Progress Energy

Serial: NPD-NRC-2011-046 10 CFR 52.79
May 27, 2011

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

LEVY NUCLEAR PLANT, UNITS 1 AND 2
DOCKET NOS. 52-029 AND 52-030

REVISION TO RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 087 RELATED TO SEISMIC DESIGN PARAMETERS

Reference:
1) Letter from Terri Spicher (NRC) to Garry Miller (PEF), dated March 17, 2010, "Request for Additional Information Letter No. 087 Related to SRP Section 3.7.1 for the Levy County Nuclear Plant, Units 1 and 2 Combined License Application"
2) Letter from John Elnitsky to NRC, dated July 19. 2010, "Response To Request For Additional Information Letter No. 087 Related To Seismic Design Parameters", Letter Serial NPD-NRC-2010-060
3) Letter from John Elnitsky to NRC, dated November 10. 2010, "Supplement 1 To Response To Request For Additional Information Letter No, 087 Related To Seismic Design Parameters", Letter Serial NPD-NRC-2010-087

Ladies and Gentlemen:

Progress Energy Florida, Inc. (PEF) hereby submits our revised response to the Nuclear Regulatory Commission's (NRC) request for additional information provided in the referenced letter.

A response to the NRC request is addressed in the enclosure. The enclosure also identifies changes that will be made in a future revision of the Levy Nuclear Plant Units 1 and 2 application.

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (727) 820-4481.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on May 27, 2011.

Sincerely,

John Elnitsky
Vice President
New Generation Programs & Projects

Enclosure

cc : U.S. NRC Region II, Regional Administrator
Mr. Brian C. Anderson, U.S. NRC Project Manager

Progress Energy Florida, Inc.
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NRO

Levy Nuclear Plant Units 1 and 2
Response to NRC Request for Additional Information Letter No. 087 Related to SRP Section 3.7.1 for the Combined License Application, dated March 17, 2010

NRC RAI #	Progress Energy RAI #	Progress Energy Response
03.07.01-02	L-0727	July 19, 2010; Serial: NPD-NRC-2010-060
03.07.01-02	L-0865	November 10, 2010, Serial NPD-NRC-2010-087
03.07.01-02	L-0926	Response enclosed – see following pages

NRC Letter No.: LNP-RAI-LTR-087

NRC Letter Date: March 17, 2010

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 03.07.01-02

Text of NRC RAI:

In the applicant's response to Question 03.07.01-1 of RAI 2318 (NRC Letter No. 046), the applicant describes the approach used to develop revised site specific seismic ground motions (response spectra). These analyses include engineered fill as part of the soil columns used to develop the ground surface spectra. However, it is not clear from the discussion what the extent of the changes to the site (excavation and placement of engineered fill) are planned and if these changes are to such an extent as to affect the seismic ground motion. Thus, the staff is requesting the applicant to provide information regarding the extent of planned excavation and placement of engineered backfill and an assessment of whether these changes are sufficiently extensive such that the surface ground motion would be modified. Additionally, please provide a discussion that summarizes the planned construction sequence of removal of near surface soils, placement of engineered fill, drilled shaft installation for adjacent structures, construction of the diaphragm wall, and excavation of soil material beneath the NI structures as it relates to potentially changing the ground motion as is inferred by incorporating the engineered fill in the SSI soil columns.

PGN RAI ID #: L-0926

PGN Response to NRC RAI:

This is a revised response to NRC Letter 087 RAI 03.07.01-02 (PGN RAI ID #: L-0727) submitted via Progress Energy Letter NPD-NRC-2010-060 dated July 19, 2010. The revised response incorporates revisions submitted via Progress Energy Letter NPD-NRC-2010-087 dated November 10, 2010. The revisions also address the following action items from the March 8-10, 2011 NRC Audit and NRC April 27-28, 2011 RCC test site visit:

1. The lateral extent of the controlled engineered fill beyond the AP1000 footprints to provide lateral support for the drilled shaft foundations of the adjacent buildings
2. Description of the drilled shaft conceptual design, key installation practices, and industry codes that will be specified for installation as discussed at the NRC March 2011 Audit and NRC April 2011 RCC test site visit.

Description of the civil construction sequence construction practices as discussed at the NRC March 2011 Audit and NRC April 2011 RCC test site visit.

The revised response to NRC Letter 087 RAI 03.07.01-02 is as follows:

Figures RAI 03.07.01-02-1 and RAI 03.07.01-02-2 show the conceptual grading plan and the conceptual grading section for the LNP site respectively. The plant Nuclear Island (NI) footprint (approximately 0.8 acres for each unit) is small compared to the approximately 347 acres where fill will be placed to raise the existing grade level. The existing grade in the plant footprint area is at approximate elevation 12.8 m (42 ft.) NAVD88. The finished grade in the 347 acre fill area will vary from elevation 15.2 m (50 ft.) NAVD88 to elevation 14.3 m (47 ft.) NAVD88. The grading is designed to prevent flooding of the work area during construction and plant operation.

Figure 2.5.2-296 presents the LNP horizontal and vertical GMRS at first competent in-situ soil layer [elevation 11.0 m (36 ft.) NAVD88]. RAI 03.07.01-01 Figure 1 presents the LNP horizontal and vertical PBSRS at design grade [elevation 15.5 m (51 ft.) NAVD88]. The PBSRS is higher than the GMRS for the entire frequency range. Thus use of the full soil column to the design grade elevation 15.5 m (51 ft.) NAVD88 leads to a higher free field seismic response.

Because of the large extent of the fill area compared to the NI footprint, and because the PBSRS is higher than the GMRS for the LNP site, inclusion of the fill to design grade for the free field response analysis and the SSI analysis is appropriate.

The backfill provides lateral support to the drilled shafts supporting the Turbine Building (TB), Annex Building (AB), and Radwaste Building (RB). Thus, the backfill will be controlled engineered fill under the footprint of the TB, AB, and RB and to a lateral extent of ~30 ft. beyond the building footprint as shown in Figure RAI 03.07.01-02-3. The controlled engineering fill will conform to the requirements for Engineered Fill as presented in FSAR Table 2.5.4.5-201. The remainder of the fill required for site grading shown in Figure RAI 03.07.01-02-1 will not be controlled engineered fill. As shown in Figure RAI 03.08.05-07-1 Revision 1, the TB, AB, and RB buildings are supported on 3 ft., 4 ft., and 6 ft. diameter drilled shafts. The seismic II/I interaction evaluations show that for drilled shafts up to 6 ft. in diameter, the lateral stiffness of the drilled shafts is primarily dependent on the soil property of the top 16 ft. of soil . The ~30 ft. lateral extent of the controlled engineered fill corresponds to the lateral extent of the passive wedge for engineered fill with a friction angle of 34° as specified in revised Table 2.5.4.5-201.

