Terracon

March 8, 2012

AFIN: 16-00923
Pmt #: 0254-S1-R3
REC'D
SCAN ☒ MAR 09 2012
Doc ID#: 61939
To: BSP file
SWMD

Mr. Bill Sadler and Mr. Bryan Leamons
Arkansas Department of Environmental Quality
Solid Waste Management Division
5301 Northshore Drive
North Little Rock, AR 72118-5317

Re: Response to NOD dated February 15, 2012,
Craighead County Solid Waste Disposal Authority Class 1 Landfill
AFIN: 16-00199 Permit No.: 0254-S1-R3
Doc. No. 61674 Cross Reference: 61019 and 61020

Mr. Sadler and Mr. Leamons:

The following letter is in response to the Notice of Deficiency (NOD) letter sent by the Department on February 15, 2012. This letter includes additional information and clarifications requested by the Solid Waste Management Division of the Arkansas Department of Environmental Quality.

Document 61019 dated October 4, 2011 – Section Titled "Response to Comments – ADEQ Doc. 59781."

NOD #1

This is the second comment regarding property ownership. A site survey plat map and recorded property deeds should be submitted for the property. This should be a complete package of information for easy review and to fulfill the requirement of Regulation 22.303 (c)(3). The survey plat map should be signed and stamped by an Arkansas Registered Surveyor and should match the title search for the property deeds. This information was deficient in several ways, There was an "Exhibit A" that was not attached to a recorded deed (,'Williams"). Submit a copy of the deeds to accompany the title insurance for "Schedule A" (Sims), "Commitment for Title Insurance Schedule A" (Stevens) properties, and the "Schedule A" (Johnny Whitlatch property that contains 11.74 acres). In addition, the "major utility easement" was not shown on the "site survey map".

Response

CCSWDA gathered the remaining deed information requested and is providing a boundary plat map that has been recorded in Craighead County. The survey and deed information is presented in **ATTACHMENT A**.

NOD #2

This is the second comment regarding property ownership and the overall layout of the site landfill cells. The maps titled "Site Survey Map" (Attachment E) and "Site Location Map (Figure 2)" (7.5 minute quadrangle map) includes the outline of "Future Cells" that were not shown on previous plans. Any new areas have to go through the complete permitting process. This permit is for the vertical modification of Cell 1 through Cell 4. In addition, the cells shown on previous plans would have to go through the major modification process but should be shown on an overall site layout map. The text and maps should also be corrected in Document 61020.

Response

Drawings have been revised to match the previously permitted landfill footprint, including future cells to be permitted in the future. The southeastern most, future cell was adjusted to accommodate the right of way of the Arkansas Louisiana Gas Company Pipeline. The buffer distances are 20-feet on the northern side and 60-feet on the southern side of the pipeline. The information was provided by Centerpoint Energy. Based on this information, the actual permitted landfill footprint is roughly 297 acres. Revised drawings are provided in **ATTACHMENT B**.

NOD #3

This is the second comment regarding the location of the nearest dwellings and wells. State the distance to the nearest dwelling and well to ensure the separation distance required by Regulation 22.408. Provide a statement regarding the number of dwellings within 300 feet, the ownership of the homes or dwellings, and a statement regarding the number of wells within 500 feet, the ownership of the wells and use. If a house is within 500 feet of the landfill cells, state the owners name and the source of water supplied to the home. Update the maps in Appendix A Previously submitted documents, show additional wells such as irrigation wells located on the southern side of the landfill. A previously, submitted report (Doc. 36544) stated "The mobile home located near the northeast corner of the site has not yet been connected to the public water supply system and uses a well The liquor store located in Poinsett County southwest of the site uses a well only for sanitary purposes. Due to the poor water quality, it is not used for drinking water purposes." Provide a discussion regarding this previous statement.

Response

The location restrictions of Regulation 22.408 apply only to new Class 1 landfills and expansions to the permitted area. No new landfill or expansions to the permitted area are proposed in this application. However, there are two dwellings within 500-feet and zero dwellings within 300-feet of the landfill footprint. The nearest dwelling is roughly 400-feet from the landfill footprint. The owners of the homes within 500-feet are Jimmy Doyle Farmer and Paul Blasingame. Both residents are serviced by Jonesboro City Water and Light. The nearest wells are the wells within the property owned by CCSWDA. The closest well outside of the property is further than 500-feet away. The mobile home site referenced in your comment was visited and a well does not exist on the property. It was noted that a water meter and public

water supply is present during the visit. The liquor store located in Poinsett County is more than 1250-feet away from permitted footprint. It is understood that the well water used at the store is not used for consumption. Drawings related to dwelling and well locations are provided in **ATTACHMENT B**.

NOD #4

This is the second comment regarding Site 3CG600 and 3CG985. Doc. 52145 states "We [The Department of Arkansas Heritage] have no objection to the proposed expansion, provided that site 3CG600 and 3CG985 are protected from damage." Document 34637 from the Northeast Arkansas Regional Solid Waste Disposal Authority dated February 12, 1990 stated "concerning the registered archaeological site CG600. We have walked the site, and agreed to set aside an area bounded by an overhead electrical service line on the west, a county road to the east, and a fence row north and south." To comply with Regulation 22.303(c)(22) provide a discussion regarding the status of site 3CG600 and 3CG985. In addition, add site 3CG600 and 3CG985 to the overall site map.

Response

The set-aside boundary mentioned by the Northeast Arkansas Regional Solid Waste Disposal Authority has been illustrated on the drawings presented in **ATTACHMENT B**. The CCSWDA does not intend to expand laterally in the direction of archeological sites 3CG600 and 3CG985 due to elevation, soils and close proximity to residents. Exact locations of the sites were not provided by The Department of Arkansas Heritage, but the sites are known to be located within the set aside area described in Document 34637 and have been presented on the attached drawings.

NOD #5

This is the second comment regarding sampling procedures. Low flow sampling is proposed in the June 2011 Groundwater Sampling Analysis Plan. Low flow sampling is not currently the sampling method reported in the recently submitted groundwater monitoring reports. The site is currently taking about 10 minutes to sample each well and is purging approximately three well volumes. Please clarity on the form in Appendix D of the GWSAP what type of sampling is occurring for each sampling event.

Response

Section 2.2.3 of the June 2011 Groundwater Sampling and Analysis Plan (GWSAP) states the standard 3-5 volume method or the low flow sampling method may be utilized. The form in Appendix D now includes a section to record the purging method utilized. The revised GWSAP is presented in **ATTACHMENT C**.

NOD #6

This is the second comment regarding sampling guidelines. The previous Comment 6 stated "Section 2.2.3 in the "Groundwater Sampling and Analysis Plan" (Doc. 58488) states "In

accordance with the current facility permit, the sampler(s) will attempt to purge the wells utilizing the low-flow (minimal drawdown) sampling method as outlined in EPA/540/S-95/504, "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures." EPA has a more recent document titled "Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers" dated May 2002 (EPA 542-S-02-001). The May 2002 document includes a section titled "Standard Operating Procedure for Low-Stress (Low-Flow)/Minimal Drawdown Ground-Water Sample Collection," Provide a discussion why the older version would be used verses the newer version. Attach a copy of the appropriate EPA document to the Groundwater Sampling and Analysis Plan." The older version of the document was attached to the revised GWSAP dated June. 2011. The comment was not fully addressed regarding why an older version would be used verses the newer version. In addition, the document titled "Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers" dated May 2002 (EPA 542-S-02-001) has "Standard Operating Procedures" for both "Low-Stress Approach" and "Well-Volume Approach".

Response

A copy of the "Ground-water Sampling Guidelines for Superfund and RCRA Project Managers" dated May 2002 (EPA 542-S-02-001) is attached to the GWSAP in **ATTACHMENT C** and will be utilized during sampling events.

NOD #7

This is the second comment regarding sampling guidelines for low-flow sampling. Update Section 2.2.3 to state that the pump will be "lowered to the middle of the [saturated] screened interval or slightly above the middle."

Response

Terracon updated section 2.2.3 (see **ATTACHMENT C**) to state that the pump will be lowered to the middle of the saturated screened interval or slightly above the middle.

NOD #8

This is the second comment regarding stability readings for pH, specific conductance, and turbidity for low flow sampling. In addition to the form included in Appendix D, a form should be included in Appendix D of the revised Sampling and Analysis Plan dated June 2011 by Terracon to be consistent with the revised test in Section 2.2.3 regarding the stability readings for pH, specific conductance, and turbidity for low flow sampling. In addition, a column should be added for drawdown readings during purging of the wells for low flow sampling.

Response

Terracon included a revised form in Appendix D of the revised GWSAP (**ATTACHMENT C**). A column was added for drawdown readings during purging of the wells if low flow sampling is utilized.

NOD #9

This is the second comment regarding procedures outlined in the Unified Guidance (EPA, 2009). Section 6.3 and Section 7.0 through 7.3.2 (including all subsections) reference the chapter and page numbers in the Unified Guidance that will be followed. Several sections were revised but some sections have no reference. In addition, a reference was made to the old Interim Final Guidance Document, USEPA, February 1989. In addition, Section 6.3.4 Page 6-37 of the Unified Guidance (EPA-2009) states "Since the actual concentration is unknown, the suggested imputation when using simple substitution is to replace each non-detect having a qualifier of E or J by one-half the RL. Note, however, that E and J samples reported with estimated concentrations should be treated as valid measurements for statistical purposes. Substitution of one-half the RL *is not recommended* for these measurements, even though the degree of uncertainty associated with the estimated concentration is probably greater than that associated with measurements above the RL." The sections should be updated to follow the updated "Unified Guidance (EPA, 2009).

Response

Terracon revised any reference to the old Interim Final Guidance Document. All text was updated to follow the updated "Unified Guidance (EPA-2009)." In addition, Terracon added EPA's text concerning J values. If there are sections that remain unreferenced, the GWSAP (**ATTACHMENT C**) will follow The Unified Guidance (EPA-2009) and Regulation 22.

Doc. 61019 dated October 4, 2011 – Section Titled "Response to Comments – ADEQ Doc. 59783."

NOD #10

This is the second comment regarding the installation of gas monitoring probes. To comply with Regulation 22.426(e)(7), add the surveyed ground surface elevations to the gas probe installation field boring logs and gas probe installation records. In addition, provide a surveyed location for the gas probes in relation to the site grid system.

Response

The northing, easting, and top of casing were surveyed in 2010. This information has been added to the gas probe installation field boring logs and gas probe installation records provided in **ATTACHMENT D**. The northing and easting are on the site grid system. Terracon will measure from the top of casing to the ground surface elevation or gather additional survey data during the next groundwater sampling event and report the values to ADEQ.

NOD #11

This is the second comment regarding the installation of gas monitoring probes. The field boring log for GP-5 states the boring was drilled to 50 feet. The installation record for GP-5 states the depth of the gas probe is 38 feet. Please provide additional information or clarification.

Response

The field boring for GP-5 was initially drilled to 50 feet. Due to the presence of perched water, the boring was allowed to cave in to 38 feet. Therefore, field personnel noted the depth of GP-5 to be 38 feet on the installation record.

Doc 61020 dated October 4, 2011

NOD #12

Drawing 2 - Proposed Final Cover Plan shows a proposed anchor trench near the top of the landfill that may be associated with the previous beanie cap design. Please provide a revised Final Cover Plan drawing since the facility is not proposing an alternative final cover.

Response

The line type was labeled incorrectly on Drawing 2. The line should be labeled as a "lateral drain to down chute" around the edge of the slope that will convey water to stormwater letdown features after closure. Drawing 2 has been revised and is provided in **ATTACHMENT B**.

CCSWDA and Terracon would appreciate a timely review of this document. If you have any questions or concerns, please give us a call at (501) 847-9292 or e-mail Heath Lockley at halockley@terracon.com.

Sincerely,
Terracon Consultants, Inc.

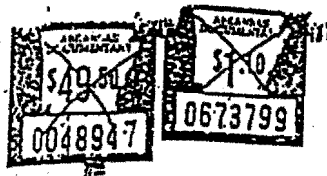
Heath A. Lockley, E.I.,
Senior Project Engineer

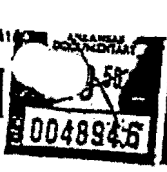
F. Owen Carpenter, P.E., P.G.,
Engineering Department Manager

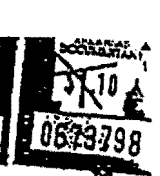
Attachments
Copy: Mr. Robert Hendrix, CCSWDA Executive Director

ATTACHMENT A

Additional Deed Information







Warranty Deed

WITH RELINQUISHMENT OF DOWER & CURTESY

Know All Men By These Presents:

THAT WE, Rick Coleman

and Pamela Jane Coleman, his wife,

for and in consideration of the sum of TEN AND NO/100----------

----------($10.00)----------DOLLARS

and other good and valuable considerations to us in hand paid by NORTHEAST ARKANSAS REGIONAL SOLID WASTE AUTHORITY, the receipt of which is hereby acknowledged,

do hereby grant, bargain, sell and convey unto the said Northeast Arkansas Regional Solid Waste Authority,

and unto its successors and assigns forever, the following lands lying in the County of Craighead and State of Arkansas, to-wit:

THE NORTHWEST QUARTER OF THE NORTHEAST QUARTER OF SECTION 32, TOWNSHIP 13 NORTH, RANGE 4 EAST.

To have and to hold the same unto the said Northeast Arkansas Regional Solid Waste Authority,

and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we hereby covenant with said Northeast Arkansas Regional Solid Waste Authority,

that we will forever warrant and defend the title to the said lands against all claims whatever.

And we, Rick Coleman and Pamela Jane Coleman, his wife,

for and in consideration of the said sum of money, do hereby release and relinquish unto the said Northeast Arkansas Regional Solid Waste Authority,

our rights of dower, curtesy and possibility of Homestead in and to said lands.

WITNESS our hands and seals on this 31st day of March, 19 89.

Rick Coleman (L.S.)
RICK COLEMAN

Pamela Jane Coleman (L.S.)
PAMELA JANE COLEMAN

I hereby certify under penalty of false swearing that at least the legally correct amount of documentary stamps have been placed on this instrument.

Grantee

403 S Main Jonesboro

Address

ACKNOWLEDGMENT

STATE OF ARKANSAS } SS
COUNTY OF CRAIGHEAD }

_____ } SS
_____ }

BE IT REMEMBERED, That on this day came before me the undersigned, a Notary Public within and for the County aforesaid, duly commissioned and acting Rick Coleman and Pamela Jane Coleman, his wife,

_____

to me well known as the grantors in the foregoing Deed, and stated that they had executed the same for the consideration and purpose therein mentioned and set forth.

And on the same day also voluntarily appeared before me each of the said grantors separately, and each grantor in the absence of such grantor's spouse declared that he or she had, of his or her own free will, executed said Deed and signed and sealed the relinquishment of dower, curtesy and homestead in the said Deed for the consideration and purposes therein contained and set forth, without compulsion or undue influence of such grantor's spouse.

WITNESS my hand and seal as such Notary Public on this 31st day of March 19 89.

My Commission Expires:
5-1-91

Susan Lewis
Notary Public

CERTIFICATE OF RECORD

STATE OF ARKANSAS, } ss.
County of Craighead }

_____ } ss.
_____ }

I, Pat Fleenwood, Circuit Clerk and Ex-Officio Recorder for the County aforesaid, do hereby certify that the annexed and foregoing instrument of writing was filed for record in my office on the 21st day of April, A.D., 19 89 at 1:05 o'clock P m. and the same is now duly recorded, with acknowledgements and certificates thereon in Deed Record 375, page 144-145.

IN WITNESS WHEREOF I have hereunto set my hand and affixed the seal of said Court this 21st day of April, 19 89.

Pat Fleenwood
Circuit Clerk and Ex-Officio Recorder

Melissa Lewis D.C.

Warranty Deed
WITH RELINQUISHMENT OF DOWER & CURTESY

FROM
RICK COLEMAN AND PAMELA JANE COLEMAN, HIS WIFE.

TO
NORTHEAST ARKANSAS REGIONAL SOLID WASTE AUTHORITY.

Filed for Record this 21st day of April, 19 89 at 1:05 o'clock P M.
By Pat Fleenwood Clerk
Melissa Lewis D.C.

GINAL

WARRANTY DEED

WELLGROVE, LASER, LANGLEY & LOVETT
P. O. Box 1346
Jonesboro, AR 72403

KNOW ALL MEN BY THESE PRESENTS:

That we, JAMES E. WHITE and CATHERYN WHITE, husband and wife, GRANTORS, for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable consideration, in hand paid by CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, GRANTEE, the receipt of which is hereby acknowledged, hereby grant, bargain, sell and convey unto the said GRANTEES, and unto its successors and assigns forever, the following lands lying in Craighead County, Arkansas, to wit:

ARKANSAS DOCUMENTARY $11 046250
ARKANSAS DOCUMENTARY $55.00 209657
$80.50 226471

Part of the Northeast Quarter of the Southwest Quarter of Section 32, Township 13 North, Range 4 East, Craighead County, Arkansas, being more particularly described as follows:

$82.50 226469
$80.50 22647

Begin at the Northeast Corner of the Northeast Quarter of the Southwest Quarter of Section 32, Township 13 North, Range 4 East, Craighead County, Arkansas; thence South 0°07'19" West, along the East line of the Northeast Quarter of the Southwest Quarter of Section 32, aforesaid, 1324.79 feet to the Southeast Corner of the Northeast Quarter of the Southwest Quarter of Section 32, aforesaid; thence South 89°39'16" West along the South line of the Northeast Quarter of the Southwest Quarter of Section 32, aforesaid, 1290.76 feet to the East right-of-way line of the Missouri Pacific Railroad; thence North 11°23'49" East, along said East right-of-way line, 1354.45 feet to the North line of the Northeast Quarter of the Southwest Quarter of Section 32, aforesaid; thence North 89°43'51" East, along said North line, 1025.92 feet to the point of beginning, containing 35.25 acres.

TO HAVE AND TO HOLD the same unto the said GRANTEE, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we hereby covenant with said GRANTEE that we will forever warrant and defend the title to the said lands against all claims whatever.

And we, the GRANTORS, JAMES E. WHITE and CATHERYN WHITE, for and in consideration of the said sum of money, do hereby release and relinquish unto the said GRANTEE all our rights of dower, curtesy and homestead in and to the said lands.

WITNESS our hands and seals on this 23 day of MAY, 1994.

James E. White (SEAL)
James E. White

Catheryn White (SEAL)
Catheryn White

I certify under penalty of false swearing that at least the legally correct amount of documentary stamps have been placed on this instrument.

Craighead County Solid Waste Disposal Authority by S. Langley
Grantee or Agent

P.O. Box 1997
Address of Buyer

Jonesboro, AR 72403

FILED
1994 MAY 24 P 4:1
CRAIGHEAD COUNTY, ARKANSAS
JOE E. PATTERSON
CIRCUIT CLERK

STATE OF ARKANSAS)
) ss. ACKNOWLEDGMENT
COUNTY OF CRAIGHEAD)

On this day, personally appeared before me James E. White and Catheryn White, husband and wife, known to me to be the persons whose names are subscribed to the within instrument and acknowledged that they executed the same for the consideration and purposes therein contained.

WITNESS my hand and official seal this 23rd day of MAY, 1994.

Notary Public

My commission expires: 7-12-02

OFFICIAL SEAL
STANLEY R. LANGLEY
NOTARY PUBLIC-ARKANSAS
CRAIGHEAD COUNTY
My Commission Expires 7-12-02

RECORDED
Deed BOOK 461 PAGE 62-63
DATE 5-25-94 TIME 9:30 AM
CRAIGHEAD COUNTY
PAT FLEETWOOD, CLERK
BY Shannon Vickers

WARRANTY DEED

KNOW ALL MEN BY THESE PRESENTS:

THAT We, JOHNNY C. WHITLATCH and CARLA JO WHITLATCH, husband and wife, Grantors, for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable considerations in hand paid by NORTHEAST ARKANSAS REGIONAL SOLID WASTE DISPOSAL AUTHORITY, Grantee, the receipt of which is hereby acknowledged, do hereby grant, bargain, sell and convey unto the said Grantee, and unto its successors and assigns forever, the following lands lying in Craighead County, Arkansas, to-wit:

Part of the East Half of the Northwest Quarter, the South Half of the Northeast Quarter, the Southeast Quarter, part of the Southeast Quarter of the Southwest Quarter, part of the Southwest Quarter of the Southwest Quarter, all being in Section 32, and part of the Southwest Quarter of the Northwest Quarter, part of the Northwest Quarter of the Southwest Quarter, the Southwest Quarter of the Southwest Quarter, all being in Section 33, and both Sections being in Township 13 North, Range 4 East, Craighead County, Arkansas, being more particularly described as follows:

Begin at the Northeast corner of the Southwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East; thence South 0° 18' 19" East 1323.0 feet; thence South 89° 34' 43" West 5590.97 feet to the Easterly right-of-way line of the Missouri Pacific Railroad; thence North 11° 23' 49" East along said railroad right-of-way line 1355.16 feet; thence North 89° 39' 16" East 1290.76 feet; thence North 0° 07' 19" East 1324.79 feet; thence South 89° 43' 51" West 1025.92 feet to the Easterly right-of-way line of the Missouri Pacific Railroad aforesaid; thence North 11° 23' 49" East along said right-of-way line 2706.00 feet; thence North 89° 47' 49" East 496.83 feet; thence South 0° 07' 19" West 1324.79 feet; thence North 89° 48' 28" East 2662.52 feet; thence South 0° 16' 36" East 841.18 feet; thence North 89° 47' 57" East 335.94 feet to the centerline of a public road; thence along said centerline as follows: South 26° 35' 54" West 50.33 feet; South 8° 18' 06" East 159.88 feet; South 30° 44' 06" East 317.58 feet; thence South 89° 25' 24" West 496.47 feet; thence South 0° 16' 36" East 1040.68 feet; thence North 89° 30' 04" East 677.02 feet to the centerline of a public road aforesaid; thence South 17° 21' 19" West along said centerline 294.68 feet; thence North 89° 30' 04" East 756.58 feet to the point of beginning, containing 382.51 acres, less and except the following tract:

This Instrument Prepared By
BARRETT, WHEATLEY, SMITH & DEACON
A Professional Association
Attorneys at Law
Jonesboro, Arkansas

A part of the Southeast Quarter of Section 32 and part of the West Half of the Southwest Quarter of Section 33, both Sections being in Township 13 North, Range 4 East, being more particularly described as follows:

Begin at the Northeast corner of the Southwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East; thence South 89° 30' 04" West 756.58 feet to the centerline of a public road, the point of beginning proper; thence South 17° 21' 19" West along said centerline 50.57 feet; thence South 10° 47' 41" East along said centerline 258.54 feet; thence South 88° 01' 14" West 542.84 feet; thence North 88° 40' 57" West 775.81 feet; thence North 5° 18' 44" West 296.59 feet; thence South 87° 19' 28" East 614.20 feet; thence North 0° 55' 28" East 197.93 feet; thence North 89° 44' 21" East 747.03 feet to the centerline of a public road aforesaid; thence South 17° 21' 19" West 172.66 feet to the point of beginning proper, containing 11.74 acres.

To have and to hold the same unto the said Grantee, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we hereby covenant with said Grantee that we will forever warrant and defend the title to the said lands against all claims whatever.

And each of us for the consideration aforesaid, does hereby separately release and relinquish unto the said Grantee all our rights of dower, curtesy and homestead in and to the said lands.

WITNESS our hands and seals on this 26 day of May, 1989.

Johnny C. Whitlatch

Johnny C. Whitlatch

Carla Jo Whitlatch

Carla Jo Whitlatch

ACKNOWLEDGMENT

STATE OF ARKANSAS
COUNTY OF CRAIGHEAD

BE IT REMEMBERED, That on this day came before me the undersigned, a Notary Public within and for the County and State aforesaid, duly qualified, commissioned and acting Johnny C. Whitlatch and Carla Jo Whitlatch, husband and wife, to me well known as the Grantors in the foregoing Warranty Deed, and stated that they had executed the same for the consideration and purposes therein mentioned and set forth.

WITNESS my hand and seal as such Notary Public this 26th day of May, 1989.

Susan Burgess
Notary Public

My Commission Expires:

11/22/91

CERTIFICATE OF RECORD

STATE OF ARKANSAS } ss.
County of Craighead }

I, PAT FLEETWOOD, Clerk of the Circuit Court and Ex Officio Recorder for the County aforesaid do hereby certify that the aanexed and foregoing instrument of writing was filed for record in my office on 30th day of May A.D. 1989 at 3:3 o'clock P M., and the same is now duly recorded, with the acknowledgment and certificate thereon, in Record Book 1st 375 Page 630-632

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seal of said court this 30th day of May A.D. 1989

PAT FLEETWOOD, Clerk

By Melissa A. Wolf Deputy Clerk

AMOUNT OF TAX $1,447.60
I certify under penalty of false swearing that at least the legally correct amount of documentary stamps have been placed on this instrument.

Tommy Womack
Grantee or Agent

Grantee's Address:

403 South Main Street
Jonesboro, AR 72401

DEED BK 719 PG 482

Approved as to form by:
John Bartlett, Attorney-at-Law
Transactional data completed by The Title Company

WARRANTY DEED
MARRIED PERSON

KNOW ALL MEN BY THESE PRESENTS:

THAT WE, JOHNNY C. WHITLATCH and CARLA JO WHITLATCH, husband and wife Grantor(S) for and in consideration of the sum of Ten and no/100 Dollars ($10.00), and other good and valuable consideration in hand paid by Grantee(S), the receipt of which is hereby acknowledged, hereby grant, bargain, sell and convey unto said CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY Grantee(S), and unto their heirs and assigns forever, the following lands lying in Craighead County, Arkansas.

SEE EXHIBIT "A" ATTACHED HERETO

To have and to hold the same unto the said GRANTEE(S), and unto their heirs and assign forever, with all appurtenances thereunto belonging.

And we hereby covenant with said GRANTEE(S) that we will forever warrant and defend the title to the said lands against all claims whatever.

And we, the GRANTOR(S) JOHNNY C. WHITLATCH and CARLA JO WHITLATCH, husband and wife , for and in consideration of the said sum of money, do hereby release and relinquish unto the said GRANTEE(S) all our rights of dower, curtesy and homestead in and to the said lands.

WITNESS our hands and seals on this 15th day of March, 2006.

Johnny C. Whitlatch
JOHNNY C. WHITLATCH

Carla Jo Whitlatch
CARLA JO WHITLATCH

"I certify under penalty of false swearing that the legally correct amount of documentary stamps have been placed on this instrument."
By: The Title Company
Grantee/Grantee's Agent
Address: PO Box 1997
Jonesboro, AR 72403

ACKNOWLEDGMENT

STATE OF ARKANSAS
COUNTY OF __CRAIGHEAD__

On this day, personally appeared before me **JOHNNY C. WHITLATCH** and **CARLA JO WHITLATCH**, husband and wife, known to me to be persons whose names are subscribed to the within instrument and acknowledged that they executed the same for the purposes therein contained.

WITNESS my hand and official seal this 15 day of March, 2006.

RHONDA JEAN LONG
Craighead County
My Commission Expires
December 9, 2015

Notary Public

My Commission Expires:

EXHIBIT "A"

A part of the Northeast Quarter of the Northeast Quarter of Section 32, Township 13 North, Range 4 East and a part of the Northwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, and being more particularly described as follows: Beginning at the North Section corner between said Sections 32 and 33; thence North 89 degrees 44' 50" East 105.37 feet; thence with a curve turning to the left with an arc length of 203.27 feet, with a radius of 357.12 feet; thence South 14 degrees 05' 24" East 277.41 feet; thence with a curve turning to the right with an arc length of 146.74 feet, with a radius of 606.81 feet, thence with a curve turning to the left with an arc length of 199.17 feet, with a radius of 761.76 feet; thence South 14 degrees 56' 34" East 175.08 feet; thence with a curve turning to the left with an arc length of 206.05 feet, with a radius of 475.44 feet; thence South 39 degrees 46' 25" East 82.21 feet; thence with a curve turning to the right with an arc length of 109.45 feet, with a radius of 297.96 feet; thence South 89 degrees 58' 09" West 457.07 feet; thence North 89 degrees 40' 51' West 1330.11 feet; thence North 00 degrees 04' 39" East 1323.43 feet; thence South 89 degees 32' 22" East 1330.45 feet, to the point of beginning, LESS AND EXCEPT THE FOLLOWING DESCRIBED TRACT:

A part of the Northeast Quarter of the Northeast Quarter of Section 32 and a Part of the Northwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas and being more particularly described as follows: Commencing at the North Section corner between Section 32 and 33; thence South 1 degree 05' 29" West 339.70 feet along Section line to the point of beginning proper; thence South 89 degrees 32' 22" East 133.44 feet; thence South 14 degrees 07' 06" East 132.22 feet; thence with a curve turning to the right with an arc length of 146.74 feet, with a radius of 606.81 feet; thence with a curve turning to the left with an arc length of 78.99 feet, with a radius of 761.76 feet; thence North 89 degrees 32' 22" West 169.40 feet; thence with a curve turning to the right with an arc length of 135.08 feet, with a radius of 319.58 feet; thence with a curve turning to the left with an arc length of 160.44 feet, with a radius of 379.58 feet; thence North 89 degrees 32' 22" West 403.52 feet; thence North 00 degrees 27' 38" East 290.31 feet; thence South 89 degrees 32' 22"East 668.53 feet to the point of beginning proper, subject to all public and private roads and easements.

DEED BK 719 PG 482 - 484
DATE 03/22/2006
TIME 01:55:32 PM
RECORDED IN
OFFICIAL RECORDS OF
CRAIGHEAD COUNTY
ANN HUDSON
CIRCUIT CLERK
_____, D.C.
RECEIPT# 147066

THIS INSTRUMENT PREPARED BY ANTHONY BARTELS, ATTORNEY AT LAW, JONESBORO, ARKANSAS

Warranty Deed

WITH RELINQUISHMENT OF DOWER & CURTESY

Know All Men By These Presents:

THAT WE, Rick Coleman

and Pamela Jane Coleman **,his wife.**

for and in consideration of the sum of TEN AND NO/100

($10.00) **DOLLARS**

and other good and valuable considerations to us in hand paid by NORTHEAST ARKANSAS REGIONAL SOLID WASTE AUTHORITY, the receipt of which is hereby acknowledged,

do hereby grant, bargain, sell and convey unto the said Northeast Arkansas Regional Solid Waste Authority,

and unto its successors **and assigns forever, the following lands lying in the County of Craighead and State of Arkansas, to-wit:**

THE NORTHWEST QUARTER OF THE NORTHEAST QUARTER OF SECTION 32, TOWNSHIP 13 NORTH, RANGE 4 EAST.

To have and to hold the same unto the said Northeast Arkansas Regional Solid Waste Authority,

and unto its successors **and assigns forever, with all appurtenances thereunto belonging.**

And we hereby covenant with said Northeast Arkansas Regional Solid Waste Authority,

that we will forever warrant and defend the title to the said lands against all claims whatever.

And we, Rick Coleman and Pamela Jane Coleman, his wife,

for and in consideration of the said sum of money, do hereby release and relinquish unto the said Northeast Arkansas Regional Solid Waste Authority,

our rights of dower, curtesy and possibility of Homestead in and to said lands.

WITNESS our hands and seals on this 31st **day of** March, 19 89.

RICK COLEMAN, (L.S.)

PAMELA JANE COLEMAN, (L.S.)

I hereby certify under penalty of false swearing that at least the legally correct amount of documentary stamps have been placed on this instrument.

Grantee

Address

(1)

This Instrument Prepared By:
SNELLGROVE, LASER, LANGLEY & LOVETT
P. O. Box 1346
Jonesboro, AR 72403

QUITCLAIM DEED

53066

KNOW ALL MEN BY THESE PRESENTS:

That we, JAMES E. WHITE and CATHERYN WHITE, husband and wife, GRANTORS, for and in consideration of the sum of Ten Dollars ($10.00) and other valuable considerations to us in hand paid by CRAIGEHAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, GRANTEE, the receipt of which is hereby acknowledged, do hereby grant, convey, sell and quitclaim unto the said GRANTEE, and unto its successors and assigns forever, all our right, title, interest and claim in and to the following lands lying in Craighead County, Arkansas:

> All of the Northeast Quarter of the Southwest Quarter of Section 32, Township 13 North, Range 4 East, less Railroad right-of-way and less and except: Starting at the Northwest Corner of the Northwest Quarter of the Southwest Quarter of Section 32; thence North 85°52' East along the North line thereof a distance of 1320.0 feet to the Northwest Corner of the Northeast Quarter of the Southwest Quarter of Section 32 for the point of beginning; thence North 85°52' East along the North line thereof a distance of 86.0 feet to a point on the proposed Easterly right-of-way line of State Highway 1 Relocation; thence South 4°30' East along said proposed right-of-way line a distance of 223.8 feet to a point; thence South 2°44' West along said proposed right-of-way line a distance of 314.2 feet to a point on the existing Westerly right-of-way line of the Missouri Pacific Railroad; thence South 7°20' West along said existing right-of-way line a distance of 241.7 feet to a point on the West line of the Northeast Quarter of Southwest Quarter; thence North 4°16' West along said West line a distance of 772.6 feet to the point of beginning and containing 1.06 acres, more or less; being 34 acres more or less.

TO HAVE AND TO HOLD the same unto the said GRANTEE, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we, the GRANTORS, JAMES E. WHITE and CATHERYN WHITE, for and in consideration of the said sum of money, do hereby release and relinquish unto the said GRANTEE, and unto its successors and assigns, all our rights and possibility of dower, curtesy and homestead in and to the said lands.

WITNESS our hands and seals on this 23 day of MAY, 1994.

James E White (SEAL)
James E. White

Catheryn White (SEAL)
Catheryn White

ORIGINAL

whitlatch
5/26/89

(A)

$82.50 0128112 $82.50 0128111 $82.50 0128109

WARRANTY DEED

$82.50 0128108 ARKANSAS DOCUMENTARY $1.10 0673806 $44.00 011675

KNOW ALL MEN BY THESE PRESENTS:

THAT We, JOHNNY C. WHITLATCH and CARLA JO WHITLATCH, husband and wife, Grantors, for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable considerations in hand paid by NORTHEAST ARKANSAS REGIONAL SOLID WASTE DISPOSAL AUTHORITY, Grantee, the receipt of which is hereby acknowledged, do hereby grant, bargain, sell and convey unto the said Grantee, and unto its successors and assigns forever, the following lands lying in Craighead County, Arkansas, to-wit:

$82.50 0128113 $82.50 0128114 $82.50 012811 $82.50 0128121 $82.50 0128122 $82.50 0128123 $82.50 0128124

Part of the East Half of the Northwest Quarter, the South Half of the Northeast Quarter, the Southeast Quarter, part of the Southeast Quarter of the Southwest Quarter, part of the Southwest Quarter of the Southwest Quarter, all being in Section 32, and part of the Southwest Quarter of the Northwest Quarter, part of the Northwest Quarter of the Southwest Quarter, the Southwest Quarter of the Southwest Quarter, all being in Section 33, and both Sections being in Township 13 North, Range 4 East, Craighead County, Arkansas, being more particularly described as follows:

Begin at the Northeast corner of the Southwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East; thence South 0° 18' 19" East 1323.0 feet; thence South 89° 34' 43" West 5590.97 feet to the Easterly right-of-way line of the Missouri Pacific Railroad; thence North 11° 23' 49" East along said railroad right-of-way line 1355.16 feet; thence North 89° 39' 16" East 1290.76 feet; thence North 0° 07' 19" East 1324.79 feet; thence South 89° 43' 51" West 1025.92 feet to the Easterly right-of-way line of the Missouri Pacific Railroad aforesaid; thence North 11° 23' 49" East along said right-of-way line 2706.00 feet; thence North 89° 47' 49" East 496.83 feet; thence South 0° 07' 19" West 1324.79 feet; thence North 89° 48' 28" East 2662.52 feet; thence South 0° 16' 36" East 841.18 feet; thence North 89° 47' 57" East 335.94 feet to the centerline of a public road; thence along said centerline as follows: South 26° 35' 54" West 50.33 feet; South 8° 18' 06" East 159.88 feet; South 30° 44' 06" East 317.58 feet; thence South 89° 25' 24" West 496.47 feet; thence South 0° 16' 36" East 1040.68 feet; thence North 89° 30' 04" East 677.02 feet to the centerline of a public road aforesaid; thence South 17° 21' 19" West along said centerline 294.68 feet; thence North 89° 30' 04" East 756.58 feet to the point of beginning, containing 382.51 acres, less and except the following tract:

$82.50 0128116 $82.50 0128117 $82.50 0128118 $82.50 0128119

This Instrument Prepared By
BARRETT, WHEATLEY, SMITH & DEACON
A Professional Association
Attorneys at Law
Jonesboro, Arkansas

(3)

A part of the Southeast Quarter of Section 32 and part of the West Half of the Southwest Quarter of Section 33, both Sections being in Township 13 North, Range 4 East, being more particularly described as follows:

Begin at the Northeast corner of the Southwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East; thence South 89° 30' 04" West 756.58 feet to the centerline of a public road, the point of beginning proper; thence South 17° 21' 19" West along said centerline 50.57 feet; thence South 10° 47' 41" East along said centerline 258.54 feet; thence South 88° 01' 14" West 542.84 feet; thence North 88° 40' 57" West 775.81 feet; thence North 5° 18' 44" West 296.59 feet; thence South 87° 19' 28" East 614.20 feet; thence North 0° 55' 28" East 197.93 feet; thence North 89° 44' 21" East 747.03 feet to the centerline of a public road aforesaid; thence South 17° 21' 19" West 172.66 feet to the point of beginning proper, containing 11.74 acres.

To have and to hold the same unto the said Grantee, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we hereby covenant with said Grantee that we will forever warrant and defend the title to the said lands against all claims whatever.

And each of us for the consideration aforesaid, does hereby separately release and relinquish unto the said Grantee all our rights of dower, curtesy and homestead in and to the said lands.

WITNESS our hands and seals on this 26 day of May, 1989.

Johnny C. Whitlatch
Johnny C. Whitlatch

Carla Jo Whitlatch
Carla Jo Whitlatch

This instrument prepared by RODNEY A. MAY

TTC

WARRANTY DEED

MARRIED PERSON

108.90

KNOW ALL MEN BY THESE PRESENTS:

#2291

THAT WE, RODNEY A. MAY and TAMMY MAY, husband and wife, GRANTOR(S) for and in consideration of the sum of Ten and no/100 Dollars ($10.00), and other good and valuable consideration in hand paid by TRACY L. KLOTZ and JENNIFER A. KLOTZ, husband and wife, as tenants by the entirety GRANTEE(S), the receipt of which is hereby acknowledged, hereby grant, bargain, sell and convey unto said GRANTEE(S), and unto their heirs and assigns forever, the following lands lying in Craighead County, Arkansas.

A part of the Northwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East, being more particularly described as follows: Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 646 feet to the point of beginning proper; thence West 420 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 104 feet; thence East 420 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 104 feet to the point of beginning proper, less and except any road rights of way of record.

To have and to hold the same unto the said GRANTEE(S), and unto their heirs and assign forever, with all appurtenances thereunto belonging.

And we hereby covenant with said GRANTEE(S) that we will forever warrant and defend the title to the said lands against all claims whatever.

And we, the GRANTOR(S) RODNEY A. MAY and TAMMY MAY, husband and wife , for and in consideration of the said sum of money, do hereby release and relinquish unto the said GRANTEE(S) all our rights of dower, curtesy and homestead in and to the said lands.

WITNESS our hands and seals on this 28th day of FEBRUARY, 1997.

RODNEY A. MAY

TAMMY MAY

"I certify under penalty of false swearing that the legally correct amount of documentary stamps have been placed on this instrument."

By JAY GAMBLIN The Title Co.

Grantee/Grantee's Agent

Address: 2952 CR 403

JONESBORO, AR 72401

ARKANSAS DOCUMENTARY $82.50 256535

ARKANSAS DOCUMENTARY $22.00 323067

ARKANSAS DOCUMENTARY $4.40 487946

ACKNOWLEDGMENT

STATE OF ARKANSAS
COUNTY OF CRAIGHEAD

On this day, personally appeared before me RODNEY A. MAY and TAMMY MAY, husband and wife, known to me to be persons whose names are subscribed to the within instrument and acknowledged that they executed the same for the purposes therein contained.

WITNESS my hand and official seal this 28th day of FEBRUARY, 1997.

My commission expires: Aug 9 2005

(SEAL)

JAY C. GAMBLIN
NOTARY PUBLIC - ARK.
CRAIGHEAD COUNTY
My Commission Expires

Jay C. Gamblin
Notary Public

~~CERTIFICATE OF RECORD~~

~~STATE OF ARKANSAS,~~
~~County of CRAIGHEAD~~ } ss.

~~I, _____, Circuit Clerk and Ex-Officio Recorder for the County aforesaid, do hereby certify that the annexed and foregoing instrument of writing was filed for record in my office on the _____ day of _____ A.D. 1997 at _____ o'clock _____.M. and the same is now duly recorded, with the acknowledgments and certificates thereon, in "Record Book _____," page _____.~~

~~IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Court this _____ day of _____, 1997.~~

~~Circuit Clerk and Ex-Officio Recorder~~

~~By _____, D.C.~~

DEED BOOK 531 PAGE 341-342
DATE : 03-05-1997
TIME : 01:27:05 P.M.
FILED & RECORDED IN
OFFICIAL RECORDS OF
CRAIGHEAD COUNTY, AR.
ANN HUDSON
CIRCUIT CLERK
Shannon Vickers, D.C.

interest, as insured, or to prevent or reduce loss or damage to the insured. The Company may take any appropriate action under the terms of this policy, whether or not it shall be liable hereunder, and shall not thereby concede liability or waive any provision of this policy. If the Company in paragraphs (b)(i) or (ii), the Company's obligations to the insured under this policy for the claimed loss or damage, other than the payments required to be made, shall terminate, including any liability or obligation to defend, prosecute or continue any litigation.

ARKANSAS TITLE INSURANCE

Sima

Arkansas Title

Insurance Company

POLICY NUMBER
0-2220-106015

Schedule A

Amount of Insurance: $84,000.00
File No: 06-0058
Premium: Standard

Date of Policy: March 13, 2006 at 10:11 am

1. Name of Insured:

   CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY

2. The estate or interest in the land described herein and which is covered by this policy is FEE SIMPLE and is at Date of Policy vested in:

   CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY

3. The land referred to in this policy is described in the said instrument, is situated in the County of Craighead, State of Arkansas, and is identified as follows:

A part of the Northeast Quarter of the Northeast Quarter of Section 32 and a Part of the Northwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas and being more particularly described as follows: Commencing at the Section corner between Section 32 and 33; thence South 1 degree 05' 29" West 339.70 feet along Section line to the point of beginning proper; thence South 89 degrees 32' 22" East 133.44 feet; thence South 14 degrees 07' 06" East 132.22 feet; thence with a curve turning to the right with an arc length of 146.74 feet, with a radius of 606.81 feet; thence with a curve turning to the left with an arc length of 78.99 feet, with a radius of 761.76 feet; thence North 89 degrees 32' 22" West 169.40 feet; thence with a curve turning to the right with an arc length of 135.08 feet, with a radius of 319.58 feet; thence with a curve turning to the left with an arc length of 160.44 feet, with a radius of 379.58 feet; thence North 89 degrees 32' 22" West 403.52 feet; thence North 00 degrees 27' 38" East 290.31 feet; thence South 89 degrees 32' 22"East 668.53 feet to the point of beginning proper, subject to all public and private roads and easements.

THE TITLE COMPANY OF CRAIGHEAD COUNTY, INC.
315 SOUTH CHURCH STREET

JONESBORO, AR 72401

Countersigned: Kathy R Woods

Authorized Officer or Agent

IA78 SA78-01

American Land Title Association Owner's Policy
1992

Valid Only If Schedule B and Cover Are Attached

Arkansas Title
Insurance Company

Whitlatch Homestead 8/17/07 250,000

Order Number: 07-0245

SCHEDULE A

1. Effective Date **June 20, 2007**, at **08:00 am**

2. Policy or policies to be issued:

(a) ALTA Owner's Policy - Form B-1970 (Rev. 10-17-70 and 10-17-84)

Proposed insured: Amount **$250,000.00**

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY

(b) ALTA Loan Policy

Proposed insured: **N/A** Amount **N/A**

[ ] Conv. [ ] FHA [ ] VA

3. The estate or interest in the land described or referred to in the commitment and covered herein is **FEE SIMPLE** and is at the effective date hereof vested in:

JOHNNY WHITLATCH and CARLA JO WHITLATCH, husband and wife

4. The land referred to in this commitment is situated in the County of Craighead, State of Arkansas, and described as follows:

A part of the Southeast Quarter of Section 32 and part of the West Half of the Southwest Quarter of Section 33, both Sections being in Township 13 North, Range 4 East, being more particularly described as follows: Begin at the Northeast corner of the Southwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East; thence South 89 degrees 30' 04" West 756.58 feet to the centerline of a public road, the point of beginning proper; thence South 17 degrees 21' 19" West along said centerline 50.57 feet; thence South 10 degrees 47' 41" East along said centerline 258.54 feet; thence South 88 degrees 01' 44" West 542.84 feet; thence North 88 degrees 40' 57" West 775.81 feet; thence North 5 degrees 18' 44" West 296.59 feet; thence South 87 degrees 19' 28" East 614.20 feet; thence North 0 degrees 55' 28" East 197.93 feet; thence North 89 degrees 44' 21" East 147.03 feet to the centerline of a public road aforesaid; thence South 17 degrees 21' 19" West 172.66 feet to the point of beginning proper, containing 11.74 acres, more or less.

THE TITLE COMPANY OF CRAIGHEAD COUNTY, INC.

315 S. CHURCH STREET
JONESBORO, ARKANSAS 72401

(6)

Countersigned: Kathy R Woods
Authorized Officer or Agent

IA 78 SA 78-01

American Land Title Association Commitment
Computer - generated Schedule A

Valid Only If Schedule B and Cover Are Attached

from Stevens
4/18/06

Lenders Title Company
2207 Fowler Avenue
Jonesboro, AR 72401
870-935-7410

COMMITMENT FOR TITLE INSURANCE

SCHEDULE A

Date Issued: **April 12, 2006, 2:45 pm**
Commitment No: **06-046739-300**
Effective Date: **April 3, 2006, 7:30 am**

Prepared For: **Craighead County Solid Waste Disposal Authority**

Inquiries Should be Directed to:
Lawyers Title Insurance Corporation

1. The policy or policies to be issued are: POLICY AMOUNT

   (a) ALTA Owner's Policy - (10-17-92) **$35,000.00**
   Proposed Insured: **Craighead County Solid Waste Disposal Authority**

   (b) ALTA Loan Policy - (10-17-92)
   Proposed Insured:

2. The Estate or interest in the land described or referred to in this Commitment and covered herein is a **Fee Simple.**

3. Title to said estate or interest in said land is at the effective date hereof of record in:
Earnest Elmo Stevens and wife, Mary Catherine Stevens

4. The land referred to in this Commitment is located in the County of Craighead, State of Arkansas and described as follows:
A part of the Northwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, more particularly described as follows: Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 332 feet to the point of beginning proper; thence West 210 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 210 feet; thence East 210 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 210 feet to the point of beginning proper, containing 1 acre, more or less.

7A

Lawyers Title Insurance Corporation

This commitment is invalid unless the Insuring provisions and Schedules A & B are attached.

Countersigned
Lenders Title Company
Arkansas License No. IA-82
By Phyllis Hall
Title Agent License Number: 66

whitlatch
3/14/06
450,000

APPENDIX "A"

POLICY NUMBER 0-2220-106014

THIS POLICY COVERS THE FOLLOWING PROPERTY:

(7B)

A part of the Northeast Quarter of the Northeast Quarter of Section 32, Township 13 North, Range 4 East and a part of the Northwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, and being more particularly described as follows: Beginning at the North Section corner between said Sections 32 and 33; thence North 89 degrees 44' 50" East 105.37 feet; thence with a curve turning to the left with an arc length of 203.27 feet, with a radius of 357.12 feet; thence South 14 degrees 05' 24" East 277.41 feet; thence with a curve turning to the right with an arc length of 146.74 feet, with a radius of 606.81 feet, thence with a curve turning to the left with an arc length of 199.17 feet, with a radius of 761.76 feet; thence South 14 degrees 56' 34" East 175.08 feet; thence with a curve turning to the left with an arc length of 206.05 feet, with a radius of 475.44 feet; thence South 39 degrees 46' 25" East 82.21 feet; thence with a curve turning to the right with an arc length of 109.45 feet, with a radius of 297.96 feet; thence South 89 degrees 58' 09" West 457.07 feet; thence North 89 degrees 40' 51' West 1330.11 feet; thence North 00 degrees 04' 39" East 1323.43 feet; thence South 89 degees 32' 22" East 1330.45 feet, to the point of beginning, LESS AND EXCEPT THE FOLLOWING DESCRIBED TRACT: L½E (7B)

A part of the Northeast Quarter of the Northeast Quarter of Section 32 and a Part of the Northwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas and being more particularly described as follows: Commencing at the North Section corner between Section 32 and 33; thence South 1 degree 05' 29" West 339.70 feet along Section line to the point of beginning proper; thence South 89 degrees 32' 22" East 133.44 feet; thence South 14 degrees 07' 06" East 132.22 feet; thence with a curve turning to the right with an arc length of 146.74 feet, with a radius of 606.81 feet; thence with a curve turning to the left with an arc length of 78.99 feet, with a radius of 761.76 feet; thence North 89 degrees 32' 22" West 169.40 feet; thence with a curve turning to the right with an arc length of 135.08 feet, with a radius of 319.58 feet; thence with a curve turning to the left with an arc length of 160.44 feet, with a radius of 379.58 feet; thence North 89 degrees 32' 22" West 403.52 feet; thence North 00 degrees 27' 38" East 290.31 feet; thence South 89 degrees 32' 22"East 668.53 feet to the point of beginning proper, subject to all public and private roads and easements.

Williams 3/06 10 acres 50,000

(8)

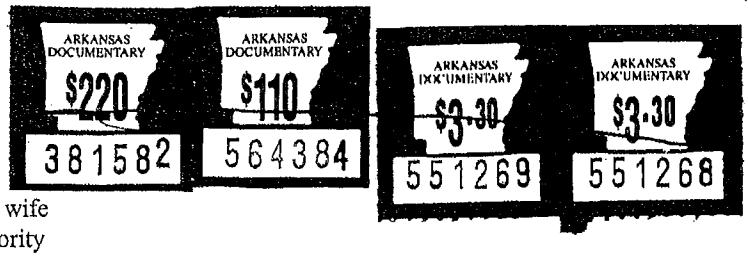
EXHIBIT "A"

Same as Less & Except 3 (Below)

Tract 1: Part of the Northwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, more particularly described as follows: Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 542 feet to the point of beginning proper; thence West 420 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 104 feet; thence East 420 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 104 feet to the point of beginning proper, containing 1 acre, more or less.

Tract 2: All that part of the Northwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, lying West of Old Ridge Road, LESS AND EXCEPT the following described tracts: (1) Beginning at the Southwest corner of the Northwest Quarter of the Southwest Quarter of said Section 33; thence North 280.5 17 rods; thence East 30 ~~rods~~ 495.0 to the public road; thence South following said public road 17 280.5 rods to the South line of said Northwest Quarter of the Southwest Quarter; thence West 30 495.0 rods to the point of beginning, containing 3-3/16 acres; (2) Commence at the point of intersection of the North line of the Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 332 feet to the point of beginning proper; thence West 210 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 210 feet; thence East 210 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 210 feet to the point of beginning proper, containing 1 acre, more or less; (3) Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 542 feet to the point of beginning proper; thence West 420 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 104 feet; thence East 420 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 104 feet to the point of beginning proper, containing 1 acre, more or less; (4) Commence at the intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence run West along said North line 245 feet; thence run Southerly parallel with the West right of way line of Old Ridge Road 180 feet; thence run East 245 feet, more or less, to the West right of way line of Old Ridge Road; thence run North along the West right of way line of Old Ridge Road 180 feet to the point of beginning proper; (5) Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of Old Ridge Road 646 feet to the point of beginning proper; thence West 420 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 104 feet; thence East 420 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 104 feet to the point of beginning proper,

containing 1 acre, more or less; and (6) Begin at the intersection of the North line of the Northwest Quarter of the Southwest Quarter aforesaid, with the West right of way line of Old Ridge Road; thence run West 245 feet to the point of beginning proper; thence continue West to the Northwest corner of said Northwest Quarter of the Southwest Quarter; thence run South along the West line of said Northwest Quarter of the Southwest Quarter, 424 feet; thence run East 340 feet, more or less, to a point which is 210 feet West of the West right of way line of Old Ridge Road; then run North 92 feet; thence run East 210 feet; thence run North 152 feet; thence run West 245 feet; thence run North 180 feet to the point of beginning proper.



Type of Instrument: Warranty Deed
Grantor: Garland Root and Tommie Root, husband and wife
Grantee: Craighead County Solid Waste Disposal Authority

This Instrument Prepared By:

DEED BK 733 PG 674

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

After recording Return to:

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

(9)

WARRANTY DEED

KNOW ALL MEN BY THESE PRESENTS:

THAT we, GARLAND ROOT and TOMMIE ROOT, husband and wife, Grantors, for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable considerations in hand paid by CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, Grantee, the receipt of which is hereby acknowledged, do hereby grant, bargain, sell and convey unto the said Grantee, and unto its successors and assigns forever, the following lands lying in Craighead County, Arkansas, to-wit:

Tract 1: A part of the Southwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, of the Fifth Principal Meridian, more particularly described as follows: From the Southwest Corner of the said Southwest Quarter of the Northwest Quarter of said Section 33, thence run North 01 degrees 16' 09" West 480.00 feet to the point of beginning proper; thence continue North 01 degrees 16' 09" West 132.79 feet; thence North 88 degrees 43' 51" East 380.98 feet to the centerline of Old Ridge Road; thence South 28 degrees 19' 00" west along the aforesaid centerline 118.77 feet; thence continuing on said centerline, South 02 degrees 52' 00" West 23.69 feet; thence leaving said centerline, South 87 degrees 38' 50" West 310.69 feet to the point of beginning proper, being subject to a 30 foot road easement along the East side thereof.

