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April 16, 2014

Ms. Amy Elliott
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BELL BEND NUCLEAR POWER PLANT
SUBMITTAL OF REVISED CONSTRUCTION
DEWATERING DESIGN REPORT
BNP-2014-041 Docket No. 52-039

Reference: 1) M. J. Caverly (PPL Bell Bend, LLC) to Ms. Amy Elliott, "Responses to Public Notice Comments Joint Permit Application PN-12-07", dated September 25, 2012

The purpose of this letter is to provide the enclosed revision of the Construction Dewatering Design Report for the Bell Bend Nuclear Power Plant (BBNPP). The previous revision was transmitted by Reference 1. The purpose of this revision is to update the report to provide consistency with the BBNPP Combined License Application regarding the values used for hydraulic conductivity.

Should you have questions, please contact the undersigned at 610.774.7552.

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosure: Construction Dewatering Design – Bell Bend Nuclear Power Plant Report No. SL-009655, Revision 4, dated February 5, 2014.

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Enclosure

Construction Dewatering Design – Bell Bend Nuclear Power Plant
Report No. SL-009655, Revision 4, dated February 5, 2014

UniStar NUCLEAR

Construction Dewatering Design

Bell Bend Nuclear Power Plant

UniStar Nuclear Energy

Non-Safety-Related

Report No. SL-009655

Revision 4

February 5, 2014

Sargent & Lundy LLC

Approval Page

Construction Dewatering Design

Non-Safety-Related

Revision Summary

Revision 0	**For OAR Review**
Revision 0	**For Use**
Revision 0A	**For OAR Review**
Revision 1	**For Use**
Revision 2A	**For OAR Review**
Revision 2	**For Use**
Revision 3A	**For OAR Review**
Revision 3	**For Use**
Revision 4A	**For OAR Review**
Revision 4	**For Use**

Prepared By: ______________ Date: 2/5/2014
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LEGAL NOTICE

This report ("Deliverable") was prepared by Sargent & Lundy, LLC (S&L), expressly for the sole use of UniStar Nuclear (Client), for the Bell Bend Nuclear Power Plant, in accordance with the agreement between S&L and Client. This Deliverable was prepared using the degree of skill and care ordinarily exercised by engineers practicing under similar circumstances. Client acknowledges: (1) S&L prepared this Deliverable subject to the particular scope limitations, budgetary and time constraints, and business objectives of the Client; (2) information and data provided by others in RFIs (i.e. measured groundwater elevations, etc) may not have been independently verified by S&L; (3) the information and data contained in this Deliverable are time sensitive and changes in the data, applicable codes, standards, and acceptable engineering practices may invalidate the findings of this Deliverable. This Deliverable is applicable only to the Bell Bend Nuclear Power Plant, as developed by UniStar Nuclear and cannot be used for any other project(s). Any use or reliance upon this Deliverable by third parties shall be at their sole risk.

Table of Contents

1. PURPOSE/OBJECTIVE

The purpose of this report is to evaluate the existing groundwater conditions around the proposed plant structures, which include [notation in parentheses is the structure identification number per Reference 10.1, i.e. (P25)]:

- Nuclear Island (NI), which primarily includes:
  - Emergency Power Generating Buildings (P23);
  - Fuel Building (P24);
  - Reactor Building (P25);
  - Safeguard Buildings Mechanical (P26);
  - Safeguard Buildings Electrical (P27);
  - Nuclear Auxiliary Building (P28);
  - Access Building (P29);
  - Vent Stack (P 30);
  - Radioactive Waste Processing Building (P31);
  - Turbine Building (P32);
  - Essential Service Water Pump Buildings (P33);
  - Essential Service Water Cooling Tower Structures (P34);
  - Fire Protection Storage Tanks (P35);
  - Fire Protection Building (P36);
  - Switchgear Building (P38);
  - Demineralized Water Tanks (P43);
- Circulating Water System Cooling Towers (CW Cooling Towers) (P40);
- Circulating Water System Pumphouse (P41);
- Essential Service Water Emergency Makeup System Retention Pond (ESWEMS Pond) (P46)
- Essential Service Water Emergency Makeup System Pump House (ESWEMS Pump House) (P47);
- Essential Service Water Emergency Makeup System Pipeline (ESWEMS Pipeline) between the ESWEMS Pump House and NI; and
- Combined Waste Water Retention Pond (CWWRP) (P8),

at the Bell Bend Nuclear Power Plant (BBNPP) and provide recommendations for the temporary construction dewatering system during the construction of the power plant. Attachment A (Reference 10.1) depicts a conceptual layout of the major elements of the plant.

This information will be used to support the Combined Operating License Application (COLA) for the BBNPP. This evaluation will be the basis for the development of the construction dewatering system and the disposal of the extracted water as addressed in the Environmental Report (ER).

The purpose of Revision 2 was to evaluate the existing groundwater condition around the NI based on its new location 972 feet north and 300 feet west of the original plant location (Reference 10.1). Revision 2 was based on the groundwater elevations collected over a three month period as an interim report during the 12 month data collection period at the new location. Revision 2 was a comprehensive revision and thus, revision bars were not indicated.

The purpose of Revision 3 was to evaluate the existing groundwater condition at the new location (same location as Revision 2) based on the groundwater elevation monitoring from two distinct 12-month groundwater elevation monitoring periods, specifically the data collected from November 2007 through October 2008 (Reference 10.5, Table 2.4-47) and from May 2010 thorough April 2011 (Reference 10.5, Table 2.4-71).

