

DEPARTMENT OF WATER RESOURCES

715 P STREET, 7th FLOOR P.O. BOX 942836
SACRAMENTO, CA 94236-0001

**INVITATION FOR BID****Notice to Prospective Bidders**

May 11, 2026

You are invited to review and respond to this Invitation for Bid (IFB) number 10218183 for Geological Exploration Sonic Drilling services service description. The anticipated term of this agreement is three (3) years with two (2) one-year options to renew. In submitting your bid, you must comply with these instructions.

Note that all agreements entered into with the Department of Water Resources, hereinafter referred to as the "State", incorporates, by reference, the State's General Terms and Conditions (GTC) and Contractor Certification Clauses (CCC) that may be viewed and downloaded at the Department of General Services (DGS) website:

<https://www.dgs.ca.gov/OLS/Resources/Page-Content/Office-of-Legal-Services-Resources-List-Folder/Standard-Contract-Language>

If you do not have Internet access, a hard copy can be provided by contacting the person listed below. The CCC package contains clauses and conditions that may apply to your Agreement and to anyone doing business with the State. The Certification will be kept on file in a central location. Inquiries regarding the processing of this bid should be referred to Adam Dell'Aringa at (916) 902-6614. Please note that no verbal information given will be binding upon the State unless such information is issued in writing as an official addendum to this solicitation.

Sincerely,

Dale Brown,
Division of Engineering

Attachment(s)

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A. Purpose and Description of Services

The Contractor will provide geological exploration sonic drilling services on an as-needed basis throughout the State of California.

B. Bidder Minimum Qualifications

1. The Contractor is required to possess a valid C-57 Well Drilling License with the California State Contractor's License Board. The license must be maintained throughout the contract period.
2. A current, valid copy of the firm's Department of Industrial Relations (DIR) registration with California State License Board (CSLB)/Certification Number listed. Documentation submitted will be used to substantiate the Contractor is currently registered on the DIR website. Documentation deemed inadequate or insufficient to determine information will cause the Contractor to be disqualified from further consideration.
3. The drill crew for each drill rig used by the Contractor in the performance of this contract must include one (1) Driller, and at least two (2) Driller's Helpers.
4. Driller used by the Contractor in the performance of regular drilling in this contract must be a person who is thoroughly experienced with at least three (3) years in drilling and sampling with the type of drill rig and equipment being used and experienced in drilling to the depths required.
5. For dam-related drilling, the driller must have at least five (5) years of documented experience on the resume in dam investigations.
6. For levee-related drilling, the Driller must have at least five (5) years of documented experience on the resume in levee investigations.
7. The Driller's Helper(s) must have at least six (6) months of drilling-related experience and must be on the drill site when work is being performed by the Driller.
8. Proof that Contractor's driller, driller's helper, and any other representatives of the Contractor that will be on the work site have successfully completed classes within the last three years equivalent to the following:
 - a. Defensive Driver Training
 - b. First Aid and CPR
 - c. Preventing Sexual Harassment
 - d. Hazardous Waste Operations and Emergency Response (HAZWOPER) Training (Only when requested in writing by the Geologist).
9. The Department has determined that Bidders responding to this solicitation must comply with Disabled Veteran Business Enterprise (DVBE) Program participation requirements, which is a minimum of three percent (3.0%) commitment. Bidders must complete and submit the following forms: Attachment VI, Bidder Certification of DVBE Participation (DWR 9526), Attachment VII, DVBE Declaration (DGS PD 843); Attachment VIII, Bidder Declaration (DGS PD 05-105) and DVBE bidder's and/or subcontractor(s)' Department of General Services Office of Small Business and Disabled Veteran Business Enterprise Services (DGS/OSDS) certification(s). ***Failure to fulfill the DVBE requirement will render your bid non-responsive and shall be cause for bid rejection.***

C. Bid Requirements and Information

1. BID KEY ACTION DATES

All bidders must adhere to the following time schedule.

IFB available to prospective bidders on	May 11, 2026
Technical questions must be submitted by	May 26, 2026 by 11:00 AM
Answers to technical questions will be disseminated by	May 29, 2026 by 1:00 PM
Bids must be received by	June 10, 2026 by 11:00 AM
Bid opening to be held on	June 10, 2026 at 1:00 PM
Anticipated start date of agreement is	October, 2026

Bid Openings: Sealed bids will be publicly opened and read via a TEAMS link. You may participate using the link provided below.

Topic: Public Bid Opening IFB # 10218183 Geological Exploration Sonic Drilling
Time: June 10, 2026 at 1:00 PM.

Join TEAMS Meeting

<https://teams.microsoft.com/meet/218820825571774?p=Gp3pSyqD7fPLa4kqnP>

Or by Telephone (audio only):

Dial: 916-573-2037

Phone Conference ID: 966 415 907#

*Please note that the bid opening via TEAMS will be visual only with no opportunity for questions and answers.

2. LOCATION WHERE WORK WILL BE PERFORMED:

Services will be performed Statewide at various locations in California.

3. QUESTIONS AND ANSWERS

Technical questions must be submitted in writing to adam.dellaringa@water.ca.gov and received by the State on or before 11:00 am on May 26, 2026. The State's representatives will provide answers in writing to all potential bidders by 1:00 pm on May 29, 2026.

4. SUBMISSION OF BID

a. Bids must be submitted by United States Postal Service (USPS) mail, hand delivery, United Parcel Service (UPS), express mail, or Federal Express.

i. Bids submitted by USPS must be addressed to:

Department of Water Resources
Contract Services
Attn: Adam Dell'Aringa
P.O. Box 942836
715 P Street
Sacramento, CA 94236-0001

- ii. Bids submitted by hand delivery, must be given to Contract Specialist Adam Dell'Aringa on or before June 10, 2026 at 11:00 am. Please coordinate a day and time via phone (916) 902-6614 or by email at adam.dellaringa@water.ca.gov.
- iii. Bids submitted by UPS, express mail, or Federal Express must be addressed to:

Department of Water Resources
Contract Services
Attn: Adam Dell'Aringa
715 P Street
Sacramento, CA 95814

- b. All bids must include original signatures on the following documents: Bid/Bidder Certification Sheet and any other documents specified in the Bid Checklist.
- c. Bids not including the documents identified in the Bid Checklist shall be deemed non-responsive and will be rejected.
- d. All bids are to be sent to DWR within the time frame indicated in the Time Schedule. Bids received after the due date and time will be returned unopened to the prospective bidder.
- e. All bids must be submitted under sealed cover. The sealed cover must be plainly marked with the IFB title and number, must show your firm's name and address, and must be marked with "DO NOT OPEN."
- f. Bids not submitted under sealed cover will be rejected. A minimum of two signed bids must be submitted. One bid must be submitted in hardcopy. One bid must be submitted in an electronic format (Word and/or PDF File) on a USB Drive. Both bids must be signed and submitted in the same envelope. USB Drives can be returned at the request of the bidder once the solicitation is concluded.
- g. Bids must be submitted for the entire service described within the Scope of Work. Deviations from the specifications will not be considered and will be cause for rejection of the bid.
- h. The State does not accept alternate language from a bidder. A bid with such language will be considered a counter proposal and will be rejected. The State's General Terms and Conditions (GTC) are not negotiable.
- i. A bid may be rejected if conditional or incomplete, or if it contains any alterations of form or other irregularities of any kind. The State may waive any immaterial deviation in a bid. The State's waiver of immaterial defect shall in no way modify the IFB document or excuse the bidder from full compliance with the objectives if awarded the Agreement. The State may reject all bids if deemed necessary.
- j. Costs for developing bids and preparation of award of the Agreement are entirely the responsibility of the bidder and shall not be chargeable to the State.
- k. This IFB must be signed by an individual who is authorized to bind the bidding firm contractually. The signature must indicate the title or position that the individual holds in the firm. An unsigned bid will be rejected.

- l. A bidder may modify a bid after its submission by withdrawal and resubmission before the bid due date. Modification of a bid offered in any other manner, oral or written, will not be considered.
- m. A bidder may withdraw their bid by submitting a written request to the State for its withdrawal, signed by the bidder or an agent authorized in accordance with Paragraph l above. A bidder may thereafter submit a new bid before the bid submission deadline. Bids may not be withdrawn after the bid due date. Bids received after the due date and time will be returned unopened to the prospective bidder.
- n. DWR may modify the IFB prior to the date fixed for submission of bids by the issuance of an Addendum to all parties who received a bid package.
- o. If all bids are too high, DWR is not required to award an Agreement.
- p. Bids are public upon bid opening.
- q. Bidders are cautioned not to rely on the State during the evaluation to discover and report all defects and errors in the bid documents. Bidders should carefully proof read documents for errors and adherence to the IFB requirements prior to bid submittal.
- r. Where applicable, the bidder should carefully examine the worksite and specifications. Bidder shall investigate the conditions, character, quality of surface, subsurface materials, or obstacles to be encountered. No additions to the Agreement amount will be made because of failure to thoroughly examine the worksite and specifications.
- s. Public Bid Openings may be conducted in person or online. Bid openings conducted online will be done virtually using TEAMS. You may participate using the link provided in the solicitation under Section C Paragraph 1 above.

5. EVALUATION AND SELECTION PROCESS

- a. The State will put each bid through a process of evaluation to determine the responsiveness of bidders to the State's needs. The final selection will be made on the basis of the lowest responsible bid meeting the specifications.
- b. Bids containing false or misleading statements or providing references that do not support an attribute or condition claimed by the bidder may be rejected. If, in the opinion of the State, information was intended to mislead the State in its evaluation of the bid, and the attribute, condition, or capability is a requirement of this IFB, it will be the basis for rejection of the bid.
- c. At the time of bid opening, each bid will be checked for the presence or absence of required information in conformance with the submission requirements of this IFB.
- d. Bids submitted that include option years will be evaluated based on the total bid amount for all years provided for the overall bid ranking. However, the total bid amount, for determining the contract amount will not include the option years.
- e. The contract will be awarded to the lowest responsible bidder after consideration of any applicable preferences. If there are tied bids, representatives of the State will draw straws to

pick the winning bidder. The drawing will be witnessed and documented by two or more State employees.

6. TAX DELINQUENT STATUS VERIFICATION

- a. Effective July 1, 2012 [Public Contract Code 10295.4](#), requires state agencies to verify the tax delinquent status of bidders responding to state solicitations.
- b. At the time of bid evaluation, prior to contract award and execution, the State will verify all proposing firms and identified subcontractors as not listed as tax delinquent by the Franchise Tax Board and the California Department of Tax and Fee Administration. Any proposing firms or subcontractor listed as tax delinquent shall result in a proposal rejection and will not be considered for contract award. Proposing firms wanting further clarification can refer to the statute above or to the web sites listed below for additional information.

California Department of Tax and Fee Administration – Top 500 Sales Tax and Use Delinquencies in California
<https://www.cdtfa.ca.gov/taxes-and-fees/top500.htm>

Franchise Tax Board – Top 500 Delinquent Tax Payers
<https://www.ftb.ca.gov/about-ftb/newsroom/top-500-past-due-balances/index.html>

7. GENERATIVE ARTIFICIAL INTELLIGENCE (GEN AI) DISCLOSURE

- a. The State of California seeks to realize the potential benefits of GenAI, through the development and deployment of GenAI tools, while balancing the risks of these new technologies.
- b. Bidder / Offeror must notify the State in writing if it: (1) intends to provide GenAI as a deliverable to the State; or (2), intends to utilize GenAI, including GenAI from third parties, to complete all or a portion of any deliverable that materially impacts: (i) functionality of a State system, (ii) risk to the State, or (iii) Contract performance. For avoidance of doubt, the term “materially impacts” shall have the meaning set forth in State Administrative Manual (SAM) § 4986.2 Definitions for GenAI.
- c. Failure to report GenAI to the State may result in disqualification. The State reserves the right to seek any and all relief to which it may be entitled to as a result of such non-disclosure.
- d. Upon notification by a Bidder / Offeror of GenAI as required, the State reserves the right to incorporate GenAI Special Provisions into the final contract or reject bids/offers that present an unacceptable level of risk to the State.
- e. Government Code 11549.64 defines “Generative Artificial Intelligence (GenAI)” as an artificial intelligence system that can generate derived synthetic content, including text, images, video, and audio that emulates the structure and characteristics of the system’s training data.

8. DEPARTMENT OF INDUSTRIAL RELATIONS REGISTRATION OF CONTRACTORS AND PREVAILING WAGE MONITORING AND ENFORCEMENT

- a. In addition to complying with other applicable laws, effective for all bids on public works received on or after March 1, 2015, each bidder submitting a bid for such contract work must be a Department of Industrial Relations Registered Contractor pursuant to Labor Code § 1725.5 (“DIR Registered Contractor”). A Bidder who is not a DIR Registered Contractor when

submitting a bid for the contract work is deemed "not qualified." Pursuant to Labor Code § 1725.5, all subcontractors identified in a Bidder's Subcontractor' List shall also be DIR Registered Contractors.

- b. Effective for contracts for public works awarded on or after April 1, 2015, all awarded Prime Contractors, and all subcontractors of any tier, at all times during the performance of the work, shall be DIR Registered Contractors. Also, all such contractors and subcontractors must furnish electronic certified payroll records directly to the Labor Commissioner (of the Division of Labor Standards Enforcement). The contracts are subject to compliance monitoring and enforcement by the Department of Industrial Relations.
- c. Effective January 1, 2016, all public works projects whether new or ongoing are subject to the requirement to furnish electronic certified payroll records directly to the Labor Commissioner.
- d. All contractors who are awarded a contract shall also post any required notice adopted by DIR regarding prevailing wage monitoring and enforcement program.

9. AWARD AND PROTEST

A bidder may protest the award of a contract on the grounds that it (the bidder) is the lowest responsible bidder meeting the specifications and should therefore be awarded the contract.

A protestant must be able to prove that the awarding agency has committed a material error in the conduct of the bid award process.

Public inspection of all bids will be allowed after the bid opening.

Protests must be received in a timely manner pursuant to Public Contract Code Section 10345, as applicable. In order to be considered timely, a protest must be filed with the State Agency conducting the solicitation and DGS before the contract award is made.

Please note that if the award will be made to other than the low bidder, any protests must be filed within five business days of notice to the low bidder that the contract was awarded to another bidder. If a written request was submitted by a bidder to the State agency requesting that a notice of intent to award be posted, the protest must be filed during the five business days the notice is posted.

Within five business days of filing the protest, the protestant must submit a detailed written statement of protest if the original protest did not contain the complete grounds for the protest.

Both the original protest and/or the detailed statement of protest, if any, must include the IFB number, the name of the State Agency conducting the solicitation, State agency contact person, and protestant's fax number, if any.

The protest documents may be sent by regular mail, email, courier, or personal delivery to:

Department of General Services
Office of Legal Services
Attention: Bid Protest Coordinator
707 Third Street, 7th Floor, Suite 7-330
West Sacramento, CA 95605
Bid Protest Coordinator Email address: OLSProtests@dgs.ca.gov

AND

Department of Water Resources

Contract Specialist Email Address: adam.dellaringa@water.ca.gov

Upon receipt of the protest, DGS shall send the protestant an acknowledgement letter and thereafter communicate with the parties regarding further disposition of the protest.

10. DISPOSITION OF BIDS

Upon bid opening, all documents submitted in response to this IFB will become the property of the State and will be regarded as public records under the California Public Records Act (Government Code Section 7920 et seq.) and are subject to review by the public. Bids may be returned at the request and expense of the bidder.

D. Standard Conditions of Service

1. Service(s) shall not commence until the Agreement is fully executed and all approvals have been obtained.
2. All performance under the Agreement shall be completed on or before the termination date of the Agreement unless this Agreement is amended to extend the term.
3. No oral understanding or agreement shall be binding on either party.

E. Payee Data Record

1. The Contractor awarded this Agreement must have completed and submitted form STD 204, Payee Data Record, to determine if the Contractor is subject to a seven percent State Income Tax withholding pursuant to California Revenue and Taxation Code Sections 18662, 18805, and 26131.
2. No payment shall be made unless the Payee Data Record form has been completed and returned to the State.

F. Key Employee Policies and Guidelines Notice Acknowledgment (Consultants and Contractors)

1. The selected contractor awarded this Agreement must complete and submit the form DWR 9524a, Key Employee Policies and Guidelines Notice Acknowledgment. These policies and guidelines communicate expectations for contractors. Every contractor or subcontractors employee is expected to read and understand the material contained within. Primary contractor/subcontractors are responsible to ensure that their employees are aware of and adhere to the policies and guidelines.

G. Economic Incentive Programs

Bidders may be eligible for additional preferences when their place of business is located within certain economic regions and when they hire persons living and working within those economic regions. Please access the following links to read information about these economic incentive programs.

TACPA CONTRACT PREFERENCE

This solicitation contains Target Area Contract Preference Act (TACPA) preference request forms. Please carefully review the forms and requirements. Bidders are not required to apply for these preferences. Denial of the TACPA preference request is not a basis for rejection of the bid.

The State as part of its evaluation process reserves the right to verify, validate, and clarify all information contained in the bid. This may include, but is not limited to, information from bidders, manufacturers, subcontractors and any other sources available at the time of the bid evaluation. Bidder refusal to agree to and/or comply with these terms, or failure to provide additional supporting information at the State's request may result in denial of preference requested.

Contracts awarded with applied preferences will be monitored throughout the life of the contract for compliance with statutory, regulatory, and contractual requirements. The State will take appropriate corrective action and apply sanctions as necessary to enforce preference programs. Links to forms and contact information are below.

- [TACPA Preference Request \(STD 830\)](#)
- [Manufacturer's Summary of Contract Activities and Labor Hours \(DGS PD 525\)](#)
- [Bidder's Summary of Contract Activities and Labor \(DGS PD 526\)](#)

Any questions regarding the TACPA preference should be directed to DGS, Procurement Division at (916) 375-4609 or TACPA@dgs.ca.gov.

H. Small Business Preference Program

1. The Small Business Procurement and Contract Act [Government Code \(GC\) Section 14838 et. seq.](#) requires that a fair share of the State's purchases and contracts for goods, information technology services and construction be placed with a certified Small Business (SB) or Micro-Business (MB). The Act mandates that state agencies:
 - a. Establish participation goals,
 - b. Provide a five percent (5.0%) SB calculation preference, and
 - c. Provide the opportunity for bidders to receive a five percent (5.0%) non-small business (NSB) calculation preference when achieving twenty-five percent (25.0%) SB participation through subcontracted efforts.

Bidder which is awarded the contract is committed to paying the stated percentage of the total contract amount (including contract amendments) to the SB subcontractor(s) as declared on the DGS PD 05-105 form. SB bidders and subcontractors must be certified by DGS/OSDS to participate in SB Preference program.

2. SMALL BUSINESS PREFERENCE

The SB Preference offers certified SB's and MB's a calculation preference in the amount of five percent (5%) of the lowest responsible bid submitted by a bidder who is not a certified SB. The SB Preference is used as a calculation for determining the lowest bidder and does not affect the actual price bid. Responding bidders must:

- a. Includes in its bid a notification to the awarding department that it is an SB or that it has submitted to The Department of General Services, Office of Small Business & Disabled Veteran Business Enterprise Services (DGS/OSDS) a complete application no later than 5:00 p.m. on the bid due date, and is subsequently certified by DGS/OSDS as an SB; and
- b. Include copy of firm's DGS/OSDS SB certification
- c. Submits a timely, responsive bid; and
- d. Be determined to be a responsible bidder.

3. NON-SMALL BUSINESS PREFERENCE

Non-small business (NSB) bidders will be granted a five percent (5.0%) NSB preference on a bid evaluation when a responsible NSB has agreed to subcontract at least twenty-five percent (25.0%) of their bid price with a California certified SB and if the NSB bidder's bid is not the low price bid, or when a proposal has been not been ranked as the highest scored bid pursuant to the evaluation of the solicitation. Responding bidders must:

- a. Include information on required form DGS PD 05-105, Attachment VIII, of the DGS/OSDS certified SB subcontractor(s) with which it commits to subcontract a total of at least twenty-five percent (25%) of its net bid price (refer to page two of form for detailed instructions);
- b. Include copy of the DGS/OSDS certification for each identified SB;
- c. Submits a timely, responsive bid; and
- d. Be determined to be a responsible bidder.

4. NON-SMALL BUSINESS PREFERENCE CALCULATION

The NSB calculation preference five percent (5.0%) is used for bid evaluation purposes only. Awards made as a result of the NSB preferences shall be awarded at the bidder's original bid price. The preference shall be computed as follows:

Bidder A, (Low Bid), non-small business:	\$125,000
Bidder B, non-small business (subcontracting 25% to a certified small business)	\$131,000
Calculation Preference:	$\$125,000 \times .05 = \$6,250$
Bidder B	\$131,000
Subtract calculated preference	<u>- \$6,250</u>
Adjusted Bid for Bidder B	\$124,750

Award is made to Bidder B as the low bidder at the bid price of \$131,000.

5. TIES BETWEEN CERTIFIED SMALL BUSINESSES AND DVBE BUSINESSES

In the event of a precise tie between the bid of an SB and the bid of a Disabled Veteran Business Enterprise (DVBE) that is also an SB, the award shall go to the DVBE that is also an SB.

6. MAXIMUM ALLOWABLE PREFERENCES

In no event shall the amount of the SB or NSB subcontractor preferences awarded on a single bid exceed \$50,000, and in no event shall the combined cost of the SB or NSB subcontractor preference and preferences awarded pursuant to any other provision of law exceed \$100,000. The five percent (5%) calculation preference is used for computation purposes only and does not alter or affect the actual bid price or the amount of the executed contract. When a certified SB is the lowest responsive, responsible bidder, then there is no need to compute the SB preference as the SB is the low bidder.

7. COMMERCIALLY USEFUL FUNCTION (SBs) ([Government Code \(GC\) section 14837\(d\) \(4\)](#))

A certified SB, micro-business (MB) contractor, subcontractor or supplier, must meet commercially useful function (CUF) requirements under [Government Code \(GC\) section 14837\(d\) \(4\)](#). Selected firms must perform a CUF relevant to this contract.

The term “small business contractor, subcontractor or supplier” means any person or entity that satisfies the ownership (or management) and control requirements in accordance with [GC section 14837\(d\) \(4\)](#) and provides services or goods that contribute to the fulfillment of the contract requirements by performing a CUF. A person or an entity is deemed to perform a CUF if that person or entity does **all** of the following:

1. Is responsible for the execution of a distinct element of the work of the contract.
2. Carries out contractual obligations by actually performing, managing, or supervising the work involved.
3. Performs work that is normal for its business services and functions.
4. Is not further subcontracting a portion of the work that is greater than that expected to be subcontracted by normal industry practices.
5. Is responsible, with respect to products, inventories, materials, and supplies required for the contract, for negotiating price, determining quality and quantity, ordering, installing, and, if applicable, making payment
6. Its role is not an extra participant in the transaction, contract or project through which funds are passed in order to obtain the appearance of DVBE participation.

8. BIDDER CUF REQUIREMENTS

The Department will determine, to the best of its ability, that your firm meets the criteria above for CUF. In responding to this solicitation, you are confirming that, under [GC 14837 \(d\) \(4\)](#) above, your business provides goods and/or services meet the definition of CUF. All bidders are required to provide CUF documentation using the State’s Bidder Declaration form DGS PD 05-105, Attachment VIII, included in the solicitation document. When completing the DGS PD 05-105, bidders must identify all subcontractors proposed for participation in the contract. Any bidder awarded a contract is contractually obligated to use the subcontractor for the corresponding work defined unless the State agrees to a substitution.

I. Disabled Veteran Business Enterprise Program

DVBE Program Participation is Required for Solicitation

This solicitation includes DVBE Program participation requirements, which is a minimum of three percent (3.0%) commitment. Complete and provide the following forms for DVBE Program participation compliance:

1. DWR 9526, Attachment VI (Bidder Certification of DVBE Participation)
2. DGS PD 843 Attachment VII (DVBE Declarations)
3. DGS PD 05-105, Attachment VIII (Bidder Declaration) - refer to page two of form for detailed instructions
4. DGS/OSDS Certification(s) for bidder and/or subcontractor(s). Bidder and/or subcontractors must be certified by DGS/OSDS in order to take part in DVBE Participation Program.U

DVBE Incentive is as follows:

DVBE Required Participation	Incentive Percentage (%)
5.0% or over	5.0%
4.0% to 4.99%	4.0%
3.0% to 3.99%	3.0%

If you need assistance with finding a certified DVBE subcontractor, you can contact California Department of Veterans Affairs (CalVet) DVBE Program

- <https://www.calvet.ca.gov/contact>
 - o Phone Number: 800-952-5626
 - o Email: DVBE@calvet.ca.gov

You can also do a certified vendor search on Cal eProcure:

<https://caleprocure.ca.gov/pages/PublicSearch/supplier-search.aspx?psNewWin=true>

1. DWR SB/DVBE PROGRAM MANAGER PRE-REVIEW OF DVBE DOCUMENTATION

The Department's SB/DVBE Program Manager offers a pre-review of a bidder's DVBE documentation prior to proposal submission. Since non-compliance with the DVBE program is immediate cause for rejection, the State strongly recommends firms interested in bidding take advantage of this opportunity to ensure they are fully compliant with DVBE Program participation requirements.

Bidders should allow at least five (5) working days for pre-review of their DVBE documentation and submit them to the following:

SB/DVBE Program Manager
Email: SB.DVBE@water.ca.gov

Upon satisfactory review of the bidder's DVBE documentation, the DWR SB/DVBE Program Manager issues a Notification of Compliance which the bidder will submit with their bid submittal.

2. DVBE INCENTIVE PROGRAM

Under [CCR 1896.99.100](#), the California DVBE Incentive provides responsive and responsible bidders the opportunity to receive additional incentive calculations. The incentive is applied at the time of solicitation evaluation when a proposing firm identifies and commits to using a California-certified DVBE subcontractor to provide services or commodities in support of the overall contract. Application of the DVBE Incentive may place the bidder in line for contract award.

The following are key elements of the DVBE Incentive Program:

- a. The DVBE Incentive is applied during the evaluation process and is only applied to responsive bids from responsible bidders proposing the percentage(s) of DVBE participation for the incentive(s) specified in the solicitation.
- b. DVBE Incentive participation is at the discretion of the bidder and is *optional* when overall DVBE Program requirements are exempt by the State for that solicitation.
- c. When requesting the DVBE Incentive Application, a bidder must complete and return the DVBE Incentive Application Request included within this solicitation with their proposal at time of submission.
- d. DVBE certified firm (bidder and/or subcontractor(s)) must be certified by DGS/OSDS.
- e. Services or commodities provided by the DVBE firm MUST meet the definition of CUF as defined under Government Codes: [14837](#) and [14842.5](#); [Military and Veterans Code 999 \(B\) \(i\) \(ii\)](#); and [California Code of Regulations 1896.71](#). A DVBE firm determined as not meeting CUF regulations will render the responding firm ineligible for the DVBE Incentive Application.
- f. Bidder which is awarded this contract, is committed to paying the stated percentage (on each form DWR 9526) of the total contract amount (including contract amendments) to the DVBE subcontractor declared on this form.

3. COMMERCIALY USEFUL FUNCTION - DVBEs ([MVC 999\(B\)](#))

Firms selected must perform a “commercially useful function” relevant to this contract. The term “DVBE contractor, subcontractor or supplier” means any person or entity that satisfies the ownership (or management) and control requirements of [CCR 1896.61\(f\)](#); is certified in accordance with [CCR 1896.70](#) and provides services or goods that contribute to the fulfillment of the contract requirements by performing a commercially useful function. As defined in [MVC 999\(B\)](#), a person or an entity is deemed to perform a “commercially useful function” if a person or entity does *all* of the following:

- a. Is responsible for the execution of a distinct element of the work of the contract;
- b. Carries out the obligation by actually performing, managing, or supervising the work involved;
- c. Performs work that is normal for its business services and functions
- d. Is not further subcontracting a portion of the work that is greater than that expected to be subcontracted by normal industry practices

- e. Is responsible, with respect to products, inventories, materials, and supplies required for the contract, for negotiating price, determining quality and quantity, ordering, installing, if applicable, and making payment; and
- f. Its role is not an extra participant in the transaction, contract or project through which funds are passed in order to obtain the appearance of DVBE participation.

4. ORDER OF EVALUATION

For purposes of evaluation, first SB Preference will be applied, followed by the DVBE Incentive calculation.

J. Pending Small Business or Disabled Veteran Business Enterprise Certification Applications

Bidders wishing to apply for the SB Preference, NSB Preference or DVBE Incentive related to this solicitation and have pending SB or DVBE certification(s) applications under review by DGS/OSDS, you must have:

1. notified DGS/OSDS that you are responding to a solicitation and are seeking an expedite review of your SB or DVBE certification application in relation to the solicitation;
2. provided DGS/OSDS with the Bid Key Action Dates page from the solicitation itself; and
3. must have submitted a complete application with all required forms and documentation to DGS/OSDS for review and approval by close of business of the Bid Submittal due date.

Bidders must notify the State in writing at the time of bid submission that they have an application for SB or DVBE certification under review at the DGS/OSDS, and that they wish to be considered for the SB Preference, NSB Preference or DVBE Incentive.

Contact DGS/OSDS at (916) 375-4940 to obtain information about the application expedite process. Website: <https://www.dgs.ca.gov/PD/About/Page-Content/PD-Branch-Intro-Accordion-List/OSDS/OSDS>

BID CHECKLIST

Please review the following checklist for a list of documents that must be returned with your bid package. Please read the State of California's General Terms and Conditions (GTC) before signing and submitting your bid package. The State does not accept alternate language from a bidder. A bid with such language will be considered a counter proposal and will be rejected. The GTC's are *not* negotiable. Unless otherwise noted, failure to include the required documents will be cause for bid rejection.

DOCUMENTS REQUIRED WITH SUBMISSION OF BID

- ☐ Attachment I – Bid Sheet (*must be signed and include all pages*)
- ☐ Attachment 1a – Bid Sheet (First One Year Extension)
- ☐ Attachment 1b – Bid Sheet (Second One Year Extension)
- ☐ Attachment II – Bid/Bidder Certification Sheet
- ☐ Attachment III – Bidder References
- ☐ Attachment IV – Darfur Contracting Act Certification
- ☐ Attachment V – GenAI Disclosure (DWR 9834)
- ☐ Attachment VIII, Bidder Declaration (DGS PD 05-105) – include all subcontracting information for entire bid on this one form also indicate if you are not subcontracting services.
- ☐ Attachment IX – California Civil Rights Laws Attachment
- ☐ Attachment X – Iran Contracting Act
- ☐ Bidder's Bond (DWR 4021)
 - Bidder's Bond must be equal to 10% of the bid amount; and
 - Surety must be registered with the CA Department of Insurance
- ☐ Copy of C-57 Well Drilling Contractor's License
- ☐ Current valid copy of the DIR Registration
- ☐ Non-Collusion Declaration (DWR 4206)
- ☐ Resumes of Key Personnel
- ☐ Provide proof that the Drill crew for each drill rig used by the Contractor in the performance of this contract includes one (1) Driller, and at least two (2) Driller's Helpers.
- ☐ Resume of Driller showing at least three (3) years in drilling and sampling with the type of drill rig and equipment being used and experienced in drilling to the depths required.
- ☐ For dam-related drilling, provide resume of Driller showing at least five (5) years of documented experience on the resume in dam investigations.
- ☐ For levee-related drilling, provide resume of Driller showing at least five (5) years of documented experience on the resume in levee investigations.
- ☐ Resumes of Driller's Helper(s) showing at least six (6) months of drilling-related experience and must be on the drill site when work is being performed by the Driller.
- ☐ Proof that Contractor's driller, driller's helper, and any other representatives of the Contractor that will be on the work site have successfully completed classes within the last three years equivalent to the following:
 1. Defensive Driver Training
 2. First Aid and CPR
 3. Preventing Sexual Harassment
 4. Hazardous Waste Operations and Emergency Response (HAZWOPER) Training (Only when requested in writing by the Geologist).
- ☐ If you are a prime firm which is DVBE-certified and/or subcontracting to a DVBE, you must complete and return the following forms:
 - Attachment VI, Bidder Certification of DVBE Participation (DWR 9526);
 - Attachment VII, DVBE Declaration (DGS PD 843);
 - List all subcontracting information on Attachment VIII, Bidder Declaration (DGS PD 05-105) mentioned above; and
 - Copy of current DGS/OSDS DVBE certification(s) for prime and/or subcontractor(s)
- ☐ SB/DVBE Program Manager's Notification of Compliance (*if obtained in advance from the SB/DVBE Program Manager*)

ADDITIONAL STATE MANDATED PREFERENCE PROGRAMS

Required only when the bidding firm claims following:

- ☐ Target Area Contract Preference Act (TACPA) (Std. 830)

DOCUMENTS REQUIRED UPON CONTRACTOR SELECTION/BID AWARD

These documents are not required at the time of bid submittal; however these documents will be required of the awarded firm upon contractor selection/bid award.

- ☐ Contractor Certification Clauses (CCC) (CCC must be signed once a contractor has been selected)
- ☐ Payee Data Record (Std. 204)
- ☐ Payment Bond (DWR 3373)
- *Payment Bond must be equal to 100% of the contract amount; and*
- *Surety must be registered with the CA Department of Insurance*
- ☐ Performance Bond (DWR 156)
- *Performance Bond must be equal to 100% of the contract amount; and*
- *Surety must be registered with the CA Department of Insurance*
- ☐ Certificate(s) of Insurance
- ☐ Key Employee Policies and Guidelines Notice Acknowledgment (Consultants and Contractors) (DWR 9524a)

ATTACHMENT I **BID SHEET - THREE (3) YEAR CONTRACT**

The items and quantities indicated below will be used solely for computing the cost as a fair and equitable formula to determine the low bidder and is not binding on the contracting agency. However, the actual costs quoted below by the bidder shall be binding for the term of the Agreement.

The bidder hereby agrees to provide all labor, materials, licenses, permits, and transportation necessary to perform all services required for the foregoing titled work in accordance with the Scope of Work, Exhibit A. The rates listed on this Bid Sheet shall include every item of expense, direct and indirect, including taxes incidental to the specified rates. **The cost of security services is to be included in the costs of bid items one and two. Security services, even when required by the State, will not be reimbursed through bid items three (special equipment) or four (special services).**

The bidder is required to bid each item. Failure to indicate a dollar amount in any item will be grounds to reject the entire bid. A zero-dollar (\$0.00) amount listed for any and all items will be interpreted and understood by the State to mean that the bidder indicating a zero-dollar amount shall perform any such services, up to and including the quantity indicated, at no cost to the state.

BID ITEM	QUANTITY	ITEM WITH UNIT PRICE IN WORDS (e.g. Two hundred for 200) ACCORDING TO EXHIBIT A, ITEM 6	UNIT PRICE IN NUMBERS	EXTENDED TOTALS
1A	1,125 hours	Drilling, sampling and other services as described in Exhibit A, Item 6.B, charges, hourly, per rig	\$_____ per hour	\$_____
1B	170 hours	Drilling, sampling and other services as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$_____ per hour	\$_____
2A	450 hours	Well Development Services as described in Exhibit A, Item 6.C, charges, hourly, per rig	\$_____ per hour	\$_____
2B	70 hours	Well Development Services, as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$_____ per hour	\$_____
3A	450 hours	Well Destruction Services, as described in Exhibit A, Item 6.D, charges, hourly, per rig	\$_____ per hour	\$_____

3B	70 hours	Well Destruction Services, as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$ _____ per hour	\$ _____
4	\$150,000 dollars	Providing Site Security as described in Exhibit A, Item 6.F, at Contractor's cost plus _____ Percent	_____ % Markup (shall not exceed 10%)	\$150,000 +\$ _____ =\$ _____
5	\$300,000 dollars	Providing Special Equipment, and Other Services as described in Exhibit A, Item 6.G, at Contractor's cost plus _____ percent	_____ % Markup (Shall not exceed 10%)	\$300,000 +\$ _____ =\$ _____
6	\$300,000 dollars	Miscellaneous Materials and Supplies, as described in Exhibit A, Item 6.H, at the Contractor's cost plus a markup of _____ percent	_____ % Markup (Shall not exceed 10%)	\$300,000 +\$ _____ =\$ _____
GRAND TOTAL				\$ _____

NO GUARANTEE OF WORK UNDER THIS CONTRACT.

In the event of computational error, unit prices will prevail over extended totals. The State will check bid calculations and recalculate bid totals.

I certify under penalty of perjury under the laws of the State of California, the foregoing is true and correct.

The Contractor's signature, in ink, affixed hereon and dated will constitute a certification under the penalty of perjury under the laws of the State of California that the Contractor's license number and expiration date are true and correct.

Company Name

Contractor's License Number

Contractor's License Expiration Date

Printed Name and Title of Bidder

Signature of Bidder

Date

EXHIBIT B, ATTACHMENT 1A
BID SHEET - FIRST ONE (1) YEAR EXTENSION

The items and quantities indicated below will be used solely for computing the cost as a fair and equitable formula to determine the low bidder and is not binding on the contracting agency. However, the actual costs quoted below by the bidder shall be binding for the term of the Agreement.

The bidder hereby agrees to provide all labor, materials, licenses, permits, and transportation necessary to perform all services required for the foregoing titled work in accordance with the Scope of Work, Exhibit A. The rates listed on this Bid Sheet shall include every item of expense, direct and indirect, including taxes incidental to the specified rates. **The cost of security services is to be included in the costs of bid items one and two. Security services, even when required by the State, will not be reimbursed through bid items three (special equipment) or four (special services).**

The bidder is required to bid each item. Failure to indicate a dollar amount in any item will be grounds to reject the entire bid. A zero dollar (\$0.00) amount listed for any and all items will be interpreted and understood by the State to mean that the bidder indicating a zero dollar amount shall perform any such services, up to and including the quantity indicated, at no cost to the state.

BID ITEM	QUANTITY	ITEM WITH UNIT PRICE IN WORDS (e.g. Two hundred for 200) ACCORDING TO EXHIBIT A, ITEM 6	UNIT PRICE IN NUMBERS	EXTENDED TOTALS
1A	375 hours	Drilling, sampling and other services as described in Exhibit A, Item 6.B, charges, hourly, per rig	\$_____ per hour	\$_____
1B	55 hours	Drilling, sampling and other services as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$_____ per hour	\$_____
2A	150 hours	Well Development Services as described in Exhibit A, Item 6.C, charges, hourly, per rig	\$_____ per hour	\$_____
2B	30 hours	Well Development Services, as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$_____ per hour	\$_____
3A	150 hours	Well Destruction Services, as described in Exhibit A, Item 6.D, charges, hourly, per rig	\$_____ per hour	\$_____

3B	30 hours	Well Destruction Services, as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$ _____ per hour	\$ _____
4	\$50,000 dollars	Providing Site Security as described in Exhibit A, Item 6.F, at Contractor's cost plus _____ Percent	_____ % Markup (shall not exceed 10%)	\$50,000 +\$ _____ =\$ _____
5	\$100,000 dollars	Providing Special Equipment, and Other Services as described in Exhibit A, Item 6.G, at Contractor's cost plus _____ percent	_____ % Markup (Shall not exceed 10%)	\$100,000 +\$ _____ =\$ _____
6	\$100,000 dollars	Miscellaneous Materials and Supplies, as described in Exhibit A, Item 6.H, at the Contractor's cost plus a markup of _____ percent	_____ % Markup (Shall not exceed 10%)	\$100,000 +\$ _____ =\$ _____
GRAND TOTAL				\$ _____

NO GUARANTEE OF WORK UNDER THIS CONTRACT.

In the event of computational error, unit prices will prevail over extended totals. The State will check bid calculations and recalculate bid totals.

I certify under penalty of perjury under the laws of the State of California, the foregoing is true and correct.

The Contractor's signature, in ink, affixed hereon and dated will constitute a certification under the penalty of perjury under the laws of the State of California that the Contractor's license number and expiration date are true and correct.

Company Name

Contractor's License Number

Contractor's License Expiration Date

Printed Name and Title of Bidder

Signature of Bidder

Date

**EXHIBIT B, ATTACHMENT 1B
BID SHEET - SECOND ONE (1) YEAR EXTENSION**

The items and quantities indicated below will be used solely for computing the cost as a fair and equitable formula to determine the low bidder and is not binding on the contracting agency. However, the actual costs quoted below by the bidder shall be binding for the term of the Agreement.

The bidder hereby agrees to provide all labor, materials, licenses, permits, and transportation necessary to perform all services required for the foregoing titled work in accordance with the Scope of Work, Exhibit A. The rates listed on this Bid Sheet shall include every item of expense, direct and indirect, including taxes incidental to the specified rates. **The cost of security services is to be included in the costs of bid items one and two. Security services, even when required by the State, will not be reimbursed through bid items three (special equipment) or four (special services).**

The bidder is required to bid each item. Failure to indicate a dollar amount in any item will be grounds to reject the entire bid. A zero dollar (\$0.00) amount listed for any and all items will be interpreted and understood by the State to mean that the bidder indicating a zero dollar amount shall perform any such services, up to and including the quantity indicated, at no cost to the state.

BID ITEM	QUANTITY	ITEM WITH UNIT PRICE IN WORDS (e.g. Two hundred for 200) ACCORDING TO EXHIBIT A, ITEM 6	UNIT PRICE IN NUMBERS	EXTENDED TOTALS
1A	375 hours	Drilling, sampling and other services as described in Exhibit A, Item 6.B, charges, hourly, per rig	\$_____ per hour	\$_____
1B	55 hours	Drilling, sampling and other services as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$_____ per hour	\$_____
2A	150 hours	Well Development Services as described in Exhibit A, Item 6.C, charges, hourly, per rig	\$_____ per hour	\$_____
2B	30 hours	Well Development Services, as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$_____ per hour	\$_____
3A	150 hours	Well Destruction Services, as described in Exhibit A, Item 6.D, charges, hourly, per rig	\$_____ per hour	\$_____

3B	30 hours	Well Destruction Services, as described in Exhibit A, Item 6.E, charges, hourly, OVERTIME after the first 8 hours each day	\$ _____ per hour	\$ _____
4	\$50,000 dollars	Providing Site Security as described in Exhibit A, Item 6.F, at Contractor's cost plus _____ Percent	_____ % Markup (shall not exceed 10%)	\$50,000 +\$ _____ =\$ _____
5	\$100,000 dollars	Providing Special Equipment, and Other Services as described in Exhibit A, Item 6.G, at Contractor's cost plus _____ percent	_____ % Markup (Shall not exceed 10%)	\$100,000 +\$ _____ =\$ _____
6	\$100,000 dollars	Miscellaneous Materials and Supplies, as described in Exhibit A, Item 6.H, at the Contractor's cost plus a markup of _____ percent	_____ % Markup (Shall not exceed 10%)	\$100,000 +\$ _____ =\$ _____
GRAND TOTAL				\$ _____

NO GUARANTEE OF WORK UNDER THIS CONTRACT.

In the event of computational error, unit prices will prevail over extended totals. The State will check bid calculations and recalculate bid totals.

I certify under penalty of perjury under the laws of the State of California, the foregoing is true and correct.

The Contractor's signature, in ink, affixed hereon and dated will constitute a certification under the penalty of perjury under the laws of the State of California that the Contractor's license number and expiration date are true and correct.

Company Name

Contractor's License Number

Contractor's License Expiration Date

Printed Name and Title of Bidder

Signature of Bidder

Date

ATTACHMENT II BID/BIDDER CERTIFICATION SHEET

This Bid/Bidder Certification Sheet must be signed and returned along with all the required attachments as an entire package in duplicate with **original signatures**. The bid must be transmitted in a sealed envelope in accordance with IFB instructions.

Do not return Bid Requirements and Information or the Sample Agreement.

- A. Our all-inclusive bid is submitted as detailed in Attachment I, Bid Sheet.
- B. All required attachments are included with this certification sheet.
- C. The signature affixed hereon and dated certifies compliance with all the requirements of this bid document. The signature below authorizes the verification of this certification. **An unsigned Bid/Bidder Certification Sheet may be cause for rejection.**

1. Company Name	2. Telephone Number ()	2a. Email
3. Address		
Indicate your organization type:		
4. ☐ Sole Proprietorship	5. ☐ Partnership	6. ☐ Corporation
Indicate the applicable employee and/or corporation number:		
7. Federal Employee ID No. (FEIN)	8. California Corporation No.	
9. Indicate applicable license and/or certification information:		
10. Bidder's Name (Print)		11. Title
12. Signature		13. Date
14. Are you certified with the Department of General Services, Office of Small Business Certification and Resources (OSDS) as: a. California Small Business Yes ☐ No ☐ If yes, enter certification number: _____ b. Disabled Veteran Business Enterprise Yes ☐ No ☐ If yes, enter your service code below: _____ NOTE: A copy of your Certification is required to be included if either of the above items is checked "Yes". Date application was submitted to OSDS, if an application is pending:		

Completion Instructions for Bid/Bidder Certification Sheet

Complete the numbered items on the Bid/Bidder Certification Sheet by following the instructions below.

Item Numbers	Instructions
1, 2, 2a, 3	Must be completed. These items are self-explanatory.
4	Check if your firm is a sole proprietorship. A sole proprietorship is a form of business in which one person owns all the assets of the business in contrast to a partnership and corporation. The sole proprietor is solely liable for all the debts of the business.
5	Check if your firm is a partnership. A partnership is a voluntary agreement between two or more competent persons to place their money, effects, labor, and skill, or some or all of them in lawful commerce or business, with the understanding that there shall be a proportional sharing of the profits and losses between them. An association of two or more persons to carry on, as co-owners, a business for profit.
6	Check if your firm is a corporation. A corporation is an artificial person or legal entity created by or under the authority of the laws of a state or nation, composed, in some rare instances, of a single person and his successors, being the incumbents of a particular office, but ordinarily consisting of an association of numerous individuals.
7	Enter your federal employee tax identification number.
8	Enter your corporation number assigned by the California Secretary of State's Office. This information is used for checking if a corporation is in good standing and qualified to conduct business in California.
9	Complete, if applicable, by indicating the type of license and/or certification that your firm possesses and that is required for the type of services being procured.
10, 11, 12, 13	Must be completed. These items are self-explanatory.
14	If certified as a California Small Business, place a check in the "Yes" box, and enter your certification number on the line. If certified as a Disabled Veterans Business Enterprise, place a check in the "Yes" box and enter your service code on the line. If you are not certified to one or both, place a check in the "No" box. If your certification is pending, enter the date your application was submitted to OSDS.

ATTACHMENT III BIDDER REFERENCES

List below three references for services performed within the last five years, which are similar to the scope of work to be performed under this contract.

REFERENCE 1

Name of Firm

Street Address

City

State

Zip Code

Contact Person

Telephone Number ()

Dates of Service

Brief Description of Service Provided:

REFERENCE 2

Name of Firm

Street Address

City

State

Zip Code

Contact Person

Telephone Number ()

Dates of Service

Brief Description of Service Provided:

REFERENCE 3

Name of Firm

Street Address

City

State

Zip Code

Contact Person

Telephone Number ()

Dates of Service

Brief Description of Service Provided:

Please provide a statement of explanation if no references are available:

**ATTACHMENT IV
DARFUR CONTRACTING ACT CERTIFICATION**

Pursuant to Public Contract Code section 10478, if a bidder or proposer currently or within the previous three years has had business activities or other operations outside of the United States, it must certify that it is not a "scrutinized" company as defined in Public Contract Code section 10476.

Therefore, to be eligible to submit a bid or proposal, please initial one of the following three paragraphs and complete the certification below:

1. _____
 Initials We do not currently have, or we have not had within the previous three years, business activities or other operations outside of the United States.

OR

2. _____
 Initials We are a scrutinized company as defined in Public Contract Code section 10476, but we have received written permission from the Department of General Services (DGS) to submit a bid or proposal pursuant to Public Contract Code section 10477(b). A copy of the written permission from DGS is included with our bid or proposal.

OR

3. _____
 Initials We currently have, or we have had within the previous three years, business activities or other operations outside of the United States, but we certify below that we are not a scrutinized company as defined in Public Contract Code section 10476.

CERTIFICATION

I, the official named below, CERTIFY UNDER PENALTY OF PERJURY that I am duly authorized to legally bind the prospective proposer/bidder to the clause listed above. This certification is made under the laws of the State of California.

<i>Proposer/Bidder Firm Name (Printed)</i>		<i>Federal ID Number</i>
<i>By (Authorized Signature)</i>		
<i>Printed Name and Title of Person Signing</i>		
<i>Date Executed</i>	<i>Executed in the County and State of</i>	

YOUR BID OR PROPOSAL WILL BE DISQUALIFIED UNLESS YOUR BID OR PROPOSAL INCLUDES THIS FORM WITH EITHER PARAGRAPH # 1, # 2, or # 3 INITIALED AND THE CERTIFICATION SIGNED.

ATTACHMENT V

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

Generative Artificial Intelligence (GenAI) Disclosure

Bidder/Offeror Information		
Solicitation/Contract number		Bidder ID/Vendor ID (optional)
Business Name		Business Telephone Number
Address		City/State/Zip
Description of purchase or service		
Does the purchase or service include GenAI? ☐ Yes ☐ No (if no, skip to the signature section of the form.)		
GenAI Description		
1. What is the application and/or product name?		
2. What is the model and version of the product?		
3. What is the license tier of the GenAI product, if applicable (free, enterprise, platinum, etc.)?		
4. How is the GenAI solution delivered: IaaS, PaaS, SaaS, or will it be deployed on-premises?		
Approval		
By signing this document, I have identified and reported any GenAI use in the performance of this contract.		
Name	Signature	Date

ATTACHMENT VI

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

BIDDER CERTIFICATION OF DVBE PARTICIPATION

DWR is firmly committed to meeting or exceeding the State's minimum annual DVBE participation goal of three percent (3.0%) of total reportable procurements (Public Contract Code (PCC) Section 10115, Military and Veterans Code (MVC) 999 and California Code of Regulations (CCR) Title 2, Section 1896.7).

The Bidder Certification of DVBE Participation form (DWR 9526) must be signed by representatives of the Bidder's firm and of the DVBE Subcontractor's firm, who have legal authority to execute binding agreements.