Tract 2: A part of the Southwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, more particularly described as follows: From the Southwest Corner of said Northwest Quarter of said Section 33, thence North 01 degrees 16' 09" West a distance of 612.79 feet to the point of beginning; thence North 01 degrees 16' 09" West a distance of 693.38 feet; thence South 89 degrees 50' 59" East a distance of 463.66 feet to the centerline of Old Ridge Road; thence along said road centerline as follows: South 05 degrees 46' 30" East 123.69 feet; thence South 02 degrees 35' 00" West 430.37 feet; thence South 28 degrees 19' 00" West 148.55 feet; thence leaving said road centerline run South 88 degrees 43' 51' West 370.98 feet to the point of beginning, containing 7.12 acres and being subject to a 30 foot road easement along the East side of the Tract; LESS AND EXCEPT a part of the Southwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, to-wit: From the Southwest Corner of the Northwest Quarter of said Section 33, run North 01 degrees 16' 09" West a distance of 1120.53 feet to the point of beginning; thence continue North 01 degrees 16' 09" West a distance of 185.63 feet to a point; then run South 89 degrees 50' 59" East a distance of 463.67 feet to a point on the centerline of Old Ridge Road; then run South 05 degrees 46' 30" East along said centerline a distance of 123.69 feet to a point; then run South 02 degrees 35' 10" West along said road centerline a distance of 62.60 feet to a point; then leaving said road centerline run North 89 degrees 50' 59" West a distance of 469.18 feet to a point, said point being the point of beginning, containing 2.00 acres and being subject to road right of way across the East side of Tract.

To have and to hold the same unto the said Grantee, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we hereby covenant with said Grantee that we will forever warrant and defend the title to the said lands against all claims whatever.

And each of us, for the consideration aforesaid, does hereby separately release and relinquish unto the said Grantee all our rights of dower, curtesy, and homestead in and to the said lands.

WITNESS our hands and seals on this 28 day of September, 2006.

Garland Root

Garland Root

Tommie Root

Tommie Root

ACKNOWLEDGMENT

STATE OF MICHIGAN
COUNTY OF EATON

BE IT REMEMBERED, that on this day came before me the undersigned, a Notary Public within and for the County and State aforesaid, duly qualified, commissioned and acting, Garland Root and Tommie Root, husband and wife, to me well known as the Grantors in the foregoing Warranty Deed, and stated that they had executed the same for the consideration and purposes therein mentioned and set forth.

WITNESS my hand and seal as such Notary Public this 29th day of September, 2006.

TAMARA J. BATY
NOTARY PUBLIC - STATE OF MICHIGAN
COUNTY OF EATON
My Commission Expires Aug. 18, 2011
Acting in the County of Eaton

Tamara J Baty
Notary Public

My Commission Expires:
8-18-2011.

AMOUNT OF TAX $ 336.60
I certify under penalty of false swearing that the legally correct amount of documentary stamps have been placed on this instrument. Exempt or no consideration paid if none shown.

Grantee or Agent: Craighead County Solid Waste Disposal Authority

Grantee's Address: 1620 Strawberry
Jonesboro, AR 72401

DEED BK 733 PG 674 - 676
DATE 10/02/2006
TIME 04:49:12 PM
RECORDED IN,
OFFICIAL RECORDS OF
CRAIGHEAD COUNTY
ANN HUDSON
CIRCUIT CLERK
_____, D.C.
RECEIPT# 154069

F:\USERS\AA\CCSWDA\Root\warranty deed.wpd

1999

UTILITY EASEMENT

KNOW ALL MEN BY THESE PRESENTS, for and in consideration of good and valuable consideration, the receipt of which is acknowledged, the undersigned Grantor(s), (~~unmarried~~) (~~husband and~~ wife), Craighead Co. Solid Waste Disposal Authority who hereby covenant(s) that he/she/they will defend the Grantee's rights hereunder against all claims or objections, do(es) hereby Grant, Sell and Convey unto Craighead Electric Cooperative Corporation and its successors and assigns, an easement, privilege and right of entry over and across the following described lands situated in Craighead County, Arkansas:

See attached Exhibit A for description.

This easement is for the purpose of permitting the construction, operation, use, repair, relocation or removal of a power line or lines, including all necessary equipment or appurtenances and to convey a right of ingress and egress for the purposes aforesaid. The easement and covenant shall run with the land described above and shall bind not only the parties hereto, but also their heirs, successors and assigns as well as any other person or entity who might acquire any rights in this property.

IN WITNESS WHEREOF, the Grantor(s) have hereunto set his, hers, their hand(s) this 4 day of June, 1999.

E. Guy Enchelmayer FOR CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY

Craighead Electric Cooperative Corporation
Easement Information Form

Name of landowner: Craighead County Solid Waste Disposal Authority

Previous Owner:

Purchase Date:

Legals: **Township-** 13N **,Range-** 4E **,Section-** 29

Description of Utility Easement:

Part of the SW quarter of section 29, Township 13N, Range 4E of Craighead County, Ar.. Being described more particularly as follows: Starting at the SW corner of the SW quarter of section 29, thence 30' S, thence 1811' E to the point of beginning.

Thence 1848' E with a 15' width off of the Counties right of way.

TT

Approved as to form by:
John Barttelt, Attorney-at-Law
Transactional data completed by The Title Company

WARRANTY DEED
MARRIED PERSON

KNOW ALL MEN BY THESE PRESENTS:

THAT WE, MISTI D. SIMS and KELLEY R. SIMS, her husband, Grantor(S) for and in consideration of the sum of Ten and no/100 Dollars ($10.00), and other good and valuable consideration in hand paid by Grantee(S), the receipt of which is hereby acknowledged, hereby grant, bargain, sell and convey unto said CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITYGrantee(S), and unto their heirs and assigns forever, the following lands lying in Craighead County, Arkansas.

A part of the Northeast Quarter of the Northeast Quarter of Section 32 and a Part of the Northwest Quarter of the Northwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas and being more particularly described as follows: Commencing at the Section corner between Section 32 and 33; thence South 1 degree 05' 29" West 339.70 feet along Section line to the point of beginning proper; thence South 89 degrees 32' 22" East 133.44 feet; thence South 14 degrees 07' 06" East 132.22 feet; thence with a curve turning to the right with an arc length of 146.74 feet, with a radius of 606.81 feet; thence with a curve turning to the left with an arc length of 78.99 feet, with a radius of 761.76 feet; thence North 89 degrees 32' 22" West 169.40 feet; thence with a curve turning to the right with an arc length of 135.08 feet, with a radius of 319.58 feet; thence with a curve turning to the left with an arc length of 160.44 feet, with a radius of 379.58 feet; thence North 89 degrees 32' 22" West 403.52 feet; thence North 00 degrees 27' 38" East 290.31 feet; thence South 89 degrees 32' 22"East 668.53 feet to the point of beginning proper, subject to all public and private roads and easements.

To have and to hold the same unto the said GRANTEE(S), and unto their heirs and assign forever, with all appurtenances thereunto belonging.

And we hereby covenant with said GRANTEE(S) that we will forever warrant and defend the title to the said lands against all claims whatever.

And we, the GRANTOR(S) MISTI D. SIMS and KELLEY R. SIMS, her husband , for and in consideration of the said sum of money, do hereby release and relinquish unto the said GRANTEE(S) all our rights of dower, curtesy and homestead in and to the said lands.

WITNESS our hands and seals on this 24th day of February, 2006.

Misti Sims
MISTI D. SIMS

KELLEY R. SIMS

"I certify under penalty of false swearing that the legally correct amount of documentary stamps have been placed on this instrument."
By The Title Company
Grantee/Grantee's Agent
Address: PO Box 1997
Jonesboro, AR 72403

WARRANTY DEED
PAGE 2

ACKNOWLEDGMENT

STATE OF ARKANSAS
COUNTY OF __CRAIGHEAD__

On this day, personally appeared before me **MISTI D. SIMS** and **KELLEY R. SIMS**, husband and wife, known to me to be persons whose names are subscribed to the within instrument and acknowledged that they executed the same for the purposes therein contained.

WITNESS my hand and official seal this 24th day of February, 2006.

RHONDA JEAN LONG
Craighead County
My Commission Expires
December 8, 2015

Rhonda Jean Long

Notary Public

DEED BK 718 PG 692 - 693
DATE 03/13/2006
TIME 10:11:30 AM
RECORDED IN
OFFICIAL RECORDS OF
CRAIGHEAD COUNTY
ANN HUDSON
CIRCUIT CLERK
Teresa Hunter, D.C.
RECEIPT# 146585

Type of Instrument: Warranty Deed
Grantor: Earnest Elmo Stevens and Mary Catherine Stevens
Grantee: Craighead County Solid Waste Disposal Authority

This Instrument Prepared By:

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

After recording Return to:

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

WARRANTY DEED

KNOW ALL MEN BY THESE PRESENTS:

THAT we, EARNEST ELMO STEVENS AND MARY CATHERINE STEVENS, husband and wife, Grantors, for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable considerations in hand paid by CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, Grantee, the receipt of which is hereby acknowledged, do hereby grant, bargain, sell and convey unto the said Grantee, and unto its successors and assigns forever, the following lands lying in Craighead County, Arkansas, to-wit:

> A part of the Northwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, more particularly described as follows: Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 332 feet to the point of beginning proper; thence West 210 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 210 feet; thence East 210 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 210 feet to the point of beginning proper, containing 1 acre, more or less.

To have and to hold the same unto the said Grantee, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we hereby covenant with said Grantee that we will forever warrant and defend the title to the said lands against all claims whatever.

And each of us, for the consideration aforesaid, does hereby separately release and relinquish unto the said Grantee all our rights of dower, curtesy, and homestead in and to the said lands.

WITNESS our hands and seals on April 18, 2006.

Earnest Elmo Stevens

Mary Catherine Stevens

ACKNOWLEDGMENT

STATE OF ARKANSAS
COUNTY OF CRAIGHEAD

BE IT REMEMBERED, that on this day came before me the undersigned, a Notary Public within and for the County and State aforesaid, duly qualified, commissioned and acting, Earnest Elmo Stevens and Mary Catherine Stevens, husband and wife, to me well known as the Grantors in the foregoing Warranty Deed, and stated that they had executed the same for the consideration and purposes therein mentioned and set forth.

WITNESS my hand and seal as such Notary Public on April 18, 2006.

Amanda Pittman
Notary Public

AMANDA PITTMAN
NOTARY PUBLIC, STATE OF ARKANSAS
COUNTY OF CRAIGHEAD
MY COMMISSION EXPIRES 10/30/2013

My Commission Expires:

10-30-2013.

AMOUNT OF TAX $ 115.50
I certify under penalty of false swearing that the legally correct amount of documentary stamps have been placed on this instrument. Exempt or no consideration paid if none shown.

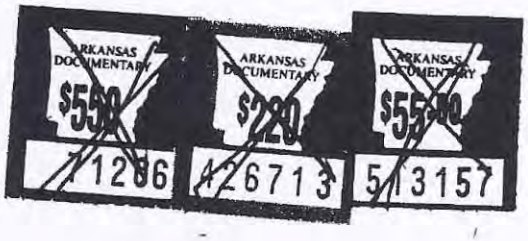
Grantee or Agent: Craighead County Solid Waste Disposal Authority

Grantee's Address: 1620 Strawfloor
Jonesboro, AR 72401

F:\USERS\AA\CCSWDA\Stevens\Stevens Deed.wpd

DEED BK 721 PG 589 - 591
DATE 04/19/2006
TIME 04:50:40 PM
RECORDED IN,
OFFICIAL RECORDS OF
CRAIGHEAD COUNTY
ANN HUDSON
CIRCUIT CLERK
_____, D.C.
RECEIPT# 148241

Type of Instrument: Warranty Deed
Grantor: Johnny Whitlatch and Carla Jo Whitlatch, husband and wife
Grantee: Craighead County Solid Waste Disposal Authority



This Instrument Prepared By:

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

After recording Return to:

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

WARRANTY DEED

KNOW ALL MEN BY THESE PRESENTS:

That we, **JOHNNY WHITLATCH and CARLA JO WHITLATCH**, husband and wife (collectively, "Grantor"), for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable consideration in hand paid by **CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY** ("Grantee") the receipt of which is hereby acknowledged, do hereby grant, bargain, sell and convey unto the said Grantee, and unto its successors and assigns forever, the following described real property lying in Craighead County, Arkansas, to wit:

> The real property is more particularly described in Exhibit "A" attached hereto and incorporated herein by reference.

To have and to hold the same unto the said Grantee, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And Grantor does hereby covenant with said Grantee that Grantor will forever warrant and defend the title to the said lands against all claims whatever.

And we, for the consideration aforesaid, do hereby separately release and relinquish unto the said Grantee all our rights of dower, curtesy, and homestead in and to the said lands.

WITNESS our hands and seals this 17 day of August, 2007.

GRANTOR:

By: Johnny W Whitlatch
Name: Johnny Whitlatch

By: Carla Jo Whitlatch
Name: Carla Jo Whitlatch

ACKNOWLEDGMENT

STATE OF ARKANSAS
COUNTY OF CRAIGHEAD

BE IT REMEMBERED, that on this day personally appeared before me the undersigned, a Notary Public, within and for the County and State aforesaid, duly qualified, commissioned and acting, JOHNNY WHITLATCH and CARLA JO WHITLATCH, husband and wife, to me well known, and who subscribed to the foregoing instrument and stated and acknowledged that they had signed, executed, and delivered the foregoing instrument for the consideration, uses, and purposes therein mentioned and set forth and relinquished their respective rights of dower, curtesy, and homestead, if any, in the subject property set forth in the foregoing instrument.

WITNESS my hand and official seal this 17 day of August, 2007

Karen Leigh Crum
Notary Public

KAREN LEIGH CRUM
NOTARY PUBLIC - STATE OF ARKANSAS
COUNTY OF LAWRENCE
MY COMMISSION EXPIRES 10/25/2016

My Commission Expires:

10/25/2016

AMOUNT OF TAX $825.00
I certify under penalty of false swearing that the legally correct amount of documentary stamps have been placed on this instrument. Exempt or no consideration paid if none shown.

Grantee or Agent

Kevan Inboden, Vice Chairman

Grantee's Address

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY
P.O. Box 16777
Jonesboro, AR 72403

EXHIBIT "A"

LEGAL DESCRIPTION

A part of the Southeast Quarter of Section 32 and part of the West Half of the Southwest Quarter of Section 33, both Sections being in Township 13 North, Range 4 East, being more particularly described as follows: Begin at the Northeast corner of the Southwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East; thence South 89 degrees 30'04" West 756.58 feet to the centerline of a public road, the point of beginning proper; thence South 17 degrees 21'19" West along said centerline 50.57 feet; thence South 10 degrees 47'41" East along said centerline 258.54 feet; thence South 88 degrees 01'14" West 542.84 feet; thence North 88 degrees 40'57" West 775.81 feet; thence North 5 degrees 18'44" West 296.59 feet; thence South 87 degrees 19'28" East 614.20 feet; thence North 0 degrees 55'28" East 197.93 feet; thence North 89 degrees 44'21"East 747.03 feet to the centerline of a public road aforesaid; thence South 17 degrees 21'19" West 172.66 feet to the point of beginning proper, containing 11.74 acres, more or less.

F:\USERS\AA\CCSWDA\Whitlatch\WD.bb.wpd

DEED BK 756 PG 35 - 37
DATE 08/21/2007
TIME 08:46:00 AM
RECORDED IN,
OFFICIAL RECORDS OF
CRAIGHEAD COUNTY
ANN HUDSON
CIRCUIT CLERK
_____, D.C.
RECEIPT# 165944

Type of Instrument: Warranty Deed
Grantor: Bill E. Williams and Mary Lee Williams
Grantee: Craighead County Solid Waste Disposal Authority

This Instrument Prepared By:

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

After recording Return to:

Barrett & Deacon, P.A.
Attorneys at Law
P.O. Box 1700
Jonesboro, Arkansas 72403

DEED BK 720 PG 105

WARRANTY DEED

KNOW ALL MEN BY THESE PRESENTS:

THAT we, BILL E. WILLIAMS AND MARY LEE WILLIAMS, husband and wife, Grantors, for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable considerations in hand paid by CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, Grantee, the receipt of which is hereby acknowledged, do hereby grant, bargain, sell and convey unto the said Grantee, and unto its successors and assigns forever, the following lands lying in Craighead County, Arkansas, to-wit:

Tract 1: Part of the Northwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, more particularly described as follows: Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 542 feet to the point of beginning proper; thence West 420 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 104 feet; thence East 420 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 104 feet to the point of beginning proper, containing 1 acre, more or less.

Tract 2: All that part of the Northwest Quarter of the Southwest Quarter of Section 33, Township 13 North, Range 4 East, Craighead County, Arkansas, lying West of Old Ridge Road, LESS AND EXCEPT the following described tracts: (1) Beginning at the Southwest corner of the Northwest Quarter of the Southwest Quarter of said Section 33; thence North 17 rods; thence East 30 rods to the public road; thence South following said public road 17 rods to the South line of said Northwest Quarter of the Southwest Quarter; thence West 30 rods to the point of beginning, containing 3-3/16 acres; (2) Commence at the point of intersection of the North line of the Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 332 feet to the point of beginning proper; thence West 210 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 210 feet; thence East 210 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 210 feet to the point of beginning proper, containing 1 acre, more or less; (3) Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of said Old Ridge Road 542 feet to the point of beginning proper; thence West 420 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 104 feet; thence East 420 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 104 feet to the point of beginning proper, containing 1 acre, more or less; (4) Commence at the intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence run West along said North line 245 feet; thence run Southerly parallel with the West right of way line of Old Ridge Road 180 feet; thence run East 245 feet, more or less, to the West right of way line of Old Ridge Road; thence run North along the West right of way line of Old Ridge Road 180 feet to the point of beginning proper; (5) Commence at the point of intersection of the North line of said Northwest Quarter of the Southwest Quarter with the West right of way line of Old Ridge Road; thence in a Southerly direction along the West right of way line of Old Ridge Road 646 feet to the point of beginning proper; thence West 420 feet; thence in a Southerly direction parallel to the West right of way line of Old Ridge Road 104 feet; thence East 420 feet to the West right of way line of Old Ridge Road; thence in a Northerly direction along the West right of way line of Old Ridge Road 104 feet to the point of beginning proper, containing 1 acre, more or less; and (6) Begin at the intersection of the North line of the Northwest Quarter of the Southwest Quarter aforesaid, with the West right of way line of Old Ridge Road; thence run West 245 feet to the point of beginning proper; thence continue West to the Northwest corner of said Northwest

Quarter of the Southwest Quarter; thence run South along the West line of said Northwest Quarter of the Southwest Quarter, 424 feet; thence run East 340 feet, more or less, to a point which is 210 feet West of the West right of way line of Old Ridge Road; then run North 92 feet; thence run East 210 feet; thence run North 152 feet; thence run West 245 feet; thence run North 180 feet to the point of beginning proper.

To have and to hold the same unto the said Grantee, and unto its successors and assigns forever, with all appurtenances thereunto belonging.

And we hereby covenant with said Grantee that we will forever warrant and defend the title to the said lands against all claims whatever.

And each of us, for the consideration aforesaid, does hereby separately release and relinquish unto the said Grantee all our rights of dower, curtesy, and homestead in and to the said lands.

WITNESS our hands and seals on this 30th day of March, 2006.

Bill E. Williams

Bill E. Williams

Mary Lee Williams

Mary Lee Williams

ACKNOWLEDGMENT

STATE OF ARKANSAS
COUNTY OF CRAIGHEAD

BE IT REMEMBERED, that on this day came before me the undersigned, a Notary Public within and for the County and State aforesaid, duly qualified, commissioned and acting, Bill E. Williams and Mary Lee Williams, husband and wife, to me well known as the Grantors in the foregoing Warranty Deed, and stated that they had executed the same for the consideration and purposes therein mentioned and set forth.

WITNESS my hand and seal as such Notary Public this 30th day of March, 2006.

Brandy L. B

Notary Public

My Commission Expires:

1-1-14.

Brandy L. Brown
Notary Public, State of Arkansas
Qualified in Craighead County
Commission Expires January 1, 2014

AMOUNT OF TAX $ 165.00
I certify under penalty of false swearing that the legally correct amount of documentary stamps have been placed on this instrument. Exempt or no consideration paid if none shown.

Grantee or Agent: Craighead County Solid Waste Disposal Authority

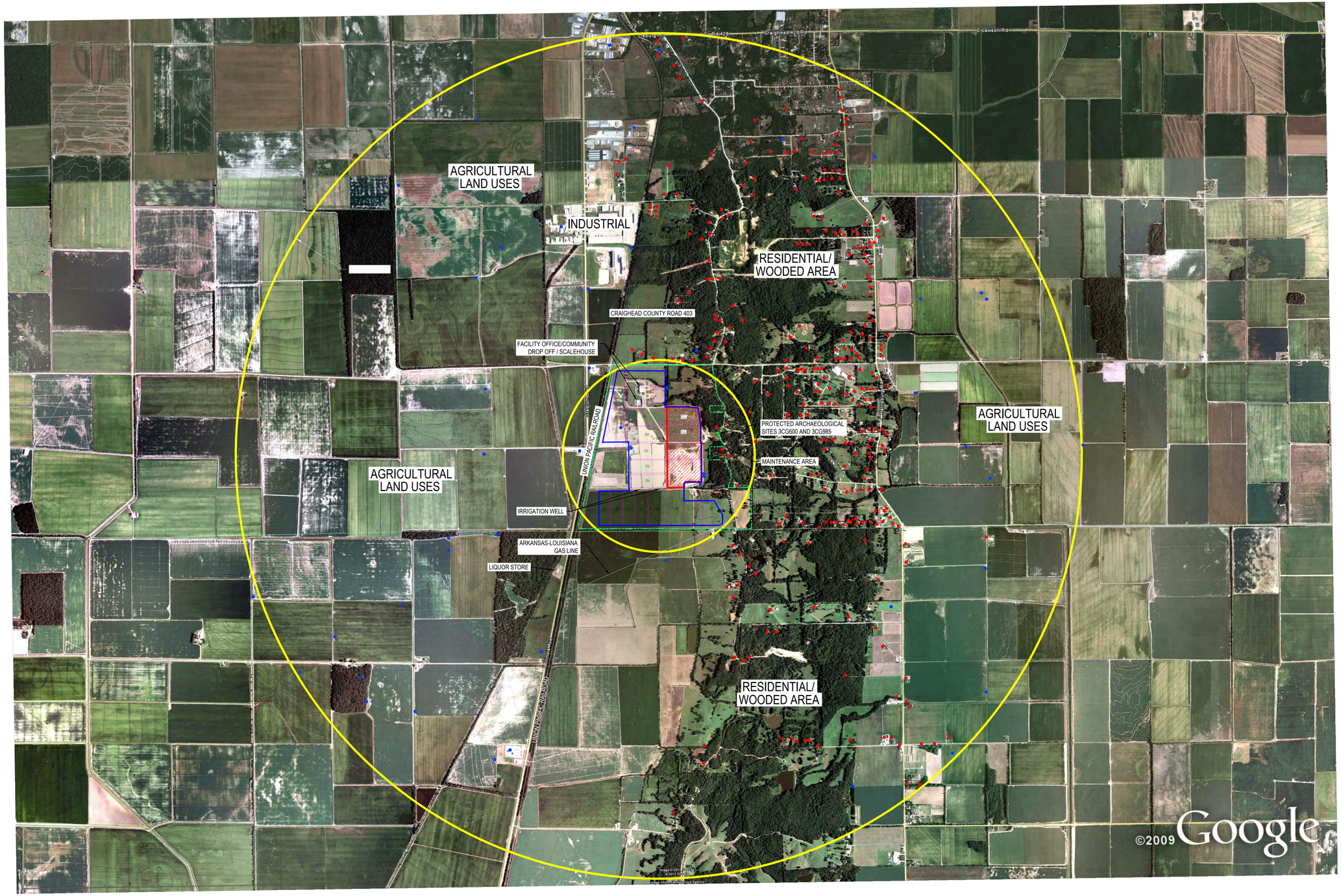
Grantee's Address: ~~1620 Strawfloor~~ PO Box 1997
Jonesboro, AR 7240~~3~~

F:\USERS\AA\CCSWDA\Williams Deed.wpd

DEED BK 720 PG 105 - 108
DATE 03/31/2006
TIME 10:04:11 AM
RECORDED IN,
OFFICIAL RECORDS OF
CRAIGHEAD COUNTY
ANN HUDSON
CIRCUIT CLERK
_____, D.C.
RECEIPT# 147429

ATTACHMENT B

Revised Drawings



N

SCALE IS APPROXIMATE

1500 0 500 1000 1500

SCALE IN FEET

LEGEND:

- PROPOSED MODIFICATION AREA (APPROX. 60.64 ACRES)
- PERMITTED FOOTPRINT (APPROX. 296 ACRES)
- PROPERTY OWNED (APPROX. 520.32 ACRES)
- HOUSES
- WELLS

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

SURROUNDING LAND USE (AERIAL PHOTOGRAPHY)

PERMIT MODIFICATION CELLS 1-4

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA)

LEGACY LANDFILL

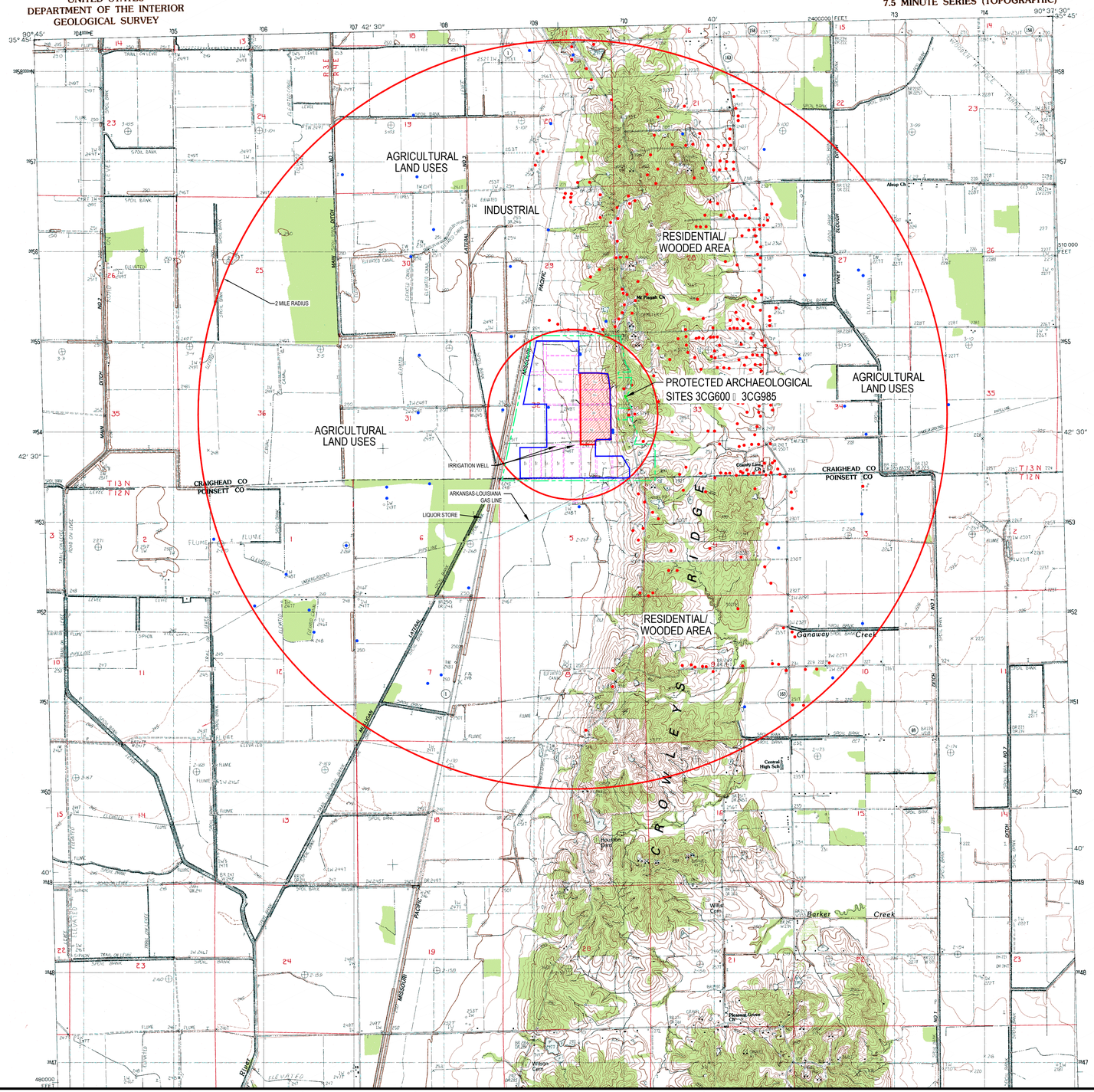
CRAIGHEAD COUNTY ARKANSAS

FIGURE 1

DESIGNED BY:	HAL
DRAWN BY:	PTG
APPVD. BY:	FOC
SCALE:	AS SHOWN
DATE:	3/1/12
JOB NO.	282-001-35117104
ACAD NO.	017
SHEET NO.:	1 OF 2

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GREENFIELD QUADRANGLE
ARKANSAS
7.5 MINUTE SERIES (TOPOGRAPHIC)



N

SCALE IS APPROXIMATE
2000 0 500 1000 2000
SCALE IN FEET

LEGEND:

- PROPOSED MODIFICATION AREA (APPROX. 60.64 ACRES)
- PERMITTED FOOTPRINT (APPROX. 296 ACRES)
- PROPERTY OWNED (APPROX. 520.32 ACRES)
- HOUSES
- WELLS

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

SITE LOCATION MAP

PERMIT MODIFICATION CELLS 1-4

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA)

LEGACY LANDFILL

CRAIGHEAD COUNTY ARKANSAS

FIGURE 2

DESIGNED BY:	HAL
DRAWN BY:	PTG
APPVD. BY:	FOC
SCALE:	AS SHOWN
DATE:	3/1/12
JOB NO.	282-001-35117104
ACAD NO.	018
SHEET NO.:	2 OF 2

NOTE:
THE BOTTOM LINER CONTOURS OF CELLS 1, 2, & 3 DEPICTED ON THIS DRAWING WERE DERIVED FROM MEHLBURGER, TANNER, ROBINSON, & ASSOCIATES DRAWINGS DATED MARCH 1990, AND ARE APPROXIMATE IN NATURE.

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

BOTTOM LINER SYSTEM - PRE-SUBTITLE D CELLS 1, 2, & 3

ADEQ NOD RESPONSE

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY

CCSWDA LANDFILL FACILITY

CRAIGHEAD COUNTY ARKANSAS

FIGURE 1

DESIGNED BY:	MTRA
DRAWN BY:	JDW
APPVD. BY:	FOC
SCALE:	1" = 200'
DATE:	07-13-11
JOB NO.	282-001-35117104
ACAD NO.	020
SHEET NO.:	1 OF 3

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

BOTTOM LINER SYSTEM - SUBTITLE D CELLS 3 & 4

ADEQ NOD RESPONSE

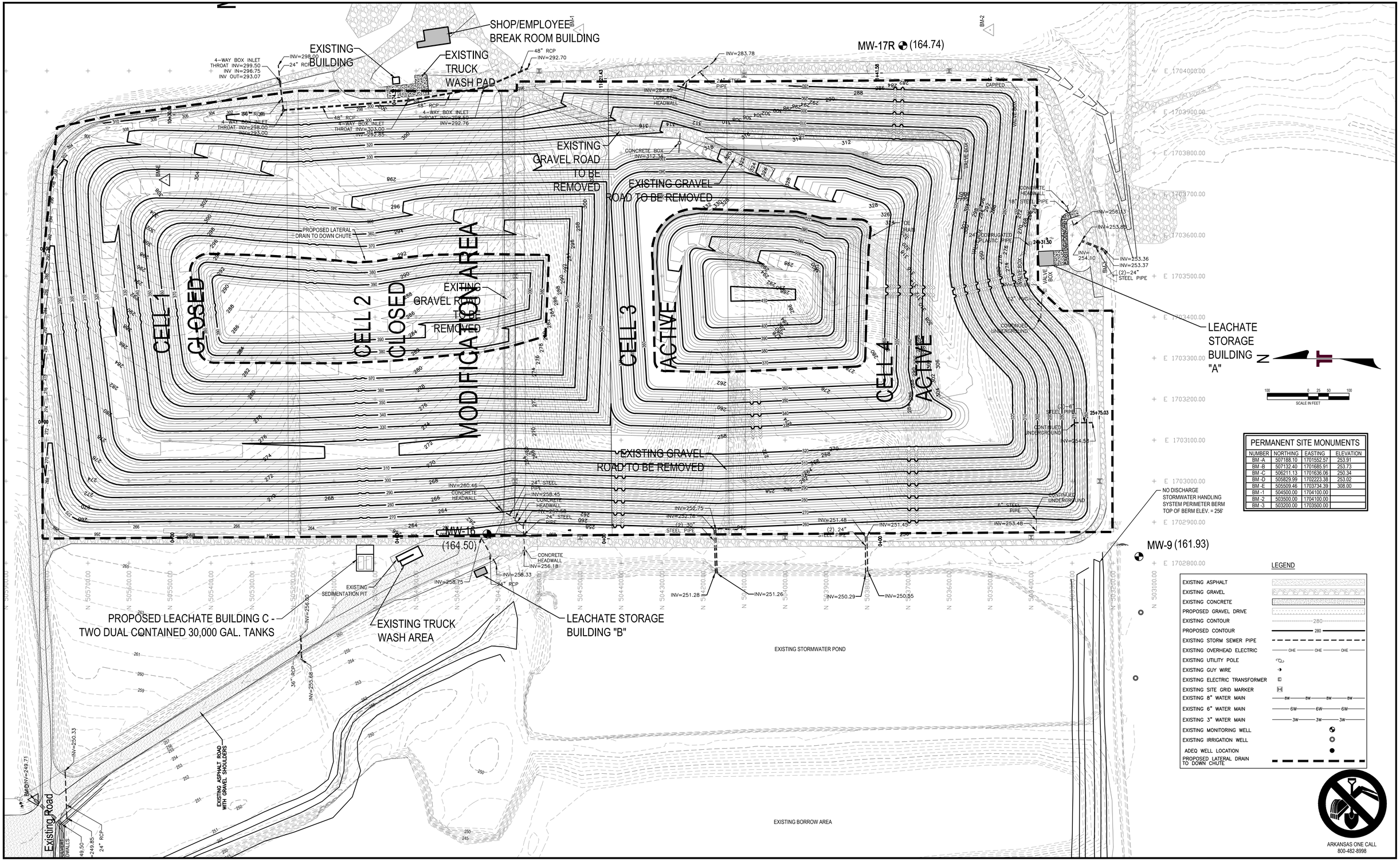
CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY

CCSWDA LANDFILL FACILITY

CRAIGHEAD COUNTY ARKANSAS

FIGURE 2

DESIGNED BY:	MTRA
DRAWN BY:	JDW
APPVD. BY:	FOC
SCALE:	1" = 200'
DATE:	07-13-11
JOB NO.	282-001-35117104
ACAD NO.	021
SHEET NO.:	2 OF 3



PERMANENT SITE MONUMENTS

NUMBER	NORTHING	EASTING	ELEVATION
BM-A	507188.10	1701552.57	253.91
BM-B	507132.40	1701685.91	253.73
BM-C	506211.13	1701636.06	250.34
BM-D	505829.99	1702223.38	253.02
BM-E	505509.46	1703734.39	308.00
BM-1	504500.00	1704100.00	
BM-2	503500.00	1704100.00	
BM-3	503200.00	1703500.00	

LEGEND

- EXISTING ASPHALT
- EXISTING GRAVEL
- EXISTING CONCRETE
- PROPOSED GRAVEL DRIVE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM SEWER PIPE
- EXISTING OVERHEAD ELECTRIC
- EXISTING UTILITY POLE
- EXISTING GUY WIRE
- EXISTING ELECTRIC TRANSFORMER
- EXISTING SITE GRID MARKER
- EXISTING 8" WATER MAIN
- EXISTING 6" WATER MAIN
- EXISTING 3" WATER MAIN
- EXISTING MONITORING WELL
- EXISTING IRRIGATION WELL
- ADEQ WELL LOCATION
- PROPOSED LATERAL DRAIN TO DOWN CHUTE

ARKANSAS ONE CALL 800-482-8998

REV.	DATE	BY	DESCRIPTION
1	5-11	FOC	REVISED PER NODs DATED APRIL 19, 2011

CERTIFICATE OF AUTHORIZATION TERRACON CONSULTANTS, INC. No.223 ARKANSAS

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No.8653 F. OWEN CARPENTER

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

PROPOSED FINAL COVER PLAN

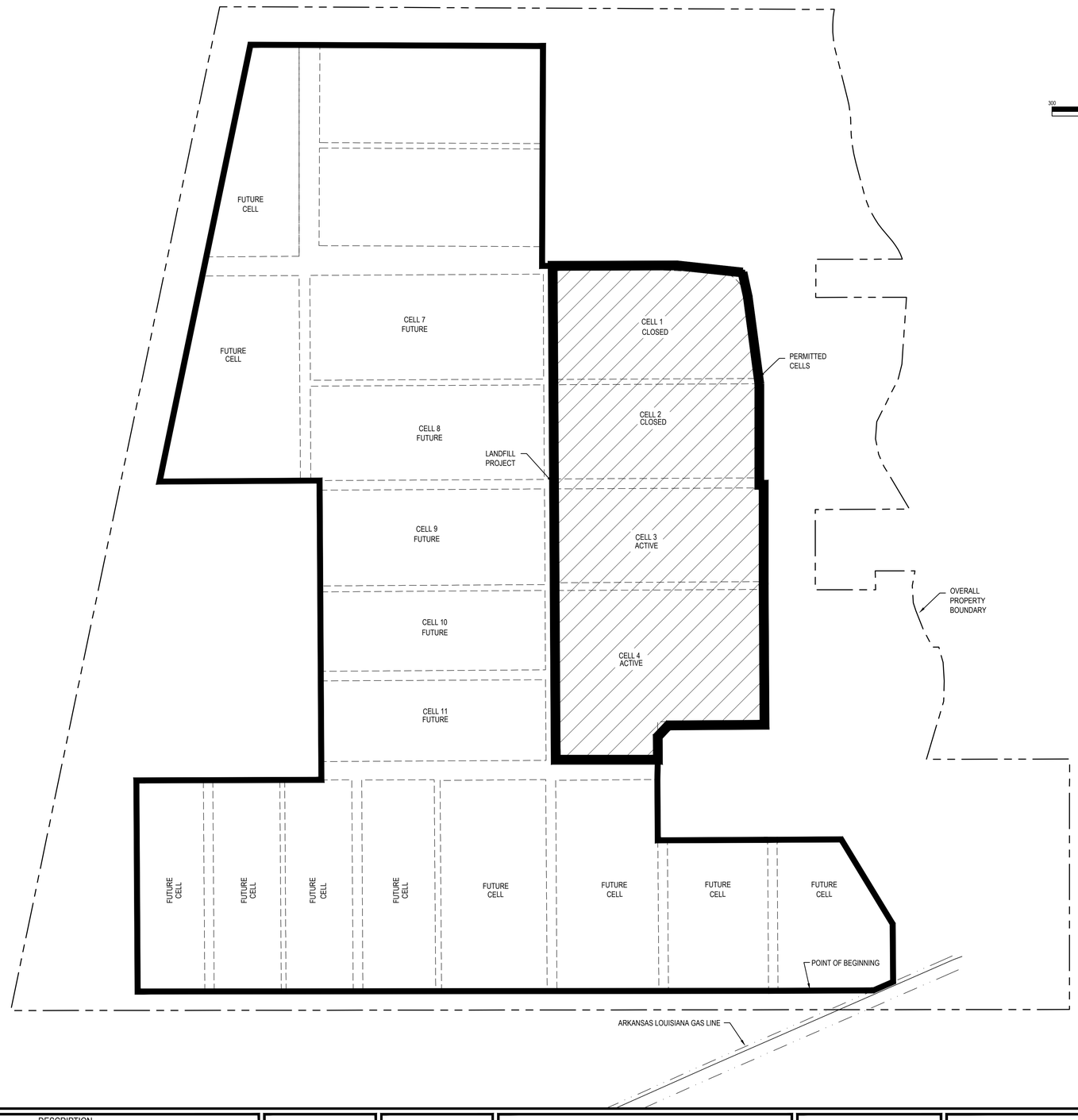
PERMIT MODIFICATION CELLS 1-4

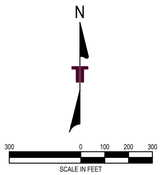
CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA)

LEGACY LANDFILL

CRAIGHEAD COUNTY ARKANSAS

DRAWING 2	
DESIGNED BY:	TSW
DRAWN BY:	TSW
APPVD. BY:	FOC
SCALE:	1" = 100'
DATE:	2/29/12
JOB NO.	282-001-35117104
ACAD NO.	003
SHEET NO.:	2 OF 14





OVERALL PROPERTY LEGAL DESCRIPTION:

THIS IS TO CERTIFY THAT HAYWOOD, KENWARD, BARE AND ASSOCIATES, INC., PROFESSIONAL LAND SURVEYORS, HAVE SURVEYED THE FOLLOWING DESCRIBED PARCELS OF LAND:

A PART OF SECTIONS 32 AND 33, TOWNSHIP 13 NORTH, RANGE 4 EAST, CRAIGHEAD COUNTY, ARKANSAS, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT THE NORTHEAST CORNER OF THE SOUTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 33, TOWNSHIP 13 NORTH, RANGE 4 EAST, CRAIGHEAD COUNTY, ARKANSAS; THENCE SOUTH 00°01'48" WEST, 1323.00 FEET; THENCE SOUTH 89°56'27" WEST, 5590.97 FEET, TO THE EASTERLY RIGHT-OF-WAY LINE OF THE UNION-PACIFIC RAILROAD; THENCE NORTH 11°45'24" EAST, ALONG SAID RIGHT-OF-WAY LINE, 5415.62 FEET; THENCE SOUTH 89°50'28" EAST, 496.86 FEET; THENCE SOUTH 89°43'54" EAST, 2653.52 FEET, THENCE NORTH 89°38'27" EAST, 95.50 FEET, TO A POINT ON THE CENTERLINE OF CRAIGHEAD COUNTY ROAD 403, THENCE ALONG SAID CENTERLINE THE FOLLOWING BEARINGS AND DISTANCES; ON A CURVE TO THE LEFT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 536.61 FEET, ARC LENGTH OF 201.55 FEET, TO A POINT WHICH BEARS SOUTH 00°26'24" EAST, 200.37 FEET FROM LAST SAID POINT; SOUTH 14°07'07" EAST, 277.41 FEET, TO A POINT ON A CURVE TO THE RIGHT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 606.81 FEET, ARC LENGTH OF 146.74 FEET, TO A POINT WHICH BEARS SOUTH 07°11'29" EAST, 146.38 FEET, FROM LAST SAID POINT, TO A POINT ON A CURVE TO THE LEFT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 761.76 FEET, ARC LENGTH OF 199.17 FEET, TO A POINT WHICH BEARS SOUTH 07°45'14" EAST, 198.60 FEET FROM LAST SAID POINT; SOUTH 14°56'35" EAST, 175.08 FEET, TO A POINT ON A CURVE TO THE LEFT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 475.44 FEET, ARC LENGTH OF 206.05 FEET, TO A POINT WHICH BEARS SOUTH 27°28'54" EAST, 204.44 FEET, FROM LAST SAID POINT; SOUTH 39°46'26" EAST, 82.21 FEET, TO A POINT ON A CURVE TO THE RIGHT; CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 297.96 FEET, ARC LENGTH OF 109.12 FEET, TO A POINT WHICH BEARS SOUTH 29°15'58" EAST, 108.51 FEET, FROM LAST SAID POINT; THENCE SOUTH 89°54'09" WEST, DEPARTING SAID CENTERLINE, 456.96 FEET; THENCE SOUTH 00°06'38" WEST, 201.27 FEET; THENCE NORTH 89°54'09" EAST, 479.19 FEET, TO THE CENTERLINE OF CRAIGHEAD COUNTY ROAD 403; THENCE ALONG SAID CENTERLINE THE FOLLOWING BEARINGS AND DISTANCES; SOUTH 03°57'08" WEST, 354.58 FEET; SOUTH 13°45'51" WEST, 79.90 FEET; SOUTH 26°39'43" WEST, 252.40 FEET; SOUTH 31°41'11" WEST, 91.27 FEET; SOUTH 11°38'10" EAST, 83.75 FEET; SOUTH 23°34'48" EAST, 67.33 FEET; SOUTH 30°50'24" EAST, 264.83 FEET; THENCE SOUTH 89°43'48" WEST, DEPARTING SAID CENTERLINE, 497.03 FEET; THENCE SOUTH 00°04'03" WEST, 424.00 FEET; THENCE NORTH 89°58'04" EAST, 318.56 FEET; THENCE NORTH 01°19'45" WEST, 99.41 FEET; THENCE NORTH 89°48'06" EAST, 210.22 FEET, TO THE WEST RIGHT-OF-WAY LINE OF CRAIGHEAD COUNTY ROAD 403; THENCE ALONG SAID RIGHT-OF WAY LINE THE FOLLOWING BEARINGS AND DISTANCES; SOUTH 10°23'39" WEST, 79.53 FEET; SOUTH 03°37'37" EAST, 90.86 FEET; SOUTH 17°35'20" EAST, 43.07 FEET; SOUTH 21°38'16" EAST, 108.77 FEET; SOUTH 27°27'56" EAST, 104.00 FEET; THENCE NORTH 89°45'16" EAST, 33.56 FEET, TO THE CENTERLINE OF CRAIGHEAD COUNTY ROAD 403; THENCE ALONG SAID CENTERLINE THE FOLLOWING BEARINGS AND DISTANCES; SOUTH 15°41'47" EAST, 83.74 FEET; SOUTH 03°16'44" EAST, 97.61 FEET; SOUTH 01°21'12" WEST, 108.42 FEET; SOUTH 16°37'00" WEST, 319.26 FEET; THENCE NORTH 89°52'45" EAST, DEPARTING SAID CENTERLINE, 756.02 FEET, TO THE POINT OF BEGINNING, CONTAINING IN ALL 520.32 ACRES, MORE OR LESS; SUBJECT TO A PUBLIC ROAD RIGHT-OF-WAY, OFF AND ACROSS THE NORTH AND EAST SIDE THEREOF; BEING SUBJECT TO ALL RIGHT OF WAY AND EASEMENTS OF RECORD.

PROJECT LEGAL DESCRIPTIONS:
A PART OF SECTION 32, TOWNSHIP 13 NORTH, RANGE 4 EAST, CRAIGHEAD COUNTY, ARKANSAS BEING MORE PARTICULARLY DESCRIBED AS:

LANDFILL PROJECT:
BEGINNING AT THE SOUTHEAST CORNER OF SECTION 32, TOWNSHIP 13 NORTH, RANGE 4 EAST, CRAIGHEAD COUNTY, ARKANSAS; THENCE SOUTH 89°56'27" WEST, 242.67 FEET; THENCE NORTH 00°21'10" WEST, 1219.64 FEET; THENCE SOUTH 89°40'59" WEST, 580.07 FEET; THENCE NORTH 01°21'55" EAST, 104.35 FEET, TO THE POINT OF BEGINNING PROPER; THENCE NORTH 90°00'00" WEST, 539.56 FEET; THENCE NORTH 00°21'12" WEST, 2608.78 FEET; THENCE NORTH 89°49'11" EAST, 656.60 FEET; THENCE SOUTH 83°52'16" EAST, 348.18 FEET; THENCE SOUTH 12°11'07" EAST, 130.57 FEET; THENCE SOUTH 07°34'22" EAST, 464.13 FEET; THENCE SOUTH 00°00'00" EAST, 533.40 FEET; THENCE NORTH 90°00'00" EAST, 22.91 FEET; THENCE SOUTH 00°12'45" EAST, 1267.90 FEET; THENCE SOUTH 89°38'09" WEST, 508.29 FEET; THENCE SOUTH 43°17'11" WEST, 81.50 FEET; THENCE SOUTH 00°19'08" EAST, 122.06 FEET; TO THE POINT OF BEGINNGING PROPER, CONTAINING 62.68 ACRES, MORE OR LESS, BEING SUBJECT TO ALL RIGHTS-OF-WAY AND EASEMENTS OF RECORD.

PERMITTED CELLS:
BEGINNING AT THE SOUTHEAST CORNER OF SECTION 32, TOWNSHIP 13 NORTH, RANGE 4 EAST, CRAIGHEAD COUNTY, ARKANSAS; THENCE NORTH 89°51'28" EAST, 332.89 FEET; THENCE NORTH 66°21'34" EAST, 112.81 FEET; THENCE NORTH 00°25'07" WEST, 305.75 FEET; THENCE NORTH 31°17'07" WEST 522.75 FEET; THENCE SOUTH 89°41'49" WEST, 968.86 FEET; THENCE NORTH 00°22'47" WEST, 548.05 FEET; THENCE NORTH 43°17'11" EAST, 81.50 FEET; THENCE NORTH 89°38'09" EAST, 508.29 FEET; THENCE NORTH 00°12'45" WEST, 1267.90 FEET; THENCE WEST 22.91 FEET; THENCE NORTH 00°00'49" EAST, 533.32 FEET; THENCE NORTH 07°35'13" WEST, 464.23 FEET; THENCE NORTH 12°11'07" WEST, 130.57 FEET; THENCE NORTH 83°52'16" WEST, 348.18 FEET; THENCE SOUTH 89°49'11" WEST, 712.40 FEET; THENCE NORTH 00°14'28" EAST, 1161.56 FEET; THENCE NORTH 89°45'19" WEST, 1544.94 FEET; THENCE SOUTH 11°45'24" WEST, 2356.78 FEET; THENCE NORTH 89°38'20" EAST, 845.15 FEET; THENCE SOUTH 00°20'41" EAST,1581.18 FEET; THENCE SOUTH 89°49'51" WEST, 977.15 FEET, THENCE SOUTH 00°27'00" EAST, 1114.85 FEET; THENCE NORTH 89°55'32" EAST, 3552.85 FEET TO THE POINT OF BEGINNING PROPER, CONTAINING 296.21 ACRES, MORE OR LESS, BEING SUBJECT TO ALL RIGHTS-OF-WAY AND EASEMENTS OF RECORD.

SURVEYOR'S NOTES:

1. SURVEYOR HAS MADE NO INVESTIGATION OR INDEPENDENT SEARCH FOR EASEMENTS OF RECORD OR ANY OTHER FACTS WHICH AN ACCURATE TITLE SEARCH MAY DISCLOSE.
2. BASIS OF BEARING: ARKANSAS STATE PLANE GRID NORTH ZONE (0301)
3. THE FOLLOWING DOCUMENTS, PROVIDED BY THE CLIENT, WERE USED IN THE CONSTRUCTION OF THIS SURVEY:
   - PLAT OF SURVEY-DATED MAY 11, 1989, BY TROY SHEETS, PLS 596.
   - PLAT OF SURVEY-DATED FEBRUARY 25, 1994, BY TROY SHEETS, PLS 596.
   - PLAT OF SURVEY-DATED MARCH 14, 2005, BY HERBERT C. HIME, PS 1142, RECORDED IN BOOK I, PAGE 158.
   - PLAT OF SURVEY-DATED MAY 31, 2006, BY TERRY BARE, PS 1048, HKB FILE I-324.
   - WARRANTY DEED, COLEMAN TO NORTHEAST ARKANSAS REGIONAL SOLID WASTE AUTHORITY, DATED MARCH 31, 1989.
   - QUITCLAIM DEED, WHITE TO CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, DATED MAY 23, 1994.
   - WARRANTY DEED, WHITLATCH TO NORTHEAST ARKANSAS REGIONAL SOLID WASTE DISPOSAL AUTHORITY, DATED MAY 26, 1989.
   - WARRANTY DEED, MAY TO KLOTZ, DEED BOOK 531, PAGE 341, DATED FEBRUARY 28, 1997.
   - LEGAL DESCRIPTION, AS SHOWN IN SCHEDULE A, ARKANSAS TITLE INSURANCE COMMITMENT, POLICY NUMBER 0-2220-106015.
   - LEGAL DESCRIPTION, AS SHOWN IN SCHEDULE A, ARKANSAS TITLE INSURANCE COMMITMENT, ORDER NUMBER 07-0245.
   - LEGAL DESCRIPTION, AS SHOWN IN SCHEDULE A, ARKANSAS TITLE INSURANCE COMMITMENT NO. 06-046739-300, LENDER' S TITLE COMPANY.
   - EXHIBIT A, ESCROW FILE NO. 06-046626-300, FROM BARRETT & DEACON.
   - WARRANTY DEED, ROOT TO CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, DEED BOOK 733, PAGE 674-676, DATED SEPTEMBER 28, 2006.
   - UTLITY EASEMENT, CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY TO CRAIGHEAD ELECTRIC COOPERATIVE, DATED JUNE 4, 1999.
4. THE SUBJECT PROPERTY LIES OUTSIDE THE 100-YEAR SPECIAL FLOOD HAZARD ZONE, AS SHOWN ON FEMA FLOOD INSURANCE RATE MAP PANEL NO. 05031C0145C, EFFECTIVE DATE SEPTEMBER 27, 1991.
5. FIELD NOTES ARE RECORDED IN HKB FIELD BOOK 1128.
6. FIELD WORK WAS COMPLETED ON JUNE 8, 2011.

