RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	6/28/99	Initial issue in Facility Engineering Manual	Doug Volkman, *PM-2*	Dennis McLain, *FWO-FE*
1	2/9/04	Incorporated IBC & ASCE 7 in place of UBC 97; incorporated DOE-STD-1020-2002 versus 1994; incorporated concepts from DOE O 420.1A; FEM became ESM, an OST.	Mike Salmon, *FWO-DECS*	Gurinder Grewal, *FWO-DO*
2	5/17/06	Added PC-0; minor editorial changes; OST became ISD.	Mike Salmon, *D-5*	Mitch Harris, *ENG-DO*
3	10/27/06	Administrative changes only. ISD number changed based on new Conduct of Engineering IMP 341.	Mike Salmon, *D-5*	Kirk Christensen, *CENG*
4	6/19/07	Added caution note for new projects at 1.0.C based on data from 2007 Update of Probabilistic Seismic Hazards Assessment and resulting increased seismic design basis.	Mike Salmon, *D-5*	Kirk Christensen, *CENG*
5	4/30/12	Admin change to 2.2.B.	Mike Salmon, *CENG*	Lawrence Goen, *CENG*
6	3/27/15	Incorporation of ASME NQA-1 2008/9, IBC 2015, and CMRR lessons.	Mike Salmon, *AET-5*	Mel Burnett, *ES-FE*

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Section IV – GEOTECHNICAL INVESTIGATIONS

1.0 GENERAL

1.1 APPLICABILITY

A. This section is applicable to all Los Alamos National Laboratory (LANL) projects where structures, systems and components (SSC) being constructed either support or are supported by soil.

B. A geotechnical investigation is required unless waived by the LANL Building Official in accordance with the IBC (*2015 Section 1803.2*).[1] Waiver requests must be submitted using Form 2137, CoE Request for Variance or Alternate Method.

1. *For New Construction – normally required where the failure of the SSC could lead to either 1) serious injury or loss of life of personnel, or 2) loss of function critical to mission or program needs.*

2. *Existing SSCs - normally applicable to all LANL modification projects where:*

   a. *The modification creates a condition outside of the scope considered in the original design which 1) increases the demand the SSC imposes on the soil, 2) increases the demand the soil imposes on the SSC, or 3) reduces the capacity of the SSC to resist demand by the soil, and*

   b. *The failure of the SSC could lead to either 1) serious injury or loss of life of personnel or, 2) loss of function critical to mission or program needs.*

1.2 GRADED APPROACH BASED ON MANAGEMENT LEVEL (ML)

Geotechnical investigations for ML-3 and ML-4 SSCs shall, at a minimum, comply with the requirements of the IBC as modified by this Chapter (see *Section 1803 in 2015*) and this section. Geotechnical investigations for new ML-1 and ML-2 SSCs for nonreactor nuclear facilities and major modifications thereto (hereafter referred to only as ML-1/2) shall, at a minimum, comply with the requirements of the IBC; ASME NQA-1-2008/NQA-1a-2009 [applicable sections of Part I and Part II Subparts 2.7 (if safety software is used for analyses), 2.14 (if commercial grade dedication is used) and 2.20]; and this document. Where conflicts occur between requirements the more stringent shall apply.

The scale of the geotechnical investigation is driven by the geotechnical engineering properties required by the designer of the SSC. This ESM section provides guidelines for sampling and testing; however, it will not prescribe the sampling and tests that need to be performed due to the variability in the information required from project to project. The extent of sampling and testing required will be determined on a project-by-project basis. **For all geotechnical investigations a Geotechnical Investigation Plan shall be developed.** The Geotechnical Investigation Plan shall describe the proposed test pits, trenches, shafts, excavations, borings and the suite of both in-situ and laboratory tests that will be performed in order to adequately define the geotechnical information needed by the project.

1.3 QUALITY REQUIREMENTS

Quality assurance requirements are substantially based on NQA-1, Subpart 2.20 which basically requires that geotechnical investigations be:

[1] Not required for temporary facilities such as transportables with ML-4 mission

1. *Planned to provide the required information,*
2. *Performed according to approved procedures or work instructions,*
3. *Performed by qualified workers,*
4. *Verified to ensure item 2 and 3 are fulfilled, and*
5. *Documented adequately to demonstrate that items 1, 2, 3, and 4 have been fulfilled.*

These five high level requirements are good practice for all geotechnical investigations, regardless of the project Management Level. Therefore, quality requirements will have similarities between Management Levels. Sections 1.3.1 through 1.3.3 discuss some of the QA requirements that are unique to certain Management Levels.