A copy of the current and valid certification from the Department of General Services, Office of Small Business and Disabled Veteran Business Enterprise, must be included for each DVBE firm, from the Cal eProcure website below:
<https://caleprocure.ca.gov/pages/PublicSearch/supplier-search.aspx?psNewWin=true>

SECTION 1 - DVBE PARTICIPATION PROGRAM (Check mark one box)				
☐ DVBE Program participation <u>is required</u> in solicitation.		☐ DVBE Program participation <u>is not required</u> in solicitation.		
SECTION 2 - BIDDER'S INFORMATION				
FIRM NAME				
FIRM CONTACT NAME				
STREET ADDRESS				
CITY	STATE	ZIP CODE		
TELEPHONE	EMAIL			
CERTIFICATION TYPE(S)	Check <u>all</u> that apply: ☐ SB ☐ MB ☐ SB-PW ☐ DVBE ☐ OSDS #			
SECTION 3 - DESCRIBE THE SERVICES OR COMMODITIES TO BE PROVIDED BY THE DVBE BIDDER, OR THE DVBE SUBCONTRACTOR WHO IS IDENTIFIED IN SECTION 5.				
SECTION 4 - IDENTIFY BIDDER'S DVBE PARTICIPATION COMMITMENT (Check mark one box)				
☐ OPTION A: COMMITTED a minimum of 100.0% - Bidder is a CA-certified DVBE firm and <u>is not</u> subcontracting to a CA-certified DVBE firm.				
☐ OPTION B: COMMITTED a minimum of 100.0% - Bidder is a CA-certified DVBE firm and <u>is</u> subcontracting to a CA-certified DVBE firm.				
☐ OPTION C: COMMITTED a minimum of 3.0% to one DVBE subcontractor listed in Section 5, _____% (fill in amount).				
☐ OPTION D: COMMITTED a combined total of _____% (fill in amount) to multiple DVBE subcontractors which includes The percentage to the DVBE subcontractor listed in Section, _____% (fill in amount). A separate DWR 9526 is required for each CA-certified DVBE subcontractor to which Bidder is making a commitment.				
(*) Bidder, if awarded the contract, is committed to paying the above stated percentage of the total contract amount (including contract amendments) to the DVBE subcontractor declared on this form.				
Printed Name of Bidder's Authorized Representative		Signature of Bidder's Authorized Representative		Date
SECTION 5 - DVBE SUBCONTRACTOR'S INFORMATION (Complete this section if you selected Options C or D above.)				
FIRM NAME				
FIRM CONTACT NAME				
STREET ADDRESS				
CITY	STATE	ZIP CODE		
TELEPHONE	EMAIL			
CERTIFICATION TYPE(S)	Check <u>all</u> that apply: ☐ SB ☐ MB ☐ SB-PW ☐ DVBE ☐ OSDS #			
Printed Name of DVBE's Authorized Representative		Signature of DVBE's Authorized Representative		Date

ATTACHMENT VII

[Link to form DGS PD 843](#)

- Select and use for titled "Disabled Veterans Business Enterprise Declarations" – 1 page

STATE OF CALIFORNIA – DEPARTMENT OF GENERAL SERVICES PROCUREMENT DIVISION

DISABLED VETERAN BUSINESS ENTERPRISE DECLARATIONS

DGS PD 843 (Rev. 9/2019)

Formerly STD. 843

Instructions: The disabled veteran (DV) owner(s) and DV manager(s) of the Disabled Veteran Business Enterprise (DVBE) must complete this declaration when a DVBE contractor or subcontractor will provide materials, supplies, services or equipment [Military and Veterans Code Section 999.2]. Violations are misdemeanors and punishable by imprisonment or fine and violators are liable for civil penalties. All signatures are made under penalty of perjury.

SECTION 1

Name of certified DVBE: _____ DVBE Ref. Number: _____

Description (materials/supplies/services/equipment proposed): _____

Solicitation/Contract Number: _____ SCPRS Ref. Number: _____

(FOR STATE USE ONLY)

SECTION 2

APPLIES TO ALL DVBEs. Check only one box in Section 2 and provide original signatures.

- ☐ I (we) declare that the DVBE is not a broker or agent, as defined in Military and Veterans Code Section 999.2 (b), of materials, supplies, services or equipment listed above. Also, complete Section 3 below if renting equipment.
- ☐ Pursuant to Military and Veterans Code Section 999.2 (f), I (we) declare that the DVBE is a broker or agent for the principal(s) listed below or on an attached sheet(s). (Pursuant to Military and Veterans Code 999.2 (e), State funds expended for equipment rented from equipment brokers pursuant to contracts awarded under this section shall not be credited toward the 3-percent DVBE participation goal.)

All DV owners and managers of the DVBE (attach additional pages with sufficient signature blocks for each person to sign):

(Printed Name of DV Owner/Manager) (Signature of DV Owner/Manager) (Date Signed)

(Printed Name of DV Owner/Manager) (Signature of DV Owner/Manager) (Date Signed)

Firm/Principal for whom the DVBE is acting as a broker or agent: _____
(If more than one firm, list on extra sheets.) (Print or Type Name)

Firm/Principal Phone: _____ Address: _____

SECTION 3

APPLIES TO ALL DVBEs THAT RENT EQUIPMENT AND DECLARE THE DVBE IS NOT A BROKER.

- ☐ Pursuant to Military and Veterans Code Section 999.2 (c), (d) and (g), I am (we are) the DV(s) with at least 51% ownership of the DVBE, or a DV manager(s) of the DVBE. The DVBE maintains certification requirements in accordance with Military and Veterans Code Section 999 et. seq.
- ☐ The undersigned owner(s) own(s) at least 51% of the quantity and value of each piece of equipment that will be rented for use in the contract identified above. I (we), the DV owners of the equipment, have submitted to the administering agency my (our) personal federal tax return(s) at time of certification and annually thereafter as defined in *Military and Veterans Code 999.2, subsections (c) and (g)*. Failure by the disabled veteran equipment owner(s) to submit their personal federal tax return(s) to the administering agency as defined in *Military and Veterans Code 999.2, subsections (c) and (g)*, will result in the DVBE being deemed an equipment broker.

Disabled Veteran Owner(s) of the DVBE (attach additional pages with signature blocks for each person to sign):

(Printed Name) (Signature) (Date Signed)

(Address of Owner) (Telephone) (Tax Identification Number of Owner)

Disabled Veteran Manager(s) of the DVBE (attach additional pages with sufficient signature blocks for each person to sign):

(Printed Name of DV Manager) (Signature of DV Manager) (Date Signed)

Page ____ of ____

ATTACHMENT VIII

[Link to form DGS PD 05-105](#)

- Select and use form titled "Bidder Declaration (Written)" – 2 pages

State of California—Department of General Services, Procurement Division GSPD-05-105 (REV 08/09)		Solicitation Number _____																													
BIDDER DECLARATION																															
1. Prime bidder information (Review attached Bidder Declaration Instructions prior to completion of this form): a. Identify current California certification(s) (MB, SB, NVSA, DVBE): _____ or None ☐ b. Will subcontractors be used for this contract? Yes ☐ No ☐ (If yes, indicate the distinct element of work your firm will perform in this contract e.g., list the proposed products produced by your firm, state if your firm owns the transportation vehicles that will deliver the products to the State, identify which solicited services your firm will perform, etc.). Use additional sheets, as necessary. _____ c. If you are a California certified DVBE: (1) Are you a broker or agent? Yes ☐ No ☐ (2) If the contract includes equipment rental, does your company own at least 51% of the equipment provided in this contract (quantity and value)? Yes ☐ No ☐ N/A ☐																															
2. If no subcontractors will be used, skip to certification below. Otherwise, list all subcontractors for this contract. (Attach additional pages if necessary): <table border="1" style="width:100%; border-collapse: collapse; font-size: x-small;"> <thead> <tr> <th style="width: 25%;">Subcontractor Name, Contact Person, Phone Number & Fax Number</th> <th style="width: 25%;">Subcontractor Address & Email Address</th> <th style="width: 25%;">CA Certification (MB, SB, NVSA, DVBE or None)</th> <th style="width: 25%;">Work performed or goods provided for this contract</th> <th style="width: 10%;">Corresponding % of bid price</th> <th style="width: 10%;">Good Standing?</th> <th style="width: 10%;">51% Rental?</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> </tbody> </table>				Subcontractor Name, Contact Person, Phone Number & Fax Number	Subcontractor Address & Email Address	CA Certification (MB, SB, NVSA, DVBE or None)	Work performed or goods provided for this contract	Corresponding % of bid price	Good Standing?	51% Rental?						☐	☐						☐	☐						☐	☐
Subcontractor Name, Contact Person, Phone Number & Fax Number	Subcontractor Address & Email Address	CA Certification (MB, SB, NVSA, DVBE or None)	Work performed or goods provided for this contract	Corresponding % of bid price	Good Standing?	51% Rental?																									
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					☐	☐																									
CERTIFICATION: By signing the bid response, I certify under penalty of perjury that the information provided is true and correct. Page _____ of _____																															
State of California—Department of General Services, Procurement Division GSPD-05-105 (REV 08/09) Instructions																															
BIDDER DECLARATION Instructions																															
All prime bidders (the firm submitting the bid) must complete the Bidder Declaration. 1.a. Identify all current certifications issued by the State of California. If the prime bidder has no California certification(s), check the line labeled "None" and proceed to item #2. If the prime bidder possesses one or more of the following certifications, enter the applicable certification(s) on the line: • Microbusiness (MB) • Small Business (SB) • Nonprofit Veteran Service Agency (NVSA) • Disabled Veteran Business Enterprise (DVBE) 1.b. Mark either "Yes" or "No" to identify whether subcontractors will be used for the contract. If the response is "No," proceed to item #1.c. If "Yes," enter on the line the distinct element of work contained in the contract to be performed or the goods to be provided by the prime bidder. Do not include goods or services to be provided by subcontractors. Bidders certified as MB, SB, NVSA, and/or DVBE must provide a commercially useful function as defined in Military and Veterans Code Section 999 for DVBEs and Government Code Section 14837(d)(4)(A) for small/microbusinesses. Bids must propose that certified bidders provide a commercially useful function for the resulting contract or the bid will be deemed non-responsive and rejected by the State. For questions regarding the solicitation, contact the procurement official identified in the solicitation. Note: A subcontractor is any person, firm, corporation, or organization contracting to perform part of the prime's contract. 1.c. This item is only to be completed by businesses certified by California as a DVBE. (1) Declare whether the prime bidder is a broker or agent by marking either "Yes" or "No". The Military and Veterans Code Section 999.2 (b) defines "broker" or "agent" as a certified DVBE contractor or subcontractor that does not have title, possession, control, and risk of loss of materials, supplies, services, or equipment provided to an awarding department, unless one or more of the disabled veteran owners has at least 51-percent ownership of the quantity and value of the materials, supplies, services, and of each piece of equipment provided under the contract. (2) If bidding rental equipment, mark either "Yes" or "No" to identify if the prime bidder owns at least 51% of the equipment provided (quantity and value). If not bidding rental equipment, mark "N/A" for "not applicable."																															
2. (continued) Column Labels Subcontractor Name, Contact Person, Phone Number & Fax Number—List each element for all subcontractors. Subcontractor Address & Email Address—Enter the address and if available, an Email address. CA Certification (MB, SB, NVSA, DVBE or None)—If the subcontractor possesses a current State of California certification(s), verify on this website (www.eprsource.pd.dgs.ca.gov). Work performed or goods provided for this contract—Identify the distinct element of work contained in the contract to be performed or the goods to be provided by each subcontractor. Certified subcontractors must provide a commercially useful function for the contract. (See paragraph 1.b above for code citations regarding the definition of commercially useful function.) If a certified subcontractor is further subcontracting a greater portion of the work or goods provided for the resulting contract than would be expected by normal industry practices, attach a separate sheet of paper explaining the situation. Corresponding % of bid price—Enter the corresponding percentage of the total bid price for the goods and/or services to be provided by each subcontractor. Do not enter a dollar amount. Good Standing?—Provide a response for each subcontractor listed. Enter either "Yes" or "No" to indicate that the prime bidder has verified that the subcontractor(s) is in good standing for all of the following: • Possesses valid license(s) for any license(s) or permits required by the solicitation or by law • If a corporation, the company is qualified to do business in California and designated by the State of California Secretary of State to be in good standing • Possesses valid State of California certification(s) if claiming MB, SB, NVSA, and/or DVBE status 51% Rental?—This pertains to the applicability of rental equipment. Based on the following parameters, enter either "N/A" (not applicable), "Yes" or "No" for each subcontractor listed. Enter "N/A" if the: • Subcontractor is NOT a DVBE (regardless of whether or not rental equipment is provided by the subcontractor) or • Subcontractor is NOT providing rental equipment (regardless of whether or not subcontractor is a DVBE) Enter "Yes" if the subcontractor is a California certified DVBE providing rental equipment and the subcontractor owns at least 51% of the rental equipment (quantity and value) it will be providing for the contract. Enter "No" if the subcontractor is a California certified DVBE providing rental equipment but the subcontractor does NOT own at least 51% of the rental equipment (quantity and value) it will be providing.																															
Read the certification at the bottom of the page and complete the "Page _____ of _____" accordingly.																															

ATTACHMENT IX

STATE OF CALIFORNIA
CALIFORNIA CIVIL RIGHTS LAWS ATTACHMENT
DGS OLS 04 (Rev. 01/17)

DEPARTMENT OF GENERAL SERVICES
OFFICE OF LEGAL SERVICES

Pursuant to Public Contract Code section 2010, a person that submits a bid or proposal to, or otherwise proposes to enter into or renew a contract with, a state agency with respect to any contract in the amount of \$100,000 or above shall certify, under penalty of perjury, at the time of the bid or proposal is submitted or the contract is renewed, all of the following:

1. **CALIFORNIA CIVIL RIGHTS LAWS**: For contracts executed or renewed after January 1, 2017, the contractor certifies compliance with the Unruh Civil Rights Act (Section 51 of the Civil Code) and the Fair Employment and Housing Act (Section 12960 of the Government Code); and
2. **EMPLOYER DISCRIMINATORY POLICIES**: For contracts executed or renewed after January 1, 2017, if a Contractor has an internal policy against a sovereign nation or peoples recognized by the United States government, the Contractor certifies that such policies are not used in violation of the Unruh Civil Rights Act (Section 51 of the Civil Code) or the Fair Employment and Housing Act (Section 12960 of the Government Code).

CERTIFICATION

I, the official named below, certify under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Proposer/Bidder Firm Name (Printed)	Federal ID Number
-------------------------------------	-------------------

By (Authorized Signature)

Printed Name and Title of Person Signing

Executed in the County of	Executed in the State of
---------------------------	--------------------------

Date Executed

**ATTACHMENT X
IRAN CONTRACTING ACT
(Public Contract Code sections 2202-2208)**

Prior to bidding on, submitting a proposal or executing a contract or renewal for a State of California contract for goods or services of \$1,000,000 or more, a vendor must either: a) certify it is **not** on the current list of persons engaged in investment activities in Iran created by the California Department of General Services ("DGS") pursuant to Public Contract Code section 2203(b) and is not a financial institution extending twenty million dollars (\$20,000,000) or more in credit to another person, for 45 days or more, if that other person will use the credit to provide goods or services in the energy sector in Iran and is identified on the current list of persons engaged in investment activities in Iran created by DGS; or b) demonstrate it has been exempted from the certification requirement for that solicitation or contract pursuant to Public Contract Code section 2203(c) or (d).

To comply with this requirement, please insert your vendor or financial institution name and Federal ID Number (if available) and complete **one** of the options below. Please note: California law establishes penalties for providing false certifications, including civil penalties equal to the greater of \$250,000 or twice the amount of the contract for which the false certification was made; contract termination; and three-year ineligibility to bid on contracts. (Public Contract Code section 2205.)

OPTION #1 - CERTIFICATION

I, the official named below, certify I am duly authorized to execute this certification on behalf of the vendor/financial institution identified below, and the vendor/financial institution identified below is **not** on the current list of persons engaged in investment activities in Iran created by DGS and is not a financial institution extending twenty million dollars (\$20,000,000) or more in credit to another person/vendor, for 45 days or more, if that other person/vendor will use the credit to provide goods or services in the energy sector in Iran and is identified on the current list of persons engaged in investment activities in Iran created by DGS.

<i>Vendor Name/Financial Institution (Printed)</i>	<i>Federal ID Number (or n/a)</i>
<i>By (Authorized Signature)</i>	
<i>Printed Name and Title of Person Signing</i>	
<i>Date Executed</i>	<i>Executed in</i>

OPTION #2 – EXEMPTION

Pursuant to Public Contract Code sections 2203(c) and (d), a public entity may permit a vendor/financial institution engaged in investment activities in Iran, on a case-by-case basis, to be eligible for, or to bid on, submit a proposal for, or enters into or renews, a contract for goods and services.

If you have obtained an exemption from the certification requirement under the Iran Contracting Act, please fill out the information below, and attach documentation demonstrating the exemption approval.

<i>Vendor Name/Financial Institution (Printed)</i>	<i>Federal ID Number (or n/a)</i>
<i>By (Authorized Signature)</i>	
<i>Printed Name and Title of Person Signing</i>	<i>Date Executed</i>

SAMPLE CONTRACT

STATEOF CALIFORNIA - DEPARTMENT OF GENERAL SERVICES

STANDARD AGREEMENT

STD 213 (Rev. 03/2019)

AGREEMENT NUMBER

PURCHASING AUTHORITY NUMBER (If Applicable)

1. This Agreement is entered into between the Contracting Agency and the Contractor named below:

CONTRACTING AGENCY NAME

CONTRACTOR NAME

2. The term of this Agreement is:

START DATE

THROUGH END DATE

3. The maximum amount of this Agreement is:

4. The parties agree to comply with the terms and conditions of the following exhibits, which are by this reference made a part of the Agreement.

EXHIBITS	TITLE	PAGES
Exhibit A	Scope of Work	
Exhibit B	Budget Detail and Payment Provisions	
Exhibit C*	General Terms and Conditions	

Items shown with an asterisk (*), are hereby incorporated by reference and made part of this agreement as if attached hereto. These documents can be viewed at <https://www.dgs.ca.gov/OLS/Resources>

IN WITNESS WHERE OF THIS AGREEMENT HAS BEEN EXECUTED BY THE PARTIES HERETO.

CONTRACTOR

CONTRACTOR NAME (if other than an individual, state whether a corporation, partnership, etc.)

CONTRACTOR BUSINESS ADDRESS

CITY

STATE

ZIP

PRINTED NAME OF PERSON SIGNING

TITLE

CONTRACTOR AUTHORIZED SIGNATURE

DATE SIGNED

STATE OF CALIFORNIA

CONTRACTING AGENCY NAME

CONTRACTING AGENCY ADDRESS

CITY

STATE

ZIP

PRINTED NAME OF PERSON SIGNING

TITLE

CONTRACTING AGENCY AUTHORIZED SIGNATURE

DATE SIGNED

CALIFORNIA DEPARTMENT OF GENERAL SERVICES APPROVAL

EXEMPTION (If Applicable)

EXHIBIT A SCOPE OF WORK

1. **Services to Be Provided** - Contractor agrees to provide to the Department of Water Resources (DWR/the Department) on-call geological exploration sonic drilling and related services as described herein.
2. **Location of Services** - The services will be performed Statewide at various locations throughout California. The Contractor must have an office/warehouse in the State of California with full-time employees and drilling equipment.
3. **The Contract Managers during the term of this agreement will be:**

Department of Water Resources	Contractor
Name:	Name:
Address:	Address:
Phone:	Phone:
Email:	Email:

The Authorized DWR and Contractor Managers may be changed by written notice to the other party.

4. Contract Provisions

- A. Applicable Laws and Regulations** - The Contractor will perform the work in strict accordance with the terms of this contract and all applicable laws and regulations. In the event that laws or regulations conflict with the provisions herein, Provision 17 of the General Terms and Conditions will apply for those provisions that are unenforceable. Otherwise, in the case of conflict of the provisions with applicable laws or regulations, the laws, or regulations will prevail, and the parties agree that all other provisions of this Agreement will remain enforceable.
- B. Right of Way and Environmental Permits** - DWR will provide entry and environmental permits pertaining specifically to the field work sites. The Contractor must comply with all terms and conditions of any instrument granting the State, DWR, or the Contractor the right to enter upon property. Such terms, conditions, and rights, pertain to the time, method, or manner of performing the work, including any one or a combination of the following:
 1. The prevention and suppression of fires
 2. Protection of endangered species and habitat
 3. Protection of cultural, archaeological, or Tribal resources
 4. Work safety plan
 5. Call-Up letter
 6. Noise suppression
 7. Disposal of drilling mud and soil cuttings
 8. The prevention of hydrocarbon contamination
- C. County Well Permits** - If requested, the Contractor will acquire county well permits. Copies of permits will be provided to DWR prior to drilling under each Call-Up.
- D. Authority of the Geologist** - The Geologist is an agent of the State/DWR and will be in charge at the work site. The Geologist, or a designated DWR representative, will direct the activities of the

Contractor and approve all activities proposed by the Contractor. The Geologist or a designated DWR representative will be present at each site while work is in progress. The Geologist or a designated DWR representative will determine all field activities including any one or a combination of the following:

1. Exact drillhole locations
2. Depths of drillholes
3. Drilling and sampling methods, sequences, and intervals
4. Well and surface completion design and construction details
5. Geophysical surveys to be conducted
6. Well development methods
7. Well/drillhole destruction methods
8. Grouting techniques

E. Licenses - The Contractor is required to possess a valid C-57 Water Well Drilling License with the California State Contractor's State License Board. The license must be maintained throughout the contract period. Failure to maintain a valid license may result in termination of the contract or other remedies allowed under this contract or applicable law. In addition, California Water Code Section 13751 requires that anyone who constructs, alters, or destroys a water well, cathodic protection well, groundwater monitoring well, or geothermal heat exchange well must file with DWR a report of completion within 60 days of the completion of the work. **Drillers must submit their well completion reports with the Online System of Well Completion Reports (OSWCR, pronounced "Oscar")**. OSWCR users create an account based on their C-57 license that DWR will validate. Upon approval users will be able to submit Well Completion Reports. Well Completion Report services will be performed at no cost to the DWR.

F. Contractor's Supervision of the Work

1. The Contractor will provide competent and efficient supervision of all work. All work must be performed in a skillful and orderly manner, and the Contractor and the Contractor's supervisory personnel will enforce this requirement at all times.
2. The Contractor or the Contractor's representative will be present at the field work site while work is in progress. The Contractor's representative will have the authority to act for the Contractor at the field work site including the authority to sign off on daily bid item quantities (as outlined in Item 6 below – Measurement and Payment).

G. Special Requirements of the Contractor's Personnel

1. **Drilling Crew Requirements at all Sites** - The drill crew for each drill rig used by the Contractor in the performance of this contract will include one **(1)** Driller, and at least two **(2)** Driller's Helpers. The Driller will be responsible for and in charge of the drilling equipment and drilling operations at all times. The Driller experience requirements are described in the sections below. The Driller's Helper(s) must each have at least six (6) months of drilling-related experience and will be on the drill site when work is being performed by the Driller.
2. **Driller Experience Requirements for Regular Drilling** – Regular drilling in this contract is defined as all drilling performed that is NOT located at or near a dam or a levee. Recent requirements by the Federal Energy Regulatory Commission (FERC) have put special experience requirements for drillers working at or near dams. Similarly, recent requirements by the United States Army Corp of Engineers (USACE) have put special experience requirements for drillers working at or near levees. The Driller used by the Contractor in the performance of regular drilling in this contract will be a person who is thoroughly experienced with at least three (3) years in drilling, sampling, and related services with the type of drill rig and equipment being used and

experienced in drilling to the depths required. Drillers' resumes must be provided upon written request by DWR.

3. **Driller Experience Requirements for Drilling Through or Near Dams** - FERC has provided guidance to DWR regarding drilling in or around dams at FERC-regulated projects. Many DWR projects where drilling may be performed during this contract are FERC regulated. At such locations, any geotechnical investigations (borings, wells, piezometers, test pits, etc.) must be coordinated by DWR with FERC in advance by submitting investigation plan documents for FERC's review at least 30 days before the work is to begin. The drilling Contractor will be required to assist DWR with preparing investigation plan documents. For any drilling in proximity to any dam or feature, subject to these regulations, the plan should include, at a minimum: use of appropriate drilling fluid; specific procedures may need to be defined for casing installation to prevent any uncontrolled artesian flow from a boring, as the hole may not be completed in a single day; and backfilling requirements should include a method to tremie fill any open hole from the bottom up to the top of ground.
4. **Driller Experience Requirements for Drilling Through or Near Levees** - The USACE has provided Regulation No. ER 1110-1-1807 (see Exhibit A, Attachment 1) to DWR for all drilling associated with dams and levees under USACE jurisdiction. It is not anticipated that this contract will require any drilling at USACE dams. However, many of the levee projects where drilling may be performed during this contract are USACE regulated. At such locations, the policies, requirements, and guidance provided in Regulation No. ER 1110-1- 1807 must be followed by the Contractor and DWR.
5. **Resume Requirements for Drillers** - The Contractor must employ and be able to provide under this contract at least two (2) Drillers who meet the minimum requirements stated herein. Prior to awarding this contract, and throughout the duration of this contract, the Contractor must provide to DWR upon written request the resumes of the Drillers who will be performing the drilling at dam and levee sites. For dam-related drilling, the Driller must have at least five (5) years of documented experience on the resume in dam investigations. For levee-related drilling, the Driller must have at least five (5) years of documented experience on the resume in levee investigations. Failure to provide at least two (2) resumes acceptable to DWR prior to awarding the contract may result in non-awarding of the contract. Failure to maintain qualified Drillers and acceptable resumes may result in termination of the contract or other remedies allowed under this contract or applicable law. If the Contractor chooses to replace one of the acceptable Driller's resumes during the course of the project, DWR must be provided with a minimum notice of one (1) week prior to that Driller mobilizing to the site.
6. **Drilling Crew Training Requirements** - The Department is committed to having safe and professional workers at all work sites. For this reason, the Contractor's Driller, Driller's Helpers, and other representatives of the Contractor at the site must have successfully completed classes within the last three (3) years equivalent to the following:
 - a. Defensive Driver Training
 - b. First Aid and CPR
 - c. Preventing Sexual Harassment
 - d. Health and Safety HAZWOPER Training (Only when requested in writing by the Geologist).

Both the 40-hour health and safety HAZWOPER training course and 8-hour HAZWOPER refresher training course that complies with Title 8, Section 5192, California Code of Regulations, include the proper use of respirators. In such cases, respirators that have been fit-tested for each crew member and appropriate filters may be required and must be furnished by the Contractor for use by the drill crew and other representatives of the Contractor.

- H. **Removal of Personnel** - The drilling crew will work safely, efficiently, and act professionally at all times. If at any time any of the Contractor's personnel are judged by the Geologist or a designated DWR representative to be unsafe, unprofessional, untrained, their training is out of date, or the Contractor's personnel are incapable of adequately performing the work, the Contractor will be

notified of the problem and the Contractor will have two (2) working days to replace said personnel or remedy the problem to the satisfaction of the Geologist or a designated DWR representative. The Geologist or a designated DWR representative may suspend or stop the work at a site immediately at no additional cost to the DWR if the Geologist or a designated representative believes the Contractor's personnel are working unsafely. Upon resolution of the unsafe situation, the Geologist or a designated DWR representative may direct the Contractor to commence work again.

I. Contractor Furnished Equipment

1. The Contractor will maintain safe and sufficient equipment to meet the requirements of the work. The equipment must be in satisfactory operating condition and capable of safely and efficiently performing the work set forth herein. The equipment will be subject to inspection by the Geologist prior to awarding of the contract, prior to each Call-Up, and at all times at the site.
2. Equipment determined by the Geologist or a designated DWR representative to be unsafe, unsatisfactory, inefficient, or any combination thereof, will be removed from the site and will be replaced within two (2) working days, by adequate equipment at no additional cost to DWR. The Geologist or a designated DWR representative may suspend or stop the work at a site immediately at no additional cost to DWR if the Geologist or a designated DWR representative believes the Contractor's equipment is unsafe. Upon resolution of the unsafe situation, the Geologist or a designated DWR representative may direct the Contractor to commence work again.
3. Specific equipment required to perform work during a Call-Up under this contract will be described and listed in a letter to the Contractor, which will be furnished to the Contractor by the DWR at least 15 calendar days prior to the start of the Call-Up, unless a shorter notice is mutually agreed upon.
4. All equipment described and listed in a Call-Up letter will be delivered to the site on the first day of the Call-Up and remain available for use throughout the duration of the Call-Up. The Geologist or a designated DWR representative may suspend or stop the work at a site immediately at no additional cost to the DWR if the Geologist or a designated DWR representative believes the Contractor has not delivered requested equipment or supplies to the site. Upon resolution of delivering equipment and supplies to the site, the Geologist or a designated DWR representative may direct the Contractor to commence work again.
5. A printed copy of each Call-Up letter (work authorization letter) will be provided to the Driller by the Contractor prior to arriving at the site, and that copy of the letter will remain available at the site for the duration of the Call-Up.

J. Subcontractors and Suppliers - The Contractor will be responsible under the contract for the acts, omissions, and fair market pricing of subcontractors, suppliers, and persons either directly or indirectly employed by them, insofar as their activities relate to the work required by this contract, as fully as the Contractor is for the acts and omissions of the Contractor's own employees. Nothing in the contract will create any contractual relation between any subcontractor or supplier and the DWR, or any obligation on the part of the DWR to pay or cause to be paid any money to any subcontractor or supplier.

K. Air Pollution - The Contractor will comply with all air pollution control rules, regulations, ordinances, and statutes which apply to any work performed pursuant to this contract, including those specified in Government Code Section 11017. All drilling and ancillary equipment must meet the State of California emission regulations.

L. Accident Prevention - The Contractor will be responsible for accident prevention and safety, and for the protection of persons and property. These responsibilities must include, at a minimum:

1. Proper health and safety training of Contractor's employees and other representatives of the contractor.
2. Installing adequate safety guards and protective devices for equipment and machinery.

3. Providing and operating devices to give warning of any dangerous condition created or encountered as a result of the work.
4. Installing and maintaining covers or other suitable devices to protect persons, livestock, or wildlife from the hazards of equipment, open holes, and/or excavations created by the work, until all contract work is completed at each hole or excavation site, as determined by the Geologist or a designated DWR representative.
5. Supplying an up to date first aid kit and an automated external defibrillator (AED) with each drill rig, suitable to handle injuries which may occur at a site, such as minor cuts, burns, or heat/cold illness.

M. Written Program for Prevention of Injury and Illness - The Contractor will comply with California Safety Orders, Chapter 4, Division of Industrial Safety. The Contractor will prepare a written program in accordance with Title 8, Section 3395, specifically designed to prevent injury to all persons on the site and to protect against undue exposure to health hazards that reasonably could be encountered in the performance of the work. The written program will be furnished to the Geologist or a designated DWR representative within ten (10) days after the Contractor receives the notice to proceed. The Geologist or a designated DWR representative will review the program for safety of Department employees and the public within three (3) business days, and the Contractor will revise the program within three (3) business days to correct defects noted. The written program will be approved by the Geologist or a designated DWR representative before work begins at the first site. The Contractor will furnish a copy of the approved program to all persons performing work at any site where work will be performed under this contract.

N. Work Safety Plan – A written Work Safety Plan will be submitted by the Contractor prior to start of each Call-Up. The plan will be site specific and cover such things as the closest location of emergency room services, fire department, and other needs based on the drilling activities and locale. Also, safety concerns specific to the site such as working near steep slopes or open water will be addressed. The Work Safety Plan will be submitted to the Geologist or a designated DWR representative for review at least three (3) working days prior to the first day of the Call-Up; revisions, if any are requested, be made by the Contractor before the work can begin. The Contractor will keep a printed copy of the Work Safety Plan at the site at all times.

O. Heat Illness Prevention Plan - A written, site-specific Heat Illness Prevention Plan will be submitted by the Contractor to the Geologist or a designated DWR representative for each site, which complies with Title 8, Section 3395 California Code of Regulations. The site-specific heat-illness prevention plan will incorporate a work/rest schedule consistent with the NIOSH "Criteria for a Recommended Standard. Occupational Exposure to Heat and Hot Environments" (NIOSH, 2016). Rest time taken in accordance with the Heat Illness Prevention Plan will be treated as normal working time and not as drill rig standby time. The heat illness prevention plan can be incorporated into the Work Safety Plan or provided to the Geologist along with the Work Safety Plan as a separate document. The Contractor will keep a printed copy of the Heat Illness Prevention Plan at the site at all times.

P. Fire Prevention Plan - Some project areas may be hot, dry, and windy, making them particularly susceptible to the starting and spreading of fires. The Contractor will provide a fire prevention plan in accordance with Title 8, Section 3221. The Contractor will be responsible for preventing wildfire by taking all necessary precautions concerning the Contractor's actions, equipment, and vehicles. This responsibility includes, but is not limited to, allowing smoking in fire-safe areas only; having spark arresters on drill rig engines, pumps, and other equipment, and prohibiting vehicles with a catalytic converter from being driven or parked where dry vegetation may touch the catalytic converter. At least one (1) fire extinguisher will be provided with each drill rig, vehicle, or other contractor-furnished mobile equipment. A written Fire Prevention Plan will be submitted to the Geologist for review at least three (3) working days prior to the first day of a Call-Up. Revisions, if any are requested, will be made by the Contractor before the work can begin. The Contractor will keep a printed copy of the Fire Prevention Plan at the site at all times.

Q. Schedule of Work - For each Call-Up the Contractor will commence work at the project site at a mutually agreed upon date that does not exceed fifteen (15) calendar days after being notified to proceed and thereafter will diligently prosecute the work to completion.

R. Work Hours

1. **Normal Work Hours** – It is intended that the Contractor and the Contractor's employees work 40 hours each week. The Contractor and the Contractor's employees are expected to work 8 hours per day for 5 days per week, Monday through Friday, at the job site, excluding State holidays. Normal working hours will begin no earlier than 6 a.m. and end no later than 6 p.m. Normal working hours may be modified for health and safety reasons (e.g. High Temperatures). During workdays which exceed six (6) hours at the work site, the Contractor and the Contractor's employees are required to take a lunch break/rest period of a minimum of one-half hour. During the lunch break/rest period, no drilling or other related work will be performed. The lunch break/rest period should be scheduled so it is no closer than two (2) hours from the beginning of the workday, and no closer than two (2) hours from the end of the workday.
2. **Shortened Work Week** - During a week when the State is required to be closed for a one-day State holiday, or for other reasons, the Contractor will not be allowed to work at the site on that day. In such weeks, the Contractor will be allowed to work four 10-hour days, or some other mutually agreeable schedule, to reach 40 hours of work at the job site.
3. **Extended Work Hours** - On some weeks the Contractor and the Contractor's employees may be asked to work more than 8 hours per day, more than 40 hours per week, holidays, weekends, or any combination thereof, in order to complete the work. Such hours will be at the discretion of and must be approved in advance by the DWR Project, and/or Contract Managers.

S. Suspension of the Work

1. DWR may suspend the work for such period of time as it deems necessary due to unsuitable weather such as heavy rain, flooding, extremely muddy ground, lightning, wildfires, and high winds, or if other conditions, in its opinion, are considered unfavorable for safe, suitable prosecution of the work, or for such time as it deems necessary due to the failure of the Contractor to carry out orders given or to perform any provisions of the contract or a Call-Up letter.
2. No payment will be made for such suspension of work. A suspension of work for any reason will not relieve the Contractor of the Contractor's responsibilities under this contract.

T. Early Termination of the Work

1. DWR may terminate the work being performed under any Call-Up at any time for reasons including but not limited to changes in entry permits, environmental permits, weather, site conditions, and the availability of DWR funding. The DWR also may terminate this contract at any time if deemed necessary by the DWR in accordance with the Termination Clause Provision stated in Exhibit D. If a Call-Up or the contract is terminated for the convenience of the DWR before the specified work is completed, the DWR will reimburse the Contractor for all work performed up to the time of termination and for reasonable costs incurred because of early termination in accordance with Exhibit D.
2. DWR may suspend contract payments or terminate the contract, or both, and the Contractor may be subject to debarment, if the Contractor has made a false certification under Government Code Section 8355, relating to a drug-free workplace, or violates the certification by failing to carry out its requirements.

U. Field Work Site Security

1. **Contractor Responsibilities** - The Contractor is responsible for securing the field work site and for any vandalism or theft, or both, on the site which could result in damaged drillholes, damaged and/or stolen equipment, materials, or supplies. The Contractor is responsible to secure the sites at all times, including nights, weekends, State holidays, and other non-work times. The Contractor

must use industry best practices for securing drillholes to prevent damage to the holes, and damage or injury to people, animals, and equipment.

2. **Call-Up Work Sites on DWR Property** - On many Call-Ups, the DWR may provide the Contractor access to DWR-owned gated yards where equipment, materials, and supplies may be locked up at night and on weekends. In such cases, The Contractor is responsible for securing their equipment and materials at DWR-owned facilities and gated yards.
3. **Licensed Security Guards and Officers** - All security guards and officers in California are required to be licensed by the DWR. The Contractor will only use security guards and officers with a valid California license (guard card). Depending on the site conditions and/or location, security guards and officers may be required to have certain safety and/or other training (to be specified in the Call-Up letter).
4. **Cost of Security** - The cost of security services may be reimbursed and is expected to be included in the bid under Bid Item 4. Security services will not be reimbursed through other bid items. There will be no additional charges to the Call-Up, to the contract, or to the DWR when a security officer is required and/or provided. In special cases where work site conditions and/or location require the security guards or officers to have certain safety and/or other training, the costs associated with that training can be paid under Bid Item 4.

5. Technical Provisions

A. Description and Location of Work

1. The work consists of providing up to one (1) fully equipped drilling rig at one time, each staffed with a driller and at least two (2) driller's helpers, on a Call-Up basis to perform drilling services for projects located throughout California. Drill rigs mounted on two-wheel drive trucks, track mounted trucks, and four-wheel drive trucks are required to be available for use. Materials to be drilled will range from soft clays to loose sands, gravels and boulders, and bedrock varying from weathered and weak, to fresh and very hard. Some holes may encounter groundwater while other holes may be dry. Some holes may have stable walls while others may exhibit caving and/or flowing conditions.
2. Locations are located throughout California, potentially in all counties. The specific counties covered under this contract are: Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Luis Obispo, San Francisco, San Joaquin, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yolo, and Yuba.
3. In addition to sonic drilling services, the Contractor will provide, when requested in writing by the Geologist or a designated DWR representative, well development services, well destruction services, geophysical testing services, laboratory services, cone penetrometer testing, and other special equipment and services.

B. Access - Access to some drilling sites will be from level, paved roads. However, access to other sites may be by dirt or gravel roads in hilly terrain, and trails that may require the Contractor to have four-wheel drive equipment or to take other measures to safely access the drilling site. At some locations a dozer or other heavy equipment may be needed to prepare access and/or assist in moving the rig and equipment to the sites.

C. Field Equipment

1. The primary field equipment consists of standard geotechnical-size, truck-mounted drill rigs capable of reaching drilling depths as deep as 400 feet.
2. All-terrain, track-mounted, skid-mounted, and other styles of drill rigs may be substituted on individual Call-Ups for no additional cost to the DWR only if mutually agreed upon by the Contractor and the Geologist or a designated DWR representative.

3. The drilling equipment must be comparable to a Fraste MRS 250 or FS 250, Boart Longyear LS 600, Prosonic TM600 Geoprobe 8140, Terra Sonic International, 600 Series and 300 Series , equipped, at a minimum, as follows:
 - a. A mud pump
 - b. A water tank mounted on the truck or a trailer
 - c. Accessory tools and equipment to perform work such as Standard Penetration Tests, well development, and well destruction.

D. Drilling Equipment

1. Four hundred (400) feet of inner core rods with an inside diameter that will accommodate three-inch diameter sampling equipment. Equipment must conform to American Society of Testing Materials (ASTM) D6914/D6914M-16 (see Exhibit A, Attachment 2).
 - a. The sampling barrels should have lengths ranging from 5 to 20 feet.
 - b. A 300-gallon minimum capacity water tank, either truck or trailer mounted, to provide water for drilling and grouting of drill holes.
 - c. Water line, water pumps, portable tanks, and other related equipment for pumping water to remote drill sites.
 - d. Temporary casing of various diameters and lengths to stabilize drill holes.
 - e. Tremie pipe, hoses, pumps, and other related equipment for mixing and backfilling holes with grout.
2. Standard Penetration Tests (SPT) Equipment: including samples and sample rod conforming to the requirements of the American Society of Testing Materials (ASTM) D6066-24 and D1586-18. (see Exhibit A, Attachment 3).
 - a. For geotechnical work, the Contractor must provide and only use a two-inch outside diameter split-barrel sampler with a uniform 1 3/8- inch inside diameter throughout the entire length of the sample barrel manufactured to be used only without liners.
 - b. For environmental work, the Contractor may be required to provide and use a two-inch diameter split-barrel sampler that is made to contain liners.
 - c. The SPT sampler will be driven using an automatic-type hoist (Mobile Safe-T-Driver hoist or similar) to raise and drop a 140-pound safety-type hammer a distance of 30 inches.
 - d. The hammer must be a Mobile Safety Drive Hammer or equivalent; no "in-hole" sampling hammers will be permitted. The size of the drill rod used during the SPTs will be: N-size rod only. Various lengths of drill rod will be available to perform SPT tests at any depth up to 300 feet. All SPT equipment must be approved by the Geologist or designated DWR representative.
3. Water pressure-testing equipment including pneumatic packers for drillhole depths up to 400 feet. Equipment setup must conform to the requirements shown in Pressure Water Testing Equipment Setup, (See Exhibit A, Attachment 5).
 - a. The requested pressure gauge must read in five (5) pounds per square inch (psi) maximum graduations to a gauge total of no less than 300 psi. The requested flow gauge must read in 1-gallon graduations with at least one-tenth gallon minimum increments. Water pressure tests will be made at regular intervals in the drillhole as required by the Geologist or a designated DWR representative. The Contractor will furnish all necessary tools and

equipment to properly perform the tests within any interval of the hole.

- b. Water testing equipment must include an even flow pump capable of delivering 35 gallons per minute when operating at discharge pressure of 200 psi; an accurate flow meter similar to a Trident 1.5-inch meter measuring in gallons with a clock dial and set back device; the pressure gauge requested in Section 2 of the Contract plus a second gauge with a range of 0 to 100 psi marked at intervals of not greater than 5 psi; and all other accessory tools and equipment necessary for maintaining uninterrupted tests for each hole tested.
- c. The Contractor will provide at least two pneumatic packers with rubber expansion elements capable of being used alone (single packer test) or as a pair separated by 10 to 20 feet of perforated pipe (double packer test) to isolate any zone within a drilled interval. The rubber expansion element on the packers will not be less than 12 inches in length. Nitrogen gas or compressed air delivered from a tank with dual gauge valves will be used to inflate the packers.
- d. For testing the water pressure testing equipment, the packers are to be inflated within a section of N-size or larger casing and a pressure of 200 psi must be maintained between the packers with essentially no leakage. At the beginning of each hole or when the condition of the testing equipment is suspected of being faulty, the Contractor will be required to perform this test and, if necessary, repair the system at the Contractor's own expense.
- e. Packers must be arranged in either a single packer or double packer setup as directed by the Geologist. The depth of packers; the number and length of tests; and pressure and flows to be used, will be determined by the Geologist or a designated DWR representative.
- f. Prior to performing a water test, the hole must be surged and washed with clear water for approximately ten minutes or longer, as determined by the Geologist or a designated DWR representative, to remove cuttings from the pores and joints of the formation. The surface reservoir tanks must be cleaned out prior to washing the hole and again before actual water testing begins. Water circulated during washing process must be renewed if considered unsatisfactory.

E. Performing Standard Penetration Tests - The procedures for performing SPTs will be according to ASTM D 6066-24 and D 1586 (or more recent if available). Care will be taken by the driller to make sure that all of the SPTs are performed in 1.5 feet of undisturbed soil. Tests will not be performed in a zone where the material is known to be disturbed, such as where a Shelby tube sample was attempted but not recovered, unless directed by the Geologist or designated DWR representative. The SPT sampler may be requested by the Geologist to be used to retrieve disturbed material from the hole, but that procedure will not be recorded as an SPT. "Refusal" for an individual test will be 80 blows instead of 50 blows in a 6-inch interval. The Contractor may be required to add water to the inside of hollow-stem augers during SPTs to prevent the upward expansion of soils at the bottom of the hole. The Contractor must have extra sampler tips available at the job site to ensure that damaged or dented tips are not used during SPTs.

F. Well Development - The Geologist or a designated DWR representative may request the Contractor to provide well development services. Equipment used in well development services does not have to be owned by the Contractor; it can be rented, leased, or subcontracted (fair and reasonable market pricing considered) with the approval of the Geologist or a designated DWR representative. All well development must be requested by the Geologist or a designated DWR representative in writing. Well Development may include the following:

1. Surging with a surge block to settle filter pack material.
2. Compressed air (airlifting).
3. Dual swabbing.

4. Submersible pump (pumping and surging) capable of adequately stressing the aquifer.
5. Bailer.
6. Baker tank (or equivalent) of sufficient volume for containment and settling of development fluids without disrupting development activities.
7. Sampling and analyzing purge water for stabilization criteria, including temperature, conductivity, dissolved oxygen, oxidation reduction potential, pH, and turbidity.
8. Equipment must be in good working order and calibrated within the previous 24-hours for all criteria.

G. Well Destruction - The Geologist or a designated DWR representative may request the Contractor to provide well destruction services. Equipment used in well destruction services does not have to be owned by the Contractor; it can be rented, leased, or subcontracted (fair and reasonable market pricing considered) with the approval of the Geologist or a designated DWR representative. All well destruction must be requested by the Geologist or a designated DWR representative in writing. Well destruction may include the following:

1. The primary field equipment to be used for well destruction will consist of standard geotechnical-size, truck-mounted drill rigs. The drilling equipment for each drill rig must include, at a minimum, as follows:
 - a. Four hundred (400) feet of inner core rods with an inside diameter that will accommodate two-inch or four-inch diameter wells.
 - b. A 600-gallon minimum capacity water tank, either truck or trailer mounted, to provide water for drilling and grouting of drill holes.
 - c. Water line, water pumps, portable tanks, and other related equipment for pumping water to remote drill sites.
2. All-terrain, track-mounted, skid-mounted, and other styles of drill rigs may be substituted on individual Call-Ups for no additional cost to the DWR only if mutually agreed upon by the Contractor and the Geologist or a designated DWR representative.

H. Geophysical Services – The Geologist or designated DWR representative may request the Contractor to provide specific geophysical services. Equipment used in geophysical services does not have to be owned by the Contractor; it can be rented, leased, or subcontracted with the approval of the Geologist or a designated DWR representative. All geophysical services must be requested by the Geologist or a designated DWR representative in writing. Services may include, at a minimum, the following:

1. Electrical resistivity logging
2. Natural gamma-ray logs
3. Spectral-gamma ray logs
4. Acoustic (Sonic) with variable density log (VDL) and sonic porosity logs
5. Temperature
6. Television
7. Down-hole or cross-hole shear wave, or both
8. Video surveys
9. Caliper logs
10. Drillhole geometry/deviation surveys

I. Special Equipment and Other Services – The Geologist or a designated DWR representative may request the Contractor to furnish and use special equipment and provide other services beyond the

normal drilling equipment required by the contract (listed in "Field and Drilling Equipment" above). The furnishing and use of special equipment and other services must be requested by the Geologist or a designated DWR representative in writing. Special equipment and other services do not have to be owned by the Contractor; these provisions can be rented, leased, or subcontracted (fair and reasonable market pricing considered) with the approval of the Geologist or a designated DWR representative. Special equipment and other services may include, at a minimum, the following:

1. Rental and use of special equipment
2. Laboratory testing
3. Geophysical services (beyond what is listed under "Geophysical Services")
4. Special labor
 - a. Additional drillers and helpers
 - b. Excavation labor services
 - c. Laboratory courier services
 - d. Labor related to services within the scope of this contract
 - e. Tribal Monitoring Services:
 - 1) DWR will approve the use of Tribal Monitoring Services provided by Native American Tribes in support of DWR's compliance and consultation responsibilities, whereby the provision of tribal expertise is above and beyond participation in state and federal consultation requirements. At DWR's direction, the Contractor shall support DWR in facilitating the participation of Native American Tribes in providing these services. DWR shall approve the rates for Native American Tribes in providing Tribal Monitoring Services through their experts.
 - 2) The Contractor shall not initiate contact with Native American Tribes unless directed by DWR. The Contractor coordination work will consist of, but not be limited to, the following tasks:
 1. Compensating tribal experts under Call-Ups at DWR-approved rates per DWR's direction for activities such as, but not limited to, field visits, and monitoring.
 2. It is critical to keep confidential and sensitive information secure, including, but not limited to, prehistoric/precontact site locations. DWR's prior written authorization is required for dissemination, in any form, of confidential or sensitive information received or discovered by the Contractor during Call-Ups.
5. Bulldozer
6. Heavy duty winch or crane
7. Special fuel costs (if billed separately) of operating the special equipment
8. Cone penetrometer testing equipment
9. Other types of drill rigs
10. Additional costs for removal and off-site disposal of drill fluid, mud and cuttings
11. Associated chemical testing, and
12. Cost of delivering the special equipment to and from the field work site
13. Water truck
14. Portable toilets
15. Steam cleaners
16. Vacuum trucks
17. Backhoes

- 18. Hydraulic shoring
- 19. Temporary fencing

- J. Water Supply** - It will be the responsibility of the Contractor to identify, procure, and provide an adequate supply of water of acceptable quality at each drill site, as determined and approved by the Geologist or designated DWR representative. When available, water from the Aqueduct or other DWR facility may be utilized by the Contractor for water supply.
- K. Supplementary Holes** – Drill holes abandoned before reaching the specified total depths because of Contractor's negligence or equipment failure will be destroyed and replaced by a supplementary drill hole to the depth and testing of the original hole at no charge to the DWR. Payment for the new drillhole will start at the point where the depth of the supplemental hole exceeds the depth of the original hole. No payment will be made for setup to drill a replacement hole at the same drillhole site. All abandoned drillholes will be adequately backfilled through a tremie pipe with sand-cement grout or neat-cement grout at the Contractor's expense and in accordance with the California Bulletin 74 Well Standards.

Monitoring wells, slope inclinometers, or other instruments installed by the Contractor in drillholes during this contract will be inspected by the Geologist or a designated DWR representative and the Driller prior to completion of the Call-Up to make sure they are operational and/or functioning properly. If a monitoring well or other instrument installed in a drillhole is found to be inoperable or non-functioning because of Contractor's negligence or equipment and materials failure, it will be fully replaced at no charge to the Department. No payment will be made for a new set up or for drilling the new hole, or for additional materials and supplies. Also, no payment will be made for time, materials, and supplies required to properly destroy and backfill the inoperable or non-functioning drillhole. All materials will be removed from the drillhole. Destroyed holes must be adequately backfilled through a tremie pipe with sand-cement grout or neat-cement grout in accordance with the California Bulletin 74 Well Standards. If a monitoring well, slope inclinometer, or other instrument installed in a drillhole is found to be inoperable or non-functioning, and the cause or responsibility cannot be established by the Geologist or a designated DWR representative, the cost to abandon and replace the subject items will be split 50/50 between the Contractor and DWR.