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

SITE SURVEY MAP

PERMIT MODIFICATION CELLS 1 THROUGH 4

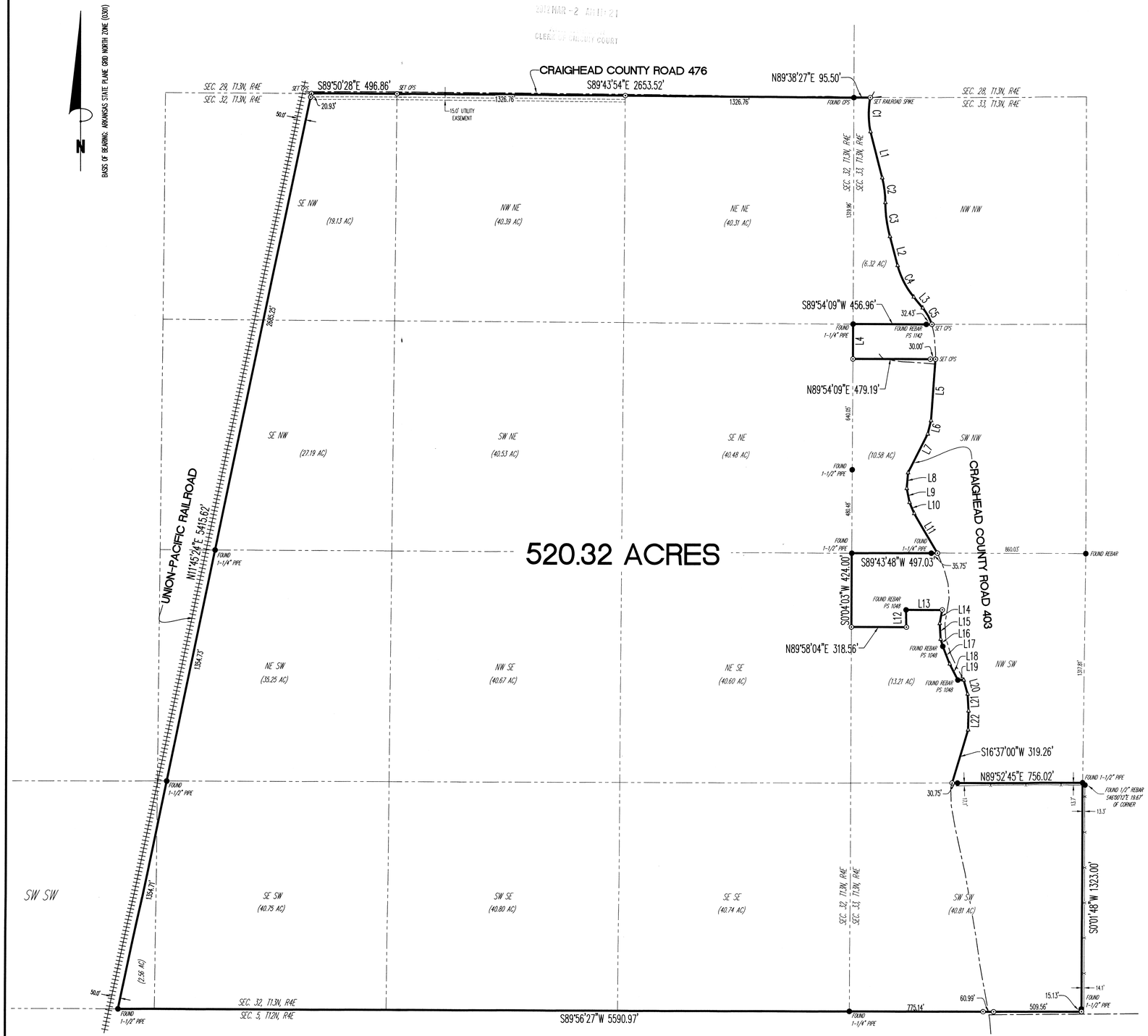
CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA)

LEGACY LANDFILL

CRAIGHEAD COUNTY ARKANSAS

ATTACHEMENT E

DESIGNED BY:	HKBA
DRAWN BY:	JDW
APPVD. BY:	FOC
SCALE:	1" = 300'
DATE:	07-27-11
JOB NO.	282-001-35117104
ACAD NO.	022
SHEET NO.:	OF



CERTIFICATE OF SURVEY:

THIS IS TO CERTIFY THAT HAYWOOD, KENWARD, BARE AND ASSOCIATES, INC., PROFESSIONAL LAND SURVEYORS, HAVE SURVEYED THE FOLLOWING DESCRIBED PARCELS OF LAND:

A PART OF SECTIONS 32 AND 33, TOWNSHIP 13 NORTH, RANGE 4 EAST, CRAIGHEAD COUNTY, ARKANSAS, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT THE NORTHEAST CORNER OF THE SOUTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 33, TOWNSHIP 13 NORTH, RANGE 4 EAST, CRAIGHEAD COUNTY, ARKANSAS; THENCE SOUTH 00°01'48" WEST, 1323.00 FEET; THENCE SOUTH 89°56'27" WEST, 5590.97 FEET, TO THE EASTERLY RIGHT-OF-WAY LINE OF THE UNION-PACIFIC RAILROAD; THENCE NORTH 11°45'24" EAST, ALONG SAID RIGHT-OF-WAY LINE, 5415.62 FEET; THENCE SOUTH 89°50'28" EAST, 496.86 FEET; THENCE SOUTH 89°43'54" EAST, 2653.52 FEET, THENCE NORTH 89°38'27" EAST, 95.50 FEET, TO A POINT ON THE CENTERLINE OF CRAIGHEAD COUNTY ROAD 403, THENCE ALONG SAID CENTERLINE THE FOLLOWING BEARINGS AND DISTANCES; ON A CURVE TO THE LEFT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 536.61 FEET, ARC LENGTH OF 201.55 FEET, TO A POINT WHICH BEARS SOUTH 00°26'24" EAST, 200.37 FEET FROM LAST SAID POINT; SOUTH 14°07'07" EAST, 277.41 FEET, TO A POINT ON A CURVE TO THE RIGHT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 606.81 FEET, ARC LENGTH OF 146.74 FEET, TO A POINT WHICH BEARS SOUTH 07°11'29" EAST, 146.38 FEET, FROM LAST SAID POINT, TO A POINT ON A CURVE TO THE LEFT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 761.76 FEET, ARC LENGTH OF 199.17 FEET, TO A POINT WHICH BEARS SOUTH 07°45'14" EAST, 198.60 FEET FROM LAST SAID POINT; SOUTH 14°56'35" EAST, 175.08 FEET, TO A POINT ON A CURVE TO THE LEFT, CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 475.44 FEET, ARC LENGTH OF 206.05 FEET, TO A POINT WHICH BEARS SOUTH 27°28'54" EAST, 204.44 FEET, FROM LAST SAID POINT; SOUTH 39°46'26" EAST, 82.21 FEET, TO A POINT ON A CURVE TO THE RIGHT; CONTINUE SOUTHEASTERLY ALONG SAID CURVE, HAVING A RADIUS OF 297.96 FEET, ARC LENGTH OF 109.12 FEET, TO A POINT WHICH BEARS SOUTH 29°15'58" EAST, 108.51 FEET, FROM LAST SAID POINT; THENCE SOUTH 89°54'09" WEST, DEPARTING SAID CENTERLINE, 456.96 FEET; THENCE SOUTH 00°06'38" WEST, 201.27 FEET; THENCE NORTH 89°54'09" EAST, 479.19 FEET, TO THE CENTERLINE OF CRAIGHEAD COUNTY ROAD 403; THENCE ALONG SAID CENTERLINE THE FOLLOWING BEARINGS AND DISTANCES; SOUTH 03°57'08" WEST, 354.58 FEET; SOUTH 13°45'51" WEST, 79.90 FEET; SOUTH 26°39'43" WEST, 252.40 FEET; SOUTH 04°31'41" WEST, 91.27 FEET; SOUTH 11°38'10" EAST, 83.75 FEET; SOUTH 23°34'46" EAST, 67.33 FEET; SOUTH 30°50'24" EAST, 264.83 FEET; THENCE SOUTH 89°43'48" WEST, DEPARTING SAID CENTERLINE, 497.03 FEET; THENCE SOUTH 00°04'03" WEST, 424.00 FEET; THENCE NORTH 89°58'04" EAST, 318.56 FEET; THENCE NORTH 01°19'45" WEST, 99.41 FEET; THENCE NORTH 89°48'06" EAST, 210.22 FEET, TO THE WEST RIGHT-OF-WAY LINE OF CRAIGHEAD COUNTY ROAD 403; THENCE ALONG SAID RIGHT-OF WAY LINE THE FOLLOWING BEARINGS AND DISTANCES; SOUTH 10°23'39" WEST, 79.53 FEET; SOUTH 03°37'37" EAST, 90.86 FEET; SOUTH 17°35'20" EAST, 43.07 FEET; SOUTH 21°38'16" EAST, 108.77 FEET; SOUTH 27°27'56" EAST, 104.00 FEET; THENCE NORTH 89°45'16" EAST, 33.56 FEET, TO THE CENTERLINE OF CRAIGHEAD COUNTY ROAD 403; THENCE ALONG SAID CENTERLINE THE FOLLOWING BEARINGS AND DISTANCES; SOUTH 15°41'47" EAST, 83.74 FEET; SOUTH 03°16'44" EAST, 97.61 FEET; SOUTH 01°21'12" WEST, 108.42 FEET; SOUTH 16°37'00" WEST, 319.26 FEET; THENCE NORTH 89°52'45" EAST, DEPARTING SAID CENTERLINE, 756.02 FEET, TO THE POINT OF BEGINNING, CONTAINING IN ALL 520.32 ACRES, MORE OR LESS; SUBJECT TO A PUBLIC ROAD RIGHT-OF-WAY, OFF AND ACROSS THE NORTH AND EAST SIDE THEREOF; BEING SUBJECT TO ALL RIGHT OF WAY AND EASEMENTS OF RECORD.

SURVEYOR'S NOTES:

1. SURVEYOR HAS MADE NO INVESTIGATION OR INDEPENDENT SEARCH FOR EASEMENTS OF RECORD OR ANY OTHER FACTS WHICH AN ACCURATE TITLE SEARCH MAY DISCLOSE.
2. BASIS OF BEARING: ARKANSAS STATE PLANE GRID NORTH ZONE (0301)
3. THE FOLLOWING DOCUMENTS, PROVIDED BY THE CLIENT, WERE USED IN THE CONSTRUCTION OF THIS SURVEY:
   - PLAT OF SURVEY–DATED MAY 11, 1989, BY TROY SHEETS, PLS 596.
   - PLAT OF SURVEY–DATED FEBRUARY 25, 1994, BY TROY SHEETS, PLS 596.
   - PLAT OF SURVEY–DATED MARCH 14, 2005, BY HERBERT C. HINE, PS 1142, RECORDED IN BOOK I, PAGE 158.
   - PLAT OF SURVEY–DATED MAY 31, 2006, BY TERRY BARE, PS 1048, HKB FILE I–324.
   - WARRANTY DEED, COLEMAN TO NORTHEAST ARKANSAS REGIONAL SOLID WASTE AUTHORITY, DATED MARCH 31, 1989.
   - QUITCLAIM DEED, WHITE TO CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, DATED MAY 23, 1994.
   - WARRANTY DEED, WHITLATCH TO NORTHEAST ARKANSAS REGIONAL SOLID WASTE DISPOSAL AUTHORITY, DATED MAY 26, 1989.
   - WARRANTY DEED, MAY TO KLOTZ, DEED BOOK 531, PAGE 341, DATED FEBRUARY 28, 1997.
   - LEGAL DESCRIPTION, AS SHOWN IN SCHEDULE A, ARKANSAS TITLE INSURANCE COMMITMENT, POLICY NUMBER 0–2220–106015.
   - LEGAL DESCRIPTION, AS SHOWN IN SCHEDULE A, ARKANSAS TITLE INSURANCE COMMITMENT, ORDER NUMBER 07–0245.
   - LEGAL DESCRIPTION, AS SHOWN IN SCHEDULE A, ARKANSAS TITLE INSURANCE COMMITMENT NO. 06–046739–300, LENDER' S TITLE COMPANY.
   - EXHIBIT A, ESCROW FILE NO. 06–046626–300, FROM BARRETT & DEACON.
   - WARRANTY DEED, ROOT TO CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY, DEED BOOK 733, PAGE 674–676, DATED SEPTEMBER 28, 2006.
   - UTILITY EASEMENT, CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY TO CRAIGHEAD ELECTRIC COOPERATIVE, DATED JUNE 4, 1999.
4. THE SUBJECT PROPERTY LIES OUTSIDE THE 100–YEAR SPECIAL FLOOD HAZARD ZONE, AS SHOWN ON FEMA FLOOD INSURANCE RATE MAP PANEL NO. 05031C0145C, EFFECTIVE DATE SEPTEMBER 27, 1991.
5. FIELD NOTES ARE RECORDED IN HKB FIELD BOOK 1128.
6. FIELD WORK WAS COMPLETED ON JUNE 8, 2011.

CURVE TABLE:

CURVE #	LENGTH	RADIUS	CHORD DIRECTION	CHORD LENGTH
C1	201.55'	536.61'	S0° 26' 24"E	200.37'
C2	146.74'	606.81'	S7° 11' 29"E	146.38'
C3	199.17'	761.76'	S7° 45' 14"E	198.60'
C4	206.05'	475.44'	S27° 28' 54"E	204.44'
C5	109.12'	297.96'	S29° 15' 58"E	108.51'

LINE TABLE:

LINE #	LENGTH	DIRECTION
L1	277.41'	S14° 07' 07"E
L2	175.08'	S14° 56' 35"E
L3	82.21'	S39° 46' 26"E
L4	201.27'	S0° 06' 38"W
L5	354.58'	S3° 57' 08"W
L6	79.90'	S13° 45' 51"W
L7	252.40'	S26° 39' 43"W
L8	91.27'	S4° 31' 41"W
L9	83.75'	S11° 38' 10"E
L10	67.33'	S23° 34' 46"E
L11	264.83'	S30° 50' 24"E
L12	99.41'	N1° 19' 45"W
L13	210.22'	N89° 48' 06"E
L14	79.53'	S10° 23' 39"W
L15	90.86'	S3° 37' 37"E
L16	43.07'	S17° 35' 20"E
L17	108.77'	S21° 38' 16"E
L18	104.00'	S27° 27' 56"E
L19	33.56'	N89° 45' 16"E
L20	83.74'	S15° 41' 47"E
L21	97.61'	S3° 16' 44"E
L22	108.42'	S1° 21' 12"W

LEGEND:

- ● FOUND MONUMENT (AS NOTED)
- △ COMPUTED POINT (NOT MONUMENTED)
- ⊙ SET 5/8" REBAR W/ RED PLASTIC CAP STAMPED "BRANCH, P.S. 1596" (OR AS NOTED)
- —x— BARB WIRE FENCE LINE

PLAT OF SURVEY

HKB
Haywood, Kenward, Bare
AND ASSOCIATES, INC.
Civil Engineering, Surveying & Planning Services
1801 Latourette Drive, Jonesboro, AR, 72404
P: 870.932.2019 F: 870.932.1076

PLAT OF SURVEY

A PART OF SECTIONS 32 & 33
TOWNSHIP 13 NORTH, RANGE 04 EAST
CRAIGHEAD COUNTY, ARKANSAS

REGISTERED PROFESSIONAL LAND SURVEYOR
STATE OF ARKANSAS
P.S. 1596
SIGNATURE
JASON H. BRANCH
JUNE 15, 2011
seal

JASON H. BRANCH, P.S.
AR – 1596

CERTIFICATE OF AUTHORIZATION
HAYWOOD, KENWARD, BARE & ASSOCIATES, INC.
No. 234
ARKANSAS
coa

Haywood, Kenward, Bare, and Associates, Inc
ARKANSAS – 234

CLIENT:
CCSWDA

REVISIONS

DATE	BY	DESCRIPTION

PROJECT NO.
C007–0029–01

DRAWN BY	CHECKED BY
JHB	
SHEET	SCALE
1 OF 1	1"=300'
DATE	DRAWING NO.
06/15/11	20–52

500–13N–04E–0–32–000–16–1596; 500–13N–04E–0–304–16–1596

ATTACHMENT C

Revised Groundwater Sampling and Analysis Plan

GROUNDWATER SAMPLING AND ANALYSIS PLAN

CRAIGHEAD COUNTY
SOLID WASTE DISPOSAL AUTHORITY
LEGACY CLASS 1 LANDFILL

ADEQ PERMIT NO. 0254-S1-R3
AFIN: 16-00199

PREPARED FOR:

Craighead County Solid Waste Disposal Authority
238 County Road 476
P.O. Box 16777
Jonesboro, Arkansas 72403

PREPARED BY:

Terracon Consultants, Inc.
25809 Interstate 30 South
Bryant, Arkansas 72022

SECOND REVISION FEBRUARY, 2012

Terracon

Groundwater Sampling and Analysis Plan
Legacy Class 1 Landfill
Jonesboro, Arkansas

Prepared for:

Craighead County Solid Waste Disposal Authority
Jonesboro, Arkansas

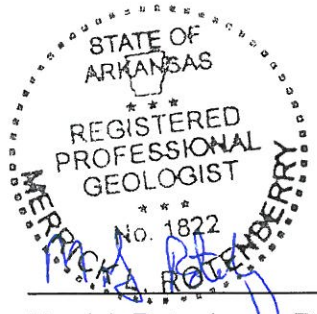
For Submittal to:

Arkansas Department of Environmental Quality
Solid Waste Management Division

Certification:

I certify that I am a qualified groundwater scientist who has received a baccalaureate or postgraduate degree in the natural sciences. I have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, which enable me to make sound professional judgments regarding groundwater monitoring and contaminant fate and transport.

I further certify that this report was prepared by me or by a subordinate working under my direction.



3-1-12

Merrick Rotenberry, P. G. — Date
Professional Geologist — *Arkansas No. 1822*

FIGURES

TABLES

APPENDICES

TABLE OF CONTENTS

1.0 INTRODUCTION

This Groundwater Sampling and Analysis Plan (GWSAP) presents the details of the groundwater monitoring program for the Craighead County Solid Waste Disposal Authority (CCSWDA) Legacy Class 1 Landfill and is submitted to satisfy the requirements of Arkansas Pollution Control & Ecology Commission (APC&EC) Regulation 22, Section 22.1204(e). All elements of this program are in general compliance with 40 CFR Part 258 (Subtitle D) and Regulation 22, Sections 22.1203 and 22.1204(e) and the facility solid waste permit. This GWSAP will serve as a guidance document for personnel performing site groundwater monitoring during the active life of the facility and during closure and post-closure periods. This plan is intended to replace the current *Sampling and Analysis Plan* and *Statistical and Contingency Plan* that was prepared for the facility by Genesis Environmental Consulting, Inc. (GEC) in 1995. The procedures outlined in this plan are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells installed at the site. This GWSAP and all reports to the Arkansas Department of Environmental Quality (ADEQ) required under the GWSAP shall be certified by a qualified ground water scientist.

The Legacy Landfill began operations on December 15, 1989. The Landfill is currently maintained and operated in accordance with Solid Waste Permit No. 0254-S1-R3 that was issued by the Arkansas Department of Environmental Quality (ADEQ), effective July 7, 2004.

1.1 SITE LOCATION

The CCSWDA Legacy Landfill is located approximately five miles south of the City of Jonesboro and 0.5 miles east of Highway 1. More specifically, the Landfill is situated in portions of Sections 32 and 33, Township 13 North, Range 4 East, in Craighead County, Arkansas. The permitted area of the Landfill is approximately 420 acres with approximately 310 acres used for Class 1 waste disposal. A 32.25 acre tract adjacent to the western boundary and a 40 acre tract adjacent to the northern boundary have been acquired by the CCSWDA and added to the property for a total acreage of approximately 495.25 acres. A vicinity map depicting the location of the Landfill is presented as **FIGURE 1**.

1.2 SITE GEOLOGY/HYDROGEOLOGY

A geotechnical and hydrogeologic investigation of the Legacy Landfill site was performed by Grubbs, Garner Hoskyn, Inc. (GG&H) in 1989. A report detailing the results of the investigation was submitted to the Arkansas Department of Pollution Control & Ecology (ADPC&E) on July 12, 1989. The document is referenced as ADEQ document identification number 34818. The investigation included 43 borings in a grid pattern across the entire property at depths ranging from 20 to 150 feet below the existing grade.

According to the GG&H report, the western portion of the site consists of alluvial terrace deposits of Quaternary Age with sand and gravel in the lower portion and silt and clay in the upper portion. The thickness of the clay was noted to be on the order of 17 to 20 feet or to an approximate elevation of 222 to 226 feet. Below the clay, the Quaternary sands with varying silt contents were encountered to an elevation near 120 feet. These sands and some gravel zones comprise the Quaternary Aquifer. The potentiometric surface of the Quaternary Aquifer at the site was found by GG&H to be near elevation 170 feet msl.

Investigation of the eastern portion of the site (western margin of Crowley's Ridge) encountered deposits of the Upper Claiborne Group at or near the surface. The Upper Claiborne Group consists of massive clay with varying amounts of sand seams to depths of about 16 to 29 feet. Occasional gravel layers were encountered within this upper zone. Underlying the upper zone, clay and sandy clay was encountered to a depth of about 56 feet. According to published geologic mapping for the state of Arkansas, the Claiborne Group outcrops along the flanks of Crowley's Ridge in the vicinity of the landfill.

The surrounding land consists of farm industries relying heavily on irrigation with groundwater pumped from high-capacity production wells. The extensive withdrawal of groundwater for crop irrigation has consistently lowered the potentiometric surface beneath the site. Based on a well survey performed by GG&H as part of their geotechnical and hydrogeologic investigation, well capacities on the order of 600 to 1,500 gallons per minute could be anticipated for wells extending to depths of 110 and 150 feet.

Below the Quaternary alluvial deposits, the Tertiary Age Claiborne Group was encountered during the GG&H investigation. The Upper Claiborne deposits consist of carbonaceous clay with some lenses of fine sand. Sands associated with the Memphis aquifer underlie the Upper Claiborne Group deposits and, according to USGS mapping, extend to an elevation of approximately 200 feet msl.

2.0 GROUNDWATER SAMPLING PROCEDURES (*22.1204(e)(i)*)

This section summarizes specific tasks involved in sampling of the groundwater monitoring system. Samples will be obtained from the facility groundwater monitoring wells by a sampling technician fully trained in the required sampling procedures.

2.1 WELL INSPECTION

Prior to performing any purging or sampling, each monitoring well will be inspected to assess its integrity. The condition of each wells surface completion will be evaluated for evidence of failure, general deterioration, tampering, or any physical damage that may have been caused by the operation of site equipment or other vehicular traffic. The security of each well will be assessed in order to confirm that no outside source contaminants have potentially been introduced into the well. The Landfill Manager will be informed of any monitoring well surface

completions that require maintenance or repair.

2.2 SAMPLE COLLECTION PROCEDURES

For sample collection, each monitoring well in the groundwater monitoring system will be sampled utilizing equipment and methodologies that minimize the potential for alteration or contamination of the sample and that are capable of obtaining a sample representative of the formation groundwater. Care will be taken to avoid placing clean sampling equipment on the ground or on any contaminated surface. Additionally, personnel who contact sampling equipment which may contact the interior of the monitoring well or the groundwater shall wear non-powdered latex (or equivalent) gloves. If contamination is known to exist at certain locations, non-contaminated wells will be sampled prior to those wells which are known to be contaminated.

2.2.1 Equipment Decontamination

All equipment which may contact the interior of the well or groundwater will be thoroughly decontaminated prior to site arrival for a specific monitoring event. This includes water level tapes, pumps, tubing and any other non-dedicated equipment that may be immersed or contact groundwater. The decontamination procedure will consist of the following steps:

- Flush pump and tubing with potable water and non-phosphate soap (e.g., Alconox or Liquinox) using a portable decontamination tube followed by a distilled or de-ionized water flush and rinse;
- Wash water level sensor probe and entire length of tape with potable water and non-phosphate soap followed by rinsing with distilled or de-ionized water; and
- Air dry prior to use.

Field decontamination procedures will also be followed by the sampler(s). After a water level is measured and as the tape is being reeled back onto the carrying spool, the tape and probe will be wiped down with a clean paper towel that has been moistened with distilled or de-ionized water. The pump and tubing are constructed of inert materials and will be rinsed with distilled or de-ionized water prior to use at each well.

Personnel who contact sampling equipment subsequent to decontamination shall wear non-powdered latex (or equivalent) disposable gloves. Gloves should be replaced immediately if they become contaminated or torn. Decontaminated sampling equipment will not be placed on the ground or other potentially contaminated surfaces prior to insertion in the well.

2.2.2 Water Level Measurements

Prior to groundwater purging and sampling at each well location, water level measurements will be taken utilizing a dedicated or portable water level indicator, tape, or other suitable measuring device capable of achieving an accuracy of 0.01 foot. The measuring device will be used in

accordance with the manufacturer's recommendations and/or directions. Prior to measuring each well, all equipment which may contact the groundwater will be decontaminated in accordance with Section 2.2.1. All wells will be measured for depth to water on the same day and immediately prior to purging. Measurements of the depth to water from the top of the well casing will be to the nearest 0.01 foot.

2.2.3 Well Purging

Immediately after a water level measurement is recorded, the water within the well will be purged using a Grundfos Redi-Flo2 electronic submersible pump (or environmental equivalent) until measured water quality parameters indicate that formation water has entered the well or until a sufficient volume has been removed to ensure that stagnant water has been purged from the well. In accordance with the current facility permit, the sampler(s) will attempt to purge the wells utilizing the low-flow (minimal drawdown) sampling method as outlined in EPA/542/S-02/001, *"Ground-Water Sampling Guidelines For Superfund And RCRA Project Managers"* (APPENDIX F).

This will be accomplished by carefully lowering the pump to a level where the pump intake is located in the middle or slightly above the middle of the saturated screened interval and pumping at a low-flow rate (generally 0.1 to 0.5 L/min). Placement of the pump too close to the bottom of the well can result in the entrainment of solids which may have collected in the well over time. The goal when utilizing low-flow purging is to achieve minimal drawdown (e.g., <0.3 ft) while avoiding excessive agitation of the water column. The water level will be checked periodically to monitor drawdown and as a guide to flow rate adjustment. If minimal drawdown cannot be maintained or if a bailer is utilized due to pump malfunction or other circumstances, the samplers will attempt to evacuate the well(s) using the standard 3 to 5 casing volume purging method. For low yield wells that may be pumped or bailed dry during purging, the well will be allowed to recover sufficiently and then sampled. If sufficient water is not available for sampling within 24 hours of purging for low yield or slowly recovering wells, the well will be considered dry, and no sample will be collected (dependent upon project objectives).

During purging, representative samples of discharged water will be collected periodically in clean containers and analyzed for various field water quality parameters to evaluate the quality of the groundwater and to aid in determining when formation water is entering the well. At a minimum, the following parameters will be measured in the field: pH, turbidity, specific conductance, and temperature. Water quality parameters measured during low-flow purging can be considered stable if three successive readings are within ± 0.1 for pH, ± 3% for conductivity, and ± 10% or below 10 NTU for turbidity. At this point, purging may be considered complete and samples will be collected.

If purging is accomplished using the standard 3 to 5 well volume method, purging may be considered complete when a minimum of three well volumes (based upon water levels and well construction records) have been evacuated from the well and two of the field measured parameters (pH, specific conductance and turbidity) have stabilized, or until the well is pumped/bailed dry and allowed to recover sufficiently to collect samples.

If standard purge methods are used, the well volume can be determined using the depth to water (DTW) and total depth (TD) of the well as shown below:

Volume (gal) = π [r (ft)]^2 [TD (ft) – DTW (ft)] (7.4805 gal/ft^3)
Volume (gal) = 0.0408 x [TD (ft) – DTW (ft)] x [Well Diameter (inch)]^2
Volume (gal) = [TD (ft) – DTW (ft)] x [A (gal/ft)]

Where TD = Total depth of well
DTW = Depth to water
r = Radius of well
π = 3.141593
A = 0.163 (for 2-inch wells)

As mentioned previously, if using low-flow methods, purge rates will be monitored and depth to water measurements recorded, to assure that evacuation rates do not induce a substantial lowering of the potentiometric head elevation within the well. Flow rates will vary for each well, but rates of approximately 0.1 to 0.5 L/min are typical. Purging of pump discharge lines is necessary prior to the collection of field parameter samples for field analysis using appropriate meters.

2.2.4 Sample Withdrawal and Collection

Specific conductance, pH, turbidity, and temperature are frequently used as indicators of water quality and to insure that the well has been properly purged because the presence or absence of a variety of parameters impacts their values (Section 2.2.3). In addition, these field parameters can be measured quickly and inexpensively on-site and, therefore, provide immediate results for use in field programs. Specific conductance and pH are influenced by various parameters in the water, and because those parameters can be impacted by such phenomena as oxidation/reduction potential (ORP), temperature, or agitation, specific conductance and pH of water may change considerably when transported from the field to the laboratory. Thus, on-site measurement of pH, specific conductance, and temperature is desirable. The field representative will complete the calibration of any in-situ monitoring equipment or field-test probes and kits at the beginning of each use, or according to manufacturer's suggestions.

Samples will be collected from each well using either a clean disposable bailer or through the discharge of pumps used to evacuate the well. Bailers that may be used to purge and sample the wells are constructed of polyethylene and are certified as being contaminant-free by the supplier. As stated in Section 2.2.3, the pump that will typically be utilized to purge and sample the wells is a Grundfos Redi-Flo2 electronic submersible pump equipped with an adjustable rate controller box.

Samples will be collected at a rate that minimizes potential alteration of the sample due to

agitation or oxidation. Pumping rates for collection of samples for volatiles analysis (VOA's, etc.) will be approximately 0.1 L/min or less, to the extent practical based on the sampling equipment used. Pumping rates for collection of other analyses may be increased, but will be adjusted to a rate that also prevents chemical alteration.

If low-flow sampling methods are employed, the sampling rate is not to exceed the purging rate, with flow rates of approximately 0.1 to 0.5 L/min recommended (EPA/542/S-02/001). Sampling pumps are to be operated in a continuous manner so that they do not produce samples that are aerated in the return tube or upon discharge. Groundwater samples should be collected as soon as possible after well evacuation.

Samples will be collected and containerized in the order of the volatilization sensitivity of the parameter (i.e., volatile organics, organic compounds, inorganic species, and major cations and anions). The samples will be collected in appropriate containers with the appropriate sample preservative as described in subsequent sections. According to the RCRA Ground-Water Monitoring: Draft Technical Guidance (1992), the preferred collection order for some of the more common groundwater analytes is as follows:

1. *Volatile organic compounds (VOCs) and total organic halogen (TOX)*
2. *Dissolved gases and total organic carbon (TOC)*
3. *Semi-volatile organic compounds (SVOCs)*
4. *Total metals and cyanide*
5. *Major water quality cations and anions (e.g., sulfate, chloride and TDS)*
6. *Radionuclides*

Volatile organic samples will be collected with zero headspace (i.e., no air bubbles trapped in the sample vial). Bottles with chemical preservative will not be overfilled and, after they are capped, will be inverted to mix the preservative with the sample. Bottle lids will not be placed on the ground or interchanged among sample bottles. A physical description of the sample will be recorded on the Groundwater Field Data Form (see **APPENDIX D**), including the color, clarity, odor, foaming and other physical characteristics.

2.3 SAMPLE PRESERVATION

Sample containers, preservation, handling, and analysis will meet the specifications described by "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, third edition, Final Update 3, May 1997" (or latest version) or an equivalent substitute as approved by the ADEQ Solid Waste Management Division. Sample containers will be supplied by the laboratory for each sampling event. The appropriate preservative and volume that is added to each sample container will be in accordance with the required analytical method.

Immediately after the samples have been collected and the containers labeled and sealed, they will be placed in a cooler on ice for storage at 4ºC until ready for transport to the contract analytical laboratory or overnight shipping courier. If necessary, additional ice will be added to

the cooler(s) after completion of the sampling event to insure the proper temperature is maintained during transport or shipment to the contract laboratory. A summary of the appropriate sample preservation and holding times for each analytical method is included herein as **TABLE 1**.

2.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Duplicate samples and various blanks will be submitted to the contract analytical laboratory as field quality assurance/quality control (QA/QC) samples. All field QA/QC samples will be prepared for each sampling event in the same manner as regular samples with respect to sample volume, containers, and preservation. The following is a description of the field QA/QC samples:

- *Trip Blanks*

  Trip blanks consist of a set of volatile organic analyte (VOA) sample vials that are filled with de-ionized water at the laboratory and shipped to the project site with the other sample containers. Trip blank results will be used to verify that the sample containers are adequately prepared and handled in the laboratory, and that the groundwater samples have been adequately protected from contamination during transport. Trip blanks are stored and transported to each well location in the same manner as the groundwater samples and returned to the laboratory for analysis.

- *Field Blanks*

  Field blanks consist of a set of VOA sample vials that are filled with de-ionized water supplied by the contract analytical laboratory. Field blanks will be collected at the site and tested to verify that ambient conditions, such as airborne materials or other factors unique to the sampling area, have not influenced the quality of the samples. At least one field blank will be collected for each day of sampling. The field blank will then be transported to the laboratory in the same manner as the environmental samples.

- *Equipment Blanks*

  Equipment blanks will be used to verify whether non-dedicated sampling equipment has been effectively decontaminated. Equipment blanks are collected by capturing the runoff of deionized water that is poured directly onto the decontaminated sampling equipment under field conditions. Equipment blanks will be collected in appropriate containers and analyzed for the entire list of detection monitoring constituents.

- *Duplicate Samples*

  Field duplicate samples are an extra set of samples taken at a particular monitoring point. For each sampling event, a duplicate well sample will be collected from one of the facility monitoring wells. Special procedures will be followed when duplicate samples are collected. Aliquots of water obtained from the well shall be alternated between sample bottles to provide samples to each group that will be as representative as

possible. Duplicate samples are typically discretely labeled in a manner that makes the laboratory unaware of where the duplicate was collected. Duplicate samples are used to verify the consistency and precision of the sampling and testing procedures.

2.5 CHAIN OF CUSTODY AND FIELD INFORMATION FORM

Chain-of-Custody procedures will allow for the possession and handling of samples to be traced from the time of collection through laboratory analysis. All sample containers will be labeled to avoid misidentification and indicate test parameters required. Chain-of-Custody procedures will ensure that collected samples are representative of the zone being monitored and will prevent cross-contamination or potential tampering with samples collected. An example Chain-of-Custody form is presented in **APPENDIX C**. At a minimum, the form must contain the following information:

- *project name,*
- *sample number,*
- *signature of collector,*
- *date and time of collection,*
- *sample location,*
- *sample type,*
- *preservatives added (if appropriate),*
- *analyses requested (including data quality objective)*
- *signatures involved in chain of possession, and*
- *inclusive dates of possession.*

Chain-of-Custody forms will be completed and placed in the sample-shipping container. Upon arrival of the sample shipping container at the laboratory, it will be opened, and the Chain-of-Custody form will be signed and time/dated by the person taking custody of the sample shipping container. If the sample container is shipped to another facility, this person will affix the bill of lading or receipt to the Chain-of-Custody form.

To provide complete documentation of on-site aspects of the sampling episode, a detailed sampling record will be prepared for samples. General sampling event information including location, time, weather conditions, sampler identification, well integrity, any numerical field data values and well purging will be documented on a *Groundwater Monitoring Sampling Record* as presented in **APPENDIX D**. The actual form utilized may vary in format but the information indicated should be recorded.

2.6 SAMPLE SHIPMENT

If samples are not delivered directly to the contract analytical laboratory, they will be shipped in accordance with the procedures outlined in this document.

After collection and sample preservation, the labeled sample containers will be placed into an insulated, plastic-shelled suitable shipping container using frozen ice packs or other suitable frozen material for temperature control. All samples included in the sample container will be packed in a manner which will minimize the potential for container breakage. A Chain-of-Custody form will be sealed in a water resistant bag and placed with the appropriate sample bottle set. A copy will be maintained by the sampling personnel. The sample container will then be either hand-delivered or sent via overnight courier to the designated analytical laboratory. The temperature of the samples will be recorded when the sample container arrives at the analytical laboratory to verify that the appropriate sample temperature was maintained during shipment.

3.0 GROUNDWATER ANALYSIS PROCEDURES (22.1204(e)(2))

This section provides procedures for analysis of the groundwater samples collected from the monitoring system at the site. Analytical methodologies as well as field and laboratory QA/QC procedures are discussed.

3.1 ANALYTICAL METHODS/PROCEDURES

Sample preservation, handling, and analysis will meet the specifications described by "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update 3, May 1997" (or latest version) or an equivalent substitute as approved by ADEQ SWMD and ADEQ Technical Services Division. Analytical methods for parameters not listed in SW-846 will also be approved by the ADEQ Technical Services Division. A summary of laboratory methods which are anticipated to be utilized as a part of the groundwater monitoring program for the facility is included herein as **TABLE 2**.

3.2 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL (22.1204 (e)(3))

A record of laboratory sample receipt, storage and analysis procedures will be kept for each sample received. A summary of this record will be part of the laboratory analysis report. The analytical laboratory will prepare sufficient blanks and spikes to assure analysis quality in accordance with that laboratory's Quality Assurance/Quality Control (QA/QC) Plan. Any internal quality control problem associated with the submitted sample/analyte will be identified on the data qualifier report included with each sample's analytical report.

3.2.1 Analytical Blanks and Spikes

The selected laboratory will use method quality control procedures that are equivalent to those described in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update 3, May 1997" or an equivalent substitute as approved by the ADEQ SWMD and ADEQ Technical Services Division. Duplicate samples, method blanks, instrument/reagent blanks, matrix spikes, blank/water reagent spikes and surrogate spikes are

typical quality control checks performed throughout the analytical laboratory. With the exception of instrument/reagent blanks and surrogate spikes, these checks are performed at frequency of 5% or 10% (i.e., 1 in 20 samples, 1 in 10 samples). Instrument/reagent blanks and surrogate spikes are performed on a daily or per sample (where required by method) frequency. Each of the above applied Quality Control checks will be compared against the Acceptance Criterion for each QC check to ensure that analytical quality is maintained.

The method blank is a blank solution which is treated as a sample for the parameter being measured, including all pretreatment/preparation procedures, is analyzed in the same manner as the environmental samples to assess analytical accuracy and the potential for sample contamination. Instrument/reagent blanks are used on a daily basis (where used) to detect contamination or interferences in the sample treatment solvents and chemicals to ensure that none of these applied chemicals could systematically bias sample results.

Matrix spikes are environmental samples fortified with known concentrations of analytes expected to be in the sample. The percent recovery of any spiked analyte is taken as a measure of the bias of the analytical method caused by the sample matrix. Blank/reagent water spikes are blank solutions fortified with known concentrations of analytes expected to be in environmental samples. These spikes may (reagent water spikes) or may not (blank spike) be taken through the full analytical procedure prior to analysis. The percent recovery of any spiked analyte is taken as a measure of control on the analytical procedure. Surrogate spikes, where a compound of known amount which is not expected to be in the environmental sample is added to the sample. Volatile Organic Compound (VOC) analysis uses this type of spike to measure method extraction efficiency. This spike is performed on every sample and QC sample where the analytical method requires it.

3.2.2 Instrument Calibration

Applicable instruments are calibrated using calibration standards and method-specified calibration criteria. A solution containing various compounds of known concentrations is diluted and analyzed to establish calibration curves is performed daily or per the method to monitor the accuracy and precision of the instrument. Instrument calibration is verified by analyzing a solution containing a known concentration of the pure compound(s) of interest and comparing it against the calibration curve. This standard compound is taken from the same stock as that used to develop the calibration curve. Calibration verification is done at a 5% frequency, or as the method requires, to check the stability of the calibration curve as well as the accuracy and precision of the system or analyst.

All standards and reagents used in laboratory procedures will be inventoried, labeled, logged and documented in accordance with Inorganics, Inorganics/chemical Methods and Robotics, Semi-volatiles and Volatiles documentation procedures. All stock standards shall be purchased as certified primary solutions from reputable, commercial lab suppliers, and prepared from neat chemicals with certified purity. Stock standards shall be combined and/or diluted into secondary dilution standards, which are then diluted into working standards.

3.2.3 Instrument Maintenance

Routine maintenance is performed and documented for all major instruments. In addition, any service agreements for laboratory equipment are renewed annually. The EPA's "Good Automated Laboratory Practices" (GALPs) shall be followed in the laboratory.

3.2.4 Method Detection Limits (MDLs)

The analytical laboratory uses the procedures described in Appendix B of 40 CFR 136 to determine MDLs. Each year method specific upper and lower precision and accuracy limits are developed from historical matrix spike and duplicate data.

An ADEQ certified laboratory will be used to analyze all groundwater samples and the method detection limit (MDL) will be in accordance with ADEQ laboratory requirements. The method reporting limit and Practical Quantitation Limit (PQL) for each parameter is presented in Table 5 (APPENDIX A). Groundwater analytical data will be sent electronically to the ADEQ directly from the contract laboratory as per Reg.22.1204(e)(4).

4.0 GROUNDWATER MONITORING SYSTEM

Historic Monitoring System

During the months of May and June, 1990, nine (9) monitoring wells (MW-4 through MW-12) were installed at the landfill by Grubbs, Garner, and Hoskyn, Inc (GG&H). Piezometers P-9, P-3, P-7, and P-1, which were installed during the original hydrogeologic investigation performed by GG&H in 1989, were subsequently renamed MW-1, MW-2, MW-3, and MW-13, respectively. According to the hydrogeologic investigation performed by GG&H, the wells closest to Crowley's Ridge appear to have been screened within water-bearing sands of the Claiborne Group (i.e., Memphis Aquifer) while the wells installed in the central and western portions of the site were screened within sands and gravels of the Quaternary alluvial aquifer. The GG&H investigation states that the two aquifers appear to be hydraulically connected along the western margin of Crowley's Ridge. However, the current monitoring system is monitoring the uppermost encountered groundwater bearing zone across the site.

Because some of the aforementioned monitoring wells were installed beyond the point of compliance and/or were suspected to have construction related problems, only two wells (MW-8 and MW-9) were included in the current ADEQ approved monitoring system. Five (5) additional monitoring wells were subsequently installed at the facility: 3 wells in 1993 by PSI, Inc. (MW-14, MW-15, and MW-16) and 2 wells in 1994 by Anderson Engineering Consultants, Inc. (MW-17 and MW-18). Well MW-15 was also suspected to have possible construction related problems, therefore, the ADEQ Solid Waste Division approved a request to monitor MW-8 rather than MW-15. Because a disposable polyethylene bailer became lodged in the lower portion of well MW-6 during the Second Half 1997 sampling event and numerous attempts to remove the bailer were unsuccessful, MW-6 was decommissioned and replaced with a new well designated MW-6R on August 25-26, 1998.

In a letter dated April 26, 1999, the ADEQ Solid Waste Management Division granted a request by the CCSWDA to plug and abandon the remaining unused monitoring wells at the site. Abandonment of the original unused wells at the site was performed under the supervision of Northstar Engineering Consultants, Inc. (NEC) during the week of June 21, 1999.

Prior to the Second Half 2004 sampling event that was performed by NEC on September 14, 2004, the ADEQ approved monitoring system for the CCSWDA Legacy Landfill consisted of seven (7) monitoring wells: MW-6R, MW-8, MW-9, MW-14, MW-16, MW-17, and MW-18 (see Northstar Engineering Consultants, Inc. (NEC) Sheet 4 shown on Page 23 of 390 of Volume 3, Terracon 2008 Permit Modification Application submittal). However, as noted in previous Groundwater Monitoring and Statistical Evaluation Reports, achieving a turbidity reading below 5 Nephelometric Turbidity Units (NTU) in samples collected from well MW-17 had been problematic. For example, it was reported that during many semi-annual sampling events, well MW-17 was purged to dryness using the low-flow purge technique. Because MW-17 was purged dry during these sampling events, the samplers had to allow the well to recover sufficiently before either re-starting the pump and then immediately collect samples or wait until the end of the day to collect samples with a disposable bailer which resulted in elevated turbidity readings. As recommended in the First Half 2000 Groundwater Monitoring and Statistical Evaluation Report prepared by NEC, well MW-17 was re-developed on September 19, 2000 in an attempt to increase yield and decrease turbidity. Re-development of well MW-17 was accomplished by overpumping and surging with a Grundfos Redi-Flo2 submersible pump. However, the re-development of well MW-17 did not appear to increase yield since the well was purged to dryness the following day during the Second Half 2000 sampling event. Once again, samples had to be collected after allowing the well to recover resulting in an elevated turbidity reading. Therefore, as recommended in the Second Half 2000 Report, well MW-17 was purged at an even lower rate (approximately 0.5 liters/minute) during the First Half 2001 sampling event resulting in the collection of low turbidity samples.

In addition, as initially noted in the NEC Second Half 2003 Groundwater Monitoring and Statistical Evaluation Report, water levels measured in each of the facility monitoring wells had exhibited a steady, significant decline due to intensive groundwater withdrawals from irrigation wells located south through west of the site. As a result of the declining potentiometric surface, well MW-18 also became difficult to properly purge and sample using a sustained, low-flow purge rate. As stated in the Second Half 2003 Report, historical water level measurements obtained for well MW-18 showed an overall potentiometric surface decline of 9.67 feet between March, 1995 and September 2003 (i.e., 1.2 feet/year) leaving in the casing a water column of only 3.83 feet which, for a two-inch well, equates to a volume of approximately 0.62 gallons. Similar to well MW-17, well MW-18 was purged to dryness at a low-flow purge rate and a steady rate could not be re-established during the September 17, 2003 sampling event. As with well MW-17, a disposable polyethylene bailer was used to collect samples from well MW-18, however, an elevated turbidity level of 305 NTU was measured for the sample. It was also noted by NEC that the total depth measurement obtained for monitoring well MW-17 on

September 17, 2003 indicates that the lower 9.18 feet of the well was filled with silt and/or clay indicating the well was not properly constructed.

Because of the low yield and construction related problems discussed above, it was concluded by NEC in the Second Half 2003 Report that wells MW-17 and MW-18 were no longer reliable monitoring points. Therefore, it was recommended that both of these upgradient wells should be properly plugged and abandoned and replaced with one well designated MW-17R. It was recommended further that, although well MW-14 continued to be a reliable upgradient monitoring point producing low turbidity samples, the water column had declined to only 7.45 feet and, assuming the potentiometric surface would continue to drop at a rate of about 1.2 feet per year, it should also be replaced during field activities to abandon wells MW-17 and MW-18 in order to avoid another drilling rig mobilization/demobilization cost that would be incurred by the CCSWDA in about 4 years. It was also noted that the remaining wells at the facility had a water column in excess of 10 feet.

In a letter dated April 7, 2004, the ADEQ Solid Waste Management Division approved the recommendation to modify the existing monitoring system by replacing wells MW-17 and MW-18 with well MW-17R and replacing well MW-14 with MW-14R. The abandonment of wells MW-14, MW-17, and MW-18 and installation of replacement wells MW-14R and MW-17R took place during the month of June, 2004. Therefore, at that time, the ADEQ approved groundwater monitoring system for the landfill consisted of wells MW-6R, MW-8, MW-9, MW-14R, MW-16, and MW-17R.

Current Monitoring System

After conducting a review of the major modification application that was submitted by Terracon in 2008, it was noted by the ADEQ that wells MW-6R and MW-8 are beyond the Point of Compliance based on the current waste unit boundary. It was also noted that the modification will allow the currently permitted cells (i.e., Cells 1-4) to go higher for the next 15 to 20 years. Therefore, ADEQ required the installation of three (3) additional monitoring wells at specified locations within 500 feet of the waste unit boundary (ADEQ Document #56064 dated November 17, 2009).

In March 2010, Terracon submitted a Workplan for the proposed modification to the groundwater monitoring system. The Workplan was approved by the ADEQ on April 13, 2010 (ADEQ Document #57295).

During implementation of the Workplan, monitoring wells MW-9 and MW-16 were plugged and abandoned and two replacement wells were subsequently relocated and renamed MW-9R and MW-16R. In addition, three new monitoring wells (MW-19, MW-20 and MW-21) were installed around the landfill to provide additional data within the point of compliance.

Therefore, there are currently nine monitoring wells designated as MW-6R, MW-8, MW-9R, MW-14R, MW-16R, MW-17R, MW-19, MW-20 and MW-21 surrounding the Landfill. FIGURE 2 presents the site layout including the locations of the current monitoring wells in relation to the

Landfill and surrounding areas. Boring logs/well construction details for the existing wells are presented in APPENDIX B.

A Groundwater Monitoring System Certification for the current monitoring system is presented in **APPENDIX E**. It should be noted that monitoring well MW-8 does not appear to be constructed in accordance with EPA and standard industry practices, but is likely capable of yielding water samples that are representative of the uppermost aquifer ground water quality at the sampling point. In the event water quality samples collected from MW-8 appear anomalous in comparision to the general site water quality parameters, it is recommended the well be replaced.

Wells MW-14R and MW-17R serve as upgradient monitoring points while the remaining wells are hydraulically downgradient of the landfill area that has received waste since the facility began operation in 1990 (i.e., Cells 1 - 4).

NOTE: In accordance with ADEQ Document #56064 dated November 17, 2009 with the addition of the three new monitoring wells (MW-19, MW-20 and MW-21), wells MW-6R and MW-8 will be sampled using an alternative frequency of every 1.5 years. Statistics will still be performed on these wells. Water level measurements will be taken during every sampling event.

5.0 BACKGROUND GROUNDWATER QUALITY (22.1203 (e))

The purpose of obtaining adequate background groundwater data is to approximate the true range of ambient concentrations of targeted analytes in the groundwater system being monitored. In other words, background groundwater data should eliminate, to the extent possible, potential causes of statistically significant changes in groundwater chemistry not attributable to the monitored facility.

Background water quality will be established in the monitoring wells that currently comprise the monitoring system. If additional wells are added to the system at a later date, background groundwater quality will be established in accordance with APC&EC Regulation 22, Section 22.1203 (e).

6.0 DETECTION MONITORING PROGRAM (22.104)

Detection monitoring involves the effective use of monitoring parameters (or "indicator" parameters) and sampling locations to provide earliest possible detection of a potential release from a facility. The objective is to select proper sample locations and parameters, identify an appropriate "background" (i.e., sampling medium that has not been affected by the facility and that represents the media at the relevant point(s) of compliance), and evaluate potential changes in water quality using an effective statistical methodology. The statistical methodology must be environmentally sensitive, while balancing the false positive error rate.

A Detection Monitoring Program has been implemented at the facility in accordance with Section 22.1204 of APC&EC Regulation 22.

6.1 GROUNDWATER DETECTION MONITORING PARAMETERS (22.1204 (a))

The monitoring wells at the CCSWDA Legacy Landfill will be monitored during Detection Monitoring for the parameters listed in Appendix 1 of Regulation 22 plus total iron, total manganese, and total organic carbon (TOC). An alternative list of parameters may be used if approval is obtained in writing from the ADEQ Solid Waste Management Division. The detection monitoring constituent list has been included as **TABLE 4**.

6.2 GROUNDWATER DETECTION MONITORING FREQUENCY (22.1204 (b))

After the establishment of background groundwater quality (refer to Section 5), sampling and analysis of the wells within the monitoring system will be conducted on a semi-annual basis for the life of the facility and the duration of the specified post-closure care period, with the exception of the following alternate frequency as approved by ADEQ:

- *In accordance with ADEQ Document #56064 dated November 17, 2009 with the addition of the three new monitoring wells (MW-19, MW-20 and MW-21), wells MW-6R and MW-8 will be sampled using an alternative frequency of every 1.5 years. Statistics will still be performed on these wells. Water level measurements will be taken during every sampling event.*

6.3 REPORTING REQUIREMENTS (22.1203 (k))

Analytical results from each sampling event will be directly submitted to ADEQ by the contract analytical laboratory. In addition, a groundwater monitoring report (GWMR) containing the field data and analytical results from each site sampling event will be submitted to the ADEQ on a semi-annual basis as a condition of the facility's solid waste management permit and in accordance with Regulation 22.1203(k). A copy of the groundwater database will also be included in each GWMR (including a copy of the historical database).

Detections of parameters at concentrations between the MDL and PQL will be reported in the historical database. In accordance with Section 6.3.4 Page 6-37 of the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (EPA, March 2009)., since the actual concentration is unknown, the suggested imputation when using simple substitution is to replace each non-detect having a qualifier of E or J by one-half the RL. Note, however, that E and J samples reported with estimated concentrations should be treated as valid measurements for statistical purposes. Substitution of one-half the RL is not recommended for these measurements, even though the degree of uncertainty associated with the estimated concentration is probably higher than that associated with measurement above the RL.

Additionally, the final GWMR will include a discussion of the rate and direction of groundwater flow to satisfy the requirements of Section 22.1203(d), a discussion of all sampling, re-sampling, and verification re-sampling activities conducted during the monitoring period, and a determination of whether a statistically significant increase (SSI) has occurred for any constituent detected above established background concentrations at the facility.

If an initial statistical exceedance (or ISE, defined as the initial exceedance of a calculated limit prior to verification re-sampling activities) of any monitored constituent is identified from the analytical results, verification re-sampling for those constituents will be conducted in accordance with the verification re-sampling plan discussed in Section 7.3. Verification sampling will consist of re-sampling event(s) scheduled at an interval sufficient to ensure sample independence. If the verification re-sampling results indicate that a source other than the facility being sampled caused the contamination or that the ISE resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality, these conclusions will be documented in the report for the semi-annual sampling event. The procedures utilized for verification resampling will be consistent with the methodologies described in 40 CFR 264.98(g)(3). If the exceedance is verified a notice will be placed in the Operating Record that a statistically significant increase (SSI) has occurred within 14 days of verification. The owner or operator will notify the ADEQ that this notice has been placed in the Operating Record.

7.0 DATA EVALUATION

This section outlines the proposed evaluation methodology that may be used for detection of a release from the facility by using PQLs as the concentration limits for VOCs and Prediction Limits comparisons.

7.1 OUTLIER DETERMINATION

During background sample collection, it will be necessary to examine the data for outliers, anomalies, and trends that might be an indication of a release. Outliers and anomalies are inconsistently large or small values that can occur due to sampling, laboratory, transportation or transcription errors, or other unknown factors. Significant trends indicate a source of systematic error, or an actual contamination occurrence, that must be evaluated and corrected before the detection monitoring program can be implemented. The inclusion of such values in the historical database used for statistical evaluation could cause misinterpretation of the data set, and result in an artificial increase in the magnitude of statistical limits, which could result in an increase in the false negative rate (i.e., a decrease in the sensitivity of the statistical procedure). Outliers will be evaluated in accordance with *Chapter 6 – Detection Monitoring Design, Section 6.3.3 Outliers, pg 6-34 to 6-36* of the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (EPA, March 2009).

7.2 STATISTICAL METHODOLOGY (22.103)

In compliance with ***Reg.22.1203(j)(5)***, a method for statistically evaluating ground water analytical data for significant changes must be selected. The method must be tailored to fit the hydrogeology of the site. For data quality assurance purposes, the statistical evaluation should be performed by a third party independent from the contract laboratory analyzing the ground water. Software designed for statistical analysis of groundwater will be utilized to compile and statistically evaluate the data following each sampling event. **TABLE 4** represents a list of the current detection monitoring constituents for the Legacy Landfill.