1.3.1 Planning Requirements

Projects required to have a geotechnical investigation must submit a Geotechnical Investigation Plan for acceptance by LANL.

A. ML-3/4 SSCs – The Geotechnical Investigation Plan must be prepared and its execution overseen by a Professional Engineer Licensed in the State of New Mexico. The LANL project engineer must engage a structural SME to review prior to accepting/proceeding.

B. ML-1/2 SSCs– The Geotechnical Investigation Plan must be prepared and its execution overseen by a Professional Engineer Licensed in the State of New Mexico with previous experience in the geotechnical aspects of the design of the type (i.e. non-reactor nuclear, biological, etc.) of facility being considered.

1. The LANL project engineer must engage the Structural Chapter POC who will initiate an SME review prior to acceptance. QA review is also recommended.

1.3.2 Qualification Requirements

A. ML-3/4 SSCs – As required by ESM Chapter 16, testing firms performing geotechnical field or lab analysis work shall be listed on the ESM Chapter 16 "Listing of Approved IBC Testing Agencies and Fabricators." *This normally necessitates AMRL certification (when available) for the ASTM procedures being used.*

B. ML-1/2 SSCs – Same requirement as above. In addition, unless Subcontractor services are dedicated in accordance with ASME NQA-1, Part II, Subpart 2.14, Subcontractors performing geotechnical investigations are required to establish and implement an ASME NQA-1 compliant QA Plan.

1.3.3 Verification Requirements

Verification refers to the checks made by those not performing the work to ensure the requirements of the plan are being implemented. This is to verify the right procedure is specified, that the procedure is being followed, by trained personnel, using the proper equipment.

A. ML-3/ML-4 SSCs –

1. For each process for which documentation is required, the documents shall contain the signature and date of the preparer or initiator and the signature and date of a checker or approver. The checker or approver cannot be the person who performed the work, but may be a person involved in the work.

2. Audits or surveillances may be conducted by LANL if deemed appropriate for the work being performed.

B. ML-1/ML-2 SSCs –

1. In addition to the requirement for checkers/approvers for ML-3/ML-4 SSCs, the Geotechnical Investigation Plan checking and verifying field, laboratory, and engineering activities shall be in accordance with ASME NQA-1, Part II, Subpart 2.20, Section 300, Verification Requirements.

2. Calculations and analyses shall be reviewed by LANL.

3. Audits or surveillances may be conducted by.

1.4 GEOTECHNICAL INVESTIGATION PLAN CONTENT

All geotechnical investigations performed at LANL shall submit a Geotechnical Investigation Plan to the LANL project engineer for acceptance prior to the initiation of field activities. The Geotechnical Investigation Plan shall, at a minimum, include the following information.

A. A brief description of the purpose of the investigation, the proposed SSC(s) and the geotechnical engineering parameters required for the design of the facility.

B. The proposed personnel in responsible charge of the investigation including any subcontractors used to perform field or laboratory work.

C. A scaled plot showing the project area, with the proposed location of any SSCs, and the proposed location of the field exploration borings, tests, samples, and/or test pits. The location of the items on the plot shall be tied to some type of benchmark which can be used to accurately locate the exploration points in the field relative to the actual location of the SSC. (See part 2.1 of this section.)

D. A description of the field exploration necessary to obtain data or samples needed to derive the required engineering parameters. Each field exploration process (boring, testing, sampling, sample handling, etc.) shall reference an applicable ASTM procedure or company specific written work instruction. Include examples of field log forms.

E. A description of the laboratory testing necessary to obtain the required engineering parameters. Each laboratory test process shall reference an applicable ASTM procedure or company specific written work instruction.

F. A description of any geotechnical analyses or calculations necessary to provide the required engineering parameters.

G. An outline of the proposed geotechnical engineering report.

H. Geotechnical Investigation plans for less-than-ML-2 SSCs shall address the requirements of the IBC including LANL amendments (*at time of writing, these amendments included changes at 1803.5.12 regarding soil-structure interaction and 1809.13 regarding footing seismic ties.)*

I. Geotechnical Investigation plans for ML-1/ML-2 SSCs shall include additional information required by ASME NQA-1, Part II, Subpart 2.20, Paragraph 201, Planning. In addition, at time of writing, ESM Ch. 5 Section III discusses geotechnical requirements under the Lateral Soil Pressure Loads (H) and Foundation Design headings.