The second part of the RAI was clarified at the May 4, 2010 public meeting. In the public meeting, the NRC stated that the second part of the RAI is requesting information on how potential changes in soil properties due to foundation construction activities are accounted in the LNP seismic analyses. The foundation construction activities that may affect the in-situ soil properties include installation of the drilled shafts, installation of the diaphragm wall, and installation of the rock anchors for the diaphragm wall.

The construction methods and construction inspections used for installation of the drilled shafts, diaphragm wall, and the diaphragm wall anchors will minimize the extent of soil disturbance and avoid cave in. The holes for the anchors will be advanced using drilling techniques designed to minimize the disturbance to the surrounding soil. Such techniques may include the use of a casing, or drilling with water or drilling slurry (not air). The boreholes for the diaphragm wall anchors will be backfilled as the casing is extracted after the anchors are set in rock to avoid cave in. Alternatively, the casings will be backfilled and left in place. The drilled shaft construction methods and construction inspections and testing will follow guidance in ACI 336.1-01 and ACI 336.3R-93.

For the SSI analysis of the nuclear island (NI) the best estimate (BE), lower bound (LB), and upper bound (UB) soil profiles presented in RAI 03.07.01-01 Table 2, RAI 03.07.01-01 Table 3, and RAI 03.07.01-01 Table 4 respectively will be considered. To account for the potential degradation of soil due to foundation installation, an additional Lower LB case (LLB) will also be considered in the NI SSI analysis.

The volume of soil being disturbed by the drilled shaft installation, and diaphragm wall anchor installation is < 5 percent of the total soil volume in the vicinity of the NI. Assuming the disturbed soil around the drilled shaft and diaphragm wall anchors to have a soil shear modulus equal to ½ of the shear modulus of the corresponding soil layers, the average reduction in the soil shear modulus of the soil volume in the vicinity of the NI is < 2.5 percent. Thus, for the LLB soil profile, in-situ soil was conservatively assigned a shear modulus equal to 90 percent of the LB soil case as presented in Table RAI 03.07.01-02-1. As shown in Table 03.07.01-02-1, the fill layer shear modulus was not changed from the LB shear modulus because of the large variation from the

BE case already considered i.e., the coefficient of variation for the LB fill shear modulus is in the range of 4.02 to 6.13 from the BE fill shear modulus as shown in Table 03.07.01-02-1. Rock layer shear modulus for the LLB soil profile are the same as for the LB soil profile because the construction activities do not degrade the rock layer shear modulus.

At the March 2011 Audit and the April 27-28, 2011 RCC test site visit, the NRC requested information on the conceptual design of drilled shafts and for conceptual construction sequence for removal of near surface soils, placement of engineered fill, drilled shaft installation for adjacent structures, construction of the diaphragm wall, and excavation of soil material beneath the NI structures during construction.

Drilled Shaft Foundation Design and Installation

The seismic category II and non safety-related adjacent buildings (Turbine Building, Annex Building, and Radwaste Building) are supported on drilled shafts as shown in Figure RAI 03.08.05-07-1 Revision 1. The conceptual drilled shaft design and installation information provided here will be incorporated in the final design drawings and associated construction specifications as follows:

- The conceptual layout and sizes of the drilled shafts used to support the adjacent buildings is shown in Figure RAI 03.08.05-07-1 Revision 1. The conceptual design of the drilled shaft socket shows that a 10 ft. socket length is sufficient for current loading provided that the rock has a minimum RQD of 25 percent. The load capacity of the drilled shaft socket is based on the average from the AASHTO and NAVFAC methods. The construction of the drilled shaft foundation for the TB, AB, and RB buildings will consider the measured RQD and the final building loads.
- The rock socket is designed on the basis that the rock surrounding the socket will have a RQD of at least 25 percent over the full depth of the rock socket. The design of the rock socket will take no credit for the rock above the rock socket, having a depth of 2 ft., regardless of the RQD of the rock in this zone. The top of rock, design top of the rock socket, and design bottom of the rock socket will be specified on the construction drawings. A pilot hole will be drilled at the location of each shaft, with core obtained over depth of the expected socket plus at least two socket diameters. If the pilot hole indicates that the RQD does not meet design requirements, the rock socket will be extended to a new design depth based on the core obtained from the pilot holes. The drilled shaft will derive its vertical load carrying capacity entirely from the rock socket. Thus, soil properties will not be measured in the pilot hole program.
- Shaft excavation through the overburden will be performed using a construction methodology designed to minimize the disturbance to the surrounding soils. This may include installing the drilled shafts using either the "dry" or "wet" methods. Advancing the hole through the overburden with air shall be prohibited. A steel casing will be used to maintain the sidewalls of the hole as the drilled shaft is excavated. The steel casing will extend from the ground surface to the top of rock, and will be "twisted" into rock. The steel casing will be left in place as a permanent feature.
- Rock sockets will be telescoped downward inside the casing with a lip at the top of the socket to allow for seating of the casing. Rock sockets will be cleaned, pumped dry if practicable, and inspected before concrete is placed. The inspection of the rock socket will preferably be through remote visual observations. If this is not practicable a Shaft Inspection Device (SID) will be used. The time lapse between inspection and cleaning, and concrete placement shall be minimized to limit degradation of the exposed sidewalls and bottom of the excavation.

- The acceptance criteria for the inspecting engineer/geologist shall be as follows:
  - The bottom of the socket shall be free of all deleterious material, loose cuttings and muck. If the dry method of construction is specified, the excavation shall be reasonably dry and ready to receive concrete. Pumping shall be used to achieve a reasonably dry socket bottom, if necessary. If it is not practicable to achieve a reasonably dry socket bottom in the judgment of the inspecting engineer/geologist, the contractor may place loose cement at the bottom immediately prior to placing tremie concrete. If the rate of water inflow is excessive in the judgment of the inspecting engineer/geologist, the inspecting engineer/geologist may call for grouting on a case-by-case basis, or wet construction methods for concrete placement will be followed as specified in ACI 336.1-01 and ACI 336.3R-93.
  - For 6 ft. diameter drilled shafts, the exposed side wall rock of the socket will be judged by the inspecting engineer/geologist to have an RQD equal to or greater than 25 percent based on counting fractures, joints and bedding planes on the exposed side wall of the socket. The inspecting engineer/geologist preferably will use remote visual observations to inspect the sidewall of the socket. Field notes and sketches shall be kept by the inspecting engineer/geologist. For 3 ft. and 4 ft. diameter drilled shafts, the minimum RQD determination may be made from the rock core data obtained during the pilot hole program.
- During construction or inspection of the drilled-out socket, if it is determined that, in spite of the core retrieved from the pilot holes drilled in advance of the rock socket drilling, the RQD is not at least 25 percent over the full depth of the socket, the following measures will be taken:
  - If the core from the pilot hole indicates that the RQD is improving with depth and the rock socket design depth can be achieved by drilling the socket deeper to a reasonable depth (approximately one shaft diameter), the design socket depth will be extended.
  - If based on the cuttings from the socket drilling and/or the core from the pilot holes, there is no basis for drilling a deeper socket, then the rock at the base of the socket already drilled will be grouted (mix and design pressure to be determined at the time of construction). For 3- and 4-ft. diameter sockets, the grouting may be achieved with a packer system installed in the pilot hole. For 6-ft. diameter sockets, two or three grout holes will be drilled and grouted over a depth equal to the design depth of socket plus one diameter.
- The contractor shall drill a test drilled shaft to verify the constructability of his proposed casing installation procedure, rebar cage installation procedure and tremie operation. The test shaft will be drilled and tested by geophysical means to assure the integrity of the completed concrete shaft.