The motive for performing statistical analysis on groundwater quality data is to distinguish if a facility has negatively impacted groundwater quality. Little is known about the behavior of the overall population of groundwater quality. Since the only information available is groundwater sample results, statistical evaluations are employed in order to estimate typical (normal) behavior of groundwater data. Despite sample fluctuations due to random variation, statistical analysis helps to determine if compliance concentrations are significantly higher, on average, than background groundwater concentrations.

The specific statistical method used to evaluate the groundwater data will depend on the data and its distribution. The statistical method will be in compliance with ***Reg.22.1203(h)*** and Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (EPA, March 2009).

Intra-Well Prediction Intervals

The prediction interval is a statistical interval used to compare a single observation to a group of observations. The prediction interval is calculated to include observations from the same population (well or spring) with a specified confidence. In groundwater monitoring, a prediction interval approach may be used to make comparisons between background and compliance well (or spring) data. The interval is constructed to contain all future observations with stated confidence. If any future observation exceeds this interval, this is statistically significant evidence that the observation is not representative of the background group.

When performing Prediction Interval statistics, parametric prediction intervals are the first choice when performing prediction interval statistics. The parametric alternative is constructed assuming that the background data have a normal or transformed-normal distribution. During parametric prediction interval analysis, the mean and the standard deviation are calculated for the raw or transformed background data. The number of comparison observations, *K*, is specified to be included in the interval. Once the interval has been calculated, at each sampling period, the mean of the compliance well (or spring) observations is obtained. This mean is compared to see if it falls within the interval. If less than 15 percent of the background observations are non-detects, the non-detect values will be replaced with one half of the PQL prior to running the analysis (EPA, March 2009). If more than 15 percent but less than 50 percent of the background data are less than the MDL, the data's sample mean and standard deviation are adjusted according to the Cohen Adjustment method.

However, when the background data are not transformed-normal or contain between 50 and 90

percent observations below the detection limit, *SANITAS*™ *For Groundwater* automatically constructs a non-parametric prediction interval. During non-parametric analysis, the highest value from the background data is used to set the upper limit of the prediction interval.

If more than 90 percent of the background data are less than the MDL, a Poisson distribution-based prediction interval will be computed. The Poisson distribution is a probability distribution modeled for rare events. The Poisson probability of a detectable observation is rare unless there is an impact. The sum of the Poisson counts across background samples is computed by adding the number of parts per billion (ppb) across all observations for the background well (spring). Prior to any calculation non-detects are set to one-half the PQL and all trace values are evaluated as an average of the PQL. To test the upper prediction limit, the Poisson count of the sum of the next *k* observations from the well is compared to the 99 percent upper Poisson prediction limit. If this sum exceeds the prediction limit, there is significant evidence of an impact.

Sen's Slope/Mann-Kendall Test

When used in conjunction with one another, the Mann-Kendall test for temporal trend and the Sen's Slope Estimator are two types of evaluation monitoring statistics useful in determining the significance of an apparent trend and to estimate the magnitude of that trend. Prior to performing intra-well control chart or prediction interval statistics, the Sen's Slope/Mann-Kendall tests are performed on all detected constituents from each well to determine whether a significant upward trend in data is present.

The Mann-Kendall test is non-parametric, meaning that it does not depend on an assumption of a particular underlying distribution. The test uses only the relative magnitude of data rather than actual values. Values reported by the lab as below the MDL are assigned values equal to one half the PQL. For wells having less than 41 data points, an "Exact test" is performed. This version of the Mann-Kendall assigns a positive or negative score based on the differences between the data points. The Mann-Kendall Statistic is then computed, which is the number of positive differences minus the number of negative differences.

If the absolute value of the Mann-Kendall Statistic exceeds the absolute value of the critical value then a trend is significant at a 95 percent Confidence Level (two-tailed). Positive and negative values of Mann-Kendall Statistics and critical values respectively relate to increasing and decreasing trends. The plots contain the slope in units per year, a plot of the slope and concentrations over time, the Mann-Kendall Statistic, the critical value, and an indication if the trend is or is not significant at the 95 percent confidence level for a two-tailed test.

An important consideration in any graphical presentation is whether the data is significantly influenced by seasonal changes. If this is the case, then the data should be adjusted for seasonal influences. In order to make such a determination, there should exist at least eight and preferably sixteen observations for each parameter. However, seasonal influences will likely be first suspected from visual observation of the data graphs discussed above. Based on the data generated thus far and as stated in previous reports, it is suspected that concentration

levels are significantly influenced by the amount of precipitation and the timing of individual precipitation events in relation to sampling events.

7.3 DETECTION VERIFICATION PROCEDURE

Once groundwater analysis results have been collected, checked for QA/QC consistency, and determined to be above the appropriate statistical level, the results must be verified in accordance with the objectives of ***Reg.22.1203(i)***. Verification procedures will be conducted in accordance to *Chapter 19 – Prediction Limit Strategies with Retesting, Section 19.1 Retesting Strategies, pg 19-1 to 19-3* of the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (EPA, March 2009).

Verification re-sampling is an integral part of the statistical methodology. Without verification re-sampling, much larger statistical limits would be required to achieve site-wide false positive rates of 5% or less. Furthermore, the resulting false negative rate would be greatly increased. The following procedure will be performed for each compound determined to be initially above its statistical limit. Only compounds that initially exceed their statistical limit will be sampled for verification purposes.

If one or more of the inorganic parameters are detected above their statistical limit, a verification re-sample will be collected prior to or in association with the next regularly scheduled sampling event. A SSI will be recorded if verification of an elevated parameter is confirmed in a concentration greater than the control/prediction limit for the discrete verification re-sample. If the re-sampling program confirms that the initial sample represented a laboratory or sampling-induced outlier, the inititial sample will be flagged as an outlier and the verification sample value will be used to eliminate bias from the prediction interval, which compares the most recent data points to calculated limits. The original sample value will be maintained in the database as an outlier.

7.3.1 Volatile Organic Compounds

Practical Quantitation Limits (PQLs) assure that the quantitative value of the analyte is close to the measured value. Conversely, method detection limits (MDLs) indicate that the analyte is present in the sample with a specified degree of confidence. For analytes with estimated concentrations greater than the MDL but less than the PQL, it can only be concluded that the true concentration is greater than zero; the actual concentration cannot be determined.

The use of laboratory-specific PQLs (or EQLs) already incorporates a measure of the statistical uncertainty that is associated with the measurement process. Any VOC detected and verified at a concentration above the PQL (or EQL) would be statistically significant, and therefore trigger assessment monitoring. These decision rules apply only in cases where the constituent has rarely, or never, been detected in background. VOC's detected at concentrations between the MDL and PQL will be reported but will not be considered statistically significant until a verified concentration above the PQL is detected.

If one or more VOCs are detected above their statistical limit, a verification re-sample will be collected prior to or in association with the next regularly scheduled sampling event. A statistically significant increase (SSI) will be recorded if any single VOC is verified above its PQL based on the results of the re-sampling event.

7.3.2 Inorganic Constituents

If one or more of the inorganic parameters are detected above their statistical limit, a verification re-sample will be collected prior to or in association with the next regularly scheduled sampling event. A SSI will be recorded if verification of an elevated parameter is confirmed in a concentration greater than the control/prediction limit for the discrete verification re-sample.

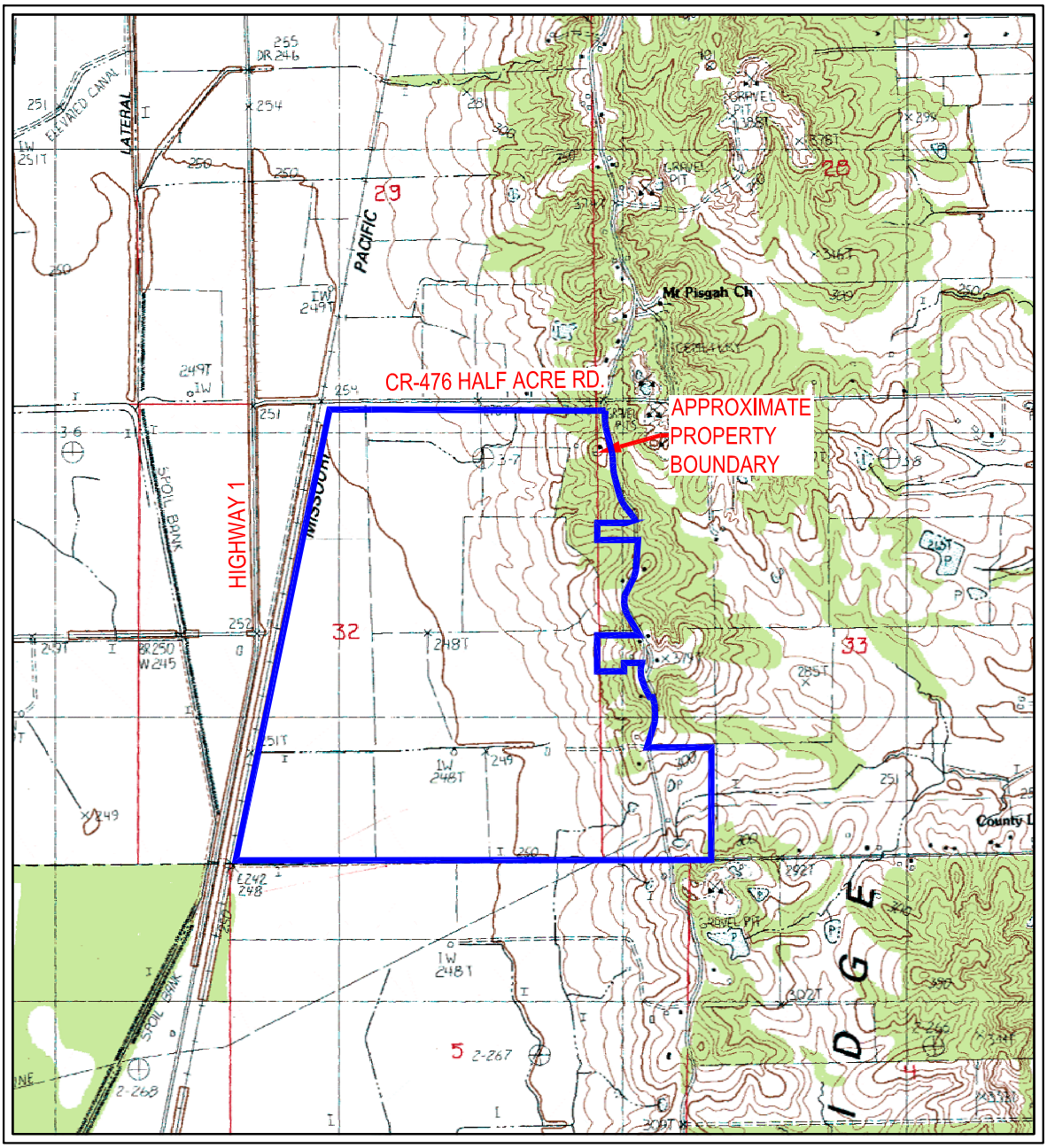
8.0 ASSESSMENT MONITORING CONTINGENCY PROCEDURE (22.1205)

The Assessment Monitoring Program will be triggered when a verified statistically significant increase (SSI) is indicated for one or more detection monitoring parameters when compared to the established background as stated in previous sections. Within fourteen (14) days of this finding, the facility will place a notice in the Operating Record indicating which constituents have shown statistically significant changes from background levels and notify the department. Subsequently, the facility will establish an assessment monitoring program that meets the requirement of ***Reg.22.1205*** within ninety (90) days except as provided for in ***Reg.22.1204(c)(3)***.

If after ninety (90) days, a successful demonstration provided for in ***Reg.22.1204(c)(3)*** is not made, the facility will re-sample and analyze for *Appendix 2* constituents in accordance with ***Reg.22.1205***.

If assessment monitoring is triggered, an assessment plan will be developed and the facility will follow the assessment procedures in accordance with ***Reg.22.1205, Reg.22.1206, Reg.22.1207, and Reg.22.1208***.

UNITED STATES – DEPARTMENT OF THE INTERIOR – GEOLOGICAL SURVEY



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MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

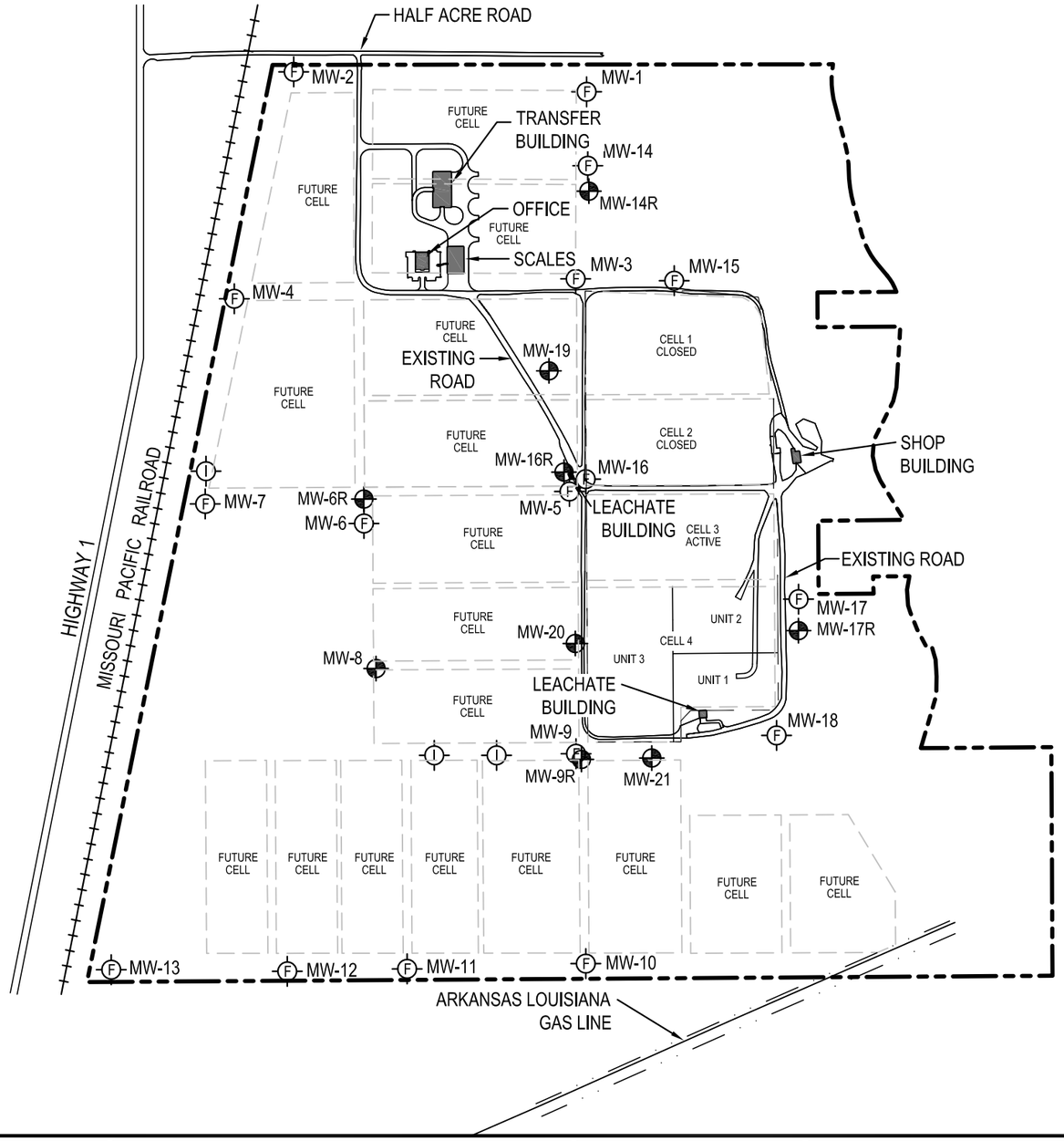
CONTOUR INTERVAL 10 FEET

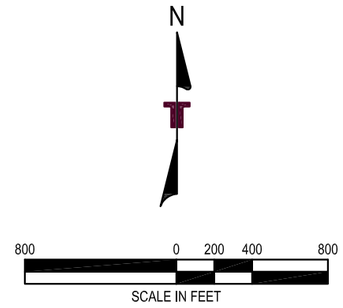
NATIONAL GEODETIC VERTICAL DATUM OF 1929

N

GREENFIELD QUADRANGLE 1983 7.5 MINUTE SERIES (TOPOGRAPHIC)

Project Mngr: MR	Project No. 282-001-35107090	Terracon Consulting Engineers and Scientists	SITE LOCATION MAP	FIG. No.
Drawn By: PTG	Scale: AS SHOWN	25809 I-30 BRYANT, AR 72022	CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY	1
Checked By: CM	File No. 020	PH. (501) 847-9292 FAX. (501) 847-9210	LEGACY LANDFILL	
Approved By: MR	Date: 9/2/2010		JONESBORO ARKANSAS	





LEGEND:

- PROPERTY BOUNDARY
- MW-6R — EXISTING GROUNDWATER MONITORING WELL LOCATION
- MW-16 — FORMER GROUNDWATER MONITORING WELL LOCATION
- IRRIGATION WELL LOCATION

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

MONITORING WELL LOCATION MAP

GROUNDWATER SAMPLING AND ANALYSIS PLAN

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA)

LEGACY LANDFILL

JONESBORO ARKANSAS

FIGURE 1

DESIGNED BY:	HAL
DRAWN BY:	PTG
APPVD. BY:	HAL
SCALE:	1" = 800'
DATE:	3/8/2012
JOB NO.	282-001-35117105
ACAD NO.	032
SHEET NO.:	OF

APPENDIX A

TABLES

TABLE 1
CCSWDA Legacy Landfill
Sample Collection, Preservation, and Holding Times

PARAMETER[1]	SAMPLE COLLECTION[2] AND CONTAINER	SAMPLE[3,4] PRESERVATION	RECOMMENDED[5] HOLDING TIME
Acid Extractables	1000 ml Glass only (Amber) w/Teflon liner	Cool, 4°C	Extract within 7 days; analyze within 40 days
Alkalinity	100 ml P,G, zero headspace	Cool, 4°C	14 days
Ammonia	125 ml P,G	Cool, 4°C H_2SO_4 to pH <2	28 days
Base/Neutral Extractables (priority pollutants)	1000 ml Glass only (Amber) w/Teflon liner	Cool, 4°C	Extract within 7 days; analyze within 40 days
Biochemical Oxygen demand, 5 day (BOD5)	500 ml P,G	Cool, 4°C	48 hours
Boron	100 ml P	Preserve in lab	6 months
Chemical Oxygen demand (COD)	125 ml P,G	Cool, 4°C H_2SO_4 to pH <2	28 days
Chloride	125 ml P,G	None required	28 days
Coliform, fecal and total	100 ml P,G sterilized	Cool, 4°C	6 hours
Cyanide	125 ml P,G	Cool, 4°C NaOH to pH >12 0.6g ascorbic acid[6]	14 days[7]
Fluoride	125 ml P	None required	28 days
Hardness	100 ml P,G	HNO_3 to pH <2	6 months
Metals			
Chromium (hexavalent)	125 ml P,G	Cool, 4°C	24 hours
Mercury (dissolved)	500 ml P,G	Filter on site HNO_3 to pH <2	28 days
Mercury (total)	500 ml P,G	HNO_3 to pH <2	28 days

TABLE 1 (Cont'd)
CCSWDA Legacy Landfill
Sample Collection, Preservation, and Holding Times

PARAMETER[1]	SAMPLE COLLECTION[2] AND CONTAINER	SAMPLE[3,4] PRESERVATION	RECOMMENDED[5] HOLDING TIME
Other metals, (dissolved) (Arsenic, Barium, Calcium Cadmium, Chromium, Iron, Lead, Magnesium, Manganese, Nickel, Potassium, Selenium, Silver, Sodium, Zinc)	500 ml P,G	Filter on site HNO_3 to pH <2	6 months
Other metals, (totals) (Antimony, Arsenic, Barium, Beryllium, Calcium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zinc)	500 ml P,G	HNO_3 to pH <2	6 months
Nitrate[8]	125 ml P,G	Cool, 4°C	48 hours
Nitrite	125 ml P,G	Cool, 4°C	48 hours
Oil and Grease	1000 ml, G only	Cool, 4°C H_2SO_4 to pH <2	28 days
PCB (priority pollutant)	1000 ml, Glass only (Amber w/Teflon liner	Cool, 4°C	Extract within 7 days; analyze within 40 days
Pesticides Endrin Lindane Toxaphene Methoxychlor	1000 ml, Glass only (Amber) w/Teflon liner	Cool, 4°C pH 5 - 9	Extract within 7 days; analyze within 40 days
pH (field)	25 ml P,G	None required	Analyze immediately
Phenols	125 ml G only	Cool, 4°C H_2SO_4 to pH <2	28 days
Phosphorous (total)	125 ml P,G	Cool 4°C H_2SO_4 to pH <2	28 days

TABLE 1 (Cont'd)
CCSWDA Legacy Landfill
Sample Collection, Preservation, and Holding Times

PARAMETER[1]	SAMPLE COLLECTION[2] AND CONTAINER	SAMPLE[3,4] PRESERVATION	RECOMMENDED[5] HOLDING TIME
Semi-volatile Organics	1000 ml, Glass only (Amber) W/ Teflon liner	Cool, 4°C	Extract within 7 days Analyze W/I 40 days
Specific Conductance (field)	25 ml P,G	None required	Analyze immediately
Sulfate	125 ml P,G	Cool, 4°C	28 days
Temperature (field)	25 ml P,G	None required	Analyze immediately
Total Dissolved Solids residue on evaporation (TDS/ROE) 180° C	500 ml P	Cool, 4°C	7 days
Total Suspended Solids (TSS)	500 ml P	Cool, 4°C	7 days
Volatile Organic Acids, priority pollutants	3-40 ml glass vial w/septum caps, zero headspace	Cool, 4°C HCl to pH < 2	14 days
Volatile Organics	3-40 ml glass vial w/septum caps, zero headspace	Cool, 4°C HCl to pH < 2	14 days

1. Table may include more parameters than required for groundwater sampling. A general discussion on sampling water and industrial waste water may be found in ASTM, Part 31, pages 72-81 (1976) Method D-3370.

2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.

3. Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

4. When any sample is to be shipped by common carrier or sent through the United States mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table 5-4, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCI) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

5. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of sample under study are stable for the longer time, and has received a variance from the Regional Administrator. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.

6. Should only be used in the presence of residual chlorine.

7. Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before the pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

8. In accordance with Regulation 22, Appendix 1, sample preservation, handling, and analysis will meet the specifications described by "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, third edition" (EPA Publication Number SW-846, 1986, as revised December, 1987) or an equivalent substitute as approved by the administrative authority

Note: Many tests can be combined in bottles. For example, Chloride, Fluoride, Nitrate, Nitrite, pH, Sulfate, TDS, TSS will be collected in a 1 liter plastic bottle.

TABLE 2
CCSWDA Legacy Landfill
Methodologies for Testing and Analysis*

PARAMETER	METHOD DESCRIPTION	METHOD
Acid Extractables (priority pollutants)	GC/MS	(E)EPA625/8270C(D)
Alkalinity	Colorimetric; Automated Methyl Orange	(A)310.2
Ammonia	Colorimetric; Automated Phenate	(A)350.1
Base/Neutral Extractables (priority pollutants)	GC/MS	(E)EPA625/8270C(D)
Biochemical Oxygen demand, 5 day (BOD5)	BOD (5 day, 20°C)	(A)405.1
Calcium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Chemical Oxygen demand (COD)	Colorimetric	(A)410.4
Chloride	Ion Chromatography	(A)300.0
Coliform (fecal)	Delayed Incubation Procedure	(B)909C
Coliform (total)	Standard Membrane Filter Procedure	(B)909A
Cyanide (total)	Titrimetric-Spectrophotometric	(A)335.2/9014(D)
Fluoride	Ion Chromatography	(A)300.0
Hardness	Calculation	(C)2340B
Metals, dissolved		
Antimony	Atomic Emission/Mass Spectrometric	(A)200.8/ 6020(D)
Arsenic	Atomic Emission Spectrometric	(A)200.7/6010B (D)
Barium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Beryllium	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Boron	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Cadmium	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Chromium	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Chromium (hexavalent)	Colorimetric	(D)7196A
Cobalt	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Copper	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Iron	Atomic Emission Spectrometric	(A)200.7/ 6010B(D)

TABLE 2 (Cont'd)
CCSWDA Legacy Landfill
Methodologies for Testing and Analysis

PARAMETER	METHOD DESCRIPTION	METHOD
Lead	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Magnesium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Manganese	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Mercury	Atomic Absorption, cold vapor technique	(A)245.1/7470(D)
Nickel	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Potassium	Atomic Emission Spectrometric	(A) 200.7/6010B(D)
Selenium	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Silver	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Sodium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Thallium	Atomic Emission/Mass Spectrometric	(A) 200.8/6020(D)
Vanadium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Zinc	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Metals, total		
Antimony	Atomic Emission/ Mass Spectrometric	(A)200.8/ 6020(D)
Arsenic	Atomic Emission Spectrometric	(A) 200.7/6010B (D)
Barium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Beryllium	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Boron	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Cadmium	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Chromium	Atomic Emission/ Mass Spectrometric	(A)200.8/6020(D)
Chromium (hexavalent)	Colorimetric	(D)7196A
Cobalt	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Copper	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Iron	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Lead	Atomic Emission/Mass Spectrometric	(A)200.8/6020(D)
Magnesium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Manganese	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Mercury	Atomic Absorption, cold vapor technique	(A)245.1/7470(D)
Nickel	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Potassium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Selenium	Atomic Emission/Mass Spectrometric	(A)200.8/6020(D)
Silver	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Sodium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Thallium	Atomic Emission/Mass Spectrometric	(A) 200.8/6020 (D)
Vanadium	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Zinc	Atomic Emission Spectrometric	(A)200.7/6010B(D)
Nitrate	Colorimetric, Automated, Cadmium Reduction Or Ion Chromatography	(A)353.2 300.0
Nitrite	Colorimetric, Automated, Cadmium Reduction Or Ion Chromatography	(A)353.2 300.0
Oil and Grease	Gravimetric, Separatory Funnel Extraction or or Spectrometric, Infrared	(A)413.1/9070(D) or (A)413.2
PCB (priority pollutants)	Gas Chromatograph	EPA608(A)or 8082(D)
Pesticides (Endrin, Lindane, Toxaphene, Methoxychlor)	Gas Chromatograph	EPA608(A)or8081A(D)

TABLE 2 (Cont'd)
CCSWDA Legacy Landfill
Methodologies for Testing and Analysis

PARAMETER	METHOD DESCRIPTION	METHOD
pH (field)	Electrometric	(A)150.1
Phenols	Colorimetric, Automated 4-AAP with Distillation	(A)420.2/9066(D)
Phosphorous	Colorimetric, Automated Ascorbic Acid	(A)365.3
Semi-volatile Organics	GC/MS Acids & Base Neutrals	(E)EPA 625/8270C(D)
Specific Conductance (field)	Wheatstone bridge	(A)120.1
Sulfate	Ion Chromatography	(A)300.0
Temperature (field)	Reversing Thermometer	(B)212
Total dissolved solids residue on evaporation (TDS/ROE)	Gravimetric, Dried at 180°C	(A)160.1
Total Organic Carbon (TOC)	Combustion or Oxidation	(A)415.1
Total Suspended Solids (TSS)	Gravimetric, Dried at 103-105°C	(A)160.2
Volatile Organic Acids (PP/VOA), priority pollutants	Purge and Trap/GC/MS	EPA 624/(E) /8260B(D)
Volatile Organics	Purge and Trap/GC/MS	EPA 624/(E) /8260B(D)/524.2
DBCP, EDB	Microextraction	EPA 504.1/ 8011(D)

**NOTE: Analytical methods listed above may be substituted for as deemed necessary provided that the alternate methods provide adequate analytical data to fulfill monitoring requirements and meet regulatory standards.*

References:
A: Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-0920, EMSL, Cincinnati, Revision (March 1983)
B: Standard Methods for the Examination of Water and Wastewaters, 15th Edition, APHA-AQWQA-WPCF, 1980
C*: Standard Methods for the Examination of Water and Wastewaters, 18th Edition, APHA-AWWA-WEF, 1992
D: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update 3, May 1997.
* 2340B is the same in the 18th Edition as in the 17th Edition.
E: "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act"; 40 CFR, Part 136; USEPA; October 26, 1984

TABLE 3
CCSWDA Legacy Landfill
Monitoring Well Construction Details

Well Number	Date Installed	Top of PVC Casing Elevation (fmsl)	Total Depth[1] (ft)	Screen Length (ft)	Solid Riser Length[2] (ft)	Depth to Top of Filter Sand[2] (ft)	Depth to Top of Bentonite Seal[2] (ft)
MW-6R	8-25-98	251.84	97.05	20	75	69	60
MW-8	6-6-90	250.30	101.75	30	65	19	12
MW-14R	6-15-04	266.09	122.59	20	100	91	86
MW-17R	6-17-04	282.22	138.35	20	116	97	92
MW-9R	5-27-10	252.90	103.10	20.3	79.30	78	76
MW-16R	5-27-10	259.12	112.98	20.3	89.18	86	84
MW-19	5-28-10	263.89	118.50	20.3	94.70	92	90
MW-20	5-27-10	257.83	108.02	20.3	84.22	82	80
MW-21	5-26-10	253.11	102.86	20.3	79.06	77	75

[1] below top of PVC casing
[2] below ground surface

TABLE 4
CCSWDA Legacy Landfill
Detection Monitoring Parameter List

COMMON NAME	CAS RN
Inorganic Constituents (Total):	
(1) Antimony	7440-36-0
(2) Arsenic	7440-38-2
(3) Barium	7440-39-3
(4) Beryllium	7440-41-7
(5) Cadmium	7440-43-9
(6) Chromium	7440-47-3
(7) Cobalt	7440-48-4
(8) Copper	7440-50-8
(9) Lead	7439-92-1
(10) Nickel	7440-02-0
(11) Selenium	7782-49-2
(12) Silver	7440-22-4
(13) Thallium	7440-28-0
(14) Vanadium	7440-62-2
(15) Zinc	7440-66-6
Organic Constituents:	
(16) Acetone	67-64-1
(17) Acrylonitrile	107-13-1
(18) Benzene	71-43-2
(19) Bromochloromethane	74-97-5
(20) Bromodichloromethane	75-27-4
(21) Bromoform (tribromomethane)	75-25-2
(22) Carbon disulfide	75-15-0
(23) Carbon tetrachloride	56-23-5
(24) Chlorobenzene	108-90-7
(25) Chloroethane (ethyl chloride)	75-00-3
(26) Chloroform (trichloromethane)	67-66-3
(27) Dibromochloromethane (chlorodibromomethane)	124-48-1
(28) 1,2-Dibromo-3-chloropropane (DBCP)	96-12-8
(29) 1,2-Dibromoethane (ethylene dibromide,EDB)	106-93-4
(30) o-Dichlorobenzene (1,2-dichlorobenzene)	95-50-1
(31) p-Dichlorobenzene (1,4-dichlorobenzene)	106-46-7
(32) trans-1,4-Dichloro-2-butene	110-57-6
(33) 1,1-Dichloroethane (ethyldidene chloride)	75-34-4
(34) 1,2-Dichloroethane (ethylene dichloride)	107-06-2
(35) 1,1-Dichloroethylene (1,1-dichloroethene, vinylidene chloride)	75-35-3
(36) cis-1,2-Dichloroethylene (cis-1,2-dichloroethene)	156-59-2
(37) trans-1,2-Dichloroethylene (trans-1,2-dichloroethene)	156-60-5
(38) 1,2-Dichloropropane (Propylene dichloride)	78-87-5
(39) cis-1,3-Dichloropropene	10061-01-5
(40) trans-1,3-Dichloropropene	10061-02-6
(41) Ethylbenzene	100-41-4
(42) 2-Hexanone (methyl butyl ketone)	591-78-6
(43) Methyl bromide (bromomethane)	74-83-9

TABLE 4 (Cont'd)
CCSWDA Legacy Landfill
Detection Monitoring Parameter List

COMMON NAME		CAS RN
(44)	Methyl chloride (chloromethane)	74-87-3
(45)	Methylene bromide (dibromomethane)	74-95-3
(46)	Methylene chloride (dichloromethane)	75-09-2
(47)	Methyl ethyl ketone (MEK, 2-butanone)	78-93-3
(48)	Methyl iodide (iodomethane)	74-88-4
(49)	4-Methyl-2-pentanone (methyl isobutyl ketone)	108-10-1
(50)	Styrene	100-42-5
(51)	1,1,1,2-Tetrachloroethane	630-20-6
(52)	1,1,2,2-Tetrachloroethane	79-34-5
(53)	Tetrachloroethylene (tetrachloroethane, perchloroethylene)	127-18-4
(54)	Toluene	108-88-3
(55)	1,1,1-Trichloroethane (methylchloroform)	71-55-6
(56)	1,1,2-Trichloroethane	79-00-5
(57)	Trichloroethylene (trichloroethene)	79-01-6
(58)	Trichlorofluoromethane (CFC-11)	75-69-4
(59)	1,2,3-Trichloropropane	96-18-4
(60)	Vinyl acetate	108-05-4
(61)	Vinyl chloride	75-01-4
(62)	Xylenes (total)	1330-20-7
Indicator Parameters:		
(63)	Chloride	16887-00-6
(64)	Sulfate	14808-79-8
(65)	Total Dissolved Solids (TDS)	C-010
(66)	Total Organic Carbon (TOC)	C-012
(67)	Iron (Total)	7439-89-6
(67)	Manganese (Total)	7439-96-5
(68)	Specific conductance (field measurement)	
(69)	pH (field measurement)	
(70)	Turbidity (field measurement)	

.

TABLE 5 (MDL and PQL)

Parameter	MDL (ug/l)	PQL (ug/l)
Chloride	150	1000
Sulfate	460	5000
TOC	220	1000
TDS	1700	10000
Antimony	0.21	1.0
Arsenic	0.25	1.0
Beryllium	0.12	1.0
Cadmium	0.16	0.50
Copper	0.52	2.0
Lead	0.24	1.0
Selenium	0.38	1.0
Thallium	0.19	1.0
Zinc	2.6	10
Barium	1.0	5.0
Chromium	1.7	10
Cobalt	1.7	10
Iron	19	100
Manganese	1.1	10
Nickel	5.3	20
Silver	3.3	10
Vanadium	2.2	10
Mercury	0.024	0.20
Acetone	16	50
Acrylonitrile	1.9	10
Benzene	0.23	1.0
Bromochloromethane	0.25	1.0
Bromodichloromethane	0.23	1.0
Bromoform	0.37	1.0
Bromomethane	1.6	5.0
Carbon disulfide	0.28	1.0
Carbon tetrachloride	0.20	1.0
Chlorobenzene	0.30	1.0
Chlorodibromomethane	0.24	1.0
Chloroethane	0.87	5.0
Chloroform	0.27	5.0
Chloromethane	0.76	2.5
Dibromomethane	0.35	1.0
1,2-Dibromoethane	0.27	1.0
1,2-Dibromo-3-Chloropropane	1.3	5.0
1,2-Dichlorobenzene	0.29	1.0

Parameter	MDL (ug/l)	PQL (ug/l)
1,4-Dichlorobenzene	0.31	1.0
Trans-1,4-Dichloro-2-butene	0.82	2.5
1,1-Dichloroethane	0.32	1.0
1,2-Dichloroethane	0.25	1.0
1,1-Dichloroethene	0.41	1.0
cis-1,2-Dichloroethene	0.34	1.0
trans-1,2-Dichloroethene	0.26	1.0
1,2-Dichloropropane	0.39	1.0
cis-1,3-Dichloropropene	0.25	1.0
trans-1,3-Dichloropropene	0.24	1.0
Ethylbenzene	0.22	1.0
2-Hexanone	3.6	5.0
Idomethane	1.9	5.0
2-Butanone (MEK)	3.4	15
Methylene Chloride	0.91	5.0
4-Methyl-2-pentanone	1.7	5.0
Styrene	0.24	1.0
1,1,1,1-Tetrachloroethane	0.32	1.0
1,1,2,2-Tetrachloroethane	0.25	1.0
Tetrachloroethene	0.32	1.0
Toluene	0.32	5.0
1,1,1-Trichloroethane	0.31	1.0
1,1,2-Trichloroethane	0.29	1.0
Trichloroethene	0.31	1.0
Trichloroflouromethane	1.1	5.0
1,2,3-Trichloropropane	0.74	2.5
Vinyl Acetate	4.0	5.0
Vinyl Chloride	0.34	1.0
Xylenes, Total	0.86	3.0

APPENDIX B

MONITORING WELL BORING LOGS AND CONSTRUCTION DIAGRAMS

BORING LOG

Boring:	MW-6R	Location:	CCSWDA Class 1 Landfill
Date:	8/25/98	Drilling Contractor:	Richard Simmons Drilling
Elevation:	248.92'	Drilling Method:	Hollow Stem Auger (HSA)
Project No.:	016-04D	Logged By:	David Johnston, P.G.

NORTHSTAR ENGINEERING CONSULTANTS, INC.
Bentonville, AR Little Rock, AR

Elevation (Ft. MSL)	Layer Depth (Ft.)	Material Description	Symbolic Log	Samples: REC (%) or REC & RQD (%)	Samples: SPT Values Blows Per 6"	Samples: SPT Values N	Comments
		CLAYEY SILT: tan to light brown, dry					Topsoil to 2.0'
	10	SILTY CLAY: light brown, slightly moist, moderately plastic					
228.92	20	SAND: light brown, fine to medium-grained, slightly moist					
	30						
208.92	40						
Scale Change →	50	- sand slightly coarser below 50 feet					
178.92	70						
		- sand brown, wet at 80 feet					
	90						
TD 153.92							Total Depth 95'
	110						

MONITORING WELL INSTALLATION RECORD

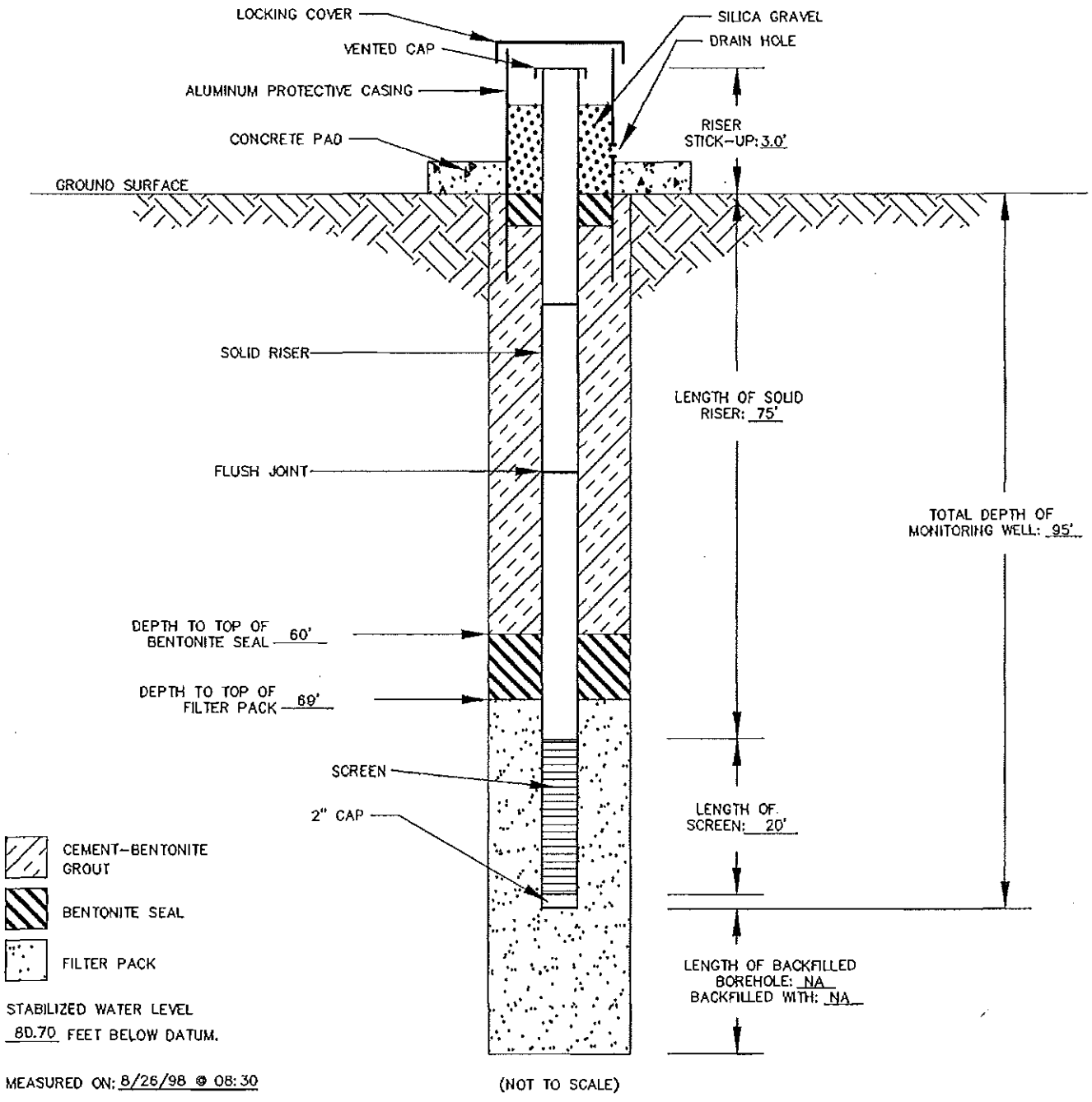
NORTHSTAR ENGINEERING CONSULTANTS, INC.

Civil Engineering
Environmental Engineering
Landscape Architecture
Geological Services
Planning

211 South Main Street
Bentonville, Arkansas 72712
(501) 271 - 0906
(501) 271-8144 Fax

1506 Macon Drive Suite B-7
Little Rock, Arkansas 72211
(501) 223 - 8959
(501) 223 - 8963 Fax

PROJECT NO.	016-04D
WELL NO.	MW-6R
PREPARED BY	MB
DATE	1/11/99
CHECKED BY	DJ



PROJECT NAME: CCSWDA CLASS 1 LANDFILL	SCREEN SLOT SIZE: 0.010"
WELL LOCATION: 58' SOUTH OF MW-6 LOCATION	FILTER PACK MATERIAL: 20/40 SILICA SAND
INSTALLATION DATE: 8/25/98	BOREHOLE DIAMETER: 8.5"
CONCRETE PAD ELEVATION: 249.26'	DRILLING METHOD: HOLLOW STEM AUGER
DATUM ELEVATION: 251.84'	SAMPLE METHOD: NA
DATUM FOR WATER LEVEL MEASUREMENT: TOP OF PVC CASING (TOC)	DRILL RIG: GUS PECH GP-1000R
RISER DIAMETER AND MATERIAL: 2" SCHEDULE 40 PVC	DRILLING CONTRACTOR: RICHARD SIMMONS DRILLING
SCREEN DIAMETER AND MATERIAL: 2" PVC	NEC REPRESENTATIVE: DAVID JOHNSTON

LOG OF BORING NO. MW-8

MONITORING WELLS – LANDFILL
JONESBORO, ARKANSAS.

TYPE: Wash

LOCATION: See Place 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)
SURF. EL:						
10			Gray and tan clay – with ferrous stains			Protective Steel Cover; Cement/Bentonite Grout
			Light gray clay with ferrous stains			Bentonite Seal
20			Tan silty fine sand			
30						2-inch diameter PVC Riser
40						
50						Filter Sand
60						
70			Gray sand with gravel layer at 81 ft			
80						Slotted Screen (0.010-Inch Slots) (With Sock)
90						
100						

COMPLETION DEPTH: 100 ft
DATE: 6/6/90

DEPTH TO WATER IN BORING:

DATE:

BORING LOG

Boring:	MW-14R	Location:	CCSWDA Class 1 Landfill
Date:	6/15/04	Drilling Contractor:	Richard Simmons Drilling Co , Inc.
Elev.:	263.30'	Drilling Method:	Air and Mud Rotary
Project No.:	016-006	Logged By:	David Johnston, P G.

NORTHSTAR ENGINEERING CONSULTANTS, INC.
211 S. Main St. Bentonville, AR 72712

Elevation (Ft. MSL)	Layer Depth (Ft.)	Material Description	Symbolic Log	Samples: REC (%) or REC RQD (%)	Samples: SPT Values Blows Per 6"	Samples: SPT Values N	Comments
		SILTY CLAY: light brown to brown, moist, cohesive, hard					Begin w/ 6" Tri-cone Bit using air rotary @ 08 34
253 30	10	- dry below 10'					
243 30	20						18' @ 08 34
233 30	30	- soft @ 32'					27' @ 10 33
		SAND: fine, light brown, non-cohesive					
223 30	40						Swith to mud rotary @ 38 ft @ 10 40 - resume drilling @ 10 53
							Good circulation
213 30	50	- becoming tan to light gray @ 50'					
Scale Change →	60						58' @ 11 20
		- occasional very fine to fine gravel from 63' to 76'					
183 30	80						76' @ 11 43 & break for lunch - resume drilling @ 13 29
163.30	100						Good circulation
143 30	120						

BORING LOG

Boring:	MW-14R	Location:	CCSWDA Class 1 Landfill
Date:	6/15/04	Drilling Contractor:	Richard Simmons Drilling Co., Inc
Elev.:	263 30'	Drilling Method:	Mud Rotary
Project No.:	016-006	Logged By:	David Johnston, P.G.

NORTHSTAR ENGINEERING CONSULTANTS, INC.
211 S. Main St. Bentonville, AR 72712

Elevation (Ft. MSL)	Layer Depth (Ft.)	Material Description	Symbolic Log	Samples: REC (%) or REC RQD (%)	Samples: SPT Values: Blows Per 6"	Samples: SPT Values: N	Comments
TD 135 30							Total Depth 128' @ 14 40

140
160
180
200
220
240
260
280
300

MONITORING WELL INSTALLATION RECORD

NORTHSTAR ENGINEERING CONSULTANTS, INC.

Civil & Environmental Engineering
Landscape Architecture
Geological Services
Land Surveying
Planning

211 South Main Street
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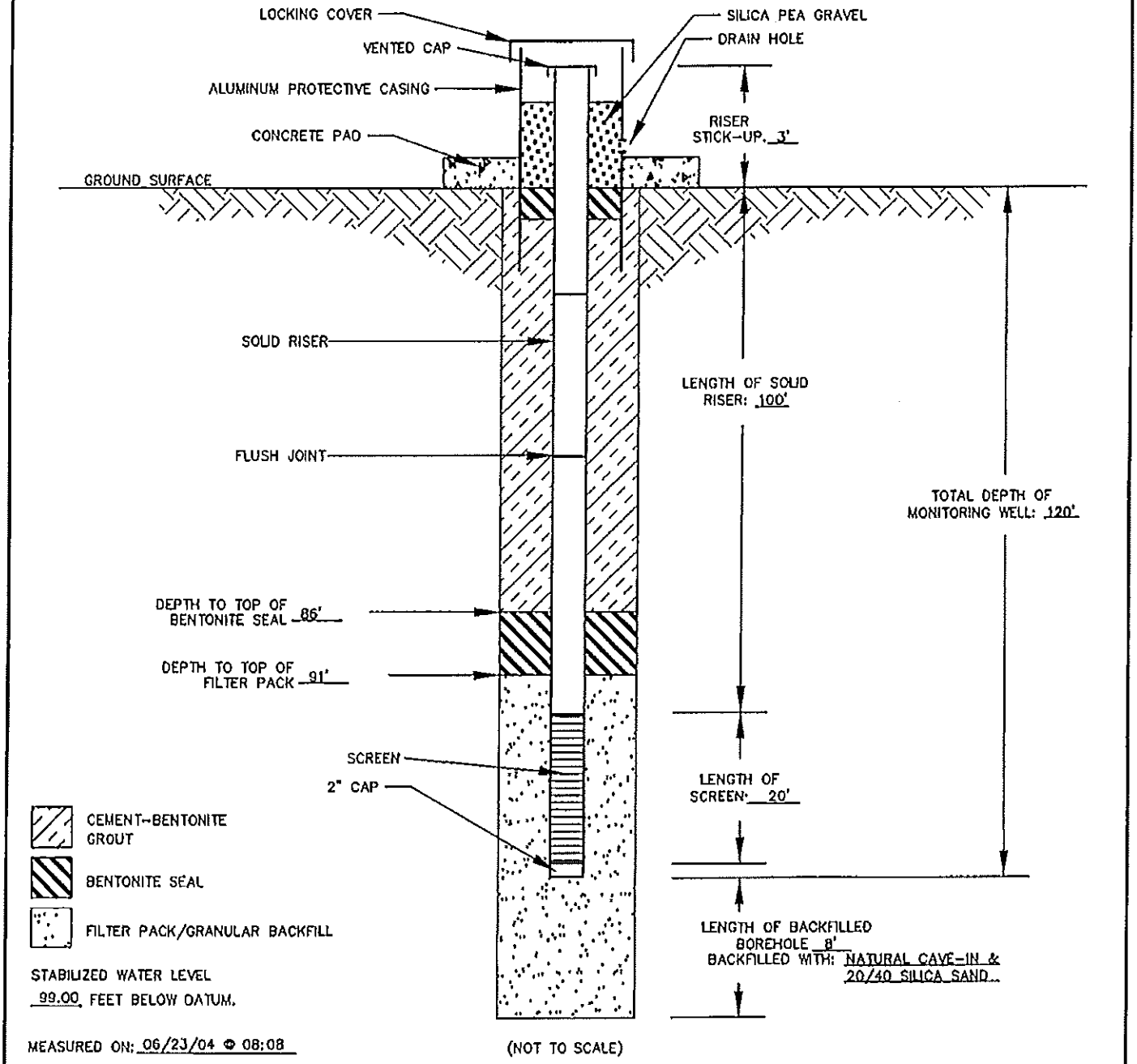
(479) 271-8144 Fax

2512 S. Culberhouse Rd. Suite B
Jonesboro, Arkansas 72401
(870) 932-6700
Fax (870) 932-7850

PROJECT NO.	016-006
WELL NO.	MW-14R
PREPARED BY	MAB
DATE	9/9/04
CHECKED BY	DHJ



PROJECT NAME: CCSWDA CLASS 1 LANDFILL	SCREEN SLOT SIZE: 0.010"
WELL LOCATION: 20' SOUTH OF MW-14 LOCATION	FILTER PACK MATERIAL: 20/40 SILICA SAND
INSTALLATION DATE: 06/15/04	BOREHOLE DIAMETER: 6"
CONCRETE PAD ELEVATION: 263.75'	DRILLING METHOD: AIR & MUD ROTARY
DATUM ELEVATION: 266.09'	SAMPLE METHOD: GRAB
DATUM FOR WATER LEVEL MEASUREMENT: TOP OF PVC CASING (TOC)	DRILL RIG: DRILLTECH T25K
RISER DIAMETER AND MATERIAL: 2" SCHEDULE 40 PVC	DRILLING CONTRACTOR: RICHARD SIMMONS DRILLING, CO. INC.
SCREEN DIAMETER AND MATERIAL: 2" SCHEDULE 40 PVC	NEC REPRESENTATIVE: DAVID JOHNSTON, P.G.