The format and layout should be concise, avoiding the inclusion of excessive verbiage and attachments. ASTM and other nationally recognized procedures need only be referenced and do

not need to be submitted. Company specific work instructions shall be submitted with the Geotechnical Investigation Plan for acceptance by LANL. Justification shall be provided when a company specific work instruction is used for a process covered by an existing ASTM procedure.

Proposed deviations from the accepted Geotechnical Investigation Plan shall be submitted in writing and accepted by the LANL project engineer and original SME reviewers prior to performing work affected by the change. Revisions and changes to company specific instructions and procedures shall be submitted as deviations.

1.5 GEOLOGY AT LANL

1.5.1 Geologic Environment

A majority of LANL is situated in a geologic setting of layered volcanic deposits of tuff. The following reports are excellent resources for information regarding the structural geology at Los Alamos National Laboratory. These reports are available in electronic form from the LANL Research Library and may be useful in planning a geotechnical investigation.

A. Broxton, D.E. and Reneau, S.L., 1995, "Stratigraphic Nomenclature of the Bandelier Tuff for the Environmental Restoration Project at Los Alamos National Laboratory", Report LA-13010-MS, Los Alamos National Laboratory, Los Alamos, NM.

B. Gardner, J.N. et al, 1999, "Structural Geology of the Northwestern Portion of Los Alamos National Laboratory, Rio Grande Rift, New Mexico: Implications for Seismic Surface Rupture Potential from TA-3 to TA-55", Report LA-13589-MS, Los Alamos National Laboratory, Los Alamos, NM.

1.5.2 Conceptual Design Values

Table IV-1 provides geotechnical engineering parameter values that may be used for conceptual design. These are based on previous investigations at LANL. Only values for the upper tuff layers, in which foundations are likely to bear, have been provided. These values are provided for the purpose of planning and bidding and are not to be used as final design values unless supported by a project-specific investigation.

Table IV-1: Conceptual Design Values

Tuff Unit	Moist Unit Weight, pcf[2]	Friction Angle, ϕ, degrees[1]	Apparent Cohesion, c, psi[1]	Unconfined Compressive Strength, psi[1]	Shear Wave Velocity (ft/sec)[3]	Modulus of Elasticity, ksi (E)[1]	Poisson's Ratio[1]
Recompacted tuff fill	114	32	0	N/A	1050	9.5	0.3
Qbt4	76	33	4	262	1000	95	0.24
Qbt3U	101	45	7	585	1640	286	0.16
Qbt3L	89	33	13	20	1050	5.8	0.38
Qbt2	119	60	67	2248	2450	1030	0.24

[2] Geotechnical Engineering Report Chemistry and Metallurgy Research Facility Replacement (CMRR) Project, Rev. 0, May 25, 2007, Tables VIII-2a and 2b
[3] Ibid, Table VIII-3b

2.0 FIELD EXPLORATIONS

2.1 SURVEY CONTROL

All field exploration elements (i.e., borings, test pits, trenches, shafts, excavations, in situ testing) shall be laid out according to the Geotechnical Investigation Plan based on an official benchmark. Coordinate systems and benchmarks shall conform to the requirements of the LANL Engineering Standards Manual Chapter 3- Civil, Section G10-30GEN General Requirements (*Part 5.0-Surveying*). Surveying for ML-1/ML-2 shall also meet the requirements of ASME NQA-1, Part II, Subpart 2.20, Paragraph 404, *Surveying Requirements*.

2.2 BORING METHODS

A. All procedures to be used to advance and maintain the hole and take and protect samples should be clearly described and included in the Geotechnical Investigation Plan before the onset of the exploration program.

B. Unless otherwise specified in the geotechnical investigation plan, instructions, or procedures, borings for ML-1/ML-2 SSCs shall be advanced in such a manner as to satisfy the requirements of ASTM D 1452, *Standard Practice for Soil Exploration and Sampling by Auger Borings*, ASTM D 1586, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*, ASTM D 1587, *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purpose*, or other accepted standards.

C. The boring program should make use of methods of drilling that can maintain the hole open without significant caving of the sides. Casing or viscous drilling fluid can be used to advance the borings if there is danger of collapse of the uncased hole. The type of casing shall consider the compatibility with any required subsequent geophysical measurements. If perched or other ground water is encountered at the site, the drilling fluid should be of the revert type.

D. If perched or ground water is encountered in the boring and if ground water is considered important in the foundation evaluation, screened well points shall be placed in about 10% of the borings after completion of the borings to monitor water levels.