Construction Sequence of Civil Work

The conceptual design and construction methods of LNP site specific civil work within and around the nuclear island and the Seismic Category II and non safety-related adjacent buildings' footprint are summarized in the following FSAR Subsections:

- Diaphragm Walls and Grouting: Subsection 2.5.4.5.1
- Excavation: Subsections 2.5.4.5.2 and 2.5.4.5.3
- Roller Compacted Concrete Bridging Mat: Subsection 2.5.4.5.4
- Construction Dewatering: Subsection 2.5.4.6.2
- Engineering Backfill Properties and Extent: Subsections 2.5.4.5.4 and 3.7.1.1.1 as revised in NRC Letter 087 RAI 03.07.01-02 Response (PGN RAI ID#: L-0926)
- Vertical and Horizontal Drains for Liquefaction Mitigation: Subsections 2.5.4.8.5 as revised in NRC Letter 086 RAI 03.08.05-07 Response (PGN RAI ID#: L-0864)
- Drilled Shaft Foundation for Adjacent Buildings: Subsections 2.5.4.5.2 as revised in NRC Letter 086 RAI 03.08.05-07 Response (PGN RAI ID#: L-0864) and 3.8.5.9 as revised in NRC Letter 087 RAI 03.07.01-02 Response (PGN RAI ID#: L-0926)

The design of the excavation and the temporary works necessary for excavation and construction of the Bridging Mat involves construction practices, which if not carried out in a conservative manner, could lead to distress to the excavation and surrounding soils outside the Nuclear Island (NI) excavation. Thus, the design drawings and associated construction specifications will include the following:

- The design and construction of the starter trench, design of the slurry mix, width and thickness of diaphragm wall panels, slurry mixing and conveyance system and procedures and timing of tremie concrete operations to avoid the potential of collapse of the slurry trench walls.
- The choice and availability of backup equipment and stockpile material to deal with trench collapses, excavation delays, and slurry trench maintenance.
- The mixing and conveyance of tremie concrete to the trench excavation, the placement procedure of the tremie concrete (to be pumped under pressure, not gravity fed), placement of the reinforcing steel cage, design and placement of longitudinal reinforcing steel at panel joints, design and construction of the panel joints to assure water tightness and structural integrity to ensure the integrity of the diaphragm wall.
- The design, installation, testing and monitoring of the anchors to assure adequate capacity, minimum disturbance of the soil outside the diaphragm wall. Anchor holes will be advanced with water or drilling slurry, not air. Directional drilling where interference with drill shafts is possible shall be identified in the design drawings and the construction specifications.
- Design, installation, testing, maintenance and monitoring of shallow dewatering wells to drain the "bathtub," deep wells to relieve uplift pressure on the grouted zone beneath the Bridging Mat excavation, and piezometers to monitor the rate of dewatering and piezometric levels. Iron fouling and bacterial fouling on the well screens and in the pumps will be anticipated and accounted in the design. Replacement pumps will be maintained on site.

- Grouting pressures, grout penetrability, grout mix stability, grout mix constituents and grout mix design must all be designed and specified to prevent hydro-fracturing but adequate penetration and grout-take to effect a watertight grout zone beneath the Bridging Mat. The Grouting Intensity Number (GIN) Methodology for grouting in angled holes shall be specified. This method takes into account the volume of grout injected into the rock as well as the grouting pressure to target the appropriate grout take and penetration while avoiding hydro-fracturing.
- Excavation of the soil within the "bathtub" will be scheduled such as to allow for installation and testing of the anchors in a methodical manner so as not to overstress the diaphragm wall and allow for mapping of the excavation walls as the excavation proceeds downward.
- Excavation, cleanup, mapping and treatment of the rock surface, including dental concrete work, and removal of unsuitable material at the top of rock all shall be done without encroaching on the integrity of the diaphragm wall, anchors, and pressure relief wells.
- Design and construction of the horizontal and vertical drains to relieve excess pore pressures under dynamic conditions shall assure their performance over the life of the plant. Contamination of the drains shall be prevented. Vertical drains will not be made of fabric or paper. Bacterial clogging and iron clogging will be addressed in the design. Limestone shall not be used for the drains.

The civil construction is anticipated to consist of work packages that will be implemented in sequence. However, given the large size of the AP1000 NI footprint, overlapping schedules for the work packages is likely as the civil construction progresses from one area to another. The work packages would consist of the following activities and would generally be implemented in the sequence presented below:

- Site mobilization including erection of RCC Batch plants; build aggregate, ash, and cement stockpiles, mobilize excavation equipment; implement erosion and sedimentation control program; clearing, grubbing and stripping; installation of temporary surface drainage features; implement construction security program; and construct access roads.
- Grouting to form the bottom of the "Bathtub"; installation of shallow dewatering wells; diaphragm wall construction; and construction instrumentation installation.
- Dewatering the "Bathtub"; excavation for the NI foundation and RCC Bridging mat, installation of diaphragm wall anchors with a layout that avoids interference with Turbine Building (TB), Annex Building (AB), and Radwaste Building (RB) drilled shafts, cleaning of diaphragm wall during excavation; side-wall mapping of excavation cuts, mapping and preparation of rock surface for RCC Bridging mat construction.
- RCC Bridging mat construction; construction of the AP1000 basemat, construction of NI structure walls, and backfilling of NI structure walls, all sequenced in accordance with the AP1000 DCD.
- Installation of shallow dewatering system (eductors, well points and/or sumps); excavation to required grades, installation of vertical drains; installation of horizontal drains; and drilling of pilot holes for the drilled shafts for the TB.
- Installation of the drilled shafts for the TB.

- Clean-up and final grade excavation, construction of the shaft caps, and construction of the TB foundations and below grade walls.
- Grade all building areas per grading plan; installation of drilled shafts for the AB and RB, construction of AB and RB drilled shaft caps, construction of AB and RB foundations; and installation of site drainage system.

The final determination of the activities to be included in each specific work package will be determined by the contractor prior to the start of construction. However, the sequence of when each package will be implemented will generally follow the sequence specified above.

Associated LNP COL Application Revisions:

The following changes will be made to Section 3.7 of the FSAR in a future revision:

1) Text changes to Subsection 3.7.1 as noted below;
2) New Figures for Subsections 3.7.1 are included in Attachment 03.07.01-02A;
3) New Table for Subsection 3.7.1 is included in Attachment 03.07.01-02B.