BORING LOG

Boring:	MW-17R	Location:	CCSWDA Class 1 Landfill
Date:	6/17/04	Drilling Contractor:	Richard Simmons Drilling Co , Inc.
Elev.:	279 20'	Drilling Method:	Mud Rotary
Project No.:	016-006	Logged By:	David Johnston, P G

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211 S. Main St. Bentonville, AR 72712

Elevation (Ft. MSL)	Layor Depth (Ft.)	Material Description	Symbolic Log	Samples: REC (%) or REC RQD (%)	Samples: SPT Values Blows Per 6"	Samples: SPT Values N	Comments
		SILTY CLAY, brown, moist, soft cohesive					Begin w/ 6" Tri-cone Bit using mud rotary @ 13 54
269 20	10	- becoming dry, medium hard @ 10'					Good circulation
259 20	20						18' @ 09 01
		CLAY: brown, dry, soft, cohesive					
		SILTY CLAY· brown, dry, hard, cohesive					
249 20	30						Good circulation
		- becoming soft @ 37'					
239 20	40						38' @ 09 30
		- becoming light gray @ 45'					
229 20	50						
Scale Change →	60						58' @ 09 54
199 20	80	CLAYEY SAND· light brown to tan, sand fine with some silt, slight cohesion					78' @ 10 14
							Good circulation
179 20	100						98' @ 10 40
159 20	120						

BORING LOG

Boring:	MW-17R	Location:	CCSWDA Class 1 Landfill
Date:	6/17/04	Drilling Contractor:	Richard Simmons Drilling Co., Inc
Elev.:	279.20'	Drilling Method:	Mud Rotary
Project No.:	016-006	Logged By:	David Johnston, P G

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211 S. Main St. Bentonville, AR 72712

Elevation (Ft. MSL)	Layer Depth (Ft.)	Material Description	Symbolic Log	Samples: REC (%) or REC RQD (%)	Samples: SPT Values Blows Per 6"	Samples: SPT Values N	Comments
139 20 TD 137 20	140						Total Depth 142' @ 11 18
	160						
	180						
	200						
	220						
	240						
	260						
	280						
	300						

MONITORING WELL INSTALLATION RECORD

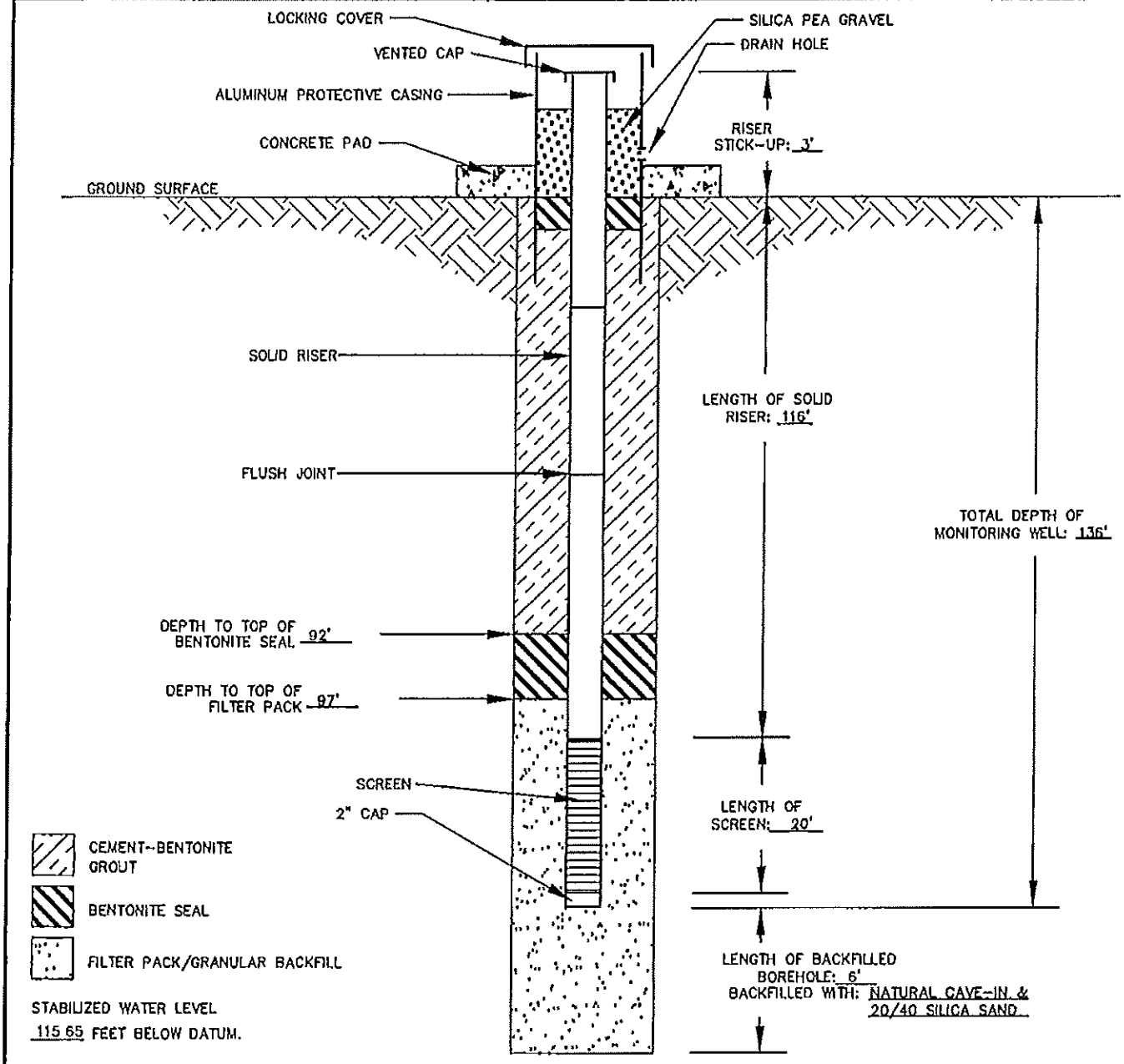
NORTHSTAR ENGINEERING CONSULTANTS, INC.

Civil & Environmental Engineering
Landscape Architecture
Geological Services
Land Surveying
Planning

211 South Main Street
Bentonville, Arkansas 72712
(479) 271-0906
(479) 271-8144 Fax

2512 S. Culberhouse Rd, Suite B
Jonesboro, Arkansas 72401
(870) 932-6700
Fax (870) 932-7850

PROJECT NO.	016-006
WELL NO.	MW-17R
PREPARED BY	MAB
DATE	9/9/04
CHECKED BY	DHJ



STABILIZED WATER LEVEL
115.65 FEET BELOW DATUM.

MEASURED ON: 08/23/04 @ 10:44

(NOT TO SCALE)

PROJECT NAME: CCSWDA CLASS 1 LANDFILL	SCREEN SLOT SIZE: 0.010"
WELL LOCATION: 69' NORTH OF MW-17 LOCATION	FILTER PACK MATERIAL: 20/40 SILICA SAND
INSTALLATION DATE: 06/17/04	BOREHOLE DIAMETER: 6"
CONCRETE PAD ELEVATION: 279.78'	DRILLING METHOD: MUD ROTARY
DATUM ELEVATION: 282.22'	SAMPLE METHOD: GRAB
DATUM FOR WATER LEVEL MEASUREMENT: TOP OF PVC CASING (TOC)	DRILL RIG: DRILLTECH T25K
RISER DIAMETER AND MATERIAL: 2" SCHEDULE 40 PVC	DRILLING CONTRACTOR: RICHARD SIMMONS DRILLING, CO. INC.
SCREEN DIAMETER AND MATERIAL: 2" SCHEDULE 40 PVC	NEC REPRESENTATIVE: DAVID JOHNSTON, P.G.

Terracon
Consulting Engineers and Scientists
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FIELD BORING LOG

BORING NO.: MW-9R PAGE: 1 of 2

TOTAL DEPTH: 105 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CRAIGHEAD COUNTY - LEGACY LANDFILL

PROJECT: MONITORING WELL INSTALLATION

JOB NO.: 282-001-35117105-002

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: JOHNSON

DATE DRILLED: 5/26/10 - 5/27/10

RIG TYPE: BUGGY RIG

DRILLING METHOD: WASH ROTARY

SAMPLING METHOD: STANDARD PENETRATION TEST

N: N/A E: N/A G.S. ELEV: 249.40'

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
0		0' - 10' SILTY CLAY tan and gray, mottled		3-3-4	
10		10' - 40' SAND tan, fine grained, loose		18 12-12-15 18 5-16-33 10	
40		40' - 60' SAND tan, medium grained, loose		7 - 50/7 6 6 - 50/6 10	
50					

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FIELD BORING LOG

BORING NO.: MW-9R PAGE: 2 of 2

TOTAL DEPTH: 105 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
55					
60		60' - 80' SAND tan, medium grained, loose, occasional gravel		6 - 50/7 8	
70				7 - 50/4 6	
80		80' - 100' SAND tan, medium grained, loose, no gravel		6 - 50/4 8	
90				7 - 50/6 6	
100		100' - 105' GRAVELLY SAND tan, coarse, loose		7 - 50/4 6	
		Total Depth of Boring = 105' bgs			
110					
120					

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FIELD BORING LOG

BORING NO.: MW-16R PAGE: 1 of 2

TOTAL DEPTH: 110 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CRAIGHEAD COUNTY - LEGACY LANDFILL

PROJECT: MONITORING WELL INSTALLATION

JOB NO.: 282-001-35117105-003

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: JOHNSON

DATE DRILLED: 5/27/10

RIG TYPE: BUGGY RIG

DRILLING METHOD: WASH ROTARY

SAMPLING METHOD: STANDARD PENETRATION TEST

N: N/A E: N/A G.S. ELEV.: 255.62'

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
0		0' - 10' SILTY CLAY brown, soft		6-9-12	
10		10' - 20' SILT brown, clayey, soft		18 6-12-16	
20		20' - 30' SILTY CLAY tan, firm		18 6-22-26	
30		30' - 60' SAND tan, fine grained, loose		10 10-20-30 10 6 - 50/7 10	
40					
50					

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FIELD BORING LOG

BORING NO.: MW-16R PAGE: 2 of 2

TOTAL DEPTH: 110 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
55					
60		60' - 70' SAND tan, medium grained, loose		6 - 50/5 6	
70		70' - 90' SAND tan, medium grained, loose, occasional gravel		7 - 50/3 6	
80				6 - 50/4 8	
90		90' - 100' SAND tan, medium grained, loose, no gravel		50/6 8	
100		100' - 110' SAND tan, medium grained, loose, occasional gravel		50/6 6	
110		Total Depth of Boring = 110' bgs		50/3 6	
120					

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FIELD BORING LOG

BORING NO.: MW-19 PAGE: 1 of 2

TOTAL DEPTH: 115 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CRAIGHEAD COUNTY - LEGACY LANDFILL	PROJECT: MONITORING WELL INSTALLATION
JOB NO.: 282-001-35117105-004	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: JOHNSON
DATE DRILLED: 5/28/10	RIG TYPE: BUGGY RIG

DRILLING METHOD: WASH ROTARY

SAMPLING METHOD: STANDARD PENETRATION TEST

N: N/A E: N/A G.S. ELEV.: 260.39'

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
0		0' - 10' SILTY CLAY tan, soft, dry		2-1-1	
10		10' - 30' CLAY tan and orange, mottled, soft		15 5-10-17 18 4-10-15	
30		30' - 40' SILT tan, clayey, soft		18 5-15-18	
40		40' - 90' SAND tan, fine grained, loose		18 8-26-50/4 10	
50					

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FIELD BORING LOG

BORING NO.: MW-19 PAGE: 2 of 2

TOTAL DEPTH: 115 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
55					
60				9-31-50/1 8	
70				7-50/5 8	
80				8-50/4 8	
90		90' - 115' SAND tan, fine grained, loose, occasional gravel		7-50/4 8	
100				8-50/4 6	
110				7-50/4 8	
		Total Depth of Boring = 115' bgs			
120					

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FIELD BORING LOG

BORING NO.: MW-20 PAGE: 1 of 2

TOTAL DEPTH: 105 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CRAIGHEAD COUNTY - LEGACY LANDFILL	PROJECT: MONITORING WELL INSTALLATION
JOB NO.: 282-001-35117105-005	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: JOHNSON
DATE DRILLED: 5/27/10	RIG TYPE: BUGGY RIG
DRILLING METHOD: WASH ROTARY	
SAMPLING METHOD: STANDARD PENETRATION TEST	

N: N/A E: N/A G.S. ELEV.: 254.33'

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
0		0' - 10' SILTY CLAY tan, some gravel, soft, dry		3-2-4	
10		10' - 20' SILT tan, clayey, soft, dry		18 7-13-20	
20		20' - 30' SILTY CLAY tan, soft, dry		18 6-14-15	
30		30' - 60' SAND tan, fine grained, loose		15 6-22-50/7 8 5-20-50/6 6	
40					
50					

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FIELD BORING LOG

BORING NO.: MW-20 PAGE: 2 of 2

TOTAL DEPTH: 105 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
55					
60		60' - 80' SAND tan, medium grained, loose		6-50/6 6	
70				6-50/6 8	
80		80' - 90' SAND tan, medium grained, loose, occasional gravel		5-50/6 6	
90		90' - 105' SAND tan, medium grained, loose, no gravel		6-50/4 6	
100				6-50/3 5	
		Total Depth of Boring = 105' bgs			
110					
120					

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FIELD BORING LOG

BORING NO.: MW-21 PAGE: 1 of 2

TOTAL DEPTH: 110 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CRAIGHEAD COUNTY - LEGACY LANDFILL	PROJECT: MONITORING WELL INSTALLATION
JOB NO.: 282-001-35117105-006	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: JOHNSON
DATE DRILLED: 5/26/10	RIG TYPE: BUGGY RIG

DRILLING METHOD: WASH ROTARY

SAMPLING METHOD: STANDARD PENETRATION TEST

N: N/A E: N/A G.S. ELEV.: 249.61'

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
0		0' - 10' SILTY CLAY brown, slightly sandy, soft			
10		10' - 20' SILTY CLAY gray and tan, mottled		5-6-11 6	
20		20' - 30' SILTY CLAY tan and orange, mottled		7-7-9 18	
30		30' - 40' SAND tan, fine grained, loose		10-10-12 18	
40		40' - 60' SAND tan and gray, medium grained, loose		7-23-35 8	
50				8-50/7 8	

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FIELD BORING LOG

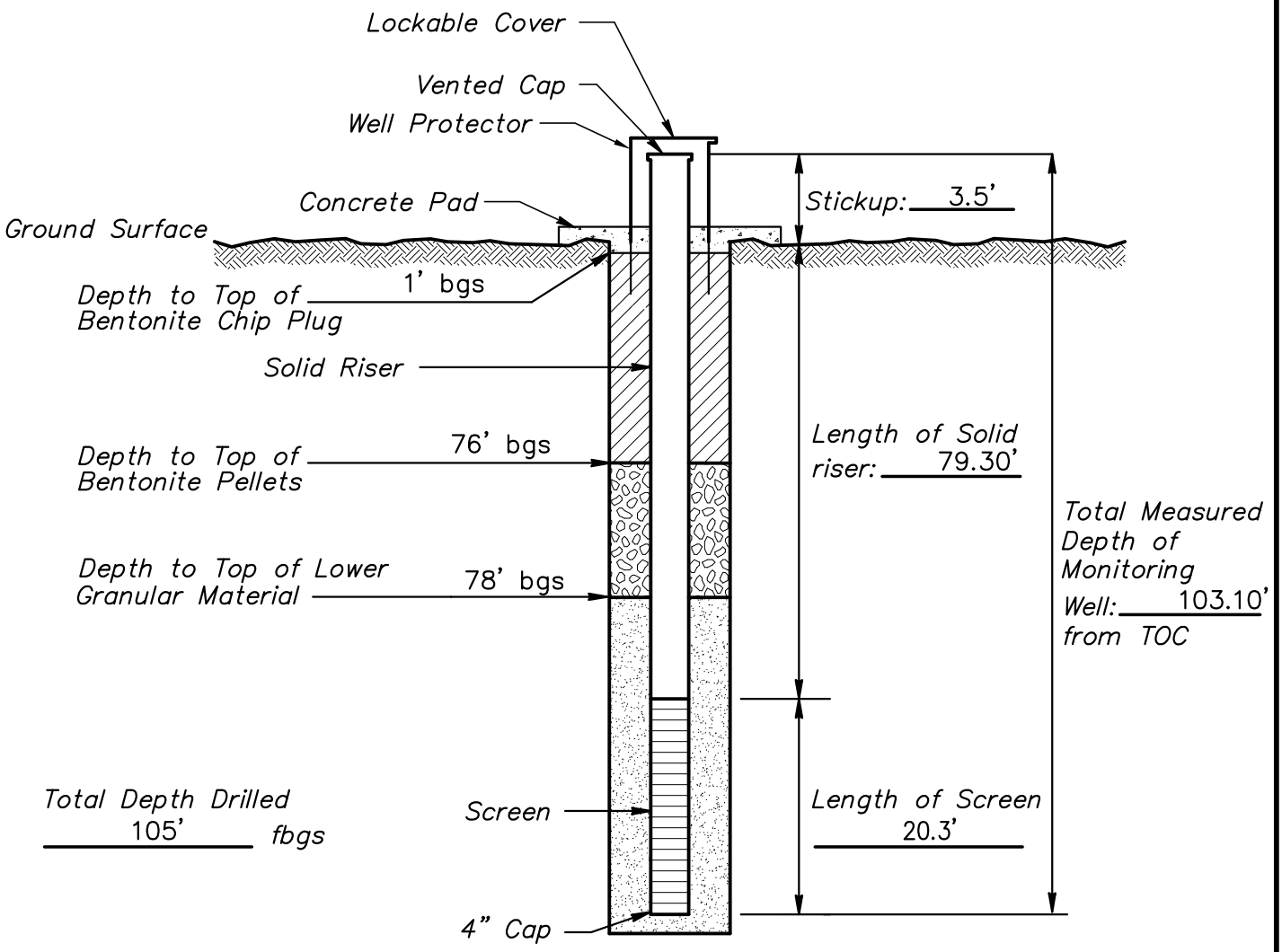
BORING NO.: MW-21 PAGE: 2 of 2

TOTAL DEPTH: 110 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	Blow Counts	Comments
55					
60		60' - 70' SAND tan, medium grained, loose, occasional gravel		8-50/7 10	
70		70' - 90' SAND tan, medium grained, loose, no gravel		6-50/7 12	
80				7-50/5 6	
90		90' - 100' SAND gray, coarse grained, loose		7-50/5 12	
100		100' - 110' SAND gray, coarse grained, gravelly, loose		6-50/5 4	
110		Total Depth of Boring = 110' bgs		7-50/4 5	
120					

MONITORING WELL INSTALLATION RECORD

Job Name C.C.S.W.D.A GROUNDWATER SYSTEM MODIFICATION Well Number MW-9R
Job Number 35117105 Installation Date 5/27/2010 Location JONESBORO, AR.
Datum Elevation 252.90' Surface Elevation 249.40'
Datum for Water Level Measurement T.O.C.
Screen Diameter & Material 2" PVC Slot Size 0.01
Riser Diameter & Material 2" PVC Borehole Diameter 6"
Granular Backfill Material 12-20 SILICA SAND Terracon Representative CLANCY McCLINTOCK
Drilling Method WASH ROTARY Drilling Contractor ANDERSON ENGINEERING



Bentonite Chip Plug

Bentonite Pellet

Granular Backfill Material

(Not to Scale)

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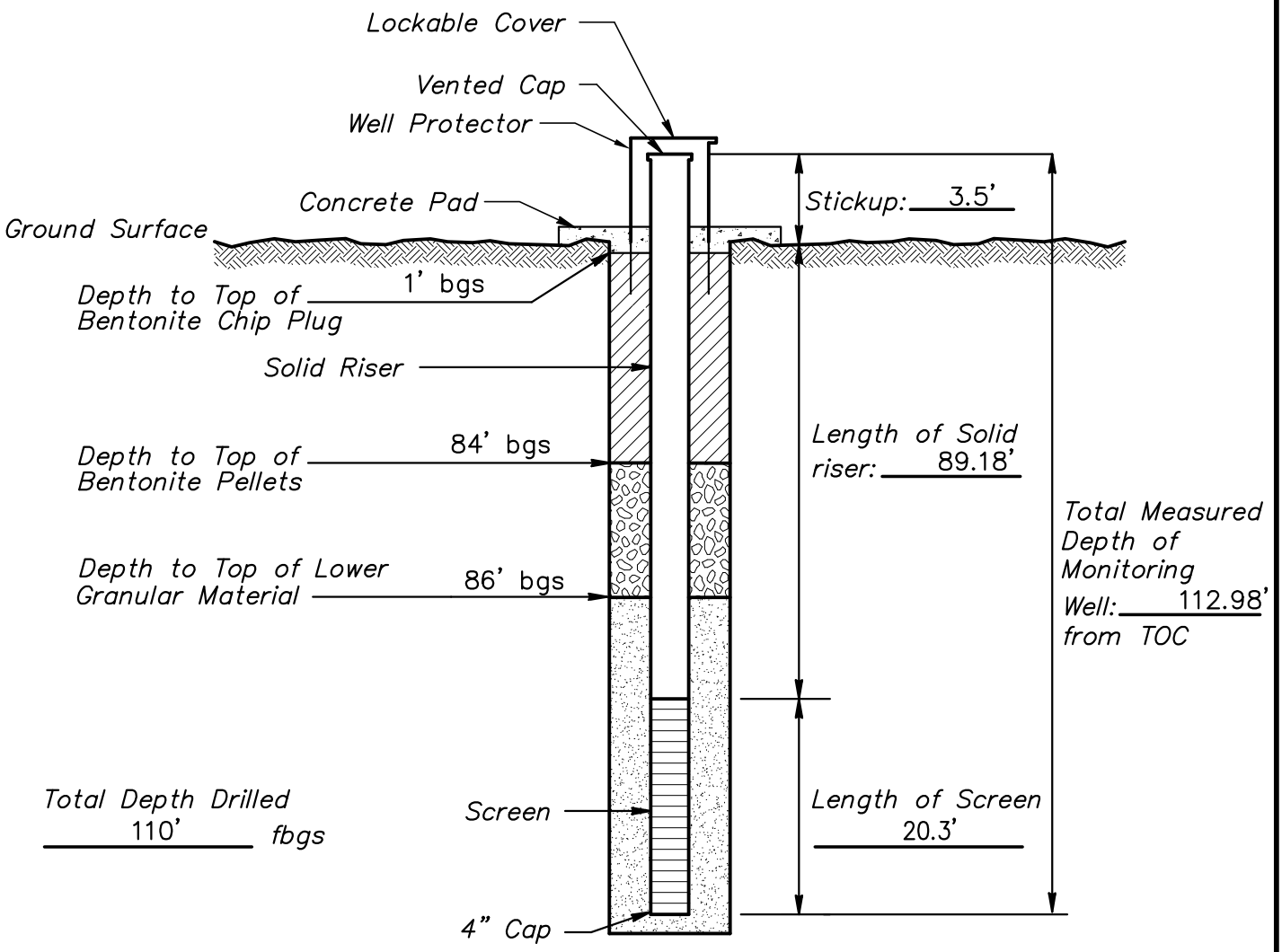
MONITORING WELL INSTALLATION RECORD

PROJECT NUMBER: 282-001-35117105
WELL NUMBER: MW-9R
DRAWING NUMBER: 007 **CHECKED BY:** MR

MONITORING WELL INSTALLATION RECORD

Job Name C.C.S.W.D.A GROUNDWATER SYSTEM MODIFICATION Well Number MW-16R
Job Number 35117105 Installation Date 5/27/2010 Location JONESBORO, AR.
Datum Elevation 259.12' Surface Elevation 255.62'
Datum for Water Level Measurement T.O.C.
Screen Diameter & Material 2" PVC Slot Size 0.01
Riser Diameter & Material 2" PVC Borehole Diameter 6"
Granular Backfill Material 12-20 SILICA SAND Terracon Representative CLANCY McCLINTOCK
Drilling Method WASH ROTARY Drilling Contractor ANDERSON ENGINEERING



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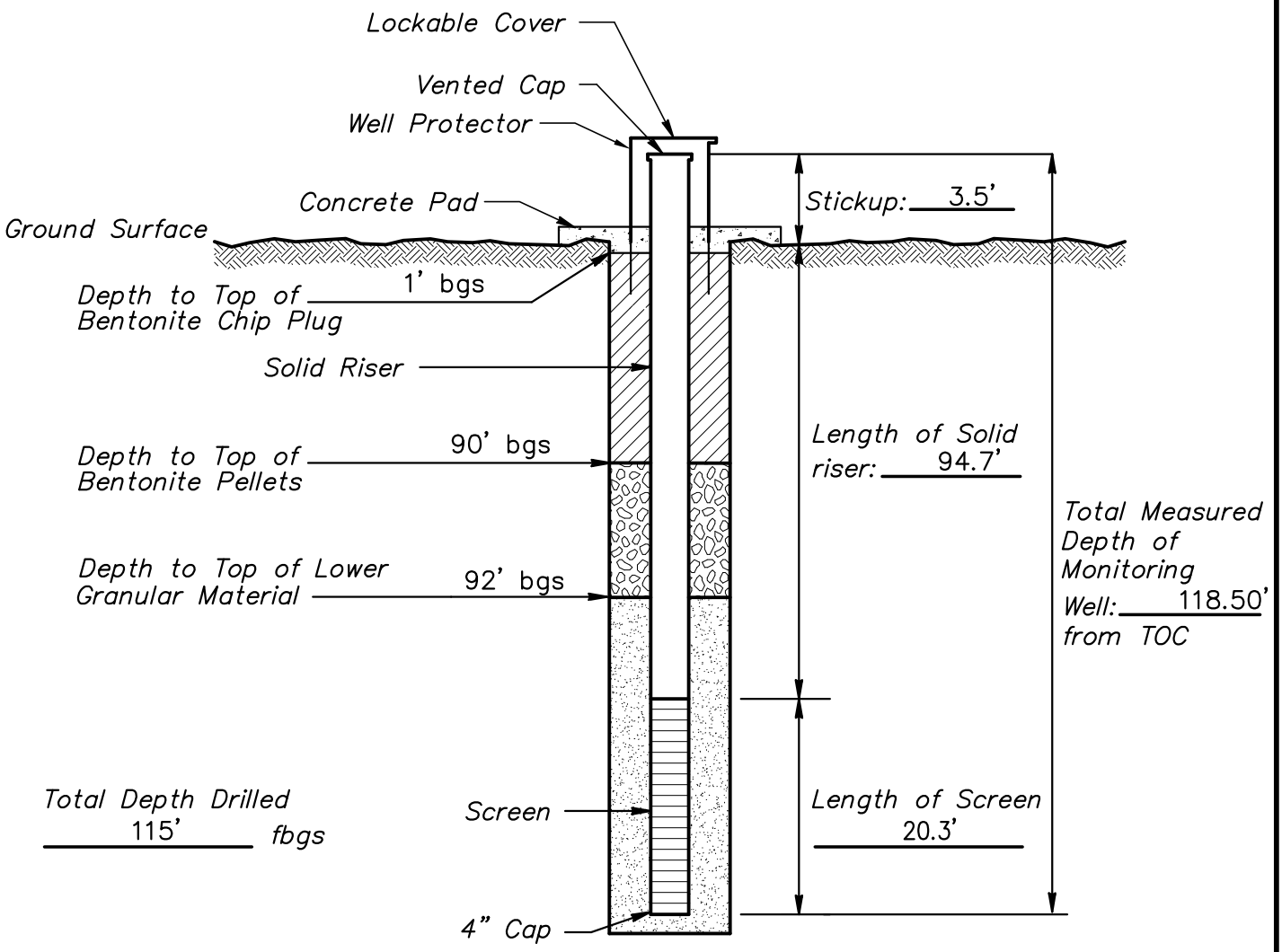
MONITORING WELL INSTALLATION RECORD
PROJECT NUMBER: 282-001-35117105
WELL NUMBER: MW-16R
DRAWING NUMBER: 008 **CHECKED BY:** MR

MONITORING WELL INSTALLATION RECORD

Job Name C.C.S.W.D.A GROUNDWATER SYSTEM MODIFICATION Well Number MW-19
Job Number 35117105 Installation Date 5/28/2010 Location JONESBORO, AR.
Datum Elevation 263.89' Surface Elevation 260.39'
Datum for Water Level Measurement T.O.C.
Screen Diameter & Material 2" PVC Slot Size 0.01
Riser Diameter & Material 2" PVC Borehole Diameter 6"
Granular Backfill Material 12-20 SILICA SAND Terracon Representative CLANCY McCLINTOCK
Drilling Method WASH ROTARY Drilling Contractor ANDERSON ENGINEERING



Bentonite Chip Plug

Bentonite Pellet

Granular Backfill Material

(Not to Scale)

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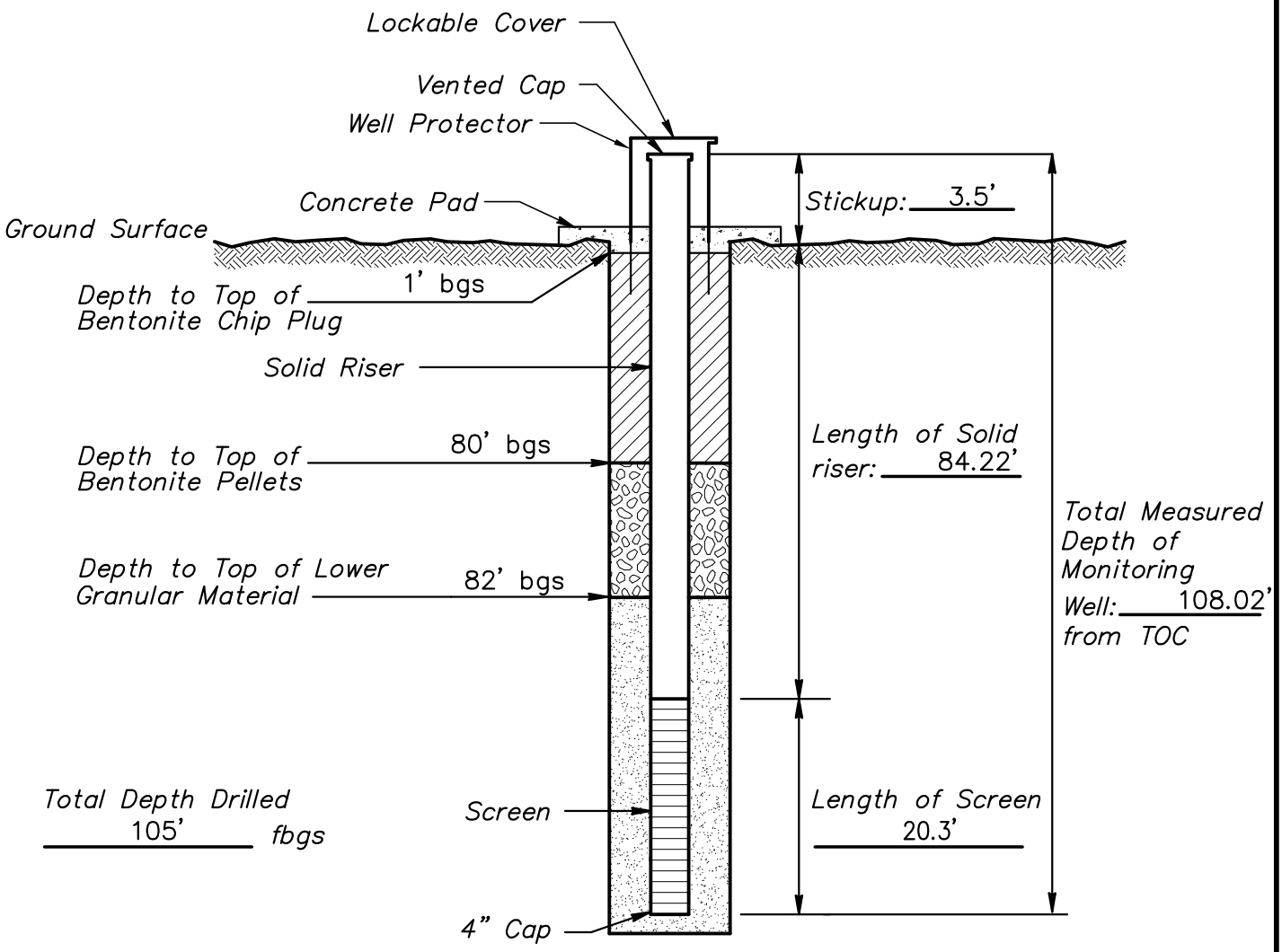
MONITORING WELL INSTALLATION RECORD

PROJECT NUMBER: 282-001-35117105
WELL NUMBER: MW-19
DRAWING NUMBER: 009 **CHECKED BY:** MR

MONITORING WELL INSTALLATION RECORD

Job Name C.C.S.W.D.A GROUNDWATER SYSTEM MODIFICATION Well Number MW-20
Job Number 35117105 Installation Date 5/27/2010 Location JONESBORO, AR.
Datum Elevation 257.83' Surface Elevation 254.33'
Datum for Water Level Measurement T.O.C.
Screen Diameter & Material 2" PVC Slot Size 0.01
Riser Diameter & Material 2" PVC Borehole Diameter 6"
Granular Backfill Material 12-20 SILICA SAND Terracon Representative CLANCY McCLINTOCK
Drilling Method WASH ROTARY Drilling Contractor ANDERSON ENGINEERING



Bentonite Chip Plug

Bentonite Pellet

Granular Backfill Material

(Not to Scale)

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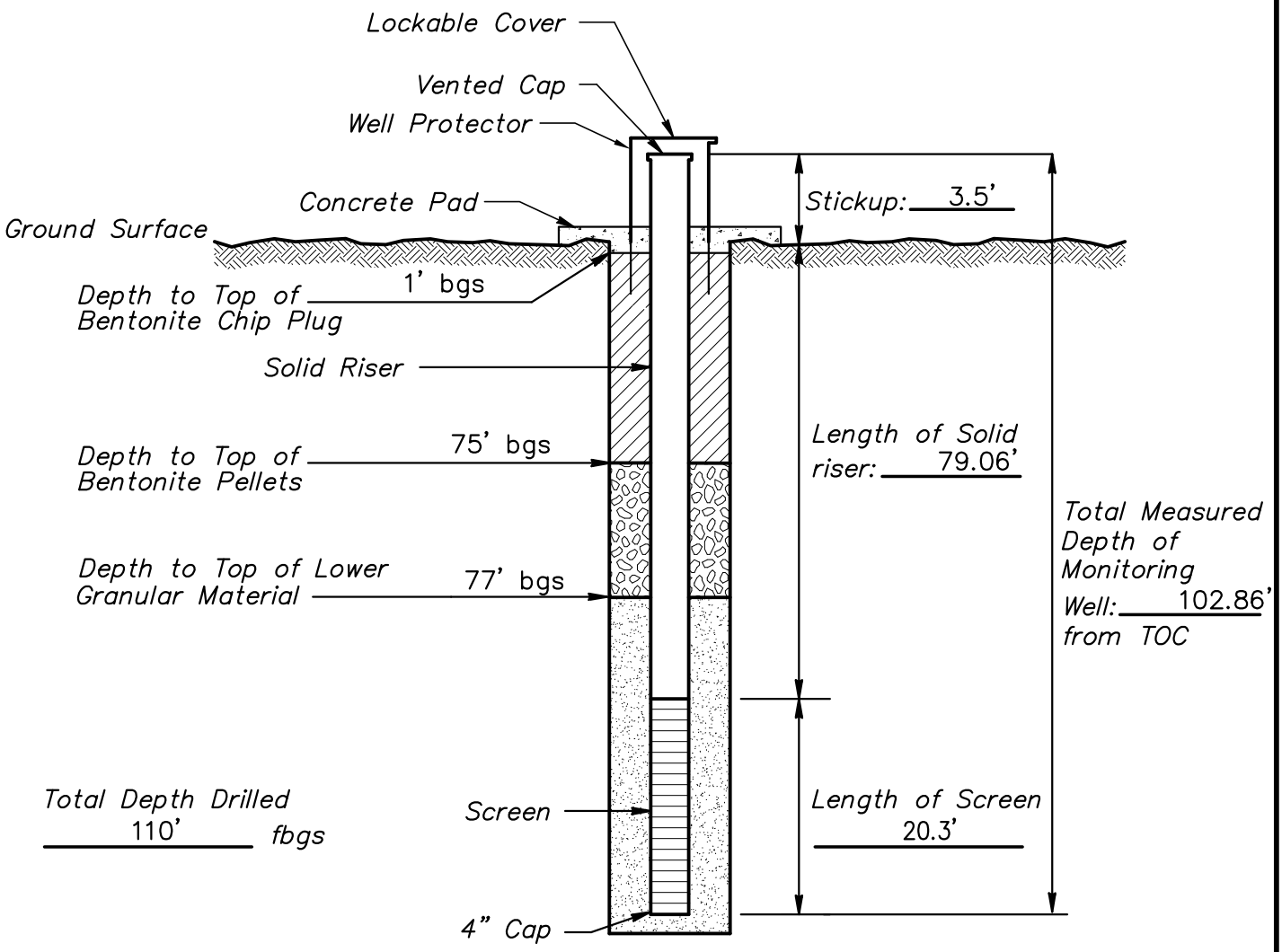
MONITORING WELL INSTALLATION RECORD

PROJECT NUMBER: 282-001-35117105
WELL NUMBER: MW-20
DRAWING NUMBER: 010 **CHECKED BY:** MR

MONITORING WELL INSTALLATION RECORD

Job Name C.C.S.W.D.A GROUNDWATER SYSTEM MODIFICATION Well Number MW-21
Job Number 35117105 Installation Date 5/26/2010 Location JONESBORO, AR.
Datum Elevation 253.11' Surface Elevation 249.61'
Datum for Water Level Measurement T.O.C.
Screen Diameter & Material 2" PVC Slot Size 0.01
Riser Diameter & Material 2" PVC Borehole Diameter 6"
Granular Backfill Material 12-20 SILICA SAND Terracon Representative CLANCY McCLINTOCK
Drilling Method WASH ROTARY Drilling Contractor ANDERSON ENGINEERING



Bentonite Chip Plug

Bentonite Pellet

Granular Backfill Material

(Not to Scale)

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25809 INTERSTATE 30 S BRYANT, AR. 72202
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MONITORING WELL INSTALLATION RECORD

PROJECT NUMBER: 282-001-35117105
WELL NUMBER: MW-21
DRAWING NUMBER: 011 **CHECKED BY:** MR

APPENDIX C

CHAIN-OF-CUSTODY FORM

Alternate billing information:

Report to:

Email to:

Project Description:

City/Sate Collected

Phone:

FAX:

Client Project #:

ESC Key:

Collected by:

Site/Facility ID#:

P.O.#:

Collected by (signature):

Packed on Ice N ____ Y ____

Rush? (Lab MUST Be Notified)

_____ Same Day. 200%
_____ Next Day.. . . . . 100%
_____ Two Day 50%

Date Results Needed:

Email? __No__Yes

FAX? __No__Yes

No. of Cntrs

Analysis/Container/Preservative

Chain of Custody
Page ___ of ___

Prepared by:

ENVIRONMENTAL SCIENCE CORP.

12065 Lebanon Road
Mt. Juliet, TN 37122

Phone (615) 758-5858
Phone (800) 767-5859
FAX (615) 758-5859

CoCode (lab use only)

Template/Prelogin

Shipped Via:

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	Remarks/Contaminant	Sample # (lab only)

*Matrix: **SS** - Soil/Solid **GW** - Groundwater **WW** - WasteWater **DW** - Drinking Water **OT** - Other_____

pH _____ Temp _____

Remarks:

Flow _____ Other _____

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☐ _____	Condition: (lab use only)	
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp:	Bottles Received:	
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date:	Time:	pH Checked: NCF:

APPENDIX D

GROUNDWATER MONITORING FORM

GROUNDWATER MONITORING SAMPLING RECORD

PROJECT:
SAMPLING LOCATION:
WEATHER CONDITIONS:
MONITORING WELL CONDITION:
WELL LOCKED? WELL NUMBER LABELED?
CASING CONDITION:
DATUM FOR WATER DEPTH MEASUREMENT:
GENERAL WELL EXTERIOR/INTERIOR CONDITIONS:
DECON FIELD EQUIPMENT:
WATER DEPTH (WD): TOTAL DEPTH OF WELL (TD):
VOLUME OF WATER IN WELL:
V = 0.0408 x [TD-WD(feet)] x [Well Diameter (inches)]^2 = **Gallons**
WATER CONDITION BEFORE WELL PURGING:
APPEARANCE: ODOR:
WELL PURGING DATE: PURGING METHOD:
TIME START PURGING: TIME END PURGING:
VOLUME PURGED (Try for 3 Volumes):
APPEARANCE: ODOR:
WELL PURGED DRY?
SAMPLING DATE: SAMPLING METHOD:
TIME START SAMPLING: TIME END SAMPLING:
FIELD MEASUREMENTS: (Need at least 3 consecutive readings w/in ± 0.1 for pH, ± 3% for conductivity, ± 10% or below 10 NTU for turbidity, ± 0.3 mg/l for D.O., and ±10 mV for ORP)

TIME	Water Level	D.O.	ORP	GALLONS	TEMP	pH	CONDUCTANCE	TURBIDITY

FIELD SAMPLE PRESERVATION:
CONTAINER HANDLING:
COMMENTS:

APPENDIX E

GROUND WATER MONITORING SYSTEM CERTIFICATIONS

GROUND WATER MONITORING SYSTEM CERTIFICATION

Facility Name:	**Craighead County Solid Waste Disposal Authority Legacy Class 1 Landfill**
AFIN:	**16-00199**
Permit Number:	**0254-S1-R3**

I, Merrick Rotenberry, hereby certify the ground water monitoring system at the above referenced facility meets the requirements of 40 CFR Part 258, Subpart E and Regulation Number 22. In making this certification, I assert that my education or training and experience authorizes me as a QUALIFIED GROUND WATER SCIENTIST as defined by §258.50(g) and Section 22.1201(f). Further, I certify that the number, spacing, and depth of sampling points in the monitoring system was determined based upon site-specific technical information including a thorough characterization of:

1) Aquifer thickness, ground water flow rate, ground water flow direction including seasonal and temporal fluctuations in groundwater flow; and
2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, materials comprising the confining unit defining the lower boundary of the uppermost aquifer; including but not limited to: thickness, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.

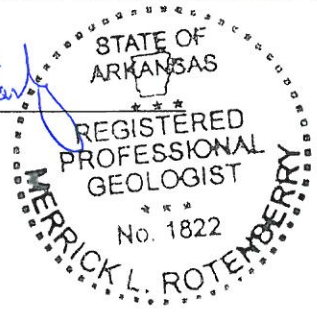
It is further certified, that:

1) With the exception of MW-8, the monitoring system components have been constructed and developed in an acceptable manner following the appropriate EPA and construction protocols and are capable of yielding water samples that are representative of the uppermost aquifer ground water quality at the sampling point; and
2) A Sampling and Analysis Plan (SAP) has been prepared that meets the requirements of §258.53, Section 22.1203(a) through (e) and 22.1204(e); and
3) A statistical analysis procedure for evaluating ground water chemistry results has been developed that meets the requirements of §258.53 and Section 22.1203(f) through (i).

I understand that making false statements may subject me to criminal penalties under Arkansas Department of Environmental Quality Regulation No. 22.

M. L. Rotenberry

Certifying Professional



3-1-12

Date

APPENDIX F

EPA/542/S-02/001, *GROUND-WATER SAMPLING GUIDELINES FOR SUPERFUND AND RCRA PROJECT MANAGERS*

Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers

GROUND WATER FORUM ISSUE PAPER

Douglas Yeskis* and Bernard Zavala**

BACKGROUND

The Ground Water, Federal Facilities and Engineering Forums were established by professionals from the United States Environmental Protection Agency (USEPA) in the ten Regional Offices. The Forums are committed to the identification and resolution of scientific, technical, and engineering issues impacting the remediation of Superfund and RCRA sites. The Forums are supported by and advise OSWER's Technical Support Project, which has established Technical Support Centers in laboratories operated by the Office of Research and Development (ORD), Office of Radiation Programs, and the Environmental Response Team. The Centers work closely with the Forums providing state-of-the-science technical assistance to USEPA project managers.

This document provides sampling guidelines primarily for ground-water monitoring wells that have a screen or open interval with a length of ten feet or less and which can accept a sampling device. Procedures that minimize disturbance to the aquifer will yield the most representative ground-water samples. This document provides a summary of current and/or recommended ground-water sampling procedures. This document was developed by the Superfund/RCRA Ground Water Forum and incorporates comments from ORD, Regional Superfund hydrogeologists and others. These guidelines are applicable to the majority of sites, but are not intended to replace or supersede regional and/or project-specific sampling plans. These guidelines are intended to assist in developing sampling plans using the project-specific goals and objectives. However, unusual and/or site-specific circumstances may require approaches other than those specified in this document. In these instances, the appropriate Regional hydrologists/geologists should be contacted to establish alternative protocols.

ACKNOWLEDGMENTS

A document of this scope involved significant participation from a number of people, such that any omission in these acknowledgments is purely unintentional. We thank all of the participants involved in the development of this document! The authors acknowledge the active participation and valuable input from the committee from the Ground Water Forum of Dick Willey, Region 1; Ruth Izraeli and Kevin Willis, Region 2; Kathy Davies, Region 3; Robert Puls, ORD-NRMRL; and Steve Gardner, ORD-NERL. In addition, valuable input from former members of the committee are gratefully acknowledged. And finally, the peer reviews of the document completed by Franceska Wilde of the Water Division of the U.S. Geological Survey, Reston, VA; Richard Duwelius and Randy Bayless of the Indiana District of the U.S. Geological Survey, Indianapolis, IN; Steve White of the Omaha District of the U.S. Army Corps of Engineers, Omaha, NE and Karl Pohlmann of the Desert Research Institute, Las Vegas, NV are gratefully acknowledged.

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TABLE OF CONTENTS

INTRODUCTION

The goal of ground-water sampling is to collect samples that are “representative” of in-situ ground-water conditions and to minimize changes in ground-water chemistry during sample collection and handling. Experience has shown that ground-water sample collection and handling procedures can be a source of variability in water-quality concentrations due to differences in sampling personnel, sampling procedures, and equipment (U.S. Environmental Protection Agency, 1995).

Several different ground-water sampling procedures can be used, which vary primarily through the criteria used to determine when a sample is representative of ground-water conditions. No single method or procedure is universally applicable to all types of ground-water-sampling programs; therefore, consideration should be given to a variety of factors when determining which method is best suited to site-specific conditions. These site-specific conditions include sampling objectives, equipment availability, site location, and physical constraints. This paper will discuss each of these conditions and how they may contribute to the decision in choosing the appropriate sampling methodology and equipment to be used during ground-water sampling.

This paper focuses on ground-water sampling procedures for monitoring wells only where separate, free-phase, Non-Aqueous Phase Liquids (NAPLs) are not present in the monitoring well. Residential and/or municipal-production wells where special sampling procedures and considerations need to be implemented are not discussed in this document. The recommendations made in this paper are based on findings presented in the current literature, and will be subject to revision as the understanding of ground-water-sampling procedures increases.

SAMPLING OBJECTIVES

The objective of a good sampling program should be the collection of a "representative" sample of the current ground-water conditions over a known or specified volume of aquifer. Ideally to meet this objective, sampling equipment, sampling method, monitoring well construction, monitoring well operation and maintenance, and sample handling procedures should not alter the chemistry of the sample. A sample that is obtained from a poorly constructed well, or using improper sampling equipment, or using poor sampling techniques, or which has been preserved improperly, can bias the sampling results. Unrepresentative samples can lead to misinterpretations of ground-water-quality data. Generally, the costs of obtaining representative ground-water samples are insignificant when compared to potential remedial responses that may be implemented based on erroneous data or when considering the overall monitoring program costs over the life of the program (Nielson, 1991).

The data quality objectives (DQOs) of the sampling program should be thoroughly developed, presented and understood by all parties involved. To develop the DQOs, the purpose of the sampling effort and data use(s) should be clearly defined. The sampling guidelines presented here can be used for a variety of monitoring programs, these include site assessment, contaminant detection, site characterization, remediation, corrective action and compliance monitoring.

For example DQOs for a site characterization sampling effort might vary from those of a remediation monitoring sampling effort. This difference could be in how much of the screen interval should be sampled. A site characterization objective may be to collect a sample that represents a composite of the entire (or as close as is possible) screened interval of the monitoring well. On the other hand, the monitoring objective of a remediation monitoring program may be to obtain a sample that represents a specific portion of the screened interval.

Additionally, the site characterization may require analyses for a broad suite of contaminants, whereas, the remediation monitoring program may require fewer contaminants to be sampled. These differences may dictate the type of sampling equipment used, the type of information collected, and the sampling protocol.

In order to develop applicable DQOs, a site conceptual model should be developed. The site conceptual model should be a dynamic model which is constantly revised as new information is collected and processed. The conceptual model, as it applies to the DQOs, should focus on contaminant fate and transport processes, such as contaminant pathways, how the geologic materials control the contaminant pathways (depositional environments, geologic structure, lithology, etc.), types of contaminants present (i.e., hydrophobic versus hydrophilic), and the processes that influence concentrations of the contaminants present such as dilution, biodegradation, and dispersion. The detail of the conceptual model will depend greatly on the availability of information, such as the number of borings and monitoring wells and the amount of existing analytical data. Clearly, a site that is being investigated for the first time will have a much simpler conceptual model compared to a site that has had a Remedial Investigation, Feasibility Study, and Remedial Design, (or, within the RCRA Program, a RCRA Facility Assessment, a RCRA Facility Investigation, and a Corrective Measures Study), and is currently in remediation/corrective action monitoring. Specific parameters that a conceptual model should describe that may impact the design of a ground-water-sampling program include:

a) The thickness, lateral extent, vertical and horizontal flow direction, and hydraulic conductivity contrasts of the geologic materials controlling contaminant transport from the site (thick units versus thin beds versus fractures, etc.)

b) The types of contaminants to be sampled (volatile organic compounds, semi-volatile organic compounds, metals, etc.) and factors that could bias sampling results (turbidity for metals, co-solvation effects on PCBs, etc.)

c) Lateral and vertical distribution of contamination (contaminants distributed throughout an entire unit being monitored versus localized distribution controlled by small scale features, etc.)

Vertical aquifer characterization is strongly recommended prior to the completion of a ground-water monitoring well installation program. A detailed vertical aquifer characterization program should include field characterization of hydraulic conductivities, determination of vertical and horizontal flow directions, assessment of lithologic and geologic variations, and determination of vertical and horizontal contaminant distributions. The successful aquifer characterization program provides detailed information to guide the technical and cost-effective placement, vertically and areally, of monitoring wells.

INFORMATION NEEDED PRIOR TO SAMPLING

To ensure appropriate methodology and expedient collection of water-quality samples, information is needed before a sample is collected. Some information should be obtained prior to the start of field activities such as well condition, construction, water-level information, contaminant types and concentrations, and direction(s) of ground-water flow. Field measurements, such as depth to water and total well depth will be needed prior to purging. Before commencement of all field activities, the field health and safety plan should be consulted under the direction of the site health and safety officer.

BACKGROUND DATA

Well construction and maintenance information are needed to better plan the sampling program, optimize personnel, and obtain more representative samples. Prior to field activities, personnel should have specific information including well casing diameter, borehole diameter, casing material, lock number and keys, physical access to wells, and length of and depth to well screen. The diameter of each well casing is used to select the correct equipment and technique for purging and sampling the well. A site map with possible physical barriers and description of access is necessary to allow for the selection of proper equipment based on several factors, such as portability, ease of repair, power sources, containment of purge water, and well accessibility. The length and depth of each well screen and depth to water is important when placing a sampling device's intake at the proper depth for purging and sampling and for choosing a sampling device. Well development information is needed to ensure that purging and sampling rates will not exceed well development extraction rates. Previous sampling information should be provided and evaluated to determine the nature and concentrations of expected contaminants. This will be useful in determining the appropriate sampling method and quality assurance/quality control (QA/QC) samples (for example, field duplicates, equipment blanks, trip blanks). Attachment 1 is an example of a sampling checklist for field personnel. This information should be kept in the field for easy access during sampling activities.

When evaluating previous sampling information, consideration should be given to the amount of time that has expired between the last sampling effort and the planned sampling effort. If this time exceeds one year, the need for redevelopment of the monitoring wells should be evaluated. The necessity of redevelopment can be evaluated by measuring constructed depth compared to the measured depth. If the depth measurement indicates siltation of the monitoring well screen, or evidence exists that the well screen is clogged, the well should be redeveloped prior to sampling. The assessment of the condition of the monitoring wells should be completed several weeks prior to sampling activities in order to allow the proper recovery of the developed wells. This is especially important in wells where prior sampling has indicated high turbidity. The time for a well to re-stabilize after development is dependent on site-specific geology and should be specified in the site sampling plan. The development method, if necessary, should be consistent with the sampling objectives, best technical criteria and USEPA guidelines (Aller et al., 1991; Izraeli et al., 1992; Lapham et al., 1997).

REFERENCE POINT

Each well should be clearly marked with a well identifier on the outside and inside of the well casing. Additionally, each well should have a permanent, easily identified reference point from which all depth measurements are taken. The reference point (the top of the inner casing, outer casing, or security/protective casing) should remain constant through all measurements, should be clearly marked on the casing and its description recorded. Whenever possible, the inner casing is recommended as a reference point, because of the general instability of outer casings due to frost heaving, vehicular damage, and other phenomena which could cause movement of casings. The elevation of this reference point should be known and clearly marked at the well site (Nielson, 1991).

This reference point should also have a known latitude and longitude that are consistent with the Regional and National Minimum Data Elements requirements. The elevation of the reference point should be surveyed relative to Mean Sea Level (MSL) using the NAVD 88 datum.

TOTAL WELL DEPTH

The depth of the well is required to calculate the volume of standing water in the well and to document the amount of siltation that may have occurred. Moreover, measuring the depth to the bottom of a well provides checks for casing integrity and for siltation of the well screen. Corrosion can cause leaking or collapse of the well casing, which could lead to erroneous or misleading water-level measurements. Corrosion, silting, and biofouling can clog well screens and result in a sluggish response or no response to water-level changes, as well as changes in ground-water chemistry. Well redevelopment or replacement may be needed to ensure accurate collection of a representative water-quality sample.

Total well depths should be measured and properly recorded to the nearest one-tenth of a foot using a steel tape with a weight attached. The steel tape should be decontaminated before use in another well according to the site specific protocols. A concern is that when the steel tape and weight hit the bottom of the well, sediment present on the bottom of a well may be stirred up, thus increasing turbidity which will affect the sampling results. The frequency of total well depth measurements varies, with no consensus for all hydrogeologic conditions. The United States Geological Survey (USGS) recommends a minimum of once a year (Lapham et al., 1997). USEPA also recommended one measurement per year (Barcelona et al., 1985) but later recommended a total well depth be taken every time a water-quality is collected or a water-level reading taken (Aller et al., 1991). Therefore, when possible, the total depth measurements should be taken following the completion of sampling (Puls and Barcelona, 1996). When total-well-depth measurements are needed prior to sampling, as much time as possible should be allowed prior to sampling, such as a minimum of 24 hours. The weight of electric tapes are generally too light to determine accurate total well depth. If the total well depth is greater than 200 feet, stretching of the tape must be taken into consideration.

DEPTH TO WATER

All water levels should be measured from the reference point by the use of a weighted steel tape and chalk or an electric tape (a detailed discussion of the pros and cons of the different water level devices is provided in Thornhill, 1989). The steel tape is a more accurate method to take water levels, and is recommended where shallow flow gradients (less than 0.05 foot/feet or 0.015 meter/meters) or deep wells are encountered. However, in those cases where large flow gradients or large fluctuations in water levels are expected, a calibrated electric tape is acceptable. The water level is calculated using the well's reference point minus the measured depth to water. At depths approximately greater than 200 feet, the water-level-measuring device should be chosen carefully, as some devices may have measurable stretching.

The depth-to-water measurement must be made in all wells to be sampled prior to activities in any single well which may change the water level, such as bailing, pumping, and hydraulic testing. All readings are to be recorded to the nearest one-hundredth of a foot.

The time and date of the measurement, point of reference, measurement method, depth-to-water level measurement, and any calculations should be properly recorded. In addition, any known, outside influences (such as tidal cycles, nearby pumping effects, major barometric changes) that may affect water levels should be noted.

GROUND-WATER SAMPLING METHODS

The ground-water sampling methods to be employed should be dependent on site-specific conditions and requirements, such as data-quality objectives and well accessibility. Ground-water sampling methods vary based on the type of device used, the position of the sampler intake, the purge criteria used, and the composition of the ground water to be sampled (e.g., turbid, containing high volatile organics, etc.). All sampling methods and equipment should be clearly documented, including purge criteria, field readings, etc. Examples of appropriate documentation are provided in Attachment 2 of this document and Appendix E of the U.S. Environmental Protection Agency, 1995 document.