2.3 TEST HOLE SPACING

A. For new construction utilizing shallow foundations (footings, slabs), borings should be located uniformly every 2,500 square feet (50 ft by 50 ft grid) across the plan area of the SSC. The plan area to be considered in the investigation includes the footprint of the facility together with sufficient area outside the building footprint within the zone of influence of the foundation. For most SSCs, a minimum of three (3) borings are required.

B. The spacing of borings can be increased to allow for 1 boring per 10,000 square feet (i.e., spacing at 100’ x 100’) of building footprint area provided sufficient justification is provide for the reduced scope of the investigation. This justification should be based on other information available for the site and only after evaluation by a licensed geotechnical engineer. Items such as whether the facility will be founded on rock or soil, uniformity of material properties encountered across the plan area and average design foundation pressures need to be evaluated to justify the increased spacing.

C. For facilities that will be supported on deep foundations (piles, piers, caissons, etc.), the required spacing of borings may be reduced to about 1,600 square feet (40 ft by 40 ft

grid). This spacing cannot be increased unless the piles are to be founded in rock[4] (or tuff) and adequate information is provided to assure relatively uniform properties of the supporting foundation material. For facilities supported on heavily loaded caissons, one boring should be provided at each caisson location.

2.4 DEPTH OF BORINGS

A. The depth of exploration depends on the size and type of the facility foundation and should be sufficient to assure that the supporting soil/rock has sufficient bearing capacity to provide adequate safety factor against foundation failure and adequate stiffness to minimize settlements under the design loads.

B. The depth of borings shall be based on the "10% rule" typically used in foundation analysis, if the borings are founded in soil. This critical depth is defined as the depth at which the vertical stress increment caused by the foundation is equal to 10% of the initial effective overburden stress beneath the foundation.

C. Borings encountering rock (or soil of exceptional bearing capacity) need not extend beyond 20 feet into the stratum to assure that sound material has been encountered and not merely boulders.

D. The minimum depth of any borings shall be 25 feet below the lowest foundation element, provided all other criteria listed above are satisfied.

E. For ML 1/ ML-2SSCs the boring depth will likely need to be greater than 25 feet below the lowest foundation element due to the need for site response and soil-structure interaction analysis information.

2.5 IN-SITU TESTING

A. Location – The planned location and/or frequency of in-situ testing shall be clearly indicated in the Geotechnical Investigation Plan.

B. Procedures – All in-situ testing shall conform to procedures included in the Geotechnical Investigation Plan.

C. Equipment – All equipment used for in-situ testing shall have current calibration and be used according to the appropriate procedure by personnel trained in its use.

D. Personnel – Personnel performing the testing shall be trained in the use of the testing equipment according to the test procedure.

2.6 SAMPLING

2.6.1 Soil Samples

A. All borings taken during the preliminary boring phase shall include Standard Penetration Test (SPT) split-barrel sampling per ASTM D 1586, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*, of all soils encountered during the program. These samples shall be taken at five-foot intervals throughout the depth of each boring.

B. Each soil sample so obtained shall be visually classified following the criteria of the Unified Soil Classification System (USC) described in D2487, *Practice for Classification*

[4] ASCE 4-98, Section 1.2 defines rock as "any material with shear-wave velocity of 3,500 ft/s or more."

of Soils for Engineering Purposes (Unified Soil Classification System. SPT samples shall be jarred (and sealed if wet) if required for further laboratory testing and evaluation.

2.6.2 Rock and Rock-like Samples

A. If foundation rock is encountered (SPT blow counts exceeding 100 bpf), the material shall be sampled by NX size diamond drill core barrel (or approved equal) to obtain continuous core samples of the foundation rock. Description of the material should include rock type, hardness, recovery ratio and Rock Quality Designator (RQD). For tuff material, the descriptors in Table IV-2 should be used. The retention and storage of recovered core that is not used for testing shall be coordinated with the Project Engineer.

