and conduct or oversee a

risk analysis to determine if these contaminants need to be addressed by the response actions at the Site in the future.

2.5.4 Conceptual Site Model

During implementation of the *Feasibility Study Work Plan – Revision 2*, additional investigations, data evaluations and groundwater flow modeling were performed to update the Site-wide CSM. The CSM, presented in detail in the Feasibility Study, describes contaminant sources, release mechanisms and migration routes, exposure pathways, and potential human and ecological receptors. The Selected Remedy for this Site is based on the CSM.

Contaminant Sources

There are three potential source areas associated with the DS&G Site: the DDA, the Grantham South Area, and the Inert Area. The primary source of organic COCs in the Upper Potomac Aquifer is the DDA. Because elevated dissolved metals concentrations within an area of the Upper Potomac Aquifer appear to be related to releases from both the DS&G Site and the Army Creek Landfill Site, groundwater contamination from both Superfund sites is addressed in the CSM.

The DDA was an unlined pit which was used for the disposal of drummed chemical wastes. Several response actions have been undertaken at the DDA, as discussed in Section 2.2 of this document, and the DS&G Remedial Trust is continuing to operate the LFExS within the slurry-wall containment area to provide hydraulic control of contaminated groundwater at the DDA. In addition to the impacts in the Columbia Aquifer at the DDA, historical releases from the DDA have impacted the underlying UPCUTZ. Because of its hydraulic properties, the contaminated UPCUTZ has become a persistent secondary source of contamination to the Upper Potomac Aquifer upper sand unit.

Site documents state that cardboard, wire, pallets, cork dust, expanded polystyrene (e.g., Styrofoam), construction rubble and "scattered chemical wastes" were disposed of at the Inert Area and the Grantham South Area. A multilayer cap with a passive gas venting system is in place at each of these landfills; however, both are sources of subsurface vapors, primarily methane, as evidenced by elevated levels of landfill gas in the gas monitoring wells around the perimeter of the landfills. EPA has not identified the Inert Area and the Grantham South Area as ongoing sources of groundwater contamination based on available information; however, groundwater monitoring data indicates there is a potential that one or both of these landfills may contribute contaminant mass to the Columbia Aquifer and/or the UPCUTZ and Upper Potomac Aquifer upper sand.[9]

[9] As discussed in the *Supplemental Site Characterization Report - Revision 2*, inorganics were detected in Columbia Aquifer groundwater samples collected from temporary wells near these landfills in 2011 (wells GMW-GSNW and GMW-11) and inorganics and organics are present in the UPCUTZ and UPA upper sand near these landfills (wells MW-34, MW-18, P-6, UPA-101-TZ and UPA-101-US).

The Army Creek Landfill Site is located immediately west of the DS&G Site on the opposite bank of Army Creek/Army Pond. A multilayer cap is in place at the landfill; however, groundwater monitoring data indicates that the Army Creek Landfill is a source of 1,2-dichloroethane and dissolved metals, primarily iron, manganese and cobalt, in the Upper Potomac Aquifer.

Contaminant Release Mechanisms and Migration Routes

The following discussion focuses on contaminant release mechanisms and contaminant migration routes at the DDA.

The original release was the result of disposal of drummed wastes and liquid wastes into the unsaturated soil of the Columbia Aquifer at the DDA. Free-phase liquids, or NAPL, would have migrated downward to the top of the UPCU. Upon encountering the UPCU, the NAPL likely migrated horizontally along the surface of the clay and followed the downward sloping surface of the UPCU to the zero-clay areas located north and northwest of the DDA. Dissolution of NAPL constituents in the Columbia Aquifer would have occurred as a result of infiltration of precipitation through the waste materials in the vadose zone and upon migration of NAPL into the saturated zone. A portion of the free-phase and dissolved-phase impacts would have sorbed onto or diffused into finer-grained materials encountered in the Columbia Aquifer. Vertical migration of impacts into the underlying UPCUTZ would have occurred at the zero-clay areas. The figure in Appendix B illustrates the current interpretation of the extent of the zero-clay areas based on available data.[10] It is expected that observations during future field activities will provide additional information about subsurface conditions at the two Superfund sites.

Contamination migration within the UPCUTZ would have occurred preferentially within the sandier portions of the unit, with a portion of the contaminants sorbing onto or diffusing into finer-grained materials encountered in the UPCUTZ. Because the UPCUTZ consists of fine-grained materials with horizontal bedding, vertical migration of NAPL into the Upper Potomac Aquifer upper sand is considered to have been unlikely. Due to the age of the release, a high degree of NAPL attenuation has occurred through natural processes. An evaluation of analytical data for soil samples collected in 2011 and 2012 and groundwater samples collected in 2013 indicates that the potential for the presence of NAPL in the Columbia Aquifer and the UPCUTZ is generally low. However, as discussed in Section 2.5.3, above, concentrations of certain contaminants in soil and/or groundwater suggest the potential presence of residual NAPL in the Columbia Aquifer at the DDA and the UPCUTZ in the immediate vicinity of the DDA.

Dissolved-phase contaminants, upon encountering the saturated zone within the UPCUTZ and/or the upper sand of the Upper Potomac Aquifer, would have migrated in the direction of groundwater flow along preferential pathways (sands) and diffused into the interspersed lower

[10] This figure shows slide 8 from Attachment 1 to Tetra Tech's April 9, 2015 Technical Memorandum Re: Summary of Groundwater Modeling Performed in Support of the Detailed Analysis of Alternatives (DAA). The Technical Memorandum, which specifies criteria for identifying zero-clay areas for the Site-specific groundwater model, is included in Appendix B of the *Detailed Analysis of Alternatives*.

permeability materials (silts and clays). The understanding of the interaction between the sandy portions of the UPCUTZ and the underlying Upper Potomac Aquifer upper sand is incomplete; however, groundwater modeling and water quality data indicate on-going mass flux from the UPCUTZ into the upper sand at the Site.[11] In the immediate vicinity of the DDA, extraction well PW-1 captures some of the contaminant mass in the upper sand, including contaminant mass migrating from the UPCUTZ into the upper sand. Downgradient of extraction well PW-1, contaminated groundwater in the upper sand migrates horizontally and vertically in response to hydraulic gradients. Groundwater contamination has entered the Upper Potomac Aquifer lower sand unit as a result of downward vertical gradients induced by withdrawals from the Llangollen well field and other well fields in the area and potential discontinuities in the UPDC. At Artesian's Llangollen well field groundwater contamination is observed in both the upper and lower sands of the Upper Potomac Aquifer.

Releases from the Columbia Aquifer at the DDA have been mitigated by remedial measures described in Section 2.5.2, above. Despite these efforts at the DDA, the back diffusion of contaminants from the finer-grained layers in the UPCUTZ into the coarser-grained layers of the UPCUTZ and the Upper Potomac Aquifer upper sand is an ongoing transport mechanism.

The distribution of dissolved-phase contamination in groundwater has been strongly influenced by local and regional groundwater extraction from the Upper Potomac Aquifer. In addition to extraction by Artesian at its Llangollen well field, historic aquifer use in the vicinity of the Site has included operation of production wells at the former Amoco Polymer Plant and other industrial facilities to the east of the DS&G Site and extraction from New Castle County's recovery wells between 1973 and 2004. The production wells in use by Artesian at the Llangollen well field have also changed over time causing shifts in the groundwater flow direction. Variations in withdrawal rates and extraction well locations over time have caused significant changes in head, horizontal and vertical gradients and groundwater flow directions, thereby exerting a strong influence on the distribution of contaminants observed within the UPCUTZ and the upper and lower sand units of the Upper Potomac Aquifer.

The foregoing discussion pertains primarily to the release and transport of organic wastes disposed of at the DDA. Releases from additional source areas at the DS&G Site and the adjacent Army Creek Landfill Site have also resulted in elevated levels of inorganic solutes, particularly iron and manganese, in groundwater between the two Superfund sites and Artesian's Llangollen well field. Iron and manganese occur naturally in minerals within the aquifer matrix. These minerals become electron acceptors and dissolve under the anoxic conditions which develop as organic wastes decompose and aerobic biodegradation of organic compounds depletes oxygen within the aquifer, releasing iron and manganese into the groundwater. The western portion of the groundwater plume migrating from the DS&G Site overlaps the eastern portion of dissolved metals contamination in groundwater at Army Creek Landfill.

[11] The mass flux from the UPCUTZ to the UPA upper sand is predominantly observed in the vicinity of extraction well PW-1. It is assumed that operation of well PW-1 is influencing flux from the UPCUTZ to the UPA upper sand between the DDA and well PW-1.

Exposure Pathways and Potential Receptors

Landfill caps and fences in place at the DDA, Grantham South Area and Inert Area have removed exposure pathways involving direct contact with contaminated soils for potential human receptors, except for any workers performing construction or excavation activities in these areas; the landfill caps are also preventing potential exposure of ecological receptors to contaminated soils. DNREC's implementation of a groundwater management zone in the area of the Site and Artesian's treatment of water at its Llangollen well field have eliminated exposure pathways involving direct (dermal, ingestion and/or inhalation) contact with contaminated groundwater. However, absent the measures implemented by the State and Artesian, contaminated groundwater would represent a complete exposure pathway for current and potential future human receptors.

Migration of landfill gas beyond the perimeter of the Inert Area and the Grantham South Area has been documented in quarterly O&M reports.[12] The potential for landfill gas to migrate into buildings or trenches represents a possible explosion hazard. As noted in Section 2.5.2 of this ROD Amendment No. 2, the DS&G Remedial Trust installed a landfill gas mitigation system along sections of the perimeters of the Inert Area and the Grantham South Area to address this potential hazard and prevent vapor intrusion, due to landfill gas migration, at existing buildings. In addition, operation of the SSDS in the office building adjacent to the Inert Area has mitigated the exposure pathway for vapor intrusion into that building. However, the potential exists for future exposure to Site-related contaminants in indoor air for any new construction in areas adjacent to the Inert Area and Grantham South Area where the landfill gas mitigation system is not being operated and migration of landfill gas may be occurring.

Potential Site receptors include individuals who may be exposed to contaminants in soil, ground water and indoor air. Based on the current understanding of the nature and extent of contamination, and the current and anticipated future remediation and use of the DS&G Site, the potential human receptors and exposure pathways are presented in Appendix C and summarized below:

Industrial/Commercial Workers

- Dermal contact and ingestion of impacted Upper Potomac Aquifer groundwater via tap water
- Inhalation of soil vapor and/or landfill gas due to migration into structures

Construction/Excavation Workers

- Dermal contact, ingestion and inhalation (particulates) of impacted subsurface soils
- Dermal contact and ingestion of impacted Columbia Aquifer and/or Upper Potomac Aquifer groundwater
- Inhalation of VOCs and/or landfill gas that may accumulate in trench air during excavation activities

[12] The quarterly O&M report for the first quarter of 2015 (Environmental Alliance, Inc., 2015) is available in the Administrative Record file.

Residents

- Dermal contact, ingestion and inhalation of impacted Upper Potomac Aquifer groundwater via tap water
- Inhalation of soil vapor and/or landfill gas resulting from migration into structures

Additional Investigation

The source and full extent of impacted groundwater observed in the UPCUTZ near monitoring well P-6 and the extent of impacted groundwater in the UPCUTZ to the east, west and south of extraction well PW-1 require further investigation. The upward vertical gradient between the Upper Potomac Aquifer upper sand and the UPCUTZ in the well P-6 area suggests that the UPCUTZ impacts in this area may be caused by the localized upward migration of contaminants from the Upper Potomac Aquifer upper sand into the UPCUTZ. However, the origin of contaminated groundwater observed in the UPCUTZ in the vicinity of well P-6, and the Upper Potomac Aquifer groundwater mounding observed in the well P-6 area, require additional investigation.

Despite the preference for the groundwater and COCs to migrate horizontally within the relatively coarser-grained layers of the UPCUTZ, rather than vertically through relatively finer-grained layers out of the UPCUTZ into the Upper Potomac Aquifer upper sand, it is apparent that the groundwater and COCs eventually migrate out of the UPCUTZ and into the Upper Potomac Aquifer upper sand. This downward migration may be facilitated by a downward vertical hydraulic gradient downgradient of extraction well PW-1, pinching out of the UPCUTZ, and/or interconnection of the coarser-grained layers within the UPCUTZ with the Upper Potomac Aquifer upper sand. The specific areas where mass transfer occurs from the UPCUTZ to the Upper Potomac Aquifer upper sand are not known.

Detections of metals in Columbia Aquifer groundwater samples collected in 2011 from temporary monitoring wells near the Grantham South Area and the Inert Area (wells GMW-GSNW and GMW-11) and the presence of metals and organic COCs in the Upper Potomac Aquifer upper sand and UPCUTZ near these landfills (at wells MW-34, MW-18, P-6, UPA-101-TZ and UPA-101-US) indicate a potential for the Inert Area and/or the Grantham South Area to contribute COC mass to the Columbia Aquifer and/or the Upper Potomac Aquifer upper sand. The uncertainty regarding the source of impacts to the Upper Potomac Aquifer in the vicinity of the Grantham South Area (elevated concentrations of VOCs and SVOCs at wells P-6/UPA-101-US and elevated manganese concentrations at MW-18) will be addressed as appropriate during remedial design.

Areas of uncertainty identified in the updated CSM will be addressed during pre-design investigations.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

The Site property has various current land uses. The owner of a majority of the Site property, Vincent Dell'Aversano, uses a 5-acre portion of the 11-acre, fenced Inert Area (the Surface Barrier Area) to store impounded vehicles, propane tanks and salvage material. Mr.

Dell'Aversano also maintains a residence adjacent to the Grantham South Area. Portions of the Site property are fenced off and currently unused, including a 3-acre area containing the DDA, where ongoing remediation work presently precludes use of the land, and the steeply sloped 2-acre Grantham South Area.

Land uses surrounding the Site are well established and include commercial and light industrial uses to the east, residential areas to the south, wildlife habitat at the Army Creek Landfill Site to the west, and open space to the north. EPA expects that a similar mix of land uses will continue into the future.

The Upper Potomac Aquifer is used regionally as a drinking water supply. Locally, Artesian operates the Llangollen well field, an active well field approximately three quarters of a mile southwest of the Site property. Artesian supplies water to area homes and businesses.

2.7 SUMMARY OF SITE RISK

The Public Health Evaluation (PHE) performed in support of the 1988 ROD identified unacceptable risks associated with potential future exposure to contaminated groundwater (due to the presence of benzene, BCEE, chlorobenzene, 1,2-dichloroethane, ethylbenzene, methylene chloride, toluene, xylenes, phenol, styrene, methyl ethyl ketone and methyl isobutyl ketone) and direct contact with surface soil (due to the presence of antimony, arsenic, barium, copper, lead and polychlorinated biphenyls) at the Ridge Area. Surface soil at the Inert Area, Grantham South Area and DDA, and Site surface water, sediment and ambient air, were found not to present unacceptable risks to human health or the environment. Risks associated with potential direct contact with subsurface soil were not evaluated in the PHE.

ROD Amendment No. 1 further identified contaminated soil at the DDA and the Ridge Area as sources of groundwater contamination that would present unacceptable risks to any exposed individuals, and established risk-based soil cleanup standards for groundwater protection for each of these areas.

In 2014, Golder Associates performed a human health risk assessment for groundwater in the Upper Potomac Aquifer using a risk ratio approach as discussed in Section 2.7.1, below. Golder Associates updated the risk assessment in October 2017, at EPA's request, using revised target organs and toxicity values from recent (2016-2017) updates in EPA's IRIS database and Regional Screening Level (RSL) tables. The calculated cumulative carcinogenic risk for all the groundwater contaminants of potential concern (COPCs) was 1.8×10^{-2} and the calculated cumulative hazard index (HI), encompassing multiple target organs, was 45. Preliminary remediation goals (PRGs) were then developed for groundwater COCs, as discussed in Section 2.7.2, below.

2.7.1 Risk Assessment Approach for Groundwater

COPCs were identified in groundwater samples collected between April 2012 and April 2014 from monitoring wells in the core of the Upper Potomac Aquifer groundwater contaminant plume. EPA's RSLs for residential tap water were used as the primary source for human risk- and health-based screening levels based, respectively, on a target cancer risk of 1.0×10^{-6} and a target hazard quotient (HQ) of 0.1. Groundwater analytes with a maximum concentration

exceeding an RSL were considered COPCs and carried forward in the risk assessment process. In addition, groundwater concentrations were compared to EPA's MCLs for primary drinking water contaminants promulgated pursuant to the Safe Drinking Water Act, 42 U.S.C. §§ 300f et seq., and codified at 40 CFR Part 141, for public drinking water supplies. Groundwater analytes with a maximum concentration exceeding their respective MCLs were also retained as COPCs.

For each COPC, a conservative 95% upper confidence limit (UCL) of the mean concentration, calculated using EPA's ProUCL software Version 5.0, was generally selected as the exposure point concentration (EPC).[13] Both cancer risks and non-cancer hazards were determined through the comparison of EPCs to the applicable RSL value.

Cancer risk was estimated by calculating the ratio of the COPC-specific EPC to the residential tap water carcinogenic RSL for that COPC and multiplying that value by a target risk (TR) level of 1.0×10^{-6}. The equation used to estimate carcinogenic risk for each COPC is presented below:

$$\text{Risk} = \frac{\text{EPC} \times \text{TR}}{\text{Carcinogenic RSL}}$$

The calculated cumulative carcinogenic risk for all of the COPCs was 1.8×10^{-2} (see Table 3 in Appendix A).

Similarly, for non-carcinogens, non-carcinogenic HQs were estimated by taking the ratio of the EPC to the ingestion/dermal and inhalation non-cancer RSLs and multiplying by a target hazard quotient (THQ) of 1.0. The equation used to estimate non-carcinogenic hazard for each COPC is presented below:

$$\text{HQ} = \frac{\text{EPC} \times \text{THQ}}{\text{Non} - \text{carcinogenic RSL}}$$

To assess the potential for non-cancer effects posed by exposure to multiple contaminants, a hazard index (HI) approach was used in accordance with EPA guidance. This approach assumes that the non-cancer hazards associated with exposure to multiple contaminants are additive for each target organ. Therefore, in cases where the overall HI was greater than 1.0, the HQs were separated by target organ to estimate the target organ-specific HI. Since the ingestion/dermal and inhalation pathways may involve different target organs, the total ingestion/dermal HQs and inhalation HQs were evaluated separately. Summing the ingestion/dermal and inhalation HQs for all of the COPCs, the calculated cumulative HI, encompassing multiple target organs, was 45 (see Table 4 in Appendix A).[14]

[13] If the calculated 95% UCL exceeded the maximum detected concentration, then the maximum concentration was substituted as the EPC.

[14] The cumulative HI of 45 was calculated using EPA's 2017 RSLs. EPA's Proposed Plan reported a cumulative HI of 37, which was based on the risk assessment documented in Golder Associates' *Development of Site-Specific Preliminary Remediation Goals – Revision 2*, December 2014, which utilized EPA's 2014 RSLs.

2.7.2 Development of Preliminary Remediation Goals for Groundwater

To facilitate the development of remedial alternatives in the Feasibility Study, Site-specific risk- and health-based PRGs were developed for COCs identified in groundwater in the Upper Potomac Aquifer.[15] COCs were selected from among the COPCs based on the calculation of cancer risk and non-cancer hazard. Consistent with EPA risk assessment guidance, a COPC was considered a significant contributor to risk and was identified as a COC if, at the EPC, one or both of the following conditions were met: 1) its carcinogenic risk contribution exceeded one in a million (1.0×10^{-6}); 2) its non-carcinogenic HQ was either greater than 1.0 or, where the HI for a target organ exceeded 1.0, greater than 0.1 for that target organ. In addition, certain COPCs were not retained as COCs based on their low frequency of detection. Based on these criteria, the following COCs were identified in Site groundwater: 1,2,4-trimethylbenzene; 1,2-dichloroethane; 1,3,5-trimethylbenzene; 1,4-dichlorobenzene; 1,4-dioxane; benzene; BCEE; chloroform; ethylbenzene; N,N-dimethylaniline; naphthalene; xylenes; arsenic; cobalt; iron; and manganese.

PRGs based on carcinogenic risk were calculated using the following equation:

$$\text{PRG} = \frac{\text{EPC} \times \text{TR}}{\text{Calculated Cancer Risk}}$$

Carcinogenic PRGs were calculated for TR values of 1.0×10^{-6}, 1.0×10^{-5}, and 1.0×10^{-4}.

PRGs based on non-carcinogenic HQs were calculated using the following equation:

$$\text{PRG} = \frac{\text{EPC} \times \text{THQ}}{\text{Calculated HQ}}$$

PRGs for individual non-carcinogenic COCs were calculated using a THQ between 0.1 and 1.0. Fractional THQs were used to calculate PRGs for those COCs that contribute to a target organ-specific HI greater than 1.0.

PRGs were selected to comply with MCLs for primary drinking water contaminants and to achieve a cumulative cancer risk of one in 10,000 (1.0×10^{-4}) or less and/or a target organ-specific HI of 1.0 or less, assuming the presence of all of the COCs in groundwater. The risk-based groundwater PRGs are initial guidelines and not final cleanup standards. Remedial action performance standards, including final groundwater cleanup standards, are presented in Section 2.12 of this Amendment.

[15] Under the 1991 Consent Decree for the Army Creek Landfill, the currently enforceable groundwater remediation standards for the Upper Potomac Aquifer at the DS&G and Army Creek Landfill Sites are National Primary Drinking Water Regulations, or MCLs, established under the Safe Drinking Water Act, 42 U.S.C. Section 300g-1, for certain contaminants in public water systems.

The PRGs for groundwater in the Upper Potomac Aquifer are presented in Table 1.[16]

Table 1

Chemical of Concern	Selected PRG (µg/L)	Selection Criterion
1,2,4-Trimethylbenzene	5.7	Target HQ of 0.1
1,3,5-Trimethylbenzene	6.1	Target HQ of 0.1
1,4-Dioxane	4.6	Target Risk of 1.0×10^{-5}
Arsenic	0.52	Target Risk of 1.0×10^{-5}
Benzene	4.6	Target Risk of 1.0×10^{-5}
Bis(2-chloroethyl)ether	0.14	Target Risk of 1.0×10^{-5}
Cobalt	6.0	Target HQ of 1.0
Ethylbenzene	15	Target Risk of 1.0×10^{-5}
Iron	13,939	Target HQ of 1.0
Manganese	260	Target HQ of 0.6
N,N-Dimethylaniline	25	Target Risk of 1.0×10^{-5}
Naphthalene	0.63	Target HQ of 0.1
Xylenes (total)	21	Target HQ of 0.1

The methodology for identifying COCs and deriving the PRGs is more fully described in Golder Associates' Technical Memorandum, *Development of Site-Specific Preliminary Remediation Goals – Revision 2* (December 2014), and Golder Associates' Addendum, *Revised Addendum to Development of Site-Specific Preliminary Remediation Goals – Revision 2* (October 2017). Tables 1 through 7 of the Addendum document the occurrence and distribution of COPCs, EPCs, carcinogenic risks, non-cancer HQs, target organ-specific non-cancer HIs, selection of COCs and the summary of PRGs, and are included in Appendix A of this document.

Uncertainty Analysis

Risk assessment provides a systematic means of organizing, analyzing and presenting information on the nature and magnitude of risks posed by chemical exposures. Uncertainties are present in all risk assessments because of the quality of available data and the need to develop inferences based on incomplete information about existing conditions and future circumstances. These uncertainties are addressed by making conservative assumptions so that the risks are more likely to be overestimated than underestimated. The primary areas of uncertainty and associated limitations are qualitatively discussed below.

- The inclusion of infrequently detected COPCs in the risk assessment has the potential to overestimate risk through the inclusion of analytes which may be anomalous or unrelated to the Site.
- If a 95% UCL of the mean could not be calculated by ProUCL, then "non-detect" results (NDs) were replaced with half the method detection limit (MDL) in order to calculate the

[16] PRGs were not developed for groundwater COCs with EPCs that present a cancer risk below 1.0×10^{-5}; however, cancer risk associated with these COCs was taken into account when developing PRGs for the remaining COCs to ensure cumulative risk will be below EPA's risk criteria.

EPC. In cases where there were infrequent detections of a COPC, the majority of the values used to calculate the EPC were based on the MDL and the uncertainty associated with the EPC is likely biased high.

- For those COPCs with a single detection, the use of the maximum detected concentration overestimates exposure since a single sample result does not reflect overall groundwater conditions. By treating all ND results as half of the MDL, a conservative 95% UCL can be calculated and this approach results in a more appropriate EPC statistic than use of the sole-detected (maximum) concentration. However, this approach is based on the assumption that the COPC in question is present in numerous samples, which may not be the case and may result in an overestimation of risk.
- The use of the EPA carcinogenic and non-carcinogenic RSLs to calculate cancer risk and non-cancer hazard, respectively, has the potential to overestimate risk because the conservative exposure factors that are used to calculate the RSLs were applied instead of Site-specific exposure parameters.
- Estimated cancer risk and non-cancer hazard relies upon the use of toxicity values developed by EPA to evaluate potential chronic toxicity of COPCs. While these values may be estimated from human experimental or epidemiological data, they are more likely to be based on animal data generated from a variety of toxicological studies. In addition, toxicity values are not available for all COPCs. The result of this uncertainty is that the estimated total cancer risks and cumulative non-cancer hazards have the potential to be both overestimated and/or underestimated.

2.7.3 Vapor Intrusion Risk Assessment

As discussed in Section 2.5.3 of this ROD Amendment No. 2, VOCs were detected in outdoor and indoor air samples collected at a business adjacent to the Inert Area in April and June 2013. While the source of the VOCs was not confirmed, several of the VOCs detected in the June 2013 indoor air sample at concentrations that exceed the industrial air screening level (benzene, 1,4-dichlorobenzene, ethylbenzene, trichloroethylene, 1,2,4-trimethylbenzene and xylenes) are COCs or COPCs in Site groundwater. These contaminants were also detected in soil gas samples collected at the Site in 2006, and their presence in soil gas is most likely due to landfill gas migration.

EPA performed conservative calculations of potential health risks using the test results for the air samples collected in June 2013. The estimated risks for exposure to outdoor air did not exceed EPA's criteria for acceptable risk. However, the estimated risks from exposure to indoor air exceeded EPA's acceptable cancer and non-cancer risk criteria as summarized below:[17]

- Estimated risks for office building basement indoor air:
  - Carcinogenic risk of 2.0×10^{-4}
  - Non-carcinogenic HI of 4.8

[17] These risk estimates were based on the assumption that office workers are exposed to levels found in the basement air sample 8 hours a day for 250 days a year, over 25 years. However, the basement is used for storage and the office workers occupy the ground floor of the building where lower concentrations of Site-related VOCs would be expected to be found.

The estimated human health risk is attributable primarily to 1,2-dibromomethane, 1,2,3-trichloropropane and 1,2,4-trimethylbenzene. 1,2,4-trimethylbenzene is a COC in groundwater and is present in landfill gas at the Site.

2.7.4 Basis for Taking Action

The Site presents unacceptable risks to human health associated with potential future exposure to impacted groundwater via tap water and/or landfill gas constituents in indoor air,[18] and additional response actions are necessary to reduce the risks to levels that are within or below EPA's acceptable risk range. EPA has determined that the additional response actions selected in this Amendment are necessary to protect human health and the environment from actual or threatened releases of hazardous substances.

2.8 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives for Groundwater

The 1988 ROD does not explicitly provide a remedial action objective (RAO) for groundwater impacted by releases from the Site. Instead, it states that the selected remedy includes continued operation of the New Castle County groundwater recovery wells until "the groundwater at the site boundary has consistently met the acceptable water exposure levels," which are given in Table 7 of the 1988 ROD. However, as discussed in Section 2.2 of this ROD Amendment No. 2, New Castle County, upon entering into the 1991 Consent Decree, agreed to operate groundwater recovery wells in the Upper Potomac Aquifer to attain primary drinking water standards beyond the Army Creek Landfill property boundary. The discrepancy between the groundwater cleanup levels given in the 1991 Consent Decree for the Army Creek Landfill and those in the 1988 ROD for this Site is discussed in EPA's September 2015 *Five-Year Review Report for Delaware Sand & Gravel Landfill Superfund Site* which is part of the Administrative Record for the Site. An additional inconsistency involves the Area of Attainment: the 1991 Consent Decree for the Army Creek Landfill specifies that groundwater cleanup levels are to be met beyond the Army Creek Landfill property boundary, while the 1988 ROD for this Site states that the groundwater cleanup levels are to be met beyond the DS&G Site property boundary. This ROD Amendment No. 2 clarifies the points of compliance for the DS&G Site.

Remedial Action Objectives for the DDA

The 1993 ROD Amendment identified the following RAOs for the DDA:

- Prevent direct contact with contaminated soil;
- Protect groundwater from hazardous substances leaching from contaminated soil;
- Reduce the soil contaminant concentrations to levels that would not cause groundwater contaminant concentrations in the Upper Potomac Aquifer to:

[18] As discussed in Section 2.5.4 of this ROD Amendment No. 2, construction and excavation workers have the potential to be exposed to contaminated subsurface soil and groundwater during Site remediation activities. Accordingly, these potential exposure risks will be managed through compliance with Occupational Safety and Health Administration requirements for workers engaged in response or other hazardous waste operations (29 CFR § 1910.120).

- present an exposed individual with a cumulative excess lifetime cancer risk above "the 10^{-6} risk range"; or
- cause adverse health effects in an exposed individual (i.e., result in an HI greater than or equal to 1.0).

Modified Remedial Action Objectives

Since implementation of the remedial actions selected in the 1988 DS&G ROD, as amended by the 1993 ROD Amendment and 2003 ESD, and the 1986 Army Creek Landfill ROD, MCLs have been attained at the Army Creek Landfill property boundary and the temporary cap and fencing at the DDA have prevented direct contact with contaminated soil. However, the existing remedies have not achieved the remainder of the RAOs for the Site. Furthermore, the RAOs do not address contamination in the UPCUTZ which represents a secondary source of long-term impacts to the Upper Potomac Aquifer sands. Nor do the RAOs address COCs in groundwater at the Llangollen well field or the potential for exposure to Site-related contaminants in indoor air due to potential future vapor intrusion. In addition, the RAOs do not address all of the groundwater COCs listed in Table 1 of this ROD Amendment No. 2. Therefore, the following modified RAOs were developed for this Amendment:

- Prevent direct contact with contaminated soil enclosed within the slurry wall at the DDA.
- Prevent migration of contaminants from the DDA that would cause contaminant concentrations in the groundwater of the Columbia Aquifer outside the DDA or the Upper Potomac Aquifer within the Area of Attainment (as defined below) to exceed MCLs, non-zero maximum contaminant level goals (MCLGs) or acceptable risk- and health-based concentrations.
- Prevent direct contact with groundwater containing contaminants from the DS&G Site at levels that exceed MCLs, non-zero MCLGs or acceptable risk- and health-based concentrations.
- Restore groundwater within the Area of Attainment (throughout the contaminant plume, at and beyond the boundary of the Waste Management Area[19]) to its beneficial use in a reasonable time frame. The Waste Management Area and the current approximation of the Area of Attainment are shown in Figure 6.
- Prevent contaminant migration from subsurface vapor intrusion into indoor air that would result in unacceptable levels of risk.

2.9 DESCRIPTION OF ALTERNATIVES

This section summarizes the portion of the remedy selected in the 1988 ROD, as amended by the 1993 ROD Amendment and 2003 ESD, that pertains to contaminated groundwater in the Upper Potomac Aquifer and contaminated soil at the DDA and Ridge Area (Previously Selected Remedy), and the Selected Remedy, which was developed to meet the modified RAOs presented in Section 2.8 of this ROD Amendment No. 2. The Selected Remedy is one of six remedial

[19] The DS&G Site includes three areas where wastes are being managed on-site (DDA, Inert Area and Grantham South Area) and one former waste storage area (Ridge Area) in close proximity. These areas and the small parcels which connect them constitute the Waste Management Area at the Site.

alternatives (including No Action) evaluated in the Feasibility Study and briefly described below. This remedial alternative was presented as the Preferred Alternative in EPA's Proposed Plan released for public comment in September 2016. The Selected Remedy, which is described below in greater detail, addresses: 1) contaminated groundwater in the Upper Potomac Aquifer, including groundwater in the UPCUTZ and groundwater pumped from Artesian's Llangollen well field, 2) contaminated soil and groundwater within the slurry wall surrounding the former DDA and 3) potential vapor intrusion at new construction adjacent to the Inert Area and the Grantham South Area.

Previously Selected Remedy:

The Previously Selected Remedy includes those components of the remedy selected in the 1988 ROD, as amended by the 1993 ROD Amendment and 2003 ESD which address waste and contaminated soil at the DDA and the Ridge Area and contaminated groundwater in the Upper Potomac Aquifer. It does not include the response actions that address waste and contaminated soil at the Grantham South Area and the Inert Area. The Previously Selected Remedy includes the following components:

- Construction of a slurry wall, keyed into the underlying natural clay layer,[20] around the DDA and the surrounding contaminated soil and groundwater in the Columbia Aquifer;
- Installation and operation of a groundwater extraction system to dewater the soil contained within the slurry-wall enclosure;
- Excavation and off-site treatment or disposal of buried drums, waste and highly contaminated soil at the DDA and the Ridge Area;
- Transfer of the remaining contaminated soil excavated from the Ridge Area to the slurry-wall containment area;
- Treatment of the soil within the containment area using soil vapor extraction and bioventing;
- Construction of a composite barrier (RCRA Subtitle C) cap over the slurry-wall enclosure;
- Installation of perimeter fencing around the containment area;
- Installation of a soil cover over the Ridge Area;
- Continued operation of the Army Creek Landfill groundwater recovery wells until cleanup levels are met at the DS&G Site property boundary;
- On-site treatment of groundwater and discharge of treated groundwater to Army Creek; and
- Institutional controls to prevent future use of the Site property which could compromise the effectiveness of the Previously Selected Remedy and the installation of drinking water wells on the Site property.

Estimated Capital Cost: *$29,241,300* [21]
Estimated Annual O&M Cost: *$380,500* [21]
Estimated Present Worth Cost: *$33,540,100* [21]

[20] A hanging slurry wall was constructed above the zero-clay area northwest of the DDA.
[21] These figures are the sum of the estimated costs in the 1993 Amendment for remediation of the DDA and Ridge Area and the estimated costs in the 1988 ROD for Upper Potomac Aquifer groundwater recovery and treatment. No adjustment was made to account for the time value of money and these costs are not directly comparable with the estimated costs for the Alternative Remedy.

All elements of the Previously Selected Remedy have been implemented with the exception of soil vapor extraction, the installation of a RCRA Subtitle C cap at the DDA and the Site property owner's implementation of several provisions of the 2004 UAO pertaining to institutional controls.

Remedial Alternatives Evaluated in the 2016 Feasibility Study:

Alternative A - No Action
Existing institutional controls would remain in place, there would be no collection and treatment of groundwater and the temporary cap at the DDA would not be upgraded or maintained.

Alternative B - DDA Containment and Groundwater Extraction from Upper Potomac Aquifer with Direct Discharge to Publicly Owned Treatment Works (POTW)
Alternative B represents a limited-action alternative which includes continuation of interim response actions (operation of the LFExS within the slurry-wall containment area and operation of groundwater extraction well PW-1 with discharge to the POTW), construction of a composite barrier cap over the slurry-wall enclosure, treatment at the Llangollen well field and institutional controls to prevent potential future exposure to contaminants capable of migrating into indoor air.

Alternative C - DDA Enhanced Containment and Groundwater Extraction from UPCUTZ and Upper Potomac Aquifer with Direct Discharge to POTW
Alternative C would provide reliable containment of contaminants at the DDA with an enhanced LFExS (eLFExS) and construction of a composite barrier cap over the slurry-wall enclosure. It includes continued groundwater extraction and the installation of additional groundwater extraction wells in the Upper Potomac Aquifer, including the UPCUTZ, with discharge of extracted groundwater to the POTW. Alternative C would also include treatment at the Llangollen well field and institutional controls to prevent potential future exposure to Site contaminants in soil vapor or landfill gas capable of migrating into indoor air.

Alternative D - DDA Soil Flushing and Groundwater Extraction from UPCUTZ and Upper Potomac Aquifer with Direct Discharge to POTW
Alternative D includes the same components as Alternative C plus treatment of contaminated soil at the DDA using soil flushing.

Alternative E - DDA Targeted In-situ Chemical Oxidation (ISCO) and Groundwater Extraction from UPCUTZ and Upper Potomac Aquifer with Direct Discharge to POTW
Alternative E includes the same components as Alternative C plus treatment of contaminated soil in targeted areas of the DDA using ISCO.

Alternative F - DDA Excavation and ISCO and Groundwater Extraction from UPCUTZ and Upper Potomac Aquifer with Direct Discharge to POTW
Alternative F includes the same components as Alternative C plus excavation and disposal, in an on-site lined landfill, of unsaturated soil at the DDA and treatment of saturated soil at the DDA using ISCO.