The water in the screen and filter pack is generally in a constant state of natural flux as ground water passes in and out of the well. However, water above the screened section remains relatively isolated and become stagnant. Stagnant water is subject to physio-chemical changes and may contain foreign material, which can be introduced from the surface or during well construction, resulting in non-representative sample data. To safeguard against collecting a sample biased by stagnant water, specific well-purging guidelines and techniques should be followed.

A non-representative sample also can result from excessive pumping of the monitoring well. Stratification of the contaminant concentrations in the aquifer may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point.

PURGING AND SAMPLING DEVICES

The device used to purge and sample a well depends on the inner casing diameter, depth to water, volume of water in the well, accessibility of the well, and types of contaminants to be sampled. The types of equipment available for ground-water sampling include hand-operated or motor-driven suction pumps, peristaltic pumps, positive displacement pumps, submersible pumps, various in-situ devices and bailers made of various materials, such as PVC, stainless steel and Teflon®. Some of these devices may cause volatilization and produce high pressure differentials, which could result in variability in the results of pH, dissolved oxygen concentrations, oxidation-reduction potential, specific electrical conductance, and concentrations of metals, volatile organics and dissolved gases. Therefore, the device chosen for well purging and sampling should be evaluated for the possible effects it may have on the chemical and physical analyses. In addition, the types of contaminants, detection levels, and levels of concern as described by the site DQOs should be consulted prior to the selection of a sampling device. The same device used for purging the monitoring well should be used for sampling to minimize agitation of the water column (which can increase turbidity, increase volatilization, and increase oxygen in the water).

In general, the device used for purging and sampling should not change geochemical and physical parameters and/or should not increase turbidity. For this reason, low-flow submersible or positive-displacement pumps that can control flow rates are recommended for purging wells. Dedicated sampling systems are greatly preferred since they avoid the need for decontamination of equipment and minimize turbulence in the well. If a sampling pump is used, the pump should be lowered into the well as slowly as possible and allowed to sit as long as possible, before pumping commences. This will minimize turbidity and volatilization within the well.

Sampling devices (bladders, pumps, bailers, and tubing) should be constructed of stainless steel, Teflon®, glass, and other inert materials to reduce the chance of these materials altering the ground water in areas where concentrations of the site contaminants are expected to be near detection limits. The sample tubing thickness should be maximized and the tubing length should be minimized so that the loss of contaminants through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of many materials makes the appropriate selection of sample tubing materials critical for these trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998). Existing Superfund and RCRA guidance suggest appropriate compatible materials (U.S. Environmental Protection Agency, 1992). Special material considerations are important when sampling for non-routine analyses, such as age-dating and biological constituents.

Preferably, wells should be purged and sampled using a positive-displacement pump or a low-flow submersible pump with variable controlled flow rates and constructed of chemically inert materials. If a pump cannot be used because the recovery rate is so slow (less than 0.03 to 0.05 gallons per minute or 100 to 200 milliliters per minute) and the volume of the water to be removed is minimal (less than 5 feet (1.6 meters) of water), then a bailer with a double check valve and bottom-emptying device with a control-flow check valve may be used to obtain the samples. Otherwise, a bailer should not be used when sampling for volatile organics because of the potential bias introduced during sampling (Pohlmann, et al., 1990; Yeskis, et al., 1988; Tai, et al., 1991). A peristaltic

pump also may be used under these conditions, unless the bias by a negative pressure may impact the contaminant concentrations of concern (generally at depths greater than 15 to 20 feet (4.5 to 6 meters) of lift). Bailers should also be avoided when sampling for metals due to increased turbidity that occurs during the deployment of the bailer, which may bias inorganic and strongly hydrophobic parameters. Dedicated sampling pumps are recommended for metals sampling because the pumps avoid the generation of turbidity from frequent sampler deployment (Puls et al., 1992). A number of alternate sampling devices are becoming available, including passive diffusion samplers (Vroblesky and Hyde, 1997; Vroblesky, 2001a and b) and other in-situ sampling devices. These devices may be particularly useful to sampling low-permeability geologic materials, assuming the device is made of materials compatible with the analytical parameters, meet DQOs, and have been properly evaluated. However, the site investigator should ensure the diffusion membrane materials are selected for the contaminants of concern (COCs) present at the site. Comparison tests with an approved sampling method and diffusion samplers should be completed to confirm that the method is suitable for the site.

POSITION OF SAMPLE INTAKE

Essentially there are two positions for placement of the sample pump intake, within the screen and above the screen. Each of the positions offers advantages and disadvantages with respect to the portion of the well screen sampled, data reproducibility and potential purge volumes.

When the sampling pump intake is set above the well screen, the pump generally is set just below the water level in the well. The sampling pump then is pumped until a purge criterion is reached (commonly either stabilization of purge parameters or a set number of well volumes). If the distance between the water level and the top of the screen is long, there is concern that the water will be altered geochemically as it flows along the riser pipe, as water flows between the well screen and the sampling pump intake. This is especially a concern if the riser pipe is made of similar material as the COC (such as a stainless steel riser with nickel as a COC, or PVC with organics as a COC). Keely and Boateng (1987) suggested that to minimize this potential influence, the sample pump be lowered gradually while purging, so that at the time of the sampling the pump intake is just above the screen. This would minimize contact time between the ground water and the well construction materials while sampling, as well as ensure the evacuation of the stagnant water above the screen.

With the final location of the sampling pump intake just above the well screen, the sample results may be more reproducible than those collected by positioning the pump intake within the well screen. Results may be more reproducible because the sampler can ensure that the ground water is moving into the well with the same portions of the aquifer being sampled each time assuming the same pump rate. If the pump is placed into different portions of the screen each time, different portions of the aquifer may be sampled. Of course, this can be avoided by the use of dedicated, permanently installed equipment. Additionally, the placement of the pump at the same vertical position within the screen can be ensured by the use of calibrated sampling pump hose, sounding with a weighted tape, or using a pre-measured hose.

The placement of the pump above the screen does not guarantee the water-quality sample represents the entire well screen length. Any bias in the pump placement will be consistently towards the top of the well screen and/or to the zone of highest hydraulic conductivity. Another possible disadvantage, or advantage, depending on the DQOs, of the placement of the pump above the well screen is that the sample may represent a composite of water quality over the well screen. This may result in dilution of a portion of the screen that is in a contaminated portion of an aquifer with another portion that is in an uncontaminated portion of the aquifer. However, shorter well screens would minimize this concern.

When the pump intake is positioned within the well screen, its location is recommended to be opposite the most contaminated zone in the well screen interval. This method is known as the low-flow, low-stress, micropurge, millipurge, or minimal drawdown method. The well is then purged with a minimal drawdown (usually 0.33 feet (0.1 meters) based on Puls and Barcelona, 1996) until selected water-quality-indicator parameters have stabilized. Use of this method may result in the vertical portion of the sampled aquifer being smaller than the well screen length. This method is applicable primarily for short well-screen

lengths (less than 5 feet (1.6 meters)) to better characterize the vertical distribution of contaminants (Puls and Barcelona, 1996). This method should not be used with well-screen lengths greater than 10 feet (3 meters). By using this method, the volume of purge water can be reduced, sometimes significantly, over other purging methods.

However, two potential disadvantages of this method exist. The first potential disadvantage may involve the lower reproducibility of the sampling results. The position of the sampling pump intake may vary between sampling rounds (unless adequate precautions are taken to lower the pump into the exact position in previous sampling rounds, or a dedicated system is used), which can result in potentially different zones within the aquifer being sampled. This potential problem can be overcome by using dedicated sampling pumps and the problem may be minimized by the use of short well screens. The second potential disadvantage, or advantage, depending on the DQOs, may be that the sample which is collected may be taken from a small portion of the aquifer volume.

PURGE CRITERIA

"Low-Stress Approach"

The first method for purging a well, known as the low-stress approach, requires the use of a variable-speed, low-flow sampling pump. This method offers the advantage that the amount of water to be containerized, treated, or stored will be minimized. The low-stress method is based on the assumption that pumping at a low rate within the screened zone will not draw stagnant water down, as long as drawdown is minimized during pumping. Drawdown should not exceed 0.33 feet (0.1 meters) (Puls and Barcelona, 1996). The pump is turned on at a low flow rate approximating the estimated recovery rate (based on the drawdown within the monitoring well during sampling). This method requires the location of the pump intake to be within the saturated-screened interval during purging and sampling. The water-quality-indicator parameters (purge parameters), pH, specific electrical conductance, dissolved oxygen concentration, oxidation-reduction potential, temperature and turbidity, are monitored at specific intervals. The specific intervals will depend on the volume within the tubing (include pump and flow-through cell volumes), pump rate and drawdown; commonly every three to five minutes. These parameters should be recorded after a minimum of one tubing volume (include pump and flow-through-cell volumes) has been purged from the well. These water-quality-indicator parameters should be collected by a method or device which prevents air from contacting the sample prior to the reading, such as a flow-through cell (Barcelona et al., 1985; Garske and Schock, 1986; Wilde et al., 1998). Once three successive readings of the water-quality-indicator parameters provided in Table 1 have stabilized, the sampling may begin. The water-quality-indicator parameters that are recommended include pH and temperature, but these are generally insensitive to indicate completion of purging since they tend to stabilize rapidly (Puls and Barcelona, 1996). Oxidation-reduction potential may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions, and for some fate and transport issues. When possible, especially when sampling for contaminants that may be biased by the presence of turbidity, the turbidity reading is desired to stabilize at a value below 10 Nephelometric Turbidity Units (NTUs). For final dissolved oxygen measurements, if the readings are less than 1 milligram per liter, they should be collected with the spectrophotometric method (Wilde et al., 1998, Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). All of these water-quality-indicator parameters should be evaluated against the specifications of the accuracy and resolution of the instruments used.

During purging, water-level measurements must be taken regularly at 30-second to five-minute intervals (depending on the hydraulic conductivity of the aquifer, diameter of the well, and pumping rate) to document the amount of drawdown during purging. The water-level measurements will allow the sampler to control pumping rates to minimize drawdown in the well.

"Well-Volume Approach"

The second method for purging wells is based on proper purging of the stagnant water above the screened interval and the stabilization of water-quality-indicator parameters prior to sampling. Several considerations in this method need to be evaluated before purging. For monitoring wells where the water level is above the screens, the pump should be set

near the top of the water column, and slowly lowered during the purging process. For water columns within the well screen, the pump should be set at a sufficient depth below the water level where drawdown during pumping does not allow air to enter the pump. The pump should not be allowed to touch or draw sediments from the bottom of the well, especially when sampling for parameters that may be impacted by turbidity. The well-purging rate should not be great enough to produce excessive turbulence in the well, commonly no greater than one gallon per minute (3.8 liters per minute) in a 2-inch well. The pump rate during sampling should produce a smooth, constant (laminar) flow rate, and should not produce turbulence during the filling of bottles. As a result, the expected flow rate for most wells will be less than one gallon per minute (3.8 liter per minute), with expected flow rates of about one-quarter gallon per minute (500 milliliter per minute).

The stabilization criteria for a “well-volume approach” may be based on the stabilization of water-quality-indicator parameters or on a pre-determined well volume. Various research indicates that purging criteria based on water-quality-indicator parameter stabilization may not always correlate to stabilization of other parameters, such as volatile organic compounds (Gibs and Imbrigiotta, 1990; Puls et al., 1990). A more technically rigorous sampling approach that would yield more consistent results over time would be a time-sequential sampling program at regular well-volume intervals while measuring water-quality-indicator parameters. However, the cost would be prohibitive for most sites. For comparison of water-quality results, by sampling under the same conditions (same purge volume and rate, same equipment, same wells, etc.) temporal evaluations of trends may be considered.

The stabilization requirements of the water-quality-indicator parameters are consistent with those described above for the low-stress approach. The parameters should be recorded approximately every well volume; when three successive readings have reached stabilization, the sample(s) are taken (Barcelona et al., 1985). If a ground-water monitoring well has been sufficiently sampled and characterized (at least several rounds of water-quality samples obtained, including the field parameters, during several seasonal variations), and if water-quality-indicator parameters are no longer needed as a part of site characterization and/or monitoring, then samples could be obtained based on a specific number of well volumes at the previous pumping rates.

LOW-PERMEABILITY FORMATIONS

Different procedures must be followed in the case of slow-recovery wells installed in low hydraulic conductivity aquifers. The following procedures are not optimum, but may be used to obtain a ground-water sample under less than ideal conditions. One suggested procedure is to remove the stagnant water in the casing to just above the top of the screened interval, in a well screened below the water table, to prevent the exposure of the gravel pack or formation to atmospheric conditions (McAlary and Barker, 1987). At no point should the pump be lowered into the screened interval. The pumping rate should be as low as possible for purging to minimize the drawdown in the well. However, if a well has an open interval across the water table in a low permeability zone, there may be no way to avoid pumping and/or bailing a well dry (especially in those cases with four feet of water or less in the well and at a depth to water greater than 20 to 25 feet (which is the practical limit of a peristaltic pump)). In these cases, the well may be purged dry. The sample should be taken no sooner than two hours after purging and after a sufficient volume for a water-quality sample, or sufficient recovery (commonly 90%) is present (Herzog et al., 1988). In these cases, a bailer with a double check valve with a flow-control, bottom-emptying device may be used, since many sampling pumps may have tubing capacities greater than the volume present within the well. If the depth of well and water column are shallow enough, consideration of a very low-flow device, such as a peristaltic pump, should be considered, especially if constituents are present that are not sensitive to negative pressures that may be created with the use of the peristaltic pump. If such constituents are present and sampled with a peristaltic pump, a negative bias may be introduced into the sampling results. To minimize the bias, thick-walled, non-porous tubing should be used, except for a small section in the pump heads, which require a greater degree of flexibility. As stated earlier in this paper, the DQOs for the sampling should be consulted to consider the potential impact of the sampling device on the potential bias versus the desired detection levels.

Another method to be considered for low-permeability conditions is the use of alternative sampling methods, such as passive diffusion samplers and other in-situ samplers. As more sites are characterized with these alternative sampling methods and devices, the potential bias, if any, can be evaluated with regard to the sampling DQOs. Regional hydrologists/geologists and Regional quality-assurance specialists should be consulted on the applicability of these methods for the site-specific conditions.

DECISION PROCESS FOR DETERMINING APPLICABLE SAMPLING METHODOLOGY

Once the project team has determined the sampling objectives and DQOs, reviewed the existing data, and determined the possible sampling devices that can be used, the team must decide the appropriate sampling methodology to be used. Table 2 provides a summary of considerations and rationale to be used in establishing the proper ground-water-sampling program using site-specific conditions and objectives.

POTENTIAL PROBLEMS

The primary objective is to obtain a sample representative of the ground water moving naturally (including both dissolved and particulate species) through the subsurface. A ground-water sample can be compromised by field personnel in two primary ways: taking an unrepresentative sample and handling the (representative) sample incorrectly. There are numerous ways of introducing foreign contaminants into a sample. These must be avoided by following strict sampling protocols and transportation procedures, and utilizing trained personnel. Common problems with sampling include the use of inappropriate sample containers and field composites, and the filtration of turbid samples.

SAMPLE CONTAINERS

Field samples must be transferred from the sampling equipment to the container that has been specifically prepared for that given parameter. Samples must not be composited in a common container in the field and then split in the lab. The USEPA Regional policy on sample containers should be consulted to determine the appropriate containers for the specified analysis.

FIELD FILTRATION OF TURBID SAMPLES

The USEPA recognizes that in some hydrogeologic environments, even with proper well design, installation, and development, in combination with the low-flow purging and sampling techniques, sample turbidity cannot be reduced to ambient levels. The well construction, development, and sampling information should be reviewed by the Regional geologists or hydrologists to see if the source of the turbidity problems can be resolved or if alternative sampling methodologies should be employed. If the water sample is excessively turbid, the collection of both filtered and unfiltered samples, in combination with turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pumping rate, and drawdown data is recommended. The filter size used to determine TSS and TDS should be the same as used in the field filtration. An in-line filter should be used to minimize contact with air to avoid precipitation of metals. The typical filter media size used is 0.45 µm because this is commonly accepted as the demarcation between dissolved and non-dissolved species. Other filter sizes may be appropriate but their use should be determined based on site-specific criteria (examples include grain-size distribution, ground-water-flow velocities, mineralogy) and project DQOs. Filter sizes up to 10.0 µm may be warranted because larger size filters may allow particulates that are mobile in ground water to pass through (Puls and Powell, 1992). The changing of filter media size may limit the comparability of the data obtained with other data sets and may affect their use in some geochemical models. Filter media size used on previous data sets from a site, region or aquifer and the DQOs should be taken into consideration. The filter media used during the ground-water sampling program should be collected in a suitable container and archived because potential analysis of the media may be helpful for the determination of particulate size, mineralogy, etc.

The first 500 to 1000 milliliters of a ground-water sample (depending on sample turbidity) taken through the in-line filter will not be collected for a sample in order to ensure that the filter media has equilibrated to the sample (manufacturer's recommendations also should be consulted). Because bailers have been shown to increase turbidity while purging and sampling, bailers should be avoided when sampling for trace element, metal, PCB, and pesticide constituents. If portable sampling pumps are used, the

pumps should be gently lowered to the sampling depth desired, carefully avoiding lowering it to the bottom of the well, and allowed to sit in order to allow any particles mobilized by pump placement to settle. Dedicated sampling equipment installed in the well prior to the commencement of the sampling activities is one of the recommended methods to reduce turbidity artifacts (Puls and Powell, 1992; Kearl et al., 1992; Puls et al., 1992; Puls and Barcelona, 1996).

SAMPLER DECONTAMINATION

The specific decontamination protocol for sampling devices is dependent on site-specific conditions, types of equipment used and the types of contaminants encountered. Once removed from the well, non-dedicated sampling equipment should be decontaminated to help ensure that there will be no cross-contamination between wells. Disposable items such as rope and low-grade tubing should be properly disposed between wells. Cleaning thoroughly that portion of the equipment that is going to come into contact with well water is especially important. In addition, a clean plastic sheet should be placed adjacent to or around the well to prevent surface soils from coming in contact with the purging and sampling equipment. The effects of cross-contamination can be minimized by sampling the least contaminated well first and progressing to the more contaminated ones. Equipment blanks should be collected on a regular basis from non-dedicated equipment, the frequency depending on the sampling plan and regional protocols, to document the effectiveness of the decontamination procedures.

The preferred method is to use dedicated sampling equipment whenever possible. Dedicated equipment should still be cleaned on a regular basis to reduce biofouling, and to minimize adsorption effects. Dedicated equipment should have equipment blanks taken after every cleaning.

POST-SAMPLING ACTIVITIES

Specific activities should be completed at monitoring wells at regular intervals to ensure the acquisition of representative ground-water samples. Activities include hydraulic conductivity testing to determine if a monitoring well needs redeveloping and/or replacing. Another activity that needs to be completed is regular surveying of well measuring points impacted by frost heaving and site activities. The schedules of these activities are to be determined on a site-by-site basis in consultation with regional geologists or hydrologists, but at a minimum, should be every five years.

CONCLUSION

This document provides a brief summary of the state-of-the-science to be used for Superfund and RCRA ground-water studies. As additional research is completed, additional sampling experience with other sampling devices and methods and/or additional contaminants are identified, this paper may be revised to include the new information/concerns. Clearly there is no one sampling method that is applicable for all sampling objectives. As new methods and/or equipment are developed, additional standard operating procedures (SOPs) should be developed and attached to this document. These SOPs for ground-water sampling should include, at a minimum: introduction, scope and application, equipment, purging and sampling procedures, field quality control, decontamination procedures and references. Example SOP's for the low-stress/minimal-drawdown and well-volume sampling procedures have been included as Attachments 3 and 4. These example SOPs are to be considered a pattern or starting point for site-specific ground-water-sampling plans. A more detailed discussion of sampling procedures, devices, techniques, etc. is provided in various publications by the USEPA (Barcelona et al., 1985; U.S. Environmental Protection Agency, 1993) and the U.S. Geological Survey (Wilde et al., 1998).

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TABLES:

Stablization Criteria with References for Water-Quality-Indicator Parameters

and

Applicability of Different Approaches for Purging and Sample Monitoring Wells

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TABLE 1: Stabilization Criteria with References for Water-Quality-Indicator Parameters

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1	Puls and Barcelona, 1996; Wilde et al., 1998
specific electrical conductance (SEC)	+/- 3%	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen (DO)	+/- 0.3 milligrams per liter	Wilde et al., 1998

TABLE 2: Applicability of Different Approaches for Purging and Sampling Monitoring Wells

	Low-Stress Approach	Well-Volume Approach	**Others** (such as passive diffusion samplers, in-situ samplers, and other non-traditional ground-water sampling pumps)
Applicable Geologic Materials[1]	Materials with moderate to high hydraulic conductivities. May be applicable to some low hydraulic conductivities, if can meet minimal drawdown criteria.	Materials with low to high hydraulic conductivities	Materials with very low to high hydraulic conductivities
Aquifer/Plume Characterization Data Needs prior to Choosing Sampling Method [2]	High definition of vertical hydraulic conductivity distribution and vertical contaminant distribution	Plume and hydraulic conductivity distributions are less critical	May need to consider the degree of hydraulic and contaminant vertical distribution definition dependent on Data Quality Objectives and sampler type.
Constituent Types Method is Applicable	Mainly recommended for constituents which can be biased by turbidity in wells. Applicable for most other contaminants.	Applicable for all sampling parameters. However, if turbidity values are elevated, low-stress approach may be more applicable if constituents of concern are turbidity sensitive.	Constituents of concern will be dependent on the type of sampler.
Data Quality Objectives	1) High resolution of plume definition both vertically and horizontally. 2) Reduce bias from other sampling methods if turbidity is of concern. 3) Target narrow sections of aquifer.	1) Basic site characterization 2) Moderate to high resolution of plume definition (will be dependent on screen length). 3) Target sample composition to represent entire screened/open interval	1) Can be applicable to basic site characterization, depending on sampler and methodology used. 2) Can reduce bias from other sampling methods. 3) May yield high resolution of plume definition.

[1]Hydraulic conductivities of aquifer materials vary from low hydraulic conductivities (clays, silts, very fine sands) to high conductivities (gravels, sands, weathered bedrock zones). This term for the use on this table is subjective, and is more dependent on the drawdown induced in a monitoring well when sampled with a ground-water sampling pump. For instance, in a well being pumped at 4 liters per minute (l/min) with less than 0.1 feet of drawdown, can be considered to have high hydraulic conductivity. A well that can sustain a 0.2 to 0.4 l/min pumping rate, but has more than 0.5 feet of drawdown can be considered to have low hydraulic conductivity. To assign absolute values of hydraulic conductivities to well performance and sustainable pumping rates cannot be completed because of the many factors in monitoring well construction, such as well diameter, screen open area, and length of screen.

[2] See last paragraph under the SAMPLING OBJECTIVES section.

ATTACHMENT 1
Example Sampling Checklist

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SAMPLING CHECKLIST

Well Identification:_____

Map of Site Included: Y or N
Wells Clearly Identified with Roads: Y or N
Well Construction Diagram Attached: Y or N

Well Construction:

Diameter of Borehole:_____ Diameter of Casing:_____
Casing Material:_____ Screen Material:_____
Screen Length:_____ Total Depth:_____

Approximate Depth to Water:_____
Maximum Well Development Pumping Rate:_____
Date of Last Well Development:_____

Previous Sampling Information:

Was the Well Sampled Previously: Y or N
(If Sampled, Fill Out Table Below)

Table of Previous Sampling Information

Parameter	Previously Sampled	Number of Times Sampled	Maximum Concentration	Notes (include previous purge rates)

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ATTACHMENT 2
Example Ground-Water Sampling Field Sheets

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GROUND-WATER SAMPLING RECORD

Well ID:_____

Station #:_____

Facility Name: Date:____/____/____

Well Depth:_____ Depth to Water:_____ Well Diameter:_____

Casing Material.:_____ Volume Of Water per Well Volume:_____

Sampling Crew:_____,_____,_____,_____

Type of Pump:_____ _____ Tubing Material:_____ Pump set at _____ ft.

Weather Conditions:_____ NOTES:_____ _____

_____

GROUND-WATER SAMPLING PARAMETERS

Time	Water Level	Volume Pumped	Pumping Rate	DO (mg/l)	Temp. (^{0}C)	SEC (μS/cm)	pH	ORP (mV)	Turbidity (NTU)

Other Parameters: _____

Sampled at:_____ Parameters taken with :_____

Sample delivered to _____ by _____ at_____.

Sample CRL #:_____ OTR #:_____ ITR #:_____ SAS #:_____

Parameters Collected	Number of Bottles	Bottle Lot Number

Ground Water Sampling Log

Site Name: **Well #:** **Date:**

Well Depth(Ft-BTOC[1]): **Screen Interval**(Ft):

Well Dia.: **Casing Material:** **Sampling Device:**

Pump placement(Ft from TOC[2]):

Measuring Point: **Water level (static)**(Ft):

Water level (pumping)(Ft): **Pump rate**(Liter/min):

Sampling Personnel:

Other info: (such as sample numbers, weather conditions and field notes)

Water Quality Indicator Parameters

Time	Pumping rates (L/Min)	Water level (ft)	DO (mg/L)	ORP (mv)	SEC[3]	Turb. (NTU)	pH	Temp. (C^0)	Volume pumped (L)

Type of Samples collected:

1 casing volume was:
Total volume purged prior to sample collection:
[1]BTOC-Below Top of Casing
[2]TOC-Top of Casing
[3]Specific Electrical Conductance

Stabilization Criteria

D.O.	+/- 0.3 mg/l
Turb.	+/- 10%
S.C.	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

ATTACHMENT 3
Example Standard Operating Procedure:

Standard Operating Procedure for Low-Stress (Low Flow)/Minimal Drawdow Ground-Water Sample Collection

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Standard Operating Procedure for Low-Stress (Low-Flow)/ Minimal Drawdown Ground-Water Sample Collection

INTRODUCTION

The collection of "representative" water samples from wells is neither straightforward nor easily accomplished. Ground-water sample collection can be a source of variability through differences in sample personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at ground-water monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample-collection procedures.

The purpose of this standard operating procedure (SOP) is to provide a method that minimizes the impact the purging process has on the ground-water chemistry and the volume of water that is being purged and disposed of during sample collection. This will take place by placing the pump intake within the screen interval and by keeping the drawdown at a minimal level (0.33 feet) (Puls and Barcelona, 1996) until the water quality parameters have stabilized and sample collection is complete. The flow rate at which the pump will be operating will depend upon both hydraulic conductivity of the aquifer and the drawdown with the goal of minimizing the drawdown. The flow rate from the pump during purging and sampling will be at a rate that will not compromise the integrity of the analyte that is being sampled. This sampling procedure may or may not provide a discrete ground-water sample at the location of the pump intake. The flow of ground-water to the pump intake will be dependent on the distribution of the hydraulic conductivity (K) of the aquifer within the screen interval. In order to minimize the drawdown in the monitoring well, a low-flow rate must be used. "Low-Flow" refers to the velocity with which water enters the pump intake from the surrounding formation in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface, which can be affected by flow regulators or restrictions (Puls and Barcelona, 1996). This SOP was developed by the Superfund/RCRA Ground Water Forum and draws from an USEPA's Ground Water Issue Paper, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure, by Robert W. Puls and Michael J. Barcelona. Also, available USEPA Regional SOPs regarding Low-Stress (Low-Flow) Purging and Sampling were used for this SOP.

SCOPE AND APPLICATION

This SOP should be used primarily at monitoring wells that have a screen or an open interval with a length of ten feet or less and can accept a sampling device that minimizes the disturbance to the aquifer or the water column in the well casing. The screen or open interval should have been optimally located to intercept an existing contaminant plume(s) or along flowpaths of potential contaminant releases. Knowledge of the contaminant distribution within the screen interval is highly recommended and is essential for the success of this sampling procedure. The ground-water samples that are collected using this procedure are acceptable for the analyses of ground-water contaminants that may be found at Superfund and RCRA contamination sites. The analytes may be volatile, semi-volatile organic compounds, pesticides, PCBs, metals, and other inorganic compounds. The screened interval should be located within the contaminant plume(s) and the pump intake should be placed at or near the known source of the contamination within the screened interval. It is critical to place the pump intake in the exact location or depth for each sampling event. This argues for the use of dedicated, permanently installed, sampling devices whenever possible. If this is not possible, then the placement of the pump intake should be positioned with a calibrated sampling pump hose sounded with a weighted-tape or using a pre-measured hose. The pump intake should not be placed near the bottom of the screened interval to avoid disturbing any sediment that may have settled at the bottom of the well.

Water-quality-indicator parameters and water levels must be measured during purging, prior to sample collection. Stabilization of the water-quality-indicator parameters as well as monitoring water levels are a prerequisite to sample collection. The water-quality-indicator parameters that are recommended include the following: specific electrical conductance, dissolved oxygen, turbidity, oxidation-reduction potential, pH, and temperature. The latter two parameters are useful data, but are generally insensitive as purging parameters. Oxidation-reduction potential may not always be appropriate stabilization parameter, and will depend on site-specific conditions. However, readings

should be recorded because of its value as a double check for oxidation conditions and for fate and transport issues.

Also, when samples are collected for metals, semi-volatile organic compounds, and pesticides, every effort must be made to reduce turbidity to 10 NTUs or less (not just the stabilization of turbidity) prior to the collection of the water sample. In addition to the measurement of the above parameters, depth to water must be measured during purging (U.S. Environmental Protection Agency, 1995).

Proper well construction, development, and maintenance are essential for any ground-water sampling procedure. Prior to conducting the field work, information on the construction of the well and well development should be obtained and that information factored into the site specific sampling procedure. The Sampling Checklist at the end of this attachment is an example of the type of information that is useful.

Stabilization of the water-quality-indicator parameters is the criterion for sample collection. But if stabilization is not occurring and the procedure has been strictly followed, then sample collection can take place once three (minimum) to six (maximum) casing volumes have been removed (Schuller et al., 1981 and U.S. Environmental Protection Agency., 1986; Wilde et al., 1998; Gibs and Imbrigiotta., 1990). The specific information on what took place during purging must be recorded in the field notebook or in the ground-water sampling log.

This SOP is not to be used where non-aqueous phase liquids (NAPL) (immiscible fluids) are present in the monitoring well.

EQUIPMENT

- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of 0.01 foot. Interface probe for determination of liquid products (NAPL) presence, if needed.
- Steel tape and weight - Used for measuring total depth of well. Lead weight should not be used.
- Sampling pump - Submersible or bladder pumps with adjustable rate controls are preferred. Pumps are to be constructed of inert materials, such as stainless steel and Teflon®. Pump types that are acceptable include gear and helical driven, centrifugal (low-flow type), and air-activated piston. An adjustable rate, peristaltic pump can be used when the depth to water is 20 feet or less.
- Tubing - Teflon® or Teflon®-lined polyethylene tubing is preferred when sampling for organic compounds. Polyethylene tubing can be used when sampling inorganics.
- Power source - If a combustion type (gasoline or diesel-driven) generator is used, it must be placed downwind of the sampling area.
- Flow measurement supplies - flow meter, graduated cylinder, and a stop watch.
- Multi-parameter meter with flow-through cell - This can be one instrument or more contained in a flow-through cell. The water-quality-indicator parameters that are monitored are pH, ORP/Eh, (ORP) dissolved oxygen (DO), turbidity, specific conductance, and temperature. Turbidity readings must be collected before the flow cell because of the potential for sediment buildup, which can bias the turbidity measurements. Calibration fluids for all instruments should be NIST-traceable and there should be enough for daily calibration throughout the sampling event. The inlet of the flow cell must be located near the bottom of the flow cell and the outlet near the top. The size of the flow cell should be kept to a minimum and a closed cell is preferred. The flow cell must not contain any air or gas bubbles when monitoring for the water-quality-indicator parameters.
- Decontamination supplies - Including a reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap will also be needed.
- Sample bottles, sample preservation supplies, sample tags or labels, and chain-of-custody forms.
- Approved Field Sampling and Quality Assurance Project Plan.
- Well construction, field, and water quality data from the previous sampling event.
- Well keys and map of well locations.
- Field notebook, ground-water sampling logs, and calculator. A suggested field data sheet (ground-water sampling record or ground-water sampling log) are provided at the end of this attachment.

- Filtration equipment, if needed. An in-line disposable filter is recommended.
- Polyethylene sheeting placed on ground around the well head.
- Personal protective equipment as specified in the site Health and Safety Plan.
- Air monitoring equipment as specified in the Site Health and Safety Plan.
- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to contain the purged water.

Construction materials of the sampling equipment (bladders, pumps, tubing, and other equipment that comes in contact with the sample) should be limited to stainless steel, Teflon®, glass, and other inert material. This will reduce the chance that sampling materials alter the ground-water where concentrations of the site contaminants are expected to be near the detection limits. The sample tubing diameter should be maximized and the tubing length should be minimized so that the loss of contaminants into and through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of material makes the appropriate selection of sample tubing material critical for trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998).

PURGING AND SAMPLING PROCEDURES

The following describes the purging and sampling procedures for the Low-Stress (Low-Flow)/ Minimal Drawdown method for the collection of ground-water samples. These procedures also describe steps for dedicated and non-dedicated systems.

Pre-Sampling Activities (Non-dedicated and dedicated system)

1. Sampling must begin at the monitoring well with the least contamination, generally up-gradient or farthest from the site or suspected source. Then proceed systematically to the monitoring wells with the most contaminated ground water.

2. Check and record the condition of the monitoring well for damage or evidence of tampering. Lay out polyethylene sheeting around the well to minimize the likelihood of contamination of sampling/purging equipment from the soil. Place monitoring, purging and sampling equipment on the sheeting.

3. Unlock well head. Record location, time, date, and appropriate information in a field logbook or on the ground-water sampling log (See attached ground-water sampling record and ground-water sampling log as examples).

4. Remove inner casing cap.

5. Monitor the headspace of the monitoring well at the rim of the casing for volatile organic compounds (VOC) with a photo-ionization detector (PID) or flame ionization detector (FID) and record in the logbook. If the existing monitoring well has a history of positive readings of the headspace, then the sampling must be conducted in accordance with the Health and Safety Plan.

6. Measure the depth to water (water level must be measured to nearest 0.01 feet) relative to a reference measuring point on the well casing with an electronic water level indicator or steel tape and record in logbook or ground-water sampling log. If no reference point is found, measure relative to the top of the inner casing, then mark that reference point and note that location in the field logbook. Record information on depth to ground water in the field logbook or ground-water sampling log. Measure the depth to water a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

7. Check the available well information or field information for the total depth of the monitoring well. Use the information from the depth of water in step six and the total depth of the monitoring well to calculate the volume of the water in the monitoring well or the volume of one casing. Record information in field logbook or ground-water sampling log.

Purging and Sampling Activities

8A. Non-dedicated system - Place the pump and support equipment at the wellhead and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a predetermined location within the screen interval. The placement of the pump intake should be positioned

with a calibrated sampling pump hose, sounded with a weighted-tape, or using a pre-measured hose. Refer to the available monitoring well information to determine the depth and length of the screen interval. Measure the depth of the pump intake while lowering the pump into location. Record pump location in field logbook or ground-water sampling log.

8B. Dedicated system - Pump has already been installed, refer to the available monitoring well information and record the depth of the pump intake in the field logbook or ground-water sampling log.

9. Non-dedicated system and dedicated systems - Measure the water level (water level must be measured to nearest 0.01 feet) and record information on the ground-water sampling log, leave water level indicator probe in the monitoring well.

10. Non-dedicated and dedicated systems - Connect the discharge line from the pump to a flow-through cell. A “T” connection is needed prior to the flow-through cell to allow for the collection of water for the turbidity measurements. The discharge line from the flow-through cell must be directed to a container to contain the purge water during the purging and sampling of the monitoring well.

11. Non-dedicated and dedicated systems - Start pumping the well at a low flow rate (0.2 to 0.5 liter per minute) and slowly increase the speed. Check water level. Maintain a steady flow rate while maintaining a drawdown of less than 0.33 feet (Puls and Barcelona, 1996). If drawdown is greater than 0.33 feet, lower the flow rate. 0.33 feet is a goal to help guide with the flow rate adjustment. It should be noted that this goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience (Puls and Barcelona, 1996).

12. Non-dedicated and dedicated systems - Measure the discharge rate of the pump with a graduated cylinder and a stop watch. Also, measure the water level and record both flow rate and water level on the ground-water sampling log. Continue purging, monitor and record water level and pump rate every three to five minutes during purging. Pumping rates should be kept at minimal flow to ensure minimal drawdown in the monitoring well.

13. Non-dedicated and dedicated systems - During the purging, a minimum of one tubing volume (including the volume of water in the pump and flow cell) must be purged prior to recording the water-quality indicator parameters. Then monitor and record the water-quality- indicator parameters every three to five minutes. The water-quality indicator field parameters are turbidity, dissolved oxygen, specific electrical conductance, pH, redox potential, and temperature. Oxidation-reduction potential may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions. Also, for the final dissolved oxygen measurement, if the readings are less than 1 milligram per liter, it should be collected and analyze with the spectrophotometric method (Wilde et al., 1998 Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). The stabilization criterion is based on three successive readings of the water quality field parameters; the following are the criteria which must be used:

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1 pH units	Puls and Barcelona, 1996; Wilde et al., 1998
specific electrical conductance (SEC)	+/- 3% S/cm	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% NTUs (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen	+/- 0.3 milligrams per liter	Wilde et al., 1998

Once the criteria have been successfully met indicating that the water quality indicator parameters have stabilized, then sample collection can take place.

14. If a stabilized drawdown in the well can't be maintained at 0.33 feet and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. Under no circumstances should the well be pumped dry. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again, turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or ground-water sampling log with a recommendation for a different purging and sampling procedure.

15. Non-dedicated and dedicated systems - Maintain the same pumping rate or reduce slightly for sampling (0.2 to 0.5 liter per minute) in order to minimize disturbance of the water column. Samples should be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. Disconnect the pump's tubing from the flow-through cell so that the samples are collected from the pump's discharge tubing. For samples collected for dissolved gases or VOC analyses, the pump tubing needs to be completely full of ground water to prevent the ground water from being aerated as it flows through the tubing. The sequence of the samples is immaterial unless filtered (dissolved) samples are collected and they must be collected last (Puls and Barcelona, 1996). All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container. When filling the VOC samples, a meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and head space prior to capping. In the event that the ground water is turbid, (greater then 10 NTUs), a filtered metal (dissolved) sample also should be collected.

If filtered metal sample is to be collected, then an in-line filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The in-line filter must be pre-rinsed following manufacturer's recommendations and if there are no recommendations for rinsing, a minimum of 0.5 to 1 liter of ground water from the monitoring well must pass through the filter prior to sampling.

16A. Non-dedicated system - Remove the pump from the monitoring well. Decontaminate the pump and dispose of the tubing if it is non-dedicated.

16B. Dedicated system - Disconnect the tubing that extends from the plate at the wellhead (or cap) and discard after use.

17. Non-dedicated system - Before locking the monitoring well, measure and record the well depth (to 0.1 feet).

Measure the total depth a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

18. Non-dedicated and dedicated systems - Close and lock the well.

DECONTAMINATION PROCEDURES

Decontamination procedures for the water level meter and the water quality field parameter sensors.
The electronic water level indicator probe/steel tape and the water-quality field parameter sensors will be decontaminated by the following procedures:

1. The water level meter will be hand washed with phosphate-free detergent and a scrubber, then thoroughly rinsed with distilled water.

2. Water quality field parameter sensors and flow-through cell will be rinsed with distilled water between sampling locations. No other decontamination procedures are necessary or recommended for these probes since they are sensitive. After the sampling event, the flow cell and sensors must be cleaned and maintained per the manufacturer's requirements.

Decontamination Procedure for the Sampling Pump

Upon completion of the ground water sample collection the sampling pump must be properly decontaminated between monitoring wells. The pump and discharge line including support cable and electrical

wires which were in contact with the ground water in the well casing must be decontaminated by the following procedure:

1. The outside of the pump, tubing, support cable and electrical wires must be pressure-sprayed with soapy water, tap water, and distilled water. Spray outside of tubing and pump until water is flowing off of tubing after each rinse. Use bristle brush to help remove visible dirt and contaminants.
2. Place the sampling pump in a bucket or in a short PVC casing (4-in. diameter) with one end capped. The pump placed in this device must be completely submerged in the water. A small amount of phosphate-free detergent must be added to the potable water (tap water).
3. Remove the pump from the bucket or 4-in. casing and scrub the outside of the pump housing and cable.
4. Place pump and discharge line back in the 4-in. casing or bucket, start pump and recirculate this soapy water for 2 minutes (wash).
5. Re-direct discharge line to a 55-gallon drum. Continue to add 5 gallons of potable water (tap water) or until soapy water is no longer visible.
6. Turn pump off and place pump into a second bucket or 4-in. casing that contains tap water. Continue to add 5 gallons of tap water (rinse).
7. Turn pump off and place pump into a third bucket or 4-in. casing which contains distilled/deionized water, continue to add 3 to 5 gallons of distilled/deionized water (final rinse).
8. If a hydrophobic contaminant is present (such as separate phase, high levels of PCBs, etc.), an additional decontamination step, or steps, may be added. For example, an organic solvent, such as reagent-grade isopropanol alcohol may be added as a first spraying/bucket prior to the soapy water rinse/bucket.

FIELD QUALITY CONTROL

Quality control (QC) samples must be collected to verify that sample collection and handling procedures were performed adequately and that they have not compromised the quality of the ground-water samples. The appropriate EPA program guidance must be consulted in preparing the field QC sample requirements for the site-specific Quality Assurance Project Plan (QAPP).

There are five primary areas of concern for quality assurance (QA) in the collection of representative ground-water samples:

1. Obtaining a ground-water sample that is representative of the aquifer or zone of interest in the aquifer. Verification is based on the field log documenting that the field water-quality parameters stabilized during the purging of the well, prior to sample collection.
2. Ensuring that the purging and sampling devices are made of materials, and utilized in a manner that will not interact with or alter the analyses.
3. Ensuring that results generated by these procedures are reproducible; therefore, the sampling scheme should incorporate co-located samples (duplicates).
4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling and purging equipment, and decontamination of the equipment is therefore required.
5. Properly preserving, packaging, and shipping samples.

All field QC samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The chain-of-custody procedures for the QC samples will be identical to the field ground-water samples. The following are QC samples that must be collected during the sampling event:

Sample Type	Frequency
● Field duplicates	1 per 20 samples
● Matrix spike	1 per 20 samples
● Matrix spike duplicate	1 per 20 samples
● Equipment blank	per Regional require-ments or policy
● Trip blank (VOCs)	1 per sample cooler
● Temperature blank	1 per sample cooler

HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site Health and Safety Plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phase through the use of appropriate personal protective equipment.

Depending on the type of contaminants expected or determined in previous sampling efforts, the following safe work practices will be employed:

Particulate or metals contaminants

1. Avoid skin contact with, and incidental ingestion of, purge water.
2. Use protective gloves and splash protection.

Volatile organic contaminants

1. Avoid breathing constituents venting from well.
2. Pre-survey the well head space with an appropriate device as specified in the site Health and Safety Plan.
3. If monitoring results indicate elevated organic constituents, sampling activities may be conducted in level C protection. At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®.

General practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when filling pre-acidified VOA bottles, hydrochloric acid fumes may be released and should not be inhaled.

POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to the following:

1. Ensuring that all field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
2. Processing all sample paperwork, including copies provided to the Regional Laboratory, Sample Management Office, or other appropriate sample handling and tracking facility.
3. Compiling all field data for site records.
4. Verifying all analytical data processed by the analytical laboratory against field sheets to ensure all data has been returned to sampler.

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SAMPLING CHECKLIST

Well Identification:_____

Map of Site Included: Y or N
Wells Clearly Identified with Roads: Y or N
Well Construction Diagram Attached: Y or N

Well Construction:

Diameter of Borehole:_____ Diameter of Casing:_____
Casing Material:_____ Screen Material:_____
Screen Length:_____ Total Depth:_____

Approximate Depth to Water:_____
Maximum Well Development Pumping Rate:_____
Date of Last Well Development:_____

Previous Sampling Information:

Was the Well Sampled Previously: Y or N
(If Sampled, Fill Out Table Below)

Table of Previous Sampling Information

Parameter	Previously Sampled	Number of Times Sampled	Maximum Concentration	Notes (include previous purge rates)

Ground Water Sampling Log

Site Name: **Well #:** **Date:**
Well Depth(Ft-BTOC[1]): **Screen Interval**(Ft):

Well Dia.: **Casing Material:** **Sampling Device:**

Pump placement(Ft from TOC[2]):

Measuring Point: **Water level (static)**(Ft):

Water level (pumping)(Ft): **Pump rate**(Liter/min):

Sampling Personnel:

Other info: (such as sample numbers, weather conditions and field notes)

Water Quality Indicator Parameters

Time	Pumping rates (L/Min)	Water level (ft)	DO (mg/L)	ORP (mv)	Turb. (NTU)	SEC[3] (S/cm)	pH	Temp. (C^0)	Volume pumped (L)

Type of Samples collected:

1 casing volume was:

Total volume purged prior to sample collection:

[1]BTOC-Below Top of Casing
[2]TOC-Top of Casing
[3]Specific Electrical Conductance

Stabilization Criteria

D.O.	+/- 0.3 mg/l
Turb.	+/- 10%
S.C.	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

ATTACHMENT 4
Example Standard Operating Procedure:

Standard Operating Procedure for the Standard/Well-Volume Method for Collecting a Ground-Water Sample

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Standard Operating Procedure for the Well-Volume Method for Collecting a Ground-Water Sample

INTRODUCTION

The collection of "representative" water samples from wells is neither straightforward nor easily accomplished. Ground-water sample collection can be a source of variability through differences in sampling personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at ground-water monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample-collection procedures.

The objectives of the sampling procedures described in this document are to minimize changes in ground-water chemistry during sample collection and transport to the laboratory and to maximize the probability of obtaining a representative, reproducible ground-water sample. Sampling personnel may benefit from a working knowledge of the chemical processes that can influence the concentration of dissolved chemical species.

The well-volume method described in this standard operating procedure (SOP) provides a reproducible sampling technique with the goal that the samples obtained will represent water quality over an entire open interval of a short-screened (ten feet or less) well. This technique is appropriate for long-term and detection monitoring of formation water quality. The resulting sample generally represents a composite of the screened interval, and thus integrates small-scale vertical heterogeneities of ground-water chemistry. This sampling technique also is useful for screening purposes for detection monitoring of contaminants in the subsurface. However, the detection of a low concentration of contaminant in a thin contaminated zone or with long well screens may be difficult and should be determined using detailed vertical profiling techniques.

This method may not be applicable for all ground-water-sampling wells, such as wells with very low yields, fractured rock, and some wells with turbidity problems. As always, site-specific conditions and objectives should be considered prior to the selection of this method for sampling.

SCOPE AND APPLICATION

The objective of a good sampling program should be the collection of a representative sample of the current ground-water conditions over a known or specified volume of aquifer. To meet this objective, the sampling equipment, the sampling method, the monitoring well construction, monitoring well operation and maintenance, and sample-handling procedures should not alter the chemistry of the sample.

An example of how a site's Data Quality Objectives (DQOs) for a characterization sampling effort might vary from those of a remediation monitoring sampling effort could be a difference of how much of the screened interval or aquifer should be sampled. A site characterization objective may be to collect a sample that represents a composite of the entire (or as close as is possible) screened interval of the monitoring well.

Additionally, the site characterization may require a large suite of contaminants to be sampled and analyzed, whereas, the remediation monitoring program may require fewer contaminants sampled and analyzed. These differences may dictate the type of sampling equipment used, the type of information collected, and the sampling protocol.

This sampling method described is for monitoring wells. However, this method should not be used for water-supply wells with a water-supply pump, with long-screened wells in complex hydrogeologic environments (such as fractured rock), or wells with separate phases of liquids (such as a Dense or Light Non-Aqueous Phase Liquids) present within the screened interval.

EQUIPMENT

- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of 0.01 foot. Interface probe for measuring separate phase liquids, if needed. Pressure transducer and data logger optional for frequent depth-to-water measuring in same well.
- Steel tape and weight - Used for measuring total depth of well. Lead weights should not be used.
- Sampling pump - Submersible or bladder pumps with adjustable rate controls are preferred. Pumps

are to be constructed of inert materials, such as stainless steel and Teflon®. Pump types that are acceptable include gear and helical driven, centrifugal (low-flow type), and air-activated piston. Adjustable rate, peristaltic pumps can be used when the depth to water is 20 feet or less.

- Tubing - Inert tubing should be chosen based on the types and concentrations of contaminants present, or expected to be present in the monitoring well. Generally, Teflon®-based tubing is recommended when sampling for organic compounds. Polyethylene or Teflon® tubing can be used when sampling for inorganic constituents.
- Power source - If a combustion type (gasoline or diesel-driven) device is used, it must be located downwind of the point of sample collection. If possible, it should also be transported to the site and sampling location in a different vehicle from the sampling equipment.
- Flow-measurement equipment - Graduated cylinder or bucket and a stop watch, or a flow meter that can be disconnected prior to sampling.
- Multi-parameter meter with flow-through cell - This can be one instrument or multiple probes/instruments contained in a flow-through cell. The water-quality-indicator parameters that are measured in the field are pH, oxidation/reduction potential (ORP, redox, or Eh), dissolved oxygen (DO), turbidity, specific electrical conductance (SEC), and temperature. Calibration standards for all instruments should be NIST-traceable, within expiration dates of the solutions, and sufficient for daily calibration throughout the sampling collection.
- Decontamination supplies - A reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap also will be needed.
- Sample bottles, sample preservation supplies and laboratory paperwork. Also, several coolers, and sample packing supplies (absorbing packing material, plastic baggies, etc.).
- Approved plans and background documents - Approved Field Sampling Plan, Quality Assurance Project Plan, well construction data, field and water-quality data from the previous sampling collection.
- Site Access/Permission documentation for site entry.
- Well keys and map showing locations of wells.
- Field notebook, field data sheets and calculator. A suggested field data sheet is provided at the end of this attachment.
- Filtration equipment - If needed, this equipment should be an in-line disposable filter used for the collection of samples for analysis of dissolved constituents.
- Polyethylene sheeting - Used for decontamination stations and during sampling to keep equipment clean.
- Site Health and Safety Plan and required equipment - The health and safety plan along with site sign-in sheet should be on site and be presented by the site health and safety officer. Personnel-protective and air-monitoring equipment specified in the Site Health and Safety Plan should be demonstrated, present and in good working order on site at all times.
- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to contain the purged water.

Construction materials of the sampling equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon®, glass, and other inert materials when concentrations of the site contaminants are expected within the detection limit range. The sample tubing thickness and diameter should be maximized and the tubing length should be minimized so that the loss of contaminants absorbed to and through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of many materials makes the appropriate selection of sample tubing materials critical for these trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998).

Generally, wells should be purged and sampled using the same positive-displacement pump and/or a low-flow submersible pump with variable controlled flow rates and constructed of chemically inert materials. If a pump cannot be used because the recovery rate of the well is so low (less than 100 to 200 ml/min) and the volume of the water to be removed is minimal (less than 5 feet of water in a small-diameter well), then a Teflon® bailer, with a double check valve and bottom-emptying device with a control-flow check

valve may be used to obtain the samples. Otherwise, a bailer should not be used when sampling for volatile organics because of the potential bias introduced during sampling (Yeskis et al., 1988; Pohlmann et al., 1990; Tai et al., 1991). Bailers also should be avoided when sampling for metals because repeated bailer deployment has the potential to increase turbidity, which biases concentrations of inorganic constituents. Dedicated sampling pumps are recommended for metals sampling (Puls et al., 1992).

In addition, for wells with long riser pipes above the well screen, the purge volumes may be reduced by using packers above the pumps. The packer materials should be compatible with the parameters to be analyzed. These packers should be used only on wells screened in highly permeable materials, because of the lack of ability to monitor water levels in the packed interval. Otherwise, if pumping rates exceed the natural aquifer recovery rates into the packed zone, a vacuum or negative pressure zone may develop. This may result in a failure of the seal by the packer and/or a gaseous phase may develop, that may bias any sample taken.

PURGING AND SAMPLING PROCEDURE

WATER-LEVEL MEASUREMENTS

The field measurements should include total well depth and depth to water from a permanently marked reference point.

TOTAL WELL DEPTH

The depth of each well should be measured to the nearest one-tenth of a foot when using a steel tape with a weight attached and should be properly recorded. The steel tape should be decontaminated before use in another well according to the site specific protocols. A concern is that when the steel tape and weight hit the bottom of the well, sediment present on the bottom of a well is stirred up, thus increasing turbidity, which will affect the sampling results. In these cases, as much time as possible should be allowed prior to sampling, such as a minimum of 24 hours. If possible, total well depth measurements can be completed after sampling (Puls and Barcelona, 1996). The weight of electric tapes is generally too light to determine accurate total well depth. If the total well depth is greater than 200 feet, stretching of the tape must be taken into consideration.

DEPTH TO WATER

All water levels should be measured from the reference point by use of a weighted steel tape and chalk or an electronic water-level indicator (a detailed discussion of the pros and cons of the different water level devices is provided in Thornhill, 1989). The steel tape is a more accurate method to take water levels, and is recommended where shallow flow gradients (less than 0.05 feet/feet) or deep wells are encountered. However, in those cases where large flow gradients or large fluctuations in water levels are expected, a calibrated electric tape is acceptable. The water level is calculated using the well's surveyed reference point minus the measured depth-to-water and should be measured to the nearest one hundredth of a foot.

The depth-to-water measurement must be made in each well to be sampled prior to any other activities at the well (such as bailing, pumping, and hydraulic testing) to avoid bias to the measurement. All readings are to be recorded to the nearest one hundredth of a foot. When possible, depth-to-water and total well depth measurements should be completed at the beginning of a ground-water sampling program, which will allow any turbidity to settle and allow a more synoptic water-level evaluation. However, if outside influences (such as tidal cycles, nearby pumping effects, or major barometric changes) may result in significant water-level changes in the time between measurement and sampling, a water-level measurement should be completed immediately prior to sampling. In addition, the depth-to-water measurement during purging should be recorded, with the use of a pressure transducer and data logger sometimes more efficient (Barcelona et al., 1985, Wilde et al., 1998).