Table IV-2: Terminology for In-Situ Tuff

General Property	Descriptive Term	Visual or Physical Properties
Weathering	Very Weathered	Abundant fractures coated with oxides, carbonates, sulfates, mud, etc., thorough discoloration, rock disintegration, mineral decomposition
	Moderately Weathered	Some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition
	Slightly Weathered	A few stained fractures slight discoloration, little to no effect on cementation, no mineral decomposition
	Fresh	Unaffected by weathering agents, no appreciable change with depth
Fracturing	Intensely Fractured	Less than 1 in. spacing
	Very Fractured	1 in. to 6 in. spacing
	Moderately Fractured	6 in. to 12 in. spacing
	Slightly Fractured	12 in. to 36 in. spacing
	Solid	36 in. spacing or greater
Stratification	Thinly Laminated	Less than 1 /10 in
	Laminated	1 /10 in. to ½ in
	Very Thinly Bedded	½ in. to 2 in
	Thinly Bedded	2 in. to 2 ft
	Thickly Bedded	more than 2 ft
Hardness	Soft	Can be dug by hand and crushed by fingers
	Moderately Hard	Friable, can be gouged deeply with knife and will crumble readily under light hammer blows
	Hard	Knife scratch leaves dust trace, will withstand a few hammer blows before breaking
	Very Hard	Scratched with knife with difficulty, difficult to break with hammer blows

2.6.3 Undisturbed Samples

A. The program for undisturbed sampling, if required, shall be presented for approval in the Geotechnical Investigation Plan.

B. Undisturbed samples are required if stipulated by the lab testing procedures indicated in the Geotechnical Investigation Plan.

C. Undisturbed soil samples can be considered if soil types are encountered during the exploration where these samples are considered appropriate to develop foundation parameters of interest to the foundation design.

D. Undisturbed samples, if required, should be taken with a sampler having a low area ratio (less than 15%), should have a recovery of at least 95% and should show no significant visual disturbance of the sample when extruded.

E. Enough undisturbed samples shall be taken of the strata to provide a statistically defensible estimate of the average strength and stiffness of the material. Typically, such samples are spaced at 10 foot-increments through the depth where such samples are appropriate.

F. The samples must be adequately protected from disturbance during shipment and handling.

2.6.4 General Sample Requirements

A. Identification of samples shall be affixed to the sample tubes or containers, which will maintain the integrity of the samples for the specified period of storage.

B. Samples shall be stored in locations where they will be protected from damage.

C. Labels shall be affixed to sample tubes with all pertinent information.

D. Tube and boring numbers shall be marked in duplicate.

E. Undisturbed samples shall be stored in a controlled environment in which the ambient temperature and humidity are maintained at predetermined levels.

F. Samples shall be shipped, protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

G. Test specimens shall be prepared in accordance with applicable ASTM Standards unless otherwise specified.

2.7 FIELD LOGS

A. Include a unique identifier tied to the Geotechnical Investigation Plan drawing and final report including coordinates and elevation.

B. A continuous final log of the boring shall be provided that indicates the drilling method used to place the boring and take samples, location of the borehole, sample types, and a graphic log with elevations of the ground surface, and depths of major strata and samples.

C. For soil samples, the log should include sample blow counts (if appropriate), a description of the material encountered (including color of tuff, and a visual classification), soil classification according to the USC system described in D2487, *Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System*, and location of any water encountered.

D. For rock samples, the log should indicate as a minimum rock descriptors, rock hardness, and recovery and RQD ratios. Any abnormalities in the strata shall be noted.

E. The final boring log prepared for the program shall additionally include estimated dry density, moisture content, Atterberg limits (if appropriate), soil strength parameters,

resistivity and other geophysical parameters determined during the field and laboratory testing program for all materials encountered in the program.

2.8 LANL-SPECIFIC CONSIDERATIONS RELATED TO GEOTECHNICAL INVESTIGATIONS

There are several LANL specific requirements that could potentially apply to geotechnical investigations field exploration activities. These include, but are not limited to:

A. Integrated Work Management safety process.

B. Excavation/Fill/Soil Disturbance Permit.

C. Security consideration for use of cameras or working in or near security areas.

D. Radiation protection –bringing radioactive sources on-site (i.e. nuclear densometer equipment) or working in potentially contaminated areas.

E. Environmental – NEPA planning.

F. Cultural and Biological Resources review.

These LANL processes should be coordinated with the LANL project engineer.

3.0 LABORATORY TESTING

A. Laboratory Quality Assurance Programs shall be in accordance with Paragraphs 1.2 and 1.3.2 of this document.

B. Procedures – All in-situ testing shall conform to procedures included in the Geotechnical Investigation Plan.

C. Equipment – All equipment used for testing shall have current calibration and be used according to the appropriate procedure.

D. Personnel – All personnel involved in testing activities shall be trained to an approved procedure.

4.0 ENGINEERING CALCULATIONS & ANALYSES

A. Calculations and analyses prepared to support determination of engineering properties used in the design of the facility shall be prepared in accordance with LANL Engineering AP 341-605,"Calculations" or a company specific procedure approved by the project's LANL QA representative or included in the Subcontractor's approved QA plan.