The purpose of Revision 4 is to update the report based on BBNPP FSAR, Section 2.4, Revision 4 (Reference 10.5). This update evaluates the effect of changes to the temporary construction dewatering program as a result of revisions to the hydraulic conductivity as documented in the updated FSAR Chapter 2.4 (Reference 10.5). Given the magnitude of the revisions to the hydraulic conductivity, Revision 4 is based on basic linear and qualitative methods provided by Weaver Boos Consultants North Central, LLC in their 2014 letter (Reference 10.17, included in Appendix A) and does not include a quantitative revision to the numeric groundwater model.

2. BACKGROUND

The explored site conditions and plant layout result in two distinct subsurface settings in regards to dewatering approaches and effects.

- The NI and CW Cooling Towers will be located in an area of relatively thin unsaturated granular soils above the shale bedrock with a substantial vertical relief. In general, the granular soils and a portion of the bedrock will be excavated to establish the plant elevation below the existing natural ground surface.

  For structural and seismic design considerations, these structures will be supported on bedrock or engineered fill (concrete or granular) extending from the bearing elevation down to the top of competent bedrock (Reference 10.9 Subsection 2.5.4.5). This report refers to this area as the upland area.

- In the vicinity of the ESWEMS Pond and ESWEMS Pump House, the granular soils that overlie the bedrock are saturated and substantially thicker than in the NI (Reference 10.2).

  Beneath the ESWEMS Pond, these soils will be removed down to competent bedrock and replaced (with cohesive fill) to modify the seismic response and permeability of the soils.

Beneath the ESWEMS Pump House, the granular soils will be removed to allow the structure to be founded directly on competent bedrock (Reference 10.9, Subsection 2.5.4.5 and Figure 2.5-18).

These construction details and the site geologic settings require an approximate maximum of 56 feet of water-bearing sands and gravels to be excavated (References 10.2, 10.5 and 10.9) for the ESWEMS Pond and ESWEMS Pumphouse. Proper placement of the backfill requires the work to be performed in a dry condition. As such, an active construction dewatering system will be implemented prior to construction to maintain dry conditions and it will continue until the subgrade portions for these structures are completed and the excavation is backfilled. The dewatering system will be decommissioned as the structures are completed and the backfill is placed to a level above the groundwater and up to the final grade.

Since the ESWEMS Pump House is contiguous with the ESWEMS Pond dike alignment, henceforth the term ESWEMS Pond incorporates the excavation for the ESWEMS Pump House.

3. DESIGN INPUTS

The following design inputs and assumptions are used in this report:

a. Groundwater levels from two independent twelve month monitoring periods (2007/2008 and 2010/2011) are documented in Reference 10.5, Tables 2.4-47 and 2.4-71.

b. Locations of the monitoring wells, well screen elevation, and top of bedrock elevations from Reference 10.5, Table 2.4-46. Attachment C (Reference 10.17, Figure 1) presents the locations of the groundwater monitoring wells.

c. Dewatering system criteria, groundwater levels with various dewatering approaches and comments as provided by Weaver Boos Consultants North Central, LLC (Weaver Boos) (Reference 10.6 – included as Appendix A of this report) as amended by Reference 10.17.

d. Potential construction reuse of groundwater pumped from the excavation (Reference 10.7).

e. General site layout per the Reduced Scale Standard Utilization Plot Plan (SUPP), (Reference 10.1), which is provided as Attachment A.

f. Final yard high-point finished grade is established at Elevation 719 feet per the North American Vertical Datum of 1988 (NAVD88), with the design finished floor elevation of the NI structures at 720 feet (Reference 10.8). Note, all elevations in this report refer to the NAVD88 and are in feet.

g. Conceptual Excavation Plan as presented in Reference 10.9, Figure 2.5-97 through Figure 2.5-118. Attachment B (Reference 10.6, Figure 3), of this report presents the conceptual grading plan.

h. The approximate elevation of the invert of the pipes from the ESWEMS Pump House to the NI is 694 feet (Reference 10.13). Black and Veatch reaffirmed the validity of Reference 10.13 in their response to RFI SL-BBNPP-211 (Reference 10.20).

i. Water quality information from on site wells and water sampling (Reference 10.10).

4. ASSUMPTIONS

Design inputs 3a, 3b, 3c, 3d, 3g, 3h and 3i listed in Section 3 (above) are the latest available information based on responses to Requests For Information (RFI) and are considered as verified information for the conceptual design of the construction dewatering system. Design inputs 3e and 3f are the site layout and grading drawings and are the latest information for the conceptual design. Thus, these inputs (3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h and 3i) are not considered assumptions.

a. The "Non-Safety Related" status of this report is based on the assumption that sequencing the construction such that safety related structures founded on soil (i.e. the pipeline from the ESWEMS Pump House to the NI) will not be constructed until the dewatering system has achieved the maximum vertical and horizontal extent of the dewatering.

Integration of the Site conceptual model with a mathematical computer code to simulate flow requires several simplifying assumptions. The following assumptions and idealizations apply to the model utilized herein (from Reference 10.6):

b. The model domain is underlain by a conductive granular soils (overburden) aquifer extending through the basin lowlands and restricted in its horizontal extent by surrounding rises in the less conductive bedrock.

c. The complex natural flow system may be represented using a system of seven discrete layers, while the natural conditions likely result in a more gradual variation in hydrogeologic properties.

d. The baseline groundwater flow system is in equilibrium and is modeled on a steady-state basis.

Assumptions 4a through 4d, listed above, are consistent with the available data and do not need further verification for this evaluation. Adjustments can be made during construction of the dewatering system to account for any subsurface discrepancies, which may be encountered during construction. All assumptions for this report are considered to be verified for its current use.

5. METHODOLOGY AND CRITERIA

The groundwater modeling and calculations discussed in this report were primarily performed by Weaver Boos based on field data obtained and evaluated by Rizzo.

The Rizzo findings from the field investigations and testing are documented in References 10.2, 10.5, 10.9, and 10.10.