The time and date of the measurement, point of reference, measurement method, depth-to-water measurement, and any calculations should be properly recorded in field notebook or sampling sheet.

STATIC WATER VOLUME

From the information obtained for casing diameter, total well depth and depth-to-water measurements, the volume of water in the well is calculated. This value is one criteria that may be used to determine the volume of water to be purged from the well before the sample is collected.

The static water volume may be calculated using the following formula:

$$V = r^2h(0.163)$$

Where:

V	=	static volume of water in well (in gallons)
r	=	inner radius of well casing (in inches)
h	=	length of water column (in feet) which is equal to the total well depth minus depth to water.
0.163	=	a constant conversion factor that compensates for the conversion of the casing radius from inches to feet for 2-inch diameter wells and the conversion of cubic feet to gallons, and pi (π). This factor would change for different diameter wells.

Static water volumes also may be obtained from various sources, such as Appendix 11.L in Driscoll (1986).

WELL PURGING

PURGE VOLUMES

In most cases, the standing water in the well casing can be of a different chemical composition than that contained in the aquifer to be sampled. Solutes may be adsorbed or desorbed from the casing material, oxidation may occur, and biological activity is possible. Therefore, the stagnant water within the well must be purged so that water that is representative of the aquifer may enter the well.

The removal of at least three well volumes is suggested (USEPA, 1986; Wilde et al., 1998). The amount of water removed may be determined by collecting it in a graduated pail of known volume to determine pumping rate and time of pumping. A flow meter may also be used, as well as capturing all purged water in a container of known volume.

The actual number of well volumes to be removed is based on the stabilization of water-quality-indicator parameters of pH, ORP, SEC, DO, and turbidity. The water initially pumped is commonly turbid. In order to keep the turbidity and other probes from being clogged with the sediment from the turbid water, the flow-through cell should be bypassed initially for the first well volume. These measurements should be taken and recorded every ½ well volume after the removal of 1 to 1 ½ well volume(s). Once three successive readings of the water-quality-indicator parameters provided in the table have stabilized, sampling may begin. The water-quality-indicator parameters that are recommended include pH and temperature, but these are generally insensitive to indicate completion of purging since they tend to stabilize rapidly (Puls and Barcelona, 1996). ORP may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions, and for some fate and transport issues. When possible, especially when sampling for contaminants that may be biased by the presence of turbidity, the turbidity reading is desired to stabilize at a value below 10 Nephelometric Turbidity Units (NTUs). For final DO measurements, if the readings are less than 1 milligram per liter, they should be collected with the spectrophotometric method (Wilde et al., 1998, Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). All of these water-quality-indicator parameters should be evaluated against the specifications of the accuracy and resolution of the instruments used. No more than six well volumes should be purged, to minimize the over pumping effects described by Gibs and Imbrigiotta (1990).

Purging Methods

In a well that is not being pumped, there will be little or no vertical mixing in the water column between sampling events, and stratification may occur. The water in the screened section may mix with the ground water due to normal flow patterns, but the water above the screened section will remain isolated and become stagnant. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in unrepresentative water quality. To safeguard against collecting nonrepresentative stagnant water in a sample, the following guidelines and techniques should be adhered to during sample collection:

Table of Stabilization Criteria with References for Water-Quality-Indicator Parameters

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1	Puls and Barcelona, 1996; Wilde et al., 1998
specific electrical conductance (SEC)	+/- 3%	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen (DO)	+/- 0.3 milligrams per liter	Wilde et al., 1998

1. As a general rule, monitoring wells should be pumped or bailed (although bailing is to be strongly avoided) prior to collecting a sample. Evacuation of a minimum of three volumes of water in the well casing is recommended for a representative sample. In a high-yielding ground-water formation where there is no stagnant water in the well above the screened section (commonly referred to as a water-table well), evacuation prior to sample withdrawal is not as critical but serves to field rinse and condition sampling equipment. The purge criteria has been described previously and will be again in the SAMPLING PROCEDURES section on the following page. The rate of purging should be at a rate and by a method that does not cause aeration of the water column and should not exceed the rate at which well development was completed.

2. For wells that can be pumped or bailed to dryness with the sampling equipment being used, the well should be evacuated to just above the well screen interval and allowed to recover prior to sample withdrawal. (Note: It is important not to completely dewater the zone being sampled, as this may allow air into that zone which could result in negative bias in organic and metal constituents.) If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred.

3. A non-representative sample also can result from excessive prepumping of the monitoring well. Stratification of the contaminant concentrations in the ground-water formation may occur or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can decrease or increase the contaminant concentrations from what is representative of the sampling point of interest, as well as increase turbidity and create large quantities of waste water.

The method used to purge a well depends on the inner diameter, depth-to-water level, volume of water in the well, recovery rate of the aquifer, and accessibility of the well to be sampled. The types of equipment available for well evacuation include hand-operated or motor-driven suction pumps, peristaltic pumps, submersible pumps, and bailers made of various materials, such as stainless steel and Teflon®. Whenever possible, the same device used for purging the well should be left in the well and used for sampling, generally in a continual manner from purging directly to sampling without altering position of the sampling device or turning off the device.

When purging/sampling equipment must be reused in other wells, it should be decontaminated consistent with the decontamination procedures outlined in this document. Purged water should be collected and screened with air-monitoring equipment as outlined in the site health and safety plan, as well as water-quality field instruments. If these parameters and/or the facility background data suggest that the water is hazardous, it should be contained and disposed of properly as determined on a site-specific basis.

During purging, water-level measurements should be recorded regularly for shallow wells, typically at 15- to 30-second intervals. These data may be useful in

computing aquifer transmissivity and other hydraulic characteristics, and for adjusting purging rates. In addition, these data will assure that the water level doesn't fall below the pump intake level

SAMPLING PROCEDURES

Ground-water sample collection should take place immediately following well purging. Preferably, the same device should be used for sample collection as was used for well purging, minimize further disturbance of the water column, and reduce volatilization and turbidity. In addition, this will save time and avoid possible contamination from the introduction of additional equipment into the well, as well as using equipment materials already equilibrated to the ground water. Sampling should occur in a progression from the least to most contaminated well, if known, when the same sampling device is used.

The sampling procedure is as follows:

1) Remove locking well cap. Note location, time of day, and date in field notebook or on an appropriate log form.
2) Note wind direction. Stand upwind from the well to avoid contact with gases/vapors emanating from the well.
3) Remove well casing cap.
4) If required by site-specific conditions, monitor headspace of well with appropriate air-monitoring equipment to determine presence of volatile organic compounds or other compounds of concern and record in field logbook.
5) If not already completed, measure the water level from the reference measuring point on the well casing or protective outer casing (if inner casing not installed or inaccessible) and record it in the field notebook. Alternatively, if no reference point exists, note that the water level measurement is from the top of the outer protective casing, top of inside riser pipe, ground surface, or some other position on the well head. Have a permanent reference point established as soon as possible after sampling. Measure at least twice to confirm measurement; the measurement should agree within 0.01 feet or re-measure. Decontaminate the water-level-measuring device.
6) If not already completed, measure the total depth of the well (at least twice to confirm measurement; the measurement should agree within 0.01 feet or re-measure) and record it in the field notebook or on log form. Decontaminate the device used to measure total depth. If the total well depth has been measured recently (in the past year), then measure it at the conclusion of sampling.
7) Calculate the volume of water in the well and the volume to be purged using the formula previously provided.
8) Lay plastic sheeting around the well to minimize the likelihood of contamination of equipment from soil adjacent to the well.
9) Rinse the outside of sampling pump with distilled water and then, while lowering the pump, dry it with disposable paper towels.
10) Lower the pump (or bailer) and tubing down the well. The sampling equipment should never be dropped into the well because this will cause degassing of the water upon impact. This may also increase turbidity, which may bias the metals analysis. The lowering of the equipment should be slow and smooth!
11) The pump should be lowered to a point just below the water level. If the water level is above the screened interval, the pump should be above the screened interval for the reasons provided in the purging section.
12) Turn the pump on. The submersible pumps should be operated in a continuous, low-flow manner so that they do not produce pulsating flows, which cause aeration in the discharge tubing, aeration upon discharge, or resuspension of sediments at the bottom of the well. The sampling pump flow rates should be lower than or the same as the purging rates. The purging and sampling rates should not be any greater than well development rates.
13) Water levels should be monitored during pumping to ensure that air does not enter the pump and to help determine an appropriate purging rate.
14) After approximately one to two well volumes are removed, a flow-through cell will be hooked up to the discharge tubing of the pump. If the

well discharge water is not expected to be highly turbid, contain separate liquid phases, or minimal bacterial activitiy that may coat or clog the electrodes within the flow-through cell, then the cell can be immediately hooked up to the discharge tubing. This cell will allow measurements of water-quality-indicator parameters without allowing contact with the atmosphere prior to recording the readings for temperature, pH, ORP, SEC, DO and turbidity.

15) Measurements for temperature, pH, ORP, SEC, DO, and turbidity will be made at each one-half well volume removed. Purging may cease when measurements for all five parameters have stabilized (provided in the earlier table) for three consecutive readings.

16) If the water level is lowered to the pump level before three volumes have been removed, the water level will be allowed to recover for 15 minutes, and then pumping can begin at a lower flow rate. If the pump again lowers the water level to below the pump intake, the pump will be turned off and the water level allowed to recover for a longer period of time. This will continue until a minimum of two well volumes are removed prior to taking the ground-water sample.

17) If the water-quality-indicator parameters have stabilized, sample the well. Samples will be collected by lowering the flow rate to a rate that minimizes aeration of the sample while filling the bottles (approximately 300 ml/min). Then a final set of water-quality-indicator parameters is recorded. The pump discharge line is rapidly disconnected from the flow-through cell to allow filling of bottles from the pump discharge line. The bottles should be filled in the order of volatile organic compounds bottles first, followed by semi-volatile organic compound's/pesticides, inorganics, and other unfiltered samples. Once the last set of samples is taken, if filtering is necessary, an in-line disposable filter (with appropriately chosen filter size) will be added to the discharge hose of the pump. Then the filtered samples will be taken. If a bailer is used for obtaining the samples, filtering occurs at the sampling location immediately after the sample is obtained from the bailer by using a suction filter. The first one-half to one liter of sample taken through the filter will not be collected, in order to assure the filter media is acclimated to the sample. If filtered samples are collected, WITHOUT EXCEPTION, filtering should be performed in the field as soon as possible after collection, and not later in a laboratory.

18) All appropriate samples that are to be cooled, are put into a cooler with ice immediately. All of the samples should not be exposed to sunlight after collection. Keep the samples from freezing in the winter when outside temperatures are below freezing. The samples, especially organics, cyanide, nutrients, and other analytes with short holding times, are recommended to be shipped or delivered to the laboratory daily. Ensure that the appropriate samples that are to be cooled remain at 4°C, but do not allow any of the samples to freeze.

19) If a pump cannot be used because the recovery rate is slow and the volume of the water to be removed is minimal (less than 5 feet of water), then a Teflon® bailer, with a double check valve and bottom-emptying device with a control-flow check valve will be used to obtain the samples. The polypropylene rope used with the bailer will be disposed of following the completion of sampling at each well.

20) The pump is removed from the well and decontaminated for the next sampling location.

Additional precautions to ensure accurate and representative sample collection are as follows:

- Check valves on bailers, if bailers are used, should be designed and inspected to ensure that fouling problems do not reduce delivery capabilities or result in aeration of the sample.
- The water should be transferred to a sample container in a way that will minimize agitation and aeration.
- If the sample bottle contains no preservatives, the bottle should be rinsed with sample water, which is discarded before sampling. Bottles for sample analyses that require preservation should be prepared before they are taken to the well. Care should be taken to avoid overfilling bottles so that the preservative is not lost. The pH should be checked and more preservatives added to inor-

ganic sample bottles, if needed. VOA bottles that do not meet the ph requirements need to be discarded and new sample bottles with more preservative added should be prepared immediately.

- Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces either prior to sampling or during storage and transport.

Special Consideration for Volatile Organic Compound Sampling

The proper collection of a sample for dissolved volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the samples. Preferred retrieval systems for the collection of un-biased volatile organic samples include positive displacement pumps, low-flow centrifugal pumps, and some in-situ sampling devices. Field conditions and other constraints will limit the choice of appropriate systems. The principal objective is to provide a valid sample for analysis, one that has been subjected to the least amount of turbulence possible.

1) Fill each vial to just overflowing. Do not rinse the vial, nor excessively overflow it, as this will effect the pH by diluting the acid preservative previously placed in the bottle. Another option is to add the acid at the well, after the sample has been collected. There should be a convex meniscus on the top of the vial.
2) Do not over tighten and break the cap.
3) Invert the vial and tap gently. Observe the vial closely. If an air bubble appears, discard the sample and collect another. It is imperative that no entrapped air remains in the sample vial. Bottles with bubbles should be discarded, unless a new sample cannot be collected, and then the presence of the bubble should be noted in the field notes or field data sheet. If an open sample bottle is dropped, the bottle should be discarded.
4) Orient the VOC vial in the cooler so that it is lying on its side, not straight up.
5) The holding time for VOCs is 14 days. It is recommended that samples be shipped or delivered to the laboratory daily. Ensure that the samples remain at 4°C, but do not allow the samples to freeze.

Field Filtration of Turbid Samples

The USEPA recognizes that in some hydrogeologic environments, even with proper well design, installation, and development, in combination with the low-flow rate purging and sampling techniques, sample turbidity cannot be reduced to ambient levels. The well construction, development, and sampling information should be reviewed by the Regional geologists or hydrologists to see if the source of the turbidity problems can be resolved or if alternative sampling methods should be employed. If the water sample is excessively turbid, the collection of both filtered and unfiltered samples, in combination with turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pumping rate, and drawdown data is recommended. The filter size used to determine TSS and TDS should be the same as used in the field filtration. An in-line filter should be used to minimize contact with air to avoid precipitation of metals. The typical filter media size used is 0.45 µm because this is commonly accepted as the demarcation between dissolved and non-dissolved species. Other filter sizes may be appropriate, but their use should be determined based on site-specific criteria (examples include grain-size distribution, ground-water flow velocities, mineralogy) and project DQOs. Filter sizes up to 10.0 µm may be warranted because larger size filters may allow particulates that are mobile in ground water to pass through (Puls and Powell, 1992). The changing of filter media size may limit the comparability of the data obtained with other data sets and may affect their use in some geochemical models. Filter media size used on previous data sets from a site, region, or aquifer and the DQOs should be taken into consideration. The filter media used during the ground-water sampling program should be collected in a suitable container and archived because potential analysis of the media may be helpful for the determination of particulate size, mineralogy, etc.

The first 500 to 1000 milliliters of sample taken through the filter, depending on sample turbidity, will not be collected for a sample, in order to ensure that the filter media has equilibrated to the sample. Manufacturers' recommendations also should be consulted. Because bailers have been shown to increase

turbidity while purging and sampling, they should be avoided when sampling for trace element, metal, PCB, and pesticide constituents. If portable sampling pumps are used, the pumps should be gently lowered to the sampling depth desired, carefully avoiding being lowered to the bottom of the well. The pumps, once placed in the well, should not be moved to allow any particles mobilized by pump placement to settle. Dedicated sampling equipment installed in the well prior to the commencement of the sampling activities is one of the recommended methods to reduce turbidity artifacts (Puls and Powell, 1992; Kearl et al., 1992; Puls et al., 1992; Puls and Barcelona, 1996).

DECONTAMINATION PROCEDURES

Once removed from the well, the purging and sampling pumps should be decontaminated by scrubbing with a brush and a non-phosphate soapy-water wash, rinsed with water, and rinsed with distilled water to help ensure that there is no cross-contamination between wells. The step-by-step procedure is:

1) Pull pump out of previously sampled well (or out of vehicle) and use three pressure sprayers filled with soapy water, tap water, and distilled water. Spray outside of tubing and pump until water is flowing off of tubing after each rinse. Use bristle brush to help remove visible dirt, contaminants, etc.
2) Have three long PVC tubes with caps or buckets filled with soapy water, tap water and distilled water. Run pump in each until approximately 2 to 3 gallons of each decon solution is pumped through tubing. Pump at low rate to increase contact time between the decon solutions and the tubing.
3) Try to pump decon solutions out of tubing prior to next well. If this cannot be done, compressed air may be used to purge lines. Another option is to install a check valve in the pump line (usually just above the pump head) so that the decon solutions do not run back down the well as the pump is lowered down the next well.
4) Prior to lowering the pump down the next well, spray the outside of the pump and tubing with distilled water. Use disposable paper towels to dry the pump and tubing.
5) If a hydrophobic contaminant is present (such as separate phase, high levels of PCBs, etc.), an additional decon step, or steps, may be added. For example, an organic solvent such as reagent-grade isopropanol alcohol may be added as a first rinse prior to the soapy water rinse.

If the well has been sampled with a bailer that is not disposable, the bailer should be cleaned by washing with soapy water, rinsing with tap water, and finally rinsing with distilled water. Bailers are most easily cleaned using a long-handled bottle brush.

It is especially important to clean thoroughly the portion of the equipment that will be in contact with sample water. In addition, a clean plastic sheet should be placed adjacent to or around the well to prevent surface soils from coming in contact with the purging equipment. The effects of cross-contamination also can be minimized by sampling the least contaminated well first and progressing to the more contaminated ones. The bailer cable/rope (if a bailer is used) and plastic sheet should be properly discarded, as provided in the site health and safety plan, and new materials provided for the next well.

FIELD QUALITY CONTROL

The quality assurance (QA) targets for precision and accuracy of sampling programs are based on accuracy and precision guidelines established by the USEPA. When setting targets, keep in mind that all measurements must be made so that the results are representative of the sample water and site-specific conditions. Various types of blanks are used to check the cleanliness of the field-handling methods. These are known as field blanks, and include field equipment blanks and transport blanks. Other QA samples include spike samples and duplicates.

There are five primary areas of concern for QA in the collection of representative ground-water samples:

1. Obtaining a sample that is representative of water in the aquifer or targeted zone of the aquifer. Verify log documentation that the well was purged of the required volume or that the temperature, pH, ORP, SEC, DO and turbidity stabilized before samples were extracted.

2. Ensuring that the purging and sampling devices are made of materials and utilized in a manner that will not interact with or alter the analyses.
3. Generating results that are reproducible. Therefore, the sampling scheme should incorporate co-located samples (duplicates).
4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling and purging equipment; decontamination of the equipment is therefore required.
5. Ensuring that samples are properly preserved, packaged, and shipped.

FIELD EQUIPMENT BLANKS

To ensure QA and quality control, a field equipment blank must be included in each sampling run, or for every twenty samples taken with the sampling device. Equiptment blanks allow for a cross check and, in some cases, quantitative correction for imprecision that could arise due to handling, preservation, or improper cleaning procedures.

Equipment blanks should be taken for each sample bottle type that is filled. Distilled water is run through the sampling equipment and placed in a sample bottle (the blank), and the contents are analyzed in the lab like any other sample. Following the collection of each set of twenty samples, a field equipment blank will be obtained. It is generally desirable to collect this field equipment blank after sampling a relatively highly contaminated well. These blanks may be obtained through the following procedure:

a) Following the sampling event, decontaminate all sampling equipment according to the site decontamination procedures and before collecting the blank.
b) VOA field blanks should be collected first, prior to water collected for other TAL/TCL analyses. A field blank must be taken for all analyses.
c) Be sure that there is enough distilled water in the pump so that the field equipment blank can be collected for each analysis.
d) The water used for the field equipment blank should be from a reliable source, documented in the field notebooks, and analyzed as a separate water-quality sample.

TRIP BLANKS

A trip blank should be included in each sample shipment and, at a minimum, one per 20 samples. Bottles, identical to those used in the field, are filled with reagent-grade water. The source of the reagent-grade water should be documented in the field notebooks, including lot number and manufacture. This sample is labeled and stored as though it is a sample. The sample is shipped back to the laboratory with the other samples and analysis is carried out for all the same constituents.

DUPLICATE SAMPLES

Duplicate samples are collected by taking separate samples as close to each other in time and space as practical, and should be taken for every 20 samples collected. Duplicate samples are used to develop criteria for acceptable variations in the physical and chemical composition of samples that could result from the sampling procedure. Duplicate results are utilized by the QA officer and the project manager to give an indication of the precision of the sampling and analytical methods.

HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phases through the use of appropriate personal protective equipment.

Depending on the type of contaminant expected or determined in previous sampling efforts, the following safe work practices will be employed:

Particulate or metals contaminants

1. Avoid skin contact with, and accidental ingestion of, purge water.
2. Wear protective gloves and splash protection.

Volatile organic contaminants

1. Avoid breathing constituents venting from well.
2. Pre-survey the well head space with an appropriate device as specified in the Site Health and Safety Plan.
3. If air monitoring results indicate elevated organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®.

General practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when filling, pre-preserved VOA bottles, hydrochloric acid fumes may be released and should not be inhaled.

POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to:

- Ensuring that all field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing all sample paperwork, including copies provided to Central Regional Laboratory, Sample Management Office, or other appropriate sample handling and tracking facility.
- Compiling all field data for site records.
- Verifying all analytical data processed by the analytical laboratory against field sheets to ensure all data has been returned to sampler.

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GROUND-WATER SAMPLING RECORD

Well ID:_____

Station #:_____

Facility Name: Date:____/____/____

Well Depth:_____ Depth to Water:_____ Well Diameter:_____

Casing Material.:_____ Volume Of Water per Well Volume:_____

Sampling Crew:_____,_____,_____,_____

Type of Pump:_____ _____ Tubing Material:_____ Pump set at _____ ft.

Weather Conditions:_____ NOTES:_____ _____

_____

GROUND-WATER SAMPLING PARAMETERS

Time	Water Level	Volume Pumped	Pumping Rate	DO (mg/l)	Temp. (^{0}C)	SEC (μS/cm)	pH	ORP (mV)	Turbidity (NTU)

Other Parameters: _____

Sampled at:_____ Parameters taken with :_____

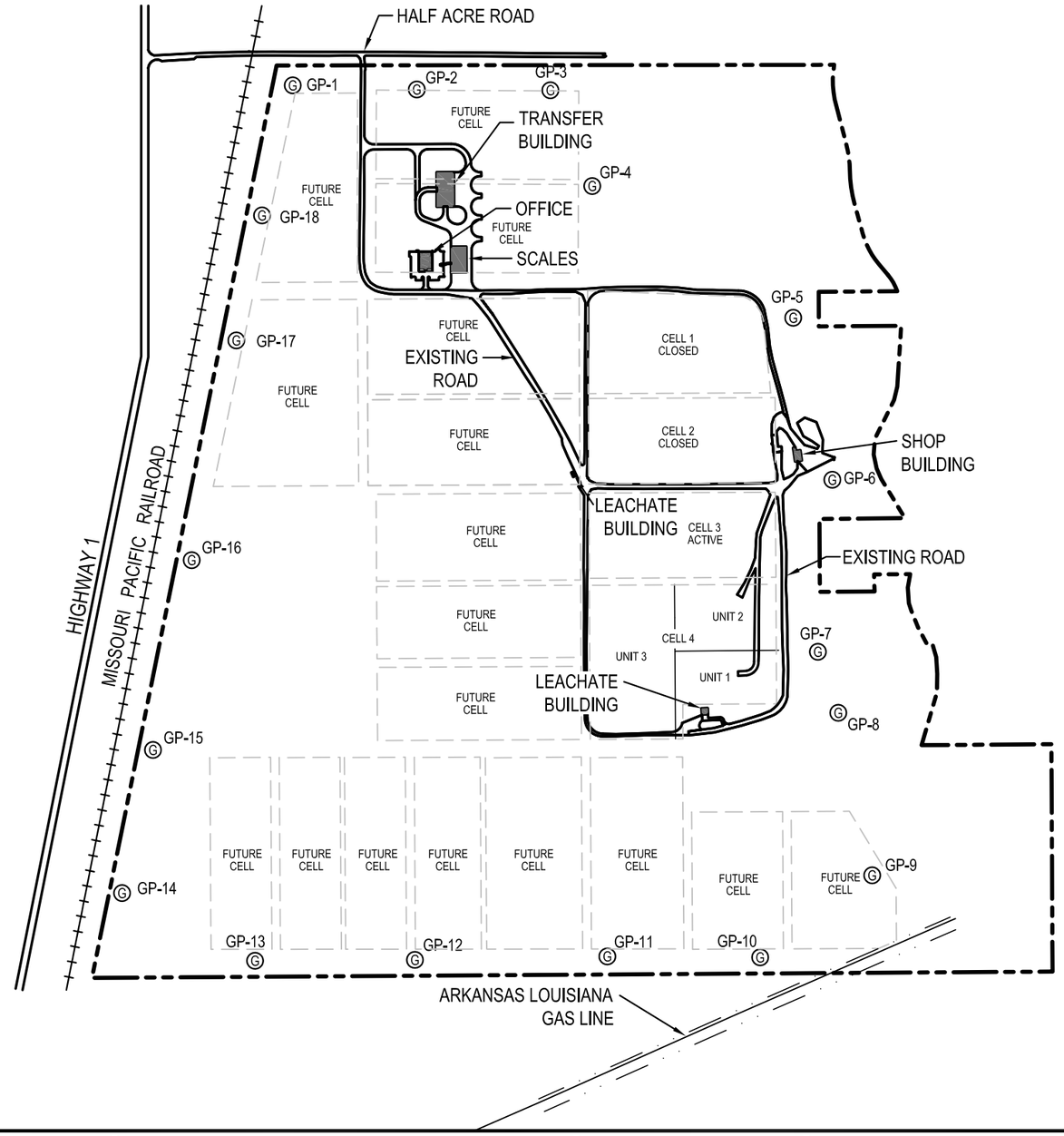
Sample delivered to _____ by _____ at_____.

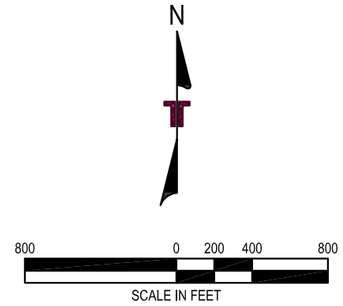
Sample CRL #:_____ OTR #:_____ ITR #:_____ SAS #:_____

Parameters Collected	Number of Bottles	Bottle Lot Number

ATTACHMENT D

Revised Gas Probe Installation Records and Boring Logs





LEGEND:

PROPERTY BOUNDARY

GP-1 EXPLOSIVE GAS PROBE MONITORING LOCATION

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

EXPLOSIVE GAS PROBE INSTALLATION MAP

EXPLOSIVE GAS PROBE INSTALLATION REPORT

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA)

LEGACY LANDFILL

JONESBORO ARKANSAS

FIGURE 2

DESIGNED BY:	HAL
DRAWN BY:	PTG
APPVD. BY:	HAL
SCALE:	1" = 800'
DATE:	3/8/2012
JOB NO.	282-001-35117105
ACAD NO.	035
SHEET NO.:	OF

Terracon
Consulting Engineers and Scientists
25809 I-30 South BRYANT, AR. 72022
PH. (501) 847-9292 FAX. (501) 847-9210

FIELD BORING LOG

BORING NO.: GP-1 PAGE: 1 of 1

TOTAL DEPTH: 33 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-014	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-19-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 28' SILTY CLAY tan, dry			Logged by cuttings
5					
10					
15					
20					
25		25' - 28' more silt			
30		28' - 33' SAND tan, fine grained, dry			
35		Total Depth of Boring at 33' bgs			

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FIELD BORING LOG

BORING NO.: GP-2 PAGE: 1 of 1

TOTAL DEPTH: 25 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-015	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-19-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 15' SILTY CLAY tan, dry			Logged by cuttings
15		15' - 25' SAND tan, fine grained, dry			
25		Total Depth of Boring at 25' bgs			
30					
35					

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FIELD BORING LOG

BORING NO.: GP-3 PAGE: 1 of 1

TOTAL DEPTH: 20 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-016	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-19-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 20' SILTY CLAY tan, dry			Logged by cuttings
20		Total Depth of Boring at 20' bgs			

5 10 15 25 30 35

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FIELD BORING LOG

BORING NO.: GP-4 PAGE: 1 of 1

TOTAL DEPTH: 20 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-017	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-19-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 20' SILTY CLAY tan, dry			Logged by cuttings
20		Total Depth of Boring at 20' bgs			

5 10 15 25 30 35

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FIELD BORING LOG

BORING NO.: GP-5 PAGE: 1 of 2

TOTAL DEPTH: 50 FEET BELOW GROUND SURFACE (BGS)

PROJECT: GAS PROBE INSTALLATION

JOB NO.: 282-001-35117105-018

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: GARY MOYER

DATE DRILLED: 5-19-2010

RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

Depth BGS	Sample Interval	N: NA E: NA G.S. ELEV. NA DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
0		0' - 25' SILTY CLAY tan, dry			Logged by cuttings
5					
10					
15					
20					

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FIELD BORING LOG

BORING NO.: GP-5 PAGE: 2 of 2

TOTAL DEPTH: 50 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
		25' - 30' SAND tan, fine grained, dry			Logged by cuttings
30		30' - 40' SANDY CLAY tan, dry			
40		40' - 50' SAND tan, fine grained			
45					Wet at 45'
50		Total Depth of Boring at 50' bgs			
55					

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FIELD BORING LOG

BORING NO.: GP-6 PAGE: 1 of 2

TOTAL DEPTH: 50 FEET BELOW GROUND SURFACE (BGS)

PROJECT: GAS PROBE INSTALLATION

JOB NO.: 282-001-35117105-019

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: GARY MOYER

DATE DRILLED: 5-19-2010

RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

Depth BGS	Sample Interval	N: NA E: NA G.S. ELEV. NA DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
0		0' - 30' SILTY CLAY tan, dry			Logged by cuttings
5					
10					
15					
20					

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FIELD BORING LOG

BORING NO.: GP-6 PAGE: 2 of 2

TOTAL DEPTH: 50 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
		0' - 30' SILTY CLAY tan, dry			Logged by cuttings
30		30' - 50' CLAY brown, some silt			
35					
40		40' - 50' gray			
45					
50		Total Depth of Boring at 50' bgs			
55					

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FIELD BORING LOG

BORING NO.: GP-7 PAGE: 1 of 2

TOTAL DEPTH: 48 FEET BELOW GROUND SURFACE (BGS)

PROJECT: GAS PROBE INSTALLATION

JOB NO.: 282-001-35117105-020

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: GARY MOYER

DATE DRILLED: 5-20-2010

RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

Depth BGS	Sample Interval	N: NA E: NA G.S. ELEV. NA DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
0		0' - 20' SANDY CLAY brown, some gravel, dry			Logged by cuttings
20		20' - 48' SAND tan, some clay and silt, dry			

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FIELD BORING LOG

BORING NO.: GP-7 PAGE: 2 of 2

TOTAL DEPTH: 48 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
		20' - 48' SAND tan, some clay and silt, dry			Logged by cuttings
		Total Depth of Boring at 48' bgs			

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FIELD BORING LOG

BORING NO.: GP-8 PAGE: 1 of 2

TOTAL DEPTH: 47 FEET BELOW GROUND SURFACE (BGS)

PROJECT: GAS PROBE INSTALLATION

JOB NO.: 282-001-35117105-021

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: GARY MOYER

DATE DRILLED: 5-20-2010

RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

Depth BGS	Sample Interval	N: NA E: NA G.S. ELEV. NA DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
0		0' - 47' SANDY CLAY brown, dry			Logged by cuttings
5					
10					
15					
20					

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FIELD BORING LOG

BORING NO.: GP-8 PAGE: 2 of 2

TOTAL DEPTH: 47 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
		25' - 47' SANDY CLAY brown, dry			Logged by cuttings
30		30' - 47' more silt			
35					
40					
45					
		Total Depth of Boring at 47' bgs			
50					
55					

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FIELD BORING LOG

BORING NO.: GP-9 PAGE: 1 of 2

TOTAL DEPTH: 45 FEET BELOW GROUND SURFACE (BGS)

PROJECT: GAS PROBE INSTALLATION

JOB NO.: 282-001-35117105-022

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: GARY MOYER

DATE DRILLED: 5-20-2010

RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV. NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
0		0' - 30' SILTY CLAY brown, dry			Logged by cuttings
5					
10					
15					
20					

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FIELD BORING LOG

BORING NO.: GP-9 PAGE: 2 of 2

TOTAL DEPTH: 45 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
		25' - 30' SILTY CLAY brown, dry			Logged by cuttings
30		30' - 45' SANDY CLAY brown, moist at 42'			
45		Total Depth of Boring at 45' bgs			

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FIELD BORING LOG

BORING NO.: GP-10 PAGE: 1 of 2

TOTAL DEPTH: 36 FEET BELOW GROUND SURFACE (BGS)

PROJECT: GAS PROBE INSTALLATION

JOB NO.: 282-001-35117105-023

DRILLING CO.: ANDERSON ENGINEERING

LOGGED BY: CLANCY McCLINTOCK

DRILLER: GARY MOYER

DATE DRILLED: 5-20-2010

RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

Depth BGS	Sample Interval	N: NA E: NA G.S. ELEV. NA DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
0		0' - 30' SILTY CLAY tan, some fine grained sand, dry			Logged by cuttings
5					
10					
15					
20					

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FIELD BORING LOG

BORING NO.: GP-10 PAGE: 2 of 2

TOTAL DEPTH: 36 FEET BELOW GROUND SURFACE (BGS)

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	P.I.D. (ppm)	Remarks
		25' - 30' SILTY CLAY tan, some fine grained sand, dry			Logged by cuttings
30		30' - 36' SAND tan, dry			
35		Total Depth of Boring at 36' bgs			
40					
45					
50					
55					

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FIELD BORING LOG

BORING NO.: GP-11 PAGE: 1 of 1

TOTAL DEPTH: 35 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-024	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-20-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 30' SILTY CLAY tan, some fine grained sand, dry			Logged by cuttings
30		30' - 35' SAND tan, dry			
35		Total Depth of Boring at 35' bgs			

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FIELD BORING LOG

BORING NO.: GP-12 PAGE: 1 of 1

TOTAL DEPTH: 35 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-025	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-20-2010	RIG TYPE: CME-75
DRILLING METHOD: SOLID FLIGHT AUGER	
SAMPLING METHOD: NA	

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 25' SILTY CLAY tan, dry			Logged by cuttings
25		25' - 35' SAND tan, fine grained, dry			
35		Total Depth of Boring at 35' bgs			

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FIELD BORING LOG

BORING NO.: GP-13 PAGE: 1 of 1

TOTAL DEPTH: 35 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-026	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-21-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 20' SANDY CLAY tan, dry			Logged by cuttings
20		20' - 35' SAND tan, fine grained, dry			
35		Total Depth of Boring at 35' bgs			

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FIELD BORING LOG

BORING NO.: GP-14 PAGE: 1 of 1

TOTAL DEPTH: 34 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-027	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-21-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 25' SILTY CLAY tan, dry			Logged by cuttings
25		25' - 34' SAND tan, fine grained, dry			
35		Total Depth of Boring at 34' bgs			

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FIELD BORING LOG

BORING NO.: GP-15 PAGE: 1 of 1

TOTAL DEPTH: 34 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-028	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-25-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 25' SANDY CLAY tan, dry			Logged by cuttings
25		25' - 34' SAND tan, dry			
35		Total Depth of Boring at 34' bgs			

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FIELD BORING LOG

BORING NO.: GP-16 PAGE: 1 of 1

TOTAL DEPTH: 33 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-029	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-25-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 24' SILTY CLAY tan, some sand, dry			Logged by cuttings
25		24' - 33' SAND tan, fine grained, dry			
35		Total Depth of Boring at 33' bgs			

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FIELD BORING LOG

BORING NO.: GP-17 PAGE: 1 of 1

TOTAL DEPTH: 34 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-030	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-26-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 23' SILTY CLAY tan, dry			Logged by cuttings
23		23' - 34' SAND tan, dry			
34		Total Depth of Boring at 34' bgs			

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FIELD BORING LOG

BORING NO.: GP-18 PAGE: 1 of 1

TOTAL DEPTH: 35 FEET BELOW GROUND SURFACE (BGS)

CLIENT: CCSWDA LEGACY LANDFILL	PROJECT: GAS PROBE INSTALLATION
JOB NO.: 282-001-35117105-031	DRILLING CO.: ANDERSON ENGINEERING
LOGGED BY: CLANCY McCLINTOCK	DRILLER: GARY MOYER
DATE DRILLED: 5-26-2010	RIG TYPE: CME-75

DRILLING METHOD: SOLID FLIGHT AUGER

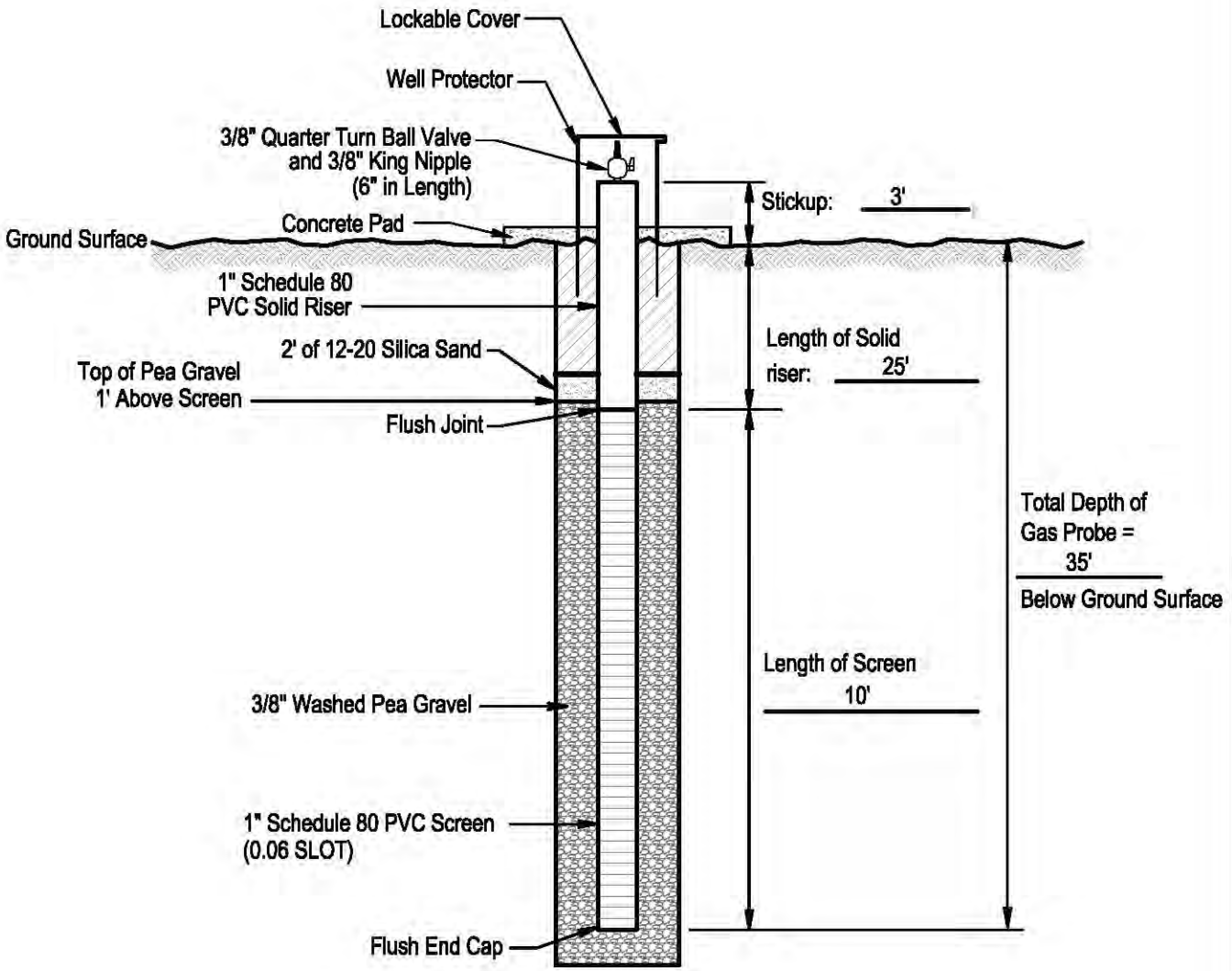
SAMPLING METHOD: NA

N: NA E: NA G.S. ELEV.: NA

Depth BGS	Sample Interval	DESCRIPTION	Litho. Symbol	PID (ppm)	Comments
0		0' - 25' SILTY CLAY tan, dry			Logged by cuttings
25		25' - 35' SAND gray, fine grained, dry			
35		Total Depth of Boring at 35' bgs			

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-18
Installation Date 5/26/2010 Location JONESBORO, AR.
Datum Elevation 252.06 Surface Elevation N/A
Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"
Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK
Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 506247.58 Easting 1700965.23
Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090
WELL NUMBER: GP-18
DRAWING NUMBER: 018 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-17

Installation Date 5/26/2010 Location JONESBORO, AR.

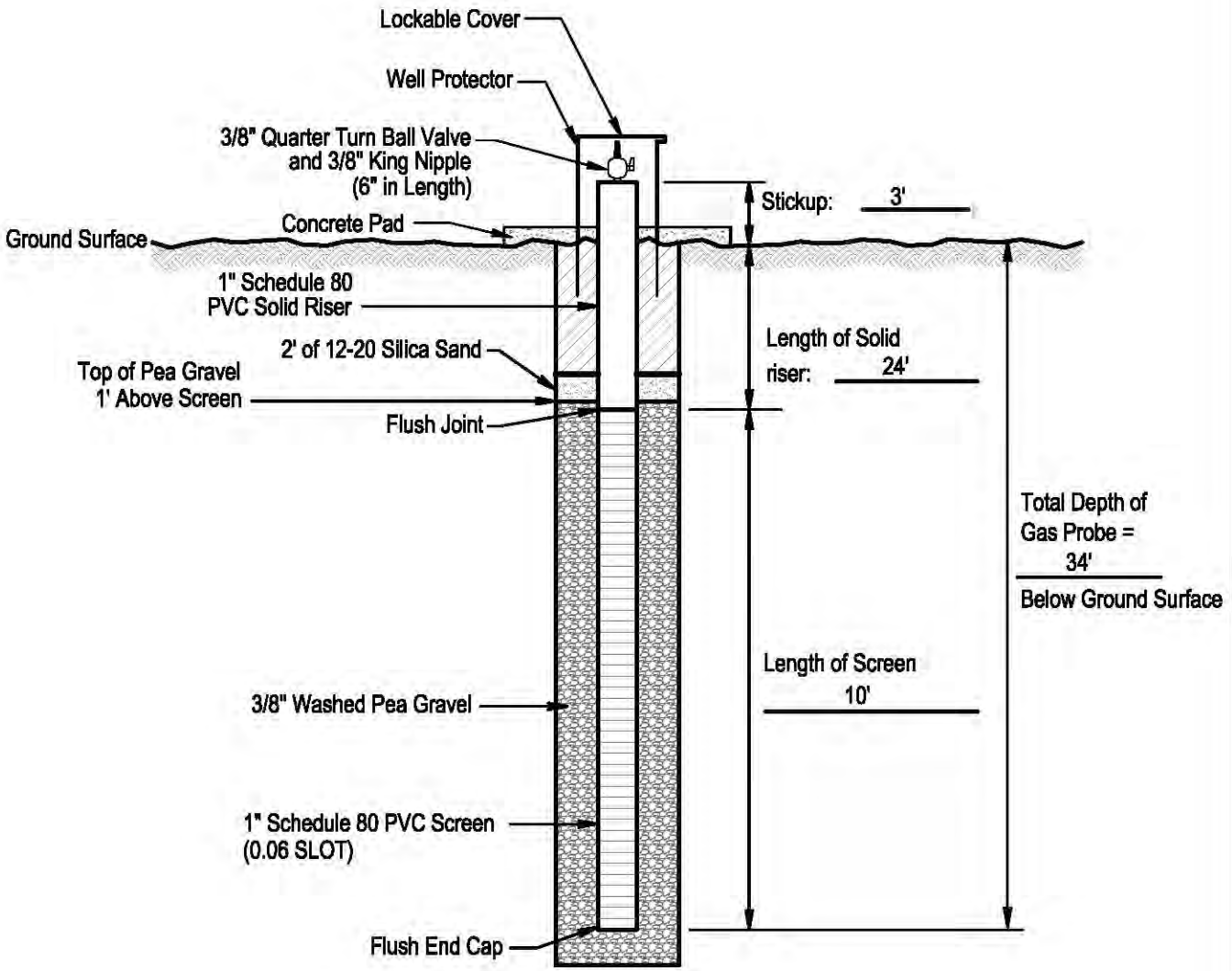
Datum Elevation 252.23 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 505520.36 Easting 1700815.74

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-17

DRAWING NUMBER: 017 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-16

Installation Date 5/25/2010 Location JONESBORO, AR.

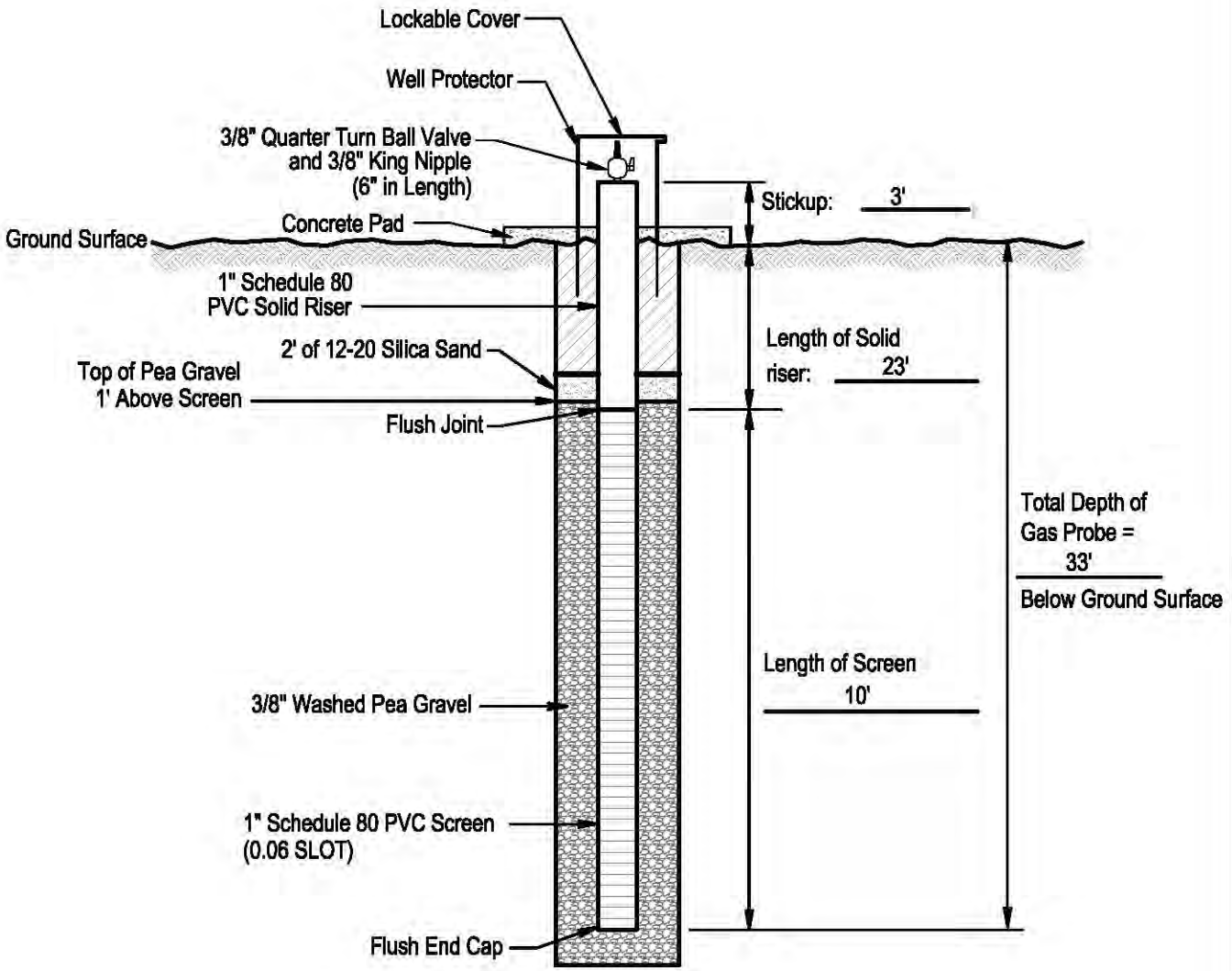
Datum Elevation 251.70 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 504242.04 Easting 1700556.01

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

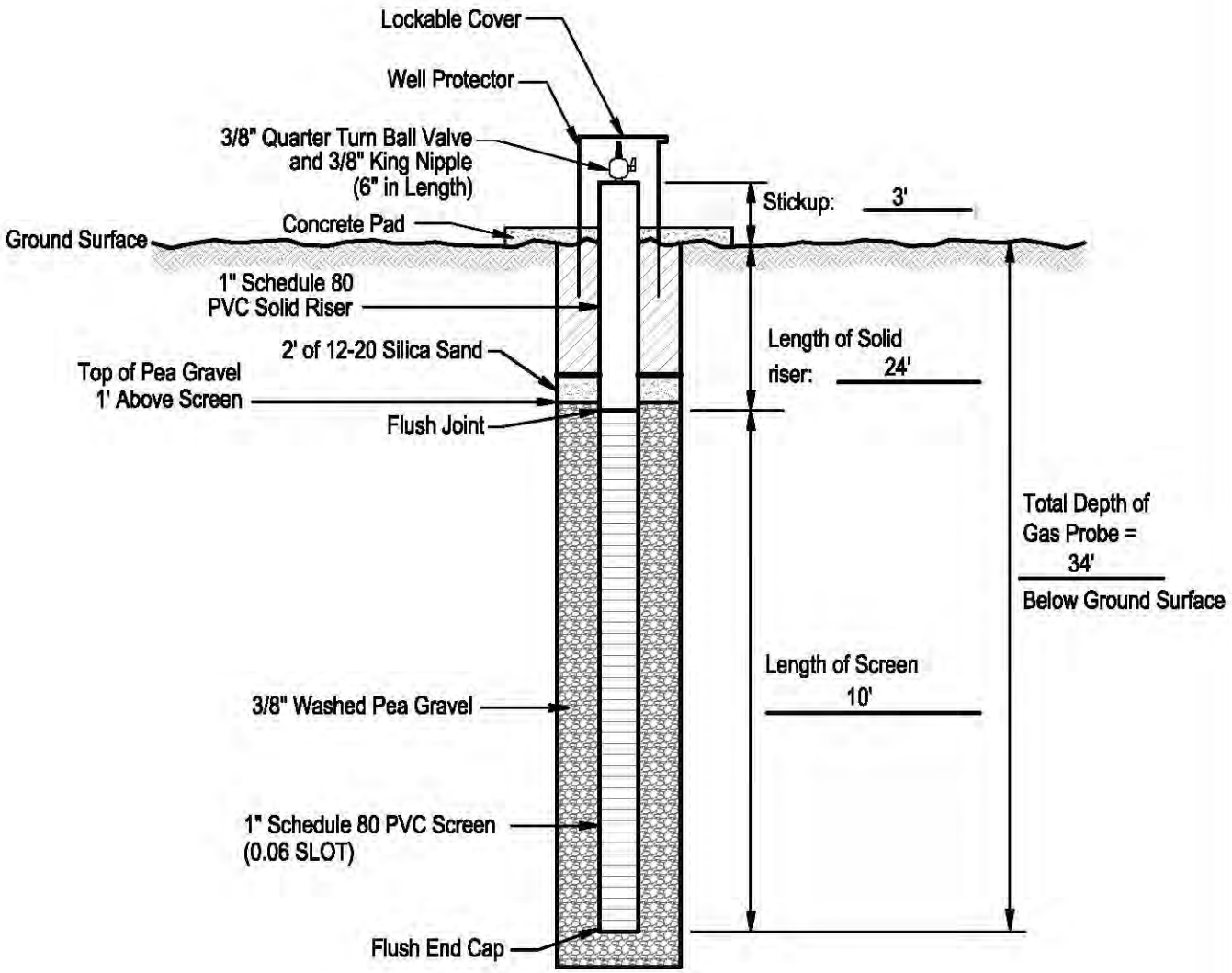
PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-16

DRAWING NUMBER: 016 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-15
Installation Date 5/25/2010 Location JONESBORO, AR.
Datum Elevation 251.88 Surface Elevation N/A
Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"
Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK
Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 503137.85 Easting 1700330.59
Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD
PROJECT NUMBER: 282-001-35107090
WELL NUMBER: GP-15
DRAWING NUMBER: 015 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-14

Installation Date 5/21/2010 Location JONESBORO, AR.