In the Proposed Plan, EPA identified Alternative C as its preferred alternative for comparison with the Previously Selected Remedy. Alternative C would achieve all the revised RAOs, address the secondary source of contamination in the UPCUTZ and remediate groundwater throughout the Area of Attainment within a reasonable time frame.[22] The operating history of the LFExS indicates that the remaining contamination at the DDA can be reliably contained by operation of the eLFExS and the installation of a permanent cap included in Alternative C. Alternative A would not be protective of human health and the environment. Alternative B would not address contamination in the UPCUTZ or remediate groundwater throughout the Area of Attainment within a reasonable time frame.[23] Alternatives D through F, like Alternative C, would achieve all of the revised RAOs, address contamination in the UPCUTZ and remediate groundwater within a reasonable time frame. Alternatives D through F also include additional treatment of the remaining soil contamination at the DDA. However, it is anticipated that long-term operation of the eLFExS would be necessary because of uncertainty regarding achievable mass reductions, the potential for long-term back diffusion of contaminants from clay-rich layers at the DDA, and the potential for mobilization of residual mass or the formation of unacceptable reaction byproducts (e.g., hexavalent chromium). In addition, Alternatives D through F would not accelerate the groundwater restoration time frame because significant contaminant mass exists outside the DDA in the fine-grained materials of the UPCUTZ.

Selected Remedy (Alternative C in the Feasibility Study):

The Selected Remedy will provide reliable containment of contamination remaining at the DDA through enhancements to the LFExS which is currently operating within the slurry wall and installation of a composite barrier cap. This alternative would also include the installation and operation of groundwater recovery wells in the Upper Potomac Aquifer, including the UPCUTZ, and extraction and *ex-situ* treatment of Upper Potomac Aquifer groundwater utilizing existing and potentially additional treatment systems at the Llangollen well field in order to restore groundwater to its beneficial use. In addition, this alternative would employ institutional controls to prevent potential future exposure to Site-related contaminants in indoor air at levels that would present unacceptable risks.

The Selected Remedy addresses the three remediation targets enumerated below and includes the following remedial components:

1. <u>DDA/Columbia Aquifer soil and groundwater</u>

- Existing slurry-wall system;[24]

[22] The estimated aquifer restoration time frame for Alternative C is approximately 25 years as presented in Appendix O of the *Final Feasibility Study – Revision 1*.
[23] The estimated aquifer restoration time frame for Alternative B is approximately 60 years as presented in Appendix O of the *Final Feasibility Study – Revision 1*.
[24] Costs associated with the slurry wall are not included in the cost estimate for the Selected Remedy.

- Enhanced LFExS (eLFExS) pumping at an estimated 25 gallons per minute (gpm)[25] and equipped with a backup generator and instrumentation and telemetry for real-time containment monitoring to maintain inward and upward hydraulic gradients;
- A groundwater monitoring program to ensure that the eLFExS is operating as designed;
- A composite barrier cap to minimize infiltration of precipitation through contaminated soil contained within the slurry wall surrounding the former DDA; and
- Institutional controls to prevent direct contact with contaminated soil, the installation of drinking water wells on the Site property and other future uses of the Site property which could compromise the effectiveness of the remedial action.

2. Upper Potomac Aquifer

- Installation and operation of extraction wells in areas determined to optimize capture and remove contaminant mass from the more highly-impacted areas of the Upper Potomac Aquifer, including the UPCUTZ. The anticipated locations of the proposed new extraction wells are shown in Figures 7 and 8. The actual configuration of the groundwater recovery well network and groundwater extraction rates would be determined by EPA, in consultation with DNREC, during the remedial design.
- Discharge of groundwater pumped from the DS&G Site extraction wells to the Wilmington Wastewater Treatment Plant.
- Continued groundwater extraction at Artesian's Llangollen well field with treatment utilizing existing systems for BCEE and 1,4-dioxane and, if necessary, additional treatment systems targeting other COCs, such as manganese.
- A program to monitor performance of the groundwater extractions wells, confirm they are preventing migration of the groundwater contaminant plume and evaluate progress toward the attainment of long-term groundwater remediation goals.
- Institutional controls to prevent future use of the Site property which could compromise the effectiveness of the remedial action and the installation of drinking water wells on the Site property.[26]

3. Potential vapor intrusion

There are several nearby buildings located within 300 feet of the on-site waste management areas. There may also be future construction within several hundred feet of those sections of the Inert Area and Grantham South Area where a landfill gas mitigation system is not being operated. Due to the documented migration of landfill gas beyond the perimeters of the Grantham South Area and the Inert Area, and the potential for vapor intrusion into nearby buildings and any future construction, the Selected Remedy includes use restrictions to prevent potential future exposure to Site contaminants in soil vapor and landfill gas that have the potential to migrate into indoor air. The use restrictions would be implemented through an

[25] The LFExS currently operates at a rate of 8 to 10 gpm.

[26] Additional groundwater use restrictions have been in effect in the area surrounding the Site since June 2006, when DNREC established a groundwater management zone encompassing several hazardous waste disposal facilities near the Site. The groundwater management zone places restrictions on the installation of new water supply wells throughout the known extent of the Upper Potomac Aquifer contaminant plume.

enforceable institutional control such as a judicial consent decree, an administrative order or an environmental covenant, and would ensure that all new habitable buildings constructed on or adjacent to the Site property in areas potentially impacted by landfill gas have, at a minimum, a foundation vapor barrier and subsurface piping for a SSDS. The institutional controls would require testing of indoor air in any buildings subject to the controls prior to occupancy and, should indoor air concentrations equal or exceed EPA risk-based criteria, activation and operation of a SSDS until such time that EPA determined that landfill gas migration no longer posed a vapor intrusion risk. The areas subject to these use restrictions would be determined prior to the remedial design.

Estimated Capital Cost:	*$16,200,000* [27, 28]
Estimated Annual O&M Cost:	*$2,400,000* [27, 28]
Estimated Present Worth Cost:	*$46,100,000* [27, 28]

Common Elements

The Previously Selected Remedy and the Selected Remedy share several common elements, including the slurry wall which was installed in 1994, a composite barrier cap and institutional controls restricting land and groundwater use.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The Previously Selected Remedy and the Selected Remedy were evaluated using the nine criteria set forth in the NCP, 40 CFR § 300.430(e)(9)(iii). The first two criteria [overall protection of human health and the environment, and compliance with applicable or relevant and appropriate requirements (ARARs)] are threshold criteria. The selected remedy must meet both of these threshold criteria (except when an ARARs waiver is invoked). The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost) are the primary balancing criteria. The remaining two criteria (state and community acceptance) are referred to as modifying criteria and are taken into account after public comment is received on the Proposed Remedial Action Plan. The following discussion summarizes the relative performance of each alternative with respect to the nine evaluation criteria.

[27] The cost estimate for the Preferred Alternative in the Proposed Plan includes costs for operation of the SSDS at the office building on Grantham Lane, but does not include costs for treatment to address manganese at Artesian's Llangollen well field. Operation of the SSDS is not part of the Selected Remedy and the costs for operation of the SSDS are not included in the cost estimate for the Selected Remedy in this ROD Amendment No. 2. Because a future need for treatment to reduce manganese concentrations in groundwater pumped from the Llangollen well field is reasonably anticipated, the costs for this treatment are included in the cost estimate for the Selected Remedy in this ROD Amendment No. 2. These changes do not significantly alter the cost of the remedy.

[28] These cost figures include estimated capital ($3,800,000), annual O&M ($300,000) and present worth ($7,540,000) costs for treatment at the Llangollen well field to address BCEE and 1,4-dioxane, beginning in 2014. The Delaware Public Service Commission approved Artesian's applications for base water rate increases to recover these investments.

Overall Protection of Human Health and the Environment

A primary requirement of CERCLA is that a selected remedial action be protective of human health and the environment. A remedy is protective if it reduces to acceptable levels current and potential future risks associated with each exposure pathway at a site.

DDA/Columbia Aquifer Soil and Groundwater

The Previously Selected Remedy includes institutional controls (groundwater and land use restrictions), land use controls (fencing, locked gates) and engineering controls (a temporary cap at the DDA) which prevent direct contact with contaminated soil and groundwater. If installation of a RCRA Subtitle C cap were completed in accordance with the 1993 ROD Amendment, the Previously Selected Remedy would also minimize infiltration and leaching of soil contaminants into groundwater in the Columbia Aquifer and prevent potential exposure of ecological receptors to contaminated soil. However, because transmissive zones and gaps occur in the UPCU beneath the slurry-wall containment area, the Previously Selected Remedy has not prevented contaminant releases from the DDA to groundwater in the Upper Potomac Aquifer.

Existing land use controls and the temporary cap at the DDA prevent direct contact with contaminated soil and groundwater. The Selected Remedy includes additional engineering controls (a composite barrier landfill cap over the DDA and an eLFExS) which would further protect human health and the environment. Operation of the eLFExS would provide hydraulic control of the groundwater within the slurry-wall enclosure, effectively eliminating future releases from the DDA to groundwater in the Upper Potomac Aquifer. Installation and maintenance of a composite barrier cap would continue to eliminate risk associated with direct contact with DDA soils, and would also minimize infiltration that results in leaching of contaminants to groundwater in the Columbia Aquifer and prevent potential exposure of ecological receptors to contaminated subsurface soil.

Upper Potomac Aquifer

The Previously Selected Remedy called for continued operation of the Army Creek Landfill groundwater recovery wells to attain "acceptable water exposure levels" beyond the DS&G Site boundary. That remedial component does not provide long term protection of human health and the environment for the following reasons: it does not address 1,4-dioxane and other groundwater COCs; it does not address contamination in the UPCUTZ; it does not restore groundwater throughout the Area of Attainment to its beneficial use; and it does not include treatment to address Site-related COCs in groundwater at the Llangollen well field.

EPA expects that the Selected Remedy will restore groundwater in the Upper Potomac Aquifer to its beneficial use within a reasonable time frame. Site-related COCs would be reduced to acceptable risk-based concentrations within the Area of Attainment through the installation and operation of groundwater extraction wells in areas determined to optimize capture and continued groundwater extraction at the Llangollen well field. Groundwater treatment currently provided by Artesian at the Llangollen well field and existing groundwater use restrictions prevent exposure to contaminated groundwater. The Selected Remedy includes treatment of

groundwater pumped from the Llangollen well field to remove Site-related COCs prior to distribution to customers.

Potential Vapor Intrusion Mitigation

The DS&G Remedial Trust is operating a SSDS at an office building adjacent to the Site and will continue to monitor indoor air at the building in accordance with the O&M plan for the Inert Area. However, the Previously Selected Remedy does not address potential vapor intrusion and would not prevent potential future exposure to Site contaminants in indoor air.

The Selected Remedy will prevent potential future exposure to Site contaminants in the indoor air of any new habitable buildings constructed on or adjacent to the Site in areas potentially impacted by landfill gas.

Compliance with ARARs

This criterion evaluates whether each alternative will meet all of the applicable or relevant and appropriate requirements (ARARs) of federal and state environmental statutes and regulations that pertain to a site or provides a basis for invoking a waiver.

Key ARARs pertaining to the Previously Selected Remedy and the Selected Remedy are discussed below; a complete list of ARARs for the Selected Remedy is included in Appendix D of this ROD Amendment No. 2.

DDA/Columbia Aquifer Soil and Groundwater

During implementation of the Previously Selected Remedy, the on-site storage of hazardous waste and soil containing hazardous waste excavated at the DDA and the Ridge Area complied with federal and State regulations for owners and operators of facilities that treat or store hazardous waste. Drum contents, highly contaminated soil and groundwater extracted from the Columbia Aquifer within the slurry wall were evaluated in accordance with federal and State regulations for identification of hazardous waste; materials determined to be hazardous waste were handled in accordance with federal and State regulations governing generators and transporters of hazardous waste. The 1993 ROD Amendment identifies State regulations governing air emissions [Delaware Regulations Governing the Control of Air Pollution (Section 6003)] and federal regulations governing emissions from process vents (40 CFR §§ 264.1031-.1034) as ARARs. However, there was no discharge from process vents during operation of the bioventing system and, therefore, air emission controls were not implemented.

The Selected Remedy will comply with State standards for owners and operators of hazardous waste landfills and federal and State standards governing discharges to publicly owned treatment works (POTWs) which accept and treat sewage and industrial wastewater. In particular, the design, construction and O&M of the composite barrier cap to be installed at the DDA would meet federally authorized State requirements for closure and post-closure care of hazardous waste landfills [7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 264.310(a) and (b)(1) and (5)] and for monitoring and inspection during the installation of the cover system [7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsection 264.303(a)]. Groundwater extracted from the Columbia Aquifer and discharged to the

Wilmington Wastewater Treatment Plant would comply with effluent limitations established by New Castle County and the City of Wilmington to meet the requirements of Delaware's National Pollutant Discharge Elimination System Program (7 DE Admin. Code 7201 Regulations Governing the Control of Water Pollution, Section 6.0) and would meet any pretreatment standards established by New Castle County and the City of Wilmington in accordance with the NPDES General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403).

Upper Potomac Aquifer

The 1988 ROD identifies MCLs as ARARs for groundwater remediation and states that the Previously Selected Remedy "would assist in meeting MCLs at or near the site boundary" within 10 years. However, benzene concentrations within the Area of Attainment in the Upper Potomac Aquifer continue to exceed the MCL for that contaminant. In addition, the Previously Selected Remedy may not have been compliant with all ARARs for the protection of surface water. While the Army Creek Landfill groundwater recovery wells were operating, the treatment plant reduced iron concentrations in the extracted groundwater to levels that met the established discharge limit for iron; however, estimated levels of BCEE in the treatment plant effluent exceeded the State water quality standard for the protection of human health (based on fish consumption) on several occasions. However, the Previously Selected Remedy did not require treatment to remove BCEE from extracted groundwater prior to its discharge to Army Creek, unless monitoring confirmed that the level of BCEE was contributing to the excursion of the applicable Delaware Surface Water Quality Standards for BCEE.

The MCLs for primary drinking water contaminants and non-zero MCLGs for public drinking water supplies established under the Safe Drinking Water Act are considered to be relevant and appropriate standards for groundwater remediation under the Superfund program. The Selected Remedy will achieve MCLs and non-zero MCLGs for groundwater contaminants within the Area of Attainment in a reasonable time frame. Groundwater extracted from the Upper Potomac Aquifer and discharged to the Wilmington Wastewater Treatment Plant would comply with effluent limitations established by New Castle County and the City of Wilmington to meet the requirements of Delaware's National Pollutant Discharge Elimination System Program (7 DE Admin. Code 7201 Regulations Governing the Control of Water Pollution, Section 6.0) and would meet any pretreatment standards established by New Castle County and the City of Wilmington in accordance with the NPDES General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403). Any pretreatment of groundwater discharged to the POTW, and treatment to remove COCs from groundwater extracted from the Llangollen well field, may result in the generation of hazardous waste. Generated hazardous waste would be managed in accordance with Delaware's standards applicable to generators of hazardous waste, including storage and manifesting of hazardous waste (7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 262.11-42).

Potential Vapor Intrusion Mitigation

The Previously Selected Remedy did not address potential vapor intrusion. Therefore, the 1988 ROD and the 1993 ROD Amendment identified no ARARs for vapor intrusion mitigation.

The Selected Remedy includes institutional controls to prevent potential future exposure to Site contaminants in soil vapor or landfill gas capable of migrating into the indoor air of any new habitable buildings constructed near those sections of the Inert Area and the Grantham South Area where the migration of landfill gas has not been mitigated.

Long-Term Effectiveness and Permanence

The evaluation of alternatives under this criterion considers the ability of an alternative to maintain protection of human health and the environment over time and takes into account the adequacy and reliability of containment systems and institutional controls needed to manage the residual risk posed by untreated waste at the conclusion of remedial activities.

The Previously Selected Remedy has not satisfied the criterion of long-term effectiveness and permanence. Engineering controls selected in the 1993 ROD Amendment and implemented at the DDA have not prevented the migration of contaminants from the DDA into the Upper Potomac Aquifer. In addition, the operation of the Army Creek Landfill recovery wells was not effective in preventing the migration of Site-specific COCs to the Llangollen well field and did not reduce the magnitude of residual risk from potential exposure to contaminated groundwater to acceptable levels. These failures are primarily attributable to unknown conditions in the subsurface at the time of remedy selection. In particular, unidentified gaps and transmissive zones in the UPCU beneath the DDA prevented adequate containment and treatment of contaminants at the DDA/BRA and the previously selected groundwater response action was not designed or intended to address a persistent secondary source of contamination in the UPCUTZ.

The Selected Remedy will use containment (a cap and the existing slurry wall) and hydraulic control (eLFExS with instrumentation and telemetry for real-time monitoring) to prevent exposure to contaminated soil and minimize the migration of contaminants from soil and groundwater within the Columbia Aquifer at the DDA into the Upper Potomac Aquifer. A properly installed and maintained cap and slurry wall and carefully monitored and maintained eLFExS would provide adequate long-term containment of contaminated soil and groundwater at the DDA. However, permanent land use restrictions and perpetual maintenance activities would be required to ensure the long-term effectiveness and permanence of the containment system.

The Selected Remedy will reduce the risks that would result from the use of groundwater located within the Area of Attainment, including groundwater extracted from the Llangollen well field, to acceptable levels through the extraction and treatment of groundwater. The installation and operation of groundwater extraction wells in the UPCUTZ would also mitigate the migration of contaminants from the UPCUTZ into the upper and lower sand units of the Upper Potomac Aquifer. Upon attainment of the groundwater cleanup standards throughout the Area of Attainment, the scope of the current restrictions on groundwater use could be reevaluated. However, restrictions on the use of groundwater beneath the Waste Management Area would be needed for the foreseeable future to prevent unacceptable future exposure risks. It is anticipated that continued operation of groundwater extraction wells would be required for some time after the groundwater cleanup standards were met in order to prevent contaminants beneath the Waste Management Area from migrating to downgradient areas of the Upper Potomac Aquifer.

Migration of landfill gas from the Inert Area and the Grantham South Area may present a source of unacceptable indoor air quality should new habitable buildings be constructed adjacent to the landfills. The Selected Remedy includes institutional controls to reduce any such risks to acceptable levels.

The long-term effectiveness and permanence of the Selected Remedy will be dependent upon the adequacy of the operation, maintenance and monitoring of the response actions and the implementation of institutional controls. Because wastes would be left in place, reassessment of the effectiveness of the Selected Remedy will be necessary at five-year intervals as required by CERCLA § 121(c).

Reduction of Toxicity, Mobility or Volume

This evaluation criterion evaluates an alternative's use of treatment technologies that permanently and significantly reduce the toxicity, mobility or volume of hazardous substances at a site.

The Previously Selected Remedy provided treatment to reduce the toxicity of contaminants at the DDA and treatment of extracted groundwater to remove iron and reduce the aquatic toxicity of effluent discharged to Army Creek. However, groundwater was not treated to remove organic COCs before it was discharged to Army Creek. In addition, the Previously Selected Remedy did not include treatment of groundwater extracted from the Llangollen well field.

Bioventing implemented at the DDA as a component of the Previously Selected Remedy has already produced significant and permanent reductions in the concentrations of hazardous substances at the DDA. The Selected Remedy includes operation of an eLFExS to provide hydraulic control at the DDA, with discharge of the extracted groundwater to the POTW for treatment.[29] The Selected Remedy also includes extraction of contaminated groundwater from the Upper Potomac Aquifer with discharge of extracted groundwater to the POTW or treatment of extracted groundwater at the Llangollen well field, which would further reduce the toxicity of contaminants and the volume of contaminated groundwater in the Upper Potomac Aquifer.

Short Term Effectiveness

This evaluation criterion considers the length of time needed to implement an alternative, as well as risks to the community, on-site workers and the environment during the construction and implementation phase.

The Previously Selected Remedy employed fencing, a temporary cap at the DDA and institutional controls to prevent unacceptable risks from potential exposure to contaminated soil and groundwater on the Site property. However, it did not include treatment of groundwater extracted from the Llangollen well field to reduce the concentrations of COCs to acceptable risk- and health-based standards or address potential future exposure to contaminants in indoor air and, therefore, does not adequately address short-term risks.

[29] It is expected that permanent reductions in the toxicity of some COCs would occur during secondary (biological) treatment at the POTW.

Artesian's treatment of groundwater at the Llangollen well field, previously implemented institutional controls, and perimeter fencing and a temporary cap at the DDA are currently preventing unacceptable exposure risks. Short-term risks associated with the implementation of the Preferred Alternative would be minimal because of the limited scope of required excavation activities. The installation of a composite barrier cap over the DDA would provide an immediate reduction in the migration of contaminants from unsaturated soil at the DDA into groundwater. The Selected Remedy includes the treatment of groundwater extracted at the Llangollen well field and would reduce the concentrations of COCs to acceptable risk- and health-based levels. Groundwater cleanup standards would ultimately be met throughout the Area of Attainment in the Upper Potomac Aquifer, and institutional controls are in place to prevent exposure to contaminated groundwater until the RAOs are met. The Selected Remedy also includes institutional controls that would prevent potential exposure to Site contaminants in indoor air for any new construction in areas adjacent to the Inert Area and Grantham South Area where landfill gas may be migrating.

Implementability

The evaluation of an alternative under this criterion considers the technical and administrative feasibility of implementing the alternative, including factors such as the availability of materials and services.

The Previously Selected Remedy has been implemented with the exception of soil vapor extraction and the installation of a composite barrier cap. However, the Previously Selected Remedy did not perform as designed. Subsurface conditions prevented dewatering of the soil at the DDA/BRA, impeding bioremediation in the saturated zone, and allowed the continued release of dissolved-phase contaminants from the DDA/BRA into the Upper Potomac Aquifer. Groundwater response actions did not address contamination in the UPCUTZ or restore groundwater quality in the Upper Potomac Aquifer downgradient of the Site property boundary.

The Selected Remedy will use technology, equipment and materials that are readily available, generally proven to mitigate the migration of contaminants from the slurry-wall containment area and expected to attain groundwater cleanup standards throughout the Area of Attainment within a reasonable time frame. Pre-design investigations would be required prior to the installation of groundwater extraction wells and the installation of extraction wells would be phased in order to optimize the design and performance of the groundwater collection system. Treatment systems to remove COCs from groundwater extracted at the Llangollen well field are either already in place and operating effectively or, with respect to manganese, available and proven technologies. Mechanisms exist within the State and County governments to institute and enforce land use restrictions to prevent potential exposure to Site contaminants in indoor air.

Cost

The estimated present worth cost of the Previously Selected Remedy, $29,241,300, is the sum of the estimated costs in the 1993 ROD Amendment for remediation of the DDA and Ridge Area and the estimated costs in the 1988 ROD for Upper Potomac Aquifer groundwater recovery and treatment. No adjustment was made to account for the time value of money and these costs are not directly comparable with the estimated costs for the Selected Remedy. The Previously Selected Remedy has been implemented with the exception of soil vapor extraction and

installation of a composite barrier cap at the DDA. The actual costs for implementation are not readily available to EPA since the DS&G Remedial Trust implemented the remedies and are not obligated to provide cost information to EPA.

The estimated present worth cost of the Selected Remedy is $46,100,000. This 30-year present worth estimate was calculated using a seven percent discount rate.

State Acceptance

The State of Delaware concurs with the Selected Remedy but has expressed concerns regarding its long-term effectiveness and permanence. EPA's response to these concerns is included in the Responsiveness Summary, which is a part of this Amendment.

Community Acceptance

The Proposed Plan and supporting documents were made available to the public in the Administrative Record file in September 2016. From September 7 to October 7, 2016, EPA held a 30-day public comment period to accept public comment on the remedial alternatives presented in the Proposed Plan and the other documents contained within the Administrative Record file for the Site. On September 21, 2016, EPA held a public meeting to discuss the Proposed Plan and accept comments. A transcript of this meeting is included in the Administrative Record file.

The local community generally supports the Selected Remedy. During the public comment period, no one objected to EPA's Preferred Alternative, although members of the local community expressed concerns regarding the on-site management of waste which is a component of the Selected Remedy, the aquifer restoration time frame and continued use of the Llangollen water supply wells while the groundwater is being remediated, and the adequacy of groundwater monitoring.

EPA received extensive comments on the Proposed Plan from the DS&G Remedial Trust and its consultant, Golder Associates, which support the Selected Remedy. A summary of significant comments received during the public comment period and EPA's responses are included in the Responsiveness Summary which is part of this ROD Amendment No. 2.

2.11 PRINCIPAL THREAT WASTE

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable [40 CFR § 300.430(a)(1)(iii)(A)]. The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, surface water or air, or acts as a source for direct exposure. Contaminated ground water generally is not considered to be a source material. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur.

Principal threat wastes which were present at the DDA have been addressed through prior remedial actions, including off-site disposal of drummed chemical waste and impacted soil and

in-situ treatment of soil at the BRA. As discussed in the *Supplemental Site Characterization Report – Revision 2*, a comparison of laboratory analytical data for soil samples collected at the DDA between 2011 and 2013 with principal threat soil screening levels indicates a low potential for remaining principal threat material at the DDA. EPA expects that the remaining contamination at the DDA source area can be reliably controlled in place through the installation of a composite barrier cap above the slurry-wall enclosure and enhanced hydraulic control measures, which are components of the Selected Remedy.

2.12 SELECTED REMEDY

Following review and consideration of the information in the Administrative Record, the requirements of CERCLA and the NCP, and public comment, EPA has selected the remedy identified as EPA's Preferred Alternative in the Proposed Plan *(Alternative C - DDA Enhanced Containment and Groundwater Extraction from UPCUTZ and Upper Potomac Aquifer with Direct Discharge to POTW*) to address contamination remaining at the Site which was not adequately addressed by the Previously Selected Remedy.

Summary of the Rationale for the Selected Remedy

EPA expects that the Selected Remedy will be protective of human health and the environment, will cost-effectively achieve the RAOs, including restoration of groundwater throughout the Area of Attainment within a reasonable time frame, and will comply with ARARs.

The Selected Remedy consists of components of the remedial action for the Site, which are categorized as follows:

1) Remedial components that were previously selected in the prior decision documents referenced above, but which are not being modified by this ROD Amendment No. 2 (each identified below as an "Existing Component");

2) Remedial components that were previously selected in the prior decision documents, but which are being modified by this ROD Amendment No. 2 (each identified below as a "Modified Component"); and

3) New remedial components that were not previously selected in the prior decision documents (each identified below as a "New Component").

Specifically, this ROD Amendment No. 2 selects the following components of the Selected Remedy:

1. Slurry-wall system (Existing Component);
2. Pre-design investigations to develop supplemental information regarding source and extent of contamination in the Upper Potomac Aquifer and hydraulic connections between hydrostratigraphic units within the Upper Potomac Aquifer, and confirm target capture zones within the Upper Potomac Aquifer (New Component);
3. Hydraulic control of contaminated groundwater within the slurry-wall enclosure using an enhanced low-flow groundwater extraction system (eLFExS) (Modified Component);

4. A composite barrier cap to minimize infiltration of precipitation through contaminated soil contained within the slurry wall surrounding the DDA (Existing Component);
5. Installation and operation of extraction wells in areas determined to optimize capture and remove contaminant mass from the more highly-impacted areas of the Upper Potomac Aquifer, including the UPCUTZ (Modified Component);
6. Discharge of groundwater pumped from the DS&G extraction wells to the Wilmington Wastewater Treatment Plant (Modified Component);
7. Continued groundwater extraction at Artesian's Llangollen well field with treatment utilizing existing systems for BCEE and 1,4-dioxane and, if necessary, additional treatment systems targeting other COCs (New Component);
8. A groundwater monitoring program to ensure that the remedial action is meeting the short-term goal of plume containment and will meet the long-term goal of aquifer restoration in the Area of Attainment within a reasonable time frame (New Component);
9. Institutional controls to prevent direct contact with contaminated soil, the installation of drinking water wells on the Site property and other future uses of the Site property which could compromise the effectiveness of the Selected Remedy (Existing Component); and
10. Institutional controls to prevent potential future exposure to Site contaminants in indoor air (New Component).

The Selected Remedy and mandatory performance standards are described in detail below.

2.12.1 Slurry-wall System

The existing slurry wall, constructed in 1994 and keyed into the underlying UPCU, will remain in place as a passive containment system at the DDA, with added instrumentation, as indicated in Section 2.12.3, below, to monitor performance.

2.12.2 Pre-design Investigations

Areas of uncertainty at the Site identified in the Feasibility Study will be addressed during pre-design investigations which will include but not be limited to the following activities:

- Delineation of the extent of contamination in the UPCUTZ;
- Verification of target capture zones for extraction wells to be installed in the UPCUTZ and the upper and lower sand units of the Upper Potomac Aquifer;
- Evaluation of the interaction between the UPCUTZ and Upper Potomac Aquifer upper sand, including the area of greatest contaminant mass flux from the UPCUTZ to the Upper Potomac Aquifer;
- Evaluation of the continuity and/or extent of the UPDC and the connection between the upper and lower sand units of the Upper Potomac Aquifer between source areas and the Llangollen well field;
- Additional characterization to evaluate the simulated silt feature near well P-6 in the Site-specific groundwater flow model;

- Assessment of the source of impacts (e.g., BCEE, 1,4-dioxane and/or manganese) in the vicinity of monitoring wells P-6, MW-18 and MW-34, BW-2 and MW-26N; and

- Delineation of areas beyond the boundary of the Inert Area and the Grantham South Area impacted by subsurface migration of landfill gas in order to ensure that institutional controls are in place to prevent potential future exposure to all areas where Site-related vapor intrusion adversely affects indoor air.

These pre-design activities will include the advancement of borings and installation of monitoring wells using rotosonic drilling methods with vertical aquifer profiling[30] and baseline groundwater sampling to confirm target capture zones. Aquifer testing will be performed in the potential extraction well locations to confirm the modeled groundwater extraction rates and evaluate the connections between hydrostratigraphic units within the Upper Potomac Aquifer. The results of the sampling and testing will be used to update the CSM and the numerical groundwater flow model, refine the simulated capture zones and develop design extraction rates for the groundwater extraction wells.

Performance Standards for Pre-Design Investigations

Wells installed during pre-design investigations will be constructed, modified and repaired in accordance with the substantive requirements of Delaware's regulations governing construction and use of wells (7 DE Admin. Code 7301). Wells and pumps will be installed and repaired by persons licensed by the Water Well Licensing Board pursuant to 7 DE Admin. Code 7302.

Drill cuttings identified as hazardous waste and other generated hazardous waste will be managed in accordance with Delaware's standards applicable to generators of hazardous waste, including storage and manifesting of hazardous waste (7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 262.11-42).

2.12.3 Enhanced Low-Flow Groundwater Extraction System

The LFExS, which is currently operating within the slurry-wall containment area, will be upgraded to ensure that the system will provide reliable source containment and migration control at the DDA.

Additional groundwater extraction wells will be installed in the Columbia Aquifer within the slurry-wall enclosure. The new wells and existing LFExS wells will be operated at an estimated 25 gpm, instead of the current extraction rate of 8 to 10 gpm, to increase the rate of contaminant mass removal from the DDA and provide reliable hydraulic containment of contaminated groundwater at the DDA. Instrumentation will be installed on the inside and outside of the slurry-wall system with telemetry to monitor head differences and the effectiveness of hydraulic containment in real-time. In addition, an emergency backup generator will be installed to provide power for the eLFExS in the event of electrical service interruption.

[30] During advancement of the borings, groundwater will be sampled using the Push-Ahead™ groundwater sampling system (vertical aquifer profiling) used with sonic drilling methods.

Performance Standards for eLFExS

The eLFExS will provide hydraulic containment at the DDA by inducing inward (horizontal) gradients in the Columbia Aquifer across the slurry wall, and upward (vertical) gradients between the Upper Potomac Aquifer and the Columbia Aquifer, thereby maintaining a lower potentiometric head within the DDA. The eLFExS will be operated until EPA, in consultation with DNREC, determines that operation of the system is no longer required to prevent contaminant releases from the DDA into the Upper Potomac Aquifer.

Additional extraction wells installed in the Columbia Aquifer at the DDA will be constructed, modified and repaired in accordance with the substantive requirements of Delaware's regulations governing construction and use of wells (7 DE Admin. Code 7301). Wells and pumps will be installed and repaired by persons licensed by the Water Well Licensing Board pursuant to 7 DE Admin. Code 7302.

Drill cuttings identified as hazardous waste and other generated hazardous waste will be managed in accordance with Delaware's EPA-authorized standards applicable to generators of hazardous waste, including storage and manifesting of hazardous waste (7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 262.11-42).

2.12.4 Installation of Composite Barrier Cap

Bioventing wells and vapor probes within the slurry-wall enclosure will be decommissioned. A composite barrier cap system, designed to minimize water infiltration, will be installed over the entire DDA, including the "containment" and "partition" areas of the slurry-wall enclosure at the DDA.[31]

Performance Standards for Installation of Composite Barrier Cap

Bioventing wells and vapor probes will be decommissioned in accordance with State requirements for well sealing (7 DE Admin. Code 7301 Regulations Governing the Construction and Use of Wells, Section 10.0).

The cap will comply with State standards for owners and operators of hazardous waste landfills. In particular, the design, construction and O&M of the composite barrier cap will meet Delaware's EPA-authorized requirements for closure and post-closure care of hazardous waste landfills [7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 264.310(a) and (b)(1) and (5)] and for monitoring and inspection during the installation of the cover system [7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsection 264.303(a)].

[31] The area within the slurry-wall system is divided by a partition wall, which isolates the portion of the DDA with contaminated soils (containment area) from the area where the clay is thin, discontinuous or not present (partition area), as discussed in the Feasibility Study.

2.12.5 Installation and Operation of Extraction Wells in the Upper Potomac Aquifer

Groundwater extraction wells shall be installed and operated in areas determined to optimize capture and removal of contaminant mass from the Upper Potomac Aquifer and shall be sufficient to control the migration of contaminants and to attain the groundwater cleanup standards throughout the Area of Attainment within a reasonable time frame.

The location and number of recovery wells in the UPCUTZ and the upper and lower sand units of the Upper Potomac Aquifer will be determined by EPA, in consultation with DNREC, based on the results of the pre-design investigations and performance monitoring during remedy implementation.[32]

The effectiveness of the groundwater extraction system in capturing and containing contaminant mass will be routinely evaluated and the system will be modified as necessary to achieve the RAO for groundwater in the Upper Potomac Aquifer.

Performance Standards for Installation and Operation of Extraction Wells in the Upper Potomac Aquifer

Additional extraction wells installed in the Upper Potomac Aquifer, including the UPCUTZ, will be constructed, modified and repaired in accordance with the substantive requirements of Delaware's regulations governing construction and use of wells (7 DE Admin. Code 7301). Wells and pumps will be installed and repaired by persons licensed by the Water Well Licensing Board pursuant to 7 DE Admin. Code 7302.

Drill cuttings identified as hazardous waste and other generated hazardous waste will be managed in accordance with Delaware's EPA-authorized standards applicable to generators of hazardous waste, including storage and manifesting of hazardous waste (7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 262.11-42).

The extraction of ground water from the Upper Potomac Aquifer will continue until MCLs (40 CFR §§ 141.11-.12 and 141.61-.62) and non-zero MCLGs (40 CFR §§141.50-.51) are attained throughout the Area of Attainment and the cumulative excess cancer risk associated with potential residential use of the ground water within the Area of Attainment is reduced to one in ten thousand (1.0×10^{-4}) and the HI is reduced to 1.0.

Once the groundwater cleanup standards have been met throughout the Area of Attainment, groundwater extraction wells will continue to be operated to prevent contaminated groundwater beneath the Waste Management Area from migrating and degrading groundwater quality in the Upper Potomac Aquifer downgradient of the Waste Management Area. Groundwater extraction wells will be operated in the Upper Potomac Aquifer, including the UPCUTZ, until EPA, in consultation with DNREC, determines that operation of the wells is no longer required to ensure

[32] Based on the results of the groundwater flow modeling performed in support of the Feasibility Study, it is anticipated that approximately 222 gpm of groundwater will be extracted from the Upper Potomac Aquifer in order to provide effective migration control.

that groundwater quality in the Upper Potomac Aquifer beyond the Waste Management Area continues to meet the cleanup standards.

EPA's determination regarding the attainment of risk- and health-based groundwater cleanup standards will be based on an assessment of cumulative risks associated with residential use of groundwater. A cumulative excess cancer risk of 1×10^{-4} was selected as the risk-based performance standard for groundwater remediation because there are multiple groundwater contaminants which contribute to carcinogenic risk. As discussed above, groundwater extraction wells will continue to be operated after the risk- and health-based groundwater cleanup standards, MCLs and non-zero MCLGs are met to prevent degradation of water quality downgradient of the Waste Management Area. As discussed in Section 2.12.7 of this ROD Amendment No. 2, treatment at the Llangollen well field shall provide an additional degree of protectiveness.

Groundwater extraction wells will be decommissioned in accordance with State requirements for well sealing (7 DE Admin. Code 7301 Regulations Governing the Construction and Use of Wells, Section 10.0).

2.12.6 Discharge of Groundwater to the Wilmington Wastewater Treatment Plant

Groundwater extracted from the Columbia Aquifer and the Upper Potomac Aquifer will be discharged to the Wilmington Wastewater Treatment Plant.