Revision 1 of the Weaver Boos report (Reference 10.6) was developed using data available in October 2011. In the interim, changes to site hydraulic conductivity data have been made in the Final Safety Analysis Report (FSAR) (Reference 10.5). Weaver Boos prepared a letter documenting the changes to be made to their report considering the changes in the hydraulic conductivity data (Reference 10.17). The value of hydraulic conductivity for the glacial overburden presented in Revision 4 of the FSAR increased by approximately 11 percent to 6.57 x 10^{-2} cm/s. Additionally, Weaver Boos reconsidered the prior delineation of the bedrock in two zones (upper and lower) and considered the bedrock in multiple layers with different hydraulic parameters. However, Weaver Boos now considers the rock to have similar hydraulic properties for the entire profile based on Revision 4 of the FSAR. These changes are conservative. The recalculated conductivity for the combined bedrock is approximately 2.5 percent less than the corresponding value previously considered by Weaver Boos for the shallow bedrock and 3.2 times higher than the prior value for the deep bedrock. The Weaver Boos letter of addendum (Reference 10.17) is based on quantitative changes to the flow rates determined by the digital model in 2011, considering a linear relationship between flow and hydraulic conductivity. Sound engineering judgment is used to qualitatively evaluate the potential changes in drawdown and radius of influence, which may result from the revised hydraulic conductivity data. Revision 4 of this report is based on the Weaver Boos addendum letter (Reference 10.17) and their report (Reference 10.6).

Prior to assessing applicable dewatering technologies, Weaver Boos developed a conceptual model, which to the extent practicable, incorporates natural hydrogeologic boundaries for the flow system of interest. Preparation of the conceptual model included the following general steps:

- Defining hydrostratigraphic units based on the data presented in References 10.2, 10.5, and 10.10;
- Defining the flow system; and
- Preparing a water budget of flows into and out of the area of interest.

Evaluation of groundwater flow was performed by Weaver Boos utilizing a seven-layered conceptual model implemented using Visual MODFLOW Version 2009, by Schlumberger Water Services. This software is a widely used implementation of the USGS's globally recognized MODFLOW-2000 program. Weaver Boos selected this software for its capability to reliably model groundwater flow in three dimensions and relative ease of use offered by its integrated graphical user interface. The modeling reflected two principal groundwater dewatering strategies:

- Open excavation and water table depression without groundwater flow barriers; and,
- Dewatering and excavation using a slurry wall, diaphragm wall, or other type of subsurface flow barrier to mitigate potential off-site water level drawdown and subsequent impact to potentially sensitive areas around the ESWEMS Pond.

5.1 Model Domain

The digital model domain is based on a rectangular block-centered grid network that covers a 1.8-square mile flow domain representing the local drainage basin. The grid includes 316 rows and 245 columns, with their spacing refined as needed to assess small-scale effects in the area where dewatering is needed. In the areas where the greatest detail was desired, the grid node spacing is approximately 22 by 22 feet and provides site-scale detail without creating a computationally excessive number of model nodes.

5.2 Model Calibration

Calibration of the baseline flow model consisted of initial simulations, with the model-estimated groundwater elevations compared to the measured groundwater elevations from Reference 10.5. To adjust for discrepancies in the model predicted and actual groundwater elevations, adjustment of selected model elements such as recharge flux and distribution, river boundary condition parameters along the edges of the model domain and along Walker Run were made. The calibration is iterative to allow a suitable set of recharge and boundary conditions to be formulated.

An evaluation of the calibration of the simulated (baseline without any dewatering activity) versus the measured groundwater levels, for all layers indicates a correlation coefficient of 0.89, which is considered reasonable given the distribution of the groundwater monitoring wells. The calibrated model generally under-predicted the groundwater elevations in the uplands of the NI and CW Cooling Towers and generally over-predicted them in the lowland area of the ESWEMS Pond (Reference 10.6). This is conservative since the model under predicts the groundwater elevation in the uplands where little groundwater is present and the hydraulic conductivity is lower and over predicts where more groundwater is present and the soils are more permeable. Thus, this calibration likely results in slightly higher pump rates to achieve and maintain the dewatered condition.

This calibrated digital model was then used to simulate the dewatering program parameters as presented in the following sections. Additionally traditional hand calculations were used to check the results of the computer modeling, determine near well hydraulics, and to determine the well spacing. These methods are presented in Appendix D of Reference 10.6.

There are no acceptance criteria for this evaluation since its purpose is to provide recommendations for the need of a flow barrier to mitigate the drawdown effects of dewatering.

6. EVALUATION

6.1 Topography

The topography of the site is gently rolling with an east-west trending set of ridges. At the BBNPP, ground elevations range from 650 feet along Walker Run in the southwest corner of the site up to elevations slightly higher than 800 feet on the hilltop located in the vicinity of the NI and CW Cooling Towers (Reference 10.8). North of Beach Grove Road (north of the site), the elevation rises sharply upward to elevations of 1,100 to 1,150 feet along the crest of the ridge. Thus, total topographic relief in the immediate vicinity of BBNPP is approximately 500 feet. The ground surface elevation in the area of the NI generally ranges from approximately 700 to 800 feet. The ground surface elevation in the area of the ESWEMS Pond ranges from approximately 670 to 740 feet. The existing grade elevation in the area of the CW Cooling Towers varies from 700 to 800 feet (Reference 10.8). Attachment A (Reference 10.1) provides a general site layout for the BBNPP along with the general topography.

6.2 Geology

The BBNPP site is located in the Ridge and Valley Province. The total thickness of Paleozoic sedimentary rocks in the vicinity of the site is nearly 33,000 ft and includes Paleozoic sandstone, siltstone, shale, and limestone units, with lesser amounts of coal and conglomerate. Groundwater in the bedrock formations surrounding the BBNPP site (including shales and clayey shales) is present primarily in secondary openings, including fractures, joints, and bedding plane separations (Reference 10.5, 2.4.12.1.2).