- L. Backfilling Holes** - Upon instruction from the Geologist or a designated DWR representative, drillholes will be backfilled. The Geologist or a designated DWR representative will determine if the drillholes are backfilled by compacting native soils back into the drillhole or by injecting a sand-cement grout or neat-cement grout through a tremie pipe that extends to the bottom of the drillhole. Drillholes not backfilled will be completed as monitoring wells, slope inclinometers, or with other methods and/or equipment as directed by the Geologist or designated DWR representative. The standard grout mix for backfilling hole in this contract will be either a sand-cement grout mixture or neat-cement grout mixture, as discussed below.
1. Sand-cement grout - Grout shall be mixed at a ratio of not more than 188 pounds of clean-inert sand to one 94-pound sack of Type I/II Portland cement (2 parts sand to 1 part cement, by weight) and about 6 gallons of clean, potable water. This is equivalent to a '10.3 sack mix'. Less water shall be used if less sand than 2 parts sand per 1 part cement by weight is used. Additional water may be required when special additives, such as bentonite, accelerators, or retardants are used. Mixing shall be performed with either a low shear (paddle mixer) or high shear mixer. If a cement truck is to deliver the grout, the following cement mixture specifications are to be adhered to: a sand-cement grout mixture consisting of (per cubic yard) 968 lbs. of Type II cement (ASTM C150-95 Standard Specification for Portland Cement) and 1,936 lbs. washed sand, to create a volume of one cubic yard of material. Approximately 60 gallons of water per cubic yard will be added, with a maximum of 63 gallons per cubic yard allowed, if necessary, to make the mixture more fluid for pumping. Care must be taken to avoid segregation of the grout mix by the addition of excessive quantities of water. The weight of the mixture will be approximately 128-lbs/cu ft. If mixed in a cement truck, sieve testing is required: A representative sample passed through a 0.25-inch (6 millimeter) mesh screen/sieve shall retain no lumps. In no case will more than two hours elapse

from the time of addition of water to the mixture at the ready-mix plant, to time of pumping the mixture down the drillhole.

2. Neat-cement grout – Grout shall be mixed to a water-to-cement ratio, by weight, of between 0.40 and 0.45 with a high shear colloidal mixer. This is equivalent to approximately 4.5 to 5 gallons of water to one 94-pound sack of Portland cement.

M. Environmental – The Contractor will place clean plastic (Visqueen) sheeting under any equipment and vehicles to collect any hydraulic and/or motor oil leaks and have materials on site for containment and clean-up of any spilled fluids. The Geologist or a designated DWR representative may request the Contractor to outfit the work area or equipment with secondary containment, lids, or other environmental protection items needed to ensure the cleanliness and/or protection of wildlife at the site.

N. Cleanup - The Contractor will keep the field work site clean of any waste and litter at all times. Upon completion of the work, the Contractor will collect all accident prevention devices installed by the Contractor, and any waste or litter resulting from the Contractor's operations and dispose of them at suitable locations at the Contractor's expense.

1. The Contractor will restore the ground surface at the field work sites and along access routes used by the Contractor to the condition existing prior to the Contractor's entry upon the site. Fences or other project facilities cut or otherwise damaged by the Contractor will be restored to original condition by the Contractor.
2. All cleanup work will be done to the satisfaction of the Geologist or a designated DWR representative prior to the completion of demobilization.

O. Disposal of Drilling Mud and Cuttings - Drill mud and cuttings from drillholes will be temporarily placed in spoils piles (with plastic sheeting below/over the pile), roll-off bins, steel drums, or other appropriate containers and tested for chemical constituents of concern (COCs), as designated by the Geologist or a designated DWR representative. One four-point composite sample will be collected from each spoils pile (max 250 cubic yard each). If any drill mud or cuttings test results are found to exceed Department and/or DWR and Federal standards, they will be transported and disposed of at an appropriate waste disposal facility. Drill mud and cuttings found to meet Department, State, and Federal criteria may be disposed of on-site (spread) or offsite (transported to an appropriate disposal facility), at the discretion of the Geologist or a designated DWR representative. All drums, roll-off bins, rental equipment, etc. must be removed from the site within 30 days after the completion of drilling. All work associated with the disposal will be the responsibility of the Contractor.

P. Disposal of Groundwater (Well Development Water) - Groundwater will be temporarily placed in baker tanks, lined roll-offs, totes, drums, or other appropriate containers and tested for COCs, as designated by the Geologist or a designated DWR representative. One sample will be collected per container, with the exception of drums, where one four-point composite will be collected per every four drums. If any containerized groundwater is found to exceed Department and/or DWR and Federal standards, it will be transported and disposed of at an appropriate waste facility. Containerized groundwater found to meet Department, DWR, and Federal criteria may be disposed of on-site (spread) or offsite (transported to an appropriate disposal facility), at the discretion of the Geologist or a designated DWR representative. If containerized groundwater is to be disposed of on-site, it will be given sufficient time for solids to settle out of suspension. Once suspended solids have settled, groundwater will be dispersed away from the drill rig in areas designated by the Geologist or designated DWR representative. The locations of disposal will be directed by the Geologist or designated DWR representative prior to beginning the work at the site. Following disposal of the groundwater, the settling containers will be cleaned of solids by the Contractor in accordance with all applicable confined space and other safe work practices. At the direction of the Geologist or designated DWR representative, the solids will be spread by the Contractor in areas designated for mud and cuttings disposal. All work associated with the disposal will be the responsibility of the Contractor.

6. Measurement and Payment

A. Contract Bid Items

1. The total amount to be paid by the DWR under this contract will be the sum of the total moneys earned for each of the contract Bid Items listed in the Bid Sheet (Exhibit B) and must not exceed the amount stated on the face sheet of the Standard Agreement or any amendments thereto. Payment of said total amount by the DWR will constitute full compensation for all work required by this Scope of Work.
2. Moneys earned for each of the contract Bid Items will be for work actually performed in accordance with the Scope of Work. DWR does not expressly, or by implication, agree that the actual amount of work will correspond to the estimated quantities provided for the purpose of bidding, but reserves the right to increase or decrease the amount of any class or portion of the work, or to omit portions of the work, as may be deemed necessary or advisable by the Geologist or a designated DWR representative.
3. Each assignment of work to the Contractor in this contract is termed a Call-Up. In regard to time, a Call-Up is defined as an interval during which drilling services are provided continuously, exclusive of downtime and standby, on successive normal workdays. A Call-Up may last a few days to several months or possibly longer.

B. Bid Items 1A - Drilling, Sampling, and other Services as described below:

1. Mobilization and Demobilization
 - a. For each drill rig called up, on the day the drill rig is mobilized to the project site in California, two (2) hours under Bid Item 1A will be credited to the Contractor for time spent at the Contractor's headquarters preparing equipment, materials, supplies, and paperwork in advance of the Call-Up. Also on the same day, the number of hours under Bid Item 1A required to deliver the drill rig from the Contractor's headquarters to the project site will be credited to the Contractor. The paid travel time for the drill rig will be based on the driving distance according to Google Maps, and a driving speed of 55 miles per hour. On the last day of the Call-Up, usually when the work is completed and the drill rig is demobilized, travel time will again be paid to return the drill rig back to the Contractor's headquarters. It is the Contractor's responsibility to submit appropriate documentation of drill rig travel time to the Geologist when requesting payment.
2. Drilling, Sampling, and other Services
 - a. A unit price per hour per drilling rig will be paid for each hour of soils drilling, soils sampling, performing Standard Penetration Tests, backfilling holes, transporting the drill rig between the Contractor's headquarters and the project site, preparing equipment, materials, supplies, and preparing/submitting paperwork as defined herein.
3. The same unit price also will be paid for:
 - a. Water pressure testing in drill holes,
 - b. Moving equipment between all drill sites within the project area or during the same Call-Up, or both,
 - c. Setting-up and breakdown at all drill holes including equipment, materials, and supplies, paperwork, and site cleanup,
 - d. Obtaining water,
 - e. Installing observation wells, piezometers, slope inclinometer casings, and other instruments, including surface completions,
 - f. Installing and removing temporary casing,
 - g. Cementing and re-drilling caving holes,
 - h. Standby time that is directed by the Geologist or designated DWR representative, and
 - i. On-site safety meetings, environmental instruction, and other non-drilling activities

approved or directed by the Geologist or designated DWR representative.

4. This Bid Item will include the time required to backfill drill holes with soil cuttings or sand-cement/neat cement grout mixtures, or both, if directed to do so by the Geologist or designated DWR representative.
5. Should two or more activities such as drilling and obtaining water be occurring simultaneously during the same hour, only one hour will be credited for pay purposes.
6. The unit price needs to be structured to cover occasional situations where the Contractor is required to pay any travel or per diem costs associated with the Contractor's employees, and to cover fuel, wear of equipment, drill bits, etc.
7. The Contractor and Geologist or a designated DWR representative will coordinate on the plans for obtaining drilling water to be used at the drill site each day.
8. When soils drilling, and soils sampling is being performed under Bid Items 1A and 1B, and water pressure testing is directed by the Geologist, the time recorded must be continuous.
9. No time will be recorded for payment for delays resulting from:
 - a. Equipment stuck in hole during drilling or performing tests,
 - b. Failure to conduct drilling and specified services in a competent and efficient manner,
 - c. Drillhole collapse due to inadequate monitoring and maintenance.
 - d. Monitoring Well or Drillhole replacement due to unacceptable drillhole deviation.
 - e. Inadequate or inefficient equipment,
 - f. Equipment breakdown, maintenance, and repair,
 - g. Failure to have requested equipment and materials at the project site,
 - h. Cleaning up the work site and/or the equipment and disposing of waste,
 - i. Delays caused by Contractors' Subcontractors, Suppliers, or Vendors,
 - j. Suspension of work due to unsafe equipment or personnel, and
 - k. Suspension of work due to unsuitable/unsafe weather conditions such as heavy rain, flooding, extremely muddy ground, lightning, wildfires, high winds, or other unforeseen conditions.

C. Bid Items 2A – Well Development Services as described below:

1. Mobilization and Demobilization
 - a. For each well development rig called up, on the day the well development rig is mobilized to the project site in California, two (2) hours under Bid Items 2A will be credited to the Contractor for time spent at the Contractor's headquarters preparing equipment, materials, supplies, and paperwork in advance of the Call-Up. Also on the same day, the number of hours under Bid Items 2A required to deliver the well development rig from the Contractor's headquarters to the project site will be credited to the Contractor. The paid travel time for the well development rig will be based on the driving distance according to Google Maps, and a driving speed of 55 miles per hour. On the last day of the Call-Up, usually when the work is completed and the well development rig is demobilized, travel time will again be paid to return the well development rig back to the Contractor's headquarters. It is the Contractor's responsibility to submit appropriate documentation of well development rig travel time to the Geologist when requesting payment.
2. Well Development Services
 - a. A unit price per hour per well development rig will be paid for each hour of well development, transporting the well development drill rig between the Contractor's headquarters and the project site, preparing equipment, materials, supplies, and preparing/submitting paperwork as defined herein.
3. The same unit price also will be paid for:

- a. Moving equipment between all drill sites within the project area or during the same Call-Up, or both,
 - b. Setting-up and breakdown at all work sites including equipment, materials, and supplies, paperwork, and site cleanup,
 - c. Obtaining water,
 - d. Standby time that is directed by the Geologist or designated DWR representative, and
 - e. On-site safety meetings, environmental instruction, and other non-drilling activities approved or directed by the Geologist or designated DWR representative.
4. The unit price needs to be structured to cover occasional situations where the Contractor is required to pay any travel or per diem costs associated with the Contractor's employees, and to cover fuel, wear of equipment, drill bits, etc.
5. The Contractor and Geologist or designated DWR representative will coordinate on the plans for obtaining drilling water to be used at the well development site each day.
6. A unit price will be paid for fluid disposal. Contractor should assume all well development water will be containerized using baker tanks, roll-off bins, totes, drums, or other appropriate containers and characterized by Contractor, and disposed of at an appropriate waste facility, or if permitted by DWR, disposed of at a DWR facility.
7. No time will be recorded for payment for delays resulting from:
 - a. Equipment stuck in hole during well development or performing tests,
 - b. Failure to conduct well development and specified services in a competent and efficient manner,
 - c. Inadequate or inefficient equipment,
 - d. Equipment breakdown, maintenance, and repair,
 - e. Failure to have requested equipment and materials at the project site,
 - f. Cleaning up the work site and/or the equipment and disposing of waste,
 - g. Delays caused by Contractors' Subcontractors, Suppliers, or Vendors,
 - h. Suspension of work due to unsafe equipment or personnel, and
 - i. Suspension of work due to unsuitable/unsafe weather conditions such as heavy rain, flooding, extremely muddy ground, lightning, wildfires, high winds, or other unforeseen conditions.

D. Bid Items 3A – Well Destruction Services as described below:

1. Mobilization and Demobilization
 - a. For each well destruction rig called up, on the day the well destruction rig is mobilized to the project site in California, two (2) hours under Bid Items 3A will be credited to the Contractor for time spent at the Contractor's headquarters preparing equipment, materials, supplies, and paperwork in advance of the Call-Up. Also on the same day, the number of hours under Bid Items 3A required to deliver the well destruction rig from the Contractor's headquarters to the project site will be credited to the Contractor. The paid travel time for the well destruction rig will be based on the driving distance according to Google Maps, and a driving speed of 55 miles per hour. On the last day of the Call-Up, usually when the work is completed and the well destruction rig is demobilized, travel time will again be paid to return the well destruction rig back to the Contractor's headquarters. It is the Contractor's responsibility to submit appropriate documentation of well destruction rig travel time to the Geologist when requesting payment.
2. Well Destruction Services
 - a. A unit price per hour per well destruction rig will be paid for each hour of well destruction, over-drilling, and transporting the well destruction drill rig between the Contractor's headquarters and the project site, preparing equipment, materials, supplies, and preparing/submitting paperwork as defined herein.

3. The same unit price also will be paid for:
 - a. Moving equipment between all drill sites within the project area or during the same Call-Up, or both,
 - b. Setting-up and breakdown at all work sites including equipment, materials, and supplies, paperwork, and site cleanup,
 - c. Cementing and re-drilling caving holes
 - d. Obtaining water,
 - e. Standby time that is directed by the Geologist or designated DWR representative, and
 - f. On-site safety meetings, environmental instruction, and other non-drilling activities approved or directed by the Geologist or designated DWR representative.
4. This Bid Item will include the time required to backfill drill holes with soil cuttings or cement-bentonite/neat cement grout, or both, if directed to do so by the Geologist or a designated DWR representative.
5. Should two or more activities such as drilling and obtaining water be occurring simultaneously during the same hour, only one hour will be credited for pay purposes.
6. The unit price needs to be structured to cover occasional situations where the Contractor is required to pay any travel or per diem costs associated with the Contractor's employees, and to cover fuel, wear of equipment, drill bits, etc.
7. The Contractor and Geologist or designated DWR representative will coordinate on the plans for obtaining drilling water to be used at the well destruction site each day.
8. No time will be recorded for payment for delays resulting from:
 - a. Equipment stuck in hole during well destruction,
 - b. Failure to conduct well destruction and specified services in a competent and efficient manner,
 - c. Inadequate or inefficient equipment,
 - d. Equipment breakdown, maintenance, and repair,
 - e. Failure to have requested equipment and materials at the project site,
 - f. Cleaning up the work site and/or the equipment and disposing of waste,
 - g. Delays caused by Contractors' Subcontractors, Suppliers, or Vendors,
 - h. Suspension of work due to unsafe equipment or personnel, and
 - i. Suspension of work due to unsuitable/unsafe weather conditions such as heavy rain, flooding, extremely muddy ground, lightning, wildfires, high winds, or other unforeseen conditions.

E. Bid Items 1B, 2B, and 3B – OVERTIME: Drilling, Sampling, Well Development, Well Destruction, and other Services:

1. After the first 8 hours each day (NOTE: time spent at the Contractor's headquarters preparing equipment, materials, supplies, and paperwork in advance of the Call-Up is not included).

F. Bid Item 4 – Providing Site Security as described below:

1. The Contractor will be paid the Contractor's costs plus the markup shown in Bid Item 4 for the following item (markup will not exceed ten percent):
 - a. Site security - securing the field work site and for any vandalism or theft, or both, on the site which could result in damaged drillholes, damaged and/or stolen equipment, materials, or supplies.

G. Bid Item 5 – Providing Special Equipment, and Other Services

1. The Contractor will be paid the Contractor's costs plus the markup shown in Bid Item 5 for the following items (markup will not exceed ten percent):

- a. Rental and use of special equipment
- b. Other types of drill rigs
- c. Laboratory testing
- d. Geophysical services (beyond what is listed in "Geophysical Services", section 5.h.)
- e. Special labor
 - 1) Additional drillers and helpers
 - 2) Laboratory courier services
 - 3) Labor related to services within the scope of this contract
 - 4) Tribal Monitoring Services:
 - a) DWR shall identify the Native American Tribes and/or Tribal experts that will participate in the work to be performed during the execution phase of a Call-Up. **DWR will approve the rates for the tribal monitoring services provided.**
 - b) **The Contractor shall work with DWR to record and verify the tribal monitoring services provided, including the costs of the services.**
- f. Special fuel costs (if billed separately) of operating the special equipment
- g. Additional costs for removal and off-site disposal of drill mud, cuttings, and development water.
- h. Associated chemical testing, and
- i. Cost of delivering the special equipment to and from the field work site. This item includes:
 - 1) Special equipment and services needed to assist in performing the setup, (Dozers or other heavy equipment needed to assist in gaining access to drill sites, prepare drill pads, evaluate drill sites, or to restore the ground to pre-drilling conditions will be considered special equipment for purposes of payment under this contract.
 - 2) Steam cleaners needed to clean drilling and sampling equipment for environmental projects will be considered special equipment for purposes of payment under this contract.
 - 3) Special equipment and services needed to assist in performing drilling.
 - 4) Special equipment and services needed to assist in performing testing.
 - 5) Special equipment and services needed to assist in performing backfilling,
 - 6) Special equipment and services needed to assist in performing well development.
 - 7) Special equipment and services needed to assist in performing well destruction.
 - 8) Special equipment and services needed to assist in performing drillhole completion/backfilling, or
 - 9) Special equipment and services (permits) needed to assist in performing subsequent monitoring that are not part of normal drilling operations.
- j. The furnishing and use of any special equipment, materials, supplies, or services must be requested by the Geologist or a designated DWR representative in writing to be eligible for payment.
- k. Contractor's billing for Bid Item 5 must be supported by copies of the supplier's invoices naming the Contractor as the renter if the equipment was rented.
- l. If the special equipment is owned by the Contractor, the Contractor's cost for pay purposes will be based upon an appropriate and reasonable equipment price list from the Contractor or from an equipment rental company nearby to the project area. The rental

price must be approved in advance by the Geologist or a designated DWR representative.

- m. The Contractor will be paid the Contractor's costs plus the markup shown in Bid Item 5 for providing requested laboratory services or geophysical services and delivering the geophysical equipment to and from the site. The geophysical services must be specifically requested by the Geologist or a designated DWR representative in writing. Extra labor costs required to operate the geophysical equipment must not exceed prevailing rates.
- n. Contractor's billings for Bid Item 5 will be supported by copies of the provider's invoices naming the Contractor as the client, along with proof of payment. If the geophysical equipment is owned and operated by the Contractor, the Contractor's cost for pay purposes will be based upon an appropriate and reasonable price list from the Contractor or from a nearby provider of such services. The prices for any requested services must be approved in advance by the Geologist or a designated DWR representative.
- o. Charges for providing laboratory services or geophysical services and special equipment must not exceed the Contractor's bid total for this item without the processing and approval of an amendment to this contract.
- p. The unit price needs to be structured to cover occasional situations where the Contractor is required to pay any travel or per diem costs associated with the Contractor's employees, and to cover fuel, wear of equipment, drill bits, etc.
- q. The Contractor and Geologist or a designated DWR representative will coordinate on the plans for obtaining drilling water to be used at the drill site each day.

H. Bid Item 6 – Miscellaneous Materials and Supplies

- 1. Miscellaneous materials and supplies which are specifically requested by the Geologist or designated DWR representative in writing will be paid for at the Contractor's cost plus the markup shown in Bid Item 6. Markup percentage for miscellaneous materials and supplies will not exceed ten (10) percent.
 - a. The Contractor's cost will be the actual purchase price including applicable taxes plus cost of delivery to the Contractor.
 - b. Costs incurred by the Contractor for taking delivery of the requested equipment and supplies and transporting them to the drill locations are not allowed to be paid as part of the Contractor's cost for purposes of this Bid Item; they are presumed to be recovered by the Contractor in the markup.
 - c. Operating supplies such as fuel and maintenance items that are associated with the normal operation of the drill equipment are not included for pay under this Bid Item.
 - d. Miscellaneous supplies may include, but are not limited to, the following:
 - 1) Steel, Stainless Steel, and PVC plastic pipe and fittings permanently installed in a hole,
 - 2) Portland cement, sand, powdered bentonite, bentonite pellets, bentonite chips, and/or polymer drill fluid additives,
 - 3) 55-gallon drums
 - 4) 3-inch diameter by 24-inch long or 36-inch-long Shelby tubes,
 - 5) Core boxes (Exhibit A, Attachment 4), bailers, brass sleeves, and soil sample bags,
 - 6) 6-inch-long brass liners for California Modified Split Spoon Samplers,
 - 7) Groundwater and soil sampling/monitoring devices, and
 - 8) Slope Indicator casings and accessories.

I. Measurement

1. All time measurements will be made to the nearest one-quarter hour per day, and all linear measurements will be to the nearest foot per day.
2. While an hourly rate is being recorded for payment at the drill site, no time will be recorded for delays resulting from:
 - a. Equipment stuck in hole during drilling, or stuck in the monitoring well during well development or well destruction,
 - b. Failure to conduct drilling and specified services in a competent, efficient, and safe manner,
 - c. Inadequate, unsuitable, or unsafe equipment,
 - d. Equipment breakdown, maintenance, and repair,
 - e. Failure to have requested equipment and materials at the drill site,
 - f. Backfilling holes with sand-cement or neat cement grout,
 - g. Having to obtain water as a result of poor planning inefficient operations,
 - h. Cleaning up the work site and/or the equipment and disposing of waste.
 - i. Suspension of work due to unsafe equipment or personnel, and
 - j. Suspension of work due to unsuitable/unsafe weather conditions such as heavy rain, flooding, extremely muddy ground, lightning, wildfires, high winds, or other unforeseen conditions.
3. End of Day Summary - Quantities of each contract bid item performed each day at the site will be measured, and agreed upon, and a summary will be prepared and signed by the Geologist or a designated DWR representative and the Contractor's representative at the work site **at the end of each day worked**.
4. If the Geologist or a designated DWR representative and the Contractor's representative at the work site should fail to agree on measurement of a contract bid item, the Geologist's or a designated DWR representative's measurement will prevail, and the Contractor may proceed with a claim as provided in the STANDARD CLAUSES, Exhibit E.

J. Payments and Progress Payments

1. The Contractor will submit receipts with each invoice showing the actual purchase price paid by the Contractor for all materials and supplies used during each Call-Up. Ten (10) percent of each progress payment will be retained by the DWR until at least 30 days have passed since satisfactory completion of all the work in the Call-Up. Final payment of the retained progress payment(s) for each Call-Up will be made upon receipt and approval of one (1) final invoice per Call-Up showing the amount(s) retained.

CECW-CE

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

ER 1110-1-1807

Regulation
No. 1110-1-1807

31 December 2014

Engineering and Design
DRILLING IN EARTH EMBANKMENT DAMS AND LEVEES

1. Purpose. This regulation establishes policy and requirements and provides guidance for drilling in dam and levee earth embankments and/or their earth and rock foundations. The primary purpose of this regulation is to prevent damage to embankments and their foundations from hydraulic fracturing, erosion, filter/drain contamination, heave, or other mechanisms during drilling operations, sampling, in-situ testing, grouting, instrumentation installation, borehole completion, and borehole abandonment.
2. Applicability. This regulation applies to all major subordinate commands (MSC), district commands, laboratories, and field operating activities having Civil Works and/or Military Program responsibilities. It applies to in-house and contracted drilling efforts for earth embankments or foundations associated with all dams and levees that have a federal interest.
3. Distribution. This regulation is approved for public release; distribution is unlimited.
4. References. References are listed in Appendix A.
5. Background. Drilling into, in close proximity to, or through embankment dams and levees and their foundations may pose significant risk to the structures. Water, compressed air, and various drilling fluids have been used as circulating media while drilling through earth embankments and their foundations. Although these methods have been successful in accomplishing the intended purposes, there have been incidents of damage to embankments and foundations. While using air (including air with foam), there have been reports of loss of circulation with pneumatic fracturing of the embankment as evidenced by connections to other borings and blowouts on embankment slopes. While using water and drilling mud as the circulating medium, there have been similar reports of erosion and/or hydraulic fracturing of the embankment or foundation materials. Conversely, there have been cases where heave, borehole collapse and significant disturbance have occurred while drilling in granular materials below the groundwater level. This typically has been the result of not using a proper drilling fluid to balance the water pressures in the soil or using high energy systems that induce heave in order to evacuate the cuttings. There is a delicate balance between too much induced fluid pressure that will cause hydraulic fracture and not enough fluid pressure that will result in borehole instability, heave, or significant sample disturbance. Other potential damaging effects include: creating preferential seepage paths due to improper backfilling, inadequate protection of embankment from drilling fluids during foundation rock coring, erosion and widening of cracks, and inadvertently clogging filters or drains with drilling fluid or grout. All drilling and associated activities that use fluid or other circulation or stabilization media need to be evaluated for the potential to hydraulically

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fracture the embankment or foundation. These activities include but are not limited to the use of drilling fluids, backfilling borings after completion, backfill grouting of instrumentation, backfill grouting of casings, water testing for permeability, piezometer rehabilitation, etc. The risk will vary with the selected methods and the site conditions. Every drilling operation must be well thought out and must have benefits of successful completion that confidently outweigh the risk of potential negative impacts. The following paragraphs describe the general concerns associated with each type of potential damage.

a. Hydraulic Fracturing. Excessive pressures from water, air, drilling fluid, or grout can fracture embankment and foundation materials. Hydraulic fracturing problems have occurred while drilling in embankments as evidenced by reports of loss of fluid circulation, blowouts into nearby borings, seepage of drilling fluids on the face of the embankment, and other similar situations. Hydraulic fracture can occur in both cohesive materials and cohesionless materials, and bedrock. It has been found that in soils, hydraulic fracturing can occur when the borehole pressure exceeds the lowest total confining stress (minimum principal stress σ_3) plus some additional strength. The additional strength can be approximated by the undrained strength of the soil. The minor principal confining stress (σ_3) in a normally consolidated soil with a level ground condition is typically the horizontal stress, which can be reasonably estimated. However, the minor principal confining stress in and under an embankment is difficult to determine and can vary significantly from idealized geostatic conditions. Effects from the side slope geometry, piezometric surface, abutment configuration, foundation rock geometry, embedded structures, compaction stress, and settlement history all are significant and can influence in-situ stress conditions. Typical drilling methods that use circulation fluids can quickly create induced fluid pressures that exceed the minimum confining stress. This often occurs when the return path for the fluid clogs and the induced pressures quickly increase. The use of non-pressurized stabilizing fluids is preferable, yet in some subsurface conditions, hydraulic fracture can occur under gravity pressure. Low stress zones may exist within and under embankments. It is possible for the confining stress in these locations to be much less than the gravity pressure exerted by a drilling fluid or grout. Certain embankment locations and conditions have a higher potential for hydraulic fracturing due to geometric configurations that create zones of low confining stress. Sherard 1973 and 1986 are good references that provide a comprehensive evaluation of the issues along with numerous case histories. Locations and conditions where hydraulic fracturing by drilling media is more likely to occur and have the higher potential of damaging the structure include the following:

- (1) Near and over steep abutments that create low confining or tensile stress conditions.
- (2) Adjacent to rock overhangs on abutments.
- (3) Adjacent to buried structures or abrupt foundation geometry change that creates a differential settlement condition and a zone of lower soil stress transfer.
- (4) Adjacent to conduits where narrow zones of soil backfill were placed between the structure and rock face.
- (5) Dam cores that can experience more settlement than the adjacent shells.
- (6) Dams in very narrow valleys. Arching keeps full confining stresses from developing.
- (7) Near abutments where abrupt changes in geometry occur.

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(8) In areas where the embankment is subject to differential settlement due to large differences in thickness of adjacent compressible foundation or embankment soils.

b. Erosion. The introduction of drilling fluids into cracks, either existing or formed by hydraulic fracture, can potentially cause erosion along the crack walls. This will enlarge the crack and could lead to an increased potential for internal erosion. Existing subsurface cracks are common in many dams and are often the result of differential settlement. The locations most at risk for existing cracks are typically the same areas that have low confining stress and have the highest risk for hydraulic fracture to occur.

c. Contamination of Filter/Drainage Features. In addition to hydraulic fracturing, the use of drilling fluids can pose a contamination risk for internal drainage features if the drill fluid or sealing grout migrates into and clogs the drain materials. Avoid drilling near drains or seepage blankets that may become contaminated by fluids. If drain penetration is justified, special provisions must be taken to prevent contamination. Special provisions may also be required for protecting the drainage features while backfilling the hole (such as placement of filter material through the zone of the drain or filter and installing lower and upper seals).

d. Heave and Sample Disturbance. Drilling programs that include performing in-situ tests or undisturbed sampling may require the use of drilling fluid to offset the confining stress relieved by the drilling of the hole. There have been cases where the failure to prevent stress relief or heave of granular soils below the water table have led to invalid in-situ test results and subsequently invalid interpretation of the subsurface conditions. This has occurred for both tests performed in drill holes and test performed in casings installed by methods that did not control heave or disturbance. Reclamation DSO 98-17 (1999) contains methods to deal with heaving sands while drilling and performing Standard Penetration Tests. If high quality undisturbed samples of fine grained soils are required for shear strength testing, then drilling mud may be required to prevent the soil from failing in undrained triaxial extension. See Ladd and DeGroot (2004) for a discussion on clay sample disturbance due to drilling.

6. Policy. This regulation provides guidance for investigation, maintenance, and remediation drilling in and near embankment dams and levees and/or their earth and rock foundations, including investigation planning, site preparation, borehole advancement, subsurface testing, instrumentation installation, piezometer and well rehabilitation, grouting, and borehole completion. It identifies drilling program plan requirements, restrictions on drilling fluids, drilling procedures to minimize risk of damage, borehole completion requirements, and prescribes personnel requirements, and the review and approval processes. It is the responsibility of the District Dam or Levee Safety Officer (DSO or LSO) to assure compliance with the restrictions and procedures outlined in this regulation.

a. Drilling Program Plan. An approved Drilling Program Plan (DPP) is required prior to any drilling, sampling, grouting, or any other invasive in-situ testing or exploration. This includes drilling activities related to investigation, maintenance, and remediation. When planning an investigation or remediation program, the data needs must be weighed against the potential risks of damage created by the drilling process. In general, all drilling and investigation should be targeted to obtain information related to a specific failure mode identified from a Potential Failure Mode Analysis (PFMA). For dams, the justification for drilling must include an approved

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recommendation from a risk assessment performed in support of the Dam Safety risk management process described in ER 1110-2-1156 Safety of Dams - Policy and Procedures. If the structure has not had a PFMA, a thorough evaluation similar to the PFMA process must be performed and presented in the DPP to show that the drilling is justified. It is paramount that all existing subsurface information is thoroughly evaluated and understood by the exploration team prior to developing a plan for additional drilling. In order to understand and communicate subsurface conditions and estimate drilling risks, the existing subsurface information must be assimilated into essential plan and section drawings showing the proposed drill holes, target sample areas and/or proposed instrumentation. For critical or complicated drilling programs the Geotechnical and Geology Community of Practice leads can be contacted to obtain recommendations for subject matter experts to assist in developing the DPP. Specific requirements for the DPP are included in Appendix B.

b. Restrictions on the Use of Drilling Fluids. All drilling programs in dams and levees should be designed to minimize the need for any drilling fluid such as air, gas, water, mud, polymers, slurries or any other drilling fluid that could pressurize the borehole soils. If the drilling objective can be performed using dry methods such as augers or sonic drilling they should be employed in lieu of methods that require fluids. If drilling fluids must be used due to the drilling objective or the subsurface conditions, the DPP must contain an analysis of the potential to cause damage and a plan that covers the measures that will be used to minimize the risk. The use of pressurized air or foam should only be considered when drilling in materials that will not transmit pressures to the soil core or other critical features or when the air pressure is reliably isolated from the borehole soils. Drilling in an open graded rockfill shell may be an example of when using air may be appropriate. All DPPs that propose the use of stabilizing or circulating fluids or other media will require additional review and approval as described in paragraph 6f.

c. Drilling Procedures. As there are many existing and potentially new methods for drilling and sampling that may be implemented on dams and levees, this regulation will not provide specific procedures. Most procedures are documented in applicable standards and reference documents. There are however, some general procedures that should be followed when using drilling fluids to limit the risk of damage.

(1) Tools should be sized and designed to minimize the likelihood of the return flow clogging. Methods that require the cuttings to flow through a small annulus between the tools or casing and the borehole wall should not be used.

(2) If possible, fluid discharges from the bit should be upward. A downward discharge increases the chance of clogging which could lead to a pressure spike. A lateral discharge into the sidewalls could lead to excessive disturbance or erosion.

(3) Lower and raise drill tools slowly to avoid pressure changes in the drill hole; this is especially important when using tools with restricted annulus space below the groundwater table as the pressure changes are more severe and can lead to suction and surging problems.

(4) Drilling feed rate must be slow enough to avoid crowding the bit and, thus, minimize the chance of inducing fracturing. The bit must be of a design such that pressure buildup is minimized.

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(5) Drilling media properties, pressure, and return should be continuously monitored. A floating needle pressure valve is required to record maximum pressure spikes that can occur instantaneously and are often unnoticed.

(6) In some conditions, casing can be advanced ahead of the drilling bit to reduce the risk of hydraulic fracturing by confining the drilling fluids within the casing.

(7) When core drilling rock, the embankment or foundation soil above top of rock must be protected and isolated from the circulating drilling fluid. Fractures in the bedrock must be considered as potential flow paths in contact with the overlying soil.

(8) In situations where the presence of significant artesian pressure is suspected, which are common at the toe of dams, it may be necessary to use weighted drilling muds or raise the drill rig or install surface casing for pressure control along with the use of drilling mud. In some cases there may be a high risk of initiating internal erosion by drilling borings or excavating test pits in these areas. Emergency materials to stop progressive erosion in an excavation, a trench, or a borehole must be on site and readily available. For this situation, it is recommended to stockpile fine (C33 concrete sand) and coarse processed aggregates to filter and plug the excavation. Specific details such as height of the drill pad and amount of surface casing must be developed on a case-by-case basis dependent upon specific site conditions.

d. Borehole Completion. All boreholes and other penetrations (including direct push sampling, Cone Penetration Test soundings, Standard Penetration Testing, Becker Penetration Testing,) in and around embankment dams and levees must be sealed after completion. Completing a borehole by backfilling with drill cuttings is not acceptable. All boreholes and similar penetrations in the impervious portions of an embankment dam or levee and their foundations must be backfilled by tremie placed cement-bentonite grout or bentonite pellets/chips. The DPP must address the possibility of confined and separate ground water aquifers and demonstrate safe completion which avoids cross-contamination and leakage. The grout must be designed to obtain strength equal to or greater than the soil. Note that some instrumentation installations may require additional considerations for the grout strength. Gravity grouting techniques should be used for backfilling boreholes. For borings that penetrate zones with low confining stress it is possible to induce hydraulic fracturing from the gravity pressure. When grouting borings in these locations or if significant grout losses are observed, the grout backfilling should be done in stages allowing the grout to set between stages. For pervious portions of the dam or levee, the borehole must be backfilled by tremie placement of granular materials that are sized to provide drainage without being susceptible to migration through the pervious embankment or foundation materials or segregation during placement. Lutenecker, et.al. (1995) is a good source for borehole backfill guidelines. Special procedures and materials may be required for installation of instrumentation in boreholes.

e. Drilling Personnel. Drill rig operators must have a minimum of 5 years experience drilling with the equipment and procedures described in the drilling program. The drill rig operator must also be familiar with these guidelines. All drilling activities on USACE dams or levees must be conducted in the presence of a geotechnical engineer that is a licensed professional engineer or a licensed professional geologist who will be responsible for maintaining the integrity of the structure.

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f. Approval Requirements. Drilling Program Plans must be reviewed and approved by the District Dam Safety Officer (Dams) or Levee Safety Officer (Levees). If any drilling fluid or other stabilizing or circulating media is proposed, a technical review performed by the Geotechnical and Materials Community of Practice (G&M CoP) Standing Committee on Drilling and Instrumentation is required. The plan will then require approval from the District DSO/LSO pending satisfactory resolution of the technical review comments. The Standing Committee on Drilling and Instrumentation will be chaired by the G&M CoP Lead, co-chaired and managed by the Risk Management Center, and staffed with G&M CoP experts.

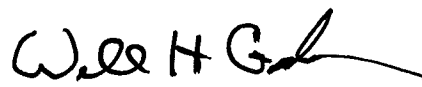
g. Reporting. All incidents of damage or potential damage related to drilling and associated activities for dams must be reported following procedures outlined in Chapter 13 Reporting Evidence of Distress in Civil Works Structures of ER 1110-2-1156 Safety of Dams- Policy and Procedures. Damage in levees must be reported to the Levee Safety Officers and Levee Safety Program Managers in the District, MSC, and Headquarters.

h. Exemptions. Drilling required for immediate emergency measures where delays required to develop the DPP and obtain approvals would result in unacceptable risk of damage or failure, may be exempted from the requirements to prepare a DPP by the District DSO/LSO. Emergency drilling should be appropriately expedited but should follow the general guidelines presented in this regulation. No other exemptions or deviations from these requirements may be made.

7. Environmental Operating Principles. The user of this ER, as a member of a Project Delivery Team, is responsible for seeking opportunities to incorporate the Environmental Operating Principles (EOPs) wherever possible. A listing of the EOPs is available at:
<http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.aspx>.

FOR THE COMMANDER:

2 Appendices
Appendix A - References and Resources
Appendix B - Drilling Program Plan


WILLIAM H. GRAHAM
COL, EN
Chief of Staff

APPENDIX A

References and Resources

Drilling Procedures

EM 1110-1-1804 Geotechnical Investigations (including Appendix F EM 1110-1-1906 Soil Sampling).

EM 1110-2-1908 Instrumentation of Embankment Dams and Levees.

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ASTM D1587-08 Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes, 2012.

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APPENDIX B

Drilling Program Plan

An approved drilling program plan (DPP) is required for any exploration or remedial drilling (including grouting) work to occur in or near an embankment dam or levee or their foundations. When drilling is justified, an exploration team must be formed to determine and document the drilling program components required to adequately and safely address the project needs. The exploration team must thoroughly discuss the drilling program to ensure that the program minimizes risk and meets the project goals. The drilling program must be prepared by experienced geotechnical engineers and/or engineering geologists familiar with subsurface exploration techniques and methods, with advice from drilling specialists. The Lead engineer on the exploration team must be a registered professional engineer. This section describes the basic information that must be developed and included in the drilling program.

a. Objective and Justification. The objective of the drilling program must be clearly summarized including the purpose of the drilling and how the borings, samples, testing, instrumentation, etc. will be used. The need for the drilling must be thoroughly justified. Drilling should be minimized by first utilizing non-destructive methods including parametric analysis, the use of published correlations, and non-destructive geophysical testing. The justification must include documentation that shows the purpose is based obtaining information related to potential failure modes identified in an approved risk assessment in support of the dam or levee safety program. If an approved PFMA or risk assessment has not been performed, the exploration team must perform a thorough evaluation similar to the PFMA process and present a valid justification demonstrating that the drilling is required to obtain information related to a credible potential failure mode.

b. Exploration Team. List members of the exploration team used in developing the DPP. Include name, organization, title, registration, and years of experience.

c. Existing Information Review. In order to understand subsurface conditions, justify additional drilling, and estimate drilling risks, all relevant existing information must be assimilated and reviewed by the exploration team and then concisely summarized in the DPP. Information review typically includes, but is not limited to:

(1) Geologic mapping, boring logs, driller's notes, and reports portraying information from previous investigations and construction.

(2) Geotechnical files and reports including Site Characterization Reports.

(3) Foundation Completion Reports.

(4) Embankment Construction Reports.

(5) Periodic Inspection or Periodic Assessment Reports.

(6) As-built drawings.

(7) Archived records.

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- (8) Other construction reports.
- (9) Construction photos for both original embankment construction and any subsequent construction.
- (10) Instrumentation plans, data, and reports.
- (11) Project records available in district and project offices.

d. Essential Geologic and Engineering Drawings. The DPP must include a set of drawings depicting the current understanding of subsurface conditions, as they relate to the proposed work. This detailed set of foundation and embankment drawings typically requires a plan showing all previous and proposed subsurface investigation locations, profile drawings, and sections of the embankment in the areas proposed for exploration. The sections must be drawn to scale with no vertical exaggeration and must show the proposed borings along with all available factual information and appropriate geologic or engineering interpretations. The drawings should be updated regularly during the drilling operations to show conditions encountered and adjust geologic interpretations to help guide the program. The information on the plan, profile and sections must be detailed and include a summary of all data significant to the analytical and exploration needs such as:

- (1) Embankment zones, including added berms, blankets, filters, and drains.
- (2) Details of subsurface material classification.
- (3) Geologic contacts and continuity interpretations supported by all nearby drilling and sampling details.
- (4) Depth of the top of rock and all other zones of importance.
- (5) Piezometer locations showing screened influence zones and recorded piezometric levels tied to the reservoir water level.
- (6) Other instrumentation such as inclinometers, movement monuments, etc., shown in the context of the foundation geology contacts and interpretations.
- (7) SPT blow counts or other test results defining engineering properties.
- (8) Geophysical data, where useful (e.g. cross hole shear wave velocity profiles).
- (9) Estimated extent of any zones of interest, including natural and made-made (grout holes).
- (10) Seepage areas tied to geologic units, where possible.
- (11) Location of all structures, including seepage control features, outlet works, etc.
- (12) Location and types of any distress features (seepage, wet spots, sand boils, sinkholes, etc.).

Maintaining updated geologic sections and a plan during the drilling operations is important for making exploration changes and for responding to unusual or unexpected conditions or events. The process for accomplishing this must be outlined in the drilling program.

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e. Drilling Scope and Methodology. The drilling program must include a summary of the scope and methods that will be used, including the following:

- (1) Number and location of proposed borings.
- (2) Utilities, surface and underground obstacles, and accessibility.
- (3) Materials expected to be drilled, sampled, and tested.
- (4) Depth, diameter, bearing, and inclination of borings.
- (5) Required sample type (disturbed or undisturbed), size, location, and reason for sampling.
- (6) Proposed laboratory testing.
- (7) Drilling, sampling, and testing methods.
- (8) Details of the proposed tools and drilling equipment.
- (9) Instrumentation and borehole completion requirements (influence zone, seals, etc.). Drill rig operators: Name and years of experience.
- (10) Field Supervision Personnel: Name, organization, title, registrations, years of experience.
- (11) Personnel responsible for logging materials and assuring geologic drawings are updated regularly during the drilling program.

f. Risk Evaluation. Include an evaluation of the risk of hydraulic fracturing, erosion, contamination of drainage features, heave, or any other damage. This should include:

- (1) A detailed description of any drilling fluid used including details on the circulation system, locations where fluid will contact soil, and circulation pressures that will be used.
- (2) Monitoring needs during drilling, and a contingency plan if loss of drilling fluid or other complications are observed during drilling.
- (3) Measures to minimize the risk of damage to the dam or foundation.
- (4) Measures to prevent the possibility of cross-contamination and leakage from confined and separate ground water aquifers.
- (5) Measures to prevent drill contact with structural features, such as conduits.
- (6) Nearby instruments whose behavior will be monitored during the investigation and the expected response including threshold and limit values, and contingency plans for unexpected response.
- (7) An emergency action plan including a list of emergency equipment and supplies to have onsite (phone/radio, filter materials, grout materials, etc.).

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g. DSO/LSO Certification. Provide a certification page with the signature of the appropriate DSO/LSO. The certification must state: This Drilling Program Plan has been developed and reviewed by experienced professionals and is in compliance with all the requirements of ER 1110-1-1807. The proposed actions are justified and have been developed to minimize the likelihood of damage to the existing structure.



Designation: D6914/D6914M – 16

EXHIBIT A, ATTACHMENT 2 D6914/D6914M-16

Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices¹

This standard is issued under the fixed designation D6914/D6914M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice covers procedures for using sonic drilling methods in the conducting of subsurface exploration for site characterization and in the installation of subsurface monitoring devices.

1.2 The use of the sonic drilling method for exploration and monitoring-device installation may often involve preliminary site research and safety planning, administration, and documentation.

1.3 Soil or Rock samples collected by sonic methods are classed as group A or group B in accordance with Practices D4220. Other sampling methods (Guide D6169) may be used in conjunction with the sonic method to collect samples classed as group C and Group D. Other drilling methods are summarized in Guide D6286.

1.4 *Units*—The values stated in either inch-pound units or SI units [presented in brackets] are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. Reporting of test results in units other than in-pound shall not be regarded as nonconformance with this practice.

1.5 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this standard.

1.6 This practice offers a set of instructions for performing one or more specific operations. It is a description of the present state-of-the-art practice of sonic drilling. It does not recommend this method as a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the

standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.6.1 This practice does not purport to comprehensively address all the methods and the issues associated with drilling practices. Users should seek qualified professionals for decisions as to the proper equipment and methods that would be most successful for their site investigation. Other methods may be available for drilling and sampling of soil, and qualified professionals should have the flexibility to exercise judgment as to possible alternatives not covered in this practice. This practice is current at the time of issue, but new alternative methods may become available prior to revisions, therefore, users should consult manufacturers or sonic drilling services providers prior to specifying program requirements.

1.7 *This practice does not purport to address all the safety concerns, if any, associated with its use and may involve use of hazardous materials, equipment, and operations. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.* For good safety practice, consult applicable OSHA regulations and drilling safety guides.^{2,3,4}

2. Referenced Documents⁵

2.1 *ASTM Standards—Soil Classification:*

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2113 Practice for Rock Core Drilling and Sampling of Rock for Site Exploration

² "Drilling Safety Guide," National Drilling Association.

³ "Drillers Handbook," Thomas C. Ruda and Peter Bosscher, National Drilling Association.

⁴ "Innovative Technology Summary Report," April 1995, U.S. Department of Energy.

⁵ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

¹ This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

Current edition approved Nov. 15, 2016. Published December 2016. Originally approved in 2004. Last previous edition approved in 2010 as D6914–04(2010). DOI: 10.1520/D6914_D6914M-16.

*A Summary of Changes section appears at the end of this standard



D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

2.2 ASTM Standards—Drilling Methods and Installation Methods:

D1452 Practice for Soil Exploration and Sampling by Auger Borings

D5088 Practice for Decontamination of Field Equipment Used at Waste Sites

D5299 Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities

D5791 Guide for Using Probability Sampling Methods in Studies of Indoor Air Quality in Buildings

D5782 Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D5784 Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D6286 Guide for Selection of Drilling Methods for Environmental Site Characterization

2.3 ASTM Standards—Soil Sampling:

D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils

D1587 Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes

D3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils (Withdrawn 2016)⁶

D4220 Practices for Preserving and Transporting Soil Samples

D4700 Guide for Soil Sampling from the Vadose Zone

D6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D6640 Practice for Collection and Handling of Soils Obtained in Core Barrel Samplers for Environmental Investigations

2.4 ASTM Standards—Aquifer Testing:

D4044 Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

D4050 Test Method for (Field Procedure) for Withdrawal and Injection Well Testing for Determining Hydraulic Properties of Aquifer Systems

D5092 Practice for Design and Installation of Groundwater Monitoring Wells

2.5 ASTM Standards—Other:

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as

Used in Engineering Design and Construction

D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 Definitions:

3.1.1 For common definitions of technical terms in this standard refer to Terminology D653.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *hydraulic extraction, n*—the removal of the sample specimen from the solid sampling barrel by the application of fluid.

3.2.2 *natural frequency, n*—the frequency or frequencies at which an object tends to vibrate when disturbed.

3.2.3 *resonance, n*—when one object (sine generator) vibrating at the natural frequency of a second object (drill pipe or casing) forces the second object into vibrational motion.

3.2.4 *sine wave generator, n*—a drill head that imparts forces in wave forms corresponding to single-frequency periodic oscillations to create resonance of the drill rods and casings to advance the drill hole.

3.2.4.1 *Discussion*—This drill head is referred to as a sonic drill head, or resonant sonic drill head throughout this standard. This drill head is attached to the drill rods and casings and can be used to lift rods for sample extrusion.

3.2.5 *sonic drilling, n*—the practice of using high frequency vibration as the primary force to advance drill tools through subsurface formations.

3.2.5.1 *Discussion*—While vibration is the primary force for drilling, the drilling process also requires rotation of the drill rods with applied downforce reaction from the drill

4. Summary of Practice

4.1 Sonic drilling is the utilization of high frequency vibration aided by down pressure and rotation to advance drilling tools through various subsurface formations. All objects have a natural frequency or set of frequencies at which they will vibrate when disturbed. The natural frequency is dependent upon the properties of the material the object is made of and the length of the object. The sonic drill head provides the disturbance to the drilling tools causing them to vibrate. To achieve penetration of the formation the strata is fractured, sheared, or displaced. The high frequency vibration can cause the soil in contact with the drill bit and drilling casing string to liquefy and flow away allowing the casing to pass through with reduced friction. Rotation of the drill string is primarily for even distribution of the applied energy, to control bit wear, and to help maintain borehole alignment. The use of vibratory technology reduces the amount of drill cuttings, provides rapid formation penetration, and the recovery of a continuous core sample of formation specimens for field analysis and laboratory testing. Boreholes generated by sonic drilling can be fitted with various subsurface condition monitoring devices. Numerous sampling techniques can also be used with this system including thin walled tubes, split barrel samplers, and *in-situ* groundwater sampling devices. Fig. 1 demonstrates the general principle of sonic drilling.

⁶ The last approved version of this historical standard is referenced on www.astm.org.

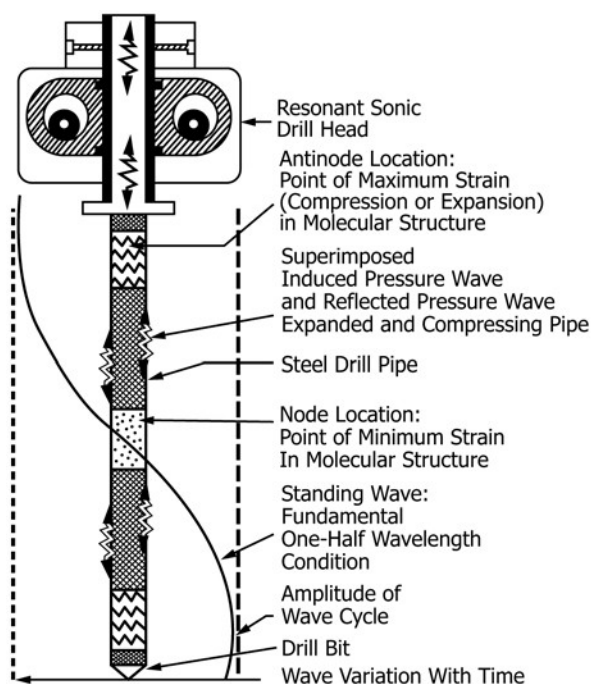


FIG. 1 General Principle of Sonic Drilling

5. Significance and Use

5.1 Sonic drilling is a rapid, primarily dry drilling method (see 5.2), used both in geotechnical applications to avoid hydraulic fracturing, and in environmental site exploration. Geotechnical applications include exploration for tunnels, underground excavations, and installation of instrumentation or structural elements. Sonic drilling methods are used in rocky soils with large diameter casing to obtain continuous samples in materials that are difficult to sample using other methods. It is well suited for projects of a production-orientated nature with a drilling rate faster than most all other drilling methods (Guide D6286). Sonic drilling is used for environmental explorations because sonic drilling offers the benefit of significantly reduced drill cuttings, a major cost element, and reduced drill fluid use and production. Sonic drilling offers rapid formation penetration thereby increasing production. It can reduce fieldwork time generating overall project cost reductions. The continuous core sample recovered provides a representative lithological column for review and analysis. Sonic drilling readily lends itself to environmental instrumentation installation and to *in-situ* testing. The advantage of a clean cased hole without the use of drilling fluids provides for increased efficiency in instrumentation installation. The ability to cause vibration to the casing string eliminates the complication of monitoring well backfill bridging common to other drilling methods and reduces the risk of casing lockup allowing for easy casing withdrawal during grouting. The clean borehole reduces well development time. Pumping tests can be performed as needed prior to well screen placement to allow for proper screen location. The sonic method is readily utilized in multiple cased well applications which are required to prevent aquifer cross contamination. The installation of inclinometers,

vibrating wire piezometers, settlement gauges, and the like can be accomplished efficiently with the sonic method.