Text changes:

COLA Part 2, FSAR Subsection 2.5.4.5 second paragraph will be modified from:

"Construction sequencing for these activities is described in FSAR Subsection 2.5.4.12. Additionally, soils may be excavated as discussed in FSAR Subsection 2.5.4.8.5 in regards to subsurface improvements associated with zones of potential liquefaction."

To read:

"Construction sequencing for these activities is described in FSAR Subsection 2.5.4.12 and 3.8.5.10."

COLA Part 2 FSAR Subsection 2.5.4.5.2 last paragraph in the NRC Letter 085 RAI 03.07.02-1 as modified in NRC Letter 086 RAI 03.08.05-07 (PGN RAI ID#: L-0864) response will be modified from:

"Non safety-related structures will be supported on drilled shaft foundations. Considering the soil conditions at the site and the anticipated structural loads, shallow foundations will not provide adequate bearing capacity within permissible settlement and differential settlement requirements, and soil improvement techniques are not recommended due to the high water table and wetland conditions at the site. The layout and design of these drilled shafts will be finalized prior to construction. Foundation design concepts under non safety-related structures are shown on Figures 2.5.4.5-201A, 2.5.4.5-201B, 2.5.4.5-202A, 2.5.4.5-202B, RAI 03.07.02-01-1, and RAI 03.08.05-07-1 Rev. 1."

To read:

"Seismic Category II and non safety related structures adjacent to the nuclear island will be supported on drilled shaft foundations. Considering the soil conditions at the site and the anticipated structural loads, shallow foundations will not provide adequate bearing capacity within permissible settlement and differential settlement requirements, and soil improvement techniques are not recommended due to the high water table and wetland conditions at the site. The conceptual design of the drilled shafts and installation is summarized in Subsection 3.8.5.9. Foundation design concepts under Seismic Category II and non safety-related structures adjacent to the nuclear island are shown on Figures 2.5.4.5-201A, 2.5.4.5-201B, 2.5.4.5-202A, 2.5.4.5-202B, RAI 03.07.02-01-1, and RAI 03.08.05-07-1 Rev. 1."

COLA Part 2 FSAR Subsection 2.5.4.5.4 last two paragraphs will be modified from:

"Table 2.5.4.5-201 is a summary of the anticipated engineering properties for each backfill type. The characteristics and use of the materials described in Table 2.5.4.5-201 are as follows:

- RCC fill. This will consist of a roller compacted concrete bridging mat to be used to replace undifferentiated Tertiary sediments and to bridge conservatively postulated karst features.
- Concrete-type fill. Concrete-type fill will be used as backfill between diaphragm walls and the sidewalls of the nuclear islands.
- Engineered fill. Engineered fill will be used to raise the site grade to elevation 15.5 m (51 ft.) NAVD88.

The engineering properties listed in Table 2.5.4.5-201 will be included in the construction specifications. Backfill material sources, once identified, will be mix-designed and tested to demonstrate that they are consistent with the properties in Table 2.5.4.5-201. The development of the concrete-type backfill specification and associated testing will occur prior to construction."

To read:

"Table 2.5.4.5-201 is a summary of the anticipated engineering properties for each backfill type. The characteristics and use of the materials described in Table 2.5.4.5-201 are as follows:

- RCC fill. This will consist of a roller compacted concrete bridging mat to be used to replace undifferentiated Tertiary sediments and to bridge conservatively postulated karst features.
- Controlled low strength material (CLSM) fill will be placed adjacent to the sidewalls of the nuclear islands to an elevation at least 1.5 m (5 ft.) below the bottom of the adjacent buildings' foundation mat as shown in Figure RAI 03.07.02-01-1.
- Engineered fill will be used under the footprint of the TB, AB, and RB and to a lateral extent of ~30 ft. beyond the building footprint as discussed in Subsection 3.7.1.1.1 and shown in Figure RAI 03.07.01-02-3. Engineered fill will also be placed from the top of the controlled low strength material fill to the bottom of the foundation mats of the adjacent Turbine Building, Annex Building, and the Radwaste Building as shown in Figure RAI 03.07.02-01-1.

The engineering properties listed in Table 2.5.4.5-201 will be included in the construction specifications. Engineered fill material sources, once identified, will be mix-designed and tested to demonstrate that they are consistent with the properties in Table 2.5.4.5-201. The development of the CLSM fill specification and associated testing will occur prior to construction."

COLA Part 2 FSAR Subsection 2.5.4.8.1 last bulleted item will be modified from:

- "Nonsafety-related structures adjacent to the nuclear islands will be supported on drilled shafts socketed into rock. Soil left in place that surrounds the shafts was addressed in the liquefaction analysis."

To read:

- "Seismic Category II and non safety-related structures adjacent to the nuclear island will be supported on drilled shafts socketed into rock. Soil left in place that surrounds the shafts was addressed in the liquefaction analysis."

COLA Part 2, FSAR Subsection 3.7.1.1.1 as revised in response to NRC Letter 046 RAI 03.07.01-1, will be further revised to add the following text at the end of the subsection:

Figures RAI 03.07.01-02-1 and RAI 03.07.01-02-2 show the conceptual grading plan and the conceptual grading section for the LNP site respectively. The plant Nuclear Island (NI) footprint (approximately 0.8 acres for each unit) is small compared to the approximately 347 acres where fill will be placed to raise the existing grade level. The existing grade in the plant footprint area is at approximate elevation 12.8 m (42 ft.) NAVD88. The finished grade in the 347 acre fill area will vary from elevation 15.2 m (50 ft.) NAVD88 to elevation 14.3 m (47 ft.) NAVD88. The large extent of the fill area compared to the NI footprint and because the PBSRS is higher than the GMRS for the LNP site, inclusion of the fill to design grade for the free field response analysis and the SSI analysis is appropriate.

The backfill provides lateral support to the drilled shafts supporting the Turbine Building (TB), Annex Building (AB), and Radwaste Building (RB). Thus, the backfill will be controlled engineered fill under the footprint of the TB, AB, and RB and to a lateral extent of ~30 ft. beyond the building footprint as shown in Figure RAI 03.07.01-02-3. The controlled engineering fill will conform to the requirements for Engineered Fill as presented in FSAR Table 2.5.4.5-201. The remainder of the fill required for site grading shown in Figure RAI 03.07.01-02-1 will not be controlled engineered fill. As shown in Figure RAI 03.08.05-07-1, the TB, AB, and RB buildings are supported on 3 ft., 4 ft., and 6 ft. diameter drilled shafts. The seismic II/I interaction evaluations show that for drilled shafts up to 6 ft. in diameter, the lateral stiffness of the drilled shafts is primarily dependent on the soil property of the top 16 ft. of soil . The ~30 ft. lateral extent of the controlled engineered fill corresponds to the lateral extent of the passive wedge for engineered fill with a friction angle of 34° as specified in Table 2.5.4.5-201.