Bedrock in the BBNPP site area is overlain by a variable thickness of glacial till, colluvium, outwash, kame, and kame terrace deposits. The outwash and kame terrace deposits constitute some of the most permeable aquifer units in the region (Reference 10.5, 2.4.12.1.2).

In upland and lowland areas at the BBNPP site, surface deposits consist largely of glacial outwash sands and gravels. Within the lowland valley near the Susquehanna River, surface deposits also include recent alluvium. The glacial outwash aquifers, located in both the upland and lowland areas of the site, are largely inter-granular in nature (Reference 10.5, 2.4.12.1.2.1).

6.3 Hydrogeology

Generally, borings in the vicinity of the NI and CW Cooling Towers did not encounter groundwater in the overburden soils based on the field exploration performed by Rizzo (Reference 10.5, Figure 2.4-63). Although not encountered, it is not uncommon for groundwater to become perched in granular soils at the soil-bedrock interface. The occurrence and quantity of this perched groundwater is often seasonally affected and highly variable in areas of a sloped interface between the granular overburden and the less permeable bedrock. The conceptual design for the temporary construction dewatering system considers this potential source of water, which must be controlled to facilitate the planned work. In the vicinity of the ESWEMS Pond, groundwater levels in the overburden typically range from 2 to 15 feet below the ground surface (bgs). Along the south side of the proposed ESWEMS Pond, the depth to water was approximately 2 to 8 feet bgs, and flows generally southerly and westerly towards Walker Run

(Reference 10.5, Figures 2.4-81 through 2.4-84). In the vicinity of the ESWEMS Pond, the overburden aquifer is recharged by downward percolating precipitation and upflow from the deeper bedrock aquifer. Groundwater discharges from the surficial aquifer as springs and seeps into ponds, the wetlands along the southern border of the site, and into Walker Run.

The underlying Mahantango Shale Formation is also considered an aquifer. There are no extensive aquitards in the vicinity of the BBNPP site. Vertical groundwater flow in the upland areas to be developed as the NI and CW Cooling Towers is generally downward. Vertical groundwater flow is generally upward from the bedrock aquifer to the overburden aquifer in the area of the ESWEMS Pond (Reference 10.5, Figure 2.4-93).

6.4 Hydraulic Properties by Layer

Groundwater flow is simulated in seven layers in the digital groundwater model. Walker Run, the site wetlands and the excavations for the ESWEMS Pond are generally located within Layer 1, which is a relatively high conductivity zone. The base of the ESWEMS Pond excavation is generally at the top of the competent bedrock, which is within Layer 2 and exhibits a lower conductivity than Layer 1. The excavations for the NI and CW Cooling Towers extend through Layer 1 and well into Layer 2. Layer 2 includes the upper weathered bedrock zone, the transition zone and the upper extent of the competent bedrock. Layer 2, the primary component of the highland ridges, and Layers 3 through 7 are shale bedrock.

6.4.1 Layer 1

Layer 1 exhibits a varying thickness across the model domain, since its upper surface is based on the topography of the site and the lower surface is based on the interface with weathered bedrock (Reference 10.2). Rizzo performed and documented (Reference 10.5) both slug and pump tests to quantify the horizontal hydraulic conductivity of Layer 1.

Slug tests were completed in all 15 monitoring wells screened in the glacial outwash aquifer at the BBNPP site. The horizontal hydraulic conductivity (K_h) values calculated from these tests ranged from 1.19 X 10^{-5} cm/s to 3.40 X 10^{-2} cm/s (i.e., K_h values for the glacial outwash aquifer vary by nearly three orders of magnitude). The geometric mean of the slug test values of K_h for the glacial outwash aquifer is 3.47 X 10^{-3} cm/s (Reference 10.5, Table 2.4-56). Slug tests of the kind implemented during the site investigation measure horizontal hydraulic conductivity only near a test well, and may reflect influences by filter pack storage or low-conductivity borehole wall residual remaining after conventional rotary drilling using mud. Considering the depositional mechanisms of Layer 1 and the nature of slug tests, the range of values is not considered unusual.

The pumping test conducted in the glacial outwash aquifer provided a geometric mean K_h estimate of 6.57 x 10^{-2} cm/s (Reference 10.5, Table 2.4-57). Pump tests of the kind implemented during the site investigation stresses a much broader area of the aquifer than a slug test, and is therefore considered more representative than the slug test results. Thus, Weaver Boos considers the geometric mean value obtained during the pump test, which is the highest mean value for the site, as a representative (yet conservative) value for the horizontal hydraulic conductivity in the overburden aquifer (6.57 x 10^{-2} cm/s).

Because sand and gravel deposits comprising the overburden aquifer are horizontally stratified as described in the boring logs, the deposit is likely anisotropic, and the vertical hydraulic conductivity (which has not been measured) is considered to be $1/10^{th}$ of the horizontal value obtained during the pump test.

The specific yields computed for the pump test indicate median value of 0.322. For a well- to fairly well-graded material such as the overburden, the median value of 0.322 appears reasonable and is therefore considered appropriate for use in the model. Thus, conservative values to quantify the hydraulic properties of the overburden aquifer were selected for use in this conceptual dewatering evaluation.

6.4.2 Layers 2 Through 7

Layer 2 also varies in thickness, since it extends from the interface with the overburden down to elevation 600 feet and is referred to as the shallow shale bedrock. Layers 3 through 7 are considered to be uniform in thickness and extend from elevation 600 feet down to elevation 0 feet.