5.0 REPORT AND RECOMMENDATIONS

A. The final report shall be sealed by a Professional Engineer licensed in the state of New Mexico.

B. The final report shall include detailed descriptions of the field exploration methods, laboratory testing and analyses completed during the investigation.

C. The final report shall include recommendations for all engineering design parameters requested by the designer of the SSC.

D. The recommendations for foundation types should include criteria for design of foundations, including: ultimate bearing pressure, the factors of safety and allowable bearing pressures including the effect of both horizontal and vertical loads on the foundation elements, the ultimate and allowable capacities for lateral loads, modulus of subgrade reaction, and estimated vertical and horizontal displacements for the various load combinations used in the foundation designs.

E. The minimum recommended depth to the bottom of footings and slab foundations shall account for the potential effects of frost penetration. The minimum required foundation depth at LANL is 36 inches.[5]

F. If retaining structures (basement walls, retaining walls, etc.) are included in the project, the final design report shall provide recommended lateral design forces using lateral soil pressure coefficients applicable to the structural restraint provided. The coefficients of active, at rest and passive lateral pressure appropriate for both static and dynamic load conditions shall be provided. When lateral earth pressure recommendations are presented as equivalent fluids, calculations shall be submitted showing the derivation for the equivalent fluid properties.

G. Recommendations for the design for seismic lateral earth pressures shall be included. These recommendations shall, at a minimum, include the PGA from the site-specific LANL hazard; the load application method per ASCE 4 (*Section 3.5.3 in 1998*), and any modification factors that should be applied to the acceleration values used for design.

H. For both shallow and deep foundations, the recommended methods for their installations shall be provided together with the potential impact of their installation on adjacent structures.

I. For engineered fill/backfill materials, the final design report shall include recommendations for lift thickness, grain size requirements, moisture content, quality control testing, and compaction methods. These shall include frequency of grain size measurements, moisture content measurements and density tests as well as acceptance criteria for each. The report shall provide recommendations regarding equipment to be used for site preparation and grading.

J. Use of recompacted tuff as backfill material.

1. Where recompacted tuff is planned to be used, the report shall include a note regarding appropriate methods for compaction and frequency of density tests.
2. Experience has shown that the tuff can be overworked making achievement of target densities difficult. Furthermore, the fines created by overworking may lead to frost heave issues in areas with a potential water source (drainage or broken pipe).
3. Sheeps-foot type compaction has the greatest tendency to overwork the material. Smooth vibratory type compaction is recommended.

K. The report shall provide recommendations for design of temporary excavation support and soil embankments, if applicable, together with criteria used for their design.

L. Appendices to the report shall include, but not be limited to, the following items if applicable.[6]

[5] From ESM Ch. 5 Section II rev. 9 regarding IBC 1809.5 Frost protections

Item	Required for all Work	Only Required for ML-1/2
1. Plan drawing(s) of the project area with actual locations of field exploration activities	X	
2. Surveying records	X	
3. Field and laboratory logs and test data	X	
Calculations and analyses	X	
Laboratory and in-situ test reports	X	
Measuring and test equipment control and calibration records	X	
Test deviations or exceptions records	X	
Checks, verifications, and examination records		X
Procurement control records		X
Reports of nonconforming equipment		X
Procurement control records		X

M. Bearing Capacities – Code minimum bearing capacities shall only be used when a geotechnical investigation is not required. Where the necessary engineering properties are available, calculations shall be submitted showing the derivation of the recommended bearing capacities.

N. Use of existing data – When existing data (e.g. friction angles and unit weights based on soil classification) is used in lieu of values based on measured data, it shall be clearly identified as existing data, the source shall be clearly identified, and justification for using published data shall be provided. Existing data does not include information that is accepted by the scientific and engineering community as an established fact (e.g., engineering handbooks, density tables, gravitational laws, etc.).

1. Use of existing data for ML-1/ML-2 activities requires LANL approval and should be qualified in accordance with AP-341-511, *Design Information Reconstitution* (instead use AP-341-513, *Qualification of Existing Data*) or a company specific procedure (approved by the project's LANL QA representative or included in the Subcontractor's approved QA plan) based on the guidance provided in ASME NQA-1-2008, Part III, Subpart 3.3, Nonmandatory Appendix 3.1, *Guidance on Qualification of Existing Data*.

O. The format of the report shall be logical, legible and include all the required content.

[6] See ASME NQA-1, Subpart 2.20, Paragraph 700