The potential degradation in soil properties due to foundation construction activities will be considered in the LNP seismic response analyses. The foundation construction activities that may affect the in-situ soil properties include installation of the drilled shafts, installation of the diaphragm wall, and installation of the rock anchors for the diaphragm wall. The construction methods and construction inspections used for installation of the drilled shafts, diaphragm wall, and the diaphragm wall anchors will minimize the extent of soil disturbance and avoid cave in. The holes for the anchors will be advanced using drilling techniques designed to minimize the disturbance to the surrounding soil. Such techniques may include the use of a casing, or drilling with water or drilling slurry (not air). The boreholes for the diaphragm wall anchors will be backfilled as the casing is extracted after the anchors are set in rock to avoid cave in. Alternatively, the casings will be backfilled and left in place. The drilled shaft construction methods and construction inspections and testing will follow guidance in ACI 336.1-01 and ACI 336.3R-93.

For the SSI analysis of the nuclear island (NI) the best estimate (BE), lower bound (LB), and upper bound (UB) soil profiles presented in RAI 03.07.01-01 Table 2, RAI 03.07.01-01 Table 3, and RAI 03.07.01-01 Table 4 respectively will be considered. To account for the potential degradation of soil due to foundation installation, an additional Lower LB case (LLB) will also be considered in the NI SSI response analysis.

The volume of soil being disturbed by the drilled shaft installation, and diaphragm wall anchor installation is < 5 percent of the total soil volume in the vicinity of the NI. Assuming the disturbed soil around the drilled shaft and diaphragm wall anchors to have a soil shear modulus equal to ½ of the shear modulus of the corresponding soil layers, the average reduction in the soil shear modulus of the soil volume in the vicinity of the NI is < 2.5 percent. Thus, for the LLB soil profile, in-situ soil was conservatively assigned a shear modulus equal to 90 percent of the LB soil case as presented in Table RAI 03.07.01-02-1. As shown in Table 03.07.01-02-1, the fill layer shear modulus was not changed from the LB shear modulus because of the large variation from the BE case already considered i.e., the coefficient of variation for the LB fill shear modulus is in the range of 4.02 to 6.13 from the BE fill shear modulus as shown in Table 03.07.01-02-1. Rock layer shear modulus for the LLB soil profile are the same as for the LB soil profile because the construction activities do not degrade the rock layer shear modulus.

COLA Part 2, Add new FSAR Subsections 3.8.5.9 and 3.8.5.10 as follows:

Add Subsections 3.8.5.9 and 3.8.5.10 following the last paragraph of DCD Subsection 3.8.5.8:

LNP SUP 3.8-2

3.8.5.9 Drilled Shaft Foundations Design and Installation

The seismic category II and non safety-related adjacent buildings (Turbine Building, Annex Building, and Radwaste Building) are supported on drilled shafts as shown in Figure RAI 03.08.05-07-1 Revision 1. The following conceptual drilled shaft design and installation information will be incorporated in the final design drawings and associated construction specifications:

- The conceptual layout and sizes of the drilled shafts used to support the adjacent buildings is shown in Figure RAI 03.08.05-07-1 Revision 1. The conceptual design of the drilled shaft socket shows that a 10 ft. socket length is sufficient for current loading provided that the rock has a minimum RQD of 25 percent. The load capacity of the drilled shaft socket is based on the average from the AASHTO and NAVFAC methods. The construction of the drilled shaft foundation for the TB, AB, and RB buildings will consider the measured RQD and the final building loads.
- The rock socket is designed on the basis that the rock surrounding the socket will have a RQD of at least 25 percent over the full depth of the rock socket. The design of the rock socket will take no credit for the rock above the rock socket, having a depth of 2 ft., regardless of the RQD of the rock in this zone. The top of rock, design top of the rock socket, and design bottom of the rock socket will be specified on the construction drawings. A pilot hole will be drilled at the location of each shaft, with core obtained over depth of the expected socket plus at least two socket diameters. If the pilot hole indicates that the RQD does not meet design requirements, the rock socket will be extended to a new design depth based on the core obtained from the pilot holes. The drilled shaft will derive its vertical load carrying capacity entirely from the rock socket. Thus, soil properties will not be measured in the pilot hole program.
- Shaft excavation through the overburden will be performed using a construction methodology designed to minimize the disturbance to the surrounding soils. This may include installing the drilled shafts using either the “dry” or “wet” methods. Advancing the hole through the overburden with air shall be prohibited. A steel casing will be used to maintain the sidewalls of the hole as the drilled shaft is excavated. The steel casing will extend from the ground surface to the top of the rock, and will be “twisted” into rock. The steel casing will be left in place as a permanent feature.
- Rock sockets will be telescoped downward inside the casing with a lip at the top of the socket to allow for seating of the casing. Rock sockets will be cleaned, pumped dry if practicable, and inspected before concrete is placed. The inspection of the rock socket will preferably be through remote visual observations. If this is not practicable, a Shaft Inspection Device (SID) will be used. The time lapse between inspection and cleaning, and concrete placement shall be minimized to limit degradation of the exposed sidewalls and bottom of the excavation.
- The acceptance criteria for the inspecting engineer/geologist shall be as follows:
  - The bottom of the socket shall be free of all deleterious material, loose cuttings and muck. If the dry method of construction is specified, the excavation shall be reasonably dry and ready to receive concrete. Pumping shall be used to achieve

a reasonably dry socket bottom, if necessary. If it is not practicable to achieve a reasonably dry socket bottom in the judgment of the inspecting engineer/geologist, the contractor may place loose cement at the bottom immediately prior to placing tremie concrete. If the rate of water inflow is excessive in the judgment of the inspecting engineer/geologist, the inspecting engineer/geologist may call for grouting on a case-by-case basis, or wet construction methods for concrete placement will be followed as specified in ACI 336.1-01 and ACI 336.3R-93.

  - For 6 ft. diameter drilled shafts, the exposed side wall rock of the socket will be judged by the inspecting engineer/geologist to have an RQD equal to or greater than 25 percent based on counting fractures, joints and bedding planes on the exposed side wall of the socket. The inspecting engineer/geologist preferably will use remote visual observations to inspect the sidewall of the socket. Field notes and sketches shall be kept by the inspecting engineer/geologist. For 3 ft. and 4 ft. diameter drilled shafts, the minimum RQD determination may be made from the rock core data obtained during the pilot hole program.

- During construction or inspection of the drilled-out socket, if it is determined that, in spite of the core retrieved from the pilot holes drilled in advance of the rock socket drilling, the RQD is not at least 25 percent over the full depth of the socket, the following measures will be taken:

  - If the core from the pilot hole indicates that the RQD is improving with depth and the rock socket design depth can be achieved by drilling the socket deeper to a reasonable depth (approximately one shaft diameter), the design socket depth will be extended.

  - If based on the cuttings from the socket drilling and/or the core from the pilot holes, there is no basis for drilling a deeper socket, then the rock at the base of the socket already drilled will be grouted (mix and design pressure to be determined at the time of construction). For 3- and 4-ft. diameter sockets, the grouting may be achieved with a packer system installed in the pilot hole. For 6-ft. diameter sockets, two or three grout holes will be drilled and grouted over a depth equal to the design depth of socket plus one diameter.