Slug tests were also completed in 15 shallow bedrock wells at the BBNPP site. The K_h values from these tests ranged from 4.69×10^{-5} cm/s to 1.36×10^{-2} cm/s, with an overall geometric mean K_h of 5.43×10^{-4} cm/s (Reference 10.5, Table 2.4-56).

Horizontal hydraulic conductivity (K_h) values calculated from slug tests in 5 deeper bedrock wells at the BBNPP site ranged from 1.15×10^{-5} cm/s to 1.51×10^{-3} cm/s (Reference 10.5, Table 2.4-56). The geometric mean K_h for the deep bedrock wells was 1.18×10^{-4} cm/s, approximately one order of magnitude less than the value determined for the shallow bedrock wells using slug tests (Reference 10.5, Table 2.4-56).

A total of 90 packer tests were conducted in nine open bedrock borings at the BBNPP site. Each packer test was completed on 12.6 to 23 ft rock intervals. Fifty one packer tests were conducted in shallow bedrock wells. These shallow wells yielded K_h test results ranging from less than 4.00×10^{-7} to 3.82×10^{-4} cm/s. The geometric mean estimate packer test derived K_h values in the shallow bedrock wells equaled 1.94×10^{-6} cm/s (Reference 10.5, Table 2.4-58). In the other 39 packer tests conducted in deep bedrock wells, K_h values calculated from these tests ranged from less than 4.00×10^{-7} to 1.18×10^{-4} cm/s. The geometric mean of these K_h calculated results is 1.52×10^{-6} cm/s (Reference 10.5, Table 2.4-58).

The K_h calculated from the packer tests on the shallow and deep bedrock wells are roughly comparable, which contradicts values based on slug test results. The shallow bedrock K_h values from the slug tests are significantly higher (one order of magnitude) than the K_h calculated from deeper bedrock.

Pumping tests completed in shallow bedrock wells provided a geometric mean K_h value of 5.30×10^{-4} cm/s (Reference 10.5, Table 2.4-57). This value is considered to confirm the values from the slug tests performed in the shallow bedrock wells.

No pumping tests were completed in the deep bedrock aquifer.

In both the shallow and deep bedrock wells, K_h values determined by packer tests were considerably lower than K_h values determined by slug tests and pumping tests.

For the reasons discussed in Section 6.4.1, Weaver Boos considered the geometric mean values obtained during the pump tests as more representative than values obtained by slug testing. However, results from the packer testing program are also considered representative for the intervals that were tested. Of the values reported for the shale bedrock, the geometric mean horizontal hydraulic conductivities from the pump testes are selected as conservatively high values for use in the dewatering evaluation. The geometric mean pump test conductivity value of 5.30 x 10^{-4} cm/s was selected as representative and conservative for both the shallow and deeper bedrock wells. These values are regarded as conservative because their selection is likely to over-predict rather than under-predict the flow of groundwater to be yielded by temporary dewatering systems. As was selected for the overburden, S&L also considered the vertical conductivities of the bedrock (shallow and deep) to equal $1/10^{th}$ of their respective horizontal values obtained during the pump tests.

Although the shale bedrock is correctly described as an aquifer in Reference 10.5 (Section 2.4.12.3.2.2), the conductivity of the bedrock used in this evaluation is about $1/125^{th}$ of the overburden aquifer conductivity. The contrast in conductivity between the overburden and bedrock aquifers means the preferential flow path is through the overburden rather than the bedrock aquifers.

6.5 Groundwater Level Observations

Monthly water table elevations in the overburden and the head elevations in the bedrock were obtained from the 12-month water level monitoring records from 2008/2009 and 2010/2011 (References 10.5, Tables 2.4-47 and 2.4-71). Generally, the shallow wells in the granular soils exhibited the most direct relationship to the expected seasonal fluctuations.

The groundwater elevation data obtained from the overburden wells generally exhibited the annual maximum groundwater elevation readings in February, March or April, with the minimum elevations recorded in September or October. For the monitoring wells in granular soils, the differences between the annual high and low elevations for each well ranged from 2.90 feet to 10.2 feet (Reference 10.5, 2.4.12.3.1.1).

The bedrock wells exhibited less definition to seasonal trends in the data set. However, considering both data sets, the bedrock wells generally exhibited higher elevations during winter and early spring months and lower groundwater levels in the summer and early fall months. The maximum range in measured groundwater elevations, 33.51 ft, is significantly higher than the range obtained in the glacial outwash and shallow bedrock aquifers. The lowest range in elevation values for the deep bedrock aquifer, 2.12 ft, is comparable to values determined for the glacial outwash and shallow bedrock aquifers (Reference 10.5, 2.4.12.3.1.3).

6.6 Excavation Approaches and Dewatering Implications

6.6.1 Collection Ponds for Dewatering Output

Prior to initiating dewatering activities, preparations must be made to receive the water discharged from the dewatering systems. Final selection of the site ponds, which will receive the flow from the dewatering system, as well as the precipitation that falls in the excavation, is based on the location of the ponds, piping routes, pond volumes and the sequence of construction of the ponds. The following paragraphs address the possible ponds, which may be selected to receive the waters.

6.6.1.1 Temporary Groundwater Storage Pond

Effluent from the dewatering system could be routed through the Temporary Groundwater Storage Pond (TGWSP), which is to be located between the ESWEMS Pond and the NI. Thus, it would be beneficial to construct this pond prior to excavation activities in order to use it as a collection area for the dewatering system. An evaluation of the groundwater elevation data from 2007/2008 and 2010/2011 from groundwater wells MW310A and MW 410 (both screened in the soils above the bedrock) indicates the range of measured groundwater elevations to be from 655.54 to 663.91 feet in this area (Reference 10.5, Tables 2.4-47 and 2.4-71). The design elevation of the bottom of the TGWSP is anticipated to be approximately elevation 690 feet (final elevation to be determined during final design), while the current ground surface is at approximately elevation 672 feet (References 10.8 and 10.18). Given this information, it is anticipated that dewatering for the construction of the TGWSP will not be needed.