5.2 The cutting action, as the sonic drilling bit passes through the formation, may cause disturbance to the soil structure along the borehole wall. The vibratory action of directing the sample into the sample barrel and then vibrating it back out can cause distortion of the specimen. Core samples can be hydraulically extracted from the sample barrel to reduce distortion. The use of split barrels, with or without liners, may improve the sample condition but may not completely remove the vibratory effect. When penetrating rock formations, the vibration may create mechanical fractures that can affect structural analysis for permeability and thereby not reflect the true *in-situ* condition. Sonic drilling in rock will require the use of air or fluid to remove drill cuttings from the face of the bit, as they generally cannot be forced into the formation. Samples collected by the dry sonic coring method from dense, dry, consolidated or cemented formations may be subjected to drilling induced heat, which could be a concern if core sampling for volatile organic compounds using Practice D6640. Heat is generated in these dry formations by the impact of the bit on the formation and the friction created when the core barrel is forced into the formation. The sampling barrel is advanced without drilling fluid whenever possible. Therefore, in very dense formations, drilling fluids may have to be used to remove drill cuttings from the bit face and to control drilling generated heat. In dry, dense formations precautions to control drilling generated heat may be necessary to avoid affecting contaminant presence. The effects of drilling generated heat can be mitigated by shortening sampling runs, changing vibration level and rotation speed, using cooled sampling barrels, collecting larger diameter samples to reduce effect on



the interior of the sample, and using fluid coring methods or by using alternate sampling methods such as the standard penetration test type samplers at specific intervals. Heat generated while casing the borehole through dense formations after the core sample has been extracted can be alleviated by potable water injection and/or by using crowd-in casing bits that shear the formation with minimal resistance. Should borehole wall densification be a concern it can be alleviated by potable water injection, by borehole wall scraping with the casing bit, by using a crowd-in style bit, or by injecting natural clay breakdown compounds.

5.3 Other uses for the sonic drilling method include mineral investigations. Bulk samples can be collected continuously, quite rapidly, in known quantities to assess mineral content. Aggregate deposits can be accurately defined by using large diameter continuous core samplers that gather representative samples. A limited amount of rock can be effectively penetrated and crushability determined. In construction, projects include freeze tube installations for deep tunnel shafts, piezometers, small diameter piles, dewatering wells, foundation anchors with grouting, and foundation movement monitoring instrumentation. Sonic drills can be used to set potable water production wells. However, production may not equal more conventional potable well drilling techniques because of the need to transport drill cuttings to the surface in short increments. Sonic drill units presently in use are in various sizes and most are truck mounted. Sonic drills can be skid or all-terrain vehicle mounted to access difficult areas.

5.4 Sonic drills can be adapted to such other drill methods as conventional rotary (Guide D1583, Guide D5782), down hole air hammer work (Guide D5782), diamond bit rock coring; conventional and wireline (Practice D2113), direct push probing (Guide D6001, Guide D6286), thin wall tube sampling (Practice D1587), and standard penetration test split barrel sampling (Practice D1586). The sonic drilling equipment offers more adaptability than most existing drilling systems. However, it is important to keep in mind that the technique the machine is designed for is the one at which it will be the most efficient. Long term use of sonic drills for other drilling methods may not be cost effective.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors. Practice D3740 was developed for agencies engaged in the testing and/or inspection of soils and rock. As such, it is not totally applicable to agencies performing this practice. However, user of this practice should recognize that the framework of Practice D3740 is appropriate for evaluating the quality of an agency performing this practice. Currently there is no known qualifying national authority that inspects agencies that perform this practice.

6. Criteria for Selection

6.1 Important criteria to consider when selecting the sonic drilling method include the following:

6.1.1 Diameter of borehole,

6.1.2 Sample quality (Class A, B) for laboratory physical testing (Refer to Practices D4220),

6.1.3 Sample handling requirements such as containers, preservation requirements,

6.1.4 Subsurface conditions anticipated: soil type or rock type/hardness,

6.1.5 Groundwater depth anticipated,

6.1.6 Boring depth,

6.1.7 Instrumentation requirements,

6.1.8 Chemical composition of soil and contained pore fluids,

6.1.9 Available funds,

6.1.10 Estimated cost,

6.1.11 Time constraints,

6.1.12 History of method performance under anticipated conditions (consult experienced users and manufacturers),

6.1.13 Site accessibility,

6.1.14 Decontamination requirements,

6.1.15 Grouting requirements, local regulations, and

6.1.16 Amount of and disposal costs for generated drill cuttings and drilling wastes.

7. Apparatus

7.1 *Sonic Drill Head*—The sonic drill head contains a sine wave generator, sine generator drive mechanism, lubrication system to reduce friction and control heat in the head, vibration isolation device, drill string rotating mechanism, and a connection to the drill string. The sine wave generator must be capable of producing sufficient energy to force movement in the drill string to accomplish the fracturing, shearing or displacement necessary for the borehole to be advanced as shown in Fig. 1.

7.1.1 *Sine Wave Generator*—The sine wave generator uses eccentric, counter rotating balance weights that are timed to direct 100 percent of the vibration at 0 degrees and at 180 degrees (Figs. 2 and 3). The sine wave generator is powered hydraulically and generally operates at frequencies between 0 and 185 Hz delivering a full range of energy outputs for advancement of up to 12 in. [300 mm] drill casing.

7.1.2 *Lubrication System*—The lubrication system is fitted with oil coolers of sufficient capacity to keep the hydraulic fluid at an allowable operating range as recommended by the oil supplier.

7.1.3 *Vibration Isolation System*—In order to transmit the maximum vibratory energy to the drill string and not damage the drilling rig the vibration applied to the drill tools must be isolated from the drill rig as shown in Figs. 2 and 3. This can be accomplished by using air charged springs, manual disk springs, or such other methods as will meet that goal.

7.2 *Drilling Tools*—A significant variety of tooling is necessary to accomplish the sonic drilling program. The tools consist of drill rods, drill casing, sampler barrels, sampler bits, casing bits, direct push sampling probes, borehole water sample collection systems, etc. Individual drillers and companies have in-house tooling designed for specific purposes and projects. If these specialized tools provide high quality sampling and efficient drilling processes they are acceptable to the practice.



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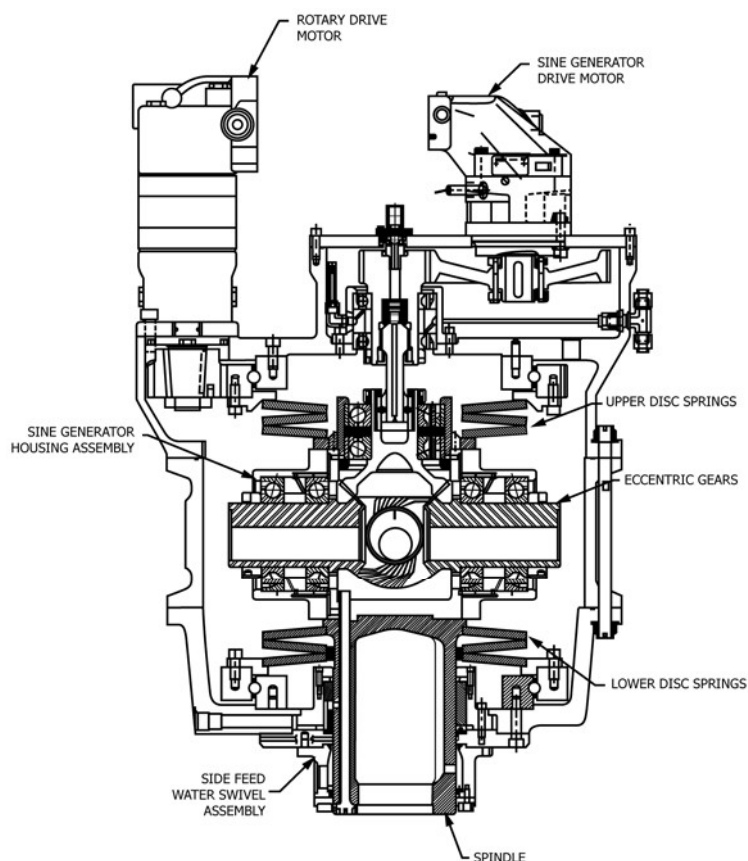


FIG. 2 Typical Sonic Drill Head with Disk Spring Form of Isolation System

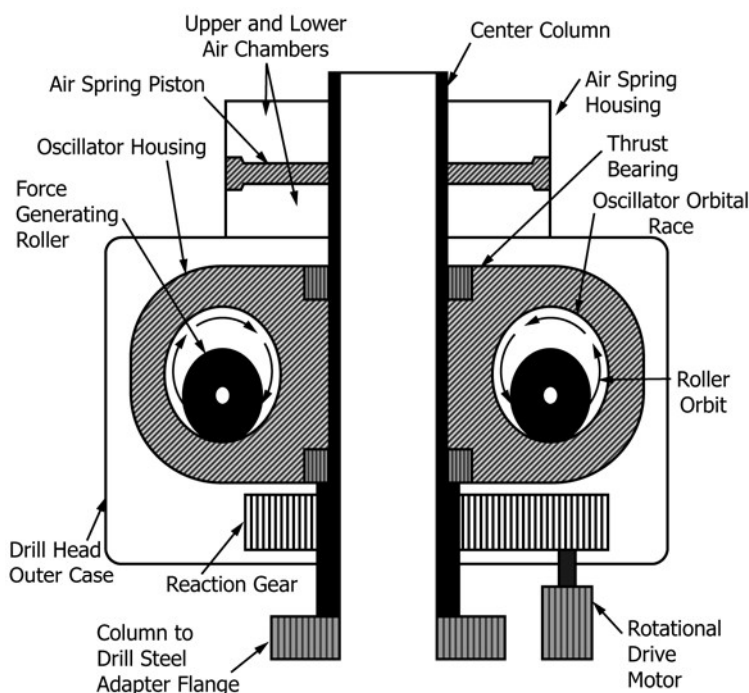


FIG. 3 Typical Sonic Drill Head with Air Spring Form of Isolation System

7.2.1 Drilling Rods and Casing—Drilling rods are used to propel and recover the sampling barrels. Drill rods are the most handled tools. The common sizes are 2 in. [50 mm] to 4 in.

[100 mm] diameter by 2 ft [0.5 m], 5 ft [1.5 m], 10 ft [3 m], and 20 ft [5 m] lengths. Annular space between casing and rod is not critical allowing the same sized drill rod to be used with



various sized sampling barrels. Current sonic drilling technology can be used to set drill casing in various sizes from 4 in. [100 mm] up to 12 in. [300 mm] nominal outside diameter depending on project requirements.

7.2.2 Sampler Barrel—Sampler barrels (a.k.a. core barrels) are used to recover formation specimens and to clean the inside of the drill casing. Sampler barrels are either solid tubes or split barrels of various diameters and lengths. The sampling barrels are generally sized to match the inside diameter of the various sizes of drill casing and to fulfill project requirements. The barrel is fitted with a drill bit/cutting shoe that holds the borehole alignment as it passes through the outer casing into the formation.

7.2.2.1 Solid Barrels—Solid sampler barrels are a solid length of tubing with thread sections on each end. They are available in various sizes and lengths. Typical sampling runs are 10 to 20 ft [3 to 5 m] in length. Sampling run length can be adjusted to provide the most optimum sample recovery. Sampler barrels can be joined to increase the length of sampling increment. In some formations there is a tendency to lose recovery with longer core run lengths while in others longer core runs may improve recovery. Samples of loose unconsolidated granular formations can be consolidated by the vibratory action. In loose or soft formations the inability of the soil structure to support the force necessary to move the material into the barrel can cause that material to be forced into the formation.

7.2.2.2 Split Barrel Samplers—Split barrel samplers are tubes that are split lengthwise with thread sections on both ends. The split sections utilize a tongue & groove feature that interlocks to prevent lateral movement between the two halves of the tube. Split barrel samplers are available in various diameters and lengths. While split barrel samplers provide a better format to view the specimen and may subject it to less disturbance, they do receive vibratory action during penetration. Depending on the method of construction, split barrels have a tendency to spread open in hard formations. They are quite heavy when fully loaded and may require special handling techniques. Liners, clear butyl or polyethylene based plastic, or stainless steel are available for use with split barrel and solid barrel samplers.

7.2.2.3 Standard formation sampling devices can be used in conjunction with the sonic drill rig for geotechnical applications. The standard penetration test **D1586** can be performed if the unit is equipped with a cathead or an automatic-hammer 140 lb [63.523 kg]. The hydraulically activated, D6519, as well as manual, fixed piston, thin wall tube samplers **D1587** can be

used if the unit is equipped with a fluid pump of sufficient capacity. Sonic drills are generally equipped with winch lines for using sampling tools in geotechnical drilling programs.

7.2.3 Casing Drill Bits—Drill bits are attached to the leading section of drill casing. Their function is to provide a cutting edge to assist in moving the casing through the various formations encountered and to direct the movement of formation materials during the making of the boring. The face of the drill bit follows one of three basic directional designs: (1) “Crowd-in” move most of the material encountered at the drill face into the borehole or casing as it is advanced. This style of bit face provides the best service in dense, dry, or cohesive formations as it helps reduce formation compaction and friction; (2) “Crowd-out” moves most of the material encountered at the drill face into the borehole wall. This design works better in softer and more granular, sands, gravels, and silt formations; and (3) “Neutral” allows the bit face material to choose the path of least resistance. Different bit face configurations are used to effectively penetrate different formations. The general-purpose bit face is fitted with carbide buttons spaced equally across and around the bit face. **Fig. 4** shows a typical carbide button faced bit. The carbide buttoned bit works well in most formations and is considered a general-purpose bit. Carbide buttons are well suited for the impact action that occurs in sonic drilling. Other configurations include welded carbide chips and blocks in a matrix, saw tooth shapes both hard surfaced and plain, and tearing shoe designs with large irregular carbides for working in construction debris and penetrating refuse in landfills. Each of these designs has a useful purpose and can be quite effective at penetrating their respective formations.

7.2.4 Sample Barrel Bit—The sample barrel bit is designed to both penetrate the formation and to shape the sample so it will pass through the bit into the sample barrel with the least amount of friction or compression. The bit may be constructed with serrated, carbide buttoned, or some other form of roughened inside diameter surface, or with a machined space for a retainer basket to assist in the retention of the sample. The interior of the sampler bit should have a minimum inside diameter $\frac{1}{8}$ in. [3 mm] less than the inside diameter of the sampling barrel to allow the passage of the sample into the core barrel with the least amount of resistance so as to not impede recovery or create unnecessary disturbance to the sample. The cutting face of the bit used should be the design best suited to the formation being penetrated. For dense formations with cobbles and boulders a bit face with carbide buttons may be used. For soft formations a serrated face, sharpened to force the

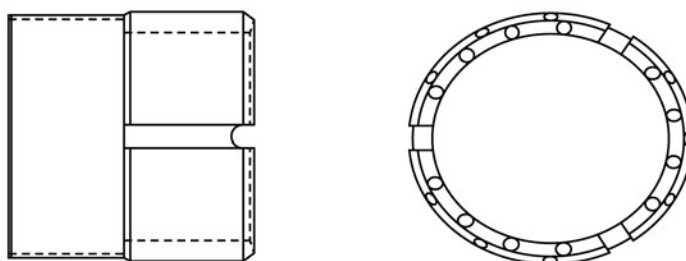


FIG. 4 Sonic Casing Bit



cuttings away from the bit, works well. The choice of bit face type and sample retention method is governed by the characteristics of the formation and should be optimized as the borehole progresses to obtain the highest recovery percentage with the least possible sample disturbance.

7.2.5 Direct Push Water Sampling Tools—Sonic drilling is a direct push drilling method as well. Therefore, other sampling tools similar to those used in the direct push industry are also available to the sonic drilling practice. *In-situ* water sampling tools are constructed using a screened inner stem attached to a point that is surrounded by an outer drive pipe. The point is the same diameter as the outer drive pipe to prevent the creation of an enlarged annular space that could provide an avenue for cross contamination between aquifers. The inner screen assembly is sealed from the formation during installation by an outer drive pipe fitted with “o” rings. With the friction of the soil holding the point in place while being driven to depth, the screen section is then exposed to the formation by pulling back on the outer drive pipe. The inner tube can have an inside diameter of 2 to 4 in. [50 to 100 mm] or larger to allow for larger capacity sampling pumps. Using higher capacity pumps accelerates the purging process and allows for rapid sampling from deep formations. The water sampling probes can be fitted with disposable points to allow for pressure grouting or installation of small diameter monitor wells. There are also water sampling probes driven in advance of the boring that have inflatable packers that seal inside the sonic casing.

7.3 Sonic Drill Rig—The sonic drill rig is similar to other drilling rigs in that it is a machine attached to a frame mounted on some form of carrier. The unit can be driven by a power take off assembly from the carrier engine or by an auxiliary engine. The unit has a feed frame for moving the drill head up and down to apply feed and retract pressure to the drill string and a mast for tool handling. Some units are equipped with automated tool handling devices. The sonic drill head is powered hydraulically. In addition to the sonic head, the feed system, drill fluid pumps, rod handling systems, and other auxiliary equipment demand power as well. Therefore, the power supply must be capable of providing the horsepower necessary to drive the system. The horsepower requirement is based on the desired productive capacity of the drill. The carrying vehicle must have sufficient gross vehicle weight to support the drill structure, rod handling equipment, fluid pumps, air compressors, and such tool storage as deck space allows.

7.3.1 Drill Tower—The drill rig may have a tower for extracting tools from the borehole. Tower lengths can vary, however, higher towers allow for longer tool pulls. The drill rig should have sufficient retraction power to lift a full-length string of the largest rated diameter drill tools from the deepest rated depth plus an additional 50 % or more of that total weight.

7.3.2 Tool Handling—Sonic drills traditionally use several different sizes of tooling. The units are generally equipped with some form of tool handling devices. Some units are equipped with a pivotal sonic head. This allows the head to tilt up 90 degrees to vertical so drill rod or casing can be aligned to the spindle for mechanical attachment. The length is then raised

and rotated back to vertical for attachment to the drill string. Other units use mechanical rod loaders, which position drill rods or casing for hook up. Wire rope winches can be used for drill rod tripping. Units using the winch method are generally fitted with a slide tray that can accommodate up to 20 ft [5 m] lengths of drill rod for reducing sample barrel retrieval time.

7.3.2.1 Tool Joint Wrench and Rod Holder Table—A key component of the sonic drill is the tool joint make-up, breakout, and rod holding table. The upper vice of the tool joint should be capable of bi-directional rotation to both close and open the tool joints. The throat of the joint wrench must be large enough to accommodate the largest rated O.D. tooling of the drill. The throat clearance may be accomplished by jaw retraction or by installing different sized jaws. The lower jaw assembly and its supporting members should be capable of supporting the total weight of the maximum O.D. tooling at the maximum depth rating of the machine. The upper jaw may include some form of high-speed rod spinning device to expedite rod disconnection.

7.3.3 Auxiliary Equipment—Sonic drill units require a fluid pump or pumps depending on the anticipated work program. The pumps serve many purposes; to push drilling fluids down the bore hole for lubrication and bit face cuttings removal while advancing the outer casing over core barrels in certain formations, when rock drilling to assist in the removal of cuttings, for bit cooling and cuttings removal while diamond bit rock coring, for mixing of drill fluids and grouts, for grouting of instrumentation, to grout (backfill) bore holes, and for equipment cleaning. Drill fluid injection is generally more predominate when installing casing in saturated granular formations to maintain pressure equalization than when drilling more cohesive formations. The primary purpose of injecting fluids is to keep the inside of the drilling casing clean as it is advanced over the sampling barrel. Normally drill fluids are not recycled during sonic drilling so volume generated is generally small. As the sonic drilled borings can go to considerable depth it is recommended that the unit have a least one positive displacement type pump. If a second fluid pump is desired, it should be capable of supplying 200 psi [1400 kN/m²] for mixing and for cleaning. Progressive cavity, or peristaltic pumps, work well for this purpose. All fluid pumps should be equipped with pressure indicating gauges and pressure relief valves set at the necessary level to protect the pumps from damage and to prevent fracturing of the formation. Air compressors are sometimes used in conjunction with sonic drilling. They are utilized when operating down hole hammers or other air drilling methods to penetrate formations not conducive to penetration by sonic methods. Air pressure requirements are governed by tool requirements, depth, and bore diameter, see Guide **D5782**. General tools needed to operate the sonic drill unit include rod lifting tools, pipe wrenches, fluid swivels, and handtools for general maintenance and repair. Other useful equipment would include portable or hydraulic powered arc welders, acetylene torches, steam cleaners, and portable generators. Portable fluid pumps and tanks are also useful for fluid containment and transfer.

7.4 Expendable Supplies—Expendable supplies are items such as monitor well materials, bentonite, cement, and their



proper uses are described in referenced ASTM standards. They are not addressed in this practice.

8. Conditioning

8.1 *General*—Preparation of the sonic rotary drill unit for project work starts with a thorough check of the drill's operating system. This includes the inspection, testing, and repair of all emergency shutdown switches and other safety devices. The performance of regular routine maintenance procedures including fluid level checks, lubrication, hydraulic hose inspection, leakage repairs, and the checks of the physical components with necessary repairs completed. A thorough cleaning of the drill unit is also recommended. Operating tools should be checked, repaired if necessary, and inventoried, so that an adequate supply is on hand for the project. Drilling tools, casing, rods, bits, etc., should be checked for proper repair, and loaded in sufficient quantities to complete the project. It is recommended that additional tooling, beyond that required for the project, be taken to the site to reduce down time from breakage or damage, and to allow for increases in work effort that may occur because of site conditions.

NOTE 2—The items in Section 8 regarding inspection, cleaning, inventory, repair, storage, transportation, decontamination, equipment checks, and necessary supplies are primarily related to contractor efficiency. This is only a partial list of activities that are considered good drilling practice to prepare for drilling and are offered for consideration by users. It is recognized that strict conformance with these items is not imperative for sonic drilling and does not necessarily correlate to the quality of the work.

8.1.1 *Equipment Movement*—All tools, materials, and equipment needed for the project should be loaded in a safe manner and secured in compliance with U.S. Department of Transportation, state, and local regulations. The drilling rig, support vehicles, and auxiliary equipment should be brought to the project site fully fueled and ready for operation. Extra tooling, instrumentation installation supplies, and other expendables should be stored in a central location in a safe and secure manner. The materials should be stored in a clean dry area in their original containers until transported to the decontamination area for cleaning if necessary or to the actual drill site for installation. All packaging debris, damaged or contaminated materials, and miscellaneous trash accumulate during drilling operations should be containerized and disposed of properly.

8.2 *Decontamination*—If the drilling rig and tooling are to be used on a chemically contaminated site, site specific decontamination procedures must be followed. For general decontamination information refer to Practice D5088 for recommended procedures.

8.3 *Sampling Barrels*—The sampling barrels are in various lengths, generally 5, 10, and 20 ft [1.5, 3, 6 m]. Barrels should be in equal increments to facilitate the accuracy of borehole depth measurements. Sampling barrels are either solid or split styles.

8.3.1 *Solid Sampling Barrels*—Check the barrel thread section for thread condition, dents, kinks, or excessive wear that could result in the loss of the barrel or the sampling shoe, or in improper assembly that will result in a reduction of energy

transfer. The barrel body should be straight, without dents or wrench burrs that could cause injury. The inside of the barrel should be clean, free of any debris, rust build-up, or any obstructions.

8.3.2 *Split Sampling Barrels*—Check barrel thread section for thread condition, dents, kinks or excessive wear that could result in the loss of the barrel or sampling shoe, or in improper assembly that will result in a reduction of energy transfer. The barrel body sections should be straight, without dents, kinks, or wrench burrs that could cause injury. The split tongue and grooves must be clean and free from dents, kinks or burrs. The split barrels halves should fit together snugly without bowing or spreading. The inside of the barrel halves must be clean and free of any obstructions.

8.3.3 *Sampler Barrel Heads and Bits*—Sampler barrel heads should be checked for thread condition for proper assembly to facilitate energy transfer. Sampler barrel bits are constructed in different configurations for use in the various formations encountered. The proper bit should be selected for the anticipated formation to be encountered. The cutting face should be free of dents, without cracks, non-manufactured grooves, or indentations. The interior of the bit should be free of obstructions that would impede the movement of the sample in the barrel. Designs in the bit to aid in recovery are permitted. Bits designed for use with basket retainers should have clean undamaged shoulders for receiving basket retainers. Check to see that the required tolerance is present.

8.3.4 *Drilling Without Sampling*—When sonic drilling without sampling is desired the solid sampling barrel bit can be modified to incorporate a drive point. When the maximum boring depth is reached, the sampling barrel is over drilled with the casing to depth and the sampling barrel is removed before setting instrumentation. If a disposable drive point is used, the sampling barrel is withdrawn the length of the point and the point knocked out. Then borehole activities such as water sampling and setting monitor wells or other devices can be accomplished.

8.3.5 *Tool Selection*—Prior to dispatch to the project site, an inventory of the necessary tooling in the proper sizes, expendable items, and instrumentation supplies should be made. Drilling is an inexact science and as such planning should include provisions for possible contingencies that may arise based on the knowledge one can gather about the project and the geology of the site. Routinely used supplies such as drill casing and sample barrel bits, rod lifters, environmentally safe thread lubrication, sampler barrel couplers, and project specific materials should be available so work can proceed unimpeded. If using split barrels or thin wall tubes a sufficient number should be on hand so sample examination does not delay drilling. Expendable supplies such as sample retainer baskets, sample storage bags, or other containers, and other project specific materials should be available in sufficient quantities so work can progress smoothly. Specialized sampling tools, necessary for project specific requirements, should be checked, cleaned and available in the required number. Refer to Guide D6169 for additional information on soil sampling tool selection. Materials for proper sealing of boreholes should always be available at the site.



9. Procedure

9.1 General Set Up—A safety meeting and site/project information meeting is held. A complete set of job safety analyses procedures is reviewed. Utility clearance information is reviewed. The drill crew puts on the required personal protective safety gear. The drill foreman makes a general site reconnaissance and specifically reviews the borehole location before moving any equipment onto the site. All underground and overhead utilities locations are checked and all members of the drill crew receive knowledge of their whereabouts. Any overhead obstructions that may impede drill rig setup and operation are noted. The travel path to the boring location is evaluated for the safe movement of the equipment. Move the drill rig and service vehicles to the borehole location. Unload any auxiliary equipment or supplies from the drill that would interfere with the rig setup. Level the drill unit. The leveling jacks should have sufficiently sized ground contact pads to spread the load and prevent settling during drilling that can cause misalignment of the drill tools. Once the drill is level, raise and secure the mast. If drilling fluids are to be collected position a fluid containment vessel. Position the service vehicles as necessary for efficient tool handling and drilling support. Hook up any pumps, hoses, and position working tools as necessary.

9.1.1 Drilling Methods—Sonic drilling can be performed wet, using a drilling medium, or dry. The choice of method is determined by project requirements, formations to be penetrated, and the depth to be achieved. In sonic drilling, the sampling barrel is advanced dry except for those occasions when actual rock or concrete penetration is occurring and drill-cutting removal is necessary to prevent tool lockup. Bouldery formations and weathered bedrock can be drilled dry as long as they will allow the cuttings at the bit face to be forced into the formation without friction causing excessive heat or impeding penetration of the formation. If sonic drilling is to be followed with rock core drilling, the criteria for sonic refusal in terms of drill rate and length of time should be specified in advance. Drilling progresses by fracturing, shearing, or displacement. Fracturing occurs when drilling through formations with cobbles, boulders, or rock formations. Shearing occurs when penetrating dense silt, clay, or soft shale. Displacement occurs in granular formations when the material is liquefied and moves away from the bit and casing, or up the casing or sampling barrel. In sonic drilling, as in other drilling practices, a combination of methods may be necessary to complete the project.

9.1.2 Tool Preparation—Attach the proper bit for the formation anticipated to the sampling barrel. Connect the sampling barrel to the drill head and tighten the drill bit and the sampling barrel to the drill head. Check the plumb of the casing in relation to the drill rig. The pre-torquing, or tightening of rod joints is essential to the transmission of energy through the rod string when using sonic technology. All drill rod and casing joints should be pre-torqued to the manufacture's rated capacity and/or to a level equal to the maximum amount of force that the sonic head can impart. Failure to do so can result in a loss of energy as well as damage to the threaded joint and/or loss of tooling. It is generally necessary to rotate the drilling casing to

provide for even bit wear, control borehole alignment, and to facilitate removal of the casing and samplers from the borehole on completion. Slow rotation speed is satisfactory as speed is not a controlling factor in advancing the tools. In certain formations rotation of the sampling barrel during core sampling may be necessary.

9.2 Sample Barrel Insertion—Advance the sample barrel into and through the topsoil, pavement, or other surface material. Withdraw the sampler from the borehole and remove initial penetration material. Reinsert the sampling barrel, apply down pressure, activate the sonic drill head, and began rotation if needed. Note bottom limit of penetration and adjust as needed by using various rod lengths to achieve desired sampling increment end point. Record drilling increments to the nearest 0.1 ft [0.3 m] or better. It is desirable to end sample increments at the even foot [meter], or 0.5 ft [0.1 m] increments for ease of bore hole measurements. Accurate measurements are critical to determine recovery, locate strata changes, and determine proper instrumentation location in the borehole.

9.2.1 Sampling-Solid Barrel—At the completion of the sampling run, stop down pressure, stop the sonic drill head and any rotation of the sampling barrel. If necessary disconnect from the sampling barrel and install casing over the sampling barrel. Extract the sampling barrel from the borehole using the drill head or such other method as will expedite the movement of the sampling barrel to the surface. At the surface, reattach the sampling barrel to the sonic drill head and position the sampling barrel to remove the sample. Remove the bit, protecting the bottom of sampling barrel to prevent any material from dropping out. Remove any material in the sampling bit and place it in the sample receiving bag in the correct orientation. Slide the sample bag over the sampling barrel the full remaining length of the bag so the sample does not fall. Allow the sample to flow into the bag by activating the sonic drill head as needed to vibrate the sample from the barrel. Keep the sample bag as close to the bottom of the sample barrel as possible while it fills to reduce sample dropping distance causing as little disturbance as possible. Samples are generally deposited in 2 to 5 ft [1 to 2 m] length plastic bags for review, logging and analysis. Sample bag length should not exceed 5 ft [2 m] as the weight of the specimen collected becomes very difficult to handle without causing excessive disturbance. Longer sample bags greater than 5 ft [2 m] can be used if disturbance is not an issue affecting exploration objectives. Change sample bags as needed until all sample is removed from the barrel. It is important that all material collected be contained for recovery measurements and for disposal. Accurate measurements of sample recovery are achievable with the solid barrel sampling method of sample collection if certain practices are followed. In some formations more precise measurements of recovery can be made using clear plastic sampler liners. Hydraulic extraction of the sample from the solid barrel sampler can also be utilized in some formations. The nature of sonic vibration and bit face displacement can cause some disturbance in granular and in other soils. This should be kept in mind when measuring recovery and examining core samples. Such measurements are best judged by experienced equipment operators and knowledgeable field



logging personnel who are knowledgeable in recognizing the differences in disturbed versus non-disturbed formation materials. Clean the sampling barrel by flushing with clean water or decontaminating as necessary. If project needs require full decontamination remove the used sampling barrel to the decontamination area, attach a cleaned sampling barrel to the drill head, add the drill bit and tighten it, and reinsert the sample barrel into the borehole to the depth of the previously sampled increment. Repeat the sampling process. It may be advantageous to rotate the sampling barrel as is withdrawn from the borehole to aid in extraction. However, rotation during extraction should only be used when necessary to retrieve the sampling tools to avoid disturbing the sample or causing it to fall from the sampling barrel. In some formations it may be necessary to activate the sonic drill head to facilitate withdrawal of the sample barrel. Once the sample is collected however, any action applied could cause disturbance to the sample. All such actions should be avoided wherever possible.

9.2.2 Sampling-Split Barrel—The procedure for using split barrel samplers is the same as solid barrel samplers except that the split barrel design it is not able to accept heavy down pressure or high friction resistance rotation. The limits of the split barrel are easily exceeded and caution must be exercised when utilizing these tools. Split barrel samplers offer the potential for reducing sample disturbance as the sample is removed from the core barrel. Sample removal and cleaning follow the procedures in referenced ASTM standards. Measuring sample recovery may be more accurate with the split barrel as result of generally shorter run length and the ability to visibly observe the material being measured in the barrel before it is removed.

9.3 Drilling with Casing—It is generally necessary to stabilize the borehole with an outer casing to control caving or slough, to facilitate sample collection, to protect against aquifer cross contamination, to provide a controlled environment for well or instrumentation installation, and to provide proper bottom up grouting. Casing is either installed using drilling fluid or installed dry depending on the formation being penetrated. Casing is available in a variety of lengths and diameters common to the drilling industry to fit a range of project requirements. The casing is either advanced over the sampling barrel when using drilling fluid or after the sample barrel has been removed from the borehole when drilling dry. Proportional sizing of the sampling barrel to the casing is required so that the casing is properly cleaned.

9.3.1 Drilling Casing Wet—Various drilling fluids can be used to advance the casing ranging from clean potable water to specialized drilling fluids. The choice of fluid is dictated by the formation and the project requirements. There is generally no recirculation of the drilling fluid during sonic drilling. The drilling fluid serves several functions. It helps keep debris and drill cuttings from entering the casing; it provides a lubrication film between the outside of the casing and the formation materials; it removes drill cuttings from the face of the bit and from the borehole annulus; and the fluid helps to keep the sample barrel and the casing from becoming sand locked as the casing passes over the barrel. It is important that the annular space between the sampler barrel and the casing bit be kept to

a minimum. This prevents material from moving into the annular space, reduces the amount of drilling fluid needed, and helps maintain borehole alignment. The drilling fluid is also used to maintain a pressure equalization head inside the casing to prevent any inflow of formation materials.

9.3.1.1 Casing Insertion Wet—The sampling barrel is advanced to the target depth increment as described previously. The drill head is disconnected from the sampling rod string. A plug is placed in the drill rod box to protect the threads and prevent any drill fluid from entering the sampling rod string. An equal length of drill casing is attached to the drill head and hoisted into position over the sampling rod string. As the casing is advanced using downpressure, rotation and vibration, drilling fluid is pumped into the casing string. The casing is advanced to the base of the sampling barrel shoe. Advancement is stopped. The drill head is disconnected from the casing and reconnected to the sampling barrel tool string. The sampling barrel is then removed and the sample extracted. The sampling barrel is cleaned and then reinserted, additional drill string added, and the sample barrel advanced to the next increment. Then the casing installation procedure is repeated. There is a slight amount of contact between the top of the sampling increment and the drilling fluid when the sample barrel is withdrawn. However, as no drilling fluid is recycled, the composition of the drilling fluid remains known and controlled. As soon as the sample specimen begins to enter the barrel the fluid in the barrel is pushed upward and the sides of the sample barrel are sweep clean by the friction of the passing soil.

9.3.1.2 Bore Hole Slough or Cave-In—As with all drilling methods there are times when special techniques are needed to maintain control of the bore hole. In certain formations, if the head pressure in the borehole is not equalized, the groundwater will carry formation materials in as it equalizes in the borehole. If project constraints do not allow the adding of compensating fluids other techniques must be employed. To provide room for the deposited material a second sampling barrel can be added on top of the first. As the materials are essentially liquefied along the barrel surface there is relatively little influence exerted on the lower portions of the sample from the upper portions. However, to provide sample quality and integrity every effort should be made to eliminate as much cave-in as possible.

9.3.1.3 Drilling Casing Dry—When installing casing dry, advance the sampling barrel through the scheduled interval. Remove the sample barrel and process the sample. Connect the drill head to the casing and advance the casing to the bottom of the previously sampled increment. Disconnect from the casing. Insert the sample barrel and vibrate through the borehole material in the casing to the top of the next scheduled sampling increment. Remove the sampling barrel and clean it in accordance with project requirements. Reinsert the sampling barrel and advance it to the end of the next sampling increment. Then repeat the procedure. In certain formations a double length sample barrel can be utilized to both remove the borehole material and to continuously sample the next increment in one tool trip. Whenever slough is encountered in the borehole it should be measured and properly noted on the boring log.



Determining the need for cleanout runs with the core barrel is primarily a driller skill.

9.4 Bore Hole Testing—The sonic drilling method lends itself well to many forms of borehole testing in most formations primarily because of the clean cased hole provided and from the versatility of the machine. Actual procedures for water and aquifer testing, or other formation properties exploration procedures are given in referenced ASTM standards and will not be individually addressed here. The very high level of energy that can be imparted to the drill bit by the sonic drill gives it the ability to advance casing and core barrels into very dense formations. In these dense formations, when drilling dry, the borehole wall may be affected by the forcing of soil particles into it. Should this condition be of concern it can be alleviated by using potable water injection while advancing the casing, by using a crowd in style bit that directs materials sheared from the borehole wall into the casing, by borehole wall scraping with the casing bit, or by injecting natural clay breakdown compounds.

9.4.1 Pump testing to determine aquifer characteristics, Test Method **D4050**, is easily accomplished because of the clean hole and the minimal disturbance that is caused to the formation. This results in a rapidly clearing formation that reaches its maximum production rate quickly. Minimum turbidity with rapid production results in less development water for disposal and expedited test results. This is especially significant when setting smaller diameter wells, which can only accommodate low volume pumps. Slug tests, Test Method **D4044**, can also readily be performed because of the clean borehole wall. Constant head and falling head tests can also be performed.

9.4.2 Well Installation—Wells, Practice **D5092**, of various sizes can be set using the sonic method. Advantages are that in many formations the casing in the screened zone can be set without fluid to keep the formation clean and to reduce development and/or pumping time. The vibratory effect can be used to good advantage to settle filterpack material around the screen and eliminate bridging of backfill materials as the casing is removed.

9.4.3 Other Instrumentation—Any type of instrumentation that can be set with any other drilling method can be set with sonic drilling. *In-situ* borehole tests such as pressure meters **D4719**, vane shear devices **D2573**, permeability testing using packers can be used with the sonic method as long as the borehole wall is prepared properly. When utilizing these types of testing methods it may be necessary to advance the casing into the borehole using water injection and a crowd in bit to reduce sonic drilling's effect on soil pore pressure.

9.5 Incorporating Other Drilling Practices—The sonic drill rig easily accommodates other drilling methods should they be needed to satisfactorily complete projects. Rock coring adaptations can be incorporated to do diamond bit coring (**D2113**) either wireline or conventional. Sonic drills generally have low rotary rpm ratings. Adequate speeds for rock coring can be acquired through a gear driven speed multiplier, a high-speed

coring head, 2-speed rotation motors, or if available, adjustment to the rotational output of the sonic drill head. Downhole hammers can be readily adapted to the sonic drill with the incorporation of a compressed air source. The low rpm rating works very well with downhole hammer. As the sonic drill offers all basic drill functions air or fluid rotary techniques can be easily adapted as well. Standard soil sampling techniques can be utilized with the sonic drill. Split barrel sampling with standard penetration tests (**D1586**), thin walled tubes (**D1587**), and the like can be easily incorporated.

10. Completion and Sealing

10.1 Information on the sealing of boreholes and installations can be found in Practice **D5092** and Guide **D5299** for wells, and in Guides **D5791**, **D5782**, **D5783**, and **D5784** for drilling methods. Local regulating agencies or organizations may control both the method and the materials for borehole sealing.

11. Report: Test Data Sheet(s)/Form(s)

11.1 The methodology used to specify how data are recorded is covered in **1.5**.

11.2 Record as a minimum the following general information (data):

11.2.1 Field Report—The field report may consist of boring log or a report of the sampling event and a description of the sample. Soil samples can be classified in accordance with Practice **D2488** or other methods as required for the exploration. Prepare the log in accordance with Guide **D5434**, which lists the parameters required for the field exploration program. Report the dates of drilling and the personnel performing the drilling. List all information related to drilling and the sampling event, including depths, fluid injection, drilling parameters (drilling rate), sampling intervals, recovery, strength index readings such as pocket penetrometer, classification of soil, and any comments on sampler or casing advancement. If a computer collects drill performance data, add identifying marks to log so correct information can be downloaded and incorporated into the final log as necessary.

11.3 Record as a minimum the following sampling data as follows;

11.3.1 Record all drilling and sampling measurements to the nearest 0.1 ft. [0.3 m] or better.

11.3.2 Sampling—Report depth interval sampled, sample recovery lengths to the nearest 0.1 ft. [0.3 m] or better and percent recovery, classification, and any other tests performed.

11.3.3 In situ Testing—Report the depths and types of insitu tests performed. For devices that were inserted below the base of the drill hole, report the depths below the base of the hole to the nearest 0.1 ft. [0.3 m] or better, and any unusual conditions during testing.

12. Keywords

12.1 drilling; resonance; soil and rock sampling; sonic drilling; subsurface exploration



SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (2004(Reapproved 2010)) that may impact the use of this standard.

(1) The revision in 2016 included editorial revisions required by Committee D18. The units were converted to in.-lb with rationalized SI units. The original version used exact metric values from rationalized US sizes, for example, it was really and in-pound primary standard. Reference was made to several new standards including D6640 on sampling soil in core barrels for environmental purposes.

(2) Terminology—unused terminology was deleted and the terminology for defining the drill head to include the sine wave generator.

(3) Significance and Use—Use of sonic drilling has expanded into the geotechnical field. When this standard was first written it was centered on environmental explorations. Throughout the standard, typical geotechnical use is recognized.

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Designation: D6066/D6066M – 24

EXHIBIT A, ATTACHMENT 3 D6066/D6066M-24 AND D1586-m18

Standard Test Method for Measuring Normalized Standard Penetration Test (SPT) Value, N_{60} , of Sands¹

This standard is issued under the fixed designation D6066/D6066M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method provides a procedure to normalize the Standard Penetration Test (SPT) N-value obtained from Test Method D1586/D1586M to standard energy for estimating engineering properties of sands. To reduce the inherent variability of the SPT, this test method requires energy measurements and restricts hammer systems and drilling methods. Refer to Standard Test Method D1586/D1586M on Penetration Test (SPT) and Split-Barrel Sampling of Soils for detailed information cited throughout this standard. Standard Guide D6286/D6286M provides additional information on drilling methods.

1.2 This test method requires the use of automatic hammers and the determination of the energy transmission, EFV, using Test Method D4633 to correct the SPT N-value and normalize it to N_{60} at 60 percent ETR (see 3.3).

1.3 The previous version of this standard was developed specifically for liquefaction evaluation of sands to provide an SPT (N_1)₆₀ value normalized to overburden stress of one-atmosphere pressure. Evaluation of liquefaction resistance requires qualified professional judgment, and (N_1)₆₀ corrections are now given in Appendix X1. Cone Penetration Testing (Test Method D5778) is also used for liquefaction evaluations as it is economical and provides detailed stratigraphic data.

1.4 *Units*—The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard. Reporting of test results in units other than inch-pound units shall not be regarded as nonconformance with this practice. SI equivalent units shown herein are in general conformance with existing international standards.

1.4.1 For overburden stress pressure correction calculations methods in Appendix X1, common units are ton/ft², kg/cm², atm, and bars. Since these units are approximately equal (within a factor of 1.1), many users prefer the use of these units in stress correction calculations. For those using kPa or kN/m², 100 kPa is approximately equal to one ton/ft². The stress exponent, n , is approximately equal for these units.

1.5 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

- D653 Terminology Relating to Soil, Rock, and Contained Fluids
- D1586/D1586M Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
- D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)
- D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

¹ This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard



D4220/D4220M Practices for Preserving and Transporting Soil Samples (Withdrawn 2023)³

D4633 Test Method for Energy Measurement for Dynamic Penetrometers

D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock (Withdrawn 2021)³

D5778 Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils

D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

D6286/D6286M Guide for Selection of Drilling and Direct Push Methods for Geotechnical and Environmental Subsurface Site Characterization

3. Terminology

3.1 Definitions:

3.1.1 For definitions of common technical terms used in this standard, refer to Standard Terminology **D653**.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *anvil, n*—that portion of the drive assembly that the hammer strikes and through which the hammer energy is transmitted into the drill rods.

3.2.2 *automatic hammer, n*—a hammer drop system that uses mechanical means to lift and control drop height of the hammer.

3.2.3 *cleanout depth, n*—depth that the bottom of the cleanout tool (end of drill bit or cutter teeth) reaches before termination of cleanout procedures.

3.2.4 *cleanout interval, n*—interval between successive penetration resistance tests from which material must be removed using conventional drilling methods.

3.2.4.1 *Discussion*—During the clean-out process, the previous penetration test interval (1.5 ft [0.45 m]) is drilled through and additional distance is cleaned to assure minimal disturbance of the next test interval. The term cleanout interval in this practice refers to the additional distance past the bottom of previous test.

3.2.5 *drill rods, n*—rods used to transmit downward and rotary force to the sampler or drill bit.

3.2.6 *drive interval, n*—interval from 0.0 to 1.5 ft [0.45 m] below the cleanout depth that consists of the 0.5 ft [0.15 m] seating and the 1.0 ft [0.3 m] test interval.

3.2.7 *drive length, n*—total length of the drive interval penetrated during testing, that is, the measured distance the sampler is advanced.

3.2.8 *hammer, n—in drilling*, that portion of the hammer drop system consisting of the 140 ± 2 lbm [63.5 ± 0.5 kg] impact mass which is successively lifted and dropped to provide the impact energy to drill rods that accomplishes the sampling and penetration (**D1586/D1586M**).

3.2.9 *hammer drop system, n—in drilling*, the equipment that includes the 140 lbm [63.5 kg] hammer, lifting and dropping assembly, and guide tube (if used) which the operator

or automatic system accomplishes the lifting and dropping of the hammer to produce the blow (**D1586/D1586M**).

3.2.10 *Standard Penetration Test (SPT), n—in drilling*, a test process in the bottom of a borehole in which a split-barrel sampler (5.3) with an outside diameter of 2 in. [50 mm] is driven a prescribed distance of 1.0 ft [0.3 m] after a seating interval of 0.5 ft [0.15 m] using a 140-lbm [63.5kg] hammer falling 30 in. [750 mm] for each hammer blow to compute the N-value (**D1586/D1586M**).

3.2.11 *test interval, n—in drilling*, the depth interval for the SPT test consists of an 0.5 ft [0.15 m] seating interval followed by the 1.0 ft [0.3 m] test interval (**D1586/D1586M**).

3.3 Symbols:

3.3.1 *EFV*—the energy transmitted to the drill rod from the hammer during the impact event (**D4633**).

3.3.1.1 *Discussion*—Test Method **D4633** requires energy measurement using a drill rod sub-assembly below the impact anvil equipped with accelerometers and strain gauges. EFV is calculated by integration of the product of force and velocity through the complete time history of the recorded impact event.

3.3.2 *ETR = (EFV/PE)*—ratio of the measured energy transferred to the drill rods to the theoretical potential energy, PE, for the SPT test, which is equivalent to a 140 lbm hammer dropped 30 in. [63.5 kg, 0.75 m] for (PE) of 350 ft-lbm [48 m-kJ].

3.3.2.1 *Discussion*—**D4633** does not specify the PE for SPT as it is applicable to all dynamic penetrometers.

3.3.3 *N-value, n*—the N-value, reported in blows per foot, equals the sum of the number of blows (N) required to drive the sampler over the test interval of 0.5 to 1.5 ft [0.15 to 0.45 m] below the base of the boring (**D1586/D1586M**).

3.3.4 *N₆₀, n*—standard penetration resistance N-value adjusted to a 60 % drill rod energy transfer ratio (**D1586/D1586M**, **D4633**).

3.4 Acronyms:

3.4.1 *SPT, n*—abbreviation for standard penetration test.

4. Summary of Test Method

4.1 Subsurface drilling is performed with minimal disturbance to advance a boring to the drive interval. Specific drilling methods and quality checks are required to assure minimal disturbance. If disturbance is evident, an alternate drilling method may be required.

4.2 The Standard Penetration Test is performed in accordance with Test Method **D1586/D1586M**, at the bottom of the boring using automatic hammers, which have been measured for energy transmission to determine the penetration resistance SPT N-value in the test interval.

4.3 The penetration resistance SPT N-Value is adjusted to a 60 % drill rod energy transfer ratio, N₆₀, through directly measured drill rod stress wave energy using Test Method **D4633**. The adjustment can be made to the N-Value for a particular hammer system, or the hammer system may be adjusted to deliver 60 % drill rod energy.

³ The last approved version of this historical standard is referenced on www.astm.org.



4.4 N_{60} can further be normalized to an effective overburden pressure. Typical adjustment factors are given to the user in [Appendix X1](#). The user may adjust the factors depending on the nature of the foundation soils, such as, previous stress history, particle size.

5. Significance and Use

5.1 This standard is used to obtain more reliable SPT N-values than those that can be obtained using Test Method [D1586/D1586M](#), which allows greater variability in equipment, calibration requirements, and hammer operation. The method described herein requires automatic or trip hammers, energy measurements, and borehole quality checks, and it restricts drilling methods to assure more repeatable N-values. Rope and cathead hammer operation is not allowed. This test method should be specified when N Values are used for geotechnical design purposes.

5.2 SPT N-values are used to estimate engineering properties of strength and compressibility of soils. The test is more useful in sands where recovery of intact samples for laboratory testing is difficult. SPT can be used in clays but is unreliable in soft clays. Reliable design requires N-values adjusted to a 60 % drill rod ETR, N_{60} , due to the wide variability of hammer systems. An ETR of 60 % is representative of the average ETR used to develop many soil property correlations. Design for sand liquefaction evaluation requires further normalization of N-values to a reference stress level (see [Appendix X1](#)).

5.2.1 SPT is used in a wide variety of soils from sand to clays both above and below the water table (refer to 4.3 [D1586/D1586M](#)) but is generally not applicable to gravels and cemented or partially lithified soils that result in refusal. This test method requires use of fluids for drilling of loose sands below water table as they become unstable. This test can be applied to unsaturated soils with other drilling methods that have a stable borehole and fluid drilling requirements waived. When applying SPT to unsaturated soil the user must consider any changes to properties if the soil becomes saturated during drilling or after construction.