Performance Standards for Discharge of Groundwater to the Wilmington Wastewater Treatment Plant

Groundwater discharged to the Wilmington Wastewater Treatment Plant will comply with effluent limitations established by New Castle County and the City of Wilmington to meet the requirements of Delaware's National Pollutant Discharge Elimination System Program (7 DE Admin. Code 7201 Regulations Governing the Control of Water Pollution, Section 6.0) and will meet all pretreatment standards established by New Castle County and the City of Wilmington in accordance with the NPDES General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403).[33]

2.12.7 Continued Groundwater Extraction and Treatment at Llangollen Well Field

The Selected Remedy includes continued groundwater extraction at Artesian's Llangollen well field with treatment utilizing existing systems for BCEE (granular activated carbon) and 1,4-dioxane (advanced oxidation process) and, if necessary to protect human health, additional treatment systems targeting manganese or other COCs. The continued operation of water supply wells at the Llangollen well field will assist in restoring groundwater to its beneficial use and prevent downgradient migration of contaminants.

[33] The need for pretreatment is not currently anticipated based on the estimated mass loading of BCEE to the POTW resulting from projected groundwater discharges from the Site.

Performance Standards for Groundwater Extraction/Treatment at Llangollen Well Field

If any Site-related COCs are determined to be present in groundwater extracted from a Llangollen well field public water supply well at concentrations determined by EPA to present an excess lifetime cancer risk greater than $1.0 \text{ X } 10^{-4}$, or potential non-cancer adverse health effects (HQ > 1.0 or, where there are multiple COCs with non-cancer endpoints affecting the same target organ, HI > 1.0), treatment will be provided at the well field to reduce the concentrations of those COCs to MCLs or, where MCLs are not available or the presence of multiple COCs would result in unacceptable cumulative risk, to acceptable risk- and health-based levels (i.e., concentrations that would not present an excess cancer risk greater than 2.0×10^{-5} or an HI exceeding 1.0).

Any generated treatment residuals identified as hazardous waste will be managed in accordance with Delaware's EPA-authorized standards applicable to generators of hazardous waste, including storage and manifesting of hazardous waste (7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 262.11-42).

2.12.8 Groundwater Monitoring

A groundwater monitoring program will be implemented to evaluate the effectiveness of hydraulic containment and contaminant migration control and progress toward the attainment of the RAO for groundwater in the Upper Potomac Aquifer. The locations, frequency, and duration of groundwater monitoring, and the analytical parameters and methods to be used, will be determined by EPA, in consultation with DNREC.

Performance Standards for Groundwater Monitoring

New monitoring wells will be constructed and repaired in accordance with the substantive requirements of Delaware's regulations governing construction and use of wells (7 DE Admin. Code 7301). Wells will be installed and repaired by persons licensed by the Water Well Licensing Board pursuant to 7 DE Admin. Code 7302.

Drill cuttings identified as hazardous waste and other generated hazardous waste will be managed in accordance with Delaware's EPA-authorized standards applicable to generators of hazardous waste, including storage and manifesting of hazardous waste (7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 262.11-42).

Monitoring wells will be abandoned in accordance with State requirements for well sealing (7 DE Admin. Code 7301 Regulations Governing the Construction and Use of Wells, Section 10.0).

2.12.9 Existing Institutional Controls

Institutional controls selected in EPA's 2003 ESD will prevent direct contact with contaminated soil, the installation of drinking water wells on the Site property and other future uses of the Site property which could compromise the effectiveness of the Selected Remedy.

2.12.10 Institutional Controls to Prevent Exposure to Site Contaminants in Indoor Air

Land use limitations will be put in place to prevent potential future exposure to Site contaminants in landfill gas that are capable of migrating into indoor air. The land use limitations will ensure that all new habitable buildings constructed on or adjacent to the Site property in areas potentially impacted by landfill gas (i.e., within several hundred feet of those sections of the Inert Area and the Grantham South Area where landfill gas mitigation measures are not in place) have, at a minimum, a foundation vapor barrier and subsurface piping for a SSDS, and will be subjected to indoor air testing prior to building occupancy. Should indoor air concentrations equal or exceed EPA risk-based criteria, the land use limitations will require activation and operation of a SSDS until such time that EPA, in consultation with DNREC, determines that landfill gas migration no longer poses a vapor intrusion risk. The use limitations will be implemented through enforceable institutional controls such as judicial consent decrees, administrative orders, State regulations, local ordinances or environmental covenants.

Performance Standards

Should indoor air concentrations in habitable buildings constructed adjacent to the Inert Area or the Grantham South Area present an excess lifetime cancer risk greater than 1.0×10^{-5} or a HI greater than 1.0 (based on target organ effects), the installation, activation and operation of a vapor intrusion mitigation system will be required. O&M of the vapor intrusion mitigation system will continue until such time that EPA determines that landfill gas migration no longer poses a vapor intrusion risk.

Summary of the Estimated Remedy Costs

The estimated cost of the Selected Remedy is $46,100,000. Details regarding the estimated costs to construct and implement the Selected Remedy are provided in Appendix E. The information in Appendix E is based on the best available information regarding the anticipated scope of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Minor changes may be documented in the form of a memorandum to the Administrative Record file. Changes which are significant, but not fundamental, may be documented in an ESD. Any fundamental changes will be documented in a ROD amendment.

Expected Outcome of the Selected Remedy

This section presents the expected outcomes of the Selected Remedy in terms of resulting land and groundwater uses and risk reduction achieved as a result of the response action.

The Selected Remedy will prevent exposure to contaminated soil and groundwater at the DDA through a combination of engineering and institutional controls. Land use at the DDA will be restricted to long-term waste management and the use of groundwater beneath the Waste Management Area will be prohibited.

The Selected Remedy will prevent exposure to groundwater COCs through groundwater treatment at the Llangollen well field and continued implementation of institutional controls

restricting groundwater use that could result in unacceptable exposure risks or interfere with the effectiveness of the remedial action.

The Selected Remedy will restore groundwater in the Area of Attainment within the Upper Potomac Aquifer which has been impacted by releases from the DS&G Site and the eastern lobe of the Army Creek Landfill.

Through operation of the eLFExS within the slurry-wall system and operation of groundwater extraction wells in the Upper Potomac Aquifer, including the UPCUTZ, it is estimated that the groundwater cleanup standards will be achieved throughout the Area of Attainment within 25 years. Upon attainment of the groundwater cleanup standards, contaminant levels in groundwater within the Upper Potomac Aquifer beyond the boundary of the Waste Management Area will be below MCLs and MCLGs, and use of the groundwater in a residential setting would present an excess lifetime cancer risk that is less than 1.0×10^{-4} and no adverse non-cancer health effects. Once the groundwater cleanup standards are achieved, the need for institutional controls restricting groundwater use can be reevaluated as part of the CERCLA five-year review process.

The Selected Remedy will prevent potential future exposure to Site-related contaminants in indoor air through institutional controls that will require property owners to implement measures to mitigate potential vapor intrusion at new construction adjacent to the Inert Area and the Grantham South Area, without prohibiting future land use.

2.13 STATUTORY DETERMINATION

Under Section 121 of CERCLA (42 U.S.C. § 9621) and the NCP [40 C.F.R. § 300.430(f)(5)(ii)], EPA must select remedies that are protective of human health and the environment, comply with ARARs, are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery to the maximum extent possible. There is also a preference for remedies that use treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as a principal element. The following sections discuss how the remedy modification meets these statutory requirements.

Protection of Human Health and the Environment

The Selected Remedy will protect human health and the environment using a combination of treatment, engineering controls and institutional controls. The composite barrier landfill cap to be installed at the DDA will minimize infiltration and mitigate the release of contaminants from the vadose zone within the slurry-wall enclosure into the groundwater of the Columbia Aquifer. Operation of the eLFExS will prevent the release of contaminated groundwater from the slurry-wall enclosure into the UPCUTZ and the upper sand unit of the Upper Potomac Aquifer. The operation of groundwater extraction wells in the Upper Potomac Aquifer, including the UPCUTZ, will optimize capture and removal of contaminant mass from the more highly-impacted areas of the Upper Potomac Aquifer in order to meet groundwater cleanup standards throughout the Area of Attainment within a reasonable time frame. Upon meeting the groundwater RAOs, residential use of groundwater within the Upper Potomac Aquifer

downgradient of the Waste Management Area would not present an excess lifetime cancer risk that exceeds 1.0×10^{-4} or adverse non-cancer health effects.

Treatment at the Llangollen well field will reduce the concentrations of Site-specific COCs to acceptable risk- and health-based levels, i.e., concentrations that do not present an excess cancer risk greater than 2.0×10^{-5} or an HI exceeding 1.0.

Institutional controls will require testing of indoor air in any habitable buildings constructed in areas affected by the migration of landfill gas from the Inert Area and the Grantham South Area and, should indoor air concentrations of Site-related contaminants exceed EPA's risk-based criteria, the activation and operation of a SSDS until such time that EPA determines that landfill gas migration no longer poses a vapor intrusion risk.

Short-term risks associated with the implementation of the Selected Remedy are expected to be minimal because of the limited scope of required excavation activities. Groundwater discharged to the POTW will meet effluent limitations established by local authorities to ensure compliance with State regulations governing discharge to surface water. No adverse cross-media impacts are expected during implementation of the Selected Remedy.

Compliance with Applicable or Relevant and Appropriate Requirements

The Selected Remedy will comply with all Federal and State requirements, standards, criteria, and limitations that are applicable or relevant and appropriate, as required by Section 121(d) of CERCLA, 42 U.S.C. § 9621(d), and the NCP, 40 CFR §§ 300.430(f)(5)(ii)(B) and (C), as discussed in Section 2.12 of this Amendment and Appendix D.

Cost-Effectiveness

A cost-effective remedy in the Superfund program is one for which the implementation costs are proportional to the overall effectiveness of the remedy. Overall effectiveness of a remedial alternative is determined by considering how it satisfies the following primary balancing criteria: long-term effectiveness and permanence; reduction in toxicity, mobility and volume through treatment; and short-term effectiveness. The Selected Remedy provides long- and short-term effectiveness and includes treatment to reduce the toxicity of contaminants. EPA has determined that cost of the Selected Remedy is proportional to its overall effectiveness.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be practicably utilized at the Site. Among the alternatives considered in the Feasibility Study that are protective of human health and the environment and ARAR compliant, EPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and State and community acceptance.

Bioventing was previously implemented at the DDA to address principal threats and reduce the toxicity and mobility of contaminants. The Selected Remedy addresses lower level threats presented by residual contaminants using engineering controls, including a landfill cap and hydraulic containment, institutional controls and long-term monitoring and maintenance to ensure protection of human health and the environment.

Preference for Treatment as a Principal Element

Previously implemented response actions at the DDA included treatment as a principal element. The Selected Remedy employs treatment of groundwater extracted at the Llangollen well field to reduce the toxicity of contaminants and satisfies the statutory preference for treatment as a principal element.

Five-Year Review Requirements

Because the Selected Remedy will result in hazardous substances, pollutants or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure, five-year reviews will be conducted in accordance with statutory requirements pursuant to Section 121(c) of CERCLA, 42 U.S.C. § 9621(c) and the NCP, 40 CFR § 300.430(f)(4)(ii), to ensure that the remedy continues to provide adequate protection of human health and the environment.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

There are no significant changes from the Preferred Alternative presented in the Proposed Plan.

3.0 RESPONSIVENESS SUMMARY

This Responsiveness Summary documents public participation in the remedy selection process for the DS&G Site. It contains a summary of the significant comments EPA received on the Proposed Plan during the public comment period and EPA's responses to those comments. The Proposed Plan was released for public comment on September 7, 2016, and the thirty-day comment period ended on October 7, 2016. On September 21, 2016, EPA held a public meeting at William Penn High School in New Castle, Delaware, to inform local officials, interested citizens and other stakeholders in attendance about EPA's proposed cleanup plan, and to receive comments on, and respond to questions about, the Proposed Plan.

Section 3.1, below, summarizes issues raised by stakeholders, including citizens, the support agency and PRPs. Section 3.1.1 contains a detailed list of comments received from the general public, along with EPA's responses. Section 3.1.2 contains a summary of comments received during the public meeting directed toward Artesian and Artesian's responses. During the public comment period, DNREC requested that EPA include responses to the State's July 28, 2015 comments on the draft Feasibility Study in the Responsiveness Summary. Section 3.1.3 of this Amendment contains a summary of DNREC's comments on the draft Feasibility Study with EPA's responses. Sections 3.1.4 and 3.1.5 contain a summary of comments submitted by the DS&G Remedial Trust and the Government of New Castle County Delaware, and EPA's responses. The written comments received from the DS&G Remedial Trust, Golder Associates and the Government of New Castle County, Delaware are contained in the Administrative Record file.

3.1 STAKEHOLDER ISSUE AND LEAD AGENCY RESPONSES

3.1.1 Comments from the General Public

Comment #1: A local citizen asked during the public meeting if her residence was located in the vicinity of the plume and, if so, whether she should be concerned.

Response: The contaminated groundwater is located beneath and downgradient of the Waste Management Area (within the Area of Attainment shown in Figure 6), and is approximately 70 to 180 feet below the ground surface, with a layer of clay separating the groundwater from the surface. Therefore, because of these conditions, EPA has determined that residences in the vicinity of the Site are not susceptible to migration of vapors from the groundwater contaminant plume into indoor air.

Comment #2: Two local citizens expressed concern during the public meeting that exposure to Site-related contaminants might be responsible for their pets' health concerns or premature deaths.

Response: Potential exposure pathways at the Site include exposure to contaminated soil and groundwater and exposure to Site-related contaminants in indoor air. EPA has evaluated those exposure pathways and determined that they have been eliminated. Specifically, the potential for exposure to contaminated soil and waste at the Site has been eliminated through engineering controls (landfill caps and fences). The potential for exposure to Site-related contaminants in

indoor air exists only at buildings adjacent to the Inert Area and the Grantham South Area, both located within the Waste Management Area, where landfill gas may be migrating in the subsurface. Steps have been, and will continue to be, undertaken to prevent exposure to Site-related contaminants in indoor air as discussed in Section 2 of this Amendment. The potential for exposure to Site-related COCs in tap water has been eliminated by treatment provided by Artesian at the Llangollen well field to address BCEE (since 2000) and 1,4-dioxane (since 2014). Therefore, while EPA evaluated the risks that the Site presents to human health and the environment, and not risks posed to domestic pets, there is no basis to conclude that pets are at risk from exposure to Site-related contaminants.

Comment #3: A local citizen asked during the public meeting what contaminants may be found in vapors on or near the Site.
Response: Methane generated during waste decomposition at the Inert Area and the Grantham South Area is the predominant constituent of the landfill gas. The volume of methane generated has caused landfill gas to migrate laterally into soil beyond the perimeter of those waste disposal areas. Contaminants that may be present in the landfill gas include benzene and 1,2,4-trimethylbenzene. To address concerns about landfill gas migration beyond the perimeter of the landfills, the DS&G Remedial Trust installed a soil vapor extraction system to prevent landfill gas from migrating beyond the boundaries of the waste disposal areas.

Comment #4: A local citizen asked during the public meeting if water runoff onto her property was due to recent construction near Llangollen Boulevard.

Response: Construction activities near Llangollen Boulevard are unrelated to the Site. Therefore, EPA does not have the information to determine whether the runoff was due to the construction.

Comment #5: A number of citizens expressed concern during the public meeting that the time frame for groundwater cleanup is projected to be 25 years.

Response: Due to the nature and extent of contamination and the complexity of the subsurface environment at many Superfund sites, ground water cleanup activities often require an extended amount of time to remediate. EPA will take every opportunity to incorporate new methods and technologies to expedite cleanup activities as they are developed.

Comment #6: A local citizen asked during the public meeting how much additional construction work will be associated with the cleanup activities.

Response: Additional construction activities will include the installation of a 3-acre cap over the DDA and installation of groundwater monitoring and extraction wells and subsurface piping to convey extracted groundwater to a pump station that discharges to the sewer.

Comment #7: A local citizen stated during the public meeting that the water in her home, which is supplied by Artesian, has a gasoline odor and taste.

Response: Based on Artesian's annual water quality report, the water supplied by Artesian meets drinking water standards for all contaminants for which there are MCLs established under

the Safe Drinking Water Act, 42 U.S.C. §§ 300f et seq., and codified at 40 CFR Part 141. Artesian's annual water quality reports for public water system DE0000552 are available online and document that water distributed to local residences and businesses meets federal drinking water and other relevant standards. In addition, please see Artesian's response to this comment which is summarized in Section 3.1.2, below.

Comment #8: A local citizen asked during the public meeting if there is any potential for exposure to Site contaminants at her home on Llangollen Boulevard.

Response: EPA has evaluated exposure pathways at the Site and determined that they have been eliminated. Please see EPA's responses to Comments #1 and 2, above. In addition, water that Artesian supplies to local residential and business customers is not pumped directly from the impacted production wells. Artesian has a treatment system to reduce concentrations of groundwater COCs at the Llangollen well field to acceptable levels. The treated water from the Llangollen well field is combined with water from production wells throughout northern New Castle County and the Susquehanna and Brandywine River basins in the water distribution lines. Based on Artesian's annual water quality report, the water supplied by Artesian meets drinking water standards established under the Safe Drinking Water Act, 42 U.S.C. §§ 300f et seq., and codified at 40 CFR Part 141, otherwise known as MCLs. Please see EPA's response to Comment #7, above.

Comment #9: A local citizen asked during the public meeting if it safe to garden on her property on Llangollen Boulevard.

Response: Yes, it is safe. There is no threat of exposure to Site contamination when gardening or planting in the Llangollen Estates development. Please see EPA's responses to Comments #1 and 2, above.

Comment #10: A local citizen asked during the public meeting if it was reasonable to assume that the groundwater contamination has migrated farther south.

Response: Based upon the existing data, EPA believes that production wells in Artesian's Llangollen well field are capturing the groundwater contaminant plume and have, therefore, stopped it from migrating further south. Additional monitoring wells will be installed to ensure that capture at the Llangollen well field is maintained.

Comment #11: A local citizen asked during the public meeting if shutting down Artesian's wells would be a better solution than EPA's preferred method.

Response: EPA determined that there is no need to shut down the wells at this time. Artesian's Llangollen well field is an important source of drinking water in New Castle County. Testing has shown that the water Artesian distributes throughout northern New Castle County meets federal drinking water standards or acceptable risk-based criteria. When BCEE and 1,4-dioxane were detected in groundwater at the Site, EPA informed Artesian and the State of these findings. Both Artesian and Delaware's Office of Drinking Water have been proactive in shutting down production wells before concentrations reached levels that EPA has determined would not be protective. Treatment systems were then installed before bringing the impacted wells back

online. In addition, please see Artesian's response to this comment is summarized in Section 3.1.2, below.

Comment #12: A local citizen asked during the public meeting if it was possible that EPA would discover additional contaminants in groundwater in the future.

Response: Yes, it is possible that additional contaminants could be discovered. Analytical techniques have improved over the years, and will continue to improve, enabling the identification of additional compounds in environmental samples and providing lower detection limits. The DS&G Remedial Trust has agreed to regularly review and update the analytical program for the DS&G Site to ensure the use of appropriate analytical methods for samples collected at the Site.

Comment #13: A local citizen commented during the public meeting that he does not like the use of the phrase "non-detect" in describing testing results because analytical detection limits may vary.

Response: A representative of Delaware's Office of Drinking Water explained that he uses this phrase because it is more accurate to report a result as "non-detect" than to say that an analyte is not present in a sample or that the concentration is "zero." As analytical methodology improves, contaminants can be detected at lower and lower levels.

Comment #14: A local citizen asked during the public meeting if it is known whether treatment provided at the Wilmington Wastewater Treatment Plant would effectively remove contaminants in groundwater discharged from the Site into the sewer system.

Response: Activated sludge, a component of the treatment train at the Wilmington Wastewater Treatment Plant, has been shown to reduce concentrations of some, but not all, Site-related COCs in wastewater. Based on mass loading projections, EPA, in consultation with New Castle County's Department of Special Services, has determined that the discharge of additional groundwater from the Site to the Wilmington Wastewater Treatment Plant will not affect the ability of the POTW to comply with effluent limits to meet Delaware Water Quality Criteria for the protection of human health and aquatic life.

Comment #15: A local citizen asked during the public meeting if contaminants in the groundwater discharged from the Site could end up in sludge generated at the wastewater treatment plant.

Response: Yes, some of the contaminants remain in the sludge, but at levels that do not pose a risk. Sludge from the wastewater treatment plant is taken to mines in Pennsylvania for use in mine reclamation. In Pennsylvania, the sewage sludge may not be applied to the land if the concentration of any pollutant in the sludge exceeds the limit for the pollutant set forth in Pennsylvania's regulations governing the beneficial use of sewage sludge by land application [25 Pa. Code 271.914(b)(1)].

Comment #16: A local citizen asked during the public meeting how EPA can be sure that there aren't more instances of vapor intrusion.

Response: EPA has assessed the potential for vapor intrusion at buildings located above the groundwater contaminant plume, including buildings close to the landfills. Vapor migration from the contaminated groundwater in the Upper Potomac Aquifer into the indoor air of overlying buildings is unlikely. The groundwater contaminant plume is 75 to 100 feet below the ground surface, and there is a thick clay layer, which serves as a barrier, between the groundwater plume and any buildings above the plume. However, there is a potential for landfill gas to migrate laterally through the soil into buildings near the landfills. The DS&G Remedial Trust has addressed this risk through operation of a sub-slab depressurization system at an office building adjacent to the landfills and the installation and operation of a landfill gas mitigation system. Please see EPA's responses to Comments #1 and 2, above.

Comment #17: A local citizen asked during the public meeting if vapors rising from the landfill could contain constituents in addition to methane.

Response: Yes. Landfill gas may contain constituents that are hazardous to human health, in addition to methane. The landfill gas mitigation system recently installed at the Inert Area and the Grantham South Area will prevent landfill gas from migrating into nearby buildings.

Comment #18: A local citizen expressed concerns during the public meeting that EPA's preferred remedial alternative called for containment rather than removal of contaminants from the Site.

Response: In deciding that the remaining wastes and contaminated soil at the DDA will be managed through containment, EPA evaluated remedial alternatives that include excavation or additional treatment of contaminated soil at the DDA in the Feasibility Study as discussed in Section 2.9 of this ROD Amendment No. 2. EPA determined that because contamination is present in the UPCUTZ, removal of contaminated soil at the DDA would not shorten the groundwater remediation time frame. The contaminated UPCUTZ, located beneath the clay unit underlying the DDA, is a significant secondary source of impacts to groundwater in the Upper Potomac Aquifer. The nature (interbedded silts, sands and clays) and location (40 to 80 feet below grade and beneath 5 to 15 feet of clay) of the UPCUTZ substantially curtail remediation options for this secondary source area. The Selected Remedy includes capping the DDA, which will prevent infiltration into the subsurface at the DDA, and groundwater extraction from the UPCUTZ to remove contaminant mass and control the migration of contaminants. EPA does not believe that removal of contaminated soil from the DDA would address the principal remaining source of groundwater contamination at the Site. Based on its evaluation, EPA determined that the Selected Remedy provides an appropriate balance of trade-offs with respect to the nine evaluation criteria.

Comment #19: A local citizen asked during the public meeting if a health assessment had ever been done for the community in the Llangollen Estates area.

Response: Yes, whenever a site is listed on the NPL, the Agency for Toxic Substances and Disease Registry (ATSDR) is required to perform a health assessment for that site. ATSDR conducted a health assessment for the Site in 1989 which was focused primarily on environmental data, including analytical results for Site soil, groundwater, sediment and surface water samples. Because the available data did not indicate that human exposure to Site

contaminants was occurring at the time of the assessment, the Site was not considered for follow-up health studies. ATSDR's April 1989 Health Assessment for Delaware Sand & Gravel Landfill National Priorities List (NPL) Site is available in the Administrative Record file for the Site.

Comment #20: A local citizen stated during the public meeting that many members of the community have died from cancer.

Response: The background cancer rate in the United States is approximately one in two males and one in three females. This means that roughly forty percent of the population will get cancer at some point in their lives. Therefore, it is not uncommon for communities, small neighborhoods, cul-de-sacs, etc. to see a high incidence of cancer. For a group of cancers to be categorized as a cluster, the same form of cancer would need to be found at rates higher than what is normal for that community. Currently, the Delaware Department of Health and Social Services houses the Surveillance, Epidemiology, and End Results Program which tracks all incidence data for the State. Additionally, there have been studies conducted in the past comparing incidences in the upper and lower counties in the State. To date, EPA is not aware that a door-to-door investigation in the vicinity of the Site has been conducted. Such an investigation is certainly something ATSDR would consider if community interest warrants it.

Comment #21: A local citizen asked during the public meeting if the 1,600 drums that were removed from the Site constituted all of the drums on Site, or if any were not removed.

Response: All visible drums, and drums encountered during excavation activities, have been removed from the Site. Specifically, in 1984, more than 1,600 drums which were located at surface level and easily visible were removed from the Site. After the slurry wall was constructed in 1994, excavation activities were conducted at the DDA, and all of the buried drums, an estimated 13,000, encountered during the excavation work, were removed.

Comment #22: A local citizen asked during the public meeting how much contaminated soil will be removed from the Site.

Response: No additional contaminated soils will be removed from the Site. Waste and contaminated soil at the Inert Area and the Grantham South Area have been capped in place. Another permanent cap is to be installed over the DDA to prevent infiltration of water and mobilization of contamination above the water table.

Comment #23: A local citizen commented during the public meeting that the best solution would be to remove contaminated soil from the Site.

Response: See EPA's response to Comment # 18.

Comment #24: A local citizen asked during the public meeting who will be responsible for paying for cleanup activities.

Response: The DS&G Remedial Trust has paid for cleanup and investigation activities required at the Site under the 1995 Consent Decree. EPA will invite the parties it believes are responsible

for the contamination at the Site to implement the Selected Remedy as described in this ROD Amendment No. 2. In the future, if additional treatment is installed at the Llangollen well field to address Site-specific groundwater COCs identified in ROD Amendment No. 2, EPA will seek to have the parties who are implementing ROD Amendment No. 2 to be financially responsible for such treatment.

Comment #25: A local citizen asked during the public meeting how thick the cap that EPA will ultimately install will be and what it will be made of.

Response: A typical composite barrier cap consists of the following, from the bottom up: a foundation layer, a gas collection layer and two hydraulic barriers, which may include a clay layer and a flexible plastic liner. A drainage layer is installed above the hydraulic barriers to drain water resulting from precipitation to the edges of the cap. Topsoil is placed above the drainage layer to protect the underlying layers of the cap and support a grass cover. The thickness of the cap, which depends upon the materials used in cap construction, will be determined during the design phase. Depending on materials used, it is expected that the cap will be two and a half to five and a half feet thick.

Comment #26: A local citizen asked during the public meeting when the drummed chemical waste that resulted in contamination was originally placed into the ground.

Response: Wastes were disposed of at the Site beginning no later than 1968 and continued until sometime in 1976.

Comment #27: A local citizen asked during the public meeting who was responsible for placing the drums into the ground.

Response: The property owner operated the landfills on the Site, and approximately 30 companies either transported waste to, or arranged to have their waste disposed of at, the Site. The names of the owner and those 30 companies can be found in the Administrative Record as signatories to the 1995 Consent Decree.

Comment #28: A local citizen asked during the public meeting what uses the companies had for the materials that were disposed of at the Site.

Response: The materials that the companies arranged to dispose of at the Site were wastes from the companies' plants and drums of materials for which they no longer had use. Such disposal was a fairly common practice in the 1960s and 1970s prior to the enactment of environmental protection laws.

Comment #29: A local citizen asked during the public meeting what effects these contaminants could have on residents if they were to be exposed to them.

Response: The potential for adverse health effects from exposure to contaminants which are present at the Site (e.g., BCEE, 1,4-dioxane and manganese) would depend on the concentration of the contaminant and the amount of time an individual is exposed to the contaminant. Exposure to low concentrations of Site contaminants in groundwater could occur without

negative effects on human health. Exposure to higher concentrations of Site contaminants over an extended period of time could pose a health risk. BCEE is a probable human carcinogen. Exposure to high levels of BCEE can cause irritation to the skin, eyes, throat, and lungs. 1,4-dioxane is a likely human carcinogen. Exposure to high levels of 1,4-dioxane could affect the liver and kidneys. Manganese is a naturally occurring substance found in many types of rock, soil, groundwater and food. Exposure to high levels of manganese can affect the nervous system, cause changes in behavior and decrease the ability to learn and remember.

Comment #30: A local citizen commented via e-mail that he felt the composite barrier should be extended over to the Llangollen Green area. As a child, he and a friend witnessed tankers dumping their contents in the landfill area abutting Llangollen Green.

Response: EPA requested clarification from the commenter regarding the location of the Llangollen Green area. The commenter identified the Grantham South Area on a map as the area where he had witnessed tankers emptying their contents. EPA completed construction of a multi-layer landfill cap over the Grantham South Area in 1991 to prevent rainwater from entering the landfill and carrying contaminants downward into groundwater. Additional studies will be performed to evaluate whether the Grantham South Area or the nearby Inert Area may be contributing to groundwater contamination as recommended in EPA's 2015 Five-Year Report for the DS&G Landfill, which is available online at https://semspub.epa.gov/work/03/2179999.pdf.

Comment #31: A local citizen asked via e-mail what EPA's mandate is in requiring Artesian to shut down production wells instead of continuing to operate them when known carcinogens are present in the groundwater.

Response: Artesian installed treatment systems in 2000 to remove BCEE and in 2014 to remove 1,4-dioxane. EPA, DNREC and Delaware's Office of Drinking Water have been carefully monitoring conditions at the Llangollen well field and have not found contaminants in drinking water at levels above drinking water standards or acceptable risk-based concentrations. Therefore, because treatment provided at the Llangollen well field has been reliable and effective in protecting human health, the production wells can continue to be used.

Comment #32: A local citizen asked via e-mail what contaminant levels were found in treated drinking water and where the community could access this data.

Response: Artesian's annual water quality reports are available online and the most recent report for the system that includes the Llangollen well field can be found online at http://www.artesianwater.com/WQR/AWC2015.pdf. As indicated in the most recent report, concentrations of BCEE and 1,4-dioxane in the water supply are well below levels of concern. There are no federal drinking water standards for BCEE and 1,4-dioxane. However, Site-specific risk-based groundwater cleanup standards were developed for these chemicals as discussed in Section 2.7.2 of this ROD Amendment No. 2. Groundwater pumped from the Llangollen well field is being treated prior to distribution so that drinking water meets regulatory and risk-based standards.

Comment #33: A local citizen asked via e-mail if there was a possibility that Artesian will reach a diminishing rate of return in operating the Llangollen well field and renege on treatment.

Response: The Selected Remedy requires treatment to address Site-related COCs at the Llangollen well field. EPA will seek to have the PRPs implement the Selected Remedy which includes treatment to address Site-related COCs.

Comment #34: A local citizen asked via e-mail what contaminants citizens might be exposed to in addition to those discussed in the Proposed Plan and why additional contaminant testing is not part of EPA's Proposed Plan.

Response: All known contaminants of potential concern in groundwater are discussed in the Proposed Plan and the Administrative Record file. The DS&G Remedial Trust is implementing a comprehensive groundwater monitoring program at the Site which has been updated with additional target analytes several times in recent years. As part of the groundwater monitoring plan, the DS&G Remedial Trust has agreed to review and update the analytical program for the DS&G Site every two years in order to ensure the use of appropriate analytical methods for Site samples.

Comment #35: A local citizen asked via e-mail if EPA will wait for citizens to become sick with cancer before responding.

Response: No. There are currently no exposures to Site-related contaminants at levels of concern (i.e., levels that present an excess lifetime cancer risk greater than 1×10^{-4} or a non-cancer HI greater than 1.0). Implementation of the Selected Remedy will prevent potential future exposure to Site-related contaminants at levels of concern and restore groundwater in the Upper Potomac Aquifer within a reasonable time frame.

Comment #36: A local citizen asked via e-mail if the events in Flint, Michigan, will be repeated at the DS&G Site.

Response: No. EPA has addressed the release of contaminants from the DS&G and Army Creek Landfill Sites through a number of response actions discussed in Section 2 of this ROD Amendment No. 2 and will continue to address contamination at the Sites in the future to ensure adequate protection of human health and the environment.

3.1.2 Comments Regarding Artesian Water Company's Operations and Testing

A number of citizens during the public meeting had questions and comments directly for the Artesian Water Company. Those questions and comments raised concerns about observed odors and tastes; whether the Llangollen wells should continue to be operated or be shut down; Artesian's construction activities in the community; and Artesian's groundwater monitoring and treatment systems. Artesian's responses to citizens' questions and comments are recorded in the transcript of the public meeting which is available in the Administrative Record file. A short summary of Artesian's responses to these comments can be found below:

Odor and taste - Should a customer have a concern about drinking water taste or odor, the customer may contact Artesian's Water Quality Department and a representative will visit the residence or business and test the water quality. Inquiries may be made by calling (302) 453-6900 or sent via email to custserv@artesianwater.com.

Shutting down production wells - If there is any sign of trouble within the treatment system, Artesian will shut down the well(s) until a solution is found and implemented. It is Artesian's opinion that it can serve the community by continuing to operating the Llangollen well field which is an integral part of the remedy for the DS&G Site.

Local construction projects - Artesian construction crews will be seen in the community from time to time performing maintenance activities.

Testing frequency - Testing schedules can vary from contaminant to contaminant. Citizens are encouraged to contact Artesian and request a copy of the testing schedule for their public water system.

Artesian's monitoring program - Artesian is doing everything within its power to ensure that contaminants detected by the monitoring system are never released into the water distribution system. Citizens interested in the testing and monitoring programs are encouraged to contact Artisan for details.

3.1.3 Written Comments from DNREC

Comment #1: During the development of the Feasibility Study, DNREC made it clear that it was most interested in a permanent solution to remediate the source(s) of impact to groundwater and an efficient solution to clean up the contaminants that have migrated from source areas to the surrounding aquifer. It is not evident that DNREC's desire for permanence and a shorter remediation time frame was seriously considered.

Response: EPA disagrees with DNREC's characterization. EPA's response to Comment #18 in Section 3.1.1, above, addresses this comment.

Comment #2: The time frame for meeting groundwater RAOs is very unclear in the draft Feasibility Study. Based on the cost opinion in the Feasibility Study, a 30-year time frame is assumed. DNREC recalls the DS&G Remedial Trust stating that any pump-and-treat- style remedy would take between 40 and 60 years to achieve cleanup goals

Response: In response to questions raised by DNREC about the expected time frame for achieving groundwater RAOs, the DS&G Remedial Trust estimated groundwater restoration time frames based on particle tracking simulations with the Site-specific groundwater flow model and the application of a modifying factor based on pore volume exchanges. Based on this approach, which is described in Appendix O of the *Final Feasibility Study – Revision 1*, the estimated time frame for achieving groundwater RAOs is 60 years for the current pumping regime, which includes operation of extraction well PW-1 and the LFExS, and 25 years for the Selected Remedy.

Comment #3: DNREC generally accepts the technical merits of the recommended remedy, but does not support the long time frame necessary for achieving RAOs or the permanence of the proposed remedy.

Response: Please see the responses to Comments #1 and 2 in this section.

Comment #4: DNREC is concerned that changes in sea level and regional pumping may result in an elevated regional water table or changes in regional flow directions, either of which could dramatically affect the proposed remedy. Changes in aquifer withdrawal rates and locations, groundwater elevations, horizontal and vertical hydraulic gradients and groundwater flow directions cannot easily be predicted. However, the success of the recommended remedy is reliant upon continuous control over groundwater elevation and migration.
Response: EPA agrees that the success of the Selected Remedy will depend upon regular performance evaluations of the remedial action and system modifications as necessary to achieve RAOs, as well as communication and coordination among water withdrawers (e.g., Artesian), the parties implementing the Selected Remedy and the regulatory agencies. EPA and DNREC will have a significant role in determining the requirements for performance monitoring and evaluations during remedy design and implementation.

Comment #5: Detection of "new" contaminants of concern can easily cause shutdown (temporary or permanent) of area water supply systems.

Response: EPA's responses to Comments #12 and 34 in Section 3.1.1, above, address this comment.

Comment #6: DNREC believes that the recommended remedy will eventually accomplish goals established by EPA as long as regional hydrogeologic conditions remain essentially unchanged and if intensive operation and maintenance activities continue at the Site. However, another containment and migration control strategy for the DDA and surrounding areas (the same basic remedial approach selected in ROD Amendment No. 1) does not seem efficient or permanent.

Response: EPA agrees that a comprehensive and rigorous O&M plan will be crucial to the performance of the Selected Remedy. The DS&G Remedial Trust has demonstrated its willingness and ability to conduct effective O&M with self-initiated improvements to the operation of the LFExS and extraction well PW-1. Regulatory agency oversight is also an important component of successful remediation outcomes.

ROD Amendment No. 1 included *in-situ* treatment of soil (bioventing) to remove contaminant mass at the DDA, in addition to containment measures, but did not achieve remediation objectives due, in part, to gaps in the CSM. Significant changes have been incorporated into the CSM based on the recent supplemental Site characterization activities. The CSM will continue to be updated as information is generated during remedy implementation and performance evaluations. Continual refinement of the CSM will support remedy optimization efforts, identify potential challenges and assist in assessment of performance metrics to help ensure that the remedy is functioning as intended.