6.6.1.2 Combined Waste Water Retention Pond

The Combined Waste Water Retention Pond (CWWRP) is located east of the ESWEMS Pond. References 10.8 and 10.16 indicate the design elevation of the bottom of the CWWRP is 686 feet. The current ground surface elevation in the vicinity of the CWWRP ranges from approximately 676 to 728 feet (Reference 10.8). Monitoring wells have not been installed in or near the CWWRP. However using the nearest monitoring well (MW302), the maximum groundwater elevation is estimated to be below elevation 670 feet (Reference 10.5, Tables 2.4-47 and 2.4-71), except where the groundwater may be perched on top of the bedrock. Although the field exploration program by Rizzo did not encounter groundwater perched on the bedrock, some perched groundwater can be anticipated. Given this information, it is anticipated that dewatering for the construction of the CWWRP will not be required. However, if any groundwater is encountered at the soil/rock interface, this can be controlled by utilizing diversion trenches and sumps around the periphery of the excavation to maintain a dry condition. Where soil is present beneath the pond floor, the groundwater is expected to be below the excavation limits.

The CWWRP could be used for storage and exfiltration of the dewatering effluent provided it is constructed early enough and that the lining designed for the permanent pond is not installed until after the dewatering is complete. However, the excavation for the placement of engineered fill below the ESWEMS Pond (as depicted in the drawing attachments to the Response to RFIs SL-BBNPP-149 and SL-BBNPP-234 [Reference 10.4]) appears to intersect the western portion of the CWWRP. Thus, the final excavation plan for the ESWEMS Pond construction or the final design of the CWWRP will require some slight modifications to allow the use of this waste pond for dewatering effluent while the ESWEMS Pond excavation and dewatering is active.

6.6.2 ESWEMS Pond

The ESWEMS Pond excavation is expected to fully penetrate the overburden soils and the upper weathered bedrock to establish the bearing surface (subsurface information from References 10.2 and 10.4) on the competent rock at elevations ranging from 610 to 640 feet. The excavation in the vicinity of the southern portion of the ESWEMS Pond will extend approximately 56 feet through saturated granular deposits. Existing groundwater elevations are discussed in Section 6.3.

To facilitate quality construction methods in the ESWEMS Pond, the excavations should be performed in a dry condition. A dewatering system consisting of deep wells surrounding the excavation is conceptually designed. The excavation can proceed as the dewatering takes place provided the dewatering system maintains the groundwater level below that of the excavation. As the excavation advances, a series of groundwater monitoring wells will be monitored to verify the effectiveness of the dewatering system in reducing the groundwater level.

6.6.3 Nuclear Island and CW Cooling Towers

The final plant grade in the vicinity of the NI and CW Cooling Towers is at elevation 719 and 699 feet (Reference 10.8), respectively, while the current ground surface ranges from approximately 700 to 800 feet (Reference 10.8) in these areas. These structures and/or the fill supporting these structures will extend down to the upper surface of the competent rock, which is at an approximate minimum elevation of 642 feet in the NI and elevation 646 feet in the vicinity of the CW Cooling Towers, as indicated by References 10.2 and 10.4. Thus, the excavations associated with construction of the NI and CW Cooling Towers will extend from the current ground surface, through the surficial soils and into the bedrock. Based on References 10.2 and 10.5, the overburden soils are not saturated. General groundwater conditions for the site are discussed in Section 6.3. Thus, an active dewatering system for the upper soils is not likely to be required. It is expected that groundwater inflows from localized water bearing zones in the overburden and from the bedrock (weathered and unweathered) may be controlled using trench drains at the soil-bedrock interface as well as some trenches cut into the bedrock excavation slopes and floor. The trench drains can be sloped to sumps where the water can be pumped out if a proper slope cannot be attained to drain the trenches to the groundwater storage pond by gravity.

An area of uncertainty is located at the northwest portion of the CW Cooling Towers excavation, where the available boring data is somewhat limited. Excavation plans (Reference 10.4) were developed for the CW Cooling Towers based on a boring located at the proposed center of each tower. From these two borings, the bedrock surface elevation and anticipated excavation depths were extrapolated. Reference 10.4 indicates the northwest quadrant of the CW Cooling Towers excavation will extend down to elevation 646 feet. Figure 2.4-83 of Reference 10.5 indicates groundwater elevation in the glacial outwash aquifer could be as high as elevation 715 feet, which is higher than the current ground surface. Moreover, if the overburden extends below the elevation of Walker Run, it is likely that the overburden will be saturated. Given the lack of borings and wells in this area to establish the contours of the elevation of the top of bedrock and to develop the reliable groundwater elevation contours, significant uncertainty exists in the area of the western cooling tower. If the granular soils are present within the extent of the cooling tower excavation and if they extend below the groundwater level, which is considered to be slightly higher than Walker Run, it is likely that excessive groundwater pump rates and subsequent dewatering of the adjacent wetlands and possibly Walker Run will occur. The groundwater pumping rates and subsequent drawdown determined and presented in this evaluation does not consider this potential outcome because:

- The borings do not extend westward beyond the center of the western cooling tower and the depth to bedrock in this area is uncertain;
- The groundwater contours presented are based on engineering judgment, not field measurements; and
- The contours plotted to represent the groundwater elevation in Figures 2.4-81 to 2.4-84 in Reference 10.5, for this area are not considered appropriate for this use since they are above the mapped ground surface and therefore not plausible for an unconfined aquifer, as the upper soils at this site have been determined. If this approach was correct, then a pond area would be indicated on the topographic survey.