- The contractor shall drill a test drilled shaft to verify the constructability of his proposed casing installation procedure, rebar cage installation procedure and tremie operation. The test shaft will be drilled and tested by geophysical means to assure the integrity of the completed concrete shaft.

3.8.5.10 Construction Sequence of Civil Work

The conceptual design and construction methods of LNP site specific civil work within and around the nuclear island and the Seismic Category II and non safety-related adjacent buildings' footprint are summarized in the following Subsections:

- Diaphragm Walls and Grouting: Subsection 2.5.4.5.1
- Excavation: Subsections 2.5.4.5.2 and 2.5.4.5.3
- Roller Compacted Concrete Bridging Mat: Subsection 2.5.4.5.4
- Construction Dewatering: Subsection 2.5.4.6.2
- Engineering Backfill Properties and Extent: Subsections 2.5.4.5.4 and 3.7.1.1.1

- Vertical and Horizontal Drains for Liquefaction Mitigation: Subsections 2.5.4.8.5
- Drilled Shaft Foundation for Adjacent Buildings: Subsections 2.5.4.5.2 and 3.8.5.9

The design of the excavation and the temporary works necessary for excavation and construction of the Bridging Mat involves construction practices, which if not carried out in a conservative manner, could lead to distress to the excavation and surrounding soils outside the Nuclear Island (NI) excavation. Thus, the design drawings and associated construction specifications will include the following:

- The design and construction of the starter trench, design of the slurry mix, width and thickness of diaphragm wall panels, slurry mixing and conveyance system and procedures and timing of tremie concrete operations to avoid the potential of collapse of the slurry trench walls.
- The choice and availability of backup equipment and stockpile material to deal with trench collapses, excavation delays, and slurry trench maintenance.
- The mixing and conveyance of tremie concrete to the trench excavation, the placement procedure of the tremie concrete (to be pumped under pressure, not gravity fed), placement of the reinforcing steel cage, design and placement of longitudinal reinforcing steel at panel joints, design and construction of the panel joints to assure water tightness and structural integrity to ensure the integrity of the diaphragm wall.
- The design, installation, testing and monitoring of the anchors to assure adequate capacity, minimum disturbance of the soil outside the diaphragm wall. Anchor holes will be advanced with water or drilling slurry, not air. Directional drilling where interference with drill shafts is possible shall be identified in the design drawings and the construction specifications.
- Design, installation, testing, maintenance and monitoring of shallow dewatering wells to drain the "bathtub," deep wells to relieve uplift pressure on the grouted zone beneath the Bridging Mat excavation, and piezometers to monitor the rate of dewatering and piezometric levels. Iron fouling and bacterial fouling on the well screens and in the pumps will be anticipated and accounted in the design. Replacement pumps will be maintained on site.
- Grouting pressures, grout penetrability, grout mix stability, grout mix constituents and grout mix design must all be designed and specified to prevent hydro-fracturing but adequate penetration and grout-take to effect a watertight grout zone beneath the Bridging Mat. The Grouting Intensity Number (GIN) Methodology for grouting in angled holes shall be specified. This method takes into account the volume of grout injected into the rock as well as the grouting pressure to target the appropriate grout take and penetration while avoiding hydro-fracturing.
- Excavation of the soil within the "bathtub" will be scheduled such as to allow for installation and testing of the anchors in a methodical manner so as not to overstress the diaphragm wall and allow for mapping of the excavation walls as the excavation proceeds downward.
- Excavation, cleanup, mapping and treatment of the rock surface, including dental concrete work, and removal of unsuitable material at the top of rock all shall be done without encroaching on the integrity of the diaphragm wall, anchors, and pressure relief wells.

- Design and construction of the horizontal and vertical drains to relieve excess pore pressures under dynamic conditions shall assure their performance over the life of the plant. Contamination of the drains shall be prevented. Vertical drains will not be made of fabric or paper. Bacterial clogging and iron clogging will be addressed in the design. Limestone shall not be used for the drains.

The civil construction is anticipated to consist of work packages that will be implemented in sequence. However, given the large size of the AP1000 NI footprint, overlapping schedules for the work packages is likely as the civil construction progresses from one area to another. The work packages would consist of the following activities and would generally be implemented in the sequence presented below:

- Site mobilization including erection of RCC Batch plants; build aggregate, ash, and cement stockpiles, mobilize excavation equipment; implement erosion and sedimentation control program; clearing, grubbing and stripping; installation of temporary surface drainage features; implement construction security program; and construct access roads.
- Grouting to form the bottom of the "Bathtub"; installation of shallow dewatering wells; diaphragm wall construction; and construction instrumentation installation.
- Dewatering the "Bathtub"; excavation for the NI foundation and RCC Bridging mat, installation of diaphragm wall anchors with a layout that avoids interference with Turbine Building (TB), Annex Building (AB), and Radwaste Building (RB) drilled shafts, cleaning of diaphragm wall during excavation; side-wall mapping of excavation cuts, mapping and preparation of rock surface for RCC Bridging mat construction.
- RCC Bridging mat construction; construction of the AP1000 basemat, construction of NI structure walls, and backfilling of NI structure walls, all sequenced in accordance with the AP1000 DCD.
- Installation of shallow dewatering system (eductors, well points and/or sumps); excavation to required grades, installation of vertical drains; installation of horizontal drains; and drilling of pilot holes for the drilled shafts for the TB.
- Installation of the drilled shafts for the TB.
- Clean-up and final grade excavation, construction of the shaft caps, and construction of the TB foundations and below grade walls.
- Grade all building areas per grading plan; installation of drilled shafts for the AB and RB, construction of AB and RB drilled shaft caps, construction of AB and RB foundations; and installation of site drainage system.

The final determination of the activities to be included in each specific work package will be determined by the contractor prior to the start of construction. However, the sequence of when each package will be implemented will generally follow the sequence specified above.