5.3 This test method requires measurement of the drill rod energy, EFV, and determination of the energy transfer ratio, ETR, using Test Method [D4633](#). This measurement is performed by instrumenting drill rods just below the impact anvil at the surface. A hammer system may be adjusted to any desired ETR depending on project requirements by changing hammer drop height. For example, many automatic hammers run at fast rates of 50 BPM (blows per minute) and deliver high energy. The speed may be reduced to allow for detailed recording penetration rates or to meet other project requirements.

5.3.1 It may not be practical to measure EFV continuously, in which case hammer systems are measured periodically either onsite at critical projects or on a regular schedule (see [10.2](#)). Once ETR is known for a specific hammer, it is possible to check hammer performance by monitoring blow count rates and hammer impact velocities to verify they are operating consistently.

5.4 Use of this practice provides a disturbed soil sample for identification and for laboratory testing such as water content

(Test Method [D2216](#)) and Soil Classification (Test Methods [D2487](#), [D2488](#)). The classification information is commonly used to develop site stratigraphy.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it and the suitability of the equipment and facility used. Agencies that meet the criteria of Practice [D3740](#) are generally considered capable of competent and objective testing/sampling/inspection. Reliable results depend on many factors; Practice [D3740](#) provides a means of evaluating some, but not all, of those factors.

Practice [D3740](#) was developed for agencies engaged in laboratory testing, inspection, or both, of soils and rock. As such, it is not totally applicable to agencies performing this field test. Users of this test method should recognize that the framework of Practice [D3740](#) is appropriate for evaluating the quality of an agency performing this test method. Currently, there is no known qualifying national authority that inspects agencies that perform this test method.

6. Apparatus—Consult Test Method [D1586/D1586M](#) for detail information on SPT equipment.

6.1 *Automatic Hammers*—Assemblies with completely mechanical hammer-drop systems provide the best energy reproducibility. These hammers are required to be measured for ETR prior to testing using Test Method [D4633](#). Typical Chain cam and Pawl grip hydraulic hammers systems are rate dependent. Check and record the hammer drop rate daily or if there is a noticeable change in drop rate. At the measured blow rate these hammers typically deliver high energy of ETR 90 % with tight standard deviation of 2 to 3 %. Some hammer systems such as the eSPT system continuous performance checks can be made by measuring hammer impact velocity or drop height using sensors for every test.

6.1.1 Automatic hammers are designed to drop the hammer mass 30 in. [750 mm] and operate at high speeds of 40 to 55 blows per minute (bpm). In special cases, the blow rate may be reduced to deliver a reduced drop height of less than the nominal 30 in. [750 mm] and thus provide ETR = 60 %. For liquefaction evaluation or penetration per blow measurement it may be desirable to reduce the blow rate to 20 to 40 bpm. Automatic hammers have many adjustments and maintenance requirements for proper operation. Operations and maintenance guidelines must be provided to operators for the system used. Operators must be trained in the use and adjustment of the system. Changes in the hydraulic flow control will change the hammer rate, which will require a new energy calibration.

6.1.2 *Anvils*—Anvil length for chain cam automatic hammers vary by manufacturer and range from about 9 to 12 in. [225 to 300 mm]. The anvil used during calibration must be dedicated to that hammer system and must not be used or interchanged with other drill hammers. It is advisable to mark anvils to assure they go with the drill hammer system.

6.2 *Trip Hammers*—Assemblies that provide for rope lifting, or other hoisting mechanism, and a mechanical trip are economical and have energy reproducibility approaching that of automatic hammers. The ETR of any model of a manufactured unit must be documented using Test Method [D4633](#). Trip hammers are typically designed to provide a nominal 30-inch [750-millimeter] drop by a finger trigger on the upper cam. The anvils of these hammers vary in size but are generally very large and the typical ETR on these systems can be 45 to 70 %



with larger anvils providing lower drill rod energy. Trip hammers have some adjustments and maintenance requirements for proper operation. Trip hammers generally operate at rates of 20 bpm or less, and the ETR is less dependent on blow rate. Operations and maintenance guidelines should be provided for the system used. Operators should be trained in the use and adjustment of the system. Adjustments and maintenance (lubrication) must be routinely performed to assure proper operation.

6.3 Drilling Equipment/Methods—Open hole rotary drilling methods are in Guide **D6286/D6286M** are used for SPT making boreholes of 3 in. [75 mm] to 6 in. [1550 mm] diameter. Sonic Drilling and Direct Push methods have not been evaluated, but they may be suitable in clays and other unsaturated soils. The selection of the drilling methods depends on many factors. A primary consideration is soil saturation by soil type. The drilling method used must be checked by evaluating cleanout success and comparing the drilled borehole depth with the depth prior to testing. If there is excessive heave or slough, the drilling method must be changed.

6.3.1 Unsaturated Soils—Rotary Hollow-Stem augers are preferred for these soils as fluids are not needed. Solid-Stem flight augers can be used if the boring is stable with cave/slough at minimal acceptable levels in the base of the boring (12.2).

6.3.2 Saturated Soils—Open hole Fluid Rotary drilling is the preferred drilling method using bentonite or polymers. In unstable sands, a fluid bypass line must be used to add fluid to the boring upon retraction of drill rods. The rate of rod withdrawal and insertion must be slow enough to maintain borehole stability.

6.3.3 Hollow-Stem Augers and Fluid Rotary casing advancer methods may be less successful in unstable sands sensitive to hydrostatic imbalances. They can be used with drill fluids or clear water. Both methods are problematic because the removal of a pilot bit creates a suction effect at the base of the boring. In those cases, they can be vented or sometimes drilling is done with no pilot bit. If the method fails quality checks of test depth condition, change to a more reliable open hole fluid rotary method.

6.3.4 Some drilling equipment and methods are not acceptable for advancing borings in loose sands. Wash boring, cable tool, and casing advancement with air rotary or fluid down hole hammer drilling methods are not acceptable due to possible disturbance of the test interval. These methods may be used to advance borings close to the test interval, but final cleanout should be performed by the approved methods listed above.

6.4 Drill Rod—Flush Joint A through N size drill rods can be used. Report the type of rods used. The ETR must be determined with the same size drill rod as used in sampling.

6.5 Sampler—Use the standard 2-in. [50 mm] diameter Split Barrel sampler 24 in. [600 mm] length described in Test Method **D1586/D1586M**. Report if the sampler has an upset wall (no liners) or a constant inside diameter. Report if retainers are used to retain unstable soil.

7. Reagents and Materials

7.1 Drilling fluids used with the fluid rotary method are water with bentonite or polymer drill additives. The water does not have to be potable, but its PH should be checked and adjusted when using additives. A wide array of drill fluid additives are available from manufacturers included easy mixing versions. Follow manufacturer's instructions for mixing drill fluid additives. Additives must be certified as safe for use in the groundwater by regional or local regulations.

7.2 Cement, bentonite, or a mixture of the two are generally used to backfill borings after testing per regional or local regulations.

8. Interferences and Technical Precautions

8.1 Refer to Test Method **D1586/D1586M** for guidance on Interferences and Precautions.

8.2 Automatic and trip hammers must be monitored and inspected to assure the hammer system energy is consistent with previously measured conditions. Operation of automatic hammers shall be in strict accordance with operations manuals. Automatic hammer blow count rates must be continuously monitored. If a change in rate is noted, restore the calibrated rate or repeat the energy calibration. Periodic inspection and maintenance must be performed to avoid friction buildup and to check the hammer and assembly mass.

8.2.1 Example—An automatic hammer is calibrated for a particular drill rig using a throttle detent of 1500 rpm to pressurize the hydraulic system. The calibration establishes an ETR at a blow rate of 45 BPM. If the blow rate is slowed by friction the energy will be reduced and the hammer can be lubricated. If the driller fails to throttle up the system prior to operation the ETR will be reduced. Note and resolve the blow rate issues. Generally, the hammer flow control system should not be changed to maintain a blow rate consistent with the ETR calibration.

8.2.2 Anvil—Check and assure the anvil being used is the same as the one used for ETR calibrations.

8.2.3 The drill operator should maintain close contact of the hammer system to the impact anvil during testing to assure constant drop heights. Some hammer systems are designed to float with the weight of the assembly or even with hydraulic pressure of the lifting system exerting downforce.

8.3 The sampler must be clean at the beginning of each test and should be smooth and free of scars, indentations, and distortions. The driving shoe must be repaired and restored to specifications tolerances or replaced when it becomes worn, dented, or distorted.

8.4 Soil deposits containing gravel, cobbles, or boulders typically result in penetration refusal and damage to the equipment.

8.5 Plugging of the vent ports and ball check system of the sampler results in unreliable penetration resistance values. Instances of vent port plugging must be noted on daily data sheets and reported in the boring log.

8.6 Drilling disturbance of the 1.5-ft [0.45 m] drive interval results in unreliable penetration resistance values.



8.7 Testing performed in borehole conditions where the sampler depth is 0.4 ft [120 mm] more or less than cleanout depth is not reliable and drilling method must be changed or improved.

9. Sampling and Test Specimens

9.1 Penetration testing shall not be performed continuously in a borehole. The minimum recommended cleanout interval is 1.0 ft [0.3 m] (see 3.2.5). The minimum cleanout interval can only be shortened by direction of a qualified Professional in charge of the project. Pay special attention to maintain drill hole quality with shorter intervals. Carefully note and compare cleanout depths to depths at beginning of sampling as described in 12.2.

9.2 See Test Method D1586/D1586M for sample handling and testing.

10. Calibration/Documentation of Hammer System ETR Values

10.1 All hammer systems used must have a reliable drill rod energy measurement to determine the ETR (calibration value) using Test Method D4633. This drill rod energy measurement is made below the impact anvil. Hammer velocity and blow rate measurements on automatic hammers are useful to assure reliable performance, as when used as calibrated. Impact anvils must be matched to each hammer system calibration and different anvils must not be used thereafter. It is recommended to mark the anvil and hammer system to avoid mixing of parts.

10.2 The energy measurement requirements for the hammer system to be used, depend on the project quality control requirements on any specific project. Drilling firms must maintain hammer calibrations at a frequency of use or time-period as required in their quality control program. The ETR of a hammer system must be determined whenever there is change in operations. Mechanical trip hammers can be used on different drills, but automatic hammer generally stays on only one drill rig. If an automatic hammer is moved to another drill rig with different hydraulics, it can be recalibrated, or checked to see if the desired blow rate is attainable. Manufacturers often publish ETR data for their hammer systems, but these values must be verified prior to use. Data quality can be assigned to three classes as detailed below based on the frequency of energy calibration:

10.2.1 *Class A*—ETR data is measured on site before and sometimes after the project begins, or periodically as required in the project quality assurance plan during testing. This class of ETR data is required on critical geotechnical design projects, such as nuclear, dams, airfields, and large expensive structures. On these projects, once the ETR for an automatic system is established, the calibrated BPM or impact velocity of the hammer must be monitored continuously and reported daily. If a hammer system goes out of calibration due to breakdown or change of equipment it will require new ETR measurement. If there is a change in rate, the hammer may be re-adjusted to deliver the previous ETR rate used, or new ETR measurement depending on project plan requirements. There are some automatic hammer systems (see D1586/D1586M) that can

continuously monitor blow rate and hammer impact velocity for every test assuring highest data quality.

10.2.2 *Class B*—ETR data has been measured recently in accordance with the drill company quality assurance plan with a selected frequency of use, or at regular time periods not to exceed one year but preferably more often and where hammer changes have been made, or observed performance has changed. The hammer system must be operated as calibrated. For Automatic hammers the blow rate or impact velocity must be confirmed during use to be the same as when the ETR was established. Class B data is sufficient for typical geotechnical design purposes.

10.2.3 *Class C*—ETR data has been measured for the hammer system in the past but not within the time period specified in the drill company's quality assurance plan. Class C data can be used for small, non-critical projects at the discretion of the project quality requirements.

11. Preparation of Apparatus

11.1 Daily, check the hammer system operation to assure proper hammer speed and drop height is in conformance with established ETR value for the hammer. During testing, if any variation in hammer operation occurs, such as failure to use throttle detent, speed change, pauses in testing report the occurrences. Confirm the matching impact anvil matches the hammer system used.

12. Hole Preparation Procedures

12.1 Hole Preparation Procedure, General:

12.1.1 The cleanout depth is measured to the nearest 0.1 ft [0.3 m] and recorded on the data sheet.

12.1.2 The minimum interval required for a complete penetration resistance test is 2.5 ft [750 mm] with a 1.5-ft [0.45 m] drive interval and 1.0-ft [0.3 m] cleanout interval. At such close intervals, special attention to drilling methods is required to avoid disturbance. Penetration tests should not be performed continuously with no cleanout interval because of possible disturbance from the previous test.

12.1.3 The hole diameter should be from 3 to 6 in. [75 to 125 mm] (use inner diameter for hollow stem augers(see 9.1)).

12.1.4 If an obstruction, such as coarse gravel, cobbles, boulders, debris, or a lithified layer is encountered, it must be noted and can be removed by drilling through the interval of the obstruction. Do not use the sampler as a chopping bit. If disturbance below the obstructions is anticipated, it must be noted. Sometimes, the boring may need to be abandoned.

12.2 *Allowable Drilling Methods and Degree of Disturbance to the Test Zone*—Any drilling method listed in 6.3 can be used if the drill hole disturbance is minimal and passes the disturbance check below. If the drilling method fails disturbance check, change drilling methods to clean and stabilize the borehole.

12.2.1 *Disturbance Checks/Quality Control*—Disturbance checks can be made after interval cleanout and upon reinsertion of the sampler to evaluate test interval disturbance. Cleanout depth is to be determined to the nearest 0.1 ft [0.3 m]. If the thickness of cuttings, cave or heave exceeds 0.4 ft [0.1 m], it is considered excessive and penetration resistance testing may be



unreliable. The basis for 0.4 ft [0.1 m] is arbitrary and not substantiated by data. It is just an indicator of possible instability of either excessive heave or jetting disturbance that must be evaluated by the user. One must consider the amount of settled material and possible plugging of the bit or vent ports or, in cases where the sampler is deeper, if there were jetting or fracturing disturbance. Further evaluation of disturbance may be possible by evaluation of incremental penetration during the test, especially that of the seating interval. The user must evaluate drilling methods with failure of this quality check and switch drilling methods if disturbance appears significant.

12.3 Drilling in Unsaturated Soils and Stable Saturated Soils—Using drilling methods in 6.3 drill to the required test depth and record cleanout depth and sampler depth disturbance check. If they meet the quality requirements for disturbance, conduct the SPT.

12.4 Special Drilling Requirements for Saturated Unstable Soils and Loose Sands—Saturated sands are most difficult to drill as they are often the cause for failed disturbance checks. Liquefaction evaluation research in loose sands has shown that fluid rotary drilling is the preferable method to use in these materials, but casing advancers and hollow-stem augers can also be used. All methods require a fluid bypass line with drill fluid or water to add to the hole.

12.4.1 Rotary Drilling with Drilling Fluids—The use of drilling fluid with bentonite or polymer additive is required. In some cases, the use of water can be successful if hydrostatic balance is maintained and heave or sanding in is not evident.

12.4.1.1 Casing—Casing may be used with or without drilling fluid to stabilize a borehole. If casing is required, care must be exercised when driving the casing to avoid disturbance of the test interval. Casing should be kept as far above the test interval as possible through proper use of drill fluids. Casing shall not be driven to the bottom of the hole or test interval. If casing is required to closely follow the drilling, maintain it at the previous test interval (2.5 ft [0.8 m] above the cleanout depth). Keep detailed casing records.

NOTE 2—Use of casing near the testing interval increases the potential for heaving if fluid level is not maintained within the casing during removal of the clean out drill string and bit. This is because the hydraulic imbalance is focused on the base of the drill hole. If the fluid level drops below existing water table elevation, seepage gradients focused on the base of the hole will cause sand to heave.

12.4.1.2 Drill Bits—The fishtail bit is the most appropriate bit for drilling in sands. The fishtail bit should be equipped with baffles which direct fluid up-hole. When harder or coarser layers must be penetrated, rock bits or other drag bits can be used, but there is a potential increase in jetting damage.

12.4.1.3 Fluid Levels—The drilling fluid level within the borehole must be always maintained at or above the in situ piezometric water level during drilling, removal of drill rods, and sampling. Maintenance of the fluid level at ground surface is recommended as this provides the maximum beneficial effect and provides a constant and easily observable fluid level. When drilling in unstable soils at close testing intervals, it also is necessary to be careful to maintain fluid levels during extraction of the drill rods and sampler. The drill bit or sampler and rods should be withdrawn slowly using a vented swivel

hoisting plug while maintaining the fluid level in the borehole by using a bypass line from the pumps.

12.4.1.4 Record any loss of circulation of drilling fluid as an indication of possible voids in the soil or very high permeability layers. Also, record any increases in circulation as an indication of possible layers with artesian water pressure.

12.4.1.5 Drilling and Checking for Disturbance in Unstable Borings—If there is excessive cuttings, cave, or heave present in the drill hole, re insert the cleanout bit and continue circulation to remove this material and recheck the drill hole depth. While circulating, advance the drill bit to the previous cleanout depth. After removal of cuttings, slightly raise the drill bit and rods and cut off fluid circulation. After several minutes have elapsed, lower the drill bit and rods to check cleanout depth again. If excessive cuttings, cave, or heave are still present, clean out again. On the second try, advance the bit deeper than the previous cleanout interval and observe drill action. If there is little resistance, then it is possible that heave has occurred, and the test interval is disturbed. Take measures to avoid heave, such as thickening mud or use of casing and cleanout to a deeper depth past the disturbance. Continue this process until undisturbed material is present with an acceptable level of slough, cuttings, or cave. Record all drilling observations on the daily data sheet and the boring log. Record the cleanout depth on the daily data sheet as the depth that the drilling bit initially reached and not when resting on the thickness of cuttings.

12.4.1.6 Withdraw the cleanout drill string and bit slowly using a vented swivel hoisting plug to avoid rapid change in fluid levels within the borehole. Add fluid to the borehole as the cleanout drill string is pulled back using a fluid bypass line.

12.4.1.7 If the depth at which the sampler rests does not meet criteria for excessive cuttings, cave, or heave given in 12.2.1, additional hole preparation may be required. Take measures to stabilize the boring and repeat cleanout and cleanout depth checks as outlined in 12.4.1.5. Some sand layers under extreme artesian pressures may be difficult to stabilize. In these cases, it may be necessary to try a new drilling method or attempt a different, minimal intrusion test, such as the cone penetrometer (see Test Method D5778).

12.4.2 Hollow Stem Auger Methods—Hollow stem augers may be advanced with or without the pilot bit assembly. Rod type Hollow-stem augers are much better than wireline systems as wireline systems have much higher of occurrence of sand heave.

12.4.2.1 Special precautions are required for use of auger systems in saturated sands. In all cases in soft or loose deposits, slowing the feed rate of the augers is necessary as the test interval is approached. When using hollow stem augers in saturated sands, the hollow stem must be filled with drilling fluid or water. Keep a complete record of water added and any circulation gains or losses. If a pilot bit is used, fluid level must be maintained with a bypass during bit withdraw. Some pilot bit assemblies create suction when pulled through the bottom bushing. Venting of the pilot bit bushing assembly, lead auger, or the bit itself, may aid in reducing heave. After the test interval is reached, it may be necessary to raise the hollow stem



augers slightly and suspend the augers with a fork to prevent downward pressure on the test interval.

12.4.2.2 Hollow stem auger cutter heads transmit shearing stresses to the bottom of the drill hole and possibly could disturb the test interval, especially if cuttings are not efficiently removed and excessive down feed pressures are used. High blow counts in the seating interval may be evidence of sand compaction below the augers. Hollow stem auger blow counts should be evaluated carefully for possible disturbance effects. If there are any questions as to disturbance, fluid rotary drilling methods can be performed.

12.4.2.3 Add water or light drill fluid into the augers to compensate fluid pressure and slowly remove the pilot bit. If the pilot bit is connected to drill rods, withdraw the bit a few feet [1 m], wait a few minutes, then place the base of the pilot bit at the base of the hole. Record and compare the cleanout depth and depth at which the bit rests after this waiting period. If disturbance and heave are persistent, it may be necessary to raise and suspend the hollow stem augers from 4 to 6 in. [100 to 150 mm] above the cleanout depth and to use rotary drilling with drill fluids for clearing the final 4 to 6 in. [100 to 150 mm] of the hole.

12.4.3 *Rotary Casing Advancer Method*—The rotary casing advancer can be advanced with or without a plug bit. The advantage to the rotary casing advancer method is that the fluid remains in the casing during pilot bit removal, and thus, reduces heave. The disadvantage is that jetting disturbance is more likely. In soil deposits the casing bit is equipped with oversize carbide drag bit inserts to over cut the hole. These bits aid in developing annulus circulation. For BX-sized rotary casing advancers without pilot bit, often the interior of the drill rod does not require secondary cleaning. Use of a pilot is recommended if disturbance checks indicate excessive cuttings or heave are present.

12.4.3.1 The rotary casing advancer circulates drill fluid up-hole between the borehole wall and casing. Either water or drill mud can be used as circulating media. Drill mud or polymer is preferred and may be required if there are circulation losses. Special care should be taken to maintain circulation and avoid hydraulic fracturing of the test interval. A pressure gage is required on the discharge line of the fluid pump to monitor fluid pressures. Hydraulic fracturing can occur if feed rate exceeds ability to remove cuttings and will be evident by a temporary rise in pump pressure. If fracturing is evident, penetration resistance samples must be inspected closely for disturbance. Disturbed zones also can be evaluated from drill action. Circulation must be maintained during advancement. Circulation rates and any losses or gains must be reported on daily drill report and drill log.

12.4.3.2 Remove the plug bit with the wireline adding drill fluid as needed to maintain pressure balance. If the depth at which the sampler rests does not meet criteria for disturbance, additional hole preparation will be required. If the sampler rests below the clean out depth, jetting disturbance is possible. Take measures to stabilize the boring and minimize disturbance and repeat cleanout depth checks as outlined in 12.3. If disturbance persists it will be necessary to use fluid rotary drilling using the casing advancer in place as a casing.

13. Procedure

13.1 All drilling and test data are to be recorded on the Penetration Resistance Data Sheet form as in the example presented in [Appendix X2](#) or on a similar form.

13.2 With the sampler attached to the drill rods, and with each rod joint securely tightened, slowly lower the sampler to the bottom of the hole. Do not drop the sampler and rods onto the soil to be sampled.

13.3 Determine and record the sampler tip depth to the nearest 0.1 ft [0.3 m] or less at which the sampler rests. Compare the cleanout depth to assure the disturbance meets criteria in 12.2.1.

13.4 Attach the hammer assembly securely to the drill rods. If the sampler sinks due to the weight of the hammer record the new start depth. If the sampler sinks more than the seating interval of 0.5 ft [0.15m] abandon the test. This test interval is likely invalid either by excessive drilling disturbance or from very soft clays which are not applicable to SPT testing (Test Method [D1586/D1586M](#)). In this case it is not possible to report a valid N-value.

13.5 Mark the drill rods in three successive 0.5-ft [0.15-m] increments so the advance of the sampler under the impact of the hammer can be observed for each 0.5-ft [0.15 m] increment. If the penetration is known from the hammer system or a laser depth recorder, the rods do not need to be marked, however, the marks can be used as a visual check (Test Method [D1586/D1586M](#)).

13.6 *Driving Sampler, General*—The drill rods and assembly must be maintained in the vertical position during testing. Care must be exercised to maintain a proper drop height and uniform hammer blow rate during testing.

13.6.1 *Automatic Hammers*—Drive the sampler through the drive interval using the same blow rate as calibrated for ETR. Maintain the guide tube as close as possible to the impact anvil during driving. Note any deviations in hammer blow rate or drop height including, failure to use throttle detent, apparently slow blow rate, or pauses in testing.

13.6.2 *Energy Measurements*—If energy measurements are made during testing, they should not delay conduct of the hammer blows for rate dependent hammers. Measurement data should be reported and any delays in testing noted.

13.7 Count the number of blows applied in each of the 0.5-ft [0.15 m] increments and stop the test when one of the following occurs. If necessary, according to project requirements, record penetration per blow without affecting hammer blow rates.

13.7.1 A total of 50 blows has been applied during any of the three drive increments.

13.7.2 A total of 100 blows has been applied.

13.7.3 There is no observed advance of the sampler during application of ten successive hammer blows.

13.7.4 The sampler is advanced the complete 1.5 ft [0.45 m] without limiting blow counts as described in 13.7.1, 13.7.2, or 13.7.3.

13.8 If the sampler advances rapidly through the test interval with less than 5 blows the test data are not valid as the



material is disturbed or there are very soft clays not applicable to SPT (see 13.4). If there is drilling disturbance, change drilling methods for the next depth. Report the number of blows and partial penetration on the data sheet.

13.9 Record the number of hammer blows for each 0.5 ft [0.15 m] of penetration or penetration per blow as provided for in 13.9.1. The first 0.5 ft [0.15 m] is the seating interval. The sum of the number of blows to penetrate the test interval is termed the penetration resistance or N-value.

13.9.1 If the sampler is driven less than 1.5 ft [0.45 m] (as permitted in 13.7.2 and 13.7.3), the number of blows to penetrate each complete 0.5-ft [0.15 m] increment or each partial increment is to be recorded. Determine partial penetration to the nearest 0.1 ft [0.025 m] and record along with the appropriate number of blows.

13.9.2 Note any irregularities in penetration. For example, if, within a 0.5-ft [0.15 m] interval, only two blows result in 0.4-ft [0.15 m] penetration but six additional blows are required to drive the remaining 0.1 ft [0.025 m], the variation should be noted and recorded. Record the drive length as the sum of the distances penetrated in the seating and test intervals.

13.10 To remove the sampler, apply two rotations to the drill rods to shear the soil at the bottom of the sampler. The hammer can be used to back tap the drill string to free the sampler, if necessary. Withdraw the drill strings slowly and detach the sampler from the drill rods. Rapid withdraw may result in a vacuum being developed at the tip of the sampler, with resulting complete or partial loss of the sample.

13.11 Determine and record recovery length of the sample to the nearest 0.1 ft [0.025 m]. Do not include slough and cuttings in the recovery length. Calculate and record percent recovery to two significant digits.

13.12 Calculate and record the N-value. Calculate the N-value only if penetration of the complete 1.0-ft [0.3 m] test interval was achieved.

13.13 Perform a visual classification and description of the soil(s) obtained from the sampler according to Practice D2488 and record. If the sample mass is insufficient for a representative classification, the sample still is to be classified and this fact noted on the data form.

13.14 *Obtaining Laboratory Test Specimens from the Sample*—Obtain laboratory test specimens for moisture content (Test Method D2216), and laboratory soil classification (Test Method D2487) using procedures in Practice D4220/D4220M on preserving and transporting disturbed soil samples.

13.15 *Groundwater Information*—For holes drilled with bentonite or polymer, groundwater information is of questionable reliability; however, it should be monitored. Monitor groundwater levels before and after removal of protective casings or augers. Obtain groundwater levels at times suitable for the material encountered during drilling and after hole completion or as specified by the project investigation plan. Groundwater elevations should be measured daily and recorded on data forms. Where possible, enough holes should be left open and vented caps provided to allow observations to be made over a period of days. In clean coarse-grained soils,

shorter monitoring times may yield stabilized groundwater information, while in fine-grained soils longer times, 24 h or greater, may be required. If groundwater is not encountered or if the level is of doubtful reliability, such information also should be reported. Note if hole caving or closure occurs during observations.

13.16 *Hole Completion*—Methods and details of hole completion must be recorded and reported on drilling logs (Test Method D1586/D1586M).

14. Calculations

14.1 Calculate the nominal N-value, N, using the following expression:

$N = \text{No. of blows from the test interval of 0.5 to 1.5 ft (15 to 45 cm)}$

14.1.1 The N value is calculated only if penetration was achieved for the complete test interval. Do not extrapolate N values from tests with partial penetration. Instead, report the number of blows and distance penetrated.

14.2 *Determination of N_{60} -value*—Penetration Resistance normalized to 60 % drill rod energy transfer ratio. Correct the raw N-value to an equivalent rod energy transfer ratio of 60 %, N_{60} , by the following equation:

$N_{60} = N (\text{ETR}/60\%)$

14.3 For determination of stress normalized (N_1)₆₀ value consult Appendix X1.

15. Report: Test Data Sheet(s)/Form(s)

15.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as given below, is covered in 1.5 and in Practice D6026.

15.2 *Data Sheet*—A data sheet must be maintained as testing progresses. An example of a daily data sheet is included in Appendix X2. Data obtained in each borehole shall be recorded in accordance with the Subsurface Logging Guide D5434 as required by the exploration program. The data sheet allows for detailed notes for each individual test. The drill hole log has additional required information below.

15.3 Record as a minimum the following general information (data):

15.3.1 Project, Feature, Location of jobsite,

15.3.2 Boring Number and location (coordinates),

15.3.3 Ground elevation—note if surveyed,

15.3.4 Names of driller, crew, and logger,

15.3.5 Type and make of drilling equipment including fluid pump, fluid circulation and discharge systems. Note intervals of equipment change or drilling method changes and reasons for change.

15.3.6 Make, model, serial number of hammer system and anvil used and rated ETR.

15.3.6.1 Hammer system blow count rates and drop heights for driving the sampler must be checked daily and periodically during testing if changes are noted. Report any deviations in ETR due to change in BPM speed or failure to follow hammer guide tube on the impact anvil.

15.3.6.2 *Hammer Energy Data*—Report the rated ETR of the hammer system to the nearest percent and the Quality Class



A, B, or C. If the energy transfer ratio (ETR) of the hammer system is known from previous measurements, report the data and how and when the data were obtained. For any hammer that has had previous past measurement and is currently being used, report the most recent date of measurement. Report hammer drop heights and blow rates to confirm hammer performance. If energy measurements are performed onsite during testing, report the energy data with locations and frequency on drill logs or in the report.

15.3.6.3 Report the energy values recorded during testing. Report locations of energy testing and the values obtained. The report must conform to the requirements outlined in Test Method **D4633**.

15.3.7 Weather conditions

15.3.8 Dates and time of start and finish of borehole and individual tests.

15.3.9 Method of drilling and advancing and cleaning the borehole, and method of keeping borehole open, fluid circulation rates and losses. Include descriptions of circulation rates, cuttings returns, including quantities, over intervals used. Note quantity and locations of loss of circulation and probable cause. Include descriptions of drilling conditions related to drilling pressures, rotation rates, and general ease of drilling related to subsurface materials encountered.

15.3.10 Size of casing, depth of cased portion of borehole to the nearest 0.1 ft [0.025 m] or better.

15.3.11 Sampler length and inside diameter of barrel, no liner, or liner and liner type if used, shoe type, and if a sample basket retainer is used,

15.3.12 Size, type, and section length of the sampling rods.

15.3.13 Working hours, operating times, break-down times, and sampling times. Report any long-term delays in the drilling and installation process.

15.3.14 Report any unusual occurrences that may have happened during the exploration.

15.4 Record as a minimum the following test data:

15.4.1 Record all drilling and sampling measurements to the nearest 0.1 ft. [0.025 m] or better.

15.4.1.1 Depth of water surface to the nearest and drilling depth and time and date when reading or notation was made,

15.4.1.2 Location of strata changes, to the nearest 0.5 ft [0.15 m] or better,

15.4.1.3 Cleanout depth, Sampler depth to the nearest 0.1 ft [0.025 m]

15.4.2 Sampler penetration and recovery lengths to the nearest 0.1 ft [0.025 m] or better, and

15.4.3 Number of blows per 0.5 ft [0.15 m] or partial increment.

15.4.4 Report the N -value rounded to the nearest whole number.

15.4.5 Report calculated N_{60} values to the nearest whole number rounded down.

16. Precision and Bias

16.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible or too costly at this time to have ten or more agencies participate in an in-situ testing program at a given site.

16.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

16.3 Subcommittee D18.02 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

17. Keywords

17.1 liquefaction; N_{60} value; N -value; SPT; Standard Penetration Test

APPENDIXES

(Nonmandatory Information)

X1. NORMALIZED PENETRATION RESISTANCE, (N_1)₆₀

X1.1 Normalization of penetration resistance data is a frequently used method to evaluate the liquefaction susceptibility of sands. A large case history database from many countries has been accumulated to estimate instability of saturated sands during earthquakes (**1, 2, 3, 4**)⁴. This test is used extensively for a great variety of geotechnical exploration programs where earthquake induced instability of soil needs to be evaluated. The data from different countries with differing drilling techniques have been interpreted to develop a preferred normalization approach. This approach has been termed the N_1 method proposed by H. Bolton Seed and his colleagues (**2, 3**). Evaluation of liquefaction potential is beyond the scope of this

Test method. Interpretation of normalized penetration resistance values should be performed by qualified personnel familiar with the multitude of factors influencing interpretation of the data (see **D1586/D1586M**). The normalized penetration resistance determined in this practice may be useful for determination of other engineering properties of sands.

X1.2 The stress correction is based on field studies of limited depth and chamber testing of limited stress conditions (**1, 2, 5, 6**). The existing data bases also are limited in soil types examined. Drilling equipment and methods vary widely from country to country. Much of the data previously obtained was done so by using the fluid rotary method of drilling with small drill rods and donut and safety type hammers. Some studies have shown that other drilling methods, such as hollow stem

⁴ The boldface numbers in parentheses refer to a list of references at the end of this standard.

augers can be used to successfully collect penetration resistance data (7, 8). When using alternate drilling methods, however, it is easier to cause disturbance, and potential disturbance must be evaluated carefully. If there is any question regarding disturbance from alternative drilling methods, use of fluid rotary drilling is recommended.

X1.3 Most case history liquefaction data has been collected at shallow depths of less than 50 ft [15 m]. Stress correction information is limited to 3 to 6 ton/ft² [3000 to 6000 kPa] range. Knowledge is limited for energy transmission effects with drill rod lengths exceeding 100 to 150 ft [30 to 45 m].

X1.4 This practice is limited to evaluation of level ground sites. For soils subjected to non-level ground conditions, other correction factors may be required (3).

X1.5 The correction of N_{60} to a reference stress level is based on a stress correction factor, C_n . A typical stress exponent, n , used in practice, ranges from 0.45 to 0.6 (6, 9). The stress adjustment factor was developed using chamber testing of clean sands. The adjustments depend on particle size, density, over consolidation and aging (5, 10). Frequently, the soils of concern are young alluvial sand deposits of low density. These factors may not be applicable to sands with fines (SM, SC) or sands with more compressible minerals (mica or calcareous). With the lack of controlled data for these soils, however, current practice is to apply these factors to these soils for preliminary evaluations of soil stability. Other methods for normalizing soil values can be used and are acceptable if the method and reasoning are documented (5, 10).

X1.6 Soil liquefaction is most often associated with saturated sands. Most explorations will be performed below the water table. The normalization of penetration resistance also may be applicable to dry sands. In some cases, where future soil saturation is anticipated, testing can be performed in dry sands. If the testing is performed in dry sands, the user should be aware of possible changes in the soil upon saturation. This is especially true with silty/clayey dry sands that may undergo collapse upon saturation. Dry sands are more stable during drilling such that a wider variety of drilling methods are acceptable.

X1.7 Determination of $(N_1)_{60}$ Value—Definitions:

X1.7.1 *vertical effective stress, n , σ_v'* —the average effective force per unit area transmitted from grain to grain of a soil mass normal to the horizontal plane.

X1.7.2 $(N_1)_{60}$ —penetration resistance adjusted for energy and stress level.

X1.8 In this practice, penetration resistance is normalized to a 1 ton/ft² [100 kPa] stress level. Calculate the $(N_1)_{60}$ value as follows:

$$(N_1)_{60} = C_n \times N_{60} \quad (X1.1)$$

where:

C_n = the stress correction factor:

$$C_n = \left(\frac{\sigma'_{vref}}{\sigma_v'} \right)^n \quad (X1.2)$$

where:

σ'_{vref} = reference stress level,
 σ_v' = vertical effective stress at test depth, and
 n = stress exponent (see X1.14).

For $\sigma'_{vref} = 1$ tsf ($\approx \text{kgf/cm}^2_1 \approx \text{bar}, \approx \text{atm}$)

$$C_n = \left(\frac{1}{\sigma_v'} \right)^n \quad (X1.3)$$

For $n = 0.5$,

$$C_n = \left(\frac{1}{\sigma_v'} \right)^{-0.5} = \sqrt{\left(\frac{1}{\sigma_v'} \right)} \quad (X1.4)$$

X1.9 For stress units in kPa and for $n = 0.5$ as simplified for tsf stress units:

$$C_n = 9.8 \sqrt{\left(\frac{1}{\sigma_v'} \right)} \quad (X1.5)$$

X1.10 *Vertical Effective Stress, σ_v' , (tsf, kPa, kg/cm², bar, atm)*—The vertical effective stress is calculated by knowledge of hydrostatic pressures and total stresses in the deposit. The vertical effective stress is the difference between total vertical stress and hydrostatic pressure.

$$\sigma_v' = \sigma_v - u_o \quad (X1.6)$$

where:

σ_v = $\Sigma h_{us} \times \gamma_{wet \text{ or sat.}}$

And:

where:

$\gamma_{wet \text{ or sat.}}$ = wet or saturated unit weight of the soil above the test zone.

X1.11 The equilibrium water pressure can be estimated by calculation as follows:

$$u_o = \text{estimated equilibrium water pressure} = h_i \times \gamma_{water} \quad (X1.7)$$

where:

h_i = height of water, ft [m], estimated from site conditions and

γ_{water} = unit weight of water = 62.4 lb/ft³ [9.8 kN/m³].

NOTE X1.1—For soil deposits under salt water the unit weight of water is 64.0 lb/ft³, [10 kN/m³].

X1.12 In layered soils, with multiple perched aquifers, the assumption of a single height of water table may be in error. Often borehole water level data may be unreliable for estimation of water pressures in the test zone. Additionally, accurate piezometric data from independent measurements may be required for accurate determination of equilibrium pore water pressure.

X1.13 For subsurface conditions with a single aquifer the effective stress is the summation of total stresses above the water table plus the summation of buoyant stresses below the water table:

$$\sigma_v' = \Sigma h_{us} \times \gamma_{wet} + \Sigma h_s (\gamma_{sat} - \gamma_{water}) \quad (X1.8)$$



where:

- h_{us} = thickness of individual layers above the water table,
- γ_{wet} = wet unit weight of soil of the layers above the water table,
- h_s = thickness of saturated soil deposits below the water table,
- γ_{sat} = saturated unit weight of soil layers, and
- γ_{water} = unit weight of water (62.4 lb/ft³ [1 gm/cm³] [9.8 kn/m³]).

X1.14 Determination of vertical effective stress requires detailed knowledge of site conditions. Under perched or artesian aquifer conditions, it may be difficult to estimate water pressures. Borehole water level information may not provide accurate water pressure information (see 12.4.1.3 and 13.15). In certain geologic conditions, such as cemented zones, overlying normally consolidated zones, the total stresses may be difficult to estimate. Estimation of vertical effective stress requires experienced qualified professional judgement.

X1.15 *Stress Exponent, n* —The exponent is derived from chamber testing and depends on cavity expansion theory. The exponent varies with density, particle size, over consolidation ratio, and aging of the soil (5, 6, 9, 10). Also, boundary effects are not accounted for among the chamber tests. Typical values for normally consolidated clean sands used in practice today range from 0.45 to 0.6. Examination of chamber penetration tests indicates that the exponent is lower in dense sands (as low as 0.4) (10). The typical value used in practice is $n = 0.5$ or the square root of effective vertical overburden pressure (9). Limited evidence from penetration in dirty (fines > 15 %) or compressible sands, suggests the exponent increases toward 1.0 as less drainage occurs during penetration such that

selection of 0.6 or 0.7 may be appropriate for those soils. Fig. X1.1 (11) shows several trends in the C_N factor suggested by several investigators. Note that the C_N factor can reach very large values at shallow depth. Some investigators have recommended limiting the C_N to about 1.6 at very shallow depths.

X1.16 Alternately, the C_N factor can take other forms such as those proposed by Skempton (5, 9). The user is reminded that the C_N factor is a function of many variables such as particle size, density, stress history, and aging. Report the method of correction and the reasoning for varying applications.

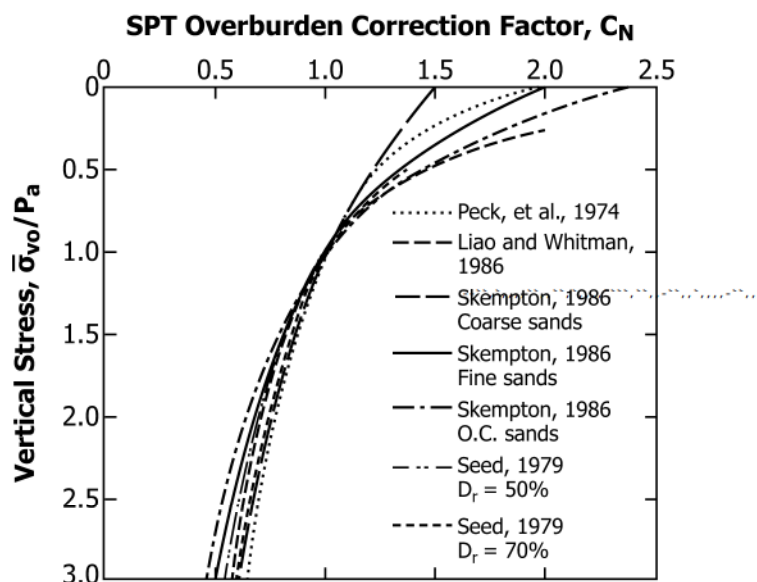


FIG. X1.1 C_N Factors by Various Investigations



X2. EXAMPLE DATA SHEET

X2.1 See **Fig. X2.1** for example data sheet.

Fig. X2.1



D6066/D6066M – 24

SPT N60 FIELD DATA FORM				ASTM D6066				
PROJECT				FEATURE		HOLE NO.		
GROUND ELEVATION				LOCATION				
FOREMAN		DRILLER		LOGGED BY		DATE		
DRILLING METHOD								
SPT HAMMER				HAMMER BLOW RATE AS CALIBRATED		HAMMER ETR. CLASS		
CLEANOUT DEPTH				TEST 1		TEST 2		
SEATING PENETRATION (0.5 ft. maximum)								
DEPTH TO SAMPLER TIP								
DIFFERENCE BETWEEN CLEANOUT AND SAMPLER DEPTH < 0.4 FT IS REQUIRED								
NO. OF BLOWS FOR STANDARD 0.5 ft. SEATING PENETRATION (50 blows max.)				NO. OF BLOWS		PENETRATION		
TEST PENETRATION (1.0 ft. maximum)								
NO. OF BLOWS FOR STANDARD 1.0 ft. PENETRATION TEST	NO. OF BLOWS			PENETRATION	NO. OF BLOWS			PENETRATION
	0.5 – 1.0 ft.	1.0 – 1.5 ft.	N		0.5 – 1.0 ft.	1.0 – 1.5 ft.	N	
DEPTH TO SAMPLER TIP								
RECOVERY				(1)	(2)	(3)-%		
DRIVE LENGTH (ft) (1)								
RECOVERY LENGTH (ft) (2)								
(1)/(2) X 100 (3)								
VISUAL CLASSIFICATION AND DESCRIPTION OF SAMPLE								
ROLL PHOTO NO.								
MOISTURE SAMPLE								
REMARKS:								
DRILLER				FOREMAN				
(signature)				(signature)				

FIG. X2.1 Example Data Sheet



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SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D6066–11) that may impact the use of this standard. (December 15, 2024)

(1) Standard Practice D6066 on SPT for evaluation liquefaction is being extensively revised to a test method to determine SPT N₆₀ values. The scope has changed to apply to all soils, not limited to liquefaction, and the corrections for N₁ were moved to the appendix.
Test method D1586 was comprehensively revised in 2018 and

does not require SPT energy measurement. Subcommittee D18.02 requires a more reliable SPT test procedure which can produce N₆₀ values for all soils. D6066 was initially written as a strict method to produce reliable blow counts in unstable sands for liquefaction evaluation. This new version also can be used for all geotechnical design purposes.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

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Designation: D1586/D1586M – 18^{ε1}

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils¹

This standard is issued under the fixed designation D1586/D1586M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

^{ε1} NOTE—Reference (14) was editorially corrected in April 2022.

1. Scope*

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler with a 140 lb [63.5 kg] hammer dropped 30 in. [750 mm] to obtain a soil sample for identification purposes, and measure the resistance of the soil to penetration of the standard 2 in. [50 mm] diameter sampler. The SPT “N” value is the number of hammer blows required to drive the sampler over the depth interval of 0.5 to 1.5 ft [0.15 to 0.45 m] of a 1.5 ft [0.45 m] drive interval.

1.2 Test Method D4633 is generally necessary to measure the drill rod energy of a given drop hammer system and using the measured drill rod energy, N values can be corrected to a standard energy level. Practice D6066 uses Test Methods D1586 and D4633 and has additional requirements for hammers, hammer energy, and drilling methods to determine energy corrected penetration resistance of loose sands for liquefaction evaluation.

1.3 Practice D3550/D3550M is a similar procedure using a larger diameter split barrel sampler driven with a hammer system that may allow for a different hammer mass. The penetration resistance values from Practice D3550/D3550M do not comply with this standard.

1.4 Test results and identification information are used in subsurface exploration for a wide range of applications such as geotechnical, geologic, geoenvironmental, or geohydrological explorations. When detailed lithology is required for geohydrological investigations, use of continuous sampling methods (D6282/D6282M, D6151/D6151M, D6914/D6914M) are recommended when the incremental SPT-N value is not needed for design purposes (see 4.1.1).

1.5 Penetration resistance testing is typically performed at 5 ft [1.5 m] depth intervals or when a significant change of materials is observed during drilling, unless otherwise specified.

1.6 This test method is limited to use in nonlithified soils and soils whose maximum particle size is approximately less than one-half of the sampler diameter.

1.7 This test method involves use of rotary drilling equipment (Guide D5783, Practice D6151/D6151M). Other drilling and sampling procedures (Guides D6286 and D6169/D6169M) are available and may be more appropriate. Considerations for hand driving or shallow sampling without boreholes are not addressed. Subsurface investigations should be recorded in accordance with Practice D5434. Samples should be preserved and transported in accordance with Practice D4220/D4220M using Group B. Soil samples should be identified by group name and symbol in accordance with Practice D2488.

1.8 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this test method.

1.8.1 The procedures used to specify how data are collected/recorded and calculated in the standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user’s objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering data.

1.9 Units—The values stated in either inch-pound or SI units [presented in brackets] are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. Reporting of test results in units other than inch-pound shall not be regarded as

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Dec. 1, 2018. Published December 2018. Originally approved in 1958. Last previous edition approved in 2011 as D1586 – 11. DOI: 10.1520/D1586_D1586M-18E01.

*A Summary of Changes section appears at the end of this standard

nonconformance with this practice. SI equivalent units shown herein are in general conformance with existing international standards.

1.10 Penetration resistance measurements often will involve safety planning, administration, and documentation. This test method does not purport to address all aspects of exploration and site safety.

1.11 Performance of the test usually involves use of a drill rig; therefore, safety requirements as outlined in applicable safety standards (for example, OSHA regulations,² NDA Drilling Safety Guide,³ drilling safety manuals, and other applicable local agency regulations) must be observed.

1.12 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.13 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:⁴

- D653** Terminology Relating to Soil, Rock, and Contained Fluids
- D854** Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
- D1452/D1452M** Practice for Soil Exploration and Sampling by Auger Borings
- D1587/D1587M** Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
- D2216** Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D2487** Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D2488** Practice for Description and Identification of Soils (Visual-Manual Procedures)
- D2573/D2573M** Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils
- D3550/D3550M** Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
- D3740** Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D4220/D4220M** Practices for Preserving and Transporting Soil Samples

² Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, <http://www.osha.gov>.

³ Available from the National Drilling Association, 3511 Center Rd., Suite 8, Brunswick, OH 44212, <http://www.nda4u.com>.

⁴ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- D4633** Test Method for Energy Measurement for Dynamic Penetrometers
- D5088** Practice for Decontamination of Field Equipment Used at Waste Sites
- D5092** Practice for Design and Installation of Groundwater Monitoring Wells
- D5299** Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
- D5434** Guide for Field Logging of Subsurface Explorations of Soil and Rock (Withdrawn 2021)⁵
- D5778** Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils
- D5782** Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
- D5783** Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
- D5784/D5784M** Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Devices
- D5872/D5872M** Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water Quality Monitoring Devices
- D6026** Practice for Using Significant Digits and Data Records in Geotechnical Data
- D6066** Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential (Withdrawn 2020)⁵
- D6151/D6151M** Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
- D6169/D6169M** Guide for Selection of Subsurface Soil and Rock Sampling Devices for Environmental and Geotechnical Investigations
- D6282/D6282M** Guide for Direct Push Soil Sampling for Environmental Site Characterizations
- D6286** Guide for Selection of Drilling and Direct Push Methods for Geotechnical and Environmental Subsurface Site Characterization
- D6913/D6913M** Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- D6914/D6914M** Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices

3. Terminology

3.1 Definitions:

3.1.1 For definitions of common technical terms in this standard refer to Terminology **D653**.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *anvil, n—in drilling*, that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

⁵ The last approved version of this historical standard is referenced on www.astm.org.

3.2.2 *cathead, n—in drilling*, the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.2.3 *drill rods, n—in drilling*, rods used to transmit downward force and torque to the drill bit while drilling a borehole and also connect sampler to the hammer system for testing.

3.2.4 *hammer, n—in drilling*, that portion of the hammer drop system consisting of the 140 ± 2 lbm [63.5 ± 0.5 kg] impact mass which is successively lifted and dropped to provide the impact energy to drill rods that accomplishes the sampling and penetration.

3.2.5 *hammer drop system, n—in drilling*, the equipment that includes the 140 lbm [63.5 kg] hammer, lifting and dropping assembly, and guide tube (if used) which the operator or automatic system accomplishes the lifting and dropping of the hammer to produce the blow.

3.2.6 *hammer fall guide, n—in drilling*, that part of the hammer drop system used to guide the fall of the hammer.

3.2.7 *number of rope turns, n—in drilling*, the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.2.8 *sampling rods, n—in drilling*, rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.2.9 *standard penetration test (SPT), n—in drilling*, a test process in the bottom of a borehole in which a split-barrel sampler (see 5.3) with an outside diameter of 2 in. [50 mm] is

driven a prescribed distance of 1.0 ft [0.3 m] after a seating interval of 0.5 ft [0.15 m] using a 140 lbm [63.5 kg] hammer falling 30 in. [750 mm] for each hammer blow to compute the *N*-value.

3.2.10 *test interval, n—in drilling*, the depth interval for the SPT test consists of an 0.5 ft [0.15 m] seating interval followed by the 1.0 ft [0.3 m] test interval.

3.3 Definitions from D6066 Pertinent to This Standard:

3.3.1 *cleanout depth, n*—depth that the bottom of the cleanout tool (end of drill bit or cutter teeth) reaches before termination of cleanout procedures.