It should be noted that if the overburden extends below the wetlands, this condition could be mitigated by installing a flow barrier wall as discussed for the ESWEMS Pond. No further discussion is provided for the CW Cooling Towers since this condition and the extent of the CW Cooling Towers excavation will be determined during the subsurface exploration and construction phases for the CW Cooling Towers.

6.6.4 ESWEMS Pipeline

The ESWEMS Pipeline from the ESWEMS Pump House to the NI will have an approximate invert elevation of 694 feet, with the pipe bedding supported on the natural soils (Reference 10.13). Since the construction activities for the ESWEMS Pipeline is above the maximum groundwater elevation of 686 feet in this area (References 10.5), construction dewatering will not be needed.

6.6.5 Groundwater Flow Barrier

Dewatering for the ESWEMS Pond excavation can be performed either with or without a flow barrier as discussed later. Based on the inputs for this work, the ESWEMS Pond excavation is the only area where a flow barrier may be warranted. However, based on the site conditions (which may be identified when additional exploratory borings and wells are performed), a flow barrier may also be warranted for the northwestern area of the CW Cooling Towers excavation.

If a flow barrier, such as a slurry wall, is constructed for the ESWEMS Pond excavation, a significant reduction in the required pumping rate and areal extent of drawdown will be achieved. Reference 10.6 considered the effect of implementing a flow barrier along a preliminary alignment. If the final design of the flow barrier is combined with a construction phase excavation support wall to minimize the lateral extent of the pond excavation, the alignment may be adjusted inward (made smaller). An open excavation is currently planned for construction of the ESWEMS Pond as indicated in the response to RFI SL-BBNPP-149

(Reference 10.4). The extent of the excavation with this approach is quite wide. If a construction phase excavation support (earth retention system) is used, the planned dimension of the excavation will be smaller since the cut slope out of the excavation will be eliminated. Since the dimension of the excavation is now smaller, the barrier can be closer to the pond, making the overall area to be dewatered smaller.

6.7 Definition of the Flow System

Weaver Boos reviewed the available information and formulated the following definition of the flow system as presented in Reference 10.6. This review indicates that the BBNPP site may be viewed as located within a small groundwater basin storing water mostly in the overburden aquifer. The overburden aquifer basin is defined to the north by the system of higher ridges, to the east by a bedrock ridge and groundwater flow divide corresponding approximately to the route of Confers Lane, to the south by a bedrock ridge forming in the knolls, and to the west by a bedrock ridge forming in the uplands west of Walker Run. Surface water and groundwater enter the overburden basin from the north and exit the basin via Walker Run, its small tributary located on the BBNPP site.

Deeper groundwater flows through the bedrock are less constrained than in the overburden basin and are assumed to reflect high upland recharge occurring to the north, followed by upward flow just south of the site, and deeper horizontal southerly and southeasterly flow towards the Susquehanna River.

6.7.1 <u>Water Flow Budget (Initial Steady State Conditions)</u>

The groundwater digital model is presented in Reference 10.6 (included in Appendix A of this report), and is summarized in the following sections. Based on the baseline flow budget presented in Reference 10.6, the basin receives and discharges groundwater from three potential sources of groundwater flow:

- The first is groundwater discharge, assumed equal to groundwater recharge, reported in Table 2.4-45, of Reference 10.5 for the Wapwallopen Creek Basin as ranging from 6.6 to 21.8 inches per year, with an average equal to approximately 14.2 inches per year.
- The second is groundwater exchange with Walker Run that flows along the west side of the model domain.
- The third is groundwater inflow originating in the ridge that rises to elevations as high as 1,100 feet directly north of the site. This source cannot be directly measured, yet its significance is inferred from the upward vertical flow of groundwater in the lowland areas south of the proposed NI and ESWEMS Pond.

Potential discharges of groundwater originating beneath the site include bank and bottom discharge to Walker Run and subsurface outflow to the south (much of which likely occurs in overburden deposits beneath Walker Run), with eventual discharge to the Susquehanna River. Additional discharges of groundwater through the bedrock are also inferred from Figure 2.4-93 in Reference 10.5.

6.7.2 Water Flow Budget and Drawdown Forecast for Dewatering Without a Flow Barrier

The mass flow budget for this model includes drains that represent the collective withdrawal of groundwater by multiple dewatering wells to temporarily (about three years) depress the groundwater to facilitate construction of the ESWEMS Pond excavation and drains to represent dewatering trenches and/or well points to dewater the minor inflows in the NI and CW Cooling Tower excavations.

The 2011 digital model (Reference 10.6) of the dewatering system without a flow barrier indicates a total pump flow rate of 1040 gpm will be required to maintain steady state conditions in all three excavations. The liner relationship of flow and hydraulic conductivity considered by Weaver Boos (Reference 10.17) indicates a total flow increase of 15 to 30 percent is estimated. Thus, the total flow if all three excavations are simultaneously dewatered is estimated to be from 1200 to 1350 gpm. These rates are steady state and will be much higher when dewatering is first initiated. The flow rates when the dewatering program is implemented will be dependent upon the desired schedule to achieve the target groundwater elevations.

The digital model results of drawdown in Layer 1 for the dewatering system without the use of flow barriers are illustrated in Attachment D (Reference 10.6, Figure 15). This attachment has not been updated to incorporate the revised hydraulic conductivity. The drawdown is shown in feet, and represents water table depression from the steady state head calculated by the calibrated model. Review of Attachment D indicates deep water table depression (5 to 40 feet) in the areas extending west, south, and east of the proposed ESWEMS Pond. The model predicts an area of up to 25 feet of groundwater table depression extending approximately 400 feet south and east of the ESWEMS Pond. This pumping scheme would most likely result in extensive dewatering of the wetlands south of the ESWEMS Pond. It is estimated that the extent of dewatering drawdown will increase 5 to 10 percent considering the revised hydraulic conductivity. However, since the magnitude and horizontal extent of dewatering without a flow barrier are not considered to be acceptable, the digital groundwater model was not updated.