3.1.4 Written Comments from the DS&G Remedial Trust and Golder Associates

A. The following are summaries of the DS&G Remedial Trust comments on the Proposed Plan followed by EPA's responses:

Comment #1: The DS&G Remedial Trust supports EPA's decision to recommend Alternative C, as proposed by the Trust in the *Final Feasibility Study – Revision 1*, as the preferred remedial alternative.

Response to Comment: EPA acknowledges the DS&G Remedial Trust's support for the Selected Remedy.

Comment #2: The DS&G Remedial Trust, while willing to perform the Feasibility Study, is unwilling to perform any remedial action ultimately selected by EPA to address the groundwater in the Upper Potomac Aquifer downgradient of the location of well PW-l without the significant involvement of New Castle County.

Response to Comment: Apportioning liability among the PRPs for the various components of the Selected Remedy is not a component of the remedy selection process prescribed by the Superfund law and its implementing regulations.

Comment #3: In the Proposed Plan, EPA discusses extraction well PW-1, but fails to recognize that the installation of well PW-l and another well (NEW-1) by the County in 2004 was needed to complete the network of extraction wells necessary to create and maintain an effective groundwater divide between the DS&G and Army Creek Landfill Superfund sites and Artesian's Llangollen well field.

Response to Comment: The DS&G Trust's discussion, of a historical nature, is not relevant to current Site conditions which will be addressed by the Selected Remedy. However, the comment contains several factual misunderstandings which EPA addresses as follows. The operation of extraction well PW-1 was not required to maintain a groundwater divide between the Superfund sites and the Llangollen well field. Well PW-1 was installed and operated to circumvent the anticipated need for treatment to remove BCEE from the effluent from the Army Creek Landfill groundwater treatment plant.

Comment #4: In the Proposed Plan, EPA asserts that "the suspension of the County's pumping did not result in new releases of contamination from the Army Creek Landfill waste management area" and "that the BCEE groundwater plume originated at the DDA and not the Army Creek Landfill." EPA cites no technical reports or studies to support those assertions and, as far as the DS&G Remedial Trust is aware, no such studies exist.

Response to Comment: EPA concluded in its Third Five-Year Review Report for the Army Creek Landfill, based on groundwater and stream monitoring data generated during the review period, that the suspension of the County's pumping had not resulted in new releases of contamination from the Army Creek Landfill. The Third Five-Year Review Report for the Army Creek Landfill Superfund Site has been included in the Administrative Record file for the DS&G Site. Groundwater monitoring results and BCEE iso-concentration plots in the *Supplemental Site*

Characterization Report – Revision 2, prepared by Golder Associates on behalf of the DS&G Remedial Trust, provide sufficient evidence that the DS&G Site, and not the Army Creek Landfill Site, is the source of BCEE in groundwater.

Comment #5: Although EPA asserts (at pages 14-15 of the Proposed Plan) that New Castle County agreed to operate the groundwater recovery wells in the Upper Potomac Aquifer to attain primary drinking water standards beyond the Army Creek Landfill property boundary (alleging a discrepancy between the groundwater cleanup goals in the 1988 ROD for the DS&G Site and those goals for the Army Creek Landfill Site), EPA actually excused New Castle County from its Consent Decree obligation in 2009. EPA did so, despite exceedances of the drinking water standard for lead in MW-40, because EPA had concluded that certain constituents detected above applicable standards in the Army Creek Landfill boundary wells (used to define the Army Creek Landfill property boundary) had migrated from the DS&G Site, not the Army Creek Landfill. See EPA's Third Five-Year Review Report for the Army Creek Landfill, at pp. 21- 22 (noting repeated exceedances of the current drinking water standard for lead in MW-40; exceedances of the State's interim advisory levels for BCEE in boundary wells BW-1 and BW-2, and dissolved manganese concentrations [wells BW-1 and BW-2] and iron concentrations [well BW-1] exceeding EPA's health-based standards). See also page 15 of the Proposed Plan where EPA states that "MCLs have been attained at the Army Creek Landfill property boundary." That statement is inconsistent with EPA's Third Five-Year Review Report and the express recognition that lead levels in MW-40 exceeded the current drinking water standard for lead.

Response to Comment: EPA did not excuse the County from its obligations under the Army Creek Landfill Consent Decree. Because the groundwater cleanup levels specified in SOW-2[34] of the 1991 Consent Decree had been achieved at the boundary wells, with the exception of the standard for lead at well MW-40, EPA approved New Castle County's request to terminate SOW-2 on May 4, 2009, with the condition that the County perform additional lead monitoring in groundwater in the vicinity of well MW-40. As documented in the Fourth Five-Year Review Report for the Army Creek Landfill Site, lead levels in groundwater samples collected from MW-40 and nearby wells during the 2009 through 2014 review period were consistently below the 15 µg/L drinking water standard. Therefore, the statement in EPA's 2016 Proposed Plan regarding attainment of MCLs at the Army Creek Landfill is correct.

Groundwater extraction from the Army Creek Landfill recovery wells had already been discontinued in 2004, as discussed in Section 2.2 of this Amendment. Following the shutdown of the Army Creek Landfill well field, the BCEE plume in the Upper Potomac Aquifer shifted eastward as illustrated in Figures 5.1D through 5.1H in the *Supplemental Site Characterization Report – Revision 2*. By 2009, it was apparent that the DS&G Site, and not the Army Creek Landfill Site, was the source of BCEE in the Upper Potomac Aquifer. No stakeholder at either Site suggested that resuming pumping from the Army Creek Landfill well field would be an appropriate response to the groundwater plume originating from the DDA. EPA was concerned that doing so would exacerbate releases from the DDA. In 2010, due to the ongoing release of BCEE, benzene and other contaminants from inadequately controlled source areas at the DS&G Site, EPA provided the DS&G Remedial Trust with the opportunity to conduct additional Site characterization activities and a Feasibility Study. The additional Site characterization work

[34] SOW-2 does not specify groundwater cleanup standards for BCEE, iron or manganese.

performed by the DS&G Remedial Trust identified a persistent secondary source of contamination within the UPCUTZ. The Feasibility Study, which evaluated a range of potential response actions to address the DDA source area and the contaminant plume in the Upper Potomac Aquifer originating from the DDA, including the UPCUTZ, was completed in 2016.

EPA's Third Five-Year Review Report for the Army Creek Landfill Site noted that concentrations of manganese and iron at boundary wells BW-1 and/or BW-2 exceeded EPA health-based standards. Due to observed increases in dissolved iron and, particularly, manganese concentrations in portions of the Upper Potomac Aquifer, EPA's Fourth Five-Year Review Report for the Army Creek Landfill Site recommended an evaluation of the sources, fate and transport of these metals in order to assess the potential for impacts to the Llangollen well field. On September 28, 2017 EPA requested that the Army Creek Landfill PRPs perform additional response actions to address dissolved manganese and other COCs in groundwater caused by releases from the Army Creek Landfill Site. EPA's Third and Fourth Five-Year Review Reports for the Army Creek Landfill Superfund Site have been included in the Administrative Record file for ROD Amendment No. 2.

Comment #6: Under Section III.A.20 of the Army Creek Landfill Consent Decree, the Army Creek Landfill Site is defined to include both the landfill property "and the groundwater affected by the release of hazardous substances from the Army Creek Landfill Superfund Site and/or the Delaware Sand & Gravel Landfill Superfund Site."

Response to Comment: EPA does not dispute this statement; however, it is not relevant to EPA's remedy decision.

Comment #7: As EPA expressly recognized in the 2015 Five-Year Review Report (p. 22) for the DS&G Site, "[t]he groundwater remedy for the Army Creek Landfill and DS&G Landfill sites were combined in order to eliminate redundancies and implemented by New Castle County under the 1991 Army Creek Consent Decree."

Response to Comment: EPA agrees with the statement.

Comment #8: In Appendix E to the 1995 DS&G Consent Decree (describing the remedy and performance standards), EPA referenced the recovery of contaminated groundwater by New Castle County's "5 recovery well system (RW-13, Well-31, RW-12, Well-29, Well-28) currently recovering DS&G contamination" as "among the nine wells which currently comprise the Army Creek/Delaware Sand and Gravel recovery well system." EPA explained that "[p]ursuant to the [Army Creek] Consent Decree entered ... on September 12, 1991 the Army Creek Settlors are operating the recovery well system." EPA stated that "[t]he Army Creek Settlors shall continue to operate the recovery well system as required under the Consent Decree for the Army Creek Landfill. Therefore, [DS&G] Settling Defendants will not be required to operate the recovery well system."

Response to Comment: The 1991 Consent Decree requires the Army Creek Settling Defendants to operate the recovery well system until performance standards are met. The performance standards for operation of the groundwater recovery well system are given in SOW-2 of the 1991 Consent Decree. Section 6.2 in SOW-2 states, "If primary drinking water criteria

(as set out at [sic] in Table A overleaf) are met in the boundary wells at that time, the [groundwater recovery well] system may be phased out in the manner described in § 6.3 hereof." Primary drinking water criteria have been achieved at the boundary wells.

Comment #9: Pursuant to the Army Creek Consent Decree, and as recognized in EPA's 2015 Five-Year Review Report for the DS&G Site (p. 25), "[f]rom 1993 to 2004, in accordance with the Consent Decree for the neighboring Army Creek Landfill Site, New Castle County operated a groundwater collection and treatment system in the Upper Potomac Aquifer to prevent contaminants from the Army Creek Landfill and DS&G Sites from migrating to Artesian's Llangollen well field."

Response to Comment: EPA agrees. This excerpt is from the Five-Year Review Report for the DS&G Site. See EPA's reply to Comment #10, directly below, for a further response.

Comment #10: Despite its Consent Decree obligation to do so, New Castle County failed to create and maintain a groundwater divide between both Superfund sites and Artesian's Llangollen well field. As a result, constituents from both sites have migrated to the Llangollen well field and required treatment by Artesian, the costs for which are included in EPA's Preferred Alternative.

Response to Comment: EPA agrees that New Castle County's operation of the Army Creek Landfill groundwater recovery wells failed to create and maintain a groundwater divide between both Superfund sites and the Llangollen well field, but it was not a requirement of the Consent Decree to create and maintain such a divide. Nonetheless, contaminants have migrated to the Llangollen well field and it became necessary for Artesian to install treatment systems to address BCEE and 1,4-dioxane. However, EPA disagrees that the presence of BCEE and/or 1,4-dioxane at the Llangollen well field is attributable, in part, to releases from Army Creek Landfill; available data do not support such a conclusion. Other factors contributing to the unforeseen impacts at the Llangollen well field were deficiencies in the groundwater monitoring programs at both Sites, a flawed CSM and inadequate source control measures at the DDA. It should be noted that SOW-2 (p. 1) specifies that the Army Creek Landfill groundwater recovery well field is designed to "control groundwater that may contain unacceptably high levels (under drinking water standards) of either organic or inorganic compounds." Federal drinking water standards are not available for BCEE and 1,4-dioxane. However, EPA has determined that concentrations of BCEE and 1,4-dioxane in groundwater at the Llangollen well field exceed acceptable risk-based levels. Site-specific PRGs for these and other groundwater COCs were developed in support of the Feasibility Study and the Selected Remedy includes performance standards for these COCs. As stated by the commenter, the Selected Remedy includes treatment to address Site-specific groundwater COCs, including BCEE and 1,4-dioxane, at the Llangollen well field.

Comment #11: As EPA has recognized in its last two Five-Year Review Reports for the DS&G Site, "[u]nder the 1995 Delaware Sand & Gravel Consent Decree, the DS&G Remedial Trust is not required to implement response actions to address contaminants released from the Site into the groundwater of the Upper Potomac Aquifer." Consistent with this assertion, EPA further stated in the 2015 Five-Year Review Report (p. 37) that "[t]he groundwater remedy [was] implemented at the Delaware Sand & Gravel Site pursuant to the Army Creek Landfill Consent Decree."

Response to Comment: EPA agrees with these statements. However, new information and conditions warranted a reassessment of the appropriate remedial approach taken at the DS&G Site.

Comment #12: In conclusion, the Trust supports EPA's recommendation of Alternative C as the preferred remedial alternative. For the reasons set forth above and supported by Golder's letter enclosed herewith, acknowledgment of the legal obligations of the Army Creek Settlors (including but not limited to New Castle County's historic failure to maintain the groundwater divide) and the contribution of the Army Creek Landfill Site to the groundwater impacts in the commingled plume should be incorporated into the Record of Decision.

Response to Comment: Although EPA expected that the Army Creek Landfill recovery wells would capture contaminants from both Sites and prevent contaminants from reaching the public water supply wells, the 1991 Consent Decree does not require New Castle County to maintain a groundwater divide. Section 2.10 of ROD Amendment No. 2 states that the operation of the Army Creek Landfill recovery wells was not effective in preventing the migration of Site-specific COCs to the Llangollen well field.

B. The following are summaries of Golder Associates' comments on the Proposed Plan followed by EPA's responses:

Comment #1: The foundation for any proposed remedy is the CSM. The Proposed Plan does not reference the CSM presented in the *Final Feasibility Study – Revision 1* and instead only references the analytical results and evaluations presented in the *Supplemental Site Characterization Report - Revision 2*.

Response to Comment: EPA agrees and has included a description of the CSM in this ROD Amendment No. 2.

Comment #2: The information included in the Proposed Plan does not provide the public with an understanding of the contribution from the Army Creek Landfill to the constituents in groundwater for which the remedial action will be designed and implemented. Acknowledgement of the Army Creek Landfill's contribution to the groundwater impacts between the two sites should be incorporated into this ROD Amendment No. 2.

Response to Comment: Sections 2.5.3 and 2.5.4 of this Amendment discuss the Army Creek Landfill's contribution to elevated concentrations of contaminants, including 1,2-dichloroethane and dissolved metals (primarily cobalt, iron and manganese), in groundwater within the Upper Potomac Aquifer.

Comment #3: The Proposed Plan does not acknowledge that the Army Creek Landfill represents a source of groundwater impacts to the Area of Attainment that exceed the Site-specific groundwater PRGs. This acknowledgement is significant to the remedy and the ROD because one of the RAOs for groundwater is to meet the groundwater PRGs within the Area of Attainment. Instead, the Proposed Plan indicates as follows:

- "[S]uspension of pumping at the Army Creek Landfill well field did not result in new releases of contamination from the Army Creek Landfill waste management area."
- "MCLs have been attained at the Army Creek Landfill property boundary."

However, based upon review of the current and historical data for the Sites, the suspension of pumping from the Army Creek Landfill groundwater recovery well system in 2004 resulted in increasing concentrations of constituents in groundwater downgradient of the Army Creek Landfill, between the Army Creek Landfill and Artesian's Llangollen well field. Groundwater quality data presented in the *Supplemental Site Characterization Report - Revision 2* support this observation (e.g., Figure 5.5C for 1,2-dichloroethane and Figures 5.8A through 5.8E for manganese).

Furthermore, based on increasing concentrations of the metals downgradient of the two Superfund Sites, EPA recommended in its Fourth Five-Year Review Report for the Army Creek Landfill Superfund Site an evaluation of the sources, fate, and transport of dissolved iron and manganese in the Upper Potomac Aquifer, in order to assess the potential for impacts to Artesian Water Company's Llangollen well field.

In addition, EPA stated in its December 19, 2014 comments on a submission from the DS&G Remedial Trust that the Army Creek Landfill is a source of 1,2-dichloroethane, iron and manganese in groundwater of the Upper Potomac Aquifer and that elevated levels of arsenic and cobalt in groundwater appear to be related to the Army Creek Landfill site.

Acknowledgement of the Army Creek Landfill's contribution to the groundwater impacts between the two sites should be incorporated into EPA's Amendment to the ROD.

Response to Comment: EPA acknowledges, and ROD Amendment No. 2 reflects, that elevated concentrations of dissolved metals, particularly iron, manganese and cobalt, within a portion of the Area of Attainment are due, in part, to redox conditions in the Upper Potomac Aquifer caused by releases from the Army Creek Landfill. Releases from the DS&G Site are also contributing to reducing conditions and elevated levels of redox-sensitive metals in groundwater. The extent to which each Site is contributing to elevated metals concentrations in specific areas of the Upper Potomac Aquifer, including elevated manganese concentrations between the Grantham South Area and monitoring wells BW-1 and MW-26N, has not been established. However, observed increasing manganese concentrations along the central axis of the organic COC plume emanating from the DDA (at monitoring wells UPA-02D, MW-26N and AWC-E2) suggest a correlation between releases from the DS&G Site and elevated dissolved manganese concentrations at these monitoring locations. This ROD Amendment also identifies the Army Creek Landfill as a source of 1,2-dichloroethane in groundwater.

Comment #4: The Proposed Plan states that MCLs have been attained at the Army Creek Landfill property boundary. However, it does not acknowledge that MCLs represent a limited set of drinking water standards, and the Army Creek Landfill monitoring program historically did not include analysis for 1,4-dioxane and cobalt which are COCs in groundwater between the two Superfund sites. These differences underscore the inconsistent cleanup goals and monitoring programs applied by the EPA at these two adjacent Superfund sites. More specifically:

- For the Army Creek Landfill, primary drinking water standards (MCLs) for a limited set of constituents were established as performance goals for groundwater at the four wells identified by EPA as boundary wells. These wells are located between 800 and 1,800 feet downgradient of the landfill boundary, and two of these wells are located within the Area of Attainment for the DS&G Site.
- For the adjacent DS&G Site, based on the EPA's direction, the DS&G Remedial Trust has developed risk-based groundwater PRGs for a broader suite of constituents as performance goals for groundwater in the Upper Potomac Aquifer beyond the Waste Management Area (throughout the Area of Attainment). These goals must be attained at the landfill boundary and in all wells in the Upper Potomac Aquifer within the Area of Attainment, which is also downgradient of the Army Creek Landfill.

The groundwater PRGs for the DS&G Site are generally lower (i.e., more conservative) than MCLs, and there are several constituents with established PRGs at the DS&G Site for which there are no equivalent performance goals for the Army Creek Landfill (e.g., BCEE, 1,4-dioxane, manganese, iron, and cobalt). However, as acknowledged by EPA, the Army Creek Landfill represents a source of many of these constituents to the Upper Potomac Aquifer, and EPA has requested that a plume stability analysis for iron, manganese and cobalt be prepared for the Army Creek Landfill.

The Proposed Plan does not fully evaluate groundwater impacts downgradient of the Army Creek Landfill relative to risk-based standards. EPA's lack of acknowledgement of constituents from the Army Creek Landfill within the Area of Attainment could undermine the long-term achievability of the cleanup goals within the Area of Attainment. A framework for resolving the issue of the area of combined constituent mass (i.e., the area downgradient from both sites where groundwater from both sites is commingled) should be incorporated into EPA's Amendment to the ROD.

Response to Comment: Most of the available evidence points to the DS&G Site as the source of BCEE and 1,4-dioxane impacts in the Upper Potomac Aquifer (see, for example, Figures 5.1A through 5.2E of the *Supplemental Site Characterization Report - Revision 2*). Based on groundwater monitoring results depicted in figure groups 4 and 5 in the *Supplemental Site Characterization Report - Revision 2* and groundwater monitoring reports submitted by New Castle County, EPA considers the Army Creek Landfill to be a source of 1,2-dichloroethane, manganese, iron, arsenic and cobalt in the Upper Potomac Aquifer. EPA acknowledges the discrepancy between the regulatory based groundwater cleanup standards established for the Army Creek Landfill Site in the 1991 Consent Decree and the risk- and health-based groundwater cleanup standards established for the DS&G Site in this ROD Amendment No. 2. EPA has notified the Army Creek Landfill PRPs of the need for additional response actions to evaluate the nature and extent of these impacts and potential remedial alternatives to address groundwater contamination downgradient of the western lobe of the Army Creek Landfill. EPA anticipates modifying the remedy at the Army Creek Landfill Site, including the list of groundwater COCs and groundwater cleanup standards, as necessary to ensure adequate protection of human health and the environment.

As discussed in Section 2.5.3 of this Amendment, elevated concentrations of dissolved metals, particularly iron, manganese, arsenic and cobalt, in groundwater within a portion of the Upper

Potomac Aquifer are due to redox conditions in the aquifer caused by releases from both DS&G and the Army Creek Landfill. The Selected Remedy includes the installation and operation of groundwater recovery wells to optimize the capture and removal of contaminants from the Upper Potomac Aquifer. EPA anticipates that the recovery wells will need to be operated for some time after cleanup standards have been met for the organic groundwater COCs in order to prevent organic contaminant mass beneath the Waste Management Area from migrating downgradient. As the milestone for shutting down the groundwater recovery wells approaches, EPA may consider whether monitored natural attenuation (MNA) would be a viable cleanup approach for any dissolved metals present within the Area of Attainment at concentrations exceeding the cleanup level.

MNA for inorganic contaminants, when appropriately implemented, can help to restore an aquifer to beneficial uses by immobilizing contaminants onto aquifer solids and providing attenuation of contaminants in groundwater. MNA would not be an appropriate response action, however, in cases where the dissolved metals plume is expanding. However, it may be appropriate as a finishing step when it can achieve RAOs within a reasonable time frame, there is documented geochemical evidence of attenuation and the source of contaminants has been identified and addressed.

Comment #5: The Proposed Plan presents the Area of Attainment from the *Final Feasibility Study – Revision 1* without acknowledging that there are conflicting lines of evidence regarding the potential source of impacts in the western portion of the Area of Attainment. Wells BW-1 and BW-2 (two of the four boundary wells used by EPA to assess compliance for the Army Creek Landfill Site) are located downgradient of the eastern lobe of the Army Creek Landfill, are screened in the Upper Potomac Aquifer lower sand and are within the commingled plume that exists within the Area of Attainment.

As presented to and discussed with EPA in January 2015, reverse particle tracking simulations from Tetra Tech's numerical flow model (Tetra Tech, 2015) indicate that the source of constituents, including 1,4-dioxane, in the well BW-2 area is the eastern lobe of the Army Creek Landfill. Further discussion of this point is provided in Section 3.3.4 of the *Final Feasibility Study – Revision 1*. Section 3.3.3 of the *Final Feasibility Study – Revision 1* also identifies the Army Creek Landfill as a source manganese mass in the Area of Attainment. Furthermore, monitoring wells MW-28, MW-29, and MW-31, immediately downgradient of the Army Creek Landfill, consistently have manganese in excess of the PRG for manganese in groundwater at the DS&G Site.

Response to Comment: The Proposed Plan did not identify the Army Creek Landfill as a potential source of 1,4-dioxane in the Upper Potomac Aquifer in the well BW-2 area because the lines of evidence presented to EPA suggesting the Army Creek Landfill as a potential source of impacts at BW-2 have not been adequately developed and, as they stand, are insufficient to name the Army Creek Landfill as a source. As discussed in Appendix N of the *Final Feasibility Study – Revision 1*, and Section 2.12.2 of this Amendment, pre-design investigations will be conducted to address data gaps and areas of uncertainty, including the south and southwest extent of contamination in the UPCUTZ originating from the DDA and the source(s) of groundwater impacts at wells P-6, MW-18, MW-34, BW-2 and MW-26N. If the Army Creek Landfill is

found to be a source of 1,4-dioxane in the Upper Potomac Aquifer, EPA will modify the list of groundwater COCs for that site as appropriate.

Manganese concentrations at monitoring wells MW-28, MW-29, and MW-31, immediately downgradient of the Army Creek Landfill have generally remained between 1 and 1.5 mg/L since shutdown of the Army Creek Landfill recovery wells in 2004. EPA has concerns about the accuracy of the analysis of the "area of combined impacts" presented in Golder Associates' 2014 *Memorandum on Preliminary Cleanup Goals*. That analysis appears to be based on the unsubstantiated premise that elevated manganese concentrations between the eastern lobe of the Army Creek Landfill and monitoring well MW-26N are attributable to releases from the Army Creek Landfill Site rather than from the Grantham South Area or the DDA. An effort should be made to determine if the Army Creek Landfill is contributing to increasing manganese concentrations at and downgradient of monitoring well MW-26N.

Comment #6: The following are examples of constituents at concentrations that exceed MCLs at locations downgradient of the Army Creek Landfill Site:

- 1,2-dichloroethane and tetrachloroethylene (PCE) have been detected at concentrations in groundwater above MCLs at off-property wells P-4 and MW-22N, respectively.
- Lead has been detected above MCLs at well MW-40 which is one of the four wells identified by EPA as the boundary wells for the Army Creek Landfill Site.

In addition, other groundwater constituents (e.g., 1,4-dioxane, BCEE, manganese, iron, and cobalt) for which there are no primary drinking water standards are also present in groundwater downgradient of the Army Creek Landfill Site. For example:

- 1,4-dioxane has been detected above the DS&G Site groundwater PRG of 7.8 µg/L at BW-2 (110 µg/l in April 2016).
- Manganese has been detected above the DS&G Site groundwater PRG of 190 µg/L at most ACL monitoring wells, including April 2016 results from wells BW-2 (1,500 µg/l), MW-28 (958 µg/L) and MW-29 (954 µg/L).
- Cobalt has been detected above the DS&G Site groundwater PRG of 6 µg/L at most Army Creek Landfill monitoring wells, including April 2016 results from wells BW-2 (16.7 µg/l) and MW-28 (38.5 µg/L).

These examples of results from wells MW-28 and MW-29 indicate the Army Creek Landfill Site is contributing groundwater at concentrations above DS&G Site groundwater PRGs to the area of combined constituent mass (including, but not limited to the well BW-2 area) which includes portions of the DS&G Area of Attainment.

Response to Comment: 1,2-dichloroethane concentrations have cycled up and down at well P-4, in tandem with dissolved metals concentrations. Concentrations of 1,2-dichloroethane at well P-4 were below the 5 µg/L MCL from October 2009 through October 2012; from March 2013 through October 2015, concentrations ranged from 19 µg/L to 6.7 µg/L. The dissolved manganese concentration at P-4 rose to 3.2 mg/L in March 2016 and EPA has requested that the Army Creek Landfill PRPs perform additional response actions to address this concern. At well MW-22N, there were two minor exceedances of the 5 µg/L MCL for PCE between April 2006

and October 2015: 5.1 µg/L PCE was detected in the April 2012 groundwater sample and 5.4 µg/L PCE was detected in the October 2014 groundwater sample. The presence of PCE at well MW-22N warrants continued monitoring. Lead concentrations in groundwater samples collected from well MW-40 were consistently below the 0.015 mg/L action level for lead in public water systems from October 2009 through April 2013 when monitoring for lead was discontinued with EPA approval.

Evidence implicating the Army Creek Landfill as a source of 1,4-dioxane at well BW-2 is insufficient; pre-design studies are planned to further evaluate potential sources of 1,4-dioxane at this well. EPA's Fourth Five-Year Review Report for the Army Creek Landfill Superfund Site recognized manganese and other dissolved metals in the Upper Potomac Aquifer associated with the Army Creek Landfill Site and recommended an evaluation of the stability of the metals plume. On September 28, 2017, EPA requested that the Army Creek Landfill PRPs perform additional response actions to address dissolved manganese and other COCs in the groundwater of the Upper Potomac Aquifer caused by releases from the Army Creek Landfill Site. Additional investigation is recommended to evaluate the extent to which the Army Creek Landfill and other potential sources are contributing to increasing manganese concentrations in the area of monitoring well MW-26N; other potential sources of the expanding manganese plume include the Grantham South Area and the DDA.

Comment #7: There are significant differences between the monitoring well networks associated with the Army Creek Landfill Site and the DS&G Site. These differences complicate any comparison of the groundwater conditions downgradient of the sites. As documented in the DS&G Remedial Trust's August 15, 2016 Technical Memorandum, entitled "Response to Manganese Assessment by CDM Smith," it is important to recognize that the DS&G monitoring well network is much more extensive both vertically and horizontally which biases a comparison of the groundwater conditions downgradient of the sites. The following is excerpted from DS&G Remedial Trust's Technical Memorandum:

- Horizontally, both parallel and perpendicular to groundwater flow from the Army Creek Landfill, the Army Creek Landfill monitoring well network is very widely spaced; therefore, the monitoring network inadequately characterizes the groundwater flow direction and leachate plume extent.
- Vertically, there are no monitoring wells screened in the Columbia Aquifer or the UPCUTZ, either within, adjacent to or downgradient of the Army Creek Landfill.
- Most of the existing Upper Potomac Aquifer wells in the Army Creek Landfill monitoring well network have long screen intervals and are screened across both the upper and lower sand of the Upper Potomac Aquifer. There are only two wells screened solely in the Upper Potomac Aquifer upper sand in proximity to the Army Creek Landfill: wells P-4 and RW-10 (a former large diameter extraction well). Some of the highest manganese concentrations measured downgradient of the Army Creek Landfill are from well P-4 (which has a 10- foot well screen), potentially demonstrating the bias in the samples from the wells with long screen intervals.
- In comparison to the monitoring network and available data set for the DS&G Site, there is very little Upper Potomac Aquifer monitoring data associated with the Army Creek Landfill Site. Golder also notes that the Army Creek Landfill Site is much larger in aerial

extent than the DS&G Site, resulting in an even lower density of monitoring for the Army Creek Landfill Site as compared to the DS&G Site.

The differences between the monitoring networks for the Army Creek Landfill and the DS&G Site biases a comparison of the downgradient impacts of the two Superfund sites, especially as it relates to the ability to support EPA's conclusions regarding the Army Creek Landfill's contribution to the groundwater impacts between the two sites.

Response to Comment: EPA agrees that there is a need for additional wells to monitor groundwater downgradient of the Army Creek Landfill Site. However, there are sufficient data to show that the DS&G Site is the source of contamination driving the need for additional response actions within the Area of Attainment.

Comment #8: The CSM upon which the proposed remedial action is based includes contribution of inorganics (manganese, iron and cobalt) as well as organic compounds from the adjacent Army Creek Landfill Site. While Golder indicates in the *Final Feasibility Study – Revision 1* that the source to certain areas downgradient of the eastern lobe of the Army Creek Landfill remains under evaluation, the extraction well network included in the proposed remedial action was developed by the Trust, at the request of EPA, to capture impacts from the DS&G Site as well as the area of combined impacts located between the DS&G Site and the eastern lobe of the Army Creek Landfill. As stated in Section 3.3.4 of the *Final Feasibility Study – Revision 1*, "it is anticipated that the remedy would be the same whether the source [of 1,4-dioxane at well BW-2] was from the DS&G Site or the [Army Creek Landfill Site], since the potential source areas are capped, the impacts are already in the [Upper Potomac Aquifer], and there are limited remedial options for 1,4-dioxane." Acknowledgement that the remedy will capture groundwater impacts from the DS&G Site as well as from the eastern lobe of the Army Creek Landfill Site should be incorporated into EPA's Amendment to the ROD.

Response to Comment: EPA has not determined that the Army Creek Landfill is contributing to increasing manganese concentrations in the well MW-26N area. Additional investigations are to be performed to further define groundwater impacts from the Army Creek Landfill Site and also to develop suitable response actions for groundwater downgradient of the western lobe of Army Creek Landfill Site.

Comment #9: The Proposed Plan includes several statements that seem to indicate that the constituents in groundwater at the DDA and within the Upper Potomac Aquifer are associated with the potential for exposure to contaminants in indoor air. To avoid confusion, it should be acknowledged that the potential for landfill gas migration and vapor intrusion is only a potential issue for indoor air in existing buildings and potential future buildings immediately adjacent to the Inert Area and the Grantham South Area via the Columbia Aquifer.

Response to Comment: EPA has included language in this ROD Amendment No. 2 to clarify that vapor intrusion is a potential issue for indoor air in existing buildings and potential future buildings immediately adjacent to the Inert Area and the Grantham South Area which is associated with the migration of landfill gas in the vadose zone rather than contaminants in groundwater. Please also see EPA's response to Comment #16 in Section 3.1.1, above.

Comment #10: The DS&G Remedial Trust has been performing tiered monitoring of landfill gas at and in the vicinity of the Inert Area and Grantham South Area on a quarterly basis since 1997. As documented in the quarterly monitoring reports, landfill gas concentrations measured in structures adjacent to the landfills have not exceeded one percent of the lower explosive limit.

Response to Comment: EPA acknowledges this statement.

Comment #11: The DS&G Remedial Trust assessed the potential for migration of landfill gas from the Inert Area and the Grantham South Area. Based on this assessment, there is limited landfill gas migration in the immediate vicinity of the Inert Area and Grantham South that has the potential to affect two buildings. To address this issue, the DS&G Remedial Trust is designing and will install a soil vapor extraction system. The potential for landfill gas migration to other buildings is not anticipated.

Response to Comment: Information regarding the DS&G Remedial Trust's installation of a landfill gas mitigation system has been added to Section 2 of this ROD Amendment No. 2.

Comment #12: Golder has provided documents for addition to the Administrative Record.

Response to Comment: EPA has included these documents in the Administrative Record.

3.1.5 Comments Submitted by the DS&G Remedial Trust and the Government of New Castle County, Delaware ("New Castle County") After the Close of the October 7, 2016 Public Comment Period

New Castle County submitted two sets of comments and the DS&G Remedial Trust submitted one set of comments after the Public Comment Period which closed on October 7, 2106. The NCP, 40 C.F.R. 300.825(c), requires EPA to consider comments submitted after the close of the public comment period, only to the extent that such comments contain significant information not contained elsewhere in the Administrative Record file and such comments could not have been submitted during the public comment period and substantially support the need to significantly alter the response action. The NCP also requires that all comments that meet these criteria, and all responses thereto, be placed in the Administrative Record file.

EPA has reviewed the comments submitted by New Castle County and the DS&G Trust after the close of the public comment period and has determined, among other things, that they do not support the need to significantly alter the response action. Accordingly, EPA is not required to respond to the comments or include them in the Administrative Record file for the ROD Amendment No.2. Nevertheless, EPA is hereby, in its discretion, including the comments in the Administrative Record file and providing a short written response by way of feedback.

Response #1: In their respective comments, New Castle County and the DS&G Trust contend that the other is liable under CERCLA to implement some, or all, of ROD Amendment No. 2. The remedy selection process prescribed in CERCLA and the NCP does not require EPA to evaluate the liability of PRPs to implement a remedy, such as the Selected Remedy in this ROD Amendment No. 2. As such, the DS&G Remedial Trust and New Castle County's comments in this regard are irrelevant to the selection of the response action.

Response #2: In its September 17, 2017 comments, New Castle County contends that the long-term cost estimate of Alternative C was significantly understated, and that EPA should therefore reassess the remedial alternatives. Specifically, New Castle County contends that EPA's estimate of the present worth cost of Alternative C is based on a discount rate, which was changed by the Office of Management and Budget after the Proposed Plan was issued. As a result, the $42,300,000 estimate in the Proposed Plan to implement Alternative C using the old discount rate could exceed $60,000,000 using the new discount rate. EPA should therefore consider selecting Alternative B because of uncertainties regarding restoring the groundwater to "beneficial use."

EPA disagrees. Based on *A Guide to Developing and Documenting Cost Estimating During the Feasibility Study* (EPA 540-R-00-002, July 2000), EPA is correctly applying the 7 percent discount rate recited in the Proposed Plan. Accordingly, the present worth cost of Alternative C is $46,100,000 as described in Section 2.9 of this Amendment. Regardless of which discount rate applies, all of the requirements of Alternative C are necessary to restore the groundwater to its "beneficial use" and, therefore, protect human health and the environment.

FIGURES

REFERENCE

1.) BASE MAP TAKEN FROM U.S.G.S. 7.5 MINUTE QUADRANGLE OF WILMINGTON SOUTH, DELAWARE, DATED 1993.

2000 0 2000
SCALE FEET

Source: Supplemental Site Characterization - Revision 2, Golder Associated, Inc., 2016

FILE No.

PROJECT No.

TITLE

SITE LOCATION MAP

DELAWARE SAND AND GRAVEL SUPERFUND SITE

FIGURE 1

Drawing file: 013605Z006.dwg Dec 09, 2015 - 10:21am

AR319344

Path: V:\001 GIS Projects\GIS DS&G\Reports\2013\SSC Report Figs\FIGURE 1.2.mxd

REFERENCES

Base Imagery taken from United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP), 2008.