3.3.2 *cleanout interval, n*—interval between successive penetration resistance tests from which material must be removed using conventional drilling methods.

3.3.2.1 *Discussion*—During the clean-out process, the previous penetration test interval (1.5 ft [450 mm]) is drilled through and an additional distance is cleaned past the end depth of the previous test to assure minimal disturbance of the next test interval. The term cleanout interval in this practice refers to the additional distance past the previous test termination depth.

3.4 Symbols Specific to This Standard:

3.4.1 *N-value, n*—reported in blows per foot, equals the sum of the number of blows (*N*) required to drive the sampler over the depth interval of 0.5 to 1.5 ft [0.15 to 0.45 m] below the base of the boring (see 8.3).

3.4.2 *N₆₀, n*—standard penetration resistance adjusted to a 60 % drill rod energy transfer ratio (Test Method D4633, Practice D6066).

3.5 Symbols Specific to This Standard and Pertinent to This Standard from Test Method D4633:

3.5.1 *EFV, n*—the energy transmitted to the drill rod from the hammer during the impact event.

3.5.2 *ETR, n*—ratio (*EFV* / *PE*) of the measured energy transferred to the drill rods to the theoretical potential energy (*PE*).

4. Significance and Use

4.1 This test is the most frequently used subsurface exploration drilling test performed worldwide. Numerous international and national standards are available for the SPT which are in general conformance with this standard.⁶ The test provides samples for identification purposes and provides a measure of penetration resistance which can be used for geotechnical design purposes. Many local and widely published international correlations which relate blow count, or *N*-value, to the engineering properties of soils are available for geotechnical engineering purposes.

4.1.1 Incremental SPT sampling is not a preferred method of soil sampling for environmental or geohydrological exploration unless the SPT *N*-value is needed for design purposes. Continuous sampling methods such as Direct Push Soil Sampling (Guide D6282/D6282M), or continuous coring using

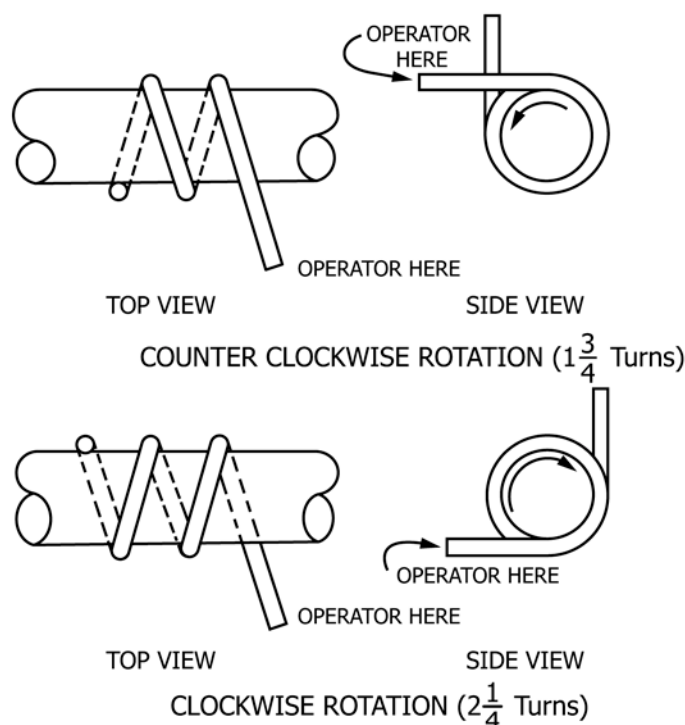


FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead



Hollow-Stem Augers (Practice [D6151/D6151M](#)) or Sonic Drills (Practice [D6914/D6914M](#)) provide the best continuous record of lithology. Continuous sampling can be performed with SPT samplers, but it is slow compared to other methods, and N values may be unreliable (see [4.6.1](#)). Sampling for detailed lithology can be reduced by using screening tests such as geophysics and Direct Push profiling tests such as Cone Penetrometers (Test Method [D5778](#)), Dynamic Cone Penetrometer, or electrical resistivity probe.

4.2 SPT N values are affected by many variables allowed in the design and execution of the test (see [Appendix X1](#)). Investigations of energy transmission in SPT testing began in the 1970's and showed that differing drop hammer systems provide different energies to the sampler at depth. There are so many different hammer designs that it is important to obtain the energy transfer ratio (ETR) for the hammer system being used according to Test Method [D4633](#). ETR of various hammer systems has shown to vary between 45 to 95 % of maximum Potential Energy (PE). Since the N -value is inversely proportional to the energy delivered, resulting N values from different systems are far from standard. It is now common practice to correct N values to an energy level of 60 % of total (PE), or N_{60} values as presented here and in Practice [D6066](#). In this standard it is not required to report ETR or N_{60} but strongly advised to be noted and reported if available. If ETR of the hammer/anvil/rod system is known, the hammer PE can still vary after calibration, thus it is essential that hammer drop heights/rates be monitored to confirm consistent performance. Report any occurrence of hammer drop heights that do not meet the required value of 30 in. [750 mm] during testing. Using previous ETR data for a hammer system does not assure that it will perform the same on the current project. If onsite ETR is not obtained, be sure to check hammer drop height/rates to assure the hammer is operating the same as when previously checked.

4.2.1 Other mechanical variables and drilling errors can also adversely affect the N value as discussed in [X1.4](#). Drilling methods can have a major effect on testing (see [4.5](#)). While the SPT hammer system is standardized knowing ETR, drilling methods are not, and a variety of drilling methods can be used.

4.3 SPT is applicable to a wide range of soils. For nomenclature on soil in terms of N -value refer to [Appendix X2](#) for consistency of clays (cohesive soils) and relative density of sands (cohesionless soils) as proposed by Terzaghi and Peck and used commonly in geotechnical practice. SPT drilling can be performed easily using a variety of drilling methods in denser soils but has some difficulty in softer and looser soils. This test method is limited to non-lithified or un-cemented soils, and soils whose maximum particle size is approximately one-half of the sampler diameter or smaller. Large particles result in higher blow counts and may make the data unsuitable for empirical correlations with finer soils. For example, chamber tests on clean sands have shown coarse sands have higher blow counts than medium fine sands (see [X1.6](#)). In gravelly soils, with less than 20 % gravel, liquefaction investigations may require recording of penetration per blow in an attempt to extrapolate the results to sand blow counts (see [X1.7](#)). Soil deposits containing gravels, cobbles, or boulders typically

result in penetration refusal, damage to the equipment, and unreliable N values if gravel plugs the sampler.

4.3.1 *Sands*—SPT is widely used to determine the engineering properties of drained clean sands during penetration. Obtaining “intact” soil samples of clean sands for laboratory testing is difficult and expensive (see thin walled tube, Practice [D1587/D1587M](#)), so engineers use penetration results in sands for predicting engineering properties ([Appendix X1](#)). [Appendix X2](#) and [X1.6](#) provides some estimated properties of sands. There are problems with SPT in loose sands below the water table since they are unstable during drilling. Practice [D6066](#) provides restricted drilling methods for SPT in loose sands for evaluating earthquake liquefaction potential. Practice [D6066](#) method relies on mud rotary drilling, casing advancers, and fluid filled hollow-stem augers.

4.3.2 *Clays*—SPT is easy to perform in clays of medium to stiff consistency and higher using a variety of drilling methods. SPT is unreliable in soft to very soft clays because the clay, yields or “fails” under the static weight of the rods alone, or weight of rods and hammer before the test is started. This problem is accentuated by the heavier weights of automatic hammer assemblies (see [X1.3.1.4](#)) but can be alleviated with automatic hammers which are designed to float over the anvil (see [5.4.2.1](#)). There is such a large variation in possible N values in soft clays it is well accepted that SPT is a poor predictor of the undrained shear strength of clay. It is recommended to evaluate soft clays with more appropriate methods such as CPT (Test Method [D5778](#)), vane shear (Test Method [D2573/D2573M](#)), and/or Thin-Wall Tube sampling (Practice [D1587/D1587M](#)) and laboratory testing.

4.4 *Hammer Drop System*—SPT can be performed with a wide variety of hammer drop systems. Typical hammer systems are listed below in order of preference of use:

- (1) Hydraulic automatic chain cam/mechanical grip-release hammers
- (2) Mechanical trip donut hammers
- (3) Rope and cathead operated safety hammers
- (4) Rope and cathead operated donut hammers

4.4.1 Automatic and trip hammers are preferred for consistent energy during the test. Automatic chain cam hammers are also the safest because the hammer is enclosed, and the operators can stand away from the equipment. If the rope and cathead method is used, the enclosed safety hammer is safer than donut hammer because the impact anvil is enclosed. For more information on hammer systems, consult [X1.3](#).

4.5 *Drilling Methods*—The predominant drilling methods used for SPT are open hole fluid rotary drilling (Guide [D5783](#)) and hollow-stem auger drilling (Practice [D6151/D6151M](#)). Limited research has been done comparing these methods and their effects on SPT N values (see [X1.5.1.1](#)).

4.5.1 Research shows that open hole bentonite fluid rotary drilling is the most reliable method for most soils below the water table. Hollow-stem augers had problems with saturated loose sands since they must be kept full of fluid. The research also showed that driven casing using water as the drilling fluid, can adversely influence the SPT if the casing is driven close to the test depth interval. Use of casing combined with allowing a fluid imbalance also causes disturbances in sands below the



water table. Fluid filled rotary casing advancers (Guide [D6286](#)) are included as an allowable drilling method for loose sands in Practice [D6066](#).

4.5.2 SPT is used with other drilling methods including reverse circulation, sonic drilling, and direct push methods practices. There are concerns, undocumented by research, with direct push (Guide [D6282/D6282M](#)), sonic drilling (Practice [D6914/D6914M](#)), and reverse circulation methods using heavy casing drive hammers (Guide [D6286](#)), that the extreme dynamic loading and vibrations could disturb some soils such as sands and soft clays past the seating interval. The professional responsible for the investigation should evaluate SPT under these conditions and if drilling disturbance is suspected, then *N* values can be checked against other drilling methods in section 4.5 or deploy the alternate drilling method through and ahead of the casings.

4.5.3 SPT is also performed at shallow depths above the groundwater table using solid stem flight augers (Practice [D1452/D1452M](#)), but below the water table borings may be subject to caving sands. Solid stem borings have been drilled to depths of 100 ft or more in stable material.

4.5.4 SPT is rarely performed in cable tool or air rotary drilling.

4.6 *Planning, Execution, and Layout*—When SPT borings are used, often there are requirements for other companion borings or test holes to be located near or around the SPT boring. In general, borings should be no closer than 10 ft [3 m] at the surface for depths of up to 100 ft [30 m]. A minimum would be as close as 5 ft [2 m], but at this spacing, boreholes may meet if there is significant vertical deviation.

4.6.1 *Test Depth Increments*—Test intervals and locations are normally stipulated by the project engineer or geologist. Typical practice is to test at 5 ft [1.5 m] intervals or less in homogeneous strata. If a different soil type in the substratum is encountered, then a test is conducted as soon as the change is noted. It is recommended to clean out the borehole a minimum cleanout interval of at least 1 ft [0.25 m] past the termination point of the previous test depth between tests to assure test isolation and to check drill hole condition for the next test. Therefore, the closest spacing for typical practice of SPT is 2.5 ft [0.75 m]. The cleanout between test intervals can be adjusted by the user depending on borehole conditions and design data needs such as hard soils or thin strata. The practice of performing continuous SPT for *N*-value determination is not recommended but can be done with careful cleanout before testing. The borehole must be cleaned out between tests (see 6.5). At continuous spacing, with no additional cleanout depth, *N* values may be adversely affected by disturbance of previous sample driving especially in softer soils but the effect has not been known. Some practitioners like to overdrive the sampler an additional 0.5 ft [0.15 m] to gain additional soil sample for a total drive interval of 2.0 [0.6 m]. This is acceptable if the *N*-value remains the sum of the 0.5 to 1.0 ft [0.15 to 0.3 m] intervals of the drive interval and reasonable cleanout is performed between tests.

4.7 This test method provides a Class A and B soil samples according to Practice [D4220/D4220M](#) which is suitable for soil identification and classification (Practices [D2487](#) and [D2488](#)),

water content (Test Methods [D2216](#)), and specific gravity tests (Test Methods [D854](#)). The soil can be reconstituted for some advanced laboratory tests. The small-diameter, thick wall, drive sampler will not obtain a sample suitable for advanced laboratory tests such as those used for strength or compressibility from the core. Consult Guide [D6169/D6169M](#) for samplers that provide laboratory grade intact samples.

NOTE 1—The reliability of data and interpretations generated by this practice is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice [D3740](#) generally are considered capable of competent testing. Users of this practice are cautioned that compliance with Practice [D3740](#) does not assure reliable testing. Reliable testing depends on several factors and Practice [D3740](#) provides a means of evaluating some of these factors.

Practice [D3740](#) was developed for agencies engaged in the testing, inspection, or both, of soils and rock. As such, it is not totally applicable to agencies performing this field test. Users of this test method should recognize that the framework of Practice [D3740](#) is appropriate for evaluating the quality of an agency performing this test method. Currently, there is no known qualifying national authority that inspects agencies that perform this test method.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitable borehole before insertion of the sampler and ensures that the penetration test is performed on intact soil shall be acceptable. A suitable borehole is one in which the drilling indicates stable conditions at the base of the boring (see 6.2). In general the boring should have an diameter of 3 to 6 in. [75 to 150 mm] diameter. Borings greater than 6 in. [150 mm] inside diameter may result in lower blow counts and require a correction factor (see [X1.5.4](#)).

5.1.1 *Fluid Rotary Drilling Drill Bits*—Use side discharge or baffled bottom discharge bits to avoid jetting fluid disturbance in the base of the boring. The tricone roller bit baffles produce some downward discharge. If the deposit is fine grained, it is preferred to use a fishtail or drag bit with baffled discharge points to advance the boring. Wash boring chopping bits should not be used near the test zone.

5.1.2 *Hollow-Stem Augers*—The boring can be advanced either using a pilot bit or an interior sampling tube. When drilling below the water table in unstable sands, add water when retrieving the cleanout string and sampler to maintain water at or above the groundwater table depth. Two types of hollow-stem auger systems are used, either center rod or wireline type. The wireline system suffers from several problems when unstable soil such as sand gets inside the augers and the pilot bit will not latch. If the bit does not latch, the sand must be cleared, but often drillers will pull back the outer augers instead of cleaning causing further disturbance. For that reason, rod type systems are preferred in unstable soils.

5.2 *Sampling Rods*—Flush-joint steel drill rod shall be used to connect the split-barrel sampler to the drive-weight assembly. Drill rod mass per foot ranges from 4 lbm/ft [6 kg/m] to 8 lbm/ft [12 kg/m]. See [X1.4.3](#) for effects on energy in drill rods. If drill rods are longer than 100 ft [30 m], an energy correction may be needed to account for energy loss in long drill strings. *N* series drill rods are the maximum size allowed for the test (see [Note 2](#) and [X1.4.3](#)).

NOTE 2—In North America, drill rods specifications commonly used are

those from the Diamond Drill Core Manufacturers Association.⁷ The most common drill rods used are A series rods (A, AW, AWJ) of 1.75 in. [45 mm] outside diameter weighing about 4 lbm/ft [6 kg/m]. For depths greater than 75 ft [20 m] some publications recommend going to stiffer B or N size rod. Some agencies drill solely with N series rod which are about 2.63 in. [67 mm] O.D. and weigh about 8 lb/ft [11 kg/m].

5.3 Split-Barrel Sampler—The standard sampler dimensions are shown in Fig. 2. Samplers are made from steel and in most cases are hardened for durability. The split-barrel sampler must be equipped with a ball check and vent. The sampler has an outside diameter of 2.00 in. [51 mm]. The inside diameter of the shoe is 1.375 in. [35 mm]. The inside diameter of the split-barrel (dimension D in Fig. 2) can be either 1.5 in. [38 mm] or 1.375 in. [35 mm]. The upset portion of the split barrel may be equipped with liners making the inside diameter 1.375 in. [35 mm]. The length of the sampler should be at least 2 ft [0.6 m] such that it can accommodate the drive interval of 1.5 ft [0.45 m] plus 0.5 ft [0.15 m] of additional length of material. This split barrel sampler is also in conformance with Practice D3550/D3550M split barrel sampler specifications as shown in Appendix X1, X1.4.2.1, and Fig. X1.6.

5.3.1 Liners—Typical practice in the North America has been to use the upset wall sampler. The use of an upset wall improves recovery of the sample but has been shown to reduce friction especially in denser soils. International practice favors the original use of a constant inside diameter sampler. Limited research suggests that *N*-values may differ as much as 10 to 30

% between a constant inside diameter sampler which provides higher *N* values than the upset wall sampler and recommends that a correction may be required for soils with blow counts exceeding $N > 10$ (see X1.4.1). For liquefaction evaluations it is common practice to correct upset wall data to constant diameter using the procedures in X1.4.1.1. Report the type of sampler used, e.g., Liner or no Liners. Liners are usually steel, brass, or plastic and may be sectional and supplied with end caps for sealing. Report the type of liner used.

5.3.2 Drive Shoe—Drive shoes are made of steel and should be hardened for durability. The drive shoe shown on Fig. 2 is the standard for use in finer soils without gravels. Manufacturers do supply thicker more durable shoes for denser soils and where coarser soils are encountered (see X1.4.4). The thicker shoes are not in conformance with this standard. There is no research on the effect of shoe size/dimensions on *N* values. If thicker shoes are used, they should be noted.

5.3.3 Retainers—Various types of retainers are used for sandy soils which may be difficult to recover. These retainers cause a restriction to sample entrance and may affect the *N*-value. There is no available research on the effect of use of retainers on blow counts. If retainers are used, they should be reported.

5.3.4 Sampler Maintenance—The sampler must be clean at the beginning of each test and should be smooth and free of scars, indentations, and distortions. The driving shoe should be repaired and restored to specifications tolerances or replaced when it becomes dented, cracked, or distorted. Plugging of the vent ports and ball check system of the sampler results in

⁷ DCDMA Technical Manual, National Drilling Association, 6089 Frantz Rd. Suite 101, Dublin, Ohio 43017, 1991.

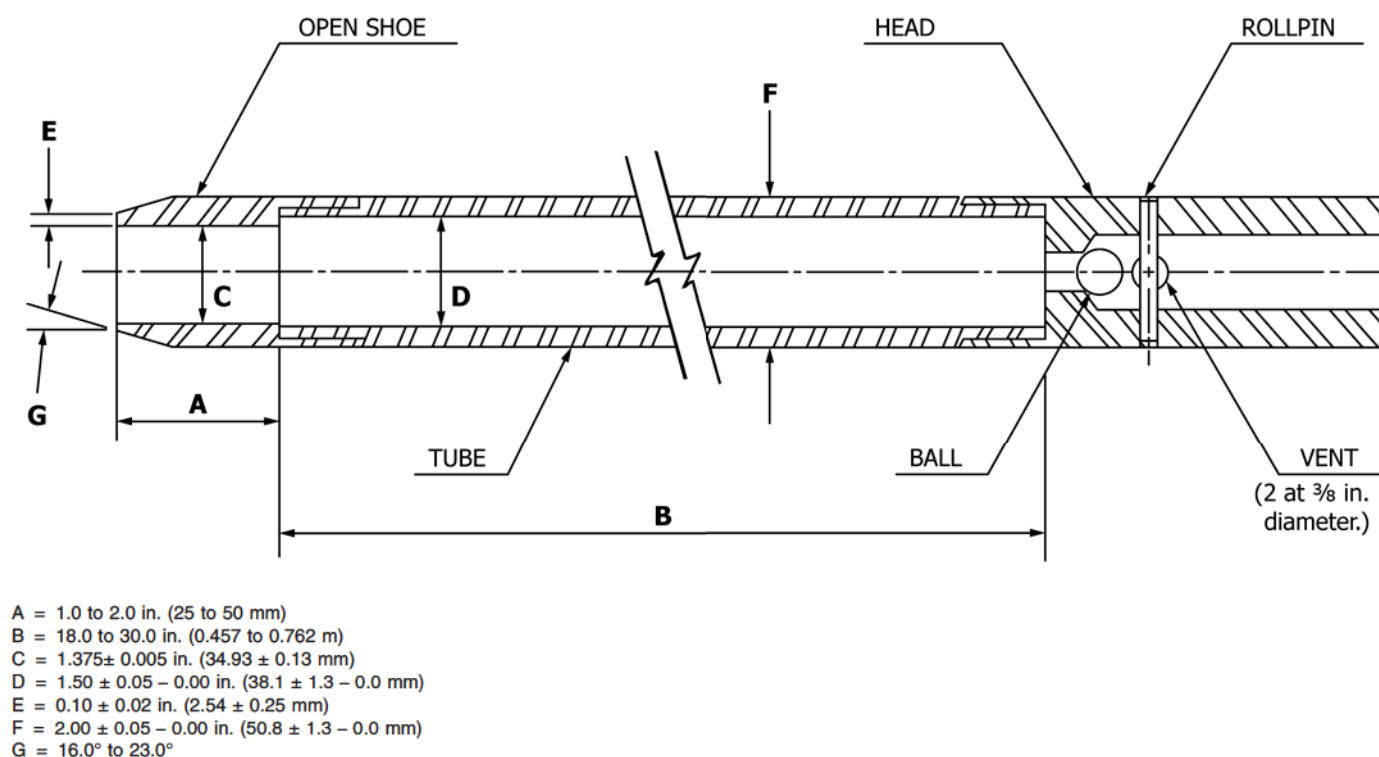


FIG. 2 Split-Barrel Sampler

unreliable penetration resistance values. Instances of vent port plugging must be noted on daily data sheets and reported in the boring log.

5.4 Hammer, Anvil, and Hammer Drop System:

5.4.1 Hammer and Anvil—The hammer shall weigh 140 ± 2 lbm [$63.5 \text{ kg} \pm 0.5 \text{ kg}$] and shall be a rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. The hammer drop system is to be designed to permit a constant and unimpeded vertical hammer fall of 30 in. [750 mm] on the impact anvil which is firmly connected by threaded connection to the top drill rods. The anvil acts as an energy damper, such that the transmitted energy through the drill rods is attenuated; therefore, the larger the anvil the lower the energy transmission. Special precautions should be taken to ensure that the energy of the falling mass is not significantly reduced by friction between the drive weight and guide system. Periodic inspection and maintenance (cleaning and lubrication) should be performed to avoid friction buildup and to check the hammer and assembly mass.

5.4.2 Hammer Drop Systems—Any hammer assembly that meets the requirements of 5.4.1 may be used for SPT. Various hammer assemblies as listed here and in section 4.4 may be used in order of preference. At a minimum, report the type and details of the hammer system being used. Many hammer systems have published information on their respective energy transfer or ETR. However, these should not be relied upon as manufacturers can change components during their production life. It is desirable that that actual hammer being used be tested for ETR within some reasonable time frame. If available, report the ETR or onsite measured ETR using Test Method D4633. Report any operational problems when conducting the test that may impact ETR. If using a previously calibrated hammer, check and report that the hammer drops heights and rates still comply with the calibrated condition. The total mass of the hammer assembly bearing on the drill rods can be changed to avoid sinking in soft clays (see X1.3.1.4).

5.4.2.1 Automatic Hammer—The typical automatic hammer finding widespread use in drilling today is an enclosed hydraulic motor operated chain cam hammer lifting system (Fig. 3). These hammers are safer and produce very reproducible drop heights or energy. These assemblies are often heavy and may add considerable static pressure to the test zone. Some hammer systems like the Diedrich or eSPT or others⁸ are designed to float over the impact anvil. Many of the automatic drop hammer systems are built on the drill and may be safely swung into position for testing but rest on the impact anvil. The drop height of 30 in. [750 mm] assumes the top of the anvil is fully inside the guide tube. If the hammer has an adjustable follower, the operator should avoid exerting extra pressure on the anvil (see X1.3.1.1). A chain cam automatic hammer should be

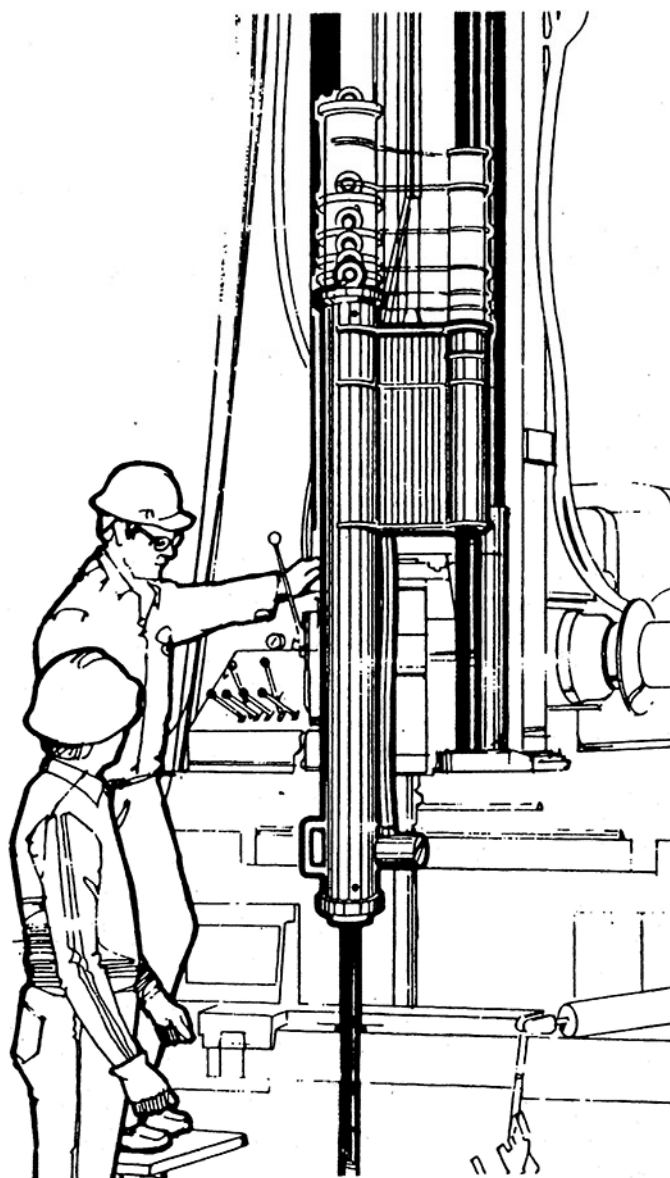


FIG. 3 Typical Hydraulic Automatic Hammer Drop System

equipped with a view slot on the guide tube to allow drop height checks although some automated systems may not require it. Heavy automatic hammers resting on the sampler may result in unreliable penetration test data in soft and very soft clays (see X1.3.1.4). The speed of a chain cam automatic hammer affects the drop height and consequently the energy transmission, ETR; therefore, the hammers must be routinely checked to be sure they are operating at the correct blow rate and drop height. The automatic hammer system should be adjusted to provide the desired blow rate and energy transmission for the project requirements prior to testing. If ETR data are not known, then adjust and operate the hammer to assure 30 in. [750 mm] drop height. If ETR is known, an automatic hammer may be adjusted to provide drop heights of less than 30 in. [750 mm] if the blow rate needs to be reduced from manufacturers design speed (see X1.3.1.2).

5.4.2.2 Mechanical Trip Donut Hammer Drop System—These hammer systems use fingers or pawls that grip a donut

⁸ The Diedrich (www.Diedrichdrill.com), and eSPT (www.marltechnologies.com) hammer systems and laser depth recorder PileTrac (www.piletrac.com) are known to the subcommittee D18.02 at this time with special characteristics cited in the text. If you are aware of alternative suppliers meeting these criteria or other special equipment, please provide this information to the subcommittee D18.02. Other hammer apparatus meeting these features can be added to the standard and will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

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hammer and release the hammer at the 30 in. [750 mm] drop height (Fig. 4). The fall guide is a central tube. This hammer is lifted with a rope and cathead but rope turns and cathead speed

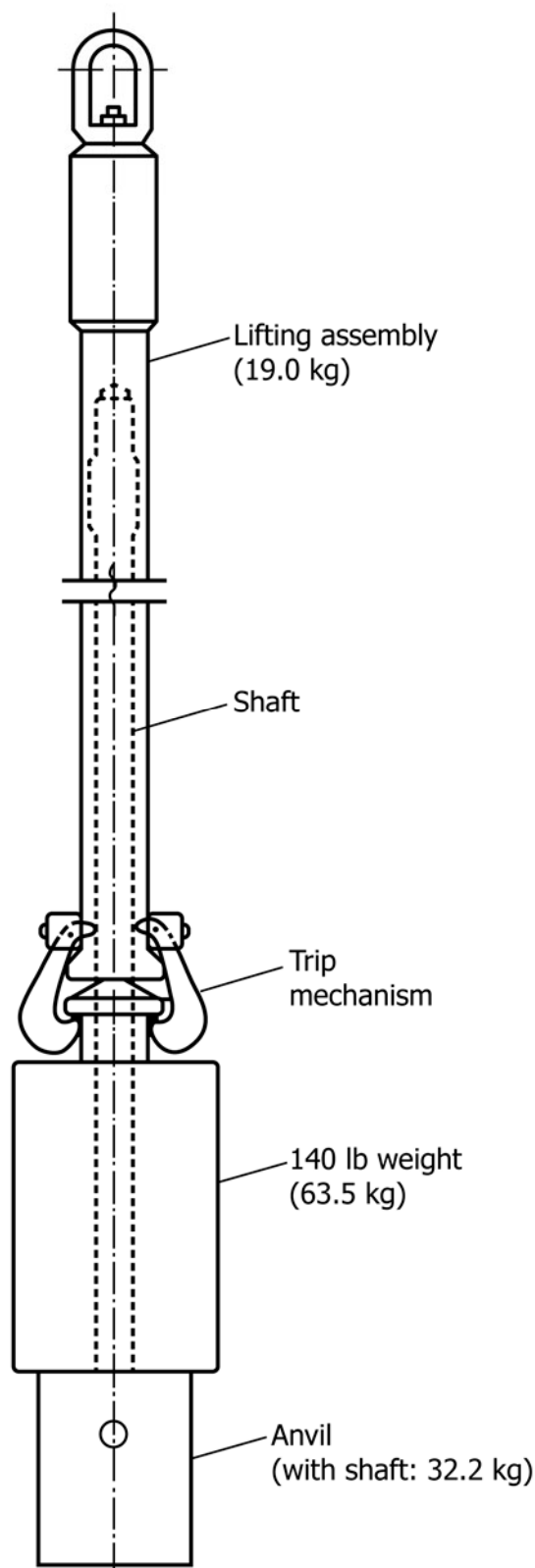


FIG. 4 Mechanical Automatic Trip Drop Donut Hammer System

do not significantly affect drop height. These hammers are often available internationally even where truck mounted drills are not used. They are not as safe as built in automatic hammers and must be hoisted and lowered using a cathead and the hammer anvil impact surface is exposed providing a dangerous pinch point. Some of these hammers have fairly large anvils which provide lower ETR. Safety problems include hoisting, lowering, cathead operation pinch points at the impact surface, and metal fragments which can come off the anvil.

5.4.2.3 Rope and Cathead Operated Safety Hammer—The safety hammer drop system shown on Fig. 5 is a long hammer assembly used on truck mounted drills in North America and was developed to enclose the impact surface for safer operation. This hammer system uses an operator cathead rope drop with two rope turns on the cathead. Since it is dependent on the operator, the energy transmission may vary between operators and single operator precision has a much larger variation than automatic hammers. The geometry is slender, with a small impact anvil, and ETR can be much higher than a donut hammer (see X1.3.3). In order to allow 30 in. [750 mm] drop height without back tapping, the hammer lift height should provide for an additional 3 to 4 in. [75 to 100 mm] of vertical lift. The hammer should have a mark on the fall guide tube, which is generally another section of A rod, so the operator can see the 30 in. [750 mm] drop height. Safety concerns include hoisting, lowering, and cathead operation.

5.4.2.4 Rope and Cathead Operated Donut Hammer—The donut hammer is the original design and the dimensions can vary widely (Fig. 5). Some countries have standardized dimensions of the hammer and anvil to maintain consistent energy transmission. This hammer system also uses an operator cathead rope drop with two rope turns on the cathead. Since it is dependent on the operator, the energy transmission may vary between operators and single operator precision has a much larger variation than automatic hammers. Donut hammer with large impact anvils generally have lower energy transmission ratios, ETR (see X1.3.4). Safety concerns include hoisting, lowering, cathead operation, pinch points at the impact surface, and metal fragments off the anvil.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2.5 Spooling Winch Hammer Systems—This hammer system uses an automated wireline spool behind the mast to lift a safety or donut hammer the prescribed 30 in. [750 mm] drop and then unwind at a computed free fall speed for the hammer system. Several published studies have shown these hammers do not perform well and often restrict the drop speed resulting in very low drill rod energy, ETR and resulting very high blow counts (see X1.3.5). These hammer systems should not be used unless their performance is checked onsite using energy measurements prescribed by Test Method D4633.

5.5 Accessory Equipment—Accessories such as labels, sample containers, data sheets, groundwater level, and SPT energy measuring devices shall be provided in accordance with the requirements of the project and other applicable ASTM standards.

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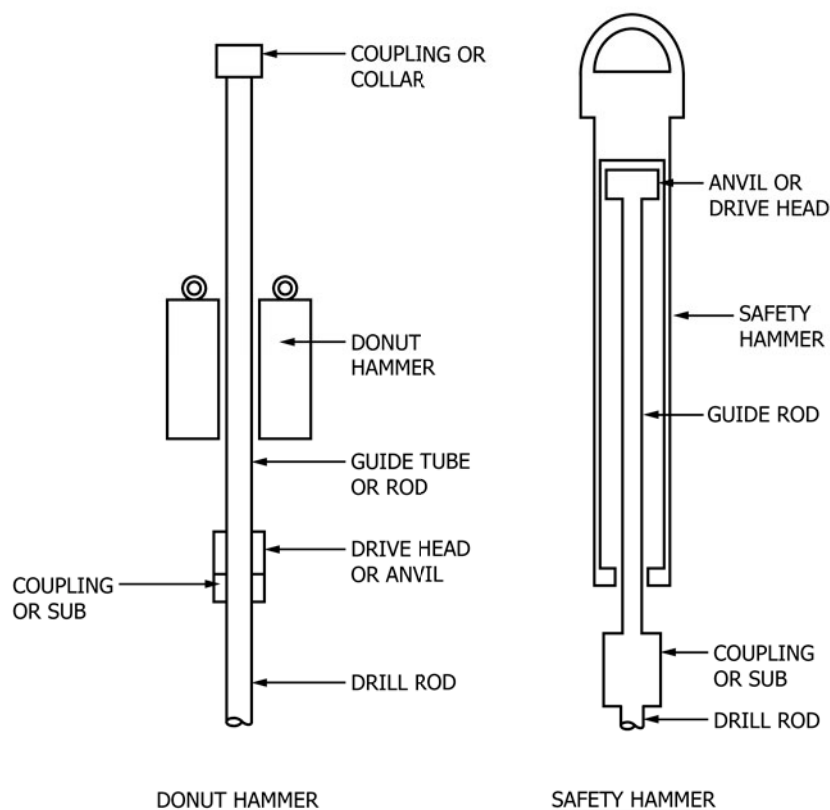


FIG. 5 Schematic Drawing of the Donut Hammer and Safety Hammer (see Note 3)

6. Drilling Procedure

6.1 The borehole shall be advanced incrementally to permit intermittent or continuous sampling. Record the depth of drilling to the nearest 0.1 ft [0.025 m] or better.

6.2 Any drilling procedure that provides a suitably clean and stable borehole before insertion of the sampler and assures that the penetration test is performed on essentially intact soil shall be acceptable. Stable borehole conditions are confirmed for each test by comparing the cleanout depths to sampler depths prior to tests and examining recovered soil cores. Each of the following procedures has proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used (see 4.5 and 5.1).

6.2.1 *Open-Hole Fluid Rotary Drilling Method (D5783).*

6.2.2 *Hollow-Stem Auger Method (D6151/D6151M).*

6.2.3 *Solid Stem Auger Method (D1452/D1452M)*—Open hole solid stem augers can be used to advance borings as long as the hole remains open, stable, and clean. These open uncased borings are subject to sloughing or caving of cohesionless soils below the water table and may not be suitable for those conditions. In stiff cohesive soils borings can often be extended below the water table. Typical diameter is 4 in. [100 mm].

6.2.4 *Fluid Rotary Casing Advancer (D5872/D5872M)*—Since this drilling method circulates fluids up the exterior annulus of the rotary casing, care must be taken to maintain fluid circulation (Practice D6066).

6.2.5 *Other Drilling Methods*, with concerns listed. It is the responsibility of the user (driller, site geologist/engineer) to examine the test conditions and evaluate if disturbance requires change of drilling method or procedures. Use of fluid rotary or hollow-stem auger drilling is recommended if there are serious concerns and a check boring is required. The other drilling methods have distinct issues with their usage:

6.2.5.1 *Wash Boring Method*—Wash borings are an older drilling method using pumped water to a chopping bit which is raised and lowered impacting the base of the boring and circulating the fluid and cuttings upward. Casing is also used to help keep the boring stabilized. This method has been listed previously in this procedure but is recognized as a jetting method, Section 12 of Guide D6286. Concerns with this method include jetting and impact disturbance in the base of the boring and disturbance caused by casing near the test zone. See X1.5.1.1 for research information on this method.

6.2.5.2 *Sonic Drilling (D6914/D6914M)*—Concerns with this drilling method include the strong vibrations produced which could influence and disturb sandy soils in the test zone. This method does not use drilling fluid and disturbance in sands below the water table can occur if fluid balance is not maintained during removal of the inner barrel. The advantage is the outer casing protect the borehole from caving. There is some preliminary research on effects of sonic drilling on SPT *N*-values which are currently inconclusive (see X1.5.3) pointing to a need to perform site specific checks with conventional drilling methods on effect on *N*-values if required.



6.2.5.3 Dual-Wall Reverse Circulation—If used with a casing hammer, this method could disturb sandy soils at the base of the boring. When drilling with air, circulation must be maintained as there is high risk of soil fracturing in the test zone. This method also provides continuous protective casing to stabilize the hole.

6.2.5.4 Direct Push Casings—SPT has been routinely used with larger diameter dual tube equipment without problems in many types of soils. The primary concern with this method is the hammer impacts disturbing sandy soils in the test zone below the water table. This affect can be mitigated by using a large diameter dual tube sampler in sampling mode (Guide [D6282/D6282M](#)) instead of driving with a center plug point. Fluid should be added in saturated sands during extraction of the inner tube. The outer dual tube stabilizes the boring for testing. There is some preliminary research on effects of Direct Push drilling on SPT *N*-values which are currently inconclusive (see [X1.5.3](#)) pointing to a need to perform site specific checks with conventional drilling methods on effect on *N*-values if required.

6.3 All drilling methods, to be successful, require the driller to advance the drill rate slow enough to ensure that the cuttings are removed, and circulation is maintained during the drilling process. If drilled too fast using fluids, the bit or hole may plug, the fluid circulation may be lost, and soil at the base of the boring may be hydraulically fractured. Report any major fluid losses.

6.4 Drilling Below Groundwater—The drilling fluid level within the borehole or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling. Numerous investigations and published data show adverse effects of allowing fluid levels to drop (see [X1.5.1](#)). If the site requires that casing be installed close to the test interval it is advised to keep it as far from the test zone as possible. When drilling in unstable saturated sands, the use of a bypass line is required to add fluid when removing the cleanout string to maintain the fluid balance. If soil heaves into a casing a considerable distance, there could be a large disturbed zone at the base of the boring. If this occurs, it must be reported. If sand is flowing into the casings, more viscous drill fluids may be required.

6.5 Several drilling methods produce unacceptable boreholes. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. Casing shall not be advanced below the sampling elevation prior to sampling. Advancing a borehole with bottom discharge bits is not permissible. It is not permissible to advance the borehole for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

7. Hammer Operating Procedures

7.1 The lifting and dropping of the 140 lbm [63.5 kg] hammer shall be accomplished using either of the following using automatic or rope and cathead methods. Drill rod energy transfer ETR can be measured according to procedures in Test Method [D4633](#) (see [4.2](#) and [Note 4](#)). For proper performance,

the hammer drop height (PE) and blow rate should be continuously monitored during testing and any deviations noted.

7.1.1 Automatic and Trip Hammers—By using a trip, automatic, or semi-automatic hammer drop system that lifts the 140 lbm [63.5 kg] hammer and allows it to drop 30 ± 1.0 in. [750 ± 30 mm] with limited frictional resistance. Check the drop height and blow count rate as required based on previous testing (see [5.4.2.1](#) and [X1.3.1](#)).

7.1.2 Rope and Cathead Method—By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.1.2.1 The cathead shall be essentially free of rust, oil, or grease with a diameter in the range of 6 to 10 in. [150 to 250 mm]. The mast should only have two well lubricated crown sheaves for the rope. A third crown sheave could reduce ETR.

7.1.2.2 The cathead should be operated at a speed of rotation of about 100 RPM.

7.1.2.3 The operator should generally use either 1- $\frac{3}{4}$ or 2- $\frac{1}{4}$ rope turns on the cathead, depending if the rope comes off the top (1- $\frac{3}{4}$ turns for counterclockwise rotation) or the bottom (2- $\frac{1}{4}$ turns for clockwise rotation) of the cathead during the penetration test, as shown in [Fig. 1](#). It is generally accepted that 2- $\frac{3}{4}$ or more rope turns impede the fall of the hammer and should not be permitted. The cathead rope should be relatively dry, clean, and should be replaced when it becomes excessively frayed, oily, or burned.

7.1.2.4 For each hammer blow, a 30 in. [750 mm] lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke. If the hammer drop height is not 30 ± 1.0 in. [750 ± 30 mm], then record the actual drop heights used.

NOTE 4—Test Method [D4633](#) provides information on making energy measurement for variable drop heights and Practice [D6066](#) provides information on adjustment of the *N*-value to a constant energy level (60 % of theoretical, N_{60}). Practice [D6066](#) allows the hammer drop height to be adjusted to provide 60 % energy.

8. Sampling and Testing Procedure

8.1 After the borehole has been advanced to the desired sampling elevation and excessive cuttings have been removed, record the cleanout depth to the nearest 0.1 ft [0.025 m], and prepare for the test with the following sequence of operations:

8.1.1 Attach the split-barrel sampler to the sampling rods and lower into the bottom of the borehole. Do not allow the sampler and rods to drop onto the soil to be sampled. Record the sampling start depth to the nearest 0.1 ft [0.025 m] or better. If the sampler penetrates past the cleanout depth record the partial penetration prior to driving.

8.1.2 Attach the anvil and hammer assembly to the top of the drill rods and rest the dead weight of the sampler, rods, anvil, and hammer on the bottom of the borehole. Compare the sampling start depth to the cleanout depth in [8.1](#). If excessive cuttings are encountered at the bottom of the borehole, remove the sampler and sampling rods from the borehole and remove the cuttings. See section [8.2.5](#) if the sampler begins to settle under the weight of rods, or rod and hammer.



8.1.3 Mark the drill rods in three successive 0.5 ft [0.15 m] increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 0.5 ft [0.15 m] increments. If the penetration is known from the hammer system, i.e., Diedrich hammer or recorded using automated methods such as the eSPT system, or laser depth recorder (PileTrac)⁸, the rods do not need to be marked, however, the marks can be used as a visual check. Record any hammer drops not meeting project requirements regarding fall heights, changes in hammer speed, or pauses during testing (Note 5).

8.2 Drive the sampler with blows from the 140 lbm [63.5 kg] hammer using procedures in Section 7 and count the number of blows for each 0.5 ft (0.15 m) increment until one of the following occurs:

8.2.1 A total of 50 blows during any one of the three 0.5 ft [0.15 m] increments described in 8.1.3.

8.2.2 A total of 100 blows have been applied.

8.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer. For automated systems an advance of less than 0.1 in. [2 mm] per blow can be considered refusal.

8.2.4 The sampler is advanced the entire 1.5 ft [0.45 m] without the limiting blow counts occurring as described in 8.2.1, 8.2.2, or 8.2.3.

8.2.5 If the sampler sinks under the weight of the hammer, weight of rods, or both, record the length of travel to the nearest 0.1 ft [0.025 m], and drive the sampler through the remainder of the test interval. If the sampler sinks the entire interval, stop the penetration, remove the sampler and sampling rods from the borehole, and advance the borehole through the very soft or very loose materials to the next sampling depth. Record the *N*-value as either weight of hammer, weight of rods, or both.

8.3 Record the number of blows (*N*) required to advance the sampler each 0.5 ft [0.15 m] of penetration or fraction thereof. The first 0.5 ft [0.15 m] is the seating drive. The sum of the number of blows required for the second and third 0.5 ft [0.15 m] of penetration is termed the “standard penetration resistance,” or “*N*-value.” If the sampler is driven less than 1.5 ft [0.45 m], as permitted in 8.2.1, 8.2.2, or 8.2.3, the number of blows per each complete 0.5 ft [0.15 m] increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 0.1 ft [0.025 m] or better in addition to the number of blows (Note 5).

NOTE 5—Often, liquefaction studies require recording of penetration per blow in gravelly soils as described in X1.7. For those cases, automated recording is desirable because the practice of hand marking the drill rods is hazardous and data recording is cumbersome. For latest automated hammer systems, the penetration per blow can be continuously recorded and the blow counts for each increment computed from the data. An example is the eSPT hammer system that uses terms of n_1 , n_2 , n_3 , to specify the penetration increments and the *N*-value is the sum of n_2 and n_3 . Another continuous depth recorder, PileTrac (www.piletrac.com), can also automate collection of penetration per blow data using exterior placed laser distance sensor.

8.4 Retrieve the sampler and open. Record the percent recovery to the nearest 5 % or the length of sample recovered to the nearest 0.1 ft [0.025 m] or better. Classify the soil

samples recovered in accordance with Practice D2488, then place one or more representative portions of the sample into sealable moisture-proof containers (ziplock bags or jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of moisture. Affix labels to the containers bearing job designation, boring number, sample depth. . Protect the samples against extreme temperature fluctuation . If there is a soil change within the sampler, use a container for each stratum and note its location in the sampler barrel. Samples should be preserved and transported in accordance with Practice D4220/D4220M using Group B.

8.5 *Borehole Completion and Sealing*—Information on the sealing of boreholes and installations can be found in Guides D5782, D5783, and D5784/D5784M for drilling methods and in Practice D5092, and Guide D5299 for wells. Local regulating agencies or organizations may control both the method and the materials required for borehole sealing. The use of low solids content bentonite slurry should not be used in the unsaturated zones (Practice D5092).

8.6 *Equipment Decontamination*—Often is required to clean the drill rig and equipment prior to and after investigation at a specific site. Practice D5088 should be used if the investigation and sampling equipment require decontamination for environmental investigations.

9. Report: Test Data Sheet(s)/Form(s)

9.1 The methodology used to specify how data are recorded is covered in section 1.8.

9.2 Record as a minimum the following general information (data) Data obtained in each borehole shall be recorded in accordance with the Subsurface Logging Guide D5434 as required by the exploration program. An example of a sample data sheet is included in Appendix X3.

9.3 Drilling information shall be recorded in the field and shall include the following:

9.3.1 Name and location of job,

9.3.2 Names of driller, crew and logger,

9.3.3 Type and make of drilling machine,

9.3.4 Weather conditions,

9.3.5 Date and time of start and finish of borehole,

9.3.6 Boring number and location (station and coordinates, if available and applicable),

9.3.7 Surface elevation, if available,

9.3.8 Method of drilling and advancing and cleaning the borehole,

9.3.9 Method of keeping borehole open, fluid circulation rates and losses,

9.3.10 Depth of water surface to the nearest 0.1 ft [0.025 m] and drilling depth to the nearest 0.1 ft [0.025 m] or better at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

9.3.11 Location of strata changes, to the nearest 0.5 ft [0.15 m] or better,

9.3.12 Size of casing, depth of cased portion of borehole to the nearest 0.1 ft [0.025 m] or better,

9.3.13 Hammer system used including notes on configuration, blow count rates, and drop heights for driving

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the sampler. Report drop heights not meeting 30 in. [750 mm] requirements or other factors affecting required drop heights or drop speed during a particular test (ETR),

9.3.14 Sampler length and inside diameter of barrel, no liner, or liner and liner type if used, shoe type, and if a sample basket retainer is used, occurrence of plugged vent ports,

9.3.15 Size, type, and section length of the sampling rods, and

9.3.16 Remarks.

9.4 *Sample Data*—Data obtained for each sample shall be recorded in the field and shall include the following:

9.4.1 Top of cleanout depth to the nearest 0.1 ft [0.025 m] or better, and any occurrence of excessive heave,

9.4.2 Top of sample depth to the nearest 0.1 ft [0.025 m] or better, and, if utilized, the sample number, report any sinking of the sampler under weight of rods, or rods and hammer.

9.4.3 Strata changes within sample,

9.4.4 Sampler penetration and recovery lengths to the nearest 0.1 ft [0.025 m] or better, and

9.4.5 Number of blows per 0.5 ft [0.15 m] or partial increment (see 8.2.1 – 8.2.3).

9.4.6 Report the N -value rounded to the nearest whole number.

9.5 *Hammer Energy Data (optional)*—If the energy ratio (ETR) of the hammer system is known from previous measurements, report the data and how and when the data were obtained. Alternately, if an assumed value is used, report the basis for such based on the type of hammer and operation. For any hammer that has had previous past measurement and is currently being used, report the most recent date of measurement. Report hammer drop heights and blow rates to confirm hammer performance. If energy measurements are performed onsite during testing, report the energy data with locations and frequency on drill logs or in the report. Rope and Cathead hammers are operator dependent, so the operator should be identified.

9.5.1 N_{60} values calculated in Practice D6066 may also be reported. However never place N_{60} corrected data solely on the boring log. The log shall contain only the measured N values or both.

9.5.2 Report calculated N_{60} values to the nearest whole number.

9.6 Record as a minimum the following sampling data, regarding significant digits (see 1.8) as follows:

9.6.1 Report SPT N values to the nearest whole number.

9.6.2 Record all drilling and sampling measurements to the nearest 0.1 ft [0.025 m] or better.

9.6.3 *Sampling*—Report depth interval sampled, sample recovery lengths to the nearest 0.1 ft [0.025 m] or better.

9.6.4 *Recovery*, to the nearest five percent.

9.6.5 *In Situ testing*—Report the depths and types of in situ tests performed. For devices which were inserted below the base of the drill hole, report the depths below the base of the hole to the nearest 0.1 ft [0.025 m] or better, and any unusual conditions during testing.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible, or too costly at this time to have ten or more agencies participate in an in situ testing program at a given site.

10.1.1 Subcommittee 18.02 is seeking additional data from the users of this test method to provide a limited statement on precision. Present knowledge indicates the following:

10.1.1.1 Variations in N -values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent boreholes in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, N -values in the same soil can be reproduced with a coefficient of variation of about 10 %.