Attachments/Enclosures:

Attachment 03.07.01-02A: Figures RAI 03.07.01-02-1, RAI 03.07.01-02-2, and RAI 03.07.01-3

Attachment 03.07.01-02B: New Table RAI 03.07.01-02-1

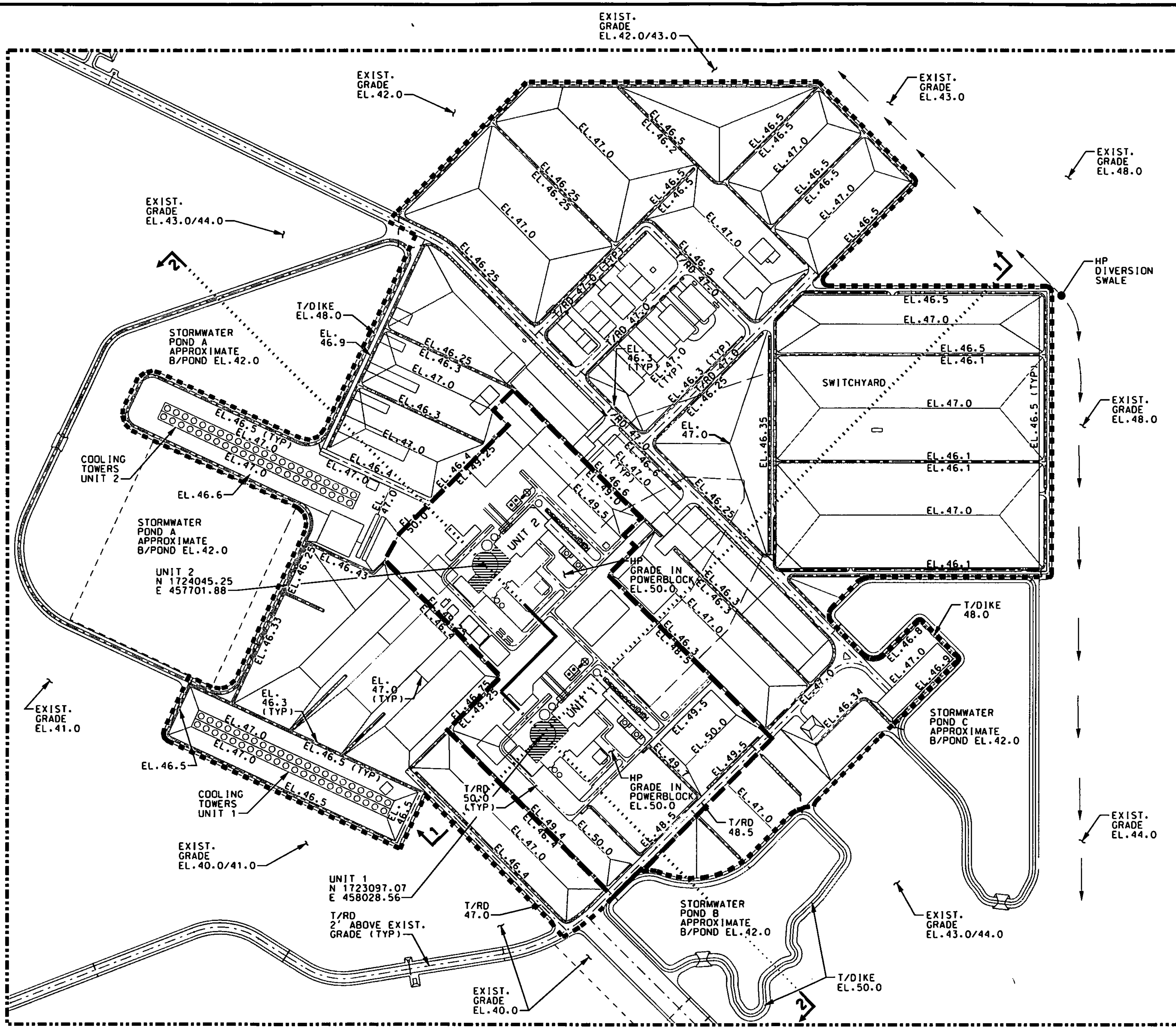
Attachments to NPD-NRC-2011-046

Figure RAI 03.07.01-02-1, Conceptual Grading Plan (1 page)

Figure RAI 03.07.01-02-2, Conceptual Grading Sections (1 page)

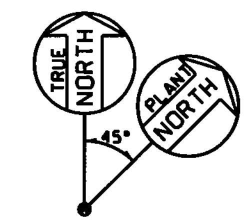
Figure RAI 03.07.01-02-3, Extent Of Controlled Engineered Fill (1 page)

Table RAI 03.07.01-02-1, Lower Lower Bound (LLB) Soil Profile For SSI Analysis (2 pages)



LEGEND FOR BOUNDARIES

- NI FOOTPRINT
- BOUNDARY FOR GRADED AREA RAISED TO EL.50.0
- BOUNDARY FOR TOTAL GRADED AREA



NOTES:

1. THE VERTICAL ELEVATION DATUM IS BASED ON NAVD 88.
2. HIGH POINT OF GRADE ADJACENT TO THE POWERBLOCK BUILDINGS WILL BE AT EL.50.0.
3. GRADED AREA:

TOTAL GRADED AREA	347 ACRES
GRADE RAISED TO EL.50.0	65 ACRES
GRADE RAISED TO EL.47.0	282 ACRES

4. NUCLEAR ISLAND (NI) FOOTPRINT (ONE UNIT) 0.8 ACRES

0 600 1200
GRAPHIC SCALE 1"=600'

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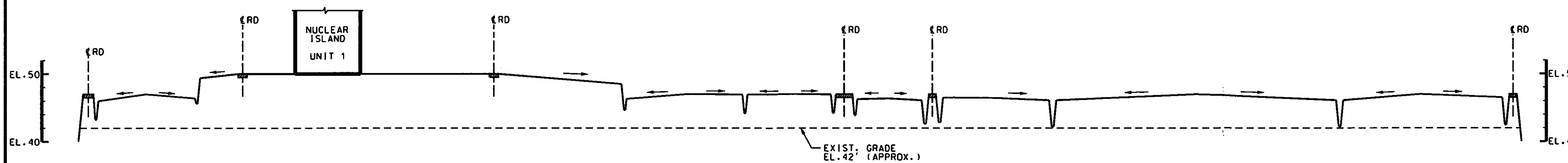
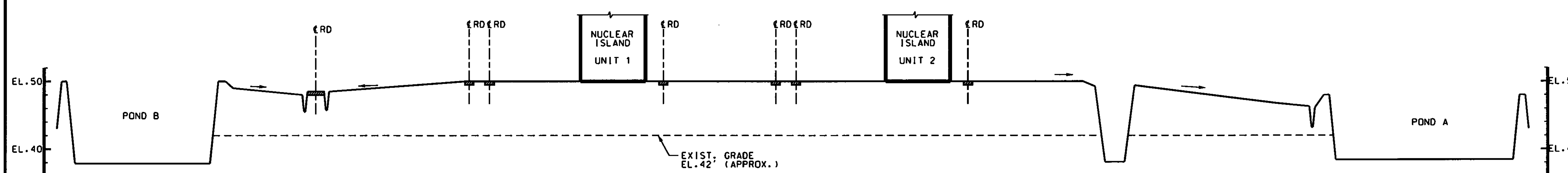
Conceptual Grading Plan