Spatial Reference:
NAD 1983 HARN StatePlane Delaware FIPS 0700

N

0 350 700 1,400 Feet

1 inch = 700 feet

FIGURE 2

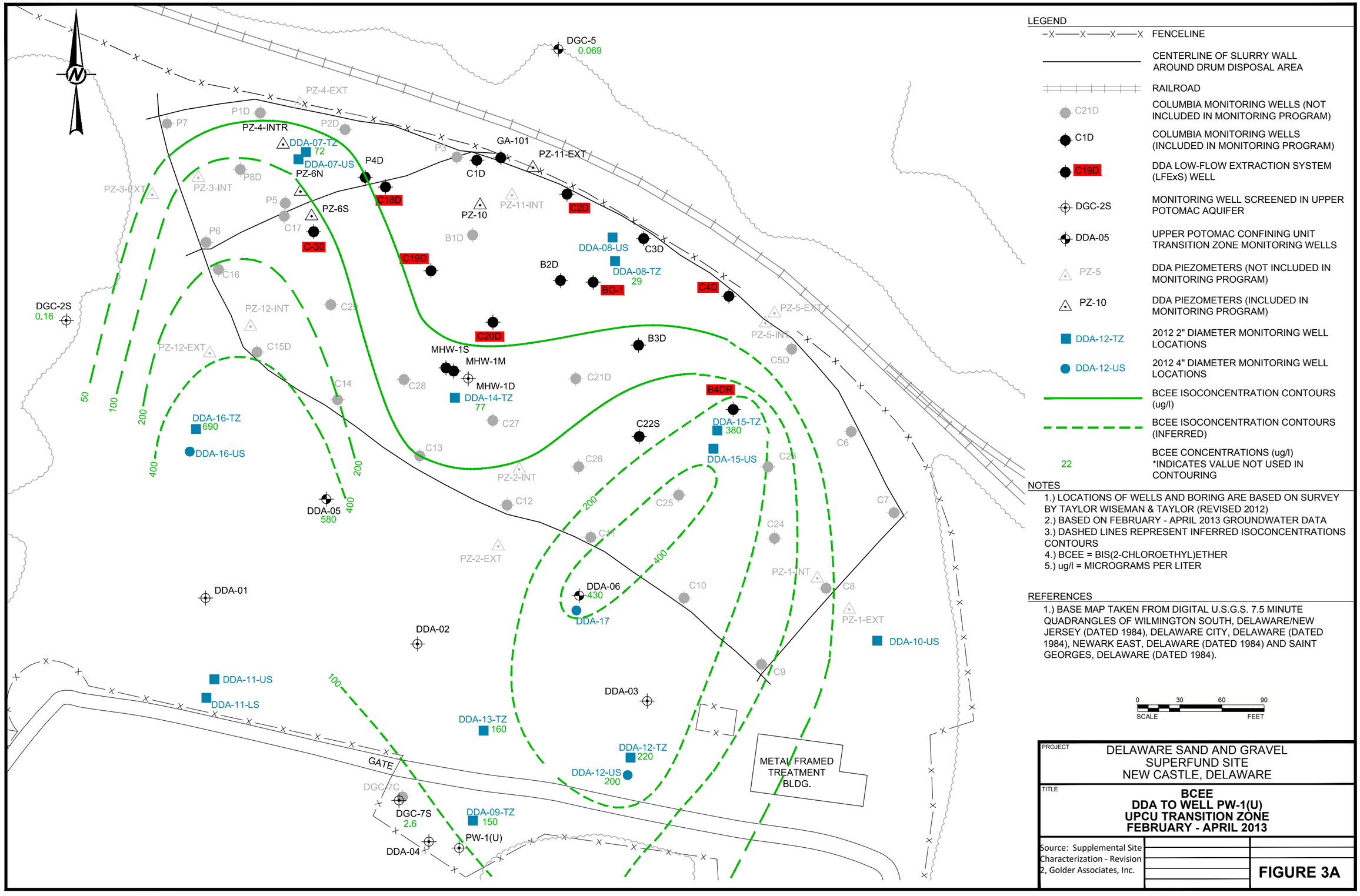
TITLE

GENERAL SITE LAYOUT

PROJECT

Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016



LEGEND

FENCELINE	
CENTERLINE OF SLURRY WALL AROUND DRUM DISPOSAL AREA	
RAILROAD	
C21D	COLUMBIA MONITORING WELLS (NOT INCLUDED IN MONITORING PROGRAM)
C1D	COLUMBIA MONITORING WELLS (INCLUDED IN MONITORING PROGRAM)
C19D	DDA LOW-FLOW EXTRACTION SYSTEM (LFExS) WELL
DGC-2S	MONITORING WELL SCREENED IN UPPER POTOMAC AQUIFER
DDA-05	UPPER POTOMAC CONFINING UNIT TRANSITION ZONE MONITORING WELLS
PZ-5	DDA PIEZOMETERS (NOT INCLUDED IN MONITORING PROGRAM)
PZ-10	DDA PIEZOMETERS (INCLUDED IN MONITORING PROGRAM)
DDA-12-TZ	2012 2" DIAMETER MONITORING WELL LOCATIONS
DDA-12-US	2012 4" DIAMETER MONITORING WELL LOCATIONS
	BCEE ISOCONCENTRATION CONTOURS (ug/l)
	BCEE ISOCONCENTRATION CONTOURS (INFERRED)
22	BCEE CONCENTRATIONS (ug/l) *INDICATES VALUE NOT USED IN CONTOURING

NOTES

1.) LOCATIONS OF WELLS AND BORING ARE BASED ON SURVEY BY TAYLOR WISEMAN & TAYLOR (REVISED 2012)
2.) BASED ON FEBRUARY - APRIL 2013 GROUNDWATER DATA
3.) DASHED LINES REPRESENT INFERRED ISOCONCENTRATIONS CONTOURS
4.) BCEE = BIS(2-CHLOROETHYL)ETHER
5.) ug/l = MICROGRAMS PER LITER

REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL U.S.G.S. 7.5 MINUTE QUADRANGLES OF WILMINGTON SOUTH, DELAWARE/NEW JERSEY (DATED 1984), DELAWARE CITY, DELAWARE (DATED 1984), NEWARK EAST, DELAWARE (DATED 1984) AND SAINT GEORGES, DELAWARE (DATED 1984).

0 30 60 90
SCALE FEET

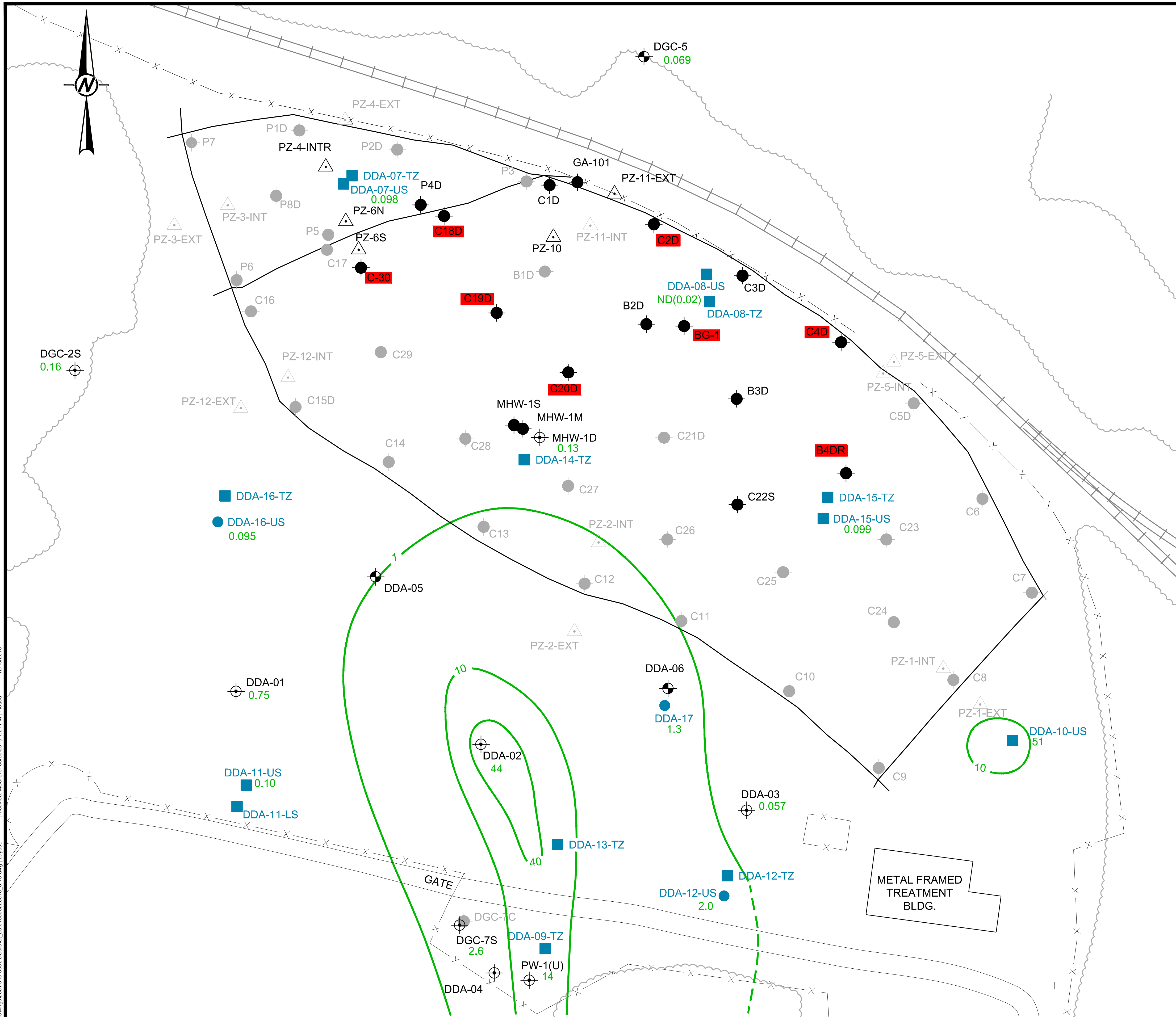
PROJECT
DELAWARE SAND AND GRAVEL
SUPERFUND SITE
NEW CASTLE, DELAWARE

TITLE
BCEE
DDA TO WELL PW-1(U)
UPCU TRANSITION ZONE
FEBRUARY - APRIL 2013

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc.

FIGURE 3A

AR319346



LEGEND

-X—X—X—X	FENCELINE
	CENTERLINE OF SLURRY WALL AROUND DRUM DISPOSAL AREA
	RAILROAD
C21D	COLUMBIA MONITORING WELLS (NOT INCLUDED IN MONITORING PROGRAM)
C1D	COLUMBIA MONITORING WELLS (INCLUDED IN MONITORING PROGRAM)
C19D	DDA LOW-FLOW EXTRACTION SYSTEM (LFExS) WELL
DGC-2S	MONITORING WELL SCREENED IN UPPER POTOMAC AQUIFER
DDA-05	UPPER POTOMAC CONFINING UNIT TRANSITION ZONE MONITORING WELLS
PZ-5	DDA PIEZOMETERS (NOT INCLUDED IN MONITORING PROGRAM)
PZ-10	DDA PIEZOMETERS (INCLUDED IN MONITORING PROGRAM)
DDA-12-TZ	2012 2" DIAMETER MONITORING WELL LOCATIONS
DDA-12-US	2012 4" DIAMETER MONITORING WELL LOCATIONS
	BCEE ISOCONCENTRATION CONTOURS (ug/l)
	BCEE ISOCONCENTRATION CONTOURS (INFERRED)
22	BCEE CONCENTRATIONS (ug/l) *INDICATES VALUE NOT USED IN CONTOURING

NOTES

1.) LOCATIONS OF WELLS AND BORING ARE BASED ON SURVEY BY TAYLOR WISEMAN & TAYLOR (REVISED 2012)
2.) BASED ON FEBRUARY - APRIL 2013 GROUNDWATER DATA
3.) DASHED LINES REPRESENT INFERRED ISOCONCENTRATIONS CONTOURS
4.) BCEE = BIS(2-CHLOROETHYL)ETHER
5.) ug/l = MICROGRAMS PER LITER

REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL U.S.G.S. 7.5 MINUTE QUADRANGLES OF WILMINGTON SOUTH, DELAWARE/NEW JERSEY (DATED 1984), DELAWARE CITY, DELAWARE (DATED 1984), NEWARK EAST, DELAWARE (DATED 1984) AND SAINT GEORGES, DELAWARE (DATED 1984).

0 30 60 90
SCALE FEET

PROJECT
DELAWARE SAND AND GRAVEL SUPERFUND SITE
NEW CASTLE, DELAWARE

TITLE
BCEE
DDA TO WELL PW-1(U) - UPA
FEBRUARY - APRIL 2013

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

FIGURE 3B

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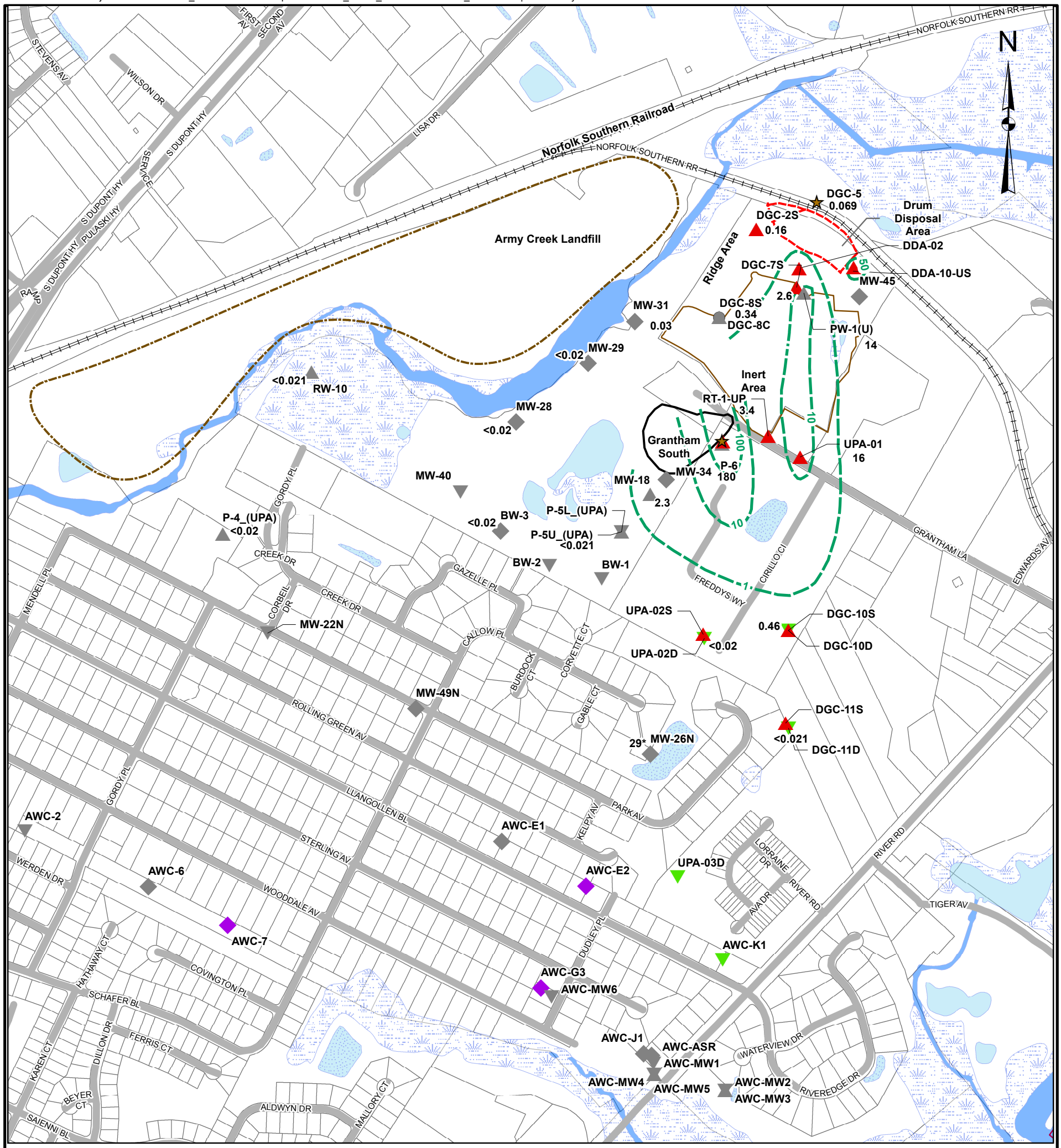

LEGEND

- Well screened in UPCU Transition Zone included in the current monitoring program
- Well screened in UPA Upper Sand included in the current monitoring program
- Well screened in UPA Upper Sand not included in the current monitoring program
- Well screened in UPA Lower Sand included in the current monitoring program
- Well screened in UPA Lower Sand not included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand not included in the current monitoring program
- Well screened in Columbia Aquifer included in the current monitoring program
- Well screened in Columbia Aquifer not included in the current monitoring program
- BCEE Isoconcentration Contour (Inferred)
- 14 - BCEE Concentrations (ug/L)

BCEE = BIS(2-CHLOROETHYL)ETHER
ug/L = Micrograms per Liter
* Indicated data not used for contouring

Notes:
1) Isoconcentration contours are approximate and should not be interpreted as exact indicators of groundwater quality at locations between wells.

2) Contours shown are based on available data interpreted through professional judgment in the context of groundwater flow direction and the conceptual site model for the area at and between the Delaware Sand & Gravel and Army Creek Landfill Superfund Sites.

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

0 300 600 1,200 Feet

FIGURE 3C

TITLE

BCEE
UPA UPPER SAND
DOWNGRADIENT OF WELL PW-1(U)
MARCH - APRIL 2013

PROJECT

Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

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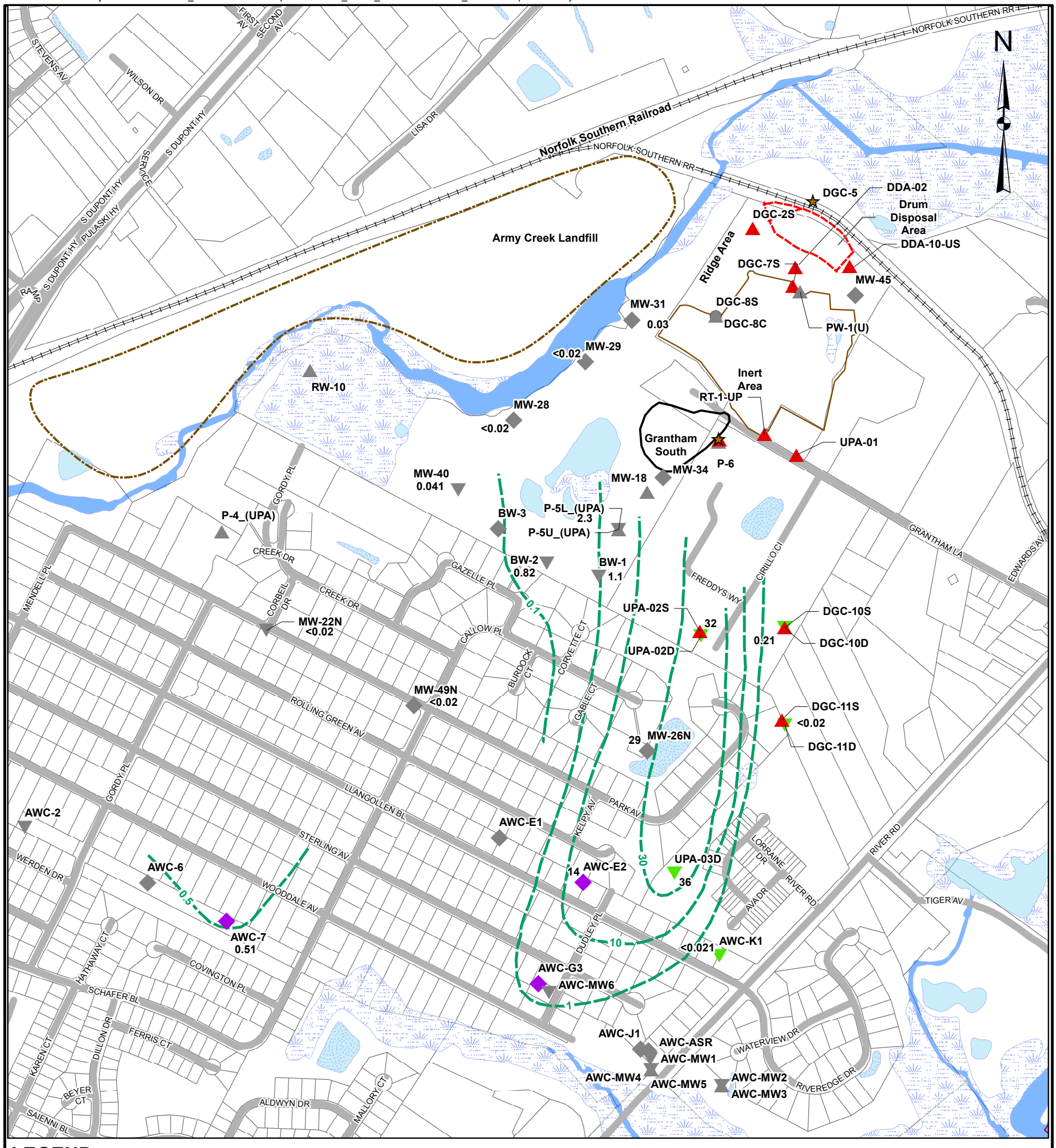


LEGEND

- Well screened in UPCU Transition Zone included in the current monitoring program
- Well screened in UPA Upper Sand included in the current monitoring program
- Well screened in UPA Upper Sand not included in the current monitoring program
- Well screened in UPA Lower Sand included in the current monitoring program
- Well screened in UPA Lower Sand not included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand not included in the current monitoring program
- Well screened in Columbia Aquifer included in the current monitoring program
- Well screened in Columbia Aquifer not included in the current monitoring program
- BCEE Isoconcentration Contour (Inferred)
- **14** - BCEE Concentrations (ug/L)

BCEE = BIS(2-CHLOROETHYL)ETHER
ug/L = Micrograms per Liter

Notes:
1) Isoconcentration contours are approximate and should not be interpreted as exact indicators of groundwater quality at locations between wells.

2) Contours shown are based on available data interpreted through professional judgment in the context of groundwater flow direction and the conceptual site model for the area at and between the Delaware Sand & Gravel and Army Creek Landfill Superfund Sites.

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

0 300 600 1,200 Feet

FIGURE 3D

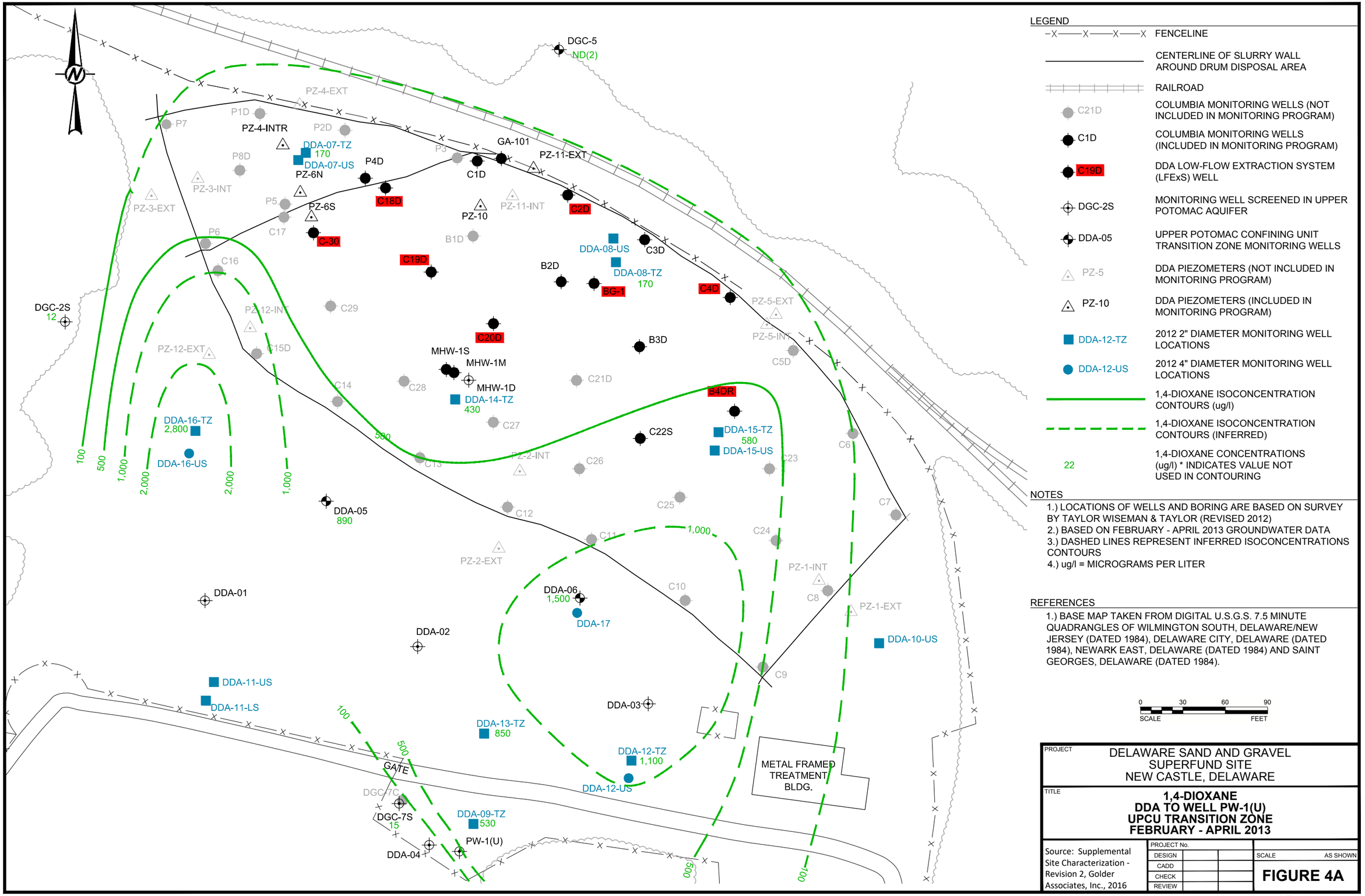
TITLE

BCEE
UPA LOWER SAND
DOWNGRADIENT OF WELL PW-1U
MARCH - APRIL 2013

PROJECT

Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016



LEGEND

- FENCELINE
- CENTERLINE OF SLURRY WALL AROUND DRUM DISPOSAL AREA
- RAILROAD
- C21D — COLUMBIA MONITORING WELLS (NOT INCLUDED IN MONITORING PROGRAM)
- C1D — COLUMBIA MONITORING WELLS (INCLUDED IN MONITORING PROGRAM)
- C19D — DDA LOW-FLOW EXTRACTION SYSTEM (LFExS) WELL
- DGC-2S — MONITORING WELL SCREENED IN UPPER POTOMAC AQUIFER
- DDA-05 — UPPER POTOMAC CONFINING UNIT TRANSITION ZONE MONITORING WELLS
- PZ-5 — DDA PIEZOMETERS (NOT INCLUDED IN MONITORING PROGRAM)
- PZ-10 — DDA PIEZOMETERS (INCLUDED IN MONITORING PROGRAM)
- DDA-12-TZ — 2012 2" DIAMETER MONITORING WELL LOCATIONS
- DDA-12-US — 2012 4" DIAMETER MONITORING WELL LOCATIONS
- 1,4-DIOXANE ISOCONCENTRATION CONTOURS (ug/l)
- 1,4-DIOXANE ISOCONCENTRATION CONTOURS (INFERRED)
- 22 — 1,4-DIOXANE CONCENTRATIONS (ug/l) * INDICATES VALUE NOT USED IN CONTOURING

NOTES

1.) LOCATIONS OF WELLS AND BORING ARE BASED ON SURVEY BY TAYLOR WISEMAN & TAYLOR (REVISED 2012)
2.) BASED ON FEBRUARY - APRIL 2013 GROUNDWATER DATA
3.) DASHED LINES REPRESENT INFERRED ISOCONCENTRATIONS CONTOURS
4.) ug/l = MICROGRAMS PER LITER

REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL U.S.G.S. 7.5 MINUTE QUADRANGLES OF WILMINGTON SOUTH, DELAWARE/NEW JERSEY (DATED 1984), DELAWARE CITY, DELAWARE (DATED 1984), NEWARK EAST, DELAWARE (DATED 1984) AND SAINT GEORGES, DELAWARE (DATED 1984).

0 30 60 90
SCALE FEET

PROJECT
DELAWARE SAND AND GRAVEL SUPERFUND SITE
NEW CASTLE, DELAWARE

TITLE
1,4-DIOXANE
DDA TO WELL PW-1(U)
UPCU TRANSITION ZONE
FEBRUARY - APRIL 2013

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

PROJECT No.			
DESIGN			SCALE AS SHOWN
CADD			**FIGURE 4A**
CHECK			
REVIEW			

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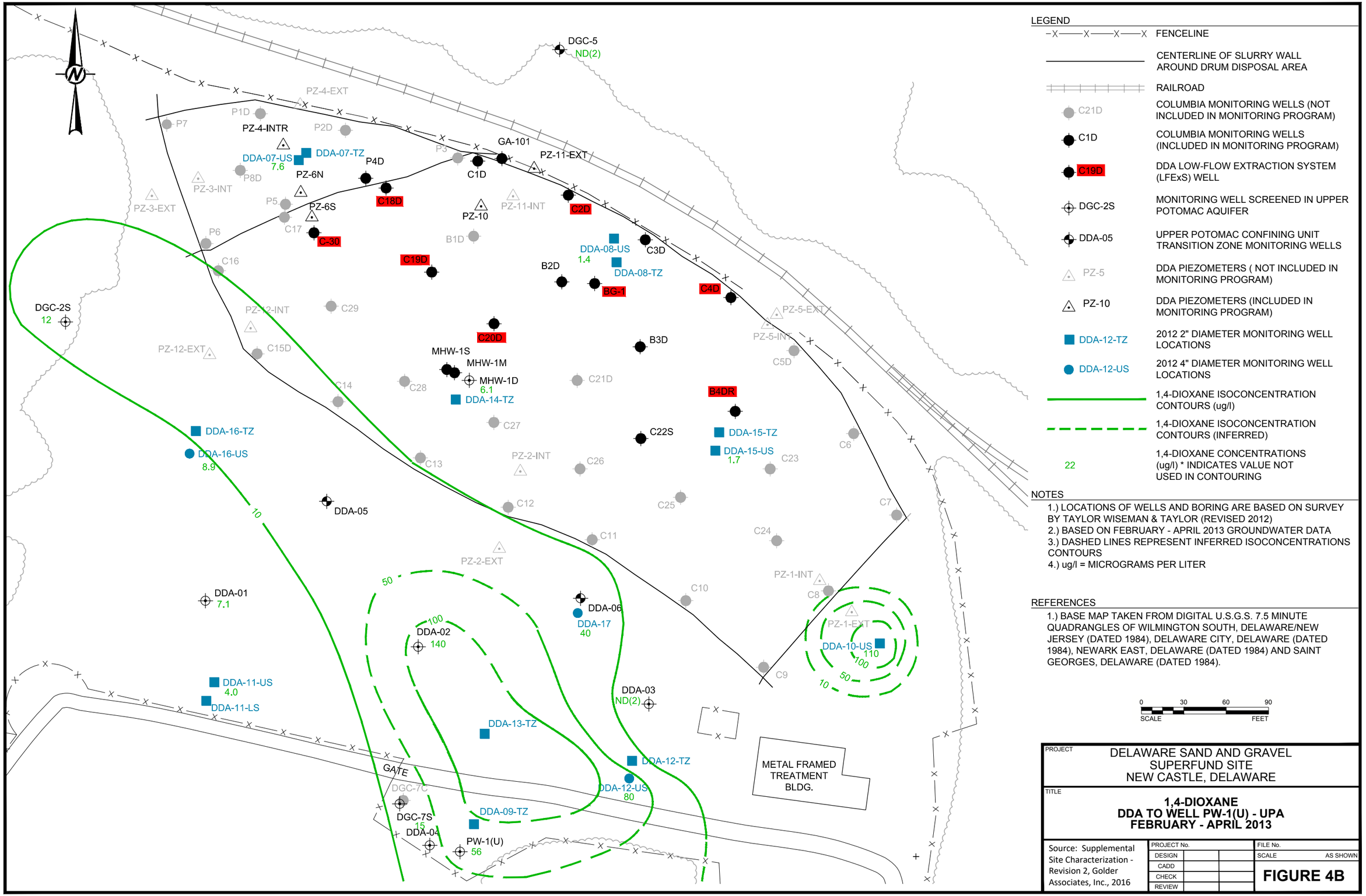

LEGEND

- FENCELINE
- CENTERLINE OF SLURRY WALL AROUND DRUM DISPOSAL AREA
- RAILROAD
- C21D — COLUMBIA MONITORING WELLS (NOT INCLUDED IN MONITORING PROGRAM)
- C1D — COLUMBIA MONITORING WELLS (INCLUDED IN MONITORING PROGRAM)
- C19D — DDA LOW-FLOW EXTRACTION SYSTEM (LFExS) WELL
- DGC-2S — MONITORING WELL SCREENED IN UPPER POTOMAC AQUIFER
- DDA-05 — UPPER POTOMAC CONFINING UNIT TRANSITION ZONE MONITORING WELLS
- PZ-5 — DDA PIEZOMETERS (NOT INCLUDED IN MONITORING PROGRAM)
- PZ-10 — DDA PIEZOMETERS (INCLUDED IN MONITORING PROGRAM)
- DDA-12-TZ — 2012 2" DIAMETER MONITORING WELL LOCATIONS
- DDA-12-US — 2012 4" DIAMETER MONITORING WELL LOCATIONS
- 1,4-DIOXANE ISOCONCENTRATION CONTOURS (ug/l)
- 1,4-DIOXANE ISOCONCENTRATION CONTOURS (INFERRED)
- 22 — 1,4-DIOXANE CONCENTRATIONS (ug/l) * INDICATES VALUE NOT USED IN CONTOURING

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2.) BASED ON FEBRUARY - APRIL 2013 GROUNDWATER DATA
3.) DASHED LINES REPRESENT INFERRED ISOCONCENTRATIONS CONTOURS
4.) ug/l = MICROGRAMS PER LITER

REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL U.S.G.S. 7.5 MINUTE QUADRANGLES OF WILMINGTON SOUTH, DELAWARE/NEW JERSEY (DATED 1984), DELAWARE CITY, DELAWARE (DATED 1984), NEWARK EAST, DELAWARE (DATED 1984) AND SAINT GEORGES, DELAWARE (DATED 1984).

0 30 60 90
SCALE FEET

PROJECT
DELAWARE SAND AND GRAVEL SUPERFUND SITE
NEW CASTLE, DELAWARE

TITLE
1,4-DIOXANE
DDA TO WELL PW-1(U) - UPA
FEBRUARY - APRIL 2013

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

PROJECT No.			FILE No.
DESIGN			SCALE AS SHOWN
CADD			**FIGURE 4B**
CHECK			
REVIEW			

AR319351

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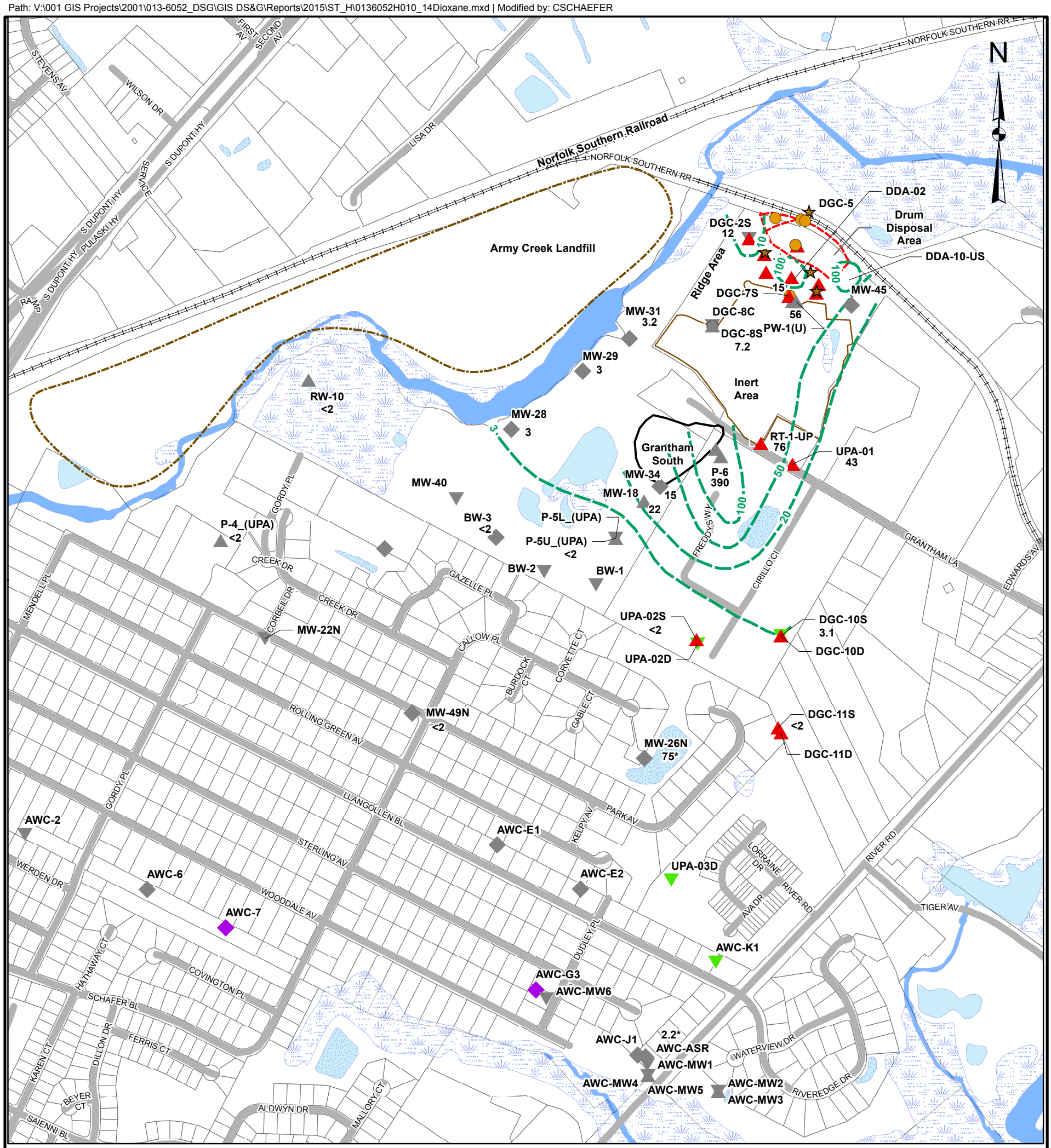


LEGEND

- Well screened in UPCU Transition Zone included in the current monitoring program
- Well screened in UPA Upper Sand included in the current monitoring program
- Well screened in UPA Upper Sand not included in the current monitoring program
- Well screened in UPA Lower Sand included in the current monitoring program
- Well screened in UPA Lower Sand not included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand not included in the current monitoring program
- Well screened in Columbia Aquifer included in the current monitoring program
- Well screened in Columbia Aquifer not included in the current monitoring program
- 1,4-Dioxane Isoconcentration Contour (Inferred)
- **14** - 1,4-Dioxane Concentrations (ug/L)
- * Indicated data not used for contouring

Notes:
1) Isoconcentration contours are approximate and should not be interpreted as exact indicators of groundwater quality at locations between wells.