10.1.1.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in N -values obtained between operator-drill rig systems.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 blow count; in-situ test; N -value; penetration resistance; soil; split-barrel sampling; SPT; standard penetration test

APPENDIXES

(Nonmandatory Information)

X1. SPT GUIDANCE ON METHODS AND EQUIPMENT

X1.1 History

X1.1.1 The International Society for Soil Mechanics and Foundation Engineering published a review of SPT on an



international scale in 1988 (1).⁹ SPT started in the 1920's when pile driving companies started using wash boring methods, standard metal pipe, and different samplers driven by a hammer. ASTM first published a recommended procedure in 1958 and in 1967 a standard was adopted. Additional references (2, 3) provide more history. Rodgers reports history of both SPT and Cone Penetration Testing (CPT) (Test Method D5778) in reference (4). CPT can be more reliable than SPT because it does not suffer from drilling disturbance problems and mechanical variables in the SPT; however, there is no soil sample.

X1.2 Energy Measurements and Hammer Systems

X1.2.1 In the 1970's Schmertmann and Palacios began testing the SPT energy transmission effects and found some significant problems with the hammer designs, the test equipment, and drilling procedures. Table X1.1 is from a 1978 paper postulating the effects from energy measurements and hammer systems and other test variables on the SPT N -value (5). This table shows some of the factors which since that time many have been further researched, so these numbers are estimates which have now been refined. Energy measurements were collected using force transducers up until the 1990's (5, 6, 7). In 1985 it was decided that SPT data should be corrected for energy to a 60 % level of PE (8, 9). Energy measurement methods switched from force transducers to also adding the use of accelerometers for velocity in the Force-Velocity method in Test Method D4633 in 2005 (10). Since that time there have been numerous publications on hammer types and energy measurements. It has now become common practice for high level quality assurance projects, to measure the ETR of the particular hammer system and use corrected N_{60} values for design purposes (Practice D6066).

⁹ The boldface numbers in parentheses refer to the list of references at the end of this standard.

X1.2.2 Refer to Test Method D4633 on how to measure drill rod energy transmission and note that Practice D6066 requires energy measurements for liquefaction evaluations. The requirements for measuring energy depend on the project requirements. Some operators calibrate hammers annually or based on frequency of use. Automatic hammers when operated at a constant speed deliver very consistent energy so calibration frequency can be reduced as long as the operation rate is checked. New automatic hammers are being designed to constantly monitor the drop height (e.g., eSPT system⁸). Projects requiring a high level of quality assurance should use automatic hammers and have them calibrated and documented for a particular test site.

X1.2.3 Rope and cathead operated hammers are also operator dependent and energy can vary widely. Certain drill rigs have features on cathead systems that impede free fall. The drill rig should have preferably only two crown sheaves. Drills with three crown sheaves have been shown to deliver lower energy, and subsequently higher N values. Field data have shown large variations in energy from extreme cold to warm weather effects on rope. The condition of the rope will also change the energy.

X1.3 Hammer Systems

NOTE X1.1—Below is a partial summary of some experience regarding the hammer systems listed in the standard.

X1.3.1 Automatic Hammer Systems:

X1.3.1.1 The typical hydraulically operated chain cam hammer system is highly reliable for delivering consistent ETR with a standard deviation of only 2 to 3 % during an individual test. A typical range of ETR is from 70 to 95 % of maximum PE. The hammers are blow rate dependent and for more information see (11). The original designers set a rate of about 50 blows per minute to throw the hammer slug 30 in. [750 mm] in the air. The 30 in. [750 mm] drop assumes the anvil top is fully inside the guide tube. To maintain the drop height the

TABLE X1.1 Factors Affecting the Variability of the Standard Penetration Test N (Schmertmann, 1978 (5)).

NOTE 1—Metric conversions: 1 ft = 0.3048 m; 1 in. = 2.54 cm.

Cause		Estimated % by Which Cause Can Change N
Basic	Detailed	
Effective stresses at bottom of borehole (sands)	1. Use drilling mud versus casing and water	+ 100%
	2. Use hollow-stem auger versus casing and water and allow head imbalance	+ 100%
	3. Small-diameter hole (3 in.) versus large diameter (18 in.)	50%
Dynamic energy reaching sampler (All Soils)	4. 2 to 3 turn rope-cathead versus free drop	+ 100%
	5. Large versus small anvil	+ 50%
	6. Length of rods Less than 10 ft	+ 50%
	30 to 80 ft	0%
	more than 100 ft	+ 10%
Sampler design	7. Variations in height drop	± 10%
	8. A-rods versus NW-rods	± 10%
	9. Larger ID for liners, but no liners	– 10% (sands) – 30% (insensitive clays)
Penetration interval	10. N_0 to 12 in. instead N_6 to 18 in.	– 15% (sands) – 30% (insensitive clays)
	11. N_{12} to 24 in. versus N_6 to 18 in.	+ 15% (sands) + 30% (insensitive clays)

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drop system must follow the anvil as penetration occurs. Different approaches have been made to accomplish this. Most hammers float in a carrier and permanently rest on the anvil exerting full mass. The Lift cylinder (Fig. X1.1) can be equipped with a double acting cylinder to maintain contact but in this case additional pressure is added to the rods. For the double acting cylinder, the operator can use a follower control on the cylinder but must be careful not to load the rods in soft material. The hydraulic motor speed can be adjusted with a Flow Control constrictor (see Fig. X1.1). Operators not familiar with the drill may allow the Flow Control (Fig. X1.1) to go off speed so it's important to check the blow rate of automatic hammers. They should always be operated at a constant Throttle Speed (Fig. X1.1) so the hydraulic supply pressure is constant. Once the hammer speed has been set, the hammer performance can be checked periodically by using the View Slot (Fig. X1.1) and the hammer can deliver consistent ETR if blow rate and speed are checked and constant during testing. There are now several different manufacturers of these hammer

systems and it is not known how much they vary in performance. New automatic hammer systems are being developed to continuously measure drop heights and penetration data such as the eSPT hammer.⁸

X1.3.1.2 The typical chain cam is operated at high speed of 50 to 55 BPM to achieve the 30 in. [750 mm] drop height using an anvil with a specific length inside the guide tube. These hammers achieve high energy but for those involved with liquefaction investigations (Practice D6066) the speed is faster than recommended 20 to 40 BPM (Seed, et., al. (8)). On most liquefaction sites the ETR is measured and the hammer than can be adjusted to give the desired speed or energy. For example, is you wish to slow the hammer to 40 BPM the hammer will not drop 30 inches. To maintain the drop height some have equipped the anvil with a spacer ring, so the anvil is lower inside the guide tube. In other cases, the rate is reduced to the desired speed and the lower ETR is used to correct the data to N_{60} . Another reason for slowing the hammer is to record penetration per blow in gravelly soils (see X1.7).

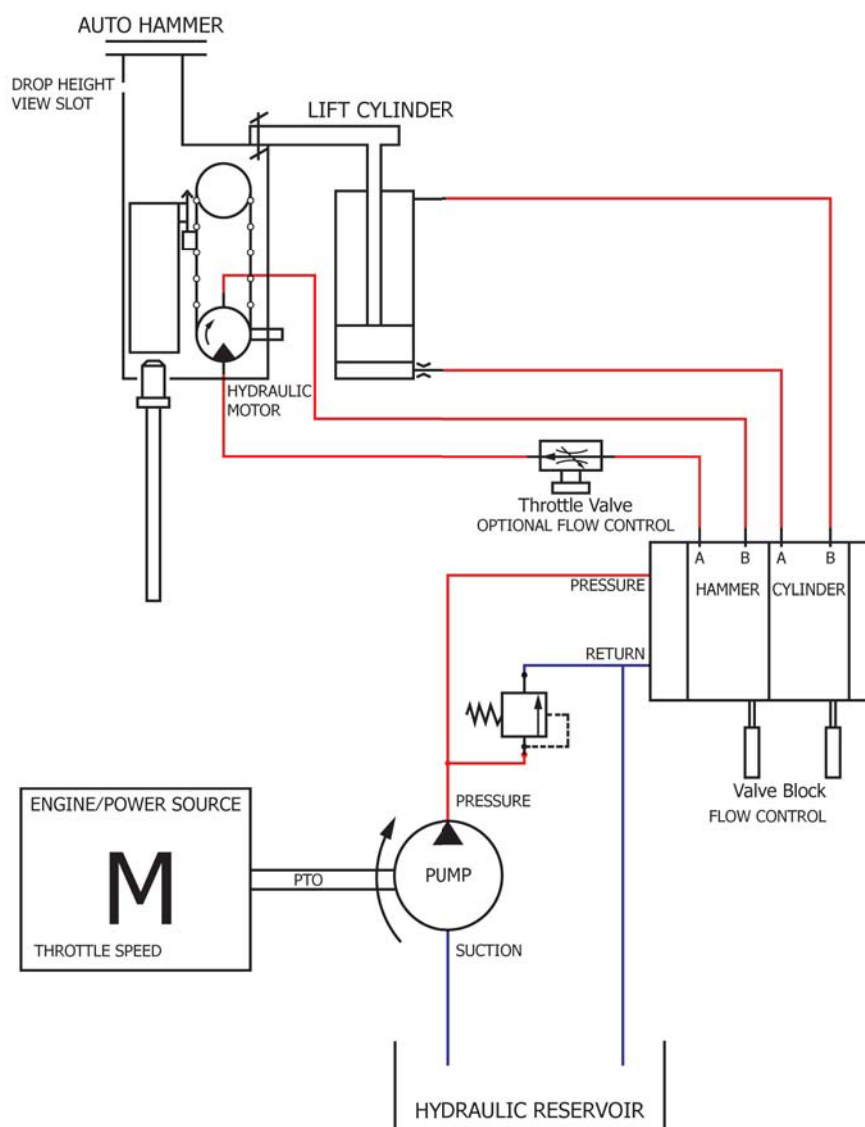


FIG. X1.1 Schematic of Hydraulic Motor Operation of Chain Cam Automatic Hammer System (courtesy MARL Technologies)

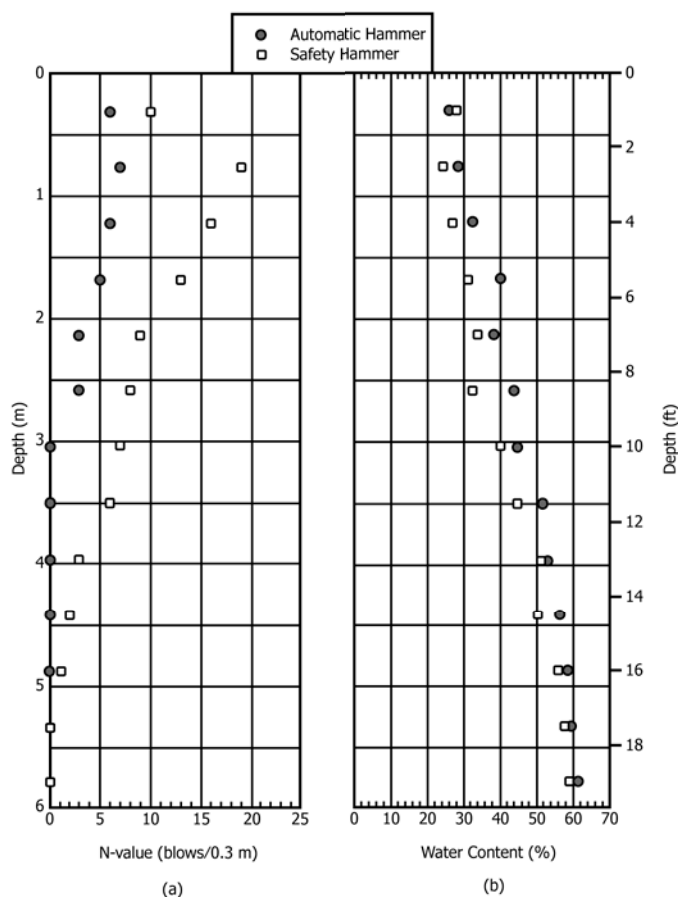
X1.3.1.3 A study of 32 automatic hammer systems was summarized by Biringen and Davie in 2008 (12) as part of major investigations for nuclear power plants. Their study also looked at previous automatic hammer studies from Utah DOT and Florida DOT. Although the hammer brands and blow rates were not reported, they found average ETR of automatic hammers averaged around 80 % with standard deviations of 6 to 8 %. Based on this and without any energy measurements they recommended a blanket correction factor of 1.24 to correct Nauto to N_{60} with that value being the lower bound standard deviation energy and thus a conservative correction factor. A more recent study of six CME automatic hammers of Alabama DOT resulted in an average ETR of 91 % and ranging from 82 to 96 % when operated near the design speed of 50 bpm (13).

X1.3.1.4 The automatic hammer systems impart considerable static mass to the rods and sampler prior to the test causing sinking under the weight of rods and hammer in soft clays. Fig. X1.2 by Luttenger and Kelley (1997) (14) shows dramatically the effect in clays. This affect does not occur in sands or denser materials. They observed that typical safety and donut hammers had masses of 150 to 220 lbm [70 to 100 kg] including the 140 lbm [63.5 kg] hammer mass while auto hammers had masses of 500 to 530 lbm [230 to 240 kg]. As

discussed section 4.3.2, the SPT is not reliable in soft clays and this example shows one of the primary reasons. Even a lighter safety hammer will sink through soft clays at depth due to the high rod weight from the longer drill string. For soft clays, alternate tests are recommended. If one must perform a check test of automatic hammers, use the mechanical trip or rope and cathead safety hammer or donut hammers. Their paper also shows a comparison of donut, safety, and automatic hammers at a sand site and show that energy correction worked well at that site and that all hammer systems are acceptable if the energy is known (Fig. X1.3). But for conditions where complete sinking occurs, N values are lost. Ideally, the hammer system should exert minimal additional weight on the rods and sampler. Some automatic hammer systems are made to float above the impact anvil using a guide tube and hydraulic lift such as the Diedrich and eSPT hammer systems. Luttenger and Kelley (14) did not test the floating Diedrich hammer although they list an assembly mass.

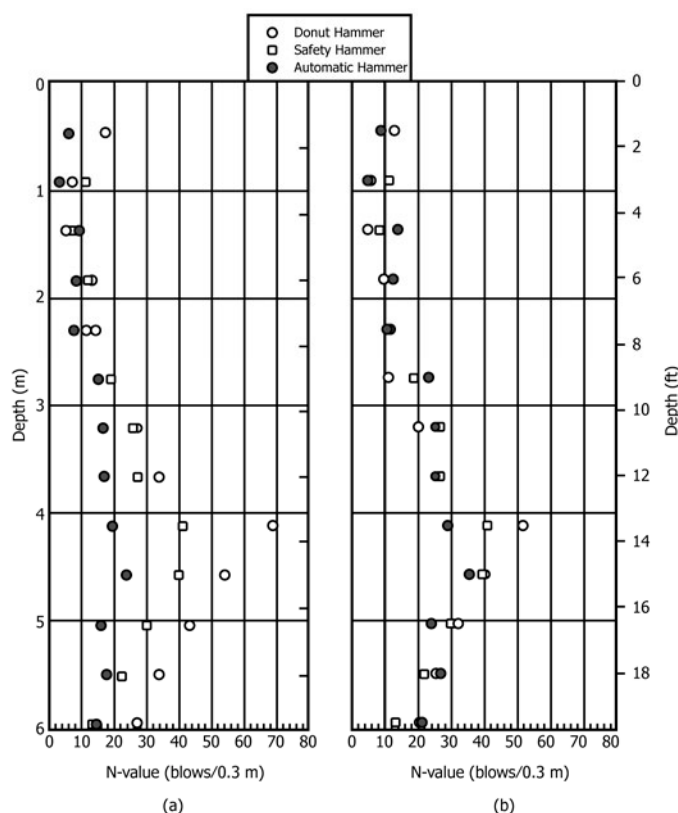
X1.3.2 Mechanical Trip Hammers:

X1.3.2.1 Mechanical Trip hammers are available in many countries. These trip hammers were reviewed by H. B. Seed (8) and summarized in Table X1.2 during the SPT review for liquefaction studies. Table X1.2 shows an effort to understand



**National Geotechnical Experimentation Site, Amherst,
Mass.: (a) Uncorrected Blow Count Data; (b) Water Content Data**

FIG. X1.2 Illustration of Automatic and Safety Hammer Data in Clays at the NGES Test Site (Luttenger and Kelley, 1997 (14))



Plattsburgh, N.Y., Sand Site: (a) Uncorrected Blow Count Data; (b) Corrected (N_{60}) Blow Count Data

FIG. X1.3 Comparison of Automatic, Safety and Donut Hammers at a Sand Site (a) Raw Data, (b) Corrected N_{60} Values (Lutenegger and Kelley, (14))

TABLE X1.2 Summary of Pilcon Mechanical Trip Hammer ETR (Seed, (8))

Study (1)	Hammer (2)	Energy Ratio (%) (3)
Decker, Holtz, and Kovacs (in press)	Pilcon	55
Douglas and Strutznsky (8)	Pilcon	62
Liang (29)	Pilcon-type	58
Overall average		60

the Chinese trip hammers which were similar to British Pilcon hammers. The ETR of these hammers depends on the hammer-anvil impedance ratio which means that larger anvils have lower energy transmission. There are quite few variations in design and some systems even have two impact anvils or built in anvil cushioning. The estimated ETR of the Chinese and British hammers was estimated at 60 % and that is due to the large anvil. Japanese Tombi trip hammers had 78 % energy transmission because the impact anvil is very small.

X1.3.3 Safety Hammers:

X1.3.3.1 Safety hammers found common use in North America in the 1970's as an improvement to donut hammers. The long assembly length could be accommodated on truck mounted drills. Kovacs and Salamone (7) measured numerous safety hammer systems and the average energy was 61 % and when efficiently operated run as high as 75 % ETR (15). These hammers have higher standard deviation of ETR during an

individual test, i.e., 5 to 10 %. Two rope turns, or wraps should be used on the cathead to operate the hammer. The energy transmission depends on the number of rope turns used on the cathead. Extra rope turns (wraps) can cause large energy transmission losses. Use of a new stiff rope can result in temporary increase of ETR until the rope has been broken in.

X1.3.4 Donut Hammers:

X1.3.4.1 The older Donut hammers have shown a wide variation of low energies ranging from 35 to 65 %. Once again, the ETR depends on the hammer anvil impedance ratio. Based on data from Kovacs, Seed estimated an average energy of these hammers at 45 % (8). Due to the large variation in ETR for these hammers it would be unwise to use an assumed value of ETR, so some kind of previous or on-site energy measurements (Test Method D4633) should be required for the hammer prior to its use. Some countries such as Japan use hammers with fixed hammer and anvil dimensions and there are considerable energy data available so that an assumed value could be used on small projects (Kovacs, Seed (7, 8)). As with the safety hammer, two rope turns, or wraps should be used on the cathead to operate the hammer. The energy transmission depends on the number of rope turns used on the cathead. Extra rope turns (wraps) can cause large energy transmission losses. Use of a new stiff rope can result in temporary increase of ETR until the rope has been broken in.

X1.3.5 Spooling Winch Hammers:

X1.3.5.1 Published data indicate the spooling mechanism can sometimes impede the free fall of the hammer resulting in very low energy measurements (15). Before using this test at any given site, the ETR must be measured to confirm proper operation. This hammer system should not be used if the ETR has not been checked.

X1.4 Mechanical Variables

X1.4.1 Sampler Split Barrel – Inside Diameter – Liners and No Liners:

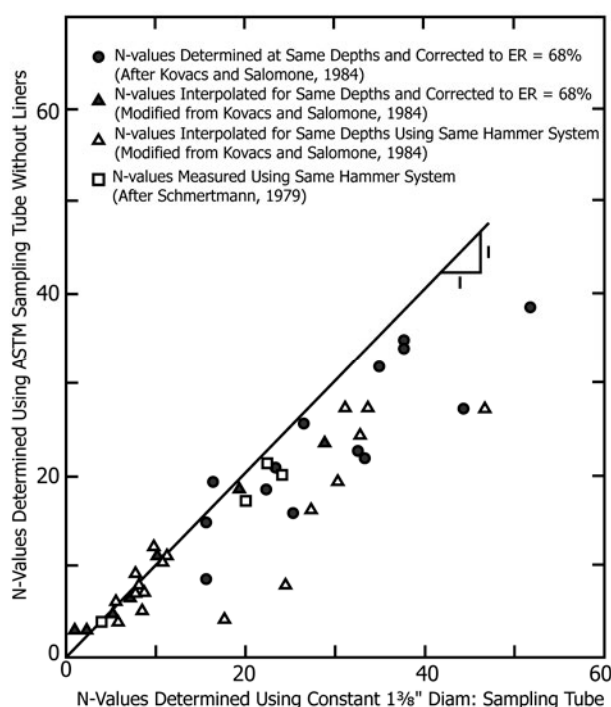
X1.4.1.1 There is limited research on the effects of the upset wall sampler barrel with and without liners. The available data were summarized by H.B Seed (8) and shown on Fig. X1.4 for liquefaction evaluation. The studies were predominantly done at sand sites. As would be expected, the differences are more pronounced in denser soils where internal friction buildup occurs in a constant wall diameter. Since the bulk of international data are collected with constant wall diameters, it is recommended that, for liquefaction studies, to correct for liners by EERI (16) a shown on Fig. X1.5. For most standard investigations the effect is minor for $N < 20$ and data are lacking for clay soils. Sample recovery is higher with upset wall split barrels due to reduced friction on the soil core.

X1.4.2 Sampler Design:

X1.4.2.1 The bulk of the samplers manufactured in North America are made to the Diamond Drill Core Manufacturers Association (DDCMA) specifications shown on Fig. X1.6 (17). These barrels have upset wall design.

X1.4.3 Drill Rod Type and Rod Length:

X1.4.3.1 There is no definitive research on the effect of A versus N size drill rods on N values. These sizes of rods should



Effect of Type of Sampling Tube on N-Value

FIG. X1.4 Comparison of Use of SPT Barrel With and Without Liners in Sands (Seed (8))

Standard split spoon without room for liners (the inside diameter is a constant 1 3/8 in.). $C_S = 1.0$.

Split-spoon sampler with room for liners but with the liners absent (this increases the inside diameter to 1 1/2 in. behind the driving shoe):

$$C_S = 1.1 \quad \text{for } (N_1)_{60} \leq 10$$

$$C_S = 1 + \frac{(N_1)_{60}}{100} \quad \text{for } 10 \leq (N_1)_{60} \leq 30$$

$$C_S = 1.3 \quad \text{for } (N_1)_{60} \geq 30$$

(from Seed et al. 1984, equation by Seed et al. 2001)

FIG. X1.5 Recommended Liner Correction for SPT in Sands for Liquefaction Evaluation (EERI (15))

transmit energy effectively to the sampler. If anything, the energy reaching the sampler would be less in N rods than smaller diameter A rods because of reflections and dispersion of the stress wave (strain energy) component in the rods with larger joint pins. There is no indication that a loose joint or rod whip and friction on the borehole wall cause significant reductions in energy flowing through the rods, however this can be noted if suspected. For general practice, the differences in drill rods and the losses from length in typical depth ranges up to 100 ft [30 m] are less than 5 % and can be ignored for most production testing. However, for liquefaction evaluations corrections are sometimes used for short length and longer rods as follows irrespective of rod type.

X1.4.3.2 Short Rod Lengths < 30 ft [10 m]—Early energy transmission research using the F2 method assumed sampler

penetration occurred primarily from the first big incident wave. Schmertmann proposed, in Table X1.1 for depths less than 30 ft [10 m] there could be some reduction in energy to the sampler because of termination of hammer contact by the reflected compression wave and reduction factors were applied for shallow blow counts. These corrections are still found today in some liquefaction guidelines (16). However, recently, researchers have argued that no reductions should be applied, and it was found that hammer anvil contact was maintained (18, 19). Part of these conclusions are due to the fact new ETR measurements use the FV method and include energy content of the first incident wave and subsequent smaller reflected pulses that occur past the first major stress pulse (see Test Method D4633, Appendix X1 and Odenbrecht et al., (20).

X1.4.3.3 Long Rod Lengths > 100 ft [30 m]—Besides the short rod corrections for liquefaction studies, there is also concern with energy losses of very long drill rods. Based on some early studies it was recommended that for borings of excess of 100 ft [30 m] one should reduce energy about 1 % for every 10 ft [3 m] (21). More recent energy measurements seem to confirm N rods lose energy at a greater rate compared to A rods and in some instances, the loss rate is greater (or efficiency is less) than previously expected (22, 23).

X1.4.4 Drive Shoes:

X1.4.4.1 As noted in the standard, manufacturers produce several types of drive shoes used for sampling. Fig. X1.7 shows shoes commonly used and only the sharper shoe to the left is made for sampling fine soils while the thicker, blunter, shoes are used in coarser and denser soils. Thicker shoes are not in conformance with section 5.3. There has been no known controlled study on the effects on N values between these different styles of drive shoes.

X1.5 Operational Variables

X1.5.1 Drilling Methods – Research on SPT and Drilling Methods:

X1.5.1.1 One of the early reports on drilling methods was Parsons (24) where he discovered poor SPT data in sands that were drilled with water below the water table. The results are summarized on Fig. X1.8. Although the drilling methods were not clearly described it was assumed that the low blow counts in sand were caused by the removal of the drill bit and a drop in borehole fluid causing sand to flow into the base of the boring. It is not clear how the casing was used or if they were rotary or wash borings. Check test holes were carefully drilled using auger and drilling mud to clear the test zone which resulted in very high blow counts in the dense sand.

X1.5.1.2 A study of mud rotary, hollow-stem augers, water fluid rotary drilling with driven casing was reported by Whited and Edil in 1986 (25). Thirty-six borings in differing geologic conditions in Wisconsin were conducted by transportation drill crews experienced with SPT. Hollow-stem auger borings were advanced with the pilot bit in-place and when below the water table drill fluid (Mud) was injected using a spindle adaptor. The water borings were advanced by driving the casing in 1.5 m increments while cleaning the casing with roller bit and clear water. The conclusions of the study were that the drilling methods had no effect on SPT in clay soils. The driven casing

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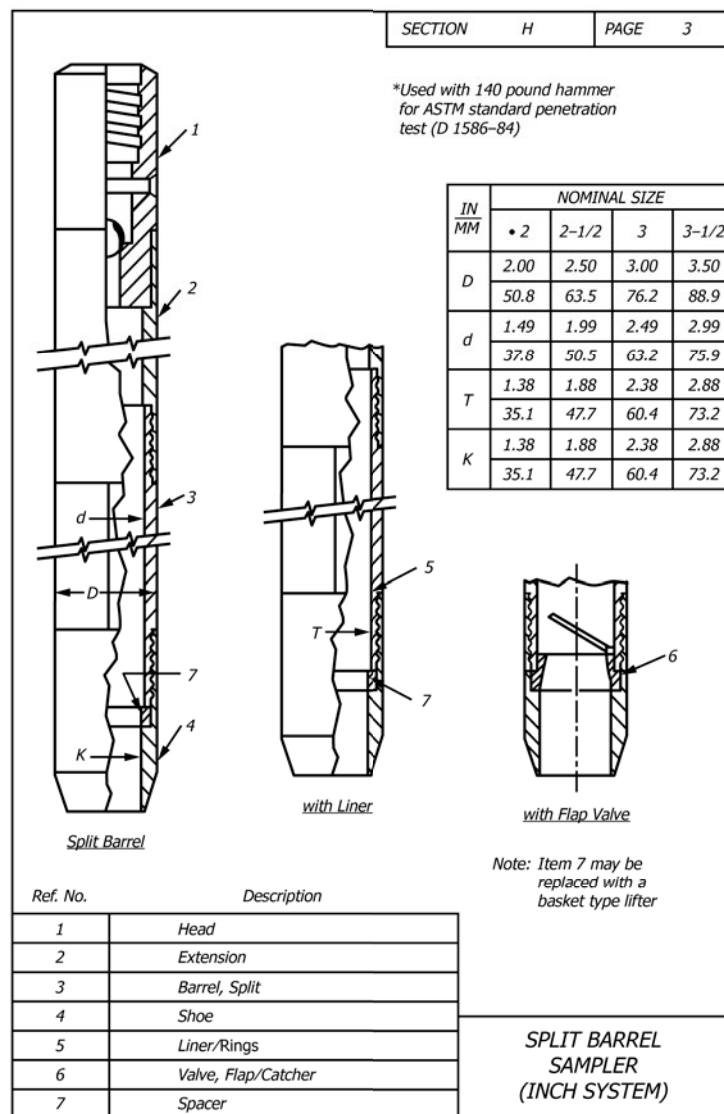


FIG. X1.6 DDCMA Split Barrel Design (17)

borings yielded high blow counts above the water table and lower blow counts below the water table in sands. This is due to suspected densification above the water table in sands and the focusing effect of groundwater seepage force at the base of the casing and sand disturbance by water imbalance by removing cleanout tools. The report does not mention if a bypass line is used to add fluid when drilling below the water table. There was some tendency for hollow-stem auger holes to record lower blow counts in sands below the water table. The important finding in this study is that driven casing should be kept away from the test zone.

X1.5.1.3 A study of mud rotary drilling and hollow-stem auger drilling was performed by Seed et al., (26) for purposes of investigating USGS blow count case history liquefaction database. The study focused on sands below the water table and all drilling methods use a fluid bypass to maintain the fluid levels at the top of the boring during removal of the cleanout string. Four different sites were investigated comparing 66 SPT drilled with water (in augers or casing) and 147 SPT drilled

with drill mud. The results indicated minimal differences in the two drilling methods. On Fig. X1.9 there was a trend of lower *N*-value with Hollow-stem versus mud rotary borings.

X1.5.1.4 These conclusions by Seed et al., (26) were worth quoting; "In either case it is clear that borehole fluid type (drilling mud or water) had no significant effect on penetration resistance so long as good drilling and sampling techniques are used, including prevention of hydraulic inflow at the base of the borehole." The purpose of the study was to prove careful hollow stem augering can be used, but the Fluid Rotary Drilling method using drill mud is considered to be the most reliable method and should be used as the reference test.

X1.5.2 Hollow-Stem Auger Type and Problems in Sands:

X1.5.2.1 There are two types of Hollow-stem Augers (Practice D6151/D6151M) the "Inner Rod" type and "Wireline" type. Both systems can be operated with a pilot bit or long inside sampling barrel and removal of these tools causes a suction effect in sands below the water table. In order to

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Drive samplers usually employ three types of cutting heads, or shoes, shown here. The sharp tapered heads are intended for soil sampling, while the more blunt tips are designed for greater longevity when sampling granular soils.

FIG. X1.7 SPT Drive Shoes for Fine and Coarse-Grained Soils (Rodgers, 2006 (4))

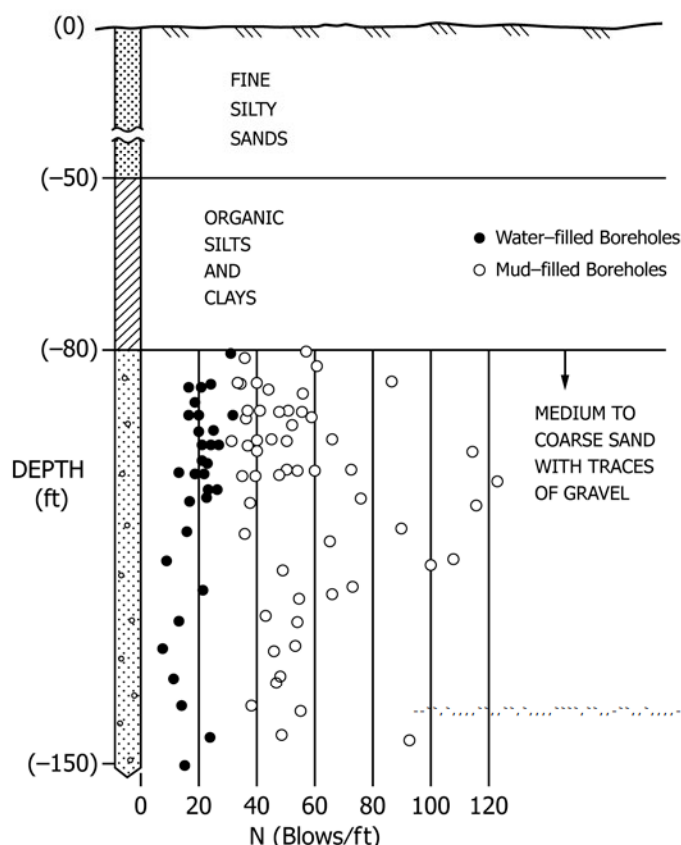


FIG. X1.8 Comparison of SPT Drilled With Water versus Drilling Fluid (Mud) (Parsons (24))

minimize disturbance to the test zone below the water table, the inner tube should be kept full of fluid and the barrel or bit removed slowly to reduce suction effect. The lesser used wireline systems have had many problems with sands below

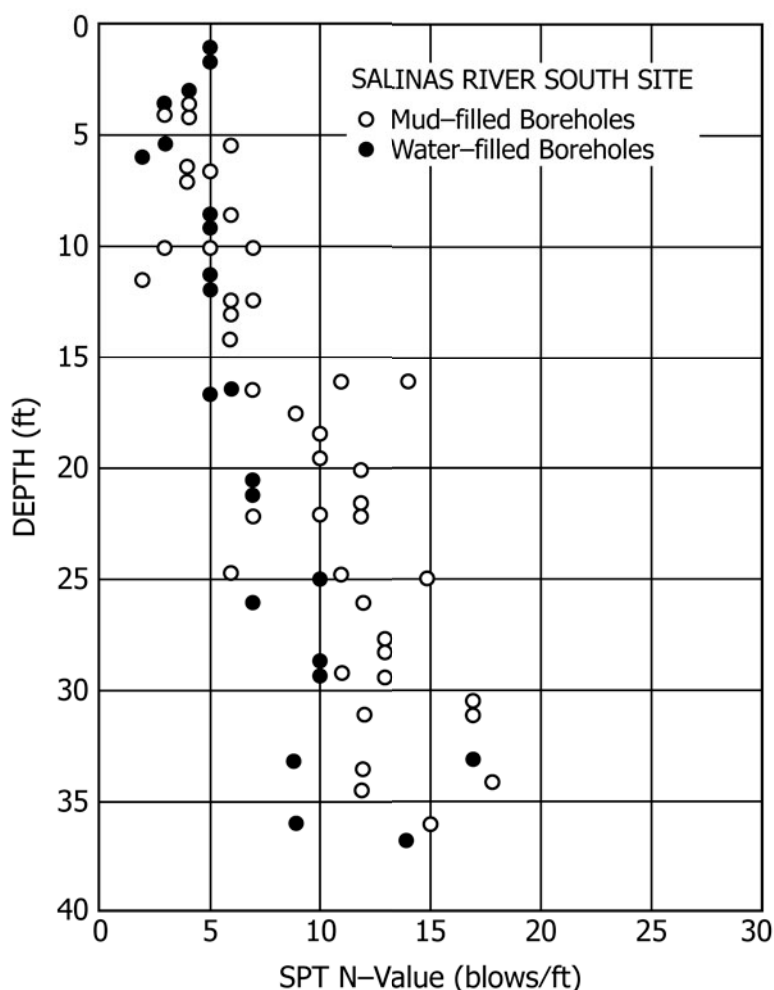
the water table because the bit or barrel is removed rapidly. When this happens and if sand flows into the barrel, it will not be able to re-latch. This may require that the whole auger string be pulled upward to clear the sand inside causing even more suction and disturbance in the bottom of the boring. Hollow-stem augers have also been advanced without an interior pilot bit, however, material may require cleaning if there are soils inside the augers. This can be checked by comparing the bit or barrel depth the SPT sampler depth.

X1.5.3 Sonic and Direct Push Drilling Methods:

X1.5.3.1 There is very limited information on comparison of SPT *N*-values from Sonic or Direct Push drilling methods but some studies are underway. One study on Sonic drilling by Wentz et al., (27) shows that there were negligible pore pressure increases in sands as close as 300 mm to casings but comparisons to conventional rotary drilling were inconclusive. A study by Wotherspoon et al., (28) compared numerous Sonic and Direct Push SPT *N*-values to *N* values predicted by CPT methods at a site in Canterbury, N.Z. showed that the drilling methods may be affecting soils with lower *N*-values and that site-specific correlations may be required. This points to a need to check site specific SPT *N*-values from these drilling methods to conventional methods such as the fluid rotary drilling or hollow stem auger drilling.

X1.5.4 Drill Hole Diameter:

X1.5.4.1 A Borehole diameter correction was proposed by Skempton (9) for use in liquefaction evaluation. He noted the majority of case history borings were 2.6 to 4 in. [65 to 100 mm] diameter but some borings as large as 8 in. [200 mm] are allowed for SPT. He proposed correction factors of 1.05 and 1.15 for 6 in. [150 mm] and 8 in. [200 mm] diameter borings, respectively. This standard specifies 3 to 6 in. [75 to 150 mm] borehole diameter. He stated that the size effect in clays was



-Data for Salinas River South Site.

FIG. X1.9 Comparison of Mud Rotary versus Hollow-Stem Augers at Salinas Site (Seed et al., (26))

probably negligible but that these correction factors are recommended of liquefaction potential in sands. He noted that there is no research on this topic and it is needed.

X1.6 Notes on Soil Types – Coarse Grained Soils

X1.6.1 Maximum Particle Size – Research on SPT in Sands:

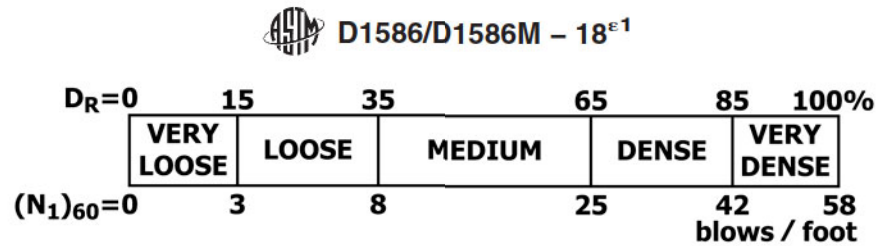
X1.6.1.1 The maximum particle size is listed in section 4.3 as $\frac{1}{2}$ the sampler diameter or smaller. Actually, the test is generally applicable to soils containing no gravels, soils with gravels, depending on the percentage will begin to artificially raise the blow count over non-gravel soils, and hence affect geotechnical engineering estimates based on SPT data.

X1.6.1.2 SPT chamber test research has been conducted for clean quartz sands by several agencies and the result were summarized by Jamiolkowski et al., (29) in 1988. Numerous field and chamber studies have been performed in an effort to correlate N and Relative Density as a function of effective overburden pressure. Actually, the ratio at which particle size begins to elevate blow count at a constant D_r and pressure is

approximately $\frac{1}{10}$ the diameter of the penetrometer or smaller. There were differences in coarse versus fine to medium sands tested by USACE in chambers (29). There are also data from field studies with coarser sands. Based on a review of the field and laboratory data, Skempton (9) proposed the following modification of Terzaghi's chart in Appendix X2 as follows on Fig. X1.10.

X1.7 Recording Penetration per Blow (PPB) in Gravelly Sands

X1.7.1 As outlined in the EERI publication on soil liquefaction (16) the presence of coarse particles in sands can interfere with obtaining usable SPT data for the sand matrix. Some agencies dealing with these soils, record PBB or penetration per 0.1 ft [0.025 m]. The goal is to extrapolate a reliable sand N -value as shown on Fig. X1.11(b). This method is only reliable for gravel contents of up to 15 to 20 %. For more information consult the EERI report.



- FOR $D_R \geq 35\%$ $\longrightarrow \frac{(N_1)_{60}}{D_R^2} \approx 60$
- FOR COARSE SANDS N_{SPT} SHOULD BE REDUCED
IN THE RATIO $\frac{55}{60}$
- FOR FINE SANDS N_{SPT} SHOULD BE INCREASED
IN THE RATIO $\frac{65}{60}$

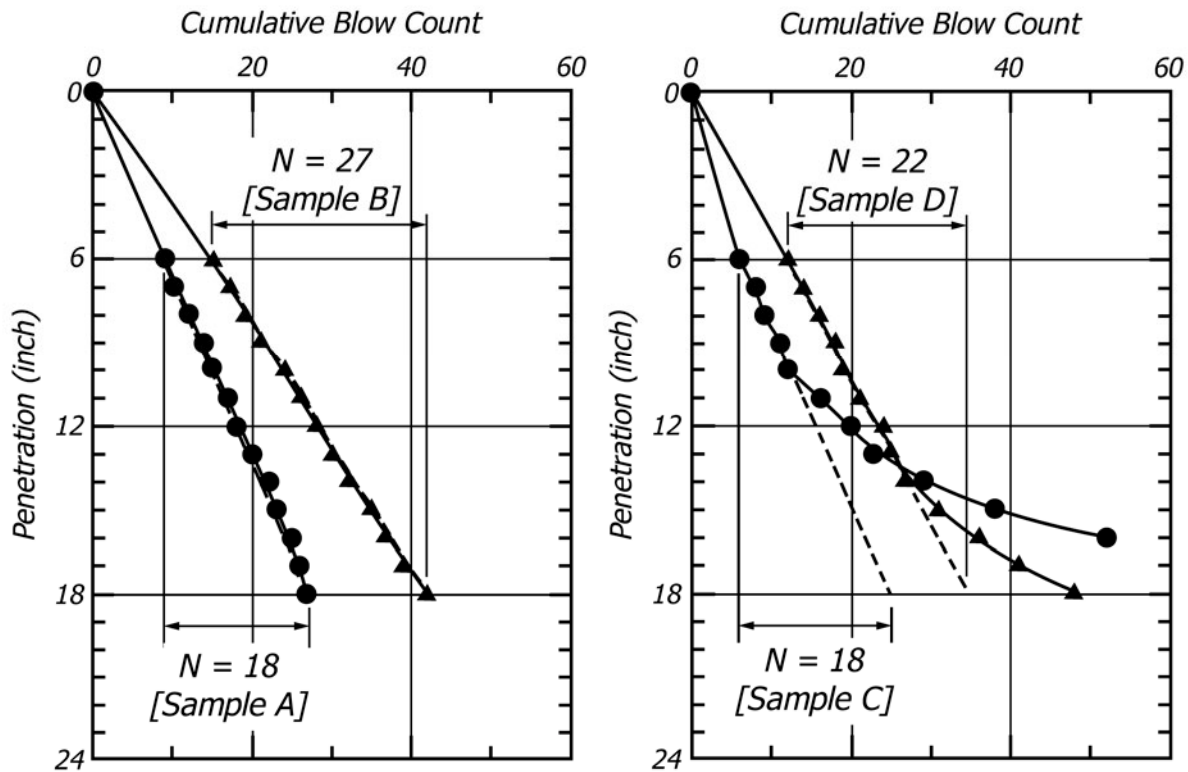
Revised Terzaghi-Peck classification
(1948) for NC sands
(Adapted from Skempton, 1986)

FIG. X1.10 Revised Classification and Estimated Relative Density of Sands Considering Differences Between Coarse and Medium to Fine Sands (Skempton (9))

X1.7.2 Use of automated systems that have laser distance recorders (PileTrac) or system like the new automated eSPT hammers greatly facilitate recording and post processing of data and reduce errors (see 8.3 and Note 5). Recording by hand

can be done but requires a third person recorder or hand marking on drill rods which is hazardous. Manual recording must be input into spreadsheets.

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Examples of interpreting SPT blow counts on a per-inch basis:
 (a) smooth driving patterns that do not require corrections to N values and
 (b) strong increases in driving resistance that, along with sample recoveries, suggest that the sampler encountered large particles; this graph also shows the adjusted N value, based on extrapolating the pre-obstruction driving rate.

FIG. X1.11 EERI Example of Recording Penetration per Blow in Sands (16).

X2. SOIL CONSISTENCY DESCRIPTORS

X2.1 The standard uses consistency descriptors in discussion of drilling and sampling of soils. Fig. X2.1 are two tables extracted from Terzaghi and Peck, *Soil Mechanics in Engineering Practice*, second edition, 1967, Wiley & Sons. These two

tables provide SPT N values from this standard and the corresponding basic soils consistency descriptors for clays and sands.

Figure X2.1 consists of two tables, (a) and (b), which provide SPT N values and corresponding basic soils consistency descriptors for clays and sands. The tables are extracted from Terzaghi and Peck, *Soil Mechanics in Engineering Practice*, second edition, 1967, Wiley & Sons.



D1586/D1586M – 18^{ε1}

Relation of Consistency of Clay, Number of Blows N on Sampling Spoon, and Unconfined Compressive Strength

q_u in tons/ ft ²						
Consistency	Very Soft	Soft	Medium	Stiff	Very Stiff	Hard
N	< 2	2–4	4–8	8–15	15–30	> 30
q_u	< 0.25	0.25–0.50	0.50–1.00	1.00–2.00	2.00–4.00	> 4.00

Relative Density of Sands according to Results of Standard Penetration Test

No. of Blows N	Relative Density
0–4	Very loose
4–10	Loose
10–30	Medium
30–50	Dense
Over 50	Very dense

FIG. X2.1 Terzaghi and Peck Descriptors of Soil from SPT N Values

X3. EXAMPLE DATA SHEET

X3.1 See Fig. X3.1.

D1586/D1586M – 18^{e1}

PENETRATION RESISTANCE DAILY DATA													
PROJECT Example			FEATURE Example				HOLE NO. DH-502						
GROUND ELEVATION 6750.5 ft.					LOCATION 200' D/S Sta. 9+50								
FOREMAN		DRILLER			LOGGED BY			DATE					
DRILLING METHOD Rotary, NX casing, 3-inch rockbit, Bentonite													
CLEANOUT DEPTH		TEST 1				TEST 2							
		40.3 ft.				43.3 ft.							
SEATING PENETRATION (0.5 ft. maximum)													
DEPTH TO SAMPLER TIP		40.1 ft.				43.2 ft.							
NO. OF BLOWS FOR STANDARD 0.5 ft. SEATING PENETRATION (50 blows max.-)		NO. OF BLOWS		PENETRATION-		NO. OF BLOWS		PENETRATION-					
		6		0.5		15		0.5					
TEST PENETRATION (1.0 ft. maximum)													
NO. OF BLOWS FOR STANDARD 0.5 ft. SEATING PENETRATION (50 blows max.-)		NO. OF BLOWS			PENETRATION-		NO. OF BLOWS			PENETRATION-			
		0.5 - 1.0 ft	1.0 - 1.5 ft	N			0.5 - 1.0 ft	1.0 - 1.5 ft	N				
		8	11	19	1.0	5	50	N/A	0.8				
DEPTH TO SAMPLER TIP		41.8 ft.				44.5 ft.							
DRIVE LENGTH (1)		(1)		(2)		(3)		(1)		(2)		(3)	
RECOVERY LENGTH (2)													
RECOVERY $\left\{ \frac{\text{RECOVERY}}{\text{DRIVE}} \right\}$ (%) (3)		1.5		1.2		80%		1.3		0.9		69%	
VISUAL CLASSIFICATION AND DESCRIPTION OF SAMPLE		POORLY GRADED SAND' About 90% fine sand; about 10% nonplastic fines, moist, grey, organic material; maximum size, medium sand, no reaction with HCL. [SP]						TOP' SP, Same as 40.3–41.8 BOTTOM' SANDY SILT' About 60% low plasticity fines; quick; dilatancy; about 35% fine sand; 5% fine subangular gravel.					
ROLL PHOTO NO.													
MOISTURE SAMPLE		JAR #48						JAR #4C (from ML)					
REMARKS: Test 1' : 0.2 ft. slough prior to test. Only 2 blows for 0.4 ft. penetration in 0.5–1.0 ft. intervals.													
TEST 2' : 0.3 ft. slough, drove on coarse gravels or cobbles. Gravels must have fell out. Had to stop test at 0.5 ft. penetration and remark rods.													
-IF 50 BLOWS DO NOT YIELD MAXIMUM PENETRATION, RECORD PENETRATION FOR 50 BLOWS AND DISCONTINUE TEST.													
DRILLER _____ (Signature)						FOREMAN _____ (Signature)							

FIG. X3.1 Example Data Sheet



REFERENCES

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SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this test method since the last issue, D1586–11, that may impact the use of this test method. (Approved December 1, 2018.)

- (1) A major revision was undertaken in 2018. The standard had significant changes to the significance and use and apparatus sections. The major changes were:
- (2) Section 4: The section was revised to include important information regarding SPT energy measurements on the test result. Its use in sand and clays was clarified and in soft clay was use has been shown to be problematic.
- (3) Section 4: Sampler with or without liners are allowed and the differences are discussed the Appendix.
- (4) Section 4: Recommends the use of automatic or trip hammer system but allows other systems.

- (5) Sections 4 and 5: Preferred drilling methods are provided but most all methods are allowed based on approval of the user.
- (6) Sections 4 and 5: Preferred hammer systems are also given but any hammer system meeting basic requirements can be used. It is strongly recommended that the user determine or know the energy of the hammer system they use and at a minimum the hammer type must be reported.
- (7) General: Appendix X1 has been added to give the user more information on the effects of equipment usage and the various drilling methods.

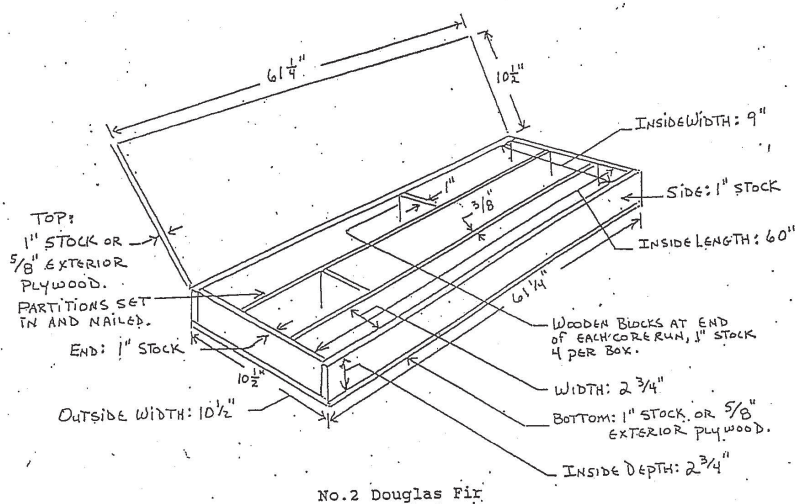
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EXHIBIT A, ATTACHMENT 4 CORE BOX SIZED



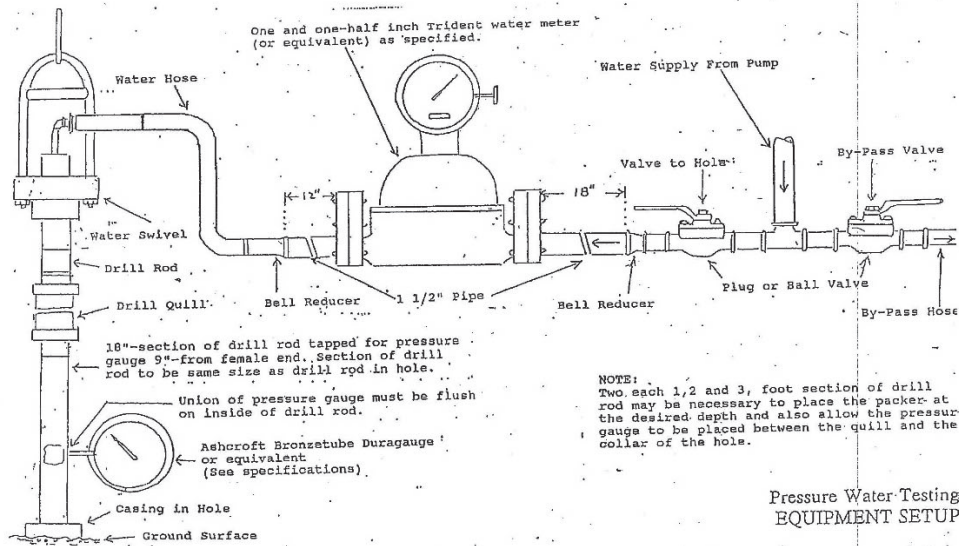
NOTES:

- Boxes should be built to inside specifications.
- Core capacity is 15 feet.
- Top of box shall be hinged and secured with spring latches.
- Bottom of boxes shall have blocks made of 1" stock located near the ends.
- Sufficient 2"x 2" lumber shall be provided to mark interval of lost core.
- For Nx cores, sufficient trough dividers (60"x 2 3/4"x 1/2") will be provided to nail into the existing core box to store any expected Nx core.