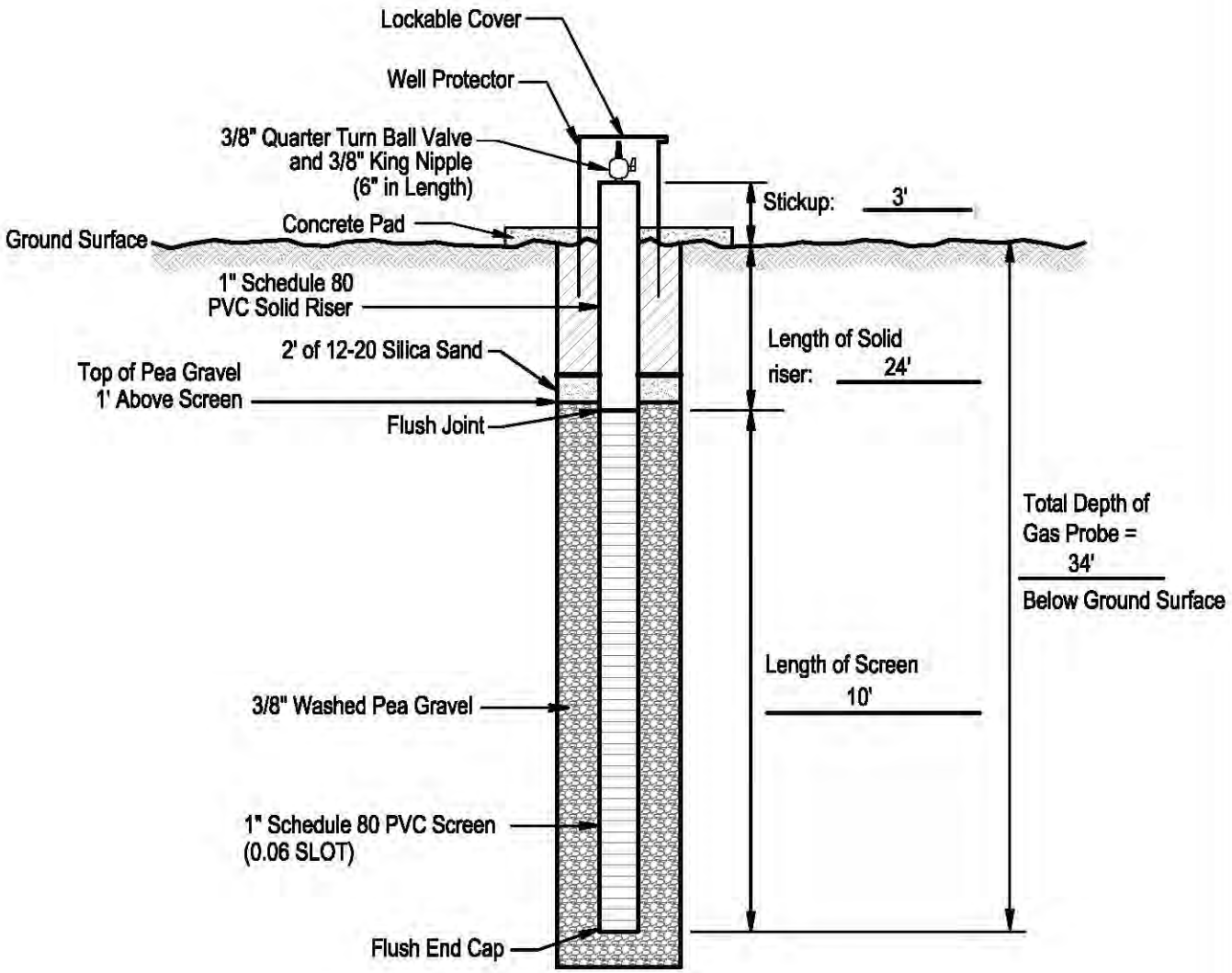
Datum Elevation 252.48 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 502304.98 Easting 1700150.73

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-14

DRAWING NUMBER: 014 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-13

Installation Date 5/21/2010 Location JONESBORO, AR.

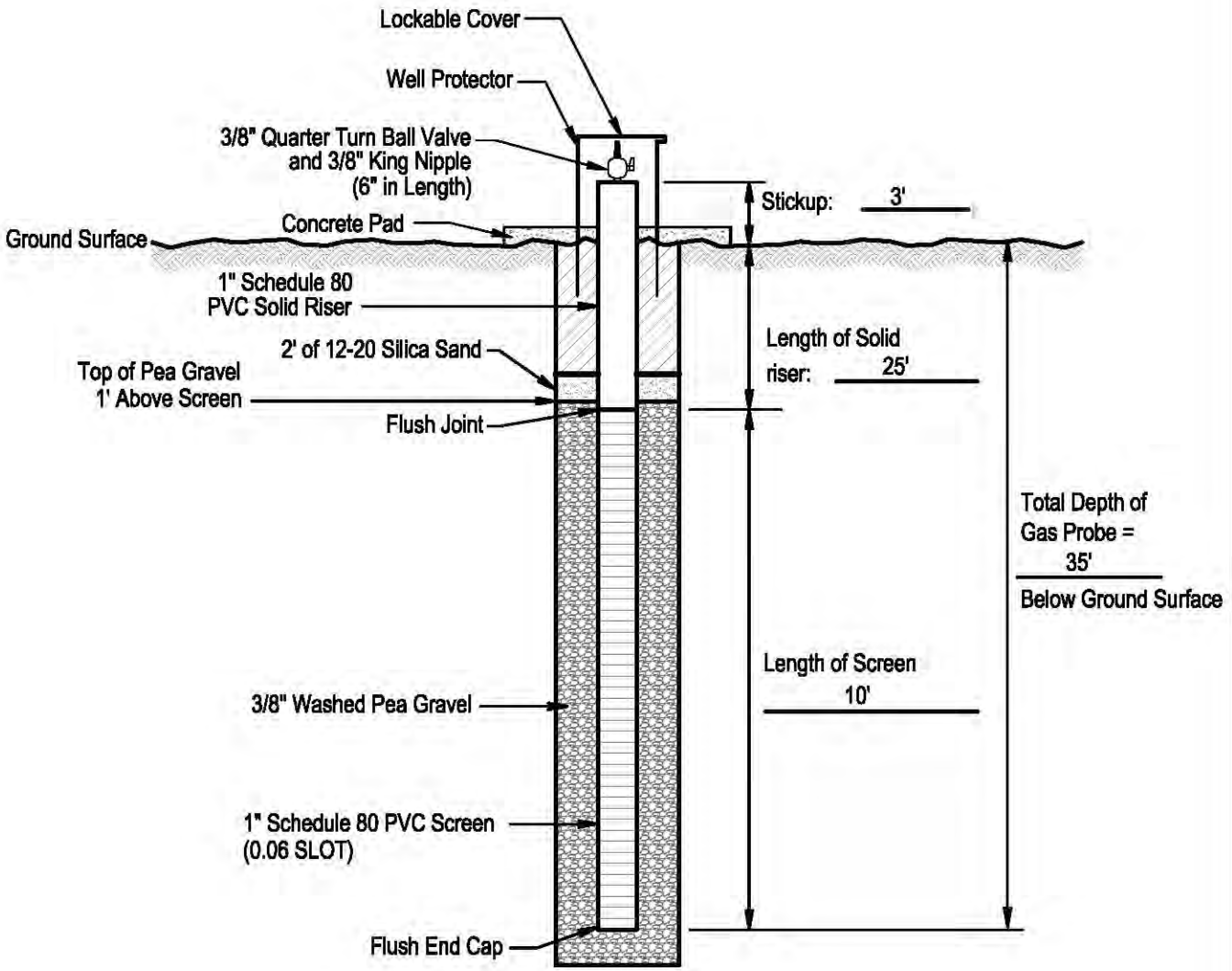
Datum Elevation 250.55 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 501911.33 Easting 1700924.71

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-13

DRAWING NUMBER: 013 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-12

Installation Date 5/20/2010 Location JONESBORO, AR.

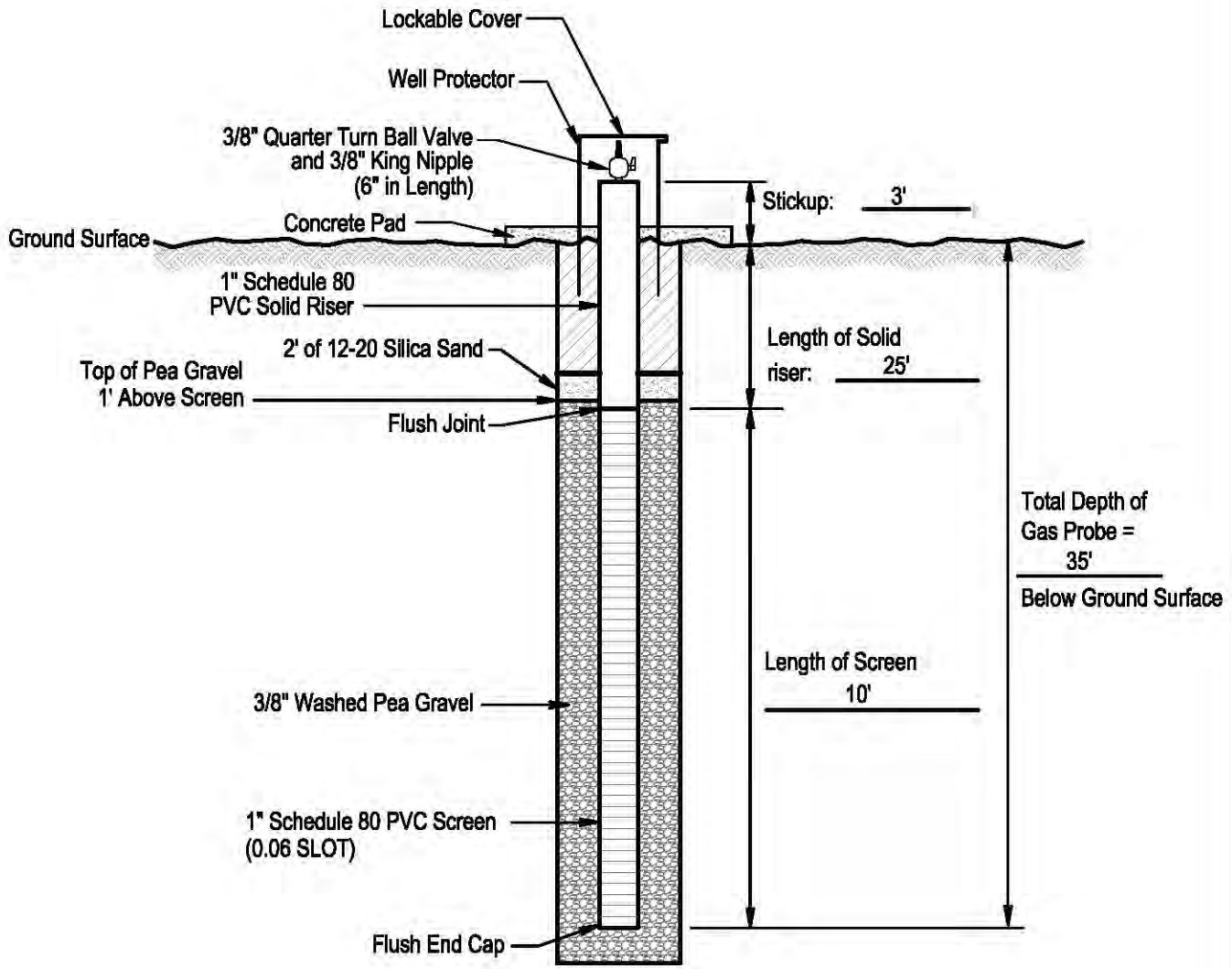
Datum Elevation 250.97 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 501916.28 Easting 1701855.20

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

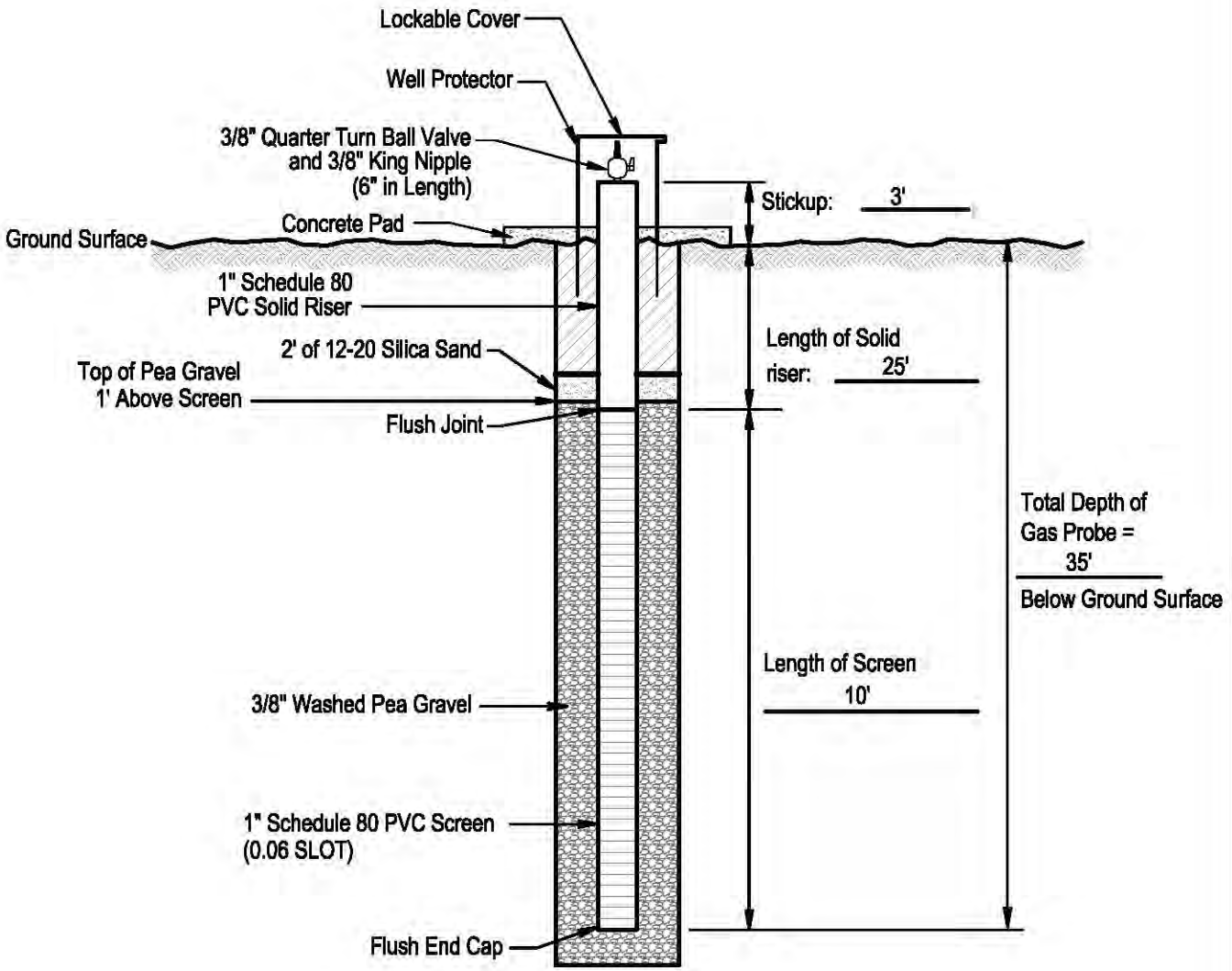
PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-12

DRAWING NUMBER: 012 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-11
Installation Date 5/20/2010 Location JONESBORO, AR.
Datum Elevation 251.82 Surface Elevation N/A
Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"
Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK
Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 501936.64 Easting 1702975.14
Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



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GAS PROBE INSTALLATION RECORD
PROJECT NUMBER: 282-001-35107090
WELL NUMBER: GP-11
DRAWING NUMBER: 011 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-10

Installation Date 5/20/2010 Location JONESBORO, AR.

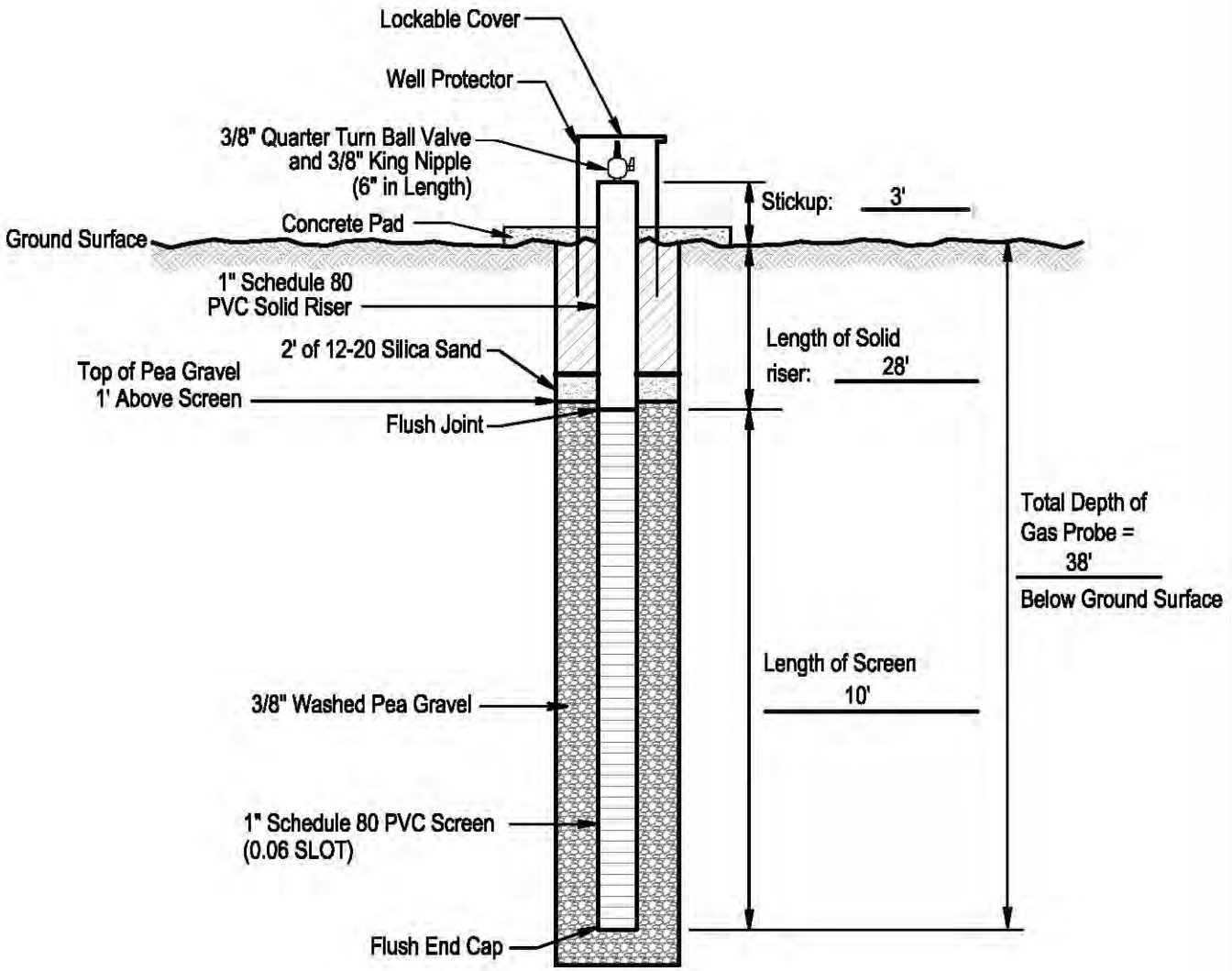
Datum Elevation 259.55 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 501931.22 Easting 1703864.88

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-10

DRAWING NUMBER: 010 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-9

Installation Date 5/20/2010 Location JONESBORO, AR.

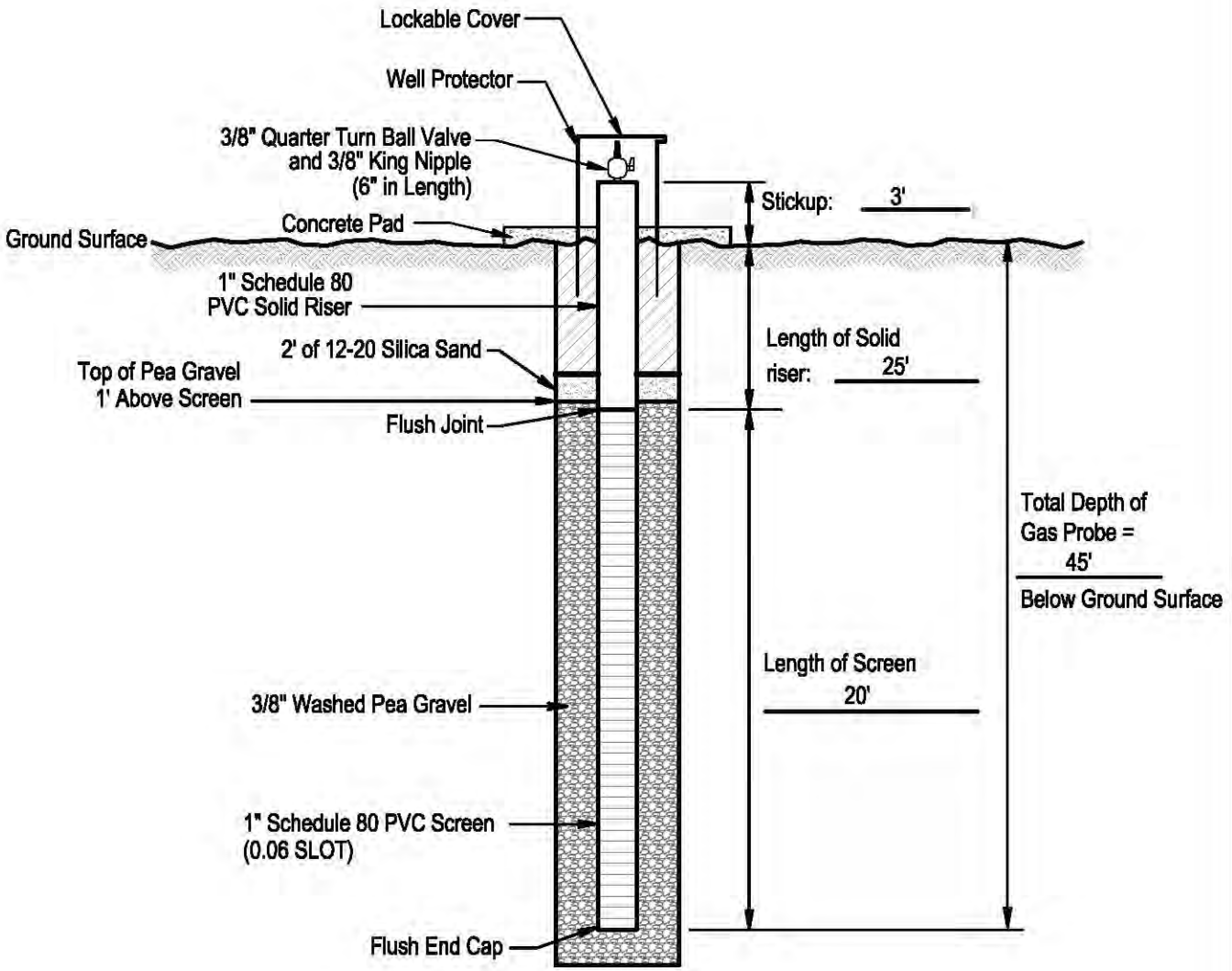
Datum Elevation 280.25 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 502408.50 Easting 1704516.65

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-9

DRAWING NUMBER: 009 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-8

Installation Date 5/20/2010 Location JONESBORO, AR.

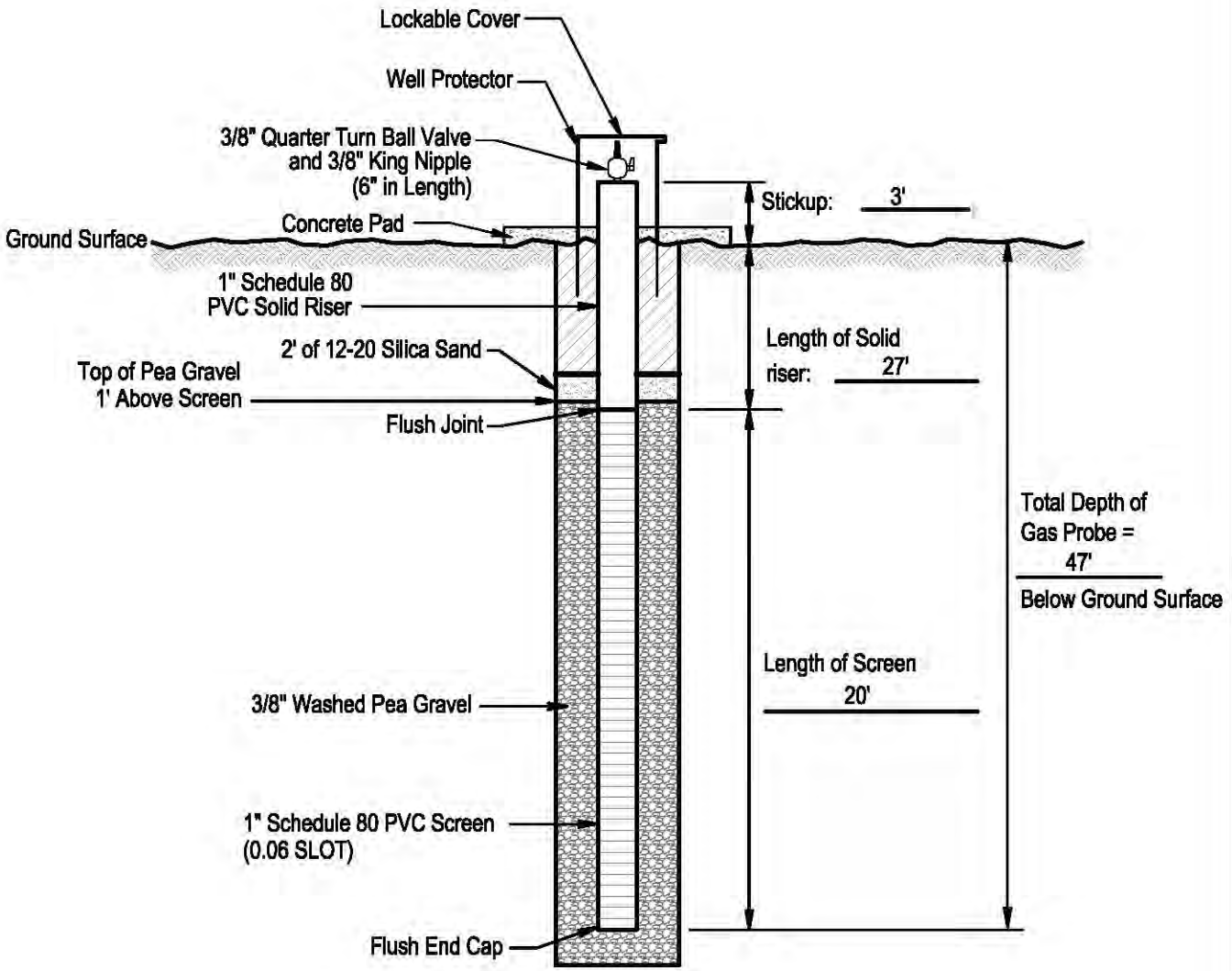
Datum Elevation 293.84 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 503353.84 Easting 1704319.34

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-8

DRAWING NUMBER: 008 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-7

Installation Date 5/20/2010 Location JONESBORO, AR.

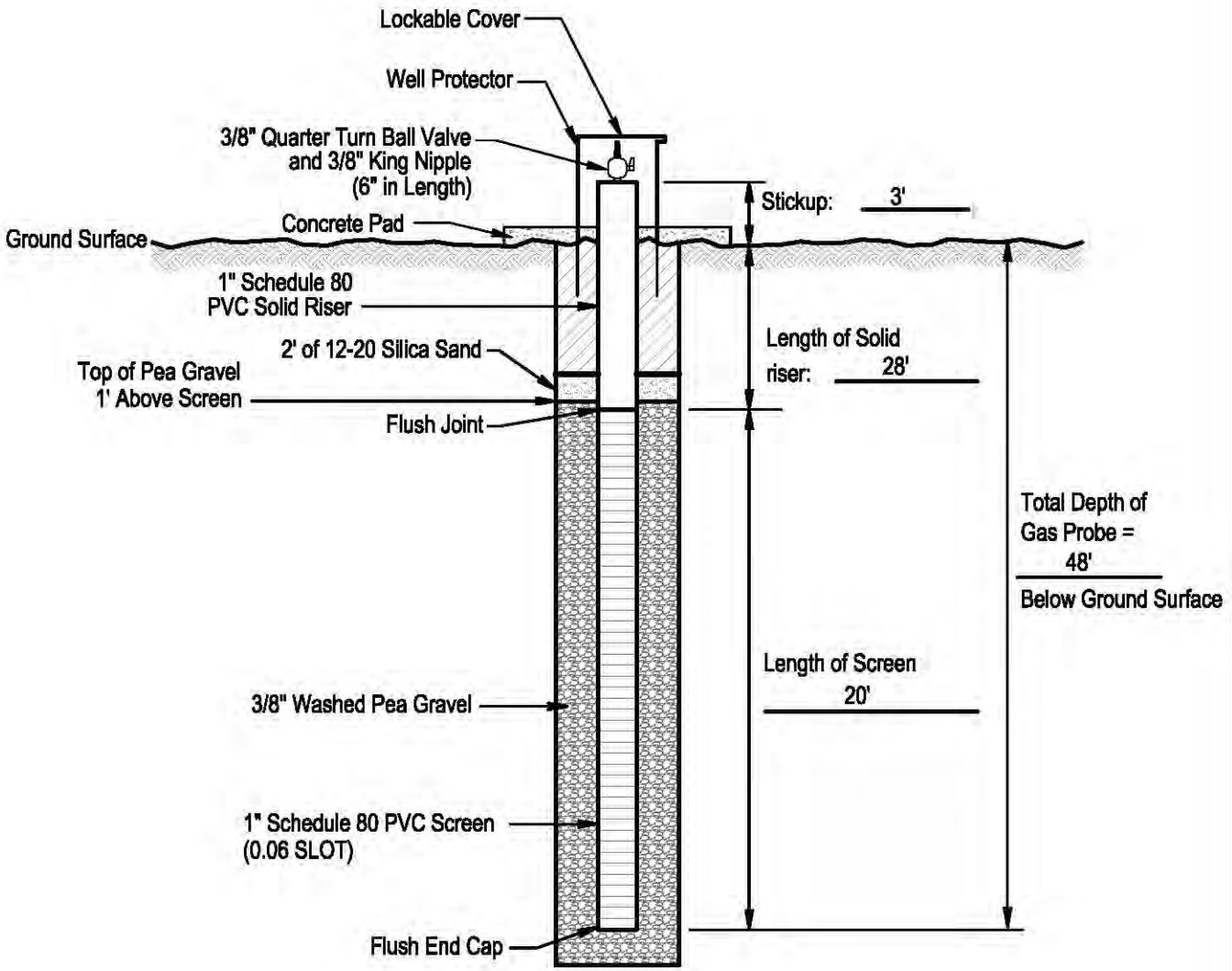
Datum Elevation 288.17 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 503708.78 Easting 1704200.57

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-7

DRAWING NUMBER: 007 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-6

Installation Date 5/19/2010 Location JONESBORO, AR.

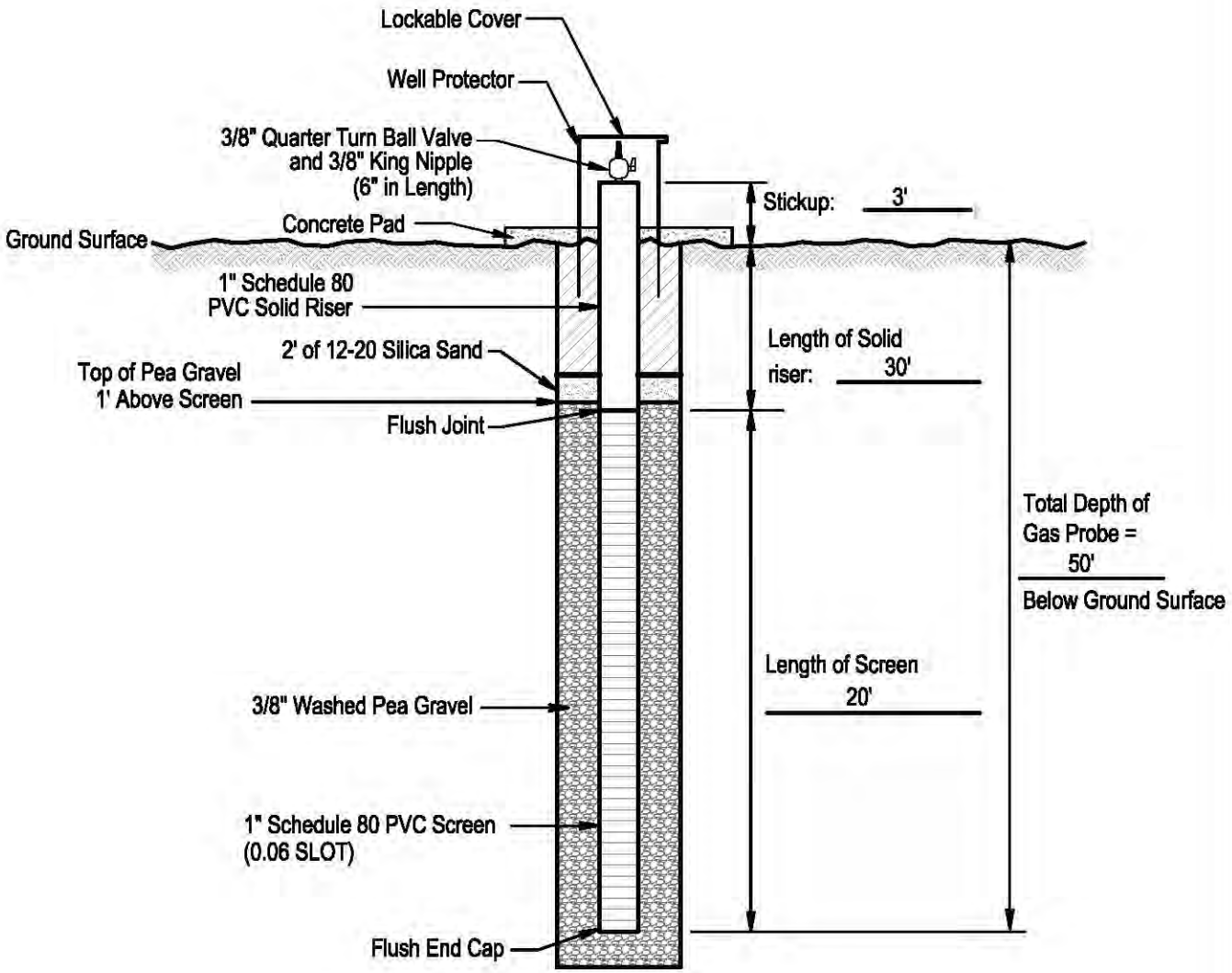
Datum Elevation 321.53 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 504709.65 Easting 1704284.66

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-6

DRAWING NUMBER: 006 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGACY LANDFILL Well Number GP-5

Installation Date 5/19/2010 Location JONESBORO, AR.

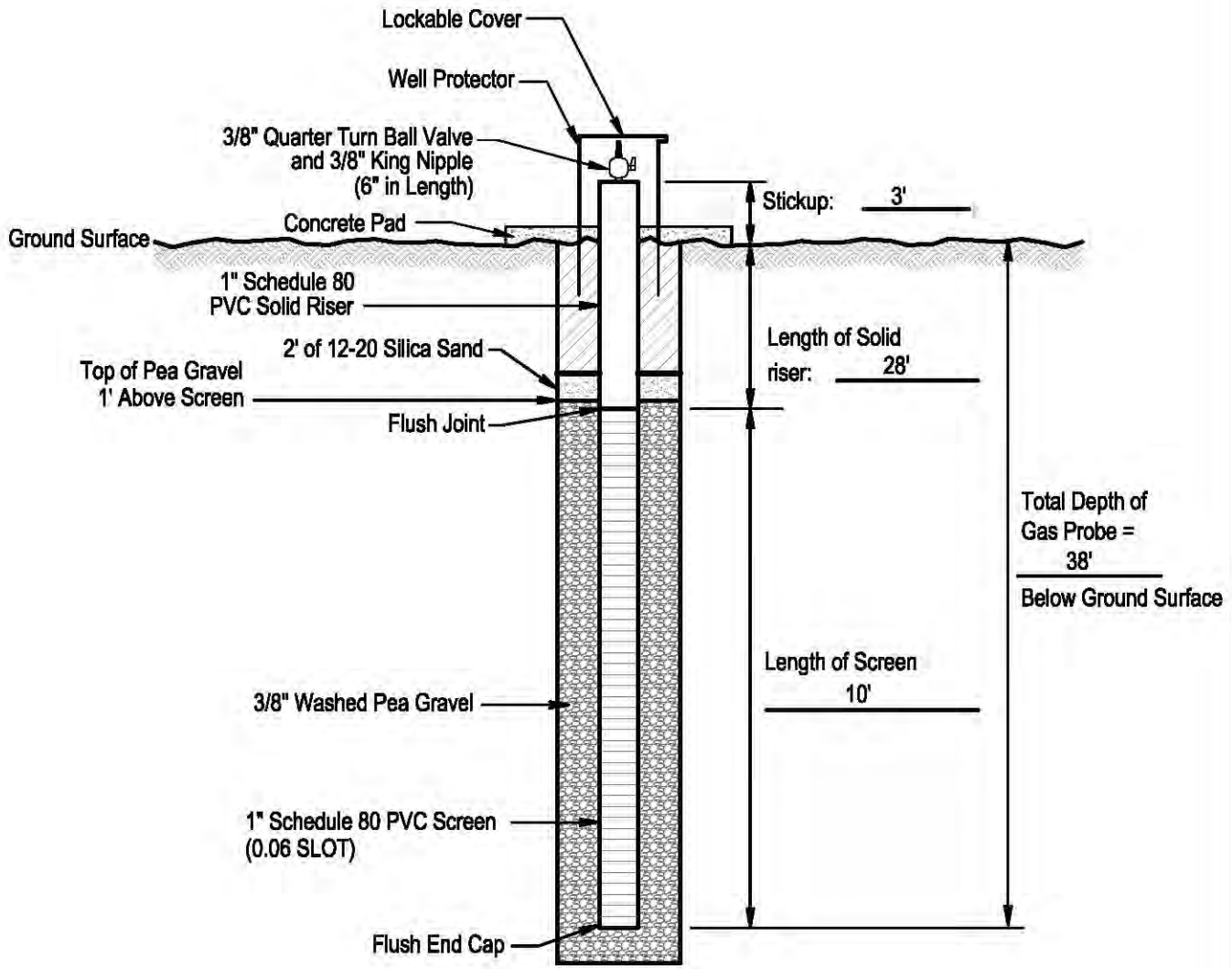
Datum Elevation 337.47 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 505652.15 Easting 1704057.12

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

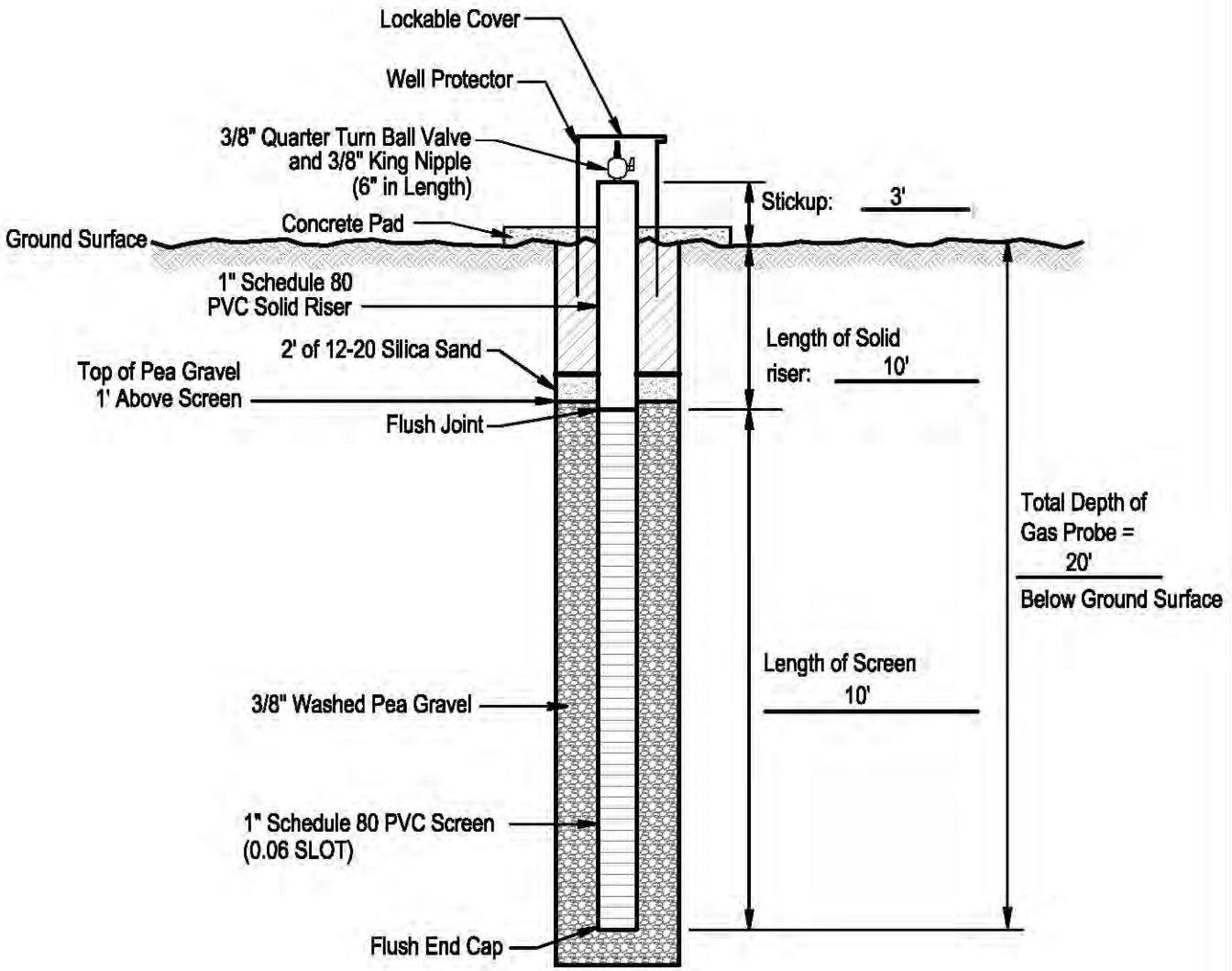
PROJECT NUMBER: 282-001-35117105

WELL NUMBER: GP-5

DRAWING NUMBER: 012 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-4
Installation Date 5/19/2010 Location JONESBORO, AR.
Datum Elevation 264.65 Surface Elevation N/A
Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"
Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK
Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 506418.70 Easting 1702887.35
Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD
PROJECT NUMBER: 282-001-35107090
WELL NUMBER: GP-4
DRAWING NUMBER: 004 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-3

Installation Date 5/19/2010 Location JONESBORO, AR.

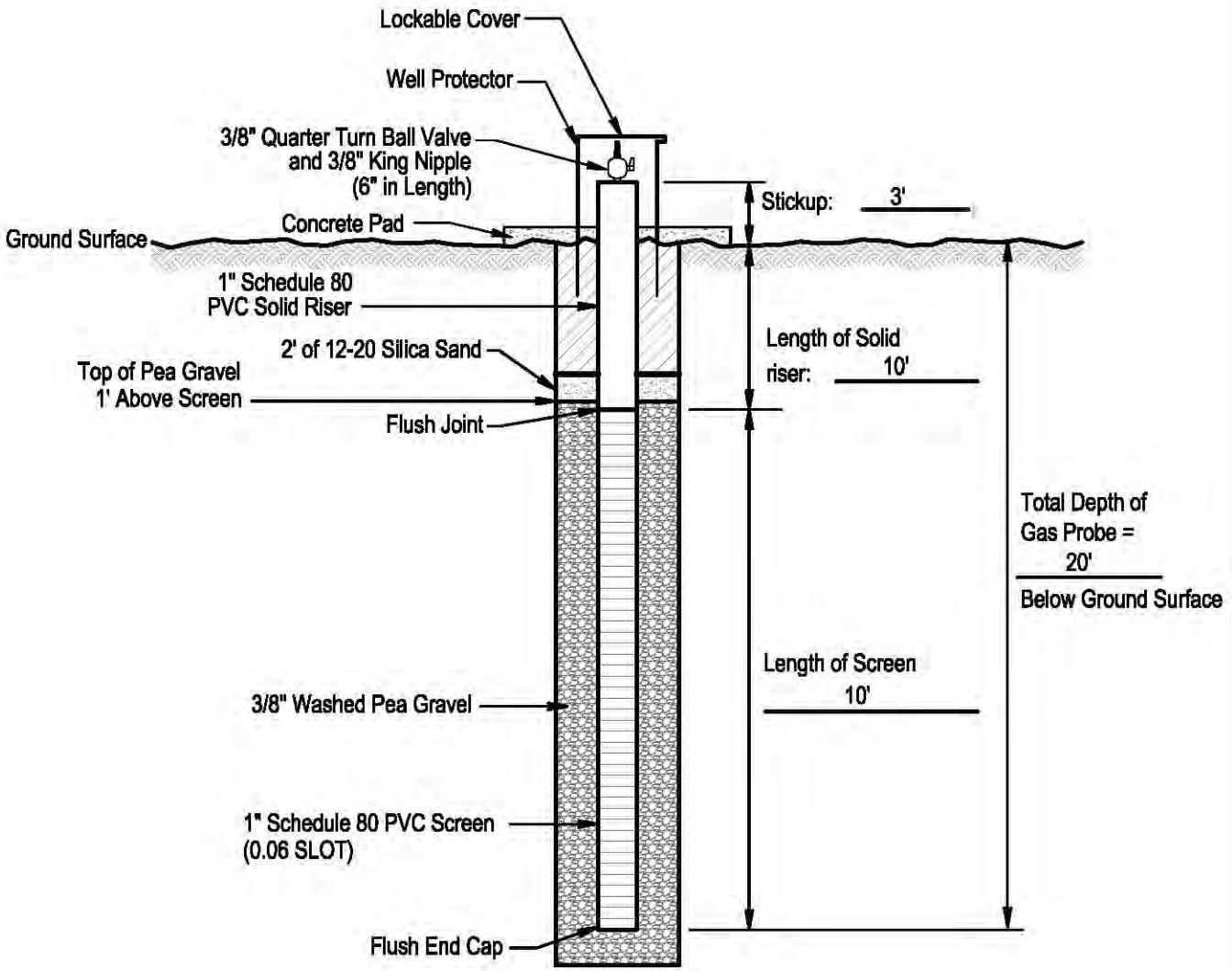
Datum Elevation 265.42 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 506975.95 Easting 1702643.80

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

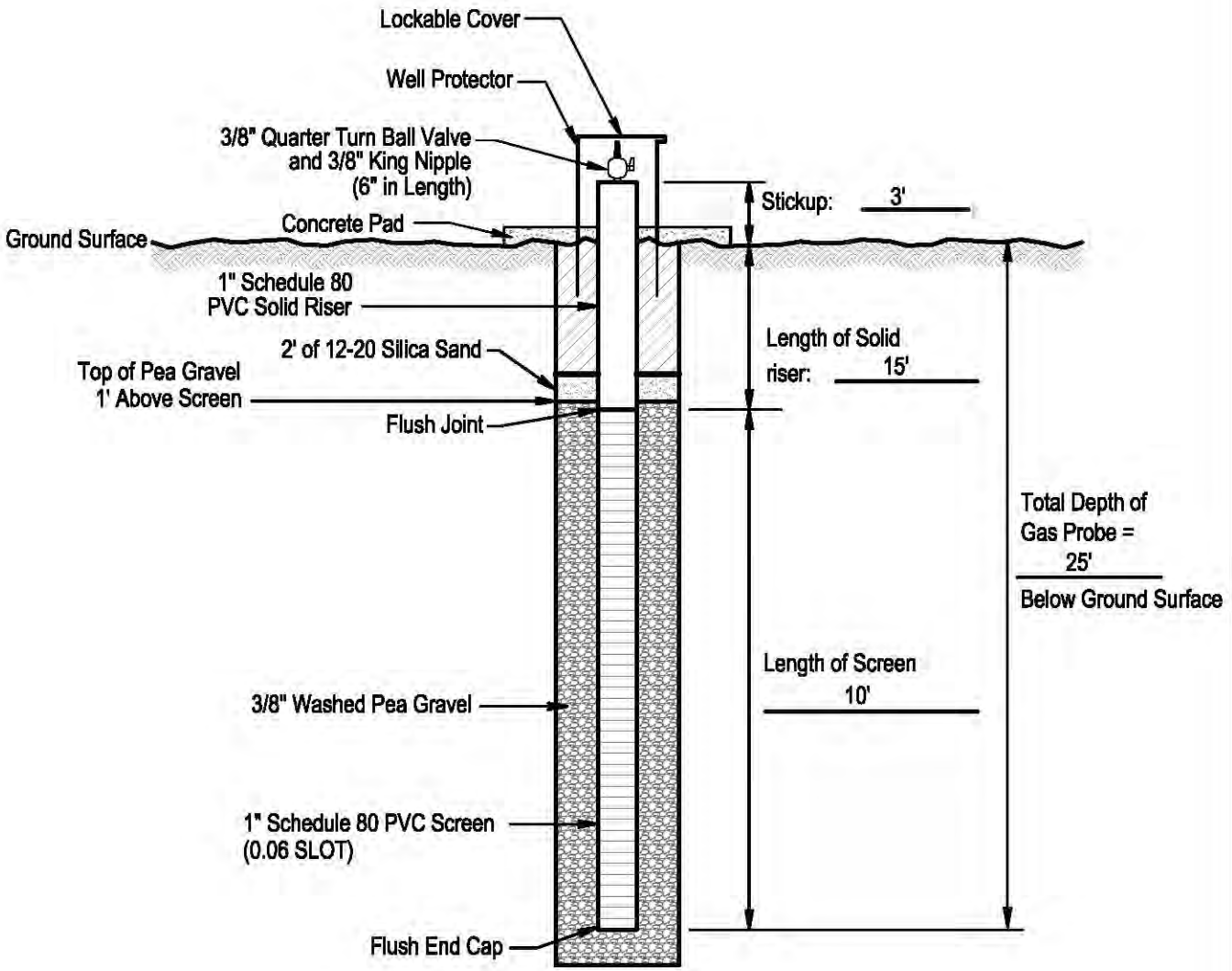
PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-3

DRAWING NUMBER: 003 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-2
Installation Date 5/19/2010 Location JONESBORO, AR.
Datum Elevation 252.62 Surface Elevation N/A
Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"
Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK
Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 506980.50 Easting 1701866.24
Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

Terracon
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GAS PROBE INSTALLATION RECORD
PROJECT NUMBER: 282-001-35107090
WELL NUMBER: GP-2
DRAWING NUMBER: 002 CHECKED BY: CM

GAS PROBE INSTALLATION RECORD

Job Name CCSWDA LEGECY LANDFILL Well Number GP-1

Installation Date 5/19/2010 Location JONESBORO, AR.

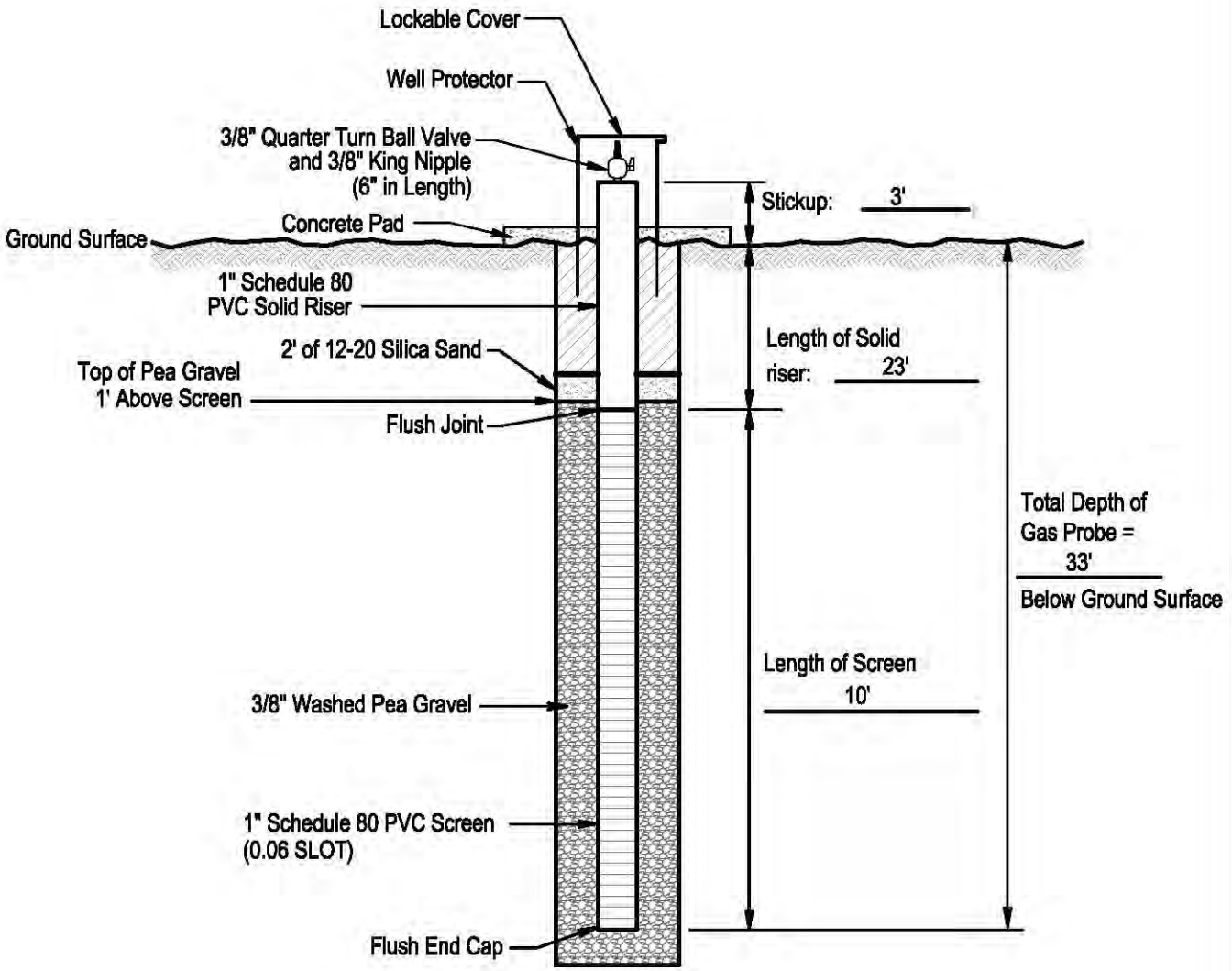
Datum Elevation 251.40 Surface Elevation N/A

Screen Diameter & Material 1" SCHEDULE 80 PVC Borehole Diameter 6"

Riser Diameter & Material 1" SCHEDULE 80 PVC Terracon Representative CLANCY McCLINTOCK

Granular Backfill Material 3/8" Pea Gravel, 12-20 Sand, Bentonite Northing 507004.47 Easting 1701143.89

Drilling Method 6" SOLID FLIGHT AUGER Drilling Contractor ANDERSON ENGINEERING



12-20 Silica Sand

Grout (Bentonite Chip)

Pea Gravel

(Not to Scale)

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GAS PROBE INSTALLATION RECORD

PROJECT NUMBER: 282-001-35107090

WELL NUMBER: GP-1

DRAWING NUMBER: 001 CHECKED BY: CM