2) Contours shown are based on available data interpreted through professional judgment in the context of groundwater flow direction and the conceptual site model for the area at and between the Delaware Sand & Gravel and Army Creek Landfill Superfund Sites.

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

0 300 600 1,200 Feet

FIGURE 4C

TITLE

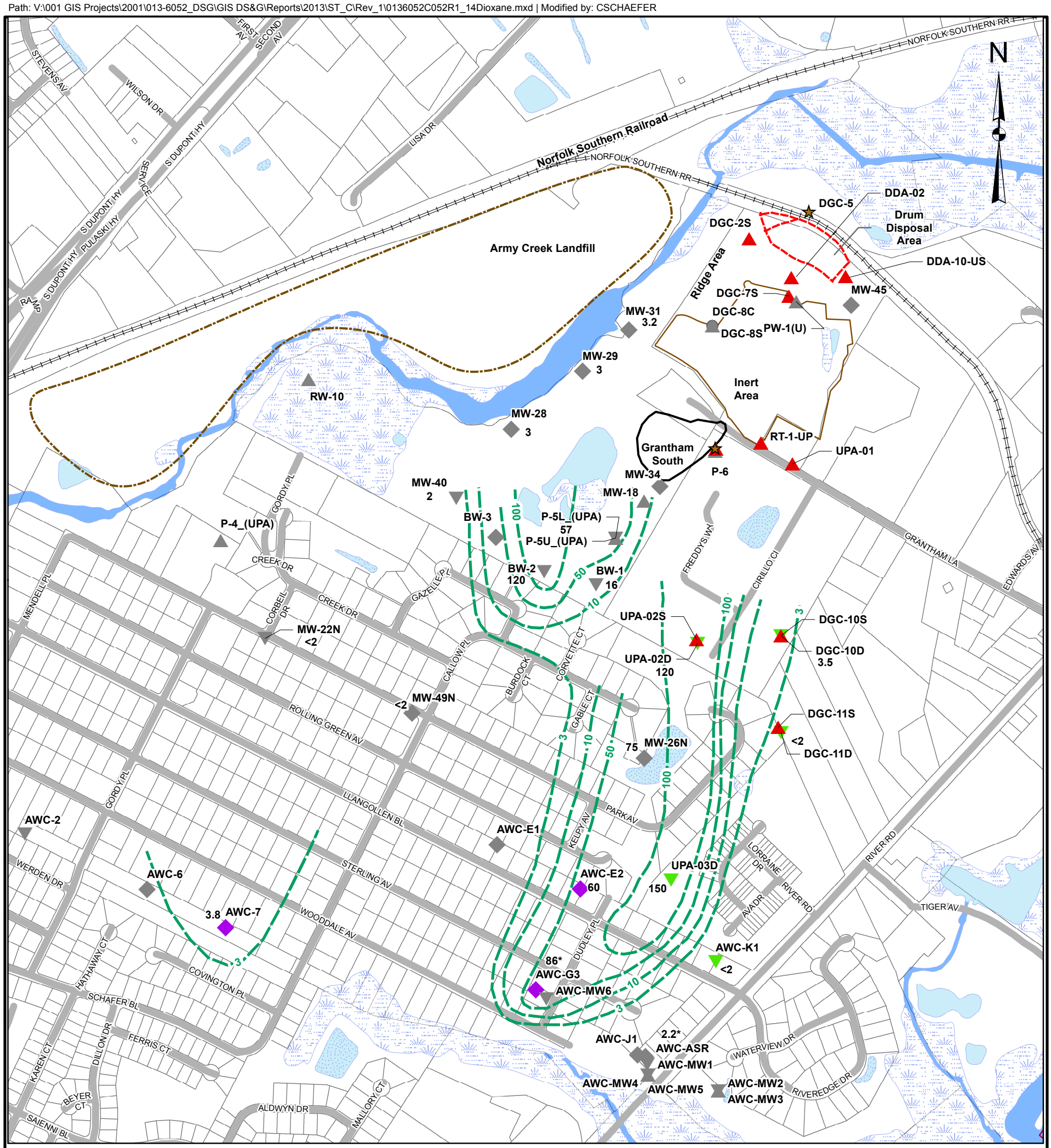
1,4-DIOXANE
UPA UPPER SAND
DOWNGRADIENT OF WELL PW-1(U)
MARCH - APRIL 2013

PROJECT

Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

Path: V:\001 GIS Projects\2001\013-6052_DSG\GIS DS&G\Reports\2013\ST_C\Rev_1\0136052C052R1_14Dioxane.mxd | Modified by: CSCHAEFER



LEGEND

- Well screened in UPCU Transition Zone included in the current monitoring program
- Well screened in UPA Upper Sand included in the current monitoring program
- Well screened in UPA Upper Sand not included in the current monitoring program
- Well screened in UPA Lower Sand included in the current monitoring program
- Well screened in UPA Lower Sand not included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand not included in the current monitoring program
- Well screened in Columbia Aquifer included in the current monitoring program
- Well screened in Columbia Aquifer not included in the current monitoring program
- 1,4-Dioxane Isoconcentration Contour (Inferred)
- **14** - 1,4-Dioxane Concentrations (ug/L)

* Indicated data provided by Artesian Water Company
ug/L = Micrograms per Liter

Notes:
1) Isoconcentration contours are approximate and should not be interpreted as exact indicators of groundwater quality at locations between wells.

2) Contours shown are based on available data interpreted through professional judgment in the context of groundwater flow direction and the conceptual site model for the area at and between the Delaware Sand & Gravel and Army Creek Landfill Superfund Sites.

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

0 300 600 1,200 Feet

FIGURE 4D

REVIEW | CHECK | GIS | DESIGN | SCALE: AS SHOWN | FILE No.

TITLE

1,4-DIOXANE
UPA LOWER SAND
DOWNGRADIENT OF WELL PW-1(U)
MARCH - APRIL 2013

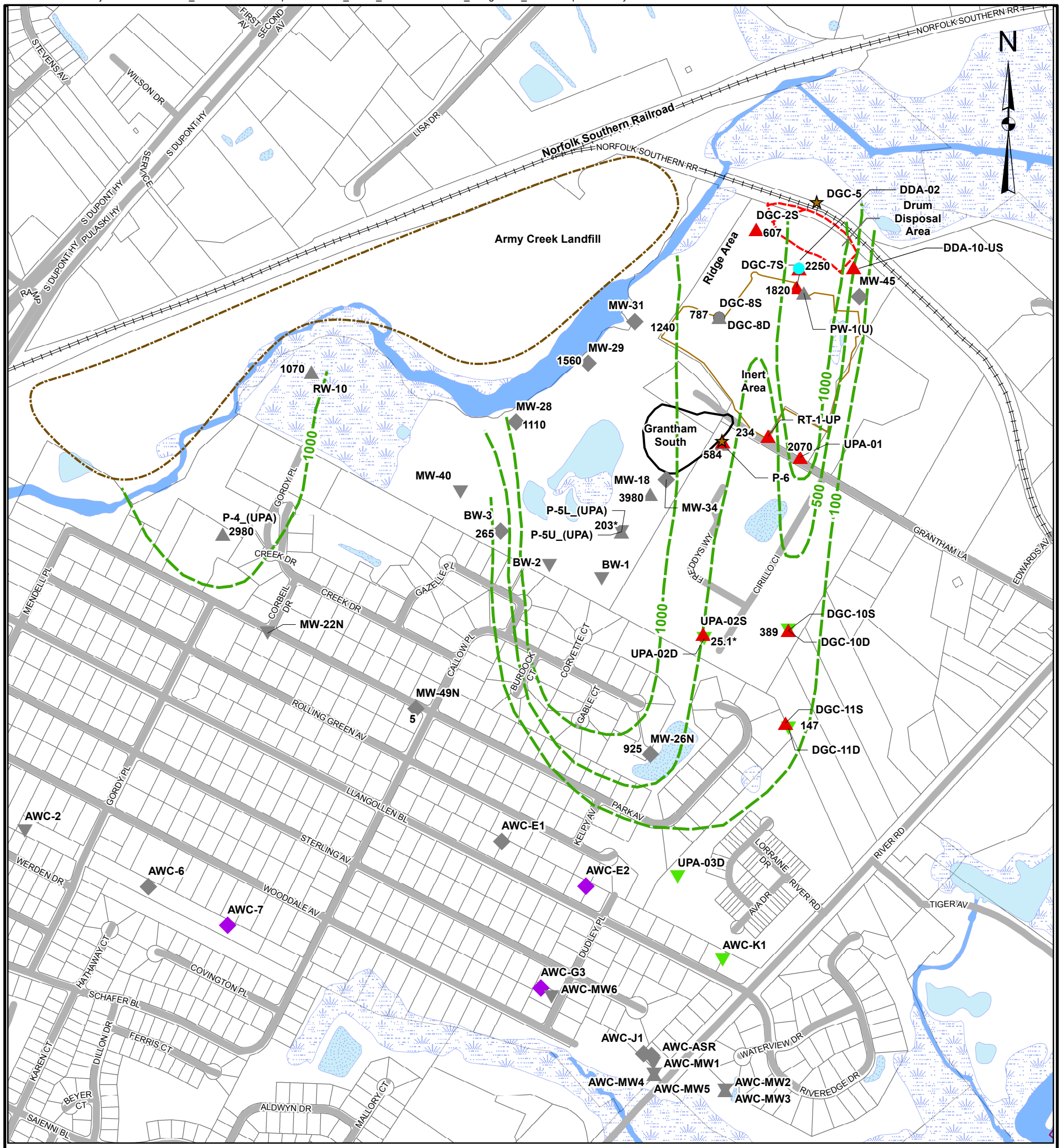
PROJECT

Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

AR319353

Path: V:\001 GIS Projects\2001\013-6052_DSG\GIS DS&G\Reports\2013\ST_C\Rev_1\0136052C039R1_Manganese_PCG.mxd | Modified by: CSCHAEFER



LEGEND

- Well screened in UPCU Transition Zone included in the current monitoring program
- Well screened in UPA Upper Sand included in the current monitoring program
- Well screened in UPA Upper Sand not included in the current monitoring program
- Well screened in UPA Lower Sand included in the current monitoring program
- Well screened in UPA Lower Sand not included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand included in the current monitoring program
- Well screened across UPA Upper Sand and Lower Sand not included in the current monitoring program
- Well screened in Columbia Aquifer included in the current monitoring program
- Well screened in Columbia Aquifer not included in the current monitoring program
- Dissolved Manganese Isoconcentration Contour (Inferred)
- <15 Dissolved Manganese Concentration (ug/L)

* Indicates datapoint not used in contouring
ug/L = Micrograms per Liter

Notes:
1) Isoconcentration contours are approximate and should not be interpreted as exact indicators of groundwater quality at locations between wells.

2) Contours shown are based on available data interpreted through professional judgment in the context of groundwater flow direction and the conceptual site model for the area at and between the Delaware Sand & Gravel and Army Creek Landfill Superfund Sites.

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

0 300 600 1,200 Feet

FIGURE 5A

REVIEW | CHECK | GIS | DESIGN | REV. | SCALE: | FILE No.

TITLE

**MANGANESE (DISSOLVED)
UPA UPPER SAND
DOWNGRADIENT OF WELL PW-1(U)
MARCH - APRIL 2013**

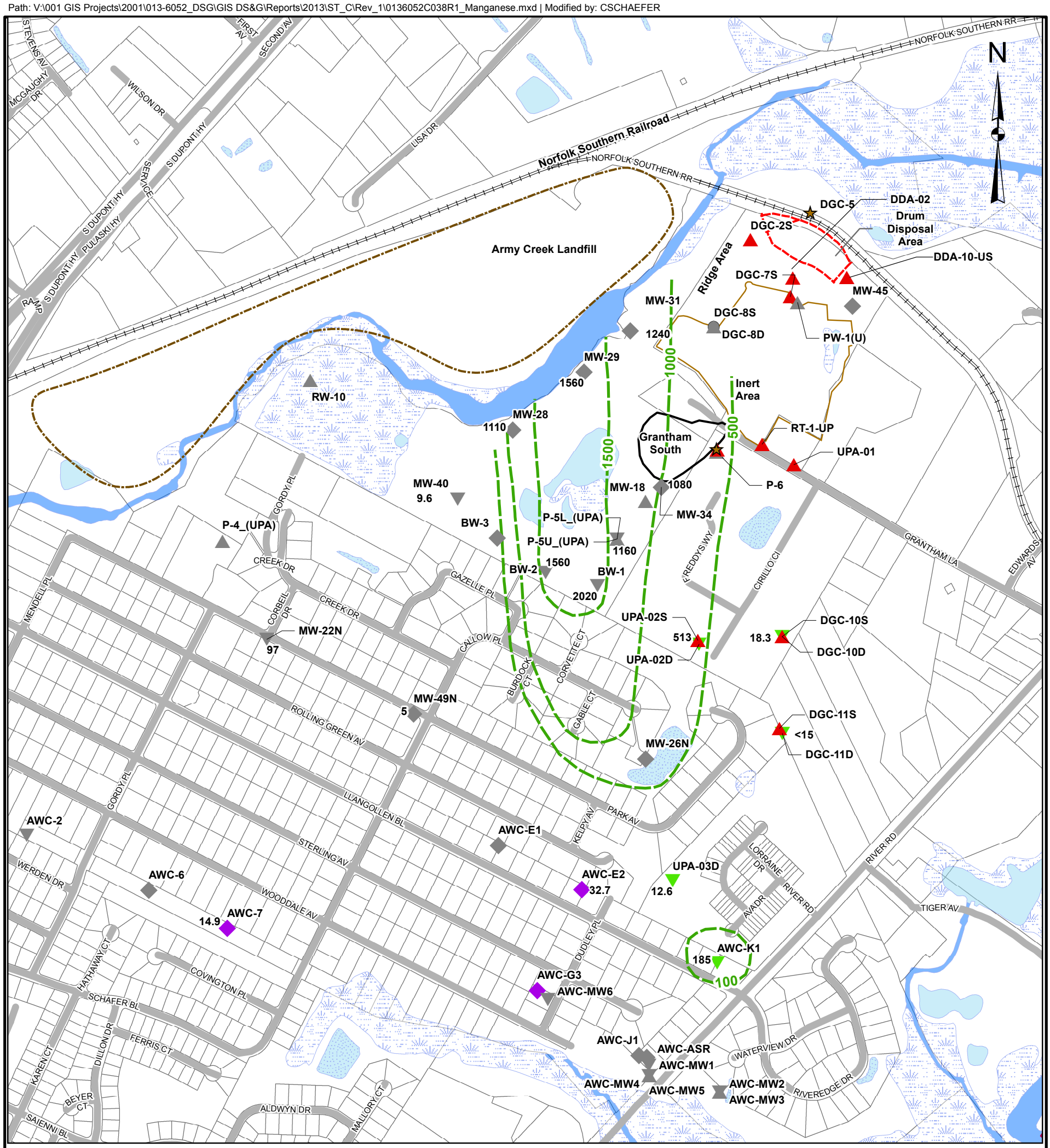
PROJECT

**Delaware Sand and Gravel
Superfund Site
New Castle, Delaware**

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

AR319354

Path: V:\001 GIS Projects\2001\013-6052_DSG\GIS DS&G\Reports\2013\ST_C\Rev_1\0136052C038R1_Manganese.mxd | Modified by: CSCHAEFER



LEGEND

- ★ Well screened in UPCU Transition Zone included in the current monitoring program
- ▲ Well screened in UPA Upper Sand included in the current monitoring program
- ▲ Well screened in UPA Upper Sand not included in the current monitoring program
- ▼ Well screened in UPA Lower Sand included in the current monitoring program
- ▼ Well screened in UPA Lower Sand not included in the current monitoring program
- ◆ Well screened across UPA Upper Sand and Lower Sand included in the current monitoring program
- ◆ Well screened across UPA Upper Sand and Lower Sand not included in the current monitoring program
- ● Well screened in Columbia Aquifer included in the current monitoring program
- ● Well screened in Columbia Aquifer not included in the current monitoring program
- Dissolved Manganese Isoconcentration Contour (Inferred)
- <15 Dissolved Manganese Concentration (ug/L)

* Indicates datapoint not used in contouring
ug/L = Micrograms per Liter

Notes:
1) Isoconcentration contours are approximate and should not be interpreted as exact indicators of groundwater quality at locations between wells.

2) Contours shown are based on available data interpreted through professional judgment in the context of groundwater flow direction and the conceptual site model for the area at and between the Delaware Sand & Gravel and Army Creek Landfill Superfund Sites.

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

0 300 600 1,200 Feet

FIGURE 5B

REVIEW | CHECK | GIS | DESIGN | REV. | FILE No.
SCALE:

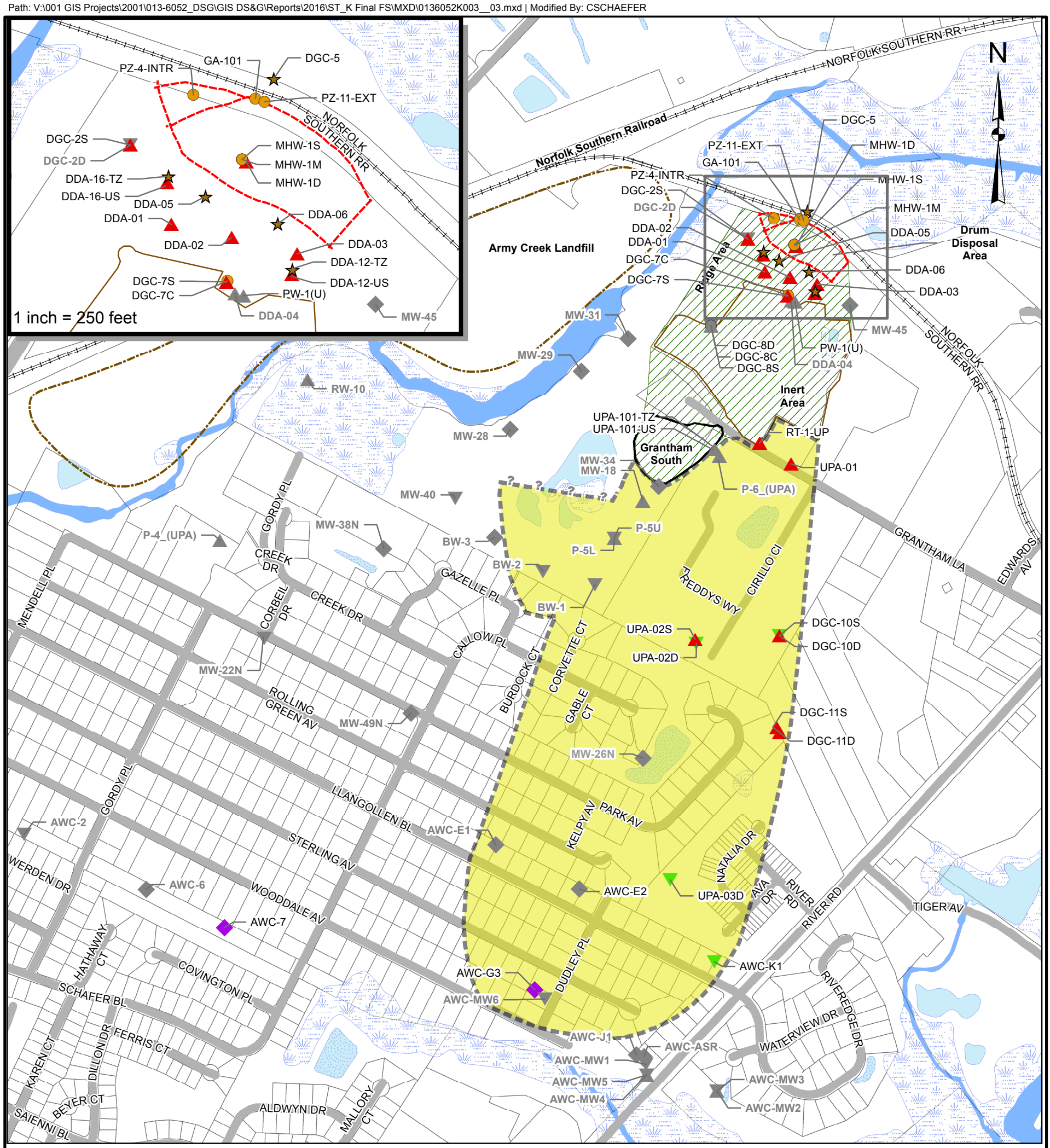
TITLE
MANGANESE (DISSOLVED)
UPA LOWER SAND
DOWNGRADIENT OF WELL PW-1(U)
MARCH - APRIL 2013

PROJECT
Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Source:
Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

AR319355

Path: V:\001 GIS Projects\2001\013-6052_DSG\GIS DS&G\Reports\2016\ST_K Final FS\MXD\0136052K003__03.mxd | Modified By: CSCHAEFER



LEGEND

- Well screened in UPCU Transition Zone included in DS&G's approved 2011 monitoring program
- Well screened in UPA Upper Sand included in DS&G's approved 2011 monitoring program
- Well screened in UPA Upper Sand not included in DS&G's approved 2011 monitoring program
- Well screened in UPA Lower Sand included in DS&G's approved 2011 monitoring program
- Well screened in UPA Lower Sand not included in DS&G's approved 2011 monitoring program
- Well screened across UPA Upper Sand and Lower Sand included in DS&G's approved 2011 monitoring program
- Well screened across UPA Upper Sand and Lower Sand not included in DS&G's approved 2011 monitoring program
- Well screened in Columbia Aquifer included in DS&G's approved 2011 monitoring program
- Well screened in Columbia Aquifer not included in DS&G's approved 2011 monitoring program
- Area of Attainment
- Waste Management Area

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

0 300 600 1,200 Feet

1 inch = 600 feet

FIGURE 6

REVIEW | CHECK | GIS | DESIGN | REV. | SCALE: | FILE No.

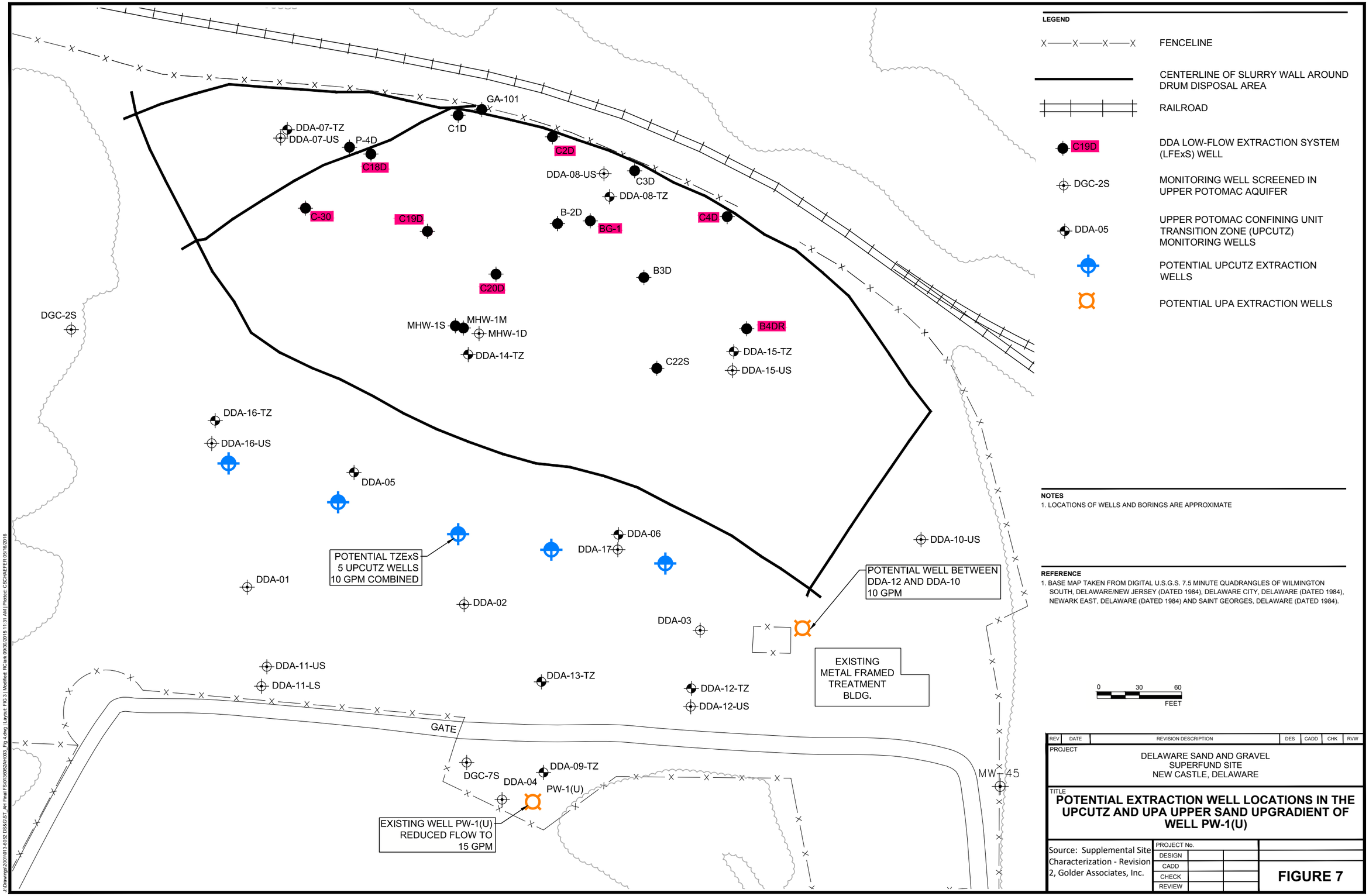
TITLE

WASTE MANAGEMENT AREA AND AREA OF ATTAINMENT

PROJECT

Delaware Sand and Gravel Superfund Site New Castle, Delaware

AR319356


GA-101
C1D
DDA-07-TZ
DDA-07-US
P-4D
C18D
C2D
DDA-08-US
C3D
DDA-08-TZ
C-30
C19D
B-2D
BG-1
C4D
B3D
C20D
DGC-2S
MHW-1S
MHW-1M
MHW-1D
DDA-14-TZ
B4DR
DDA-15-TZ
DDA-15-US
C22S
DDA-16-TZ
DDA-16-US
DDA-05
POTENTIAL TZExS
5 UPCUTZ WELLS
10 GPM COMBINED
DDA-06
DDA-17
DDA-10-US
DDA-01
DDA-02
DDA-03
POTENTIAL WELL BETWEEN
DDA-12 AND DDA-10
10 GPM
EXISTING
METAL FRAMED
TREATMENT
BLDG.
DDA-11-US
DDA-11-LS
DDA-13-TZ
DDA-12-TZ
DDA-12-US
GATE
DGC-7S
DDA-04
DDA-09-TZ
PW-1(U)
EXISTING WELL PW-1(U)
REDUCED FLOW TO
15 GPM
MW-45
LEGEND
FENCELINE
CENTERLINE OF SLURRY WALL AROUND DRUM DISPOSAL AREA
RAILROAD
C19D
DDA LOW-FLOW EXTRACTION SYSTEM (LFExS) WELL
DGC-2S
MONITORING WELL SCREENED IN UPPER POTOMAC AQUIFER
DDA-05
UPPER POTOMAC CONFINING UNIT TRANSITION ZONE (UPCUTZ) MONITORING WELLS
POTENTIAL UPCUTZ EXTRACTION WELLS
POTENTIAL UPA EXTRACTION WELLS
NOTES
1. LOCATIONS OF WELLS AND BORINGS ARE APPROXIMATE
REFERENCE
1. BASE MAP TAKEN FROM DIGITAL U.S.G.S. 7.5 MINUTE QUADRANGLES OF WILMINGTON SOUTH, DELAWARE/NEW JERSEY (DATED 1984), DELAWARE CITY, DELAWARE (DATED 1984), NEWARK EAST, DELAWARE (DATED 1984) AND SAINT GEORGES, DELAWARE (DATED 1984).
0
30
60
FEET
REV
DATE
REVISION DESCRIPTION
DES
CADD
CHK
RVW
PROJECT
DELAWARE SAND AND GRAVEL
SUPERFUND SITE
NEW CASTLE, DELAWARE
TITLE
POTENTIAL EXTRACTION WELL LOCATIONS IN THE UPCUTZ AND UPA UPPER SAND UPGRADIENT OF WELL PW-1(U)
Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc.
PROJECT No.
DESIGN
CADD
CHECK
REVIEW
FIGURE 7
J:\Drawings\20010\13-6052 DS&GS\7_AH Final FS\013605ZAH003_Fig 4.dwg | Layout: FIG 3 | Modified: RClark 09/30/2015 11:31 AM | Plotted: CSCHAEFER 05/16/2016

AR319357

Path: V:\001 GIS Projects\2001\013-6052_DSG\GIS DS&G\Reports\2016\ST_K Final FS\MXD\0136052K005_05.mxd | Modified By: CSCHAEFER

EXISTING SEWER DISCHARGE LOCATION

POTENTIAL UPA US WELL MW-18 / MW-34 AREA 52 GPM

POTENTIAL UPA LS WELL BW-2 AREA 65 GPM

GAZELLE PLACE PUMP STATION

POTENTIAL UPA US WELL RT-1-UP / UPA-01 AREA 60 GPM

POTENTIAL UPA US WELL P-6 AREA 10 GPM

Army Creek Landfill

Drum Disposal Area

Ridge Area

Inert Area

Grantham South

Norfolk Southern Railroad

STEVENS AV
WILSON DR
S DUPONT HY
S DUPONT HY
LISA DR
PULASKI HY
MENDELL PL
ROLLING GREEN AV
GORDY PL
LLANGOLLEN BL
WERDEN DR
KAREN CT
HATHAWAY CT
COVINGTON PL
SCHAFER BL
FERRIS CT
BEYER CT
DILLON DR
SAIENNI BL
ALDWYN DR
MALLORY CT
GAZELLE PL
CREEK DR
PARK AV
CALLOW PL
STERLING AV
WOODDALE AV
BURDOCK CT
CORVETTE CT
GABLE CT
KELPY AV
DUDLEY PL
CIRILLO CI
NATALIA DR
RIVER RD
TIGER AV
RIVEREDGE DR
WATERVIEW DR

DGC-5
PZ-11-EXT
MHW-1D
GA-101
MHW-1S
PZ-4-INTR
DGC-2S
MHW-1M
DGC-2D
DDA-02
DDA-05
DDA-01
DGC-7C
DDA-06
DGC-7S
DDA-03
MW-31
MW-45
DGC-8D
PW-1(U)
MW-29
DGC-8C
DDA-04
RW-10
UPA-101-TZ
UPA-101-US
RT-1-UP
MW-28
UPA-01
MW-34
P-6_(UPA)
MW-40
MW-18
P-5U
P-4_(UPA)
BW-3
P-5L
BW-2
BW-1
UPA-02S
DGC-10S
UPA-02D
DGC-10D
MW-22N
DGC-11S
MW-49N
DGC-11D
MW-26N
AWC-2
AWC-E1
AWC-E2
UPA-03D
AWC-6
AWC-7
AWC-K1
AWC-G3
AWC-MW6
AWC-J1
AWC-ASR
AWC-MW1
AWC-MW3
AWC-MW5
AWC-MW4
AWC-MW2

LEGEND

- Well screened in UPCU Transition Zone included in DS&G's approved 2011 monitoring program
- Well screened in UPA Upper Sand included in DS&G's approved 2011 monitoring program
- Well screened in UPA Upper Sand not included in DS&G's approved 2011 monitoring program
- Well screened in UPA Lower Sand included in DS&G's approved 2011 monitoring program
- Well screened in UPA Lower Sand not included in DS&G's approved 2011 monitoring program
- Well screened across UPA Upper Sand and Lower Sand included in DS&G's approved 2011 monitoring program
- Well screened across UPA Upper Sand and Lower Sand not included in DS&G's approved 2011 monitoring program
- Well screened in Columbia Aquifer included in DS&G's approved 2011 monitoring program
- Well screened in Columbia Aquifer not included in DS&G's approved 2011 monitoring program
- Potential Off-Site Extraction Well
- Pump Station / Discharge Location

0 300 600 1,200 Feet

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

FIGURE 8

REVIEW | CHECK | GIS | DESIGN | REV. | SCALE: | FILE No.