CORE SIZES

HW = 2 3/8"
Nx = 2 1/16"

EXHIBIT A, ATTACHMENT 5 PRESSURE WATER TESTING EQUIPMENT SETUP



**EXHIBIT B
BUDGET DETAIL AND PAYMENT PROVISIONS
PRIVATE ENTITIES**

A. INVOICING AND PAYMENT

Contractor shall submit three copies of the invoice to the State only after receiving written notice of satisfactory completion or acceptance of work by the DWR Contract Manager. **The State will not accept an invoice for work that has not been approved and will return the invoice as a disputed invoice to the Contractor.**

Itemized invoices shall be submitted no more often than monthly, in arrears, bearing the contract number. Small business contractors must identify their certified small business status on the invoice.

Contractor must submit three copies of each invoice to the following address in order to expedite approval and payment:

DWR Accounting Office
Contracts Payable Unit
P.O. Box 942836
Sacramento, California 94236-0001

Undisputed invoices shall be **paid** within 45 days of the date received by the DWR Accounting Office.

B. BUDGET CONTINGENCY CLAUSE

It is mutually agreed that if the Budget Act of the current year and/or any subsequent years covered under this Agreement does not appropriate sufficient funds for the program, this Agreement shall be of no further force and effect. In this event, the State shall have no liability to pay any funds whatsoever to Contractor or to furnish any other considerations under this Agreement and Contractor shall not be obligated to perform any provisions of this Agreement.

If funding for any fiscal year is reduced or deleted by the Budget Act for purposes of this program, the State shall have the option to either: cancel this Agreement with no liability occurring to the State, or offer an Agreement Amendment to Contractor to reflect the reduced amount.

C. PROMPT PAYMENT CLAUSE

Payment will be made in accordance with and within the time specified in Government Code, Chapter 4.5 (commencing with Section 927).

(Rev. 10/15)

**EXHIBIT B, ATTACHMENT 1
BID SHEET**

This is a placeholder page.

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

Contract # _____
Exhibit B, Attachment 2
Page 1 of 1

CONTRACTOR AND SUBCONTRACTOR
DEPARTMENT OF INDUSTRIAL RELATIONS (DIR) REGISTRATION CERTIFICATION

This form shall be submitted with every invoice and applies to work subject to California prevailing wage rate law.

All Contractors and Subcontractors, regardless of tier or amount, performing work under this invoice that is subject to California prevailing wage rate law are listed below. All such Contractors and Subcontractors were and are registered with DIR.

Contractor/Subcontractor Name	Contractor License Number (if applicable)	DIR Registration Number	Mailing Address	Email Address

(If more space is needed, attach additional sheets.)

Contractor Signature _____ Print Name _____ Date _____

Contractor License Number _____ DIR Registration Number _____

DWR 9777 (New 01/18)

**EXHIBIT C
GENERAL TERMS AND CONDITIONS**

This is a placeholder page.

Under the State of California's standardized contract process, a hardcopy of Exhibit C is not included in the standard agreement package or in this solicitation document. As indicated on the Std. 213, a copy of Exhibit C can be found at the internet site: [GTC 02/2025](#)

Or, you may copy and paste the following text for the GTC listing from the DGS website:

<https://www.dgs.ca.gov/OLS/Resources/Page-Content/Office-of-Legal-Services-Resources-List-Folder/Standard-Contract-Language>

If you do not have internet access, please contact the Bid Administrator below to receive a copy:

Adam Dell'Aringa
(916) 902-6614

**EXHIBIT D – Special Terms and Conditions for
Department of Water Resources
(Over \$10,000 Standard Payable)**

1. **EXCISE TAX:** The State of California is exempt from Federal Excise Taxes, and no payment will be made for any taxes levied on employees' wages.
2. **RESOLUTION OF DISPUTES:** In the event of a dispute, Contractor shall file a "Notice of Dispute" with the Director or the Director's Designee within ten (10) days of discovery of the problem. The State and Contractor shall then attempt to negotiate a resolution of such claim and, if appropriate, process an amendment to implement the terms of any such resolution. If the State and Contractor are unable to resolve the dispute, the decision of the Deputy Director of Business Operations shall be final, unless appealed to a court of competent jurisdiction.

In the event of a dispute, the language contained within this agreement shall prevail over any other language including that of the bid proposal.
3. **PAYMENT RETENTION CLAUSE:** Ten percent of any progress payments that may be provided for under this contract shall be withheld per Public Contract Code Section 10346 pending satisfactory completion of all services under the contract.
4. **AGENCY LIABILITY:** The Contractor warrants by execution of this Agreement, that no person or selling agency has been employed or retained to solicit or secure this Agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business. For breach or violation of this warranty, the State shall, in addition to other remedies provided by law, have the right to annul this Agreement without liability, paying only for the value of the work actually performed, or otherwise recover the full amount of such commission, percentage, brokerage, or contingent fee.
5. **POTENTIAL SUBCONTRACTORS:** Nothing contained in this Agreement or otherwise shall create any contractual relation between the State and any subcontractors, and no subcontract shall relieve the Contractor of its responsibilities and obligations hereunder. The Contractor agrees to be as fully responsible to the State for the acts and omissions of its subcontractors and of persons either directly or indirectly employed by any of them as it is for the acts and omissions of persons directly employed by the Contractor. The Contractor's obligation to pay its subcontractors is an independent obligation from the State's obligation to make payments to the Contractor. As a result, the State shall have no obligation to pay or enforce the payment of any moneys to any subcontractor.
6. **SUBCONTRACTING:** The Contractor is responsible for any work it subcontracts. Subcontracts must include all applicable terms and conditions of this Agreement. Any subcontractors, outside associates, or consultants required by the Contractor in connection with the services covered by this Agreement shall be limited to such individuals or firms as were specifically identified in the bid or agreed to during negotiations for this Agreement, or as are specifically authorized by the Contract Manager during the performance of this Agreement. Any substitutions in, or additions to, such subcontractors, associates or consultants shall be subject to the prior written approval of the Contract Manager. Contractor warrants, represents and agrees that it and its subcontractors, employees and representatives shall at all times comply with all applicable laws, codes, rules and regulations in the performance of this Agreement. Should State determine that the work performed by a subcontractor is substantially unsatisfactory and is not in substantial accordance with the contract terms and conditions, or that the subcontractor is substantially delaying or disrupting the process of work, State may request substitution of the subcontractor.

Contract # [REDACTED]

Exhibit D

Page 2 of 3

7. RENEWAL OF CCC: Contractor shall renew the Contractor Certification Clauses or successor documents every three (3) years or as changes occur, whichever occurs sooner.
8. REPORT OF RECYCLED CONTENT CERTIFICATION: In accordance with Public Contract Code Sections 12200-12217, et seq. and 12153-12158, et seq. the contractor must complete and return the form DWR 9557, Recycled Content Certification, for each required product to the Department at the conclusion of services specified in this contract. Form DWR 9557 is attached to this Exhibit and made part of this contract by this reference.
9. TERMINATION CLAUSE: The State may terminate this contract without cause upon 30 days advance written notice. The Contractor shall be reimbursed for all reasonable expenses incurred up to the date of termination.
10. COMPUTER SOFTWARE: For contracts in which software usage is an essential element of performance under this Agreement, the Contractor certifies that it has appropriate systems and controls in place to ensure that state funds will not be used in the performance of this contract for the acquisition, operation or maintenance of computer software in violation of copyright laws.
11. PRIORITY HIRING CONSIDERATIONS: For contracts, other than consulting services contracts, in excess of \$200,000, the Contractor shall give priority consideration in filling vacancies in positions funded by the contract to qualified recipients of aid under Welfare and Institutions Code Section 11200. (Public Contract Code Section 10353).
12. EQUIPMENT RENTAL AGREEMENTS: This provision shall apply to equipment rental agreements. The State shall not be responsible for loss or damage to the rented equipment arising from causes beyond the control of the State. The State's responsibility for repairs and liability for damage or loss to such equipment is restricted to that made necessary or resulting from the negligent act or omission of the State or its officers, employees, or agents.
13. CONTRACTOR COOPERATION DURING INVESTIGATION: Contractor agrees to cooperate fully in any investigation conducted by or for DWR regarding unsatisfactory work or allegedly unlawful conduct by DWR employees or DWR contractors. The word "cooperate" includes but is not limited to, in a timely manner, making Contractor staff available for interview and Contractor records and documents available for review.
14. CONFLICT OF INTEREST:
 - a. Current and Former State Employees: Contractor should be aware of the following provisions regarding current or former state employees. If Contractor has any questions on the status of any person rendering services or involved with the Agreement, the awarding agency must be contacted immediately for clarification.
 - (1) Current State Employees: (PCC §10410)
 - (a) No officer or employee shall engage in any employment, activity or enterprise from which the officer or employee receives compensation or has a financial interest and which is sponsored or funded by any state agency, unless the employment, activity or enterprise is required as a condition of regular state employment.
 - (b) No officer or employee shall contract on his or her own behalf as an independent contractor with any state agency to provide goods or services.
 - (2) Former State Employees: (PCC §10411)
 - (a) For the two-year period from the date he or she left state employment, no former state officer or employee may enter into a contract in which he or she engaged in any of the negotiations, transactions, planning, arrangements or any part of the decision-making process relevant to the contract while employed in any capacity by any state agency.

Contract # [REDACTED]

Exhibit D

Page 3 of 3

- (b) For the twelve-month period from the date he or she left state employment, no former state officer or employee may enter into a contract with any state agency if he or she was employed by that state agency in a policy-making position in the same general subject area as the proposed contract within the 12-month period prior to his or her leaving state service.

b. Penalty for Violation:

- (a) If the Contractor violates any provisions of above paragraphs, such action by Contractor shall render this Agreement void. (PCC §10420)

c. Members of Boards and Commissions:

- (a) Members of boards and commissions are exempt from this section if they do not receive payment other than payment of each meeting of the board or commission, payment for preparatory time and payment for per diem. (PCC §10430 (e))

d. Representational Conflicts of Interest:

The Contractor must disclose to the DWR Program Manager any activities by contractor or subcontractor personnel involving representation of parties, or provision of consultation services to parties, who are adversarial to DWR. DWR may immediately terminate this contract if the contractor fails to disclose the information required by this section. DWR may immediately terminate this contract if any conflicts of interest cannot be reconciled with the performance of services under this contract.

e. Financial Interest in Contracts:

Contractor should also be aware of the following provisions of Government Code §1090:

"Members of the Legislature, state, county district, judicial district, and city officers or employees shall not be financially interested in any contract made by them in their official capacity, or by any body or board of which they are members. Nor shall state, county, district, judicial district, and city officers or employees be purchasers at any sale or vendors at any purchase made by them in their official capacity."

f. Prohibition for Consulting Services Contracts:

For consulting services contracts (see PCC §10335.5), the Contractor and any subcontractors (except for subcontractors who provide services amounting to 10 percent or less of the contract price) may not submit a bid/SOQ, or be awarded a contract, for the provision of services, procurement of goods or supplies or any other related action which is required, suggested, or otherwise deemed appropriate in the end product of such a consulting services contract (see PCC §10365.5).

- 15. COMMERCIAL DRIVER MEAL PERIOD AND REST PERIOD: To comply with Supreme Court case *Dynamex Operations West, Inc. v. Superior Court* (2018) 4 Cal.5th 903, Contractor shall ensure that commercial drivers employed or subcontracted for under this contract shall receive meal periods and rest periods commensurate with those required by Department of Industrial Relations Wage Order 9, sections 11 and 12:
<https://www.dir.ca.gov/IWC/IWCArticle9.pdf>.
- 16. ORDER OF PRECEDENCE: In the event of any inconsistency between the terms, specifications, provisions or attachments which constitute this Contract, the following order of precedence shall apply:
 - a) The General Terms and Conditions;
 - b) The Std. 213;
 - c) The Scope of Work;
 - d) Any other incorporated attachments in the Contract by reference

EXHIBIT D, ATTACHMENT 1

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

Contract #
Exhibit , Attachment
Page 1 of 2

RECYCLED CONTENT CERTIFICATION

To be completed by the vendor/bidder/contractor and returned to:

DEPARTMENT OF WATER RESOURCES
Recycling Coordinator
Purchasing Services Office
715 P Street, 7th Floor, Sacramento, CA 95814
FAX: (916) 654-5506

COMPANY:

PERSON COMPLETING FORM:

DATE:

DESCRIPTION Please include item name, brand, and product number	% POSTCONSUMER	RECYCLED MATERIAL TYPE

All businesses shall certify in writing to the contracting officer or his or her representative the minimum percentage, if not exact percentage, of postconsumer material in the productions, materials, goods, or supplies offered or sold to the state regardless of whether the product meets the minimum content requirements specified in law (see page 2 for minimum content requirements). The certification shall be furnished under penalty of perjury. The certification shall be provided regardless of content, even if the product contains no recycled material. A state agency may waive the certification requirements if the percentage of postconsumer material in the products, materials, good or supplies can be verified in a written advertisement, including, but not limited to, a product label, a catalog, or manufacturer or vendor internet website.

Public Contract Code Sections 12200-12217, et seq. and 12153-12156, et seq.

I certify that the above information is true. I further certify that these environmental claims for recycled content regarding these products are consistent with the Federal Trade Commission's Environmental Marketing Guidelines in accordance with PCC 12404.

NAME OF PERSON COMPLETING FORM	TITLE	AGENCY/COMPANY
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➤
SIGNATURE OF PERSON COMPLETING FORM DATE

1. Postconsumer material comes from products that were bought by consumers, used, then recycled. For example: a newspaper that has been purchased and read, next recycled, and then used to make another product would be postconsumer material.

If the product does not fit into any of the product categories, enter "N/A". Common N/A products include wood products, natural textiles, aggregate, concrete, electronics such as computers, TV, software on a disk or CD, telephone.

2. Product category refers to one of the product categories listed below, into which the reportable purchase falls. For products made from multiple materials, choose the category that comprises most of the product by weight, or volume.

Note: For reuse or refurbished products, there are no minimum content requirements.

For additional information visit State Agency Buy Recycled Campaign

Description Product Categories	Minimum Content Requirement
Paper Products – Recycled	30 percent postconsumer fiber, by fiber weight
Printing and Writing – Recycled	30 percent postconsumer fiber, by fiber weight
Compost, Co-compost, and Mulch – Recycled	80 percent recovered materials i.e., material that would otherwise be normally disposed of in a landfill
Glass – Recycled	10 percent postconsumer, by weight
Re-refined Lubricating Oil – Recycled	70 percent re-refined base oil
Plastic – Recycled	10 percent postconsumer, by weight
Printer or duplication cartridges	a. Have 10 percent postconsumer material, or b. Are purchased as remanufactured, or c. Are backed by a vendor-offered program that will take back the printer cartridges after their useful life and ensure that the cartridges are recycled and comply with the definition of recycled as set forth in Sections 12200-12217, et seq. and 12153-12156, et seq. of the Public Contract Code.
Paint – Recycled	50 percent postconsumer paint (exceptions when 50 percent postconsumer content is not available or is restricted by a local air quality management district, then 10 percent postconsumer content may be substituted)
Antifreeze – Recycled	70 percent postconsumer material
Retreated Tires – Recycled	Use existing casing that has undergone retreading or recapping process in accordance with Public Resource Code (commencing with section 42400).
Tire – Derived – Recycled	50 percent post consumer tires
Metals – Recycled	10 percent postconsumer, by weight

EXHIBIT E ADDITIONAL PROVISIONS

Executive Order N-6-22 – Russia Sanctions

On March 4, 2022, Governor Gavin Newsom issued Executive Order N-6-22 (the EO) regarding Economic Sanctions against Russia and Russian entities and individuals. “Economic Sanctions” refers to sanctions imposed by the U.S. government in response to Russia’s actions in Ukraine, as well as any sanctions imposed under state law. The EO directs state agencies to terminate contracts with, and to refrain from entering any new contracts with, individuals or entities that are determined to be a target of Economic Sanctions. Accordingly, should the State determine Contractor is a target of Economic Sanctions or is conducting prohibited transactions with sanctioned individuals or entities, that shall be grounds for termination of this agreement. The State shall provide Contractor advance written notice of such termination, allowing Contractor at least 30 calendar days to provide a written response. Termination shall be at the sole discretion of the State.

GenAI Technology Use & Reporting

The State of California seeks to realize the potential benefits of GenAI, through the development and deployment of GenAI tools, while balancing the risks of these new technologies.

Bidder / Offeror must notify the State in writing if it: (1) intends to provide GenAI as a deliverable to the State; or (2), intends to utilize GenAI, including GenAI from third parties, to complete all or a portion of any deliverable that materially impacts: (i) functionality of a State system, (ii) risk to the State, or (iii) Contract performance. For avoidance of doubt, the term “materially impacts” shall have the meaning set forth in State Administrative Manual (SAM) § 4986.2 Definitions for GenAI. Failure to report GenAI to the State may result in disqualification. The State reserves the right to seek any and all relief to which it may be entitled to as a result of such non-disclosure.

Upon notification by a Bidder / Offeror of GenAI as required, the State reserves the right to incorporate GenAI Special Provisions into the final contract or reject bids/offers that present an unacceptable level of risk to the State. Government Code 11549.64 defines “Generative Artificial Intelligence (GenAI)” as an artificial intelligence system that can generate derived synthetic content, including text, images, video, and audio that emulates the structure and characteristics of the system’s training data.

1. REIMBURSEMENT CLAUSE

If applicable, travel and per diem expenses to be reimbursed under this contract shall be at the same rates the State provides for unrepresented employees in accordance with the provisions of 2 CCR § 599.631. Travel and Per Diem Expenses, DWR 9580, has been attached and labeled as Exhibit E, Attachment 1. The Contractor’s designated headquarters for the purpose of computing such expenses shall be: TBD.

2. CERTIFICATE OF INSURANCE

a. General Provisions Applying to All Policies

- i. Coverage Term – Coverage needs to be in force for the complete term of the contract. If insurance expires during the term of the contract, a new certificate must be received by the State at least 30 days prior to the expiration of this insurance. Any new insurance must still comply with the original terms of the contract.
- ii. Policy Cancellation or Termination & Notice of Non-Renewal – Contractor shall provide to the Department, within five (5) business days following receipt by contractor, a copy of any cancellation or non-renewal of insurance required by this contract. In the event Contractor fails to keep in effect at all times the specified insurance coverage, the State may, in addition to any other remedies it may have, terminate this Contract upon the occurrence of such event, subject to the provisions of this Contract.

- iii. Deductible – Contractor is responsible for any deductible or self-insured retention contained within their insurance program.
 - iv. Primary Clause – Any required insurance contained in this contract shall be primary, and not excess or contributory, to any other insurance carried by the State.
 - v. Insurance Carrier Required Rating – All insurance companies must carry a rating acceptable to the Office of Risk and Insurance Management – A or better and financial size category of VII or better to the latest edition of the A.M. Best Key Rating Guide. If the Contractor is self-insured for a portion or all of its insurance, review of financial information including a letter of credit may be required.
 - vi. Endorsements – Any required endorsements requested by the State must be physically attached to all requested certificates of insurance and not substituted by referring to such coverage on the certificate of insurance.
 - vii. Inadequate Insurance – Inadequate or lack of insurance does not negate the contractor's obligations under the contract.
 - viii. Satisfying an SIR - All insurance required by this contract must allow the State to pay and/or act as the contractor's agent in satisfying any self-insured retention (SIR). The choice to pay and/or act as the contractor's agent in satisfying any SIR is at the State's discretion.
 - ix. Available Coverages/Limits - All coverage and limits available to the contractor shall also be available and applicable to the State.
 - x. Subcontractors - In the case of Contractor utilization of subcontractors to complete the contracted scope of work, contractor shall include all subcontractors as insured's under Contractor and insurance or supply evidence of insurance to The State equal to policies, coverages and limits required of Contractor.
- b. **Insurance Requirements:** The contractor shall furnish to the State evidence of the following required insurance:
- i. **Commercial General Liability** – Contractor shall maintain general liability on an occurrence form with limits not less than \$1,000,000 per occurrence/\$2,000,000 aggregate for bodily injury and property damage liability. The policy shall include coverage for liabilities arising out of premises, operations, independent contractors, products, completed operations, personal & advertising injury, and liability assumed under an insured contract. This insurance shall apply separately to each insured against whom claim is made or suit is brought subject to the Contractor's limit of liability. The policy must include the contract number and the following additional insured designation and endorsement:

“The State of California, Department of Water Resources, its officers, agents, and employees are to be covered as additional insureds with respect to liability arising out of work or operations.”

The endorsement must be supplied under form acceptable to the Office of Risk and Insurance Management.

- ii. **Workers Compensation and Employers Liability** – Workers' Compensation insurance as required by the State of California, with Statutory Limits, and Employer's Liability Insurance with limit of no less than \$1,000,000 per accident for bodily injury or disease.

Policy shall provide a Waiver of Subrogation endorsement in favor of the State of California and the California Department of Water Resources.

- iii. **Automobile Liability** – Contractor shall maintain motor vehicle liability with limits not less than \$1,000,000 combined single limit per occurrence. Such insurance shall cover liability arising out of a motor vehicle including owned, hired and non-owned motor vehicles. **The State of California, Department of Water Resources, its officers, agents, and employees are to be covered as additional insureds with respect to liability arising out of work or operations.**

Subsequent renewals of the insurance certificate will be sent to the following name and address which also will appear on the certificate as the certificate holder.

The Department of Water Resources
Division of Engineering
ATTN: TBD
715 P Street
Sacramento CA 95814

3. PUBLIC WORKS AGREEMENTS

Contractor shall comply with the language stated in the Standard Clauses for Public Works, DWR 4197, Exhibit E, Attachment 2, and the Standard California Nondiscrimination Construction Contract Specifications, in the California Code of Regulations ([2CCR §11122](#)). Contractor must use prevailing wage rates for the appropriate classifications used in the performance of the work specified in the Scope of Work that is considered “public works”. Contractor can access these rates on the internet at <http://www.dir.ca.gov> or by calling the California Department of Industrial Relations at (415) 703-4774 for paper copies of the rates. Contractor understands that it is responsible for determination of proper classifications of work for prevailing wage purposes. Contractor is solely responsible for determining whether all or any portion of the work is considered “public works,” such that prevailing rates are payable under this contract.

4. PREVAILING WAGES

Labor Code Certifications:

The Contractor is aware of the provisions of Section 3700 of the Labor Code, which requires every employer to be insured against liability for workers’ compensation or to undertake self-insurance in accordance with the provisions of that code and the Contractor and any subcontractors will comply with such provisions before commencing the performance of the work of this contract.

In accordance with the applicable provisions of the Labor Code, the Contractor and any subcontractors shall pay their employees prevailing wages for the performance of that portion of the work, which is “public works”. The Director of the State Department of Industrial Relations has made the general prevailing wage rate determination covering the locality where work on this contract is to be performed. The general prevailing wage rates can be obtained from the Department of Industrial Relations or any source authorized by the Department of Industrial Relations. On the Internet, prevailing wage rates can be found at www.dir.ca.gov. The Contractor agrees to post a copy of the applicable general prevailing wage rates for the locality of each job site.

It is hereby mutually agreed that, pursuant to Labor Code section 1775 (a)(1), the Contractor shall forfeit to the State 200 dollars (\$200) for each calendar day, or portion thereof, for each worker paid by him or her, or subcontractor under him or her, less than the prevailing wage so stipulated and in addition, the Contractor further agrees to pay to each worker the difference between the actual amount paid for each calendar day, or portion thereof, and the stipulated prevailing wage rate for the same. This provision shall not apply to properly registered apprentices.

It is further agreed that the maximum hours a worker is to be employed is limited to eight hours a day and 40 hours a week and the contractor shall forfeit, as a penalty to the State, twenty-five dollars

(\$25) for each worker employed in the execution of the contract for each calendar day during which a worker is required or permitted to labor more than eight hours in any calendar day or more than 40 hours in any calendar week, when done in violation of Labor Code sections 1810-1815, inclusive.

Properly registered apprentices may be employed in the prosecution of the work. Every such apprentice shall be paid the standard wage paid to apprentices under the regulations of the craft or trade at which he or she is employed, and shall be employed only at the work of the craft or trade to which he or she is registered. The Contractor and each subcontractor must comply with the requirements of Labor Code section 1775.5 and any related regulations regarding the employment of registered apprentices.

The Contractor and any subcontractors shall comply with all other applicable Labor Code requirements, including section 1776 regarding record keeping.

Labor Compliance Program:

For work which is funded pursuant to Public Resources Code Sections 75070-75079 (Proposition 84), Contractor may be required to comply with the Labor Compliance Program or (LCP) requirements of Labor Code Section 1771.5. Among the requirements under these sections are: pre-construction conference regarding payment of prevailing wages, providing of certified payroll reports and audit thereof, and potential withholding of contract payments for non-compliance. DWR will notify Contractor at the time of any work to which these LCP provisions apply.

Prevailing Wage Monitoring and Enforcement:

1. DIR Registration of Contractor and Subcontractor: Contractor agrees that it shall remain registered with the Department of Industrial Relations (DIR) pursuant to Labor Code Section 1725.5 (DIR Registered Contractor) at all times during the performance of work. Contractor shall independently verify that all subcontractors of every tier are DIR registered contractors at all time during performance of work.
2. Certified Payroll Records: Contractor shall comply with the Certified Payroll Record (CPR) requirements of section 1771.4 and Section 1776 of the Labor Code and shall require and verify that all subcontractors of every tier comply with just CPR requirements.
3. Posting of Job Site Notices: Pursuant to Labor Code Section 1771.4(a)(2), Contractor shall post any job site notices prescribed by DIR.
4. DIR Enforcement: This Contract is subject to prevailing wage compliance monitoring and enforcement by DIR.
5. Penalty assessment for non-compliance with CPR requests; withholding of payment: Pursuance to Labor Code Section 1776(b), is the requirements therein regarding production of CPRs within ten (10) days of written request have not been strictly complied with, the offending Contractor or subcontractor(s) shall forfeit the sum of One Hundred Dollars (\$100) per calendar day, or portion thereof, for each worker, until such offending party has fully complied with the requirements. Upon request of DIR, these penalties shall be withheld from progress payments then due to Contractor. Contractor Is not subject to a penalty assessment for failure of a subcontractor to comply with the requirements of this paragraph.

5. PERMITS AND LICENSES

The Contractor shall procure all permits and licenses, pay all charges and fees and give all notices necessary and incidental to the due and lawful prosecution of the work.

6. OPTION TO RENEW

The Department reserves the right to renew this Agreement for two (2) one-year options under the same terms and conditions.

7. CONTRACT AMENDMENTS – DVBE PROGRAM REQUIREMENTS

Disabled Veteran Business Enterprise (DVBE) program requirements shall be included and made a part of any subsequent contract amendment(s) when DVBE program requirements were included as

part of the Department's original solicitation/contract effort. DVBE participation program goal percentage(s) committed by the contractor in the original contract are extended through the amended contract termination date and include any additionally encumbered funds that are a result of the contract amendment. The Prime Contractor's Certification – DVBE Subcontractor Report (STD 817) shall be included in all subsequent contract amendment(s). The Contractor shall be responsible for continued program compliance and reporting.

8. CONTRACT AUDITS RELATED TO DVBE PROGRAM REQUIREMENTS

Contractor agrees that the State or its designee will have the right to review, obtain, or copy all records pertaining to performance of the contract as performance pertains to DVBE requirements. Contractor agrees to provide the State or its representative with any relevant information requested and shall permit the State or its representative access to its premises, upon reasonable notice, during normal business hours for the purpose of interviewing employees and inspecting and copying such books, records, accounts, and other material that may be relevant to a matter under investigation for the purpose of determining compliance with this requirement. Contractor further agrees to maintain such records for a period of no less than three (3) years after final payment under the contract.

9. SUBSTITUTION OF A DVBE SUBCONTRACTOR

Contractor understands and agrees that should award of this contract be based in part on their commitment to use the DVBE subcontractor(s) identified in their bid or offer, per [Military and Veterans Code \(MVC\) 999.5\(g\)](#), a DVBE subcontractor may only be replaced by another DVBE subcontractor and must be approved by the Department of General Services. Changes to the scope of work that impact the DVBE subcontractor(s) identified in the bid or offer and approved DVBE substitutions will be documented by contract amendment.

Failure of Contractor to seek substitution and adhere to the DVBE participation level identified in the bid or offer may be cause for contract termination, recovery of damages under rights and remedies due the State, and penalties as outlined in [MVC 999.9](#); [Public Contract Code Section \(PCC\) 10115](#), or [PCC Section 4110](#) (applies to public works only). Contractor must immediately notify the Department's SB/DVBE Advocate that substitution of a DVBE subcontractor is requested.

10. CONTRACTOR CERTIFICATION OF PAYMENT TO SMALL BUSINESS SUBCONTRACTOR(S)

If, for this Contract, Contractor made a commitment to achieve small business participation, then Contractor upon contract close out or completion must report to the awarding department the actual percentage of small business participation that was achieved. ([Government Code § 14841](#))

Contractor's certification of payments must be made using form DWR 9683 (Small Business Subcontractor Payment Certification), Exhibit E Attachment 5. Fully complete this form with the authorized signature and submit to DWR's Contract Manager with a copy to DWR's SB/DVBE Program Manager.

11. PRIME CONTRACTOR'S CERTIFICATION – DVBE SUBCONTRACTOR REPORT (STD 817)

a. STD 817 – Statutory Reporting Requirements

Upon completion of contracts that include commitments to DVBE subcontractors, the State's Prime Contractors are required to certify, under penalty of perjury, the total amount received from the State *and* the details of payments made to all DVBE subcontractors under those contracts.

Contract awarding departments are *required to withhold \$10,000* from the final payment (or the full payment if less than \$10,000) to Prime Contractors until their compliance with the certification requirements by submitting an accurate and appropriately signed Std. 817 to the awarding department. The withhold amount will be *permanently deducted* if Prime Contractors

do not comply with Std. 817 requirements after given notice to cure deficiencies.

Prime Contractors are required to maintain supporting documentation for a minimum of six years for all payments to DVBE subcontractors identified in the Std. 817. Upon request, proof of payment must be provided. [[Military and Veteran Code 999.5\(d\)](#); [Government Code 14841](#); [California Code of Regulations 1896.78\(e\)](#); [Public Contract Code 10369](#)]

- b. STD 817 – Link to Form with Completion Instructions
<https://www.dgs.ca.gov/PD/Search-Results?search=817&divisionid=7bce8ca3ed8a4aedbdeaf52f5e77df36&activeFilters=division-or-office-facets>
- c. STD 817 – Filing Instructions
Upon completion of the contract submit one Std. 817 per contract, signed by the Prime's authorized representative, to DWR's SB/DVBE Program Manager by either option below.
 - 1. Option #1. Email electronic signed versions of the Std. 817 to: SB.DVBE@water.ca.gov and DWR Contract Manager (contact information in Exhibit A).
 - 2. Option #2. Mail or deliver signed hard copies of the Std. 817 to:

Department of Water Resources
Attention: SB/DVBE Program Manager
715 P St, 7th Floor, DBS #19
Sacramento, CA 94236-0001

EXHIBIT E, ATTACHMENT 1

TRAVEL AND PER DIEM EXPENSES

I. M&IE* Rates for In-State and Out-of-State Travel

- A. Effective October 1, 2024, the State is adopting the federal standard M&IE rate established by the federal GSA at the time of travel for in-state and out-of-state travel. The State's maximum reimbursement rate for actual in-state (GSA locations) and out-of-state (GSA and DOD locations) M&IE will be up to \$68 per day as follows:

M&IE Total	Breakfast	Lunch	Dinner	Incidental Expenses	First & Last Day of Travel
Up to \$68	Up to \$16	Up to \$19	Up to \$28	Up to \$5	Up to \$51

1. **M&IE Total** – Up to the full daily amount received for a single calendar day of travel when that day is neither the first nor last day of travel.
2. **Breakfast, Lunch, Dinner, Incidentals** – M&IE Total = Breakfast + Lunch + Dinner + Incidentals. Separate amounts for meals and incidentals as sometimes meal amounts must be deducted by the appropriate amount when such meals are furnished to the traveler or included in a conference registration, etc. For meals provided, the traveler must deduct the meal cost from the applicable M&IE rate.
3. **First & Last Day of Travel** – Up to the amount received on the first and last day of travel and equals 75% of total M&IE.

II. M&IE Timeframes

- A. Effective October 1, 2024, for travel that occurs on or after October 1, 2024, the State's updated travel timeframes determining allowable reimbursement of M&IE are as follows:

When travel status is		Maximum reimbursement for actual expenses is
More than 12 but less 24 hours		Up to 75% of the applicable M&IE standard rate for each calendar day in a travel status.
24 hours or more, on	The day of departure	Up to 75% of the applicable M&IE standard rate.
	Full days of travel	Up to 100% of the applicable M&IE standard rate.
	The last day of travel	Up to 75% of the applicable M&IE standard rate.
Travel less than 12 hours		Not eligible for M&IE reimbursement.

* Receipts are not required to claim meal and incidental expenses up to the maximum allowable reimbursement rates specified. Receipts for meals must be maintained by the employee as substantiation that the amount claimed was not in excess of the amount of the actual expense. The employing department may request receipts at any time.

III. Lodging Rates

- A. Effective October 1, 2024, the State is adopting federal standard and non-standard reimbursement lodging rates at time of travel for:
1. [GSA](#) (in-state and certain out-of-state locations): The continental United States and Washington, D.C. (CONUS)
 2. [DOD](#) (certain out-of-state locations): Non-foreign areas outside of CONUS (Alaska, Hawaii, U.S. Territories and Possessions)
 3. [State Department](#) (out-of-country): Foreign areas

IV. Excess Lodging Rate Requests

A. In-State Lodging

If a traveling employee cannot obtain lodging at or below the applicable federal standard or non-standard in-state lodging rate for their location of travel, then CalHR's existing Excess Lodging process (as provided in CalHR Manual Section [2201](#)) continues to apply:

1. Delegated authority to departments up to \$350 per night.
2. Three comparison quotes from the state's authorized online booking tool for the requested travel dates.

B. Out-of-State and/or Out-of-Country Lodging

If a traveling employee cannot obtain lodging at or below the applicable federal standard or non-standard out-of-state or out-of-country lodging rate for their location of travel, then CalHR's Excess Lodging process, which will be updated in CalHR Manual Section [2201](#), will apply, as follows:

3. Delegated authority to departments up to \$350 per night.
4. Three comparison quotes from the state's authorized online booking tool for the requested travel dates.

C. Long-Term Travel

Effective October 1, 2024:

1. The State is adopting the federal standard M&IE reimbursement rates for long-term meals, and receipted lodging shall be reimbursed up to the maximum federal standard and non-standard reimbursement rates.
2. Actual expenses for long-term meals, incidentals, and receipted lodging will be reimbursed up to the maximum rates provided above for short-term travel.

V. U.S. General Services Administrative Per Diem Rates for California Daily lodging rates (excluding taxes)

- A. Current rates may be found at [U.S. GSA Per Diem Rates for California](#)

VI. Mileage Reimbursement for Personal Vehicles

Current rates may be found at <https://www.calhr.ca.gov/employees/Pages/travel-reimbursements.aspx>.

EXHIBIT E, ATTACHMENT 2

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

Contract # _____

Exhibit E, Attachment _____

Page 1 of 2

STANDARD CLAUSES – GENERAL CONDITIONS FOR PUBLIC WORKS AND/OR DRILLING CONTRACTS

1. **DEPARTMENT OF INDUSTRIAL RELATIONS (DIR) REGISTRATION.** Labor Code Section 1725.5 requires a contractor to be registered as a public works contractor to be qualified to bid on, or listed in a bid proposal, subject to the requirements of Section 4104 of the Public Contract Code, or engage in the performance of any public work contract. For the purposes of this section, "contractor" includes a subcontractor as defined by Labor Code Section 1722.1. DIR registration is a condition of the Contractor's ability to work under this contract. Should the contractor or any subcontractor fail to maintain DIR registration, this contract may be terminated at the discretion of DWR.
2. **LICENSE.** No bidder may bid on work for which it is not properly licensed by the Contractor's State License Board. Joint Venture bidders must possess a Joint Venture License. Bidders for this Agreement must have a classification(s) of their contractor's license. Provide license number and expiration date and certify under penalty of perjury that the foregoing is true and correct.
3. **EXAMINATION OF BID DOCUMENTS AND SITE.** Bidder shall carefully examine site of work, plans and specifications. The bidder shall investigate conditions, character, quality of surface, or subsurface materials or obstacles to be encountered. No additions to the contract amount will be made because of the Contractor's failure to examine the site of work, plans, and specifications.
4. **SUBCONTRACTORS.** (See Public Contract Code Section 4104.) The bidder shall set forth in its bid:
 - a. The name and business address of each subcontractor who will perform work or labor or render services in an amount in excess of one-half of one percent (.5%) of the General Contractor's total bid; and
 - b. The portion of work to be done by each subcontractor. (See Public Contract Code Section 4104.)
5. **PAYMENT AND/OR PERFORMANCE BOND.** The Contractor shall furnish, concurrently with signing the contract, a Payment Bond to Accompany Construction Contract, DWR Form 3373, in an amount not less than 100% of the amount of the contract when the contract exceeds \$10,000 (for non-construction drilling contracts, when the contract exceeds \$25,000). Such bond shall be executed by the Contractor and a corporate surety approved by the State. If the Department deems it necessary, a Performance Bond may be required in the same amount as the Payment Bond.
6. **NOTICE.** Failure to obtain a Payment Bond within ten (10) days of notification of award shall cause the State to reject the bid.
7. **WORKERS' COMPENSATION INSURANCE CERTIFICATION.** Upon execution of the contract, the Contractor shall provide the State either with a certificate of insurance issued by an insurance carrier licensed to write workers' compensation insurance in the State of California, including the name of the carrier and date of expiration of the insurance, or a certificate of consent to self-insure issued by the Director of the Department of Industrial Relations.
8. **PREVAILING WAGE.** It is hereby mutually agreed that, pursuant to Labor Code Section 1775 (a) (1), the Contractor shall forfeit to the State a penalty of \$200 for each calendar day, or portion thereof, for each worker paid by it, or subcontractor under it, less than the prevailing wage so stipulated. In addition, the Contractor further agrees to pay to each worker the difference between the actual amount paid for each calendar day, or portion thereof, and the stipulated prevailing wage rate for the same. This provision shall not apply to properly registered apprentices.
9. **MAXIMUM HOURS.** It is further agreed that the maximum hours a worker is to be employed is limited to 8 hours a day and 40 hours a week and the Contractor shall forfeit, as a penalty to the State, \$25 for each worker employed in the execution of the contract for each calendar day during which a worker is required or permitted to labor more than 8 hours in any calendar day or more than 40 hours in any calendar week in violation of Labor Code Sections 1810-1815, inclusive.
10. **TRAVEL AND SUBSISTENCE PAYMENTS.** Travel and subsistence payments shall be paid to each worker needed to execute the work, as such travel and subsistence payments are defined in the applicable collective bargaining agreements filed in accordance with Labor Code Section 1773.8.

Contract # _____

Exhibit E, Attachment _____

Page 2 of 2

- 11. APPRENTICES.** Properly registered apprentices may be employed in the prosecution of the work. Every such apprentice shall be paid the standard wage paid to apprentices under the regulations of the craft or trade at which he or she is employed, and shall be employed only at the work of the craft or trade to which he or she is registered. The Contractor and each subcontractor must comply with the requirements of Labor Code Section 1777.5 and any related regulations regarding the employment of registered apprentices.
- 12. SUBSTITUTIONS.** Pursuant to Section 3400 of the Public Contract Code, should the Contractor seek to substitute a brand of materials other than specified, the Contractor shall submit data substantiating the request for substitution of "an equal" item. The substantiating data must be presented for approval within thirty-five (35) days after the award of the agreement. The State shall be the sole judge as the comparative quality and suitability of "an equal" item.
- 13. ANTI-TRUST CLAIMS.** The Contractor offers and agrees and will require all of their subcontractors and suppliers to agree to assign to the awarding body all rights, title, and interest in and to all causes of action they may have under Section 4 of the Clayton Act (15 U.S.C. Sec. 15) or under the Cartwright Act [Chapter 2 (commencing with Sec. 165700) of Part 2 of Division 7 of the Business and Professions Code], arising from purchases of goods, services, or materials, pursuant to the public works contract or the subcontract. The assignment made by the Contractor and all additional assignments made by the subcontractors and suppliers shall be deemed to have been made and will become effective at the time the awarding body tenders final payment to the Contractor, without further acknowledgment or the necessity of tendering to the awarding body any written assignments.

If an awarding body receives, either through judgment or settlement, a monetary recovery for a cause of action assigned under Government Code Sections 4550-4554, the assignor shall be entitled to receive reimbursement for actual legal costs incurred and may, upon demand, recover from the public body any portion of the recovery, including treble damages, attributable to overcharges that were paid by the assignor but were not paid by the public body as part of the bid price, less the expenses incurred in obtaining that portion of the recovery.

Upon demand in writing by the assignor, the assignee shall, within one year from such demand, reassign the cause of action assigned under Government Code Section 4550-4554, if the assignor has been or may have been injured by the violation of law for which the cause of action arose and (a) the assignee has not been injured thereby, or (b) the assignee declines to file a court action for the cause of action.
- 14. PROGRESS PAYMENTS.**
 - a. Ten percent of any progress payments that may be provided for under this contract shall be withheld pending satisfactory completion of all services under the contract. The Contractor may substitute securities for such retentions and receive any interest accrued provided in Section 22300 of the Public Contract Code.
 - b. Prior to execution of the contract, the Contractor shall furnish a faithful performance bond for not less than the total amount payable under the contract if the contract exceeds \$10,000 and progress payments will be made.
- 15. PAYROLL RECORDS.** The Contractor and each subcontractor shall comply with Labor Code Section 1776 regarding payroll records.
- 16. NONCOLLUSION DECLARATION.** All bidders shall submit with their bids a signed and notarized Noncollusion Declaration (DWR 4206).
- 17. LABOR CODE PROVISIONS.** Pursuant to Sections 1770 et seq. of the California Labor Code, the Director of the State Department of Industrial Relations has made the general prevailing wage determination covering the locality where work for this contract is to be performed. The general prevailing wage rates can be obtained from the Department of Industrial Relations or any source authorized by the Department of Industrial Relations. They are also made available at www.dir.ca.gov/.

The Contractor agrees to post a copy of the **General Prevailing Wage Determination** for the locality of each job site. The Contractor also agrees to comply with all requirements of the California Labor Code and to pay for the forfeiture penalties and monies, which may become due as provided in Sections 1775 and 1813 of that Code.
- 18. UNDOCUMENTED ALIENS.** No bidder or Contractor shall be eligible to bid for or receive a public works or purchase contract, who has, in the preceding five years, been convicted of violating a State or federal law respecting the employment of undocumented aliens.
- 19. SUBSTITUTION OF SUBCONTRACTORS.** A prime contractor whose bid is accepted may not substitute a subcontractor listed in the original bid unless the provisions of PCC 4107 or 4107.5 apply and a hearing is held, if required.

EXHIBIT E, ATTACHMENT 3

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

Contract No. _____

Exhibit _____

SMALL BUSINESS SUBCONTRACTOR PAYMENT CERTIFICATION

Government Code § 14841 states "Upon completion of an awarded contract for which a commitment to achieve small business or disabled veteran business enterprise participation goals was made, the contractor shall report to the awarding department the actual percentage of Small Business (SB) and Disabled Veteran Business Enterprise (DVBE) participation that was achieved."

This Small Business Subcontractor Payment Certification form (DWR 9683) must be completed and submitted to DWR once all work has been completed, and invoices have been paid under this contract.

Complete and sign a separate DWR 9683 form for each SB subcontractor and submit the form(s) in pdf format, by email, to DWR's Contract Manager identified in the Scope of Work and the SBDVBE Program Manager at SB.DVBE@water.ca.gov (STD. 817).

PRIME CONTRACTOR

Company Name	Contract Number	Street Address	City	State	Zip Code

SMALL BUSINESS SUBCONTRACTOR

Company Name	Certification Type(s) (SB, SB-Micro, SB-PW)	OSDS No.	Street Address	City	State	Zip Code

PAYMENT INFORMATION

Total Contract Amount (\$) (including amendments)	Total Dollars (\$) Paid to Prime	Total Dollars (\$) Paid to SB Subcontractor	Total Percentage (%) Committed to SB Subcontractor	Total Dollars (\$) Committed to SB Subcontractor	Explanation for Difference Between Commitment Amount and What was Paid to SB Subcontractor

PRIME CONTRACTOR - AUTHORIZED REPRESENTATIVE

Print Name	Email	Signature
Title	Phone	Date Signed

EXHIBIT F

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

BIDDER'S BOND

We _____

_____, as **PRINCIPAL**, and

as **SURETY**, are held and firmly bound unto the State of California in the penal sum of TEN PERCENT (10%) OF THE TOTAL AMOUNT OF THE BID of the Principal above named submitted by said Principal to the State of California, acting by and through the Department of Water Resources, for the work described below, for the payment of which sum in lawful money of the United States, well and truly to be made, to the Director of the Department to which said bid was submitted, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

In no case shall the liability of the surety here under exceed the sum of \$ _____.

THE CONDITION OF THIS OBLIGATION IS SUCH,

That whereas the Principal has submitted the above-mentioned bid to the State of California, as aforesaid, for certain construction specifically described as follows, for which bids are to be opened at

_____, California, on _____,
(Insert name of city where bids will be opened)

_____,
(Insert date of bid opening)

for _____

(Copy here the exact description of work, including location, as it appears on the proposal)

NOW, THEREFORE, If the aforesaid Principal is awarded the contract and, within the time and manner required under the specifications, after the prescribed forms are presented to him for signature, enters into a written contract, in the prescribed form, in accordance with the bid, and files two bonds with the Department, one to guarantee faithful performance and the other to guarantee payment for labor materials, as required by law, then this obligation shall be null and void; otherwise, it shall be and remain in full force and virtue.

IN WITNESS WHEREOF, We have hereunto set our hands and seals on this _____
day of _____, 20____.

[Seal]

[Seal]

[Seal]

Principal

[Seal]

[Seal]

[Seal]

Surety

Address _____

NOTE: Signatures of those executing for the surety must be properly acknowledged.

EXHIBIT G

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

NON-COLLUSION DECLARATION TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID FOR PUBLIC WORKS

The undersigned declares:

I am the _____ of _____ the party
making the foregoing bid.

The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder. All statements contained in the bid are true. The bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof, to effectuate a collusive or sham bid, and has not paid, and will not pay, any person or entity for such purpose.

Any person executing this declaration on behalf of a bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity, hereby represents that he or she has full power to execute, and does execute, this declaration on behalf of the bidder.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on _____ (date), at _____ (city), _____ (state).

Signed: _____

Print/Type Name _____

EXHIBIT H

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

PAYMENT BOND

WHEREAS, The State of California acting by and through the

_____, has awarded
(insert name of the Department awarding the contract)

to _____,
as Contractor, a contract for the work described as follows:

AND WHEREAS, Said Contractor is required to furnish a bond in connection with said contract, to secure the payment of claims of laborers, mechanics, materialmen, and other persons as provided by law;

NOW, THEREFORE, We the undersigned Contractor and surety are held and firmly bound unto the State of California in the amount required by law, the sum of _____

_____ dollars
(\$ _____), for which payment well and truly to be made we bind ourselves, our heirs, executors and administrators, successors or assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH,

That if said Contractor, it or its heirs, executors, administrators, successors or assigns, or subcontractors, shall fail to pay any of the persons named in Civil Code Section 9100, or amounts due under the Unemployment Insurance Code with respect to work or labor performed by any such claimant, or amounts required to be deducted, withheld and paid over to the Employment Development Department from the wages of employees of the Contractor and subcontractors under Section 13020 of the Unemployment Insurance Code with respect to the work and labor, that the surety or sureties herein will pay for the same in an amount not exceeding the sum specified in this bond, otherwise the above obligation shall be void. In case suit is brought upon this bond, the said surety will pay a reasonable attorney's fee to be fixed by the court.

This bond shall inure to the benefit of any of the persons named in Civil Code Section 9100 as to give a right of action to such persons or their assigns in any suit brought upon this bond.

IN WITNESS WHEREOF, We have hereto set our hands and seals on this _____
day of _____, 20____

Contractor

Name of Surety

By _____
Attorney-in-Fact

[[Seal]]

Address _____

Telephone No. _____

NOTE: Signatures of those executing for the surety must be properly acknowledged.

EXHIBIT I

State of California

DEPARTMENT OF WATER RESOURCES

California Natural Resources Agency

(Approved by Attorney
General 10/17/68)

PERFORMANCE BOND TO ACCOMPANY CONTRACT

(Sec. 78(b) Title 11
Administrative Code)

WHEREAS, The State of California acting by and through the

_____, has awarded
(insert name of the Department awarding the contract)

to _____,

as principal hereinafter designated as the "Contractor," a contract for

AND WHEREAS, The Contractor is required to furnish a bond in connection with said contract guaranteeing the faithful performance thereof;

NOW, THEREFORE, We the undersigned Contractor and surety are held and firmly bound unto the State of California in the sum of

_____ dollars (\$_____), to be paid to the said State or its certain attorney, its successors and assigns; for which payment, well and truly to be made, we bind ourselves, our heirs, executors and administrators, successors or assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH,

That if the Contractor, his or its heirs, executors and administrators, successors or assign, shall in all things stand to and abide by, and well and truly keep and perform the covenants, conditions and agreements in the foregoing contract and any alteration thereof made as therein provided, on his or its part to be kept and performed at the time and in the manner therein specified, and in all respects according to their true intent and meaning, and shall indemnify and save harmless the State of California, its officers and agents, as therein stipulated, then this obligation shall become and be null and void; otherwise it shall be and remain in full force and effect.

IN WITNESS WHEREOF, We have hereto set our hands and seals on this
day of _____, 20_____.

_____(Seal)

_____(Seal)

Contractor

_____(Seal)

_____(Seal)

Name of Surety

By _____(Seal)

Attorney-in-Fact

[Seal]

NOTE: Signatures of those executing for surety must be properly acknowledged.