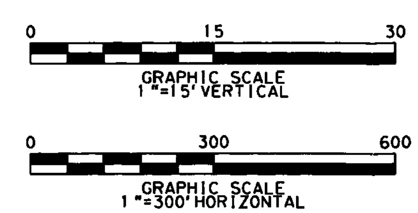
Figure RAI 03.07.01-02-1 Rev 0



SECTION 1



SECTION 2



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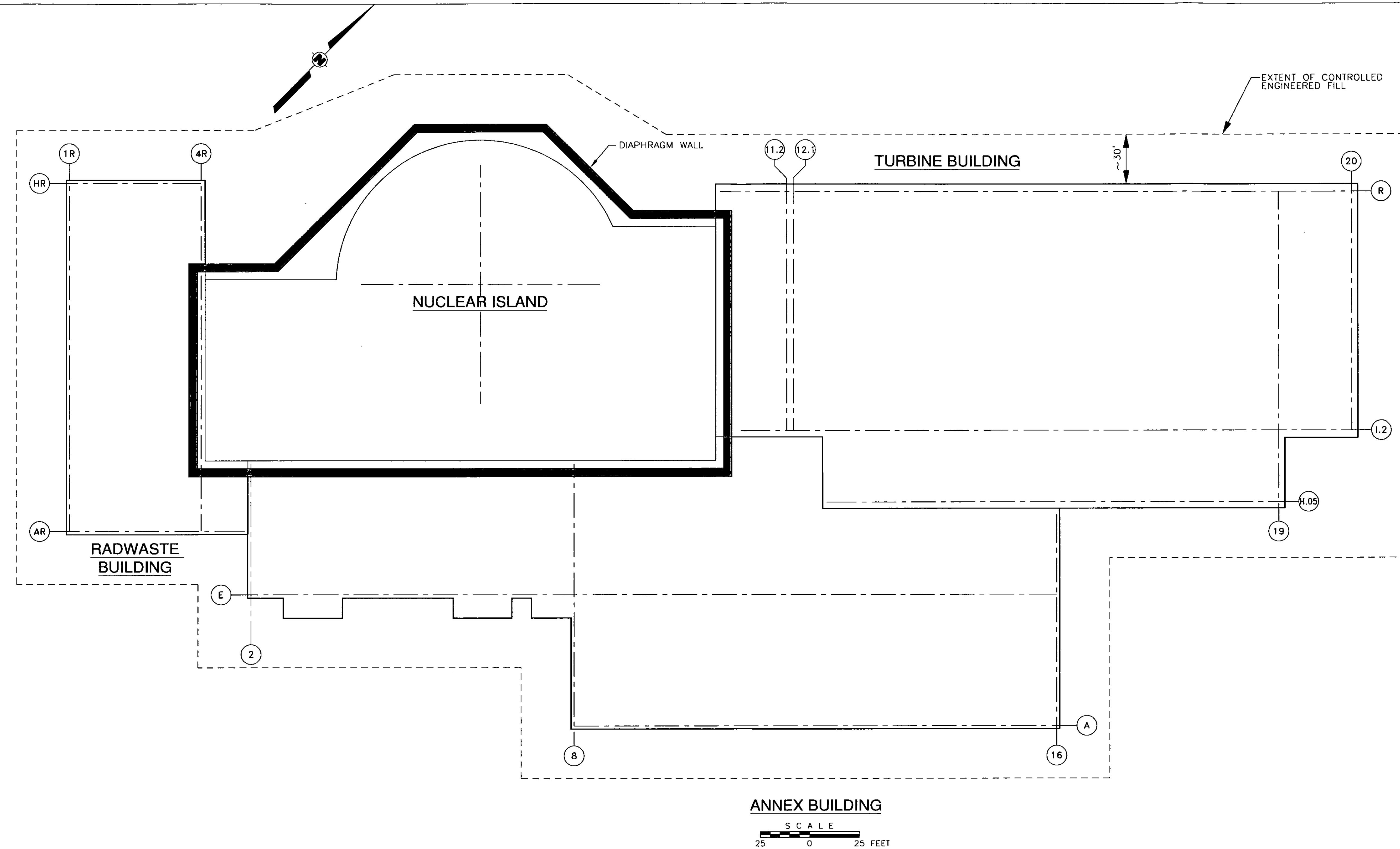
Conceptual Grading Sections

Figure RAI 03.07.01-02-2

Rev 0



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Extent of Controlled Engineered Fill

FIGURE RAI 03.07.01-02-3

Rev 0

Table RAI 03.07.01-02-1 (Sheet 1 of 2)
Lower Lower Bound (LLB) Soil Profile for SSI Analysis

Layer	Layer Thickness (ft)	D[a] (ft)	Unit Weight (kcf)	BE[c] V_s[b] (ft/sec)	LB[d] V_s[b] (ft/sec)	LB[d] G[g] (ksf)	LLB[e] G[g] (ksf)	LLB[e] - G[g] COV[f]	Description
1	2.5	2.5	110	836	373	476	476	4.02	Fill
2	2.5	5.0	110	824	342	400	400	4.81	Fill
3	2.5	7.5	110	796	315	339	339	5.38	Fill
4	3.5	11.0	110	788	300	307	307	5.92	Fill
5	2.0	13.0	110	796	301	310	310	5.97	Fill
6	2.0	15.0	110	786	294	296	296	6.13	Fill
7	3.5	18.5	120	1,503	1,123	4,702	4,232	0.99	In -situ Soil
8	2.5	21.0	120	1,500	1,115	4,632	4,169	1.01	In -situ Soil
9	1.0	22.0	120	1,500	1,115	4,632	4,169	1.01	In -situ Soil
10	3.5	25.5	120	1,501	1,074	4,301	3,871	1.17	In -situ Soil
11	3.5	29.0	120	1,496	1,070	4,270	3,843	1.17	In -situ Soil
12	6.7	35.7	120	1,482	1,111	4,596	4,137	0.98	In -situ Soil
13	4.3	40.0	120	1,476	1,100	4,507	4,056	1.00	In -situ Soil
14	2.4	42.4	120	1,476	1,100	4,507	4,056	1.00	In -situ Soil
15	8.3	50.7	130	2,267	1,851	13,830	12,447	0.67	In -situ Soil
16	8.3	59.0	130	2,266	1,850	13,822	12,440	0.67	In -situ Soil
17	7.2	66.2	130	2,254	1,841	13,680	12,312	0.67	In -situ Soil
18	7.2	73.4	130	2,251	1,838	13,639	12,275	0.67	In -situ Soil
19	1.6	75.0	138	2,772	2,264	21,960	19,764	0.67	In -situ Soil
20		> 75.0					Rock[i]		Rock

Notes:
a) D: Depth from Design Grade (EL +51 ft.) to bottom of Layer

Units:
ft: Feet

Table RAI 03.07.01-02-1 (Sheet 2 of 2)
Lower Lower Bound (LLB) Soil Profile for SSI Analysis

b) V_s: Layer Shear wave velocity
c) BE: Best Estimate soil profile (Table 17 of Calculation LNG-0000-X7C-044 Rev. 1)
d) LB: Lower Bound soil profile (Table 18 of Calculation LNG-0000-X7C-044 Rev. 1)
e) LLB: Lower Lower Bound soil profile
f) COV: Coefficient of variation
g) G: Shear Modulus
i) Rock profile same as LB rock profile

kcf: Kips per cubic feet
ksf: Kips per square feet