TITLE

POTENTIAL EXTRACTION WELL LOCATIONS IN THE UPA DOWNGRADIENT OF WELL PW-1(U)

PROJECT

Delaware Sand and Gravel Superfund Site New Castle, Delaware

Source: Supplemental Site Characterization - Revision 2, Golder Associates, Inc., 2016

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI B

AR319358

APPENDIX A

Risk and PRG Tables for Groundwater

Table 1. Occurrence, Distribution, and Selection of Chemicals of Potential Concern in the Upper Potomac Aquifer

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)		Maximum Concentration (Qualifier) (1)		Units	Location of Maximum Concentration	Detection Frequency	Range of Method Detection Limits		Concentration Used for Screening (2)	Background Value (3)	2017 Screening Toxicity Value (µg/L) (N/C) (4,5)		Potential ARAR Value µg/L	Potential ARAR/TBC Source (6)	COPC Flag (Y/N)	Rationale for Selection or Deletion (7)
UPA (including UPCUTZ) - Plume Core	75-34-3	1,1-Dichloroethane	0.21	J	2.6	J	µg/L	DDA-05	30 / 55	0.13	1.3	2.6	NA	2.8	c	NA	NA	N	BSL
	120-82-1	1,2,4-Trichlorobenzene	0.35	J	0.86	J	µg/L	DDA-05	5 / 55	0.26	1.3	0.86	NA	0.40	n	70	MCL	Y	ASL
	95-63-6	1,2,4-Trimethylbenzene	0.16	J	420	--	µg/L	DDA-05	14 / 55	0.13	1.3	420	NA	5.6	n	NA	NA	Y	ASL
	95-50-1	1,2-Dichlorobenzene	2.8	--	21	--	µg/L	DDA-06	10 / 55	2.5	13	21	NA	30	n	600	MCL	N	BSL
	107-06-2	1,2-Dichloroethane	0.19	J	4.4	--	µg/L	UPA-03D	16 / 55	0.19	1.9	4.4	NA	0.17	c**	5.0	MCL	Y	ASL
	108-67-8	1,3,5-Trimethylbenzene	0.47	--	110	--	µg/L	DDA-05	13 / 55	0.15	1.5	110	NA	6.0	n	NA	NA	Y	ASL
	106-46-7	1,4-Dichlorobenzene	2.6	J	2.6	J	µg/L	DDA-06	1 / 55	2.5	13	2.6	NA	0.48	c	75	MCL	Y	ASL
	123-91-1	1,4-Dioxane	0.39	J	2,300	--	µg/L	DDA-06	43 / 55	0.31	360	2,300	NA	0.46	c*	3.5	HA	Y	ASL
	105-67-9	2,4-Dimethylphenol	4.4	J	30	J	µg/L	DDA-05	10 / 55	3.4	18	30	NA	36	n	NA	NA	N	BSL
	95-48-7	2-Methylphenol	6.9	J	6.9	J	µg/L	P-6_UPA	1 / 55	1.8	9.3	6.9	NA	93	n	NA	NA	N	BSL
	67-64-1	Acetone	8.3	--	37	--	µg/L	UPA-01	5 / 55	2.7	27	37	NA	1,400	n	NA	NA	N	BSL
	7429-90-5	Aluminum	46	J	4,680	--	µg/L	UPA-01	27 / 30	33	33	4,680	NA	2,000	n	200	sMCL	Y	ASL
	7664-41-7	Ammonia	22	J	6,700	--	µg/L	DDA-05	22 / 30	13	800	6,700	NA	NA	NA	30,000	HA	N	BSL
	7440-38-2	Arsenic	2.1	J	8.7	--	µg/L	P-6_UPA	18 / 30	1.8	1.8	8.7	NA	0.052	c*	10	MCL	Y	ASL
	7440-39-3	Barium	36	--	457	--	µg/L	DDA-06	30 / 30	3.8	3.8	457	NA	380	n	2,000	MCL	Y	ASL
	71-43-2	Benzene	0.29	J	1,400	--	µg/L	DDA-05	40 / 55	0.080	0.80	1,400	NA	0.46	c**	5.0	MCL	Y	ASL
	56-55-3	Benzo[a]anthracene	0.043	J	0.048	J	µg/L	UPA-01	2 / 55	0.035	0.039	0.048	NA	0.030	c	NA	NA	Y	ASL
	205-99-2	Benzo[b]fluoranthene	0.038	J	0.050	--	µg/L	UPA-01	3 / 55	0.030	0.033	0.050	NA	0.25	c	NA	NA	N	BSL
	111-44-4	Bis(2-chloroethyl) Ether	0.033	--	690	--	µg/L	DDA-06	50 / 55	0.018	1.4	690	NA	0.014	c	NA	NA	Y	ASL
	117-81-7	Bis(2-ethylhexyl) Phthalate	3.4	B	5.5	B	µg/L	P-6_UPA	4 / 55	2.0	10	5.5	NA	5.6	c**	6.0	MCL	N	BSL
	80-05-7	Bisphenol A	8.8	--	150	--	µg/L	P-6_UPA	4 / 10	0.0	0.0	150	NA	77	n	NA	NA	Y	ASL
	75-27-4	Bromodichloromethane	0.59	--	1.1	--	µg/L	UPA-01	2 / 55	0.12	1.2	1.1	NA	0.13	c	80	MCL	Y	ASL
	85-68-7	Butylbenzyl Phthalate	9.2	J	9.2	J	µg/L	DDA-06	1 / 55	2.5	13	9.2	NA	16	c*	7,000	HA	N	BSL
	105-60-2	Caprolactum	8.1	J	77	--	µg/L	DDA-06	2 / 55	2.5	13	77	NA	990	n	NA	NA	N	BSL
	75-15-0	Carbon Disulfide	0.13	--	1.3	--	µg/L	UPA-02D	5 / 55	0.13	1.3	1.3	NA	81	n	NA	NA	N	BSL
	16887-00-6	Chloride	2,200	--	121,000	--	µg/L	P-6_UPA	10 / 10	200	200	121,000	NA	NA	NA	250,000	sMCL	N	NUT
	108-90-7	Chlorobenzene	0.56	J	53	--	µg/L	DDA-05	40 / 55	0.11	1.1	53	NA	7.8	n	100	MCL	Y	ASL
	75-00-3	Chloroethane	0.39	--	7.3	--	µg/L	P-6_UPA	6 / 55	0.17	1.7	7.3	NA	2,100	n	NA	NA	N	BSL
	67-66-3	Chloroform	5.3	--	7.7	--	µg/L	UPA-01	2 / 55	0.080	0.80	7.7	NA	0.22	c*	80	MCL	Y	ASL
	74-87-3	Chloromethane	0.11	--	0.11	--	µg/L	MW-26N	1 / 55	0.10	1.0	0.11	NA	19	n	0.40	HA	N	BSL
	7440-47-3	Chromium[8]	4.9	J	27	--	µg/L	UPA-03D	12 / 30	4.0	4.0	27	NA	2,200	n[8]	100	MCL	N	BSL
	156-59-2	cis-1,2-Dichloroethene	0.18	J	1.3	--	µg/L	UPA-03D	15 / 55	0.18	1.8	1.3	NA	3.6	n	70	MCL	N	BSL
	7440-48-4	Cobalt	3.9	J	15	--	µg/L	P-6_UPA	18 / 30	3.9	3.9	15	NA	0.60	n	NA	NA	Y	ASL
	7440-50-8	Copper	4.3	J	13	--	µg/L	DGC-10D	8 / 30	3.8	3.8	13	NA	80	n	1,300	MCL	N	BSL
	110-82-7	Cyclohexane	0.20	--	21	--	µg/L	P-6_UPA	8 / 30	0.16	1.6	21	NA	1,300	n	NA	NA	N	BSL
	124-48-1	Dibromochloromethane	0.25	--	0.38	J	µg/L	UPA-01	2 / 55	0.20	2.0	0.38	NA	0.87	c	80	MCL	N	BSL
	60-29-7	Diethyl Ether	0.35	J	32	--	µg/L	P-6_UPA	38 / 55	0.080	0.80	32	NA	390	n	NA	NA	N	BSL
	84-66-2	Diethyl Phthalate	5.0	--	26	J	µg/L	DDA-05	5 / 55	2.9	15	26	NA	1,500	n	NA	NA	N	BSL
	101-84-8	Diphenyl Ether	1.8	J	15	J	µg/L	DDA-05	9 / 30	1.7	8.7	15	NA	NA	NA	NA	NA	Y	NSV
	74-84-0	Ethane	0.0067	J	550	--	µg/L	P-6_UPA	28 / 28	0.0010	0.0070	550	NA	NA	NA	NA	NA	Y	NSV
	74-85-1	Ethene	0.011	--	11	--	µg/L	DDA-06	27 / 28	0.0050	0.0060	11	NA	NA	NA	NA	NA	Y	NSV
	100-41-4	Ethylbenzene	0.11	J	530	--	µg/L	P-6_UPA	22 / 55	0.10	1.0	530	NA	1.5	c*	700	MCL	Y	ASL
	118-74-1	Hexachlorobenzene	0.030	--	0.035	--	µg/L	UPA-01	2 / 55	0.017	0.019	0.035	NA	0.0098	c	1.0	MCL	Y	ASL
	7439-89-6	Iron (total)	180	--	51,500	--	µg/L	DDA-05	28 / 30	129	129	51,500	NA	1,400	n	300	sMCL	Y	ASL
	7439-89-6	Iron (dissolved)	83	J	53,900	--	µg/L	DDA-05	42 / 50	74	81	53,900	NA	1,400	n	300	sMCL	Y	ASL
	98-82-8	Isopropylbenzene	0.56	J	36	--	µg/L	DDA-05	24 / 55	0.080	0.80	36	NA	45	n	4,000	HA	N	BSL
	7439-92-1	Lead	1.2	J	3.0	--	µg/L	DDA-06	7 / 30	1.2	1.2	3.0	NA	NA	NA	15	MCL	N	BSL
	7439-95-4	Magnesium	3,020	--	31,600	--	µg/L	DDA-06	30 / 30	188	188	31,600	NA	NA	NA	NA	NA	N	NUT
	7439-96-5	Manganese (total)	14	--	2,610	--	µg/L	UPA-01	30 / 30	7.7	7.7	2,610	NA	43	n	50	sMCL	Y	ASL
	7439-96-5	Manganese (dissolved)	8.2	J	2,420	--	µg/L	UPA-01	49 / 50	4.3	4.7	2,420	NA	43	n	50	sMCL	Y	ASL
	7439-97-6	Mercury	0.21	--	0.21	--	µg/L	MW-26N	1 / 30	0.16	0.16	0.21	NA	0.063	n	2.0	MCL	Y	ASL
	74-82-8	Methane	0.50	--	26,000	--	µg/L	P-6_UPA	28 / 28	0.015	0.018	26,000	NA	NA	NA	NA	NA	Y	NSV
	108-87-2	Methyl Cyclohexane	0.56	--	29	--	µg/L	P-6_UPA	15 / 55	0.14	1.4	29	NA	1,300	n	NA	NA	N	BSL
	1634-04-4	Methyl tert-Butyl Ether	0.20	J	9.0	--	µg/L	MW-26N	32 / 55	0.14	1.4	9.0	NA	14	c*	20	HA	N	BSL
	75-09-2	Methylene Chloride	0.30	--	0.30	--	µg/L	UPA-01	1 / 55	0.18	1.8	0.30	NA	11	n	5.0	MCL	N	BSL
	121-69-7	N,N-Dimethylaniline	0.91	--	200	--	µg/L	P-6_UPA	10 / 55	0.21	1.1	200	NA	2.5	c*	NA	NA	Y	ASL
	91-20-3	Naphthalene	3.0	J	8.4	J	µg/L	P-6_UPA	9 / 55	2.7	14	8.4	NA	0.17	c**	100	HA	Y	ASL
	7440-02-0	Nickel	5.0	--	25	--	µg/L	P-6_UPA	26 / 30	4.1	4.1	25	NA	39	n	100	HA	N	BSL
	14797-55-8	Nitrate as N	6.8	--	2,000	--	µg/L	DGC-10D	12 / 30	6.2	43	2,000	NA	3,200	n	10,000	MCL	N	BSL
	14797-65-0	Nitrite as N	35	J	710	--	µg/L	DDA-06	6 / 30	24	24	710	NA	200	n	1,000	MCL	Y	ASL
	98-95-3	Nitrobenzene	28	--	56	--	µg/L	P-6_UPA	2 / 55	0.30	1.5	56	NA	0.14	c**	NA	NA	Y	ASL
	103-65-1	n-Propylbenzene	1.1	--	88	--	µg/L	DDA-05	10 / 30	0.10	1.0	88	NA	66	n	NA	NA	Y	ASL
	108-95-2	Phenol	1.2	J	16	J	µg/L	DDA-05	3 / 55	0.81	4.2	16	NA	580	n	2,000	HA	N	BSL
	7440-09-7	Potassium	980	--	11,800	--	µg/L	DDA-06	30 / 30	190	190	11,800	NA	NA	NA	NA	NA	N	NUT
	7440-23-5	Sodium	4,930	--	88,600	--	µg/L	P-6_UPA	30 / 30	190	190	88,600	NA	NA	NA	20,000	HA	N	NUT
	14808-79-8	Sulfate	810	J	19,200	--	µg/L	DGC-10S	28 / 30	210	210	19,200	NA	NA	NA	250,000	sMCL	N	BSL
	18496-25-8	Sulfide	820	J	820	J	µg/L	DGC-10D	3 / 30	630	880	820	NA	NA	NA	NA	NA	Y	NSV
	127-18-4	Tetrachloroethene	0.11	--	0.33	J	µg/L	MW-26N	9 / 55	0.10	1.0	0.33	NA	4.1	n	5.0	MCL	N	BSL
	109-99-9	Tetrahydrofuran	2.0	--	380	J	µg/L	DDA-05	33 / 55	0.37	3.7	380	NA	340	n	NA	NA	Y	ASL
	108-88-3	Toluene	0.33	--	190	--	µg/L	P-6_UPA	15 / 55	0.15	1.5	190	NA	110	n	1,000	MCL	Y	ASL
	156-60-5	trans-1,2-Dichloroethene	0.26	--	0.26	--	µg/L	P-6_UPA	1 / 55	0.13	1.3	0.26	NA	36	n	100	MCL	N	BSL
	79-01-6	Trichloroethene	0.11	J	1.0	--	µg/L	DGC-10S	23 / 55	0.090	0.90	1.0	NA	0.28	n	5.0	MCL	Y	ASL
	7440-62-2	Vanadium	5.0	--	16	--	µg/L	UPA-01	4 / 30	3.8	3.8	16	NA	8.6	n	NA	NA	Y	ASL
	1330-20-7	Xylenes, Total	0.50	--	2,100	--	µg/L	P-6_UPA	14 / 55	0.13	3.6	2,100	NA	19	n	10,000	MCL	Y	ASL
	7440-66-6	Zinc	16	J	73	--	µg/L	DDA-06	9 / 30	15	15	73	NA	600	n	5,000	sMCL	N	BSL

Footnote Instructions:

(1) J = Analyte Present. Reported value may not be accurate or precise.
B = The analyte is present in the associated laboratory and/or field blanks, as well as in the sample.
(2) Maximum detected concentration used for screening
(3) No background value available
(4) All compounds are screened against the Environmental Protection Agency's (EPA) Residential Tap Water Screening Levels dated June 2017 (cancer benchmark value = 1E-06; HQ =0.1)
(5) When no screening levels are available, surrogate screening levels are used as follows:
Manganese = Manganese (Non-dietary)
Mercury = Mercuric Chloride (and other Mercury salts)
Methyl Cyclohexane = Cyclohexane
Vanadium =Vanadium and compounds
(6) Secondary MCLs and health advisories are utilized for screening purposes only and were not utilized if an RSL value was available
(7) Rationale Codes — Selection Reason: Above Screening Level (ASL); No Screening Value Available (NSV). Deletion Reason: Below Screening Level (BSL); Essential Nutrient (NUT)
(8) Per the Revised Addendum, chromium in groundwater at the Site has been demonstrated to be trivalent and as such, the data are screened against the RSL for chromium III (soluble salts).

Definitions: NA = Not Applicable
COPC = Chemical of Potential Concern
ARAR = Applicable or Relevant and Appropriate Requirement
n = Noncarcinogen
c = Carcinogen
Y = Yes
N = No
MCL = EPA Federal Maximum Contaminant Level
sMCL = EPA Secondary Maximum Contaminant Level
** = noncancer screening level using HQ of 0.1 is used because it is more conservative than the 1.0E-06 cancer screening level
* = where: non-cancer screening levels is less than 100 times the cancer screening level
µg/L = micrograms per liter
mg/L = milligrams per liter
UPA = Upper Potomac Aquifer
UPCUTZ = Upper Potomac Confining Unit Transition Zone
HA = EPA 2012 Edition of the Drinking Water Standards and Health Advisories

Revised By: GJG
Checked by: JC

Table 2. Exposure Point Concentration Summary for the Upper Potomac Aquifer

CAS	Chemical of Potential Concern[1]	Units	Arithmetic Mean	95% Upper Confidence Limit[2]	Maximum Detected Concentration[3]		Exposure Point Concentration			
							Value	Units	Statistic[4]	Rationale[5]
120-82-1	1,2,4-Trichlorobenzene	µg/L	0.22	0.32	0.86	J	0.32	µg/L	95% KM (t) UCL	b
95-63-6	1,2,4-Trimethylbenzene	µg/L	49	75	420	--	75	µg/L	95% KM (t) UCL	b
107-06-2	1,2-Dichloroethane	µg/L	0.48	0.65	4.4	--	0.65	µg/L	95% Adjusted Gamma KM-UCL	c
108-67-8	1,3,5-Trimethylbenzene	µg/L	12	18	110	--	18	µg/L	95% KM (t) UCL	b
106-46-7	1,4-Dichlorobenzene[7]	µg/L	1.8	2.2	2.6	J	2.2	µg/L	95% Modified-t UCL	a,g
123-91-1	1,4-Dioxane	µg/L	395	754	2,300	--	754	µg/L	95% KM (Chebyshev) UCL	c
7429-90-5	Aluminum	µg/L	517	1,593	4,680	--	1,593	µg/L	97.5% KM (Chebyshev) UCL	d
7440-38-2	Arsenic	µg/L	2.8	3.8	8.7	--	3.8	µg/L	95% KM (Percentile Bootstrap) UCL	b
7440-39-3	Barium	µg/L	132	221	457	--	221	µg/L	95% Chebyshev (Mean, Sd) UCL	a
71-43-2	Benzene	µg/L	174	670	1,400	--	670	µg/L	99% KM (Chebyshev) UCL	a
56-55-3	Benzo[a]anthracene	µg/L	0.019	0.036	0.048	J	0.036	µg/L	95% KM (t) UCL	a
111-44-4	Bis(2-chloroethyl) Ether	µg/L	112	210	690	--	210	µg/L	95% KM (Chebyshev) UCL	c
80-05-7	Bisphenol A	µg/L	26	58	150	--	58	µg/L	95% KM (t) UCL	b
75-27-4	Bromodichloromethane	µg/L	0.16	0.20	1.1	--	0.20	µg/L	95% KM (t) UCL	a
108-90-7	Chlorobenzene	µg/L	11	17	53	--	17	µg/L	95% GROS Approximate Gamma UCL	c
67-66-3	Chloroform	µg/L	0.32	0.70	7.7	--	0.70	µg/L	95% KM (t) UCL	a
7440-48-4	Cobalt	µg/L	6.2	8.1	15	--	8.1	µg/L	95% KM (t) UCL	b
101-84-8	Diphenyl Ether	µg/L	2.3	3.6	15	J	3.6	µg/L	95% KM (Percentile Bootstrap) UCL	b
74-84-0	Ethane	µg/L	68	341	550	--	341	µg/L	95% Hall's Bootstrap UCL	a
74-85-1	Ethene	µg/L	1.2	6.4	11	--	6.4	µg/L	99% KM (Chebyshev) UCL	a
100-41-4	Ethylbenzene	µg/L	73	288	530	--	288	µg/L	99% KM (Chebyshev) UCL	a
118-74-1	Hexachlorobenzene	µg/L	NC	NC	0.035	--	0.035	µg/L	Maximum Detected Concentration	--
7439-89-6	Iron (total)	µg/L	11,992	23,587	51,500	--	23,587	µg/L	95% KM (Chebyshev) UCL	c
7439-89-6	Iron (dissolved)	µg/L	9,438	18,026	53,900	--	18,026	µg/L	95% KM (Chebyshev) UCL	c
7439-96-5	Manganese (total)	µg/L	585	868	2,610	--	868	µg/L	95% Adjusted Gamma UCL	c
7439-96-5	Manganese (dissolved)	µg/L	597	976	2,420	--	976	µg/L	95% KM (Chebyshev) UCL	c
7439-97-6	Mercury[7]	µg/L	0.087	0.099	0.21	--	0.099	µg/L	95% Modified-t UCL	a,g
74-82-8	Methane	µg/L	3,226	7,149	26,000	--	7,149	µg/L	95% Adjusted Gamma UCL	c
121-69-7	N,N-Dimethylaniline	µg/L	16	27	200	--	27	µg/L	95% KM (t) UCL	b
91-20-3	Naphthalene	µg/L	2.5	3.4	8.4	J	3.4	µg/L	95% KM (% Bootstrap) UCL	d
14797-65-0	Nitrite as N	µg/L	48	134	710	--	134	µg/L	95% Adjusted Gamma KM-UCL	c
98-95-3	Nitrobenzene	µg/L	1.7	4.4	56	--	4.4	µg/L	95% KM (t) UCL	a
103-65-1	n-Propylbenzene	µg/L	6.3	20	88	--	20	µg/L	95% Adjusted Gamma KM-UCL	c
18496-25-8	Sulfide	µg/L	0.46	NA	820	J	820	µg/L	Maximum Detected Concentration	e
109-99-9	Tetrahydrofuran	µg/L	45	128	380	J	128	µg/L	97.5% KM (Chebyshev) UCL	a
108-88-3	Toluene	µg/L	6.6	25	190	--	25	µg/L	95% KM (Chebyshev) UCL	d
79-01-6	Trichloroethene	µg/L	0.23	0.27	1.0	--	0.27	µg/L	95% Approximate Gamma KM-UCL	c
7440-62-2	Vanadium	µg/L	3.0	5.4	16	--	5.4	µg/L	95% KM (t) UCL	b
1330-20-7	Xylenes, Total	µg/L	216	342	2,100	--	342	µg/L	95% KM (Percentile Bootstrap) UCL	b

Footnote Instructions:

(1) Compounds on this table exceed either their respective risk-based screening level residential tap water (cancer benchmark value of 1.0E-06; HQ=0.10) or ARAR or lack an applicable screening value

(2) 95% UCL value is calculated using ProUCL software, Version 5.0. See Attachment B for full ProUCL results table

(3) Maximum Detected Concentrations represent the maximum concentration detected in the primary samples used in the analysis

Revised By: GJG

Checked by: JC

(4) Statistics:

95% Approximate Gamma KM-UCL = approximate gamma UCL using Kaplan-Meier Estimates

95% Adjusted Gamma UCL = adjusted gamma UCL

95% Chebyshev (Mean, Sd) UCL = 95% Chebyshev UCL of mean and standard deviation

95% GROS Adjusted Gamma UCL = adjusted gamma UCL using gamma regression in order statistics

95% GROS Approximate Gamma UCL = approximate gamma UCL using gamma regression in order statistics

95% KM (Chebyshev) UCL = 95% UCL based upon Kaplan-Meier Estimates using the Chebyshev Inequality

95% KM (Percentile Bootstrap) UCL = 95% UCL based upon Kaplan-Meier Estimates using the Percentile Bootstrap Method.

95% KM (t) UCL = UCL based upon Kaplan-Meier Estimates using Student's t-Distribution Critical Value

97.5% KM (Chebyshev) UCL = 97.5% UCL based upon Kaplan-Meier Estimates using the Chebyshev Inequality

99% KM (Chebyshev) UCL = 99% UCL based upon Kaplan-Meier Estimates using the Chebyshev Inequality

(5) EPC Selection Rationale:

a. Data does not follow a discernible distribution. ProUCL recommended values is used as the EPC value

b. Data are normally distributed. ProUCL recommended UCL value is used as the EPC value

c. Data are gamma distributed. ProUCL recommended UCL value is used as the EPC value

d. Data are lognormally distributed. ProUCL recommended UCL value is used as the EPC value

e. ProUCL could not calculate a UCL value. The maximum detected concentration is used

f. Maximum detected concentration was utilized as calculated UCL was greater than the maximum detection

g. Because there was only one detected result for that analyte, the 95UCL was run treating all non-detects as detects using 1/2 the detection limit

(6) J = Analyte Present. Reported value may not be accurate or precise

(7) For mercury and 1,4-dichlorobenzene, only one detected result was reported. Therefore, ProUCL was run w/o non-detects assuming half of the MDL for non-detects

Table 3. Carcinogenic Risk Calculations for the Upper Potomac Aquifer

CAS Number	Chemical of Potential Concern	Exposure Point Concentration (µg/L)	EPA Carcinogenic Residential Tap Water RSLs (µg/L)[1]	Cancer Risk[2]
120-82-1	1,2,4-Trichlorobenzene	0.32	1.2	2.6E-07
95-63-6	1,2,4-Trimethylbenzene	75	NV	NC
107-06-2	1,2-Dichloroethane	0.65	0.17	3.8E-06
108-67-8	1,3,5-Trimethylbenzene	18	NV	NC
106-46-7	1,4-Dichlorobenzene	2.2	0.48	4.6E-06
123-91-1	1,4-Dioxane	754	0.46	1.6E-03
7429-90-5	Aluminum	1,593	NV	NC
7440-38-2	Arsenic	3.8	0.052	7.3E-05
7440-39-3	Barium	221	NV	NC
71-43-2	Benzene	670	0.46	1.5E-03
56-55-3	Benzo[a]anthracene	0.036	0.030	1.2E-06
111-44-4	Bis(2-chloroethyl) Ether	210	0.014	1.5E-02
80-05-7	Bisphenol A	58	NV	NC
75-27-4	Bromodichloromethane	0.20	0.13	1.5E-06
108-90-7	Chlorobenzene	17	NV	NC
67-66-3	Chloroform	0.70	0.22	3.2E-06
7440-48-4	Cobalt	8.1	NV	NC
101-84-8	Diphenyl Ether	3.6	NV	NC
74-84-0	Ethane	341	NV	NC
74-85-1	Ethene	6.4	NV	NC
100-41-4	Ethylbenzene	288	1.5	1.9E-04
118-74-1	Hexachlorobenzene	0.035	0.0098	3.6E-06
7439-89-6	Iron	23,587	NV	NC
7439-96-5	Manganese	868	NV	NC
7439-97-6	Mercury	0.099	NV	NC
74-82-8	Methane	7,149	NV	NC
121-69-7	N,N-Dimethylaniline	27	2.5	1.1E-05
91-20-3	Naphthalene	3.4	0.17	2.0E-05
14797-65-0	Nitrite as N	134	NV	NC
98-95-3	Nitrobenzene	4.4	0.14	3.2E-05
103-65-1	n-Propylbenzene	20	NV	NC
18496-25-8	Sulfide	820	NV	NC
109-99-9	Tetrahydrofuran	128	NV	NC
108-88-3	Toluene	25	NV	NC
79-01-6	Trichloroethene	0.27	0.49	5.5E-07
7440-62-2	Vanadium	5.4	NV	NC
1330-20-7	Xylenes, Total	342	NV	NC
			Cumulative Carcinogenic Risk	**1.8E-02**

Notes:

(1) Screening criteria taken from the EPA Regional Screening Level Tables - Tap Water Screening Levels, Last updated June 2017

(2) Cancer risk is calculated using the following equations: (Exposure Point Concentration (EPC) x 1.0E-06)/RSL

(3) Iron and manganese are based on total value in accordance with Risk Assessment Guidance for Superfund (RAGS) Part A Guidance

(4) NC = Not calculated due to lack of screening value

(5) NV = No appropriate screening value

(6) RSL = EPA Regional Screening Level

Revised By: GJG

Checked by: JC

Table 4. Non-Carcinogenic Hazard Quotient Calculation for the Upper Potomac Aquifer

CAS	Chemical of Potential Concern	Exposure Point Concentration (µg/L)	Ingestion Non-Cancer RSL (THQ = 1.0)[1]	Dermal Non-Cancer RSL (THQ = 1.0)[1]	Inhalation Non-Cancer (THQ = 1.0)[1]	Non-Cancer Hazard Quotient (Ingestion/Dermal)[2]	Target Organ (Ingestion/Dermal)[3]	Reference[3]	Non-Cancer Hazard Quotient (Inhalation)[4]	Target Organ (Inhalation)[3]	Reference[3]
120-82-1	1,2,4-Trichlorobenzene	0.32	200	160	4.2	0.0036	Endocrine (adrenal)	IRIS	0.075	Urinary	PPRTV
95-63-6	1,2,4-Trimethylbenzene	75	200	200	130	0.75	Nervous	IRIS	0.58	Nervous	IRIS
107-06-2	1,2-Dichloroethane	0.65	120	2,800	15	0.0057	Kidney	PPRTV Appendix	0.043	Nervous	PPRTV
108-67-8	1,3,5-Trimethylbenzene	18	200	280	130	0.15	Nervous	IRIS	0.14	Nervous	IRIS
106-46-7	1,4-Dichlorobenzene	2.2	1,400	2,200	1,700	0.0026	Liver	ATSDR	0.0013	Liver	IRIS
123-91-1	1,4-Dioxane	754	600	190,000	63	1.3	Liver/Urinary	IRIS	12	Nervous/Respiratory	IRIS
7429-90-5	Aluminum	1,593	20,000	4,600,000	NV	0.08	Nervous	PPRTV	NC	NA	NA
7440-38-2	Arsenic	3.8	6.0	1,400	NV	0.64	Cardiovascular/Dermal	IRIS	NC	NA	NA
7440-39-3	Barium	221	4,000	64,000	NV	0.059	Urinary	IRIS	NC	NA	NA
71-43-2	Benzene	670	80	600	63	9.5	Immune	IRIS	11	Immune	IRIS
56-55-3	Benzo[a]anthracene	0.036	NV	NV	NV	NC	NA	NA	NC	NA	NA
111-44-4	Bis(2-chloroethyl) Ether	210	NV	NV	NV	NC	NA	NA	NC	NA	NA
80-05-7	Bisphenol A	58	1,000	3,200	NV	0.076	Body Weight	IRIS	NC	NA	NA
75-27-4	Bromodichloromethane	0.20	400	6,500	NV	0.00053	Urinary	IRIS	NC	NA	NA
108-90-7	Chlorobenzene	17	400	1,300	100	0.054	Liver	IRIS	0.17	Kidney	PPRTV
67-66-3	Chloroform	0.70	200	2,500	200	0.0038	Liver	IRIS	0.0035	Liver	ATSDR
7440-48-4	Cobalt	8.1	6.0	3,400	NV	1.3	Thyroid	PPRTV	NC	NA	NA
101-84-8	Diphenyl Ether	3.6	NV	NV	NV	NC	NA	NA	NC	NA	NA
74-84-0	Ethane	341	NV	NV	NV	NC	NA	NA	NC	NA	NA
74-85-1	Ethene	6.4	NV	NV	NV	NC	NA	NA	NC	NA	NA
100-41-4	Ethylbenzene	288	2,000	3,800	2,100	0.22	Liver/Urinary	IRIS	0.14	Developmental	IRIS
118-74-1	Hexachlorobenzene	0.035	16	NV	NV	0.0022	Liver	IRIS	NC	NA	NA
7439-89-6	Iron[5]	23,587	14,000	3,200,000	NV	1.7	GI Tract	PPRTV	NC	NA	NA
7439-96-5	Manganese[5,6]	868	480	4,400	NV	2.0	Nervous	IRIS	NC	NA	NA
7439-97-6	Mercury[7]	0.099	6.0	96	NV	0.017	Immune	IRIS	NC	NA	NA
74-82-8	Methane	7,149	NV	NV	NV	NC	NA	NA	NC	NA	NA
121-69-7	N,N-Dimethylaniline	27	40	310	NV	0.75	Spleen	IRIS	NC	NA	NA
91-20-3	Naphthalene	3.4	400	700	6.3	0.013	Body Weight	IRIS	0.53	Nervous/Respiratory	IRIS
14797-65-0	Nitrite as N	134	2,000	460,000	NV	0.067	Blood	IRIS	NC	NA	NA
98-95-3	Nitrobenzene	4.4	40	620	19	0.12	Blood	IRIS	0.23	Nervous/Respiratory	IRIS
103-65-1	n-Propylbenzene	20	2,000	1,800	2,100	0.021	Liver/Urinary	PPRTV Appendix	0.0095	Developmental	PPRTV Appendix
18496-25-8	Sulfide	820	NV	NV	NV	NC	NA	NA	NC	NA	NA
109-99-9	Tetrahydrofuran	128	18,000	1,700,000	4,200	0.0072	Developmental	IRIS	0.030	Liver/Nervous	IRIS
108-88-3	Toluene	25	1,600	5,300	10,000	0.020	Urinary	IRIS	0.0025	Nervous	IRIS
79-01-6	Trichloroethene	0.27	10	69	4.2	0.031	Cardiovascular/Immune/ Developmental	IRIS	0.065	Cardiovascular/Immune/ Developmental	IRIS
7440-62-2	Vanadium[8]	5.4	100	600	NV	0.063	Dermal (hair)[9]	IRIS	NC	Respiratory	ATSDR
1330-20-7	Xylenes, Total	342	4,000	7,500	210	0.13	Body Weight	IRIS	1.6	Nervous	IRIS
					Ingestion/Dermal Hazard Index	**19**		**Inhalation Hazard Index**	**26**	**Cumulative Hazard Index**	**45**

Notes:

(1) Screening Criteria taken from the U.S.EPA Regional Screening Level Tables - Tap Water Screening Levels, Last updated June 2017

(2) Ingestion Dermal Hazard Quotient is calculated using the following equation: (EPC x THQ)/(ingestion RSL) + (EPC x THQ)/(Dermal RSL)

(3) Target organs and references are taken from the U.S.EPA Regional Screening Level Tables - Screening Level Calculation Tool. Last updated June 2017

(4) Inhalation Hazard Quotient is calculated using the following equation: (EPC x THQ)/(inhalation RSL)

(5) Iron and manganese are based on total value in accordance with RAGS A Guidance

(6) Screening value for manganese is taken from "Manganese - Non-dietary"

(7) Screening values for mercury are taken from "mercuric chloride"

(8) Screening values for vanadium are taken from "vanadium and compounds"

ATSDR = Agency for Toxic Substances and Disease Registry

GI = Gastrointestinal

IRIS = Integrated Risk Information System value

NA = Not applicable

NC = Not calculated due to lack of screening value

NOAEL = No observable adverse effect level

NV = No appropriate screening value

PPRTV = EPA Provisional peer-reviewed value

PPRTV Appendix = EPA Provisional peer-reviewed value Appendix

RSL = EPA Regional Screening Level

Revised By: GJG

Checked by: JC

Table 5. Target Organ Specific Non-Cancer Hazard Index Calculation for the Upper Potomac Aquifer

CAS	Chemical of Potential Concern	Exposure Point Concentration (µg/L)	Non-Cancer Hazard Quotient (Ingestion/Dermal)[1]	Non-Cancer Hazard (Inhalation)[1]	Non-Cancer Hazard Quotient (Ingestion/Dermal/Inhalation)[2]	Is target organ HI greater than 1.0 and the COPC-Specific HQ Greater than 0.1?
Blood						
14797-65-0	Nitrite as N	134	0.067	NC	0.067	No
98-95-3	Nitrobenzene	4.4	0.12	NC	0.12	No
				Target Organ-Specific HI	**0.19**	
Body Weight						
80-05-7	Bisphenol A	58	0.076	NC	0.076	No
91-20-3	Naphthalene	3.4	0.013	NC	0.013	No
1330-20-7	Xylenes, Total	342	0.13	NC	0.13	No
				Target Organ-Specific HI	**0.22**	
Cardiovascular						
7440-38-2	Arsenic	3.8	0.64	NC	0.64	No
79-01-6	Trichloroethene	0.27	0.031	0.065	0.096	No
				Target Organ-Specific HI	**0.73**	
Developmental						
100-41-4	Ethylbenzene	288	NC	0.14	0.14	No
103-65-1	n-Propylbenzene	20	NC	0.0095	0.0095	No
109-99-9	Tetrahydrofuran	128	0.0072	NC	0.0072	No
79-01-6	Trichloroethene	0.27	0.031	0.065	0.096	No
				Target Organ-Specific HI	**0.25**	
Endocrine (adrenal)						
120-82-1	1,2,4-Trichlorobenzene	0.32	0.0036	NC	0.0036	No
				Target Organ-Specific HI	**0.0036**	
GI Tract						
7439-89-6	Iron	23,587	1.7	NC	1.7	Yes
				Target Organ-Specific HI	**1.7**	
Hair						
7440-62-2	Vanadium	5.4	0.063	NC	0.063	No
				Target Organ-Specific HI	**0.063**	
Immune						
71-43-2	Benzene	670	9.5	11	20	Yes
7439-97-6	Mercury	0.099	0.017	NC	0.017	No
79-01-6	Trichloroethene	0.27	0.031	0.065	0.096	No
				Target Organ-Specific HI	**20**	
Kidney						
107-06-2	1,2-Dichloroethane	0.65	0.0057	NC	0.0057	No
108-90-7	Chlorobenzene	17	NC	0.17	0.17	No
				Target Organ-Specific HI	**0.17**	
Liver						
106-46-7	1,4-Dichlorobenzene	2.2	0.0026	0.0013	0.0039	No
123-91-1	1,4-Dioxane	754	1.3	NC	1.3	Yes
108-90-7	Chlorobenzene	17	0.054	NC	0.054	No
67-66-3	Chloroform	0.70	0.0038	0.0035	0.0073	No
100-41-4	Ethylbenzene	288	0.22	NC	0.22	Yes
118-74-1	Hexachlorobenzene	0.035	0.0022	NC	0.0022	No
103-65-1	n-Propylbenzene	20	0.021	NC	0.021	No
109-99-9	Tetrahydrofuran	128	NC	0.030	0.030	No
				Target Organ-Specific HI	**1.6**	
Nervous						
107-06-2	1,2-Dichloroethane	0.65	NC	0.043	0.043	No
95-63-6	1,2,4-Trimethylbenzene	75	0.75	0.58	1.3	Yes
108-67-8	1,3,5-Trimethylbenzene	18	0.15	0.14	0.29	Yes
123-91-1	1,4-Dioxane	754	NC	12	12	Yes
7429-90-5	Aluminum	1,593	0.08	NC	0.08	No
7439-96-5	Manganese	868	2.0	NC	2.0	Yes
91-20-3	Naphthalene	3.4	NC	0.53	0.53	Yes
98-95-3	Nitrobenzene	4.4	NC	0.23	0.23	Yes
109-99-9	Tetrahydrofuran	128	NC	0.030	0.030	No
108-88-3	Toluene	25	NC	0.0025	0.0025	No
1330-20-7	Xylenes, Total	342	NC	1.6	1.6	Yes
				Target Organ-Specific HI	**18**	
Respiratory						
123-91-1	1,4-Dioxane	754	NC	12	12	Yes
91-20-3	Naphthalene	3.4	NC	0.53	0.53	Yes
98-95-3	Nitrobenzene	4.4	NC	0.23	0.23	Yes
				Target Organ-Specific HI	**13**	
Skin						
7440-38-2	Arsenic	3.8	0.64	NC	0.64	No
				NC - Not Calculated	**0.64**	
Spleen						
121-69-7	N,N-Dimethylaniline	27	0.75	NC	0.75	No
				Target Organ-Specific HI	**0.75**	
Thyroid						
7440-48-4	Cobalt	8.1	1.3	NC	1.3	Yes
				Target Organ-Specific HI	**1.3**	
Urinary						
120-82-1	1,2,4-Trichlorobenzene	0.32	NC	0.075	0.075	No
123-91-1	1,4-Dioxane	754	1.3	NC	1.3	Yes
7440-39-3	Barium	221	0.059	NC	0.059	No
75-27-4	Bromodichloromethane	0.20	0.00053	NC	0.00053	No
100-41-4	Ethylbenzene	288	0.22	NC	0.22	Yes
103-65-1	n-Propylbenzene	20	0.021	NC	0.021	No
108-88-3	Toluene	25	0.020	NC	0.020	No
				Target Organ-Specific HI	**1.7**	

Notes:

(1) As provided on Table 4

(2) Sum of the ingestion, dermal, and inhalation HQs

(3) NC = Not Calculated

Revised By: GJG

Checked by: JC

Table 6. Selection of Chemicals of Concern for the Upper Potomac Aquifer

CAS	Chemical of Potential Concern	Exposure Point Concentration (µg/L)	Carcinogenic Risk	Target Organ Specific Non-Carcinogenic Hazard Quotient[1]	Does the COPC meet the conditions to be considered a COC?[2]	Notes
120-82-1	1,2,4-Trichlorobenzene	0.32	2.6E-07	0.075	N	Does not meet COC Selection Criteria
95-63-6	1,2,4-Trimethylbenzene	75	NC	1.3	Y	Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
107-06-2	1,2-Dichloroethane	0.65	3.8E-06	0.043	Y	Exceeds 1.0E-06 Cancer Risk
108-67-8	1,3,5-Trimethylbenzene	18	NC	0.29	Y	Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
106-46-7	1,4-Dichlorobenzene	2.2	4.6E-06	0.0039	Y	Exceeds 1.0E-06 Cancer Risk
123-91-1	1,4-Dioxane	754	1.6E-03	12	Y	Exceeds 1.0E-06 Cancer Risk/Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
7429-90-5	Aluminum	1,593	NC	0.080	N	Does not meet COC Selection Criteria
7440-38-2	Arsenic	3.8	7.3E-05	0.64	Y	Exceeds 1.0E-06 Cancer Risk
7440-39-3	Barium	221	NC	0.059	N	Does not meet COC Selection Criteria
71-43-2	Benzene	670	1.5E-03	20	Y	Exceeds 1.0E-06 Cancer Risk/Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
56-55-3	Benzo[a]anthracene	0.036	1.2E-06	NC	N	EPC based on anomalous detections/Low frequency of detection/Not detected prior to or since 2012
111-44-4	Bis(2-chloroethyl) Ether	210	1.5E-02	NC	Y	Exceeds 1.0E-06 Cancer Risk
80-05-7	Bisphenol A	58	NC	0.076	N	Does not meet COC Selection Criteria
75-27-4	Bromodichloromethane	0.20	1.5E-06	0.00053	N	EPC based on anomalous detections/Low frequency of detection/Not site related
108-90-7	Chlorobenzene	17	NC	0.17	N	Does not meet COC Selection Criteria
67-66-3	Chloroform	0.70	3.2E-06	0.0073	Y	Exceeds 1.0E-06 Cancer Risk
7440-48-4	Cobalt	8.1	NC	1.3	Y	Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
101-84-8	Diphenyl Ether	3.6	NC	NC	N	Does not meet COC Selection Criteria
74-84-0	Ethane	341	NC	NC	N	Does not meet COC Selection Criteria
74-85-1	Ethene	6.4	NC	NC	N	Does not meet COC Selection Criteria
100-41-4	Ethylbenzene	288	1.9E-04	0.22	Y	Exceeds 1.0E-06 Cancer Risk/Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
118-74-1	Hexachlorobenzene	0.035	3.6E-06	0.0022	N	EPC lower than MCL/Low frequency of detection
7439-89-6	Iron	23,587	NC	1.7	Y	Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
7439-96-5	Manganese	868	NC	2.0	Y	Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
7439-97-6	Mercury	0.099	NC	0.017	N	Does not meet COC Selection Criteria
74-82-8	Methane	7,149	NC	NC	N	Does not meet COC Selection Criteria
121-69-7	N,N-Dimethylaniline	27	1.1E-05	0.75	Y	Exceeds 1.0E-06 Cancer Risk
91-20-3	Naphthalene	3.4	2.0E-05	0.53	Y	Exceeds 1.0E-06 Cancer Risk/Exceeds an HQ of 0.1 for a target organ HI greater than 1.0
14797-65-0	Nitrite as N	134	NC	0.067	N	Does not meet COC Selection Criteria
98-95-3	Nitrobenzene	4.4	3.2E-05	0.23	N	EPC based on anomalous detections/Low frequency of detection/Not detected since 2012
103-65-1	n-Propylbenzene	20	NC	0.021	N	Does not meet COC Selection Criteria
18496-25-8	Sulfide	820	NC	NC	N	Does not meet COC Selection Criteria
109-99-9	Tetrahydrofuran	128	NC	0.030	N	Does not meet COC Selection Criteria
108-88-3	Toluene	25	NC	0.020	N	Does not meet COC Selection Criteria
79-01-6	Trichloroethene	0.27	5.5E-07	0.096	N	Does not meet COC Selection Criteria
7440-62-2	Vanadium	5.4	NC	0.063	N	Does not meet COC Selection Criteria
1330-20-7	Xylenes, Total	342	NC	1.6	Y	Exceeds an HQ of 0.1 for a target organ HI greater than 1.0

Notes:

(1) For non-carcinogenic, maximum HQs are presented for only those COPCs that contribute to a target organ HI of 1.0 or greater

(2) COCs are defined as those COPCs that meet any of the following criteria

- COPCs with an associated cancer risk greater than 1.0E-06 if the cumulative cancer risk is greater than 1.0E-04
- COPCs with an associated HQ of 0.1 or greater for a target organ with an HI of 1.0 or greater

(3) COC = Chemical of Concern

(4) HI = Hazard Index

(5) HQ = Hazard Quotient

(6) NA = Not applicable

(7) NC = Not calculated

Revised By: GJG

Checked by: JC

Table 7. Summary of Preliminary Remediation Goals for the Upper Potomac Aquifer

CAS	Chemical of Concern[1]	Exposure Point Concentration (µg/L)	Applicable or Relevant and Appropriate Requirement		Carcinogenic Preliminary Remediation Goals (µg/L)				Non-Carcinogenic Preliminary Remediation Goals (µg/L)					Selected PRG (µg/L)[3]	Notes[4]	Cancer Risk Associated with the Selected PRG	Hazard Quotient Associated with the Selected PRG
			Value (µg/L)	Source	Cancer Risk	PRG (Target Risk of 1.0E-06)	PRG (Target Risk of 1.0E-05)	PRG (Target Risk of 1.0E-04)	Target Organ-Specific Non-Cancer Hazard	PRG (THQ of 0.1)	Site-Specific THQ[2]	Target Organ	Site-Specific Non-Cancer PRG				
95-63-6	1,2,4-Trimethylbenzene	75	NA	NA	NC	NA	NA	NA	1.3	5.7	0.10	Nervous	5.7	**5.7**	COC-specific Non-Carcinogenic PRG	--	0.1
107-06-2	1,2-Dichloroethane	0.65	5.0	MCL	3.8E-06	0.17	1.7	17	NC	NV	NA	NA	NA	**NA**	PRG was not developed	4E-06	--
108-67-8	1,3,5-Trimethylbenzene	18	NA	NA	NC	NA	NA	NA	0.29	6.1	0.10	Nervous	6.1	**6.1**	COC-specific Non-Carcinogenic PRG	--	0.1
106-46-7	1,4-Dichlorobenzene	2.2	75	MCL	4.6E-06	0.48	4.8	48	NC	NV	NA	NA	NA	**NA**	PRG was not developed	5E-06	0.004
123-91-1	1,4-Dioxane	754	NA	NA	1.6E-03	0.46	4.6	46	1.3	60	1.0	Liver/Urinary	598	**4.6**	Carcinogenic PRG with a Target Risk of 1.0E-05	1E-05	0.008
123-91-1	1,4-Dioxane (inhalation)	754	NA	NA	1.6E-03	0.46	4.6	46	12	6.3	1.0	Nervous/Respiratory	63	**4.6**	Carcinogenic PRG with a Target Risk of 1.0E-05	see above	0.07
7440-38-2	Arsenic	3.8	10	MCL	7.3E-05	0.052	0.52	5.2	NC	NV	NA	NA	NA	**0.52**	Carcinogenic PRG with a Target Risk of 1.0E-05	1E-05	--
71-43-2	Benzene	670	5.0	MCL	1.5E-03	0.46	4.6	46	20	3.3	1.0	Immune	33	**4.6**	Carcinogenic PRG with a Target Risk of 1.0E-05	1E-05	0.1
111-44-4	Bis(2-chloroethyl) Ether	210	NA	NA	1.5E-02	0.014	0.14	1.4	NC	NV	NA	NA	NA	**0.14**	Carcinogenic PRG with a Target Risk of 1.0E-05	1E-05	--
67-66-3	Chloroform	0.70	80	MCL	3.2E-06	0.22	2.2	22	NC	NV	NA	NA	NA	**NA**	PRG was not developed	3E-06	0.007
7440-48-4	Cobalt	8.1	NA	NA	NC	NA	NA	NA	1.3	0.60	1.0	Thyroid	6.0	**6.0**	COC-specific Non-Carcinogenic PRG	--	1
100-41-4	Ethylbenzene	288	700	MCL	1.9E-04	1.5	15	150	0.22	131	1.0	Liver/Urinary	1,310	**15**	Carcinogenic PRG with a Target Risk of 1.0E-05	1E-05	0.01
118-74-1	Hexachlorobenzene	0.035	1	MCL	3.6E-06	0.0098	0.098	0.98	NC	NV	NV	NA	NA	**NA**	PRG was not developed	4E-06	0.002
7439-89-6	Iron	23,587	NA	NA	NC	NA	NA	NA	1.7	1,394	1.0	GI Tract	13,939	**13,939**	COC-specific Non-Carcinogenic PRG	--	1
7439-96-5	Manganese	868	NA	NA	NC	NA	NA	NA	2.0	43	0.6	Nervous	260	**260**	COC-specific Non-Carcinogenic PRG	--	0.6
121-69-7	N,N-Dimethylaniline	27	NA	NA	1.1E-05	2.5	25	250	NC	NV	NA	NA	NA	**25**	Carcinogenic PRG with a Target Risk of 1.0E-05	1E-05	--
91-20-3	Naphthalene (Inhalation)	3.4	NA	NA	2.0E-05	0.17	1.7	17	0.53	0.63	0.10	Nervous/Respiratory	0.63	**0.63**	COC-specific Non-Carcinogenic PRG	--	0.1
1330-20-7	Xylenes, Total (Inhalation)	342	10,000	MCL	NC	NA	NA	NA	1.6	21	0.10	Nervous	21	**21**	COC-specific Non-Carcinogenic PRG	--	0.1

Risk	Hazard Index
8E-05	**3.2**

Notes:

(1) For those COCs with different target organ effects between the ingestion/dermal and inhalation pathways, the COC was listed twice so that each pathway could be evaluated separately for non-carcinogenic. Carcinogens were only evaluated once.

(2) Site-Specific Target Hazard Quotients were selected for only those COCs that contribute to a target organ-specific HI of greater than 1.0

(3) PRGs were selected using the following criterion - The lower values of the non-carcinogenic PRG (COC-specific THQ) and the carcinogenic PRG (Target Risk of 1.0E-05) or the MCL, such that the cumulative risk from COCs at the PRG does not exceed a risk of 1.0E-04 or target organ specific HQ of 1.0.

(4) PRGs were not developed because the associated cancer risk for that COC was less than 1.0E-05, or the non-cancer HQ was less than 0.1 for a target organ with an HI greater than 1.0, or was associated with a target organ HI that was less than 1.0

(5) HI = Hazard Index

(6) MCL = Maximum Contaminant Limit

(7) NA = Not applicable

(8) NC = Not calculated

(9) NOAEL = No observable adverse effect level

(10) NV = No value

(11) PRG = Preliminary Remediation Goal

(12) THQ = Target hazard quotient

Revised By: GJG

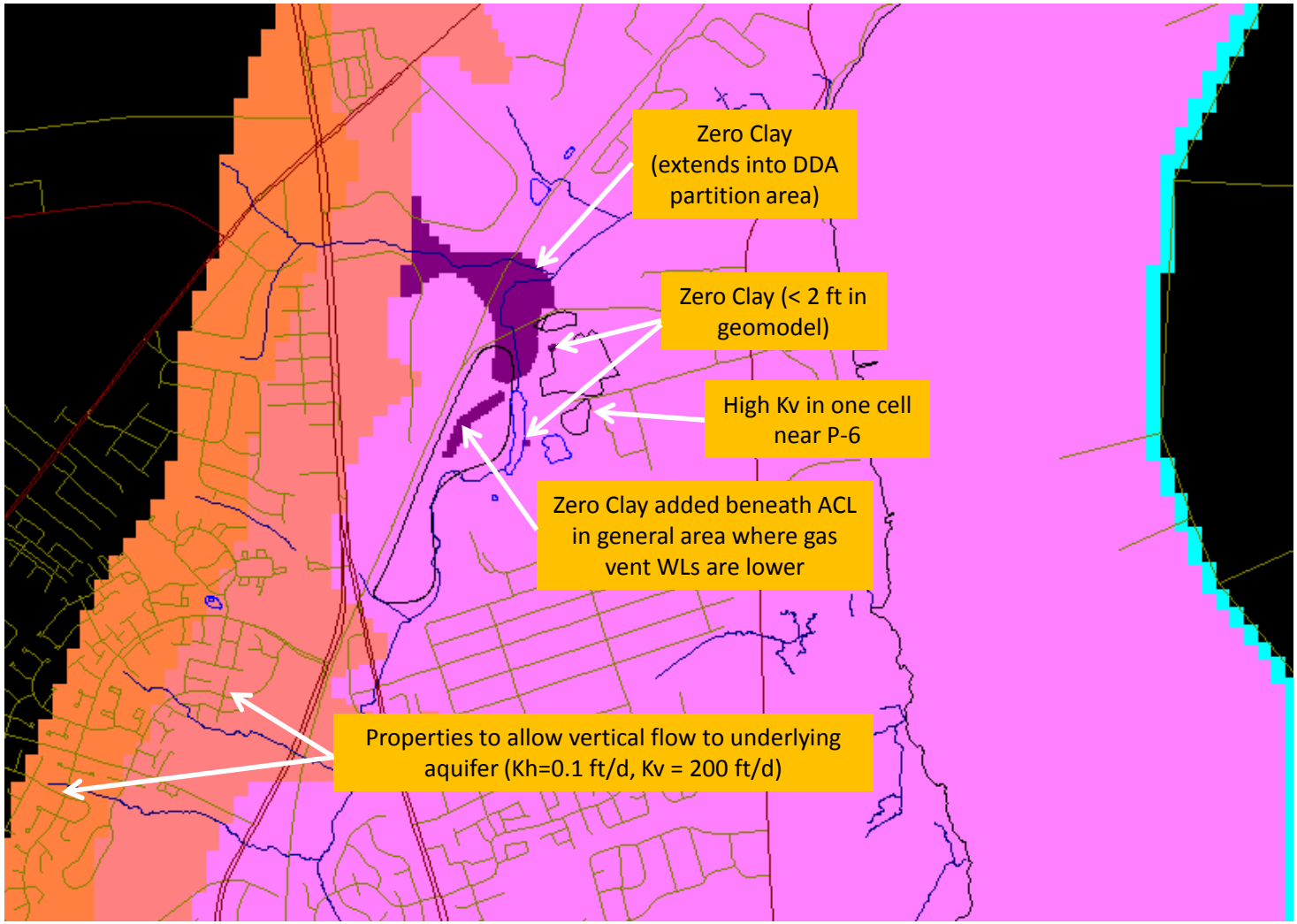
Checked by: JC

Target Organ Specific HI	
Immune	0.1
GI Tract	1
Liver	0.03
Nervous	1
Thyroid	1
Urinary	0.02

APPENDIX B

Depiction of Zero-Clay Areas

K Zones – Layer 2



APPENDIX C

Potential Exposure Pathways

Table 2
Potential Exposure Pathways
Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Source Area Timeframe	Medium	Exposure Medium	Exposure Points	Receptor Population	Receptor Age	Exposure Route	Rationale for Selection or Exclusion of Exposure Pathway
Drum Disposal Area (DDA)/ Future	Groundwater	Groundwater	Groundwater (Columbia and Upper Potomac Aquifers)	Construction/Excavation Worker	Adult	Ingestion	Potential impacts to groundwater. If excavation breaches impacted groundwater, exposure may occur.
						Dermal Contact	
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Construction/Excavation Worker	Adult	Ingestion	Source material in subsurface soil. If excavation occurs to depth of impacts, exposure may occur.
						Dermal Contact	
						Inhalation (particulates)	
	Shallow Groundwater/Soil Vapor	Air	Trench Air	Construction/Excavation Worker	Adult	Inhalation (VOCs)	VOCs in groundwater may accumulate in trench air during excavation activities.
	Groundwater	Tap water	Water Supply Well	Residential	Adult	Ingestion	Known impacts to groundwater and location of residential structure between the Inert Area and Grantham South.
						Dermal Contact	
						Inhalation (VOCs)	
				Residential	Child	Ingestion	Known impacts to groundwater and location of residential structure between the Inert Area and Grantham South.
						Dermal Contact	
				Industrial/Commercial Worker	Adult	Ingestion	Known impacts to groundwater and location of a commercial building immediately south of the Inert Area. There is a treatment system building near the DDA over groundwater contamination.
						Dermal Contact	
	Soil Vapor	Indoor Air	Indoor Air	Residential	Adult	Inhalation (VOCs)	Known impacts of VOCs in groundwater.
				Residential	Child	Inhalation (VOCs)	
				Industrial/Commercial Worker	Adult	Inhalation (VOCs)	
Grantham South and Inert Area/ Present and Future	Shallow Groundwater/Soil Vapor	Indoor Air	Groundwater (Columbia Aquifer)	Residential	Adult	Inhalation (VOCs)	Potential impacts of VOCs in groundwater.
				Residential	Child	Inhalation (VOCs)	
				Industrial/Commercial Worker	Adult	Inhalation (VOCs)	
	Shallow Groundwater/Soil Vapor	Air	Trench Air	Construction/Excavation Worker	Adult	Inhalation (VOCs)	VOCs in groundwater may accumulate in trench air during excavation activities.
	Groundwater	Groundwater	Groundwater (Columbia Aquifer)	Construction/Excavation Worker	Adult	Ingestion	Potential impacts to groundwater. If excavation breaches impacted groundwater, exposure may occur.
						Dermal Contact	
	Groundwater	Tap water	Water Supply Well	Residential	Adult	Ingestion	Known impacts to groundwater and location of residential structure between the Inert Area and Grantham South.
						Dermal Contact	
						Inhalation (VOCs)	
				Residential	Child	Ingestion	Known impacts to groundwater and location of residential structure between the Inert Area and Grantham South.
						Dermal Contact	
				Industrial/Commercial Worker	Adult	Ingestion	Known impacts to groundwater and location of a commercial building immediately south of the Inert Area. There is a treatment system building near the DDA over groundwater contamination.
						Dermal Contact	
	Landfill Gas	Indoor Air	Landfill Gas	Residential	Adult	Inhalation (VOCs)	Potential impacts of VOCs in migration of landfill gas, explosion hazard.
						Explosion Hazard	
				Residential	Child	Inhalation (VOCs)	
						Explosion Hazard	
				Industrial/Commercial Worker	Adult	Inhalation (VOCs)	
						Explosion Hazard	

Notes:

VOCs = volatile organic compounds

Prepared by: GJG

Checked by: TAM

APPENDIX D

ARARs Table

Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Materials (TBCs)
Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Requirement	Legal Citation	Classification	Summary of Requirement	Applicability to Selected Remedy
Safe Drinking Water Act Maximum Contaminant Level Goals (MCLGs)	42 U.S.C. § 300f et seq. 40 CFR §§ 141.50-.51	Relevant and Appropriate	MCLGs are non-enforceable health goals for public drinking water supply systems which have at least 15 service connections or are used by at least 25 persons. The National Contingency Plan (NCP) requires that remedial actions taken to protect groundwater that is a current or potential source of drinking water must meet non-zero MCLGs for each constituent of concern for which they exist, where they are relevant and appropriate.	The Upper Potomac Aquifer is used as a source of drinking water. Therefore, MCLGs are relevant and appropriate requirements for those Site-related contaminants for which there are non-zero MCLGs.
		Applicable		Artesian Water Company extracts groundwater from the Upper Potomac Aquifer and distributes the water to the public as drinking water (after treatment). Therefore, MCLGs are applicable requirements at Artesian's Llangollen well field for those Site-related contaminants for which there are non-zero MCLGs.
Safe Drinking Water Act Maximum Contaminant levels (MCLs)	42 U.S.C. § 300f et seq. 40 CFR §§ 141.11-.12 and 141.61-.62	Relevant and Appropriate	MCLs are enforceable standards for public drinking water supply systems which have at least 15 service connections or are used by at least 25 persons. The NCP requires that remedial actions taken to protect groundwater that is a current or potential source of drinking water must meet the MCL for each constituent of concern if the MCLG is set at a level of zero and MCLs are relevant and appropriate under the circumstances of the site.	The Upper Potomac Aquifer is used as a source of drinking water. Therefore, MCLs are relevant and appropriate requirements for those Site-related contaminants for which there are no non-zero MCLGs and there are effective MCLs.
		Applicable		Artesian Water Company extracts groundwater from the Upper Potomac Aquifer and distributes the water to the public as drinking water (after treatment). Therefore, MCLs are applicable requirements at Artesian's Llangollen well field for those Site-related contaminants for which there are no non-zero MCLGs and there are effective MCLs.
Delaware Maximum Contaminant Levels (MCLs)	16 DE Admin. Code 4462 Public Drinking Water Systems, Appendix A to Section 6.0 – Regulated Contaminants	Relevant and Appropriate	Delaware's MCLs are enforceable standards for all public water systems in the State of Delaware.	CERCLA §121 requires on-site remedial actions to attain promulgated state ARARs that are more stringent than federal ARARS. Delaware's drinking water standards for tetrachloroethylene (PCE), trichloroethylene (TCE), vinyl chloride and methyl tert-butyl ether (MTBE) are more stringent than federal drinking water standards. Therefore, they are relevant and appropriate requirements for restoration of the Upper Potomac Aquifer.
		Applicable		CERCLA §121 requires on-site remedial actions to attain promulgated state ARARs that are more stringent than federal ARARS. Delaware's drinking water standards for PCE, TCE, vinyl chloride and MTBE are more stringent than federal drinking water standards. Therefore, they are applicable requirements at Artesian's Llangollen well field.
Drinking Water Standards and Health Advisories, 2012 Edition, EPA Office of Drinking Water	EPA 822-S-12-001	To be Considered	The Health Advisories in this document serve as the informal technical guidance for unregulated drinking water contaminants to assist federal, state and local officials and managers of public or community water systems in protecting public health, as needed. The health advisories are non-enforceable guidelines for public water supply systems.	The Upper Potomac Aquifer is used as a source of drinking water. Therefore, the drinking water advisories are to be considered in implementing response actions at the Site. Furthermore, Artesian Water Company extracts groundwater from the Upper Potomac Aquifer and distributes the water to the public as drinking water (after treatment). Therefore, the drinking water advisories are to be considered with respect to treatment requirements at Artesian's Llangollen well field.
EPA Regional Screening Level (RSL) Tables	No legal citation. Source: https://www.epa.gov/risk/regional-screening-levels-rsls	To Be Considered	Risk-based screening levels are derived from equations combining exposure assumptions with chemical-specific toxicity values.	The May 2014 RSLs for tap water were used to develop the PRGs for the Upper Potomac Aquifer groundwater. Tap water RSLs are to be considered because the Upper Potomac Aquifer is used as a source of drinking water. However, these standards may be more stringent than applicable state standards and are not considered cleanup standards by EPA. RSLs are also to be considered when assessing risk associated with potential vapor intrusion at habitable structures adjacent to the landfilled areas.
Surface Water Quality Standards	7 DE Admin. Code 7401 Surface Water Quality Standards	Applicable	It is DNREC's policy to maintain within its jurisdiction surface waters of the State of satisfactory quality consistent with public health and public recreation purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of the water.	Army Creek is a surface water of the State of Delaware. Pursuant to 7 DE Admin. Code 7401 Section 3.0, its designated uses are primary and secondary contact recreation, and the propagation and protection of fish, aquatic life and wildlife. Therefore, all criteria for protection of these beneficial uses of surface water must be met by any point source discharges during construction of the Selected Remedy, e.g., as a result of dewatering activities during pipeline construction.
Delaware Wetlands Regulations	7 DE Admin. Code 7502 Wetlands Regulations	Applicable	Regulations to preserve and protect productive public and private wetlands and to prevent their despoliation and destruction consistent with the historic right of private ownership of lands.	This requirement is applicable to the extent that the pipeline from the groundwater extraction wells extends through areas of wetlands. Actions would be needed to address and avoid the potential long and short term adverse effects to wetlands.
Coastal Zone Management Act of 1972; Reauthorization Amendments of 1990; last amended February 1, 2010	16 U.S.C. § 1456(c)	Applicable	Federal activities affecting the coastal zone must be conducted in a manner consistent with approved state coastal management programs.	The Site is located within Delaware's coastal zone. The Selected Remedy will be implemented in a manner that is consistent, to the maximum extent practicable, with the substantive requirements of Delaware's Coastal Management Program.
Delaware Coastal Zone Act; Regulations Governing Delaware's Coastal Zone	7 Delaware Code, Chapter 70; Regulations of May 11, 1999, amended on October 1, 2001.	Applicable	These regulations specify the permitting requirements for existing non-conforming uses already in the coastal zone and for new manufacturing uses proposing to locate within Delaware's coastal zone.	The Site is located within Delaware's coastal zone. Therefore, the substantive requirements of the regulations apply to the Selected Remedy.
Delaware Coastal Management Program Federal Consistency Policies and Procedures	7 DE Admin. Code 108 § 2.0	Applicable	The Federal Coastal Zone Management Act of 1972, as amended, provides that each federal agency conducting or supporting activities affecting any land or water use or natural resource of the coastal zone must do so in a manner which is, to the maximum extent practicable, consistent with each state's coastal zone management program.	The Site is located within Delaware's coastal zone. Therefore, remedial activities are required to be consistent, to the maximum extent practicable, with Delaware's Coastal Management Program. EPA must provide the Delaware Coastal Management Program with its consistency determination at the earliest practicable time.

Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Materials (TBCs)
Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Requirement	Legal Citation	Classification	Summary of Requirement	Applicability to Selected Remedy
Endangered Species Act	16 U.S.C §§ 1533 and 1536	Relevant and Appropriate	Requires federal agencies to ensure that any action authorized by an agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat.	A review of threatened or endangered species will be performed during the remedial design phase to determine if any threatened or endangered species are present at or in the vicinity of the Site. If so, the Selected Remedy will need to implemented in a manner which is not likely to jeopardize those threatened or endangered species.
Clean Water Act: National Pollutant Discharge Elimination System (NPDES)	33 U.S.C. § 1342 et seq.	Applicable	Substantive and enforceable standards for all on-site point source discharges to waters of the United States. Best management practices must be used and appropriate monitoring performed to ensure that storm water runoff does not cause an exceedance of water quality standards in a receiving surface water body.	Discharge limits shall be met by any point source discharge during construction activities, including clearing, grading, and excavating, that will disturb between one and five acres of land. A storm water management plan, subject to EPA approval, is required for this project.
Purpose and scope	40 CFR 122.1(b)(1)			
Storm water discharges	40 CFR 122.26(b)(15)			
New sources and new dischargers	40 CFR 122.29			
Establishing limitations, standards, and other permit conditions	40 CFR 122.44			
Calculating NPDES permit conditions	40 CFR 122.45			
The National Pollutant Discharge Elimination System (NPDES) Program I	7 DE Admin. Code 7201 Surface Water Discharge Section: Regulations Governing the Control of Water Pollution, Section 6.0	Applicable	These regulations seek to prevent, manage and/or control the pollution from activities that affect or have the reasonable potential to affect the quality of surface water and groundwater.	These standards are applicable to discharge to surface water from dewatering activities during pipeline construction activities.
Sediment and Storm Water Regulations	7 DE Admin. Code 5101 §§ 1.3 and 1.4	Applicable	Establishes management programs for construction projects that disturb more than 5,000 square feet of land.	Substantive requirements of the general storm water permit program for storm water discharges associated with construction activities will be met if remedial action construction activities at the Site, including installation of conveyance piping, will disturb more than 5,000 square feet of land. No permit will be required.
Particulate Emissions from Construction and Materials Handling	7 DE Admin. Code 1106 Particulate Emissions from Construction and Materials Handling, Sections 3.0, 4.0 and 6.0	Applicable	No person shall cause or allow land clearing, land grading, excavation, or the use of non-paved roads on private property unless methods, such as the application of water, are employed to control dust emission, when such activities could emit dust in quantities sufficient to cause air pollution.	Grading, land clearing, excavation, material movement and material storage shall be conducted in a manner which adequately controls particulate emissions.
General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403.5 and .6	Applicable	Establishes responsibilities of federal, state, and local government, industry and the public to implement National Pretreatment Standards to control pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge.	Groundwater discharged to the Wilmington Wastewater Treatment Plant will comply with effluent limitations established by New Castle County and the City of Wilmington to meet the substantive requirements of Delaware's NPDES Program and will meet any pretreatment standards established by New Castle County and the City of Wilmington in accordance with the NPDES General Pretreatment Regulations for Existing and New Sources of Pollution.
Delaware River Basin Commission Basin (DRBC) Administrative Manual - Rules of Practice and Procedure	18 CFR 401.32 and .35(a)(2)	Applicable	No project having a substantial effect on the water resources of the Basin shall be undertaken without the approval of the DRBC.	The project entails groundwater withdrawals exceeding 100,000 gpd and, pursuant to 18 CFR 401.35(a)(2), is not excepted from review under Section 3.8 of the Delaware River Basin Compact. However, extracted groundwater will be discharged to the Wilmington Wastewater Treatment Plant and will remain in the Basin. Therefore, the withdrawal will be a Category F withdrawal, pursuant to Appendix A of the Administrative Agreement between DRBC and DNREC, and the project will be reviewed by DNREC, only, without DRBC comment, pursuant to Section IV.C.4 of the Administrative Agreement.
Office of Solid Waste and Emergency Response (OSWER) Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air	OSWER Publication 9200.2-154, June 2015	To Be Considered	This document describes EPA's recommended framework for assessing vapor intrusion by collecting and evaluating multiple lines of evidence to support risk management decisions. It also provides technical recommendations for monitoring and terminating building mitigation systems.	These recommendations are to be considered when assessing and mitigating vapor intrusion at habitable structures adjacent to the landfilled areas.
EPA-Authorized Delaware Regulations Governing Hazardous Waste	7 DE Admin. Code 1302 Regulations Governing Hazardous Waste	See below.	See below.	See below.
Requirements for Landfill Caps	7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 264.303(a), 264.310(a) and (b)(1) and (5)	Applicable	Requirements for monitoring and inspection during installation of landfill cover systems and for closure and post-closure care of hazardous waste landfills.	Closure and post-closure care of the DDA will comply with these requirements.
Identification and Listing of Hazardous Waste	7 DE Admin. Code 1302, Regulations Governing Hazardous Waste, subsections 261.20-.24 and 261.30-.34	Applicable	Identifies solid wastes which are subject to regulation as hazardous wastes.	These regulations establish the criteria for identifying waste generated during the remedial action which must be managed as hazardous waste.

Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Materials (TBCs)
Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Requirement	Legal Citation	Classification	Summary of Requirement	Applicability to Selected Remedy
Standards Applicable to Generators of Hazardous Waste	7 DE Admin. Code 1302 Regulations Governing Hazardous Waste, subsections 262.11-.42	Applicable	Establishes standards for generators of hazardous waste, including waste determination, manifests, and pre-transport requirements.	Wastes generated by the remedial action (e.g., drill cuttings) and treatment residuals at Artesian Water Company 's Llangollen well field treatment plant will be handled in accordance with these requirement.
Standards for Owners and Operators of Hazardous Waste Treatment Storage and Disposal Facilities: Use and Management of Containers	7 DE Admin. Coder 1302, Standards for Owners and Operators of Hazardous Waste Treatment Storage and Disposal Facilities, subsections 264.171-.175	Relevant and Appropriate	Requirements for storage of hazardous waste in storage containers.	Hazardous waste generated during on-site remediation or treatment shall be managed, while on-site, in accordance with these requirements.
Delaware Regulations Governing Construction and Use of Water Wells	7 DE Admin. Code 7301 §§ 4.0-9.0	Applicable	Minimum requirements are prescribed governing the location, design, installation, use, disinfection, modification, repair, and abandonment of all wells and associated pumping equipment as well as certain requirements for the protection of potable water supply wells.	Applies to substantive requirements for well construction activities (from the initial penetration or excavation of the ground through development, equipment installation, disinfection and abandonment) during implementation of the Selected Remedy.
Delaware Regulations Governing the Allocation of Water	7 DE Admin. Coder 7303 §§ 1.0 and 3.0	Applicable	Substantive requirements of water allocation permits are to be met for all water withdrawals greater than 50,000 gallons in any 24-hour period except in cases of emergency withdrawal.	Substantive requirements apply to the installation, modification and repair of groundwater monitoring and recovery wells
Implementation Policy for Groundwater Management Zone/Groundwater Exclusion Zone, Memorandum of Agreement	No legal citation. October 5, 2012	To Be Considered	This Memorandum of Agreement between DNREC's Division of Waste and Hazardous Substances and Division of Water establishes the authorities of each to create groundwater institutional controls (Groundwater Management Zones or Groundwater Exclusion Zones).	To be considered for institutional controls to be implemented at the Site.

APPENDIX E

Selected Remedy Cost Summary

Selected Remedy Cost Summary

Delaware Sand & Gravel Superfund Site
New Castle, Delaware

REMEDIAL ALTERNATIVE COMPONENTS	Enhanced LFExS with Continued Discharge to POTW	Installation of Extraction Wells for Migration Control*	Direct Discharge of Extracted Groundwater to POTW*	Enhanced (RCRA Subtitle C or equivalent) Cap System		AWC Treatment - AOP and GAC	Total Alternative C Cost (Rounded)	AWC Treatment - Manganese[(a)] (not included in Alternative C costs)
Capital								
Construction Phase								
Subtotal	$384,248	$789,578	$515,100	$2,120,425		-	-	
Contingency %	20%	25%	25%	25%		-	-	
Contingency	$76,850	$197,395	$128,775	$530,106		-	-	
Construction Phase Total	$461,098	$986,973	$643,875	$2,650,532		-	-	
Design								
Subtotal	$353,000	$1,714,000	$2,135,954	$255,000		-	-	
Contingency %	10%	15%	10%	6%		-	-	
Contingency	$35,300	$257,100	$213,595	$15,300		-	-	
Design Total	$388,300	$1,971,100	$2,349,549	$270,300		-	-	
Construction Oversight								
Subtotal	$43,825	$75,550	$72,722	$757,600		-	-	
Contingency %	15%	15%	15%	20%		-	-	
Contingency	$6,574	$11,333	$10,908	$151,520		-	-	
Construction Oversight Total	$50,399	$86,883	$83,630	$909,120		-	-	
System Start-up								
Subtotal	$19,000	$19,000	$19,000	-		-	-	
Contingency %	-	-	-	-		-	-	
Contingency	-	-	-	-		-	-	
System Start-up Total	$19,000	$19,000	$19,000	-		-	-	
Capital Total (Rounded)	**$919,000**	**$3,064,000**	**$3,096,000**	**$3,830,000**	b	**$3,800,000**	**$14,700,000**	**$1,477,000**
Annual Operation, Maintenance, Monitoring (OM&M)								
Subtotal	$337,688	$536,964	$783,522	$18,500		-	-	
Contingency %	20%	15%	10%	15%		-	-	
Contingency	$67,538	$80,545	$78,352	$2,775		-	-	
Annual OM&M Total (Rounded)	$405,000	$618,000	$862,000	$21,000	c	$300,000	-	$197,000
NPV OM&M (30 year, 7% Discount)	**$5,052,000**	**$7,709,000**	**$10,753,000**	**$262,000**		**$3,742,000**	**$27,475,000**	**$2,457,000**
Total Alternative C Cost (Rounded)	**$5,970,000**	**$10,800,000**	**$13,800,000**	**$4,090,000**		**$7,540,000**	**$42,175,000**	**$3,934,000**

Notes:

1) POTW = Publicly-Owned Treatment Works
2) LFExS = Low-Flow Extraction System
3) AWC = Artesian Water Company
4) AOP = Advanced Oxidation Process
5) GAC = Granular-Activated Carbon
6) * indicates well BW-2 area is included in these estimates; however, it is recognized that the source to the well BW-2 area is still under investigation.
7) NPV = Net Present Value calculated based on 7% discount factor per USEPA guidance (USACE and USEPA, 2000)
8) Detailed cost backup is provided in Appendix C of the Detailed Analysis of Alternatives (DAA; Golder, 2015), with the exception of manganese treatment at AWC's Llangollen wellfield and changes documented in Appendix L of the Final FS Rev 1 (Golder, 2016)** as follows:
   a) Capital and annual O&M costs for manganese treatment at AWC's Llangollen wellfield are based on the following assumptions: 1) treatment of extracted water from well G3R only at a rate 850 gallons per minute; 2) manganese influent concentrations of 2 parts per million (ppm); and 3) use of greensand filtration technology for treatment to below secondary drinking water standards of 0.05 ppm for manganese.
   b) Capital costs for the Enhanced Cap System were increased by $25,000 between the DAA and Final FS Rev 1 to include installation of five (5) soil moisture probes prior to cap installation.
   c) Annual OM&M costs for the Enhanced Cap System were increased by $12,000 to include quarterly monitoring and reporting of soil moisture probe data.

   **Costs for operation of the sub-slab depressurization system at the office building and attached garage on Grantham Lane are excluded from this table and the cost estimate in ROD Amendment No. 2, although these costs are included in Appendix L of the Final FS Rev 1.