6.7.3 Water Flow Budget and Drawdown Forecast for Dewatering With a Flow Barrier

Installation of a flow barrier, such as a soil-bentonite slurry wall, or diaphragm wall substantially reduces the steady-state outflow from the ESWEMS Pond excavation dewatering system.

Considering the preliminary alignment of the flow barrier depicted on Attachment H (Reference 10.6, Figure 22), the digital model calculated the steady state flow rate required to dewater the ESWEMS Pond excavation to be approximately 230 gpm. If a flow barrier is implemented, the majority of the flow is from the rock drains and not flow through the barrier. Thus, the increase in hydraulic conductivity in the upper layer (soil) does not significantly influence the pump rate. The revised steady state dewatering pump rate from the ESWEMS pond excavation is 235 to 310 gpm based on the revised hydraulic conductivity of the bedrock.

Total dewatering system outflow for the NI, CW Cooling Towers and ESWEMS Pond excavations is not expected to exceed 490 gpm utilizing a flow barrier around the ESWEMS Pond, and considering the revised values of hydraulic conductivity as compared to approximately 1350 gpm without a flow barrier. However, the actual flow may be less due to the wide range of hydraulic conductivities reported in Reference 10.5. Numerous packer tests conducted in the shale during the site investigation indicate hydraulic conductivity values much lower than considered in the model, and in approximately one-half of the tests, the hydraulic conductivity was effectively zero. Thus, these hydraulic conductivities and the resultant flow values are considered to be conservatively high.

The flow rates discussed herein are steady state and will be higher when dewatering is initiated. The initial rates of dewatering within the flow barrier are dependent upon the schedule allocated to achieve the target groundwater elevation and the volume of water stored in the pore space of the soils within the barrier wall. As the alignment of the barrier wall is adjusted, the initial flow rate and/or schedule of achieving the target groundwater elevation will need to be reconsidered.

As before, the flow model (modified to include a groundwater barrier wall around the ESWEMS Pond, wells and drains) used the initial heads computed by the baseline flow model and the expected drawdowns are plotted on Attachment E (Reference 10.6, Figure 16). Review of this figure again shows the deep drawdown required at the ESWEMS Pond. However, the simulated drawdown elsewhere in the basin is very much less than the simulation without the flow barrier. Drawdown greater than 5 feet is focused immediately west and southwest of the flow barrier. This effect is likely not primarily due to the withdrawal of water from within the flow barrier, but rather due to the partial cutoff of natural westerly flow of groundwater through the position of the barrier. Groundwater levels are expected to diminish on the down-gradient side of a flow barrier and possibly build along the upgradient side. The close proximity of the wetland to the flow barrier wall at the northwest corner of the ESWEMS Pond (near the 50-foot buffer zone of the wetlands) may result in some mounding of groundwater upgradient of these impermeable barriers. This groundwater mounding may result in a rise in the groundwater level and subsequent expansion of the wetlands into the 50 foot buffer zone. Thus, there will be a need to monitor the water level fluctuation in this wetland area.

6.8 Conceptual Dewatering Design

In general, the dewatering system should be designed to remove the flows suggested by the flow budgets and to evacuate the precipitation that falls into the excavation during construction. The flows discussed herein, only consider those flows originating from the groundwater and not those associated with evacuation of precipitation into the excavation. However, due to the conservatism used in this conceptual design, as noted later, the dewatering system should be capable of extracting most of the precipitation that falls within the limits of the excavation. Considering that sound construction practice dictates the area around the excavations will be graded to prevent stormwater from flowing into the excavation, the only additional water to be evacuated will be the direct precipitation that falls into the excavations. The approximate cumulative areal extent of the excavations is 53.7 acres (from the plans provided in RFI No SL-BBNPP-149, Reference 10. 4). Considering the storm water report (Report No. SL-009446 [Reference 10.15]), the 100 year storm event is 7.49 inches in a 24 hour period. The increased flow from this storm event is 10,921,000 gallons per day (10.9 mgd) or 7580 gpm. This flow, combined with seepage into the excavations equates to a flow of 8070 gpm when a flow barrier is considered. This flow should be within the capacity of the pumps for the sumps, which collect and discharge the flow. These pumps will be sized in final design.

Dewatering wells could be installed at this site using direct rotary, reverse-circulation rotary, cable tool, or other methods such as Rotosonic drilling. Reverse-circulation rotary will provide wells with the greatest efficiency and should therefore be considered. The other methods listed might tend to compact the aquifer formation, or leave low-conductivity borehole skins that cannot be completely removed during development. Because the overburden aquifer contains boulders, it may be necessary to use a chisel, percussion hammer, or other methods to remove or penetrate them.

There is the possibility that the amount of water extracted during dewatering will trigger the need for a Susquehanna River Basin Commission (SRBC) Groundwater Withdrawal Permit. Also, Pennsylvania DEP Regulation §110.201 has a requirement: "The following persons shall register the information specified in §110.203 (relating to content of registration) with the Department: (3) Each person whose total withdrawal from a point of withdrawal, or from multiple points of withdrawal operated as a system either concurrently or sequentially, within a watershed exceeds an average rate of 10,000 gallons per day in any 30 day period."

6.8.1 Conceptual Design Without Flow Barrier

Deep dewatering wells may be located around the perimeter of the ESWEMS Pond excavation to implement the first stage of water table depression. Because wells cannot depress the water table to the base of the aquifer in areas between the wells, a level of approximately 10 feet above the shale is selected as a target for use in computing cumulative drawdowns. By inspection of the drawdown curves presented in Appendix D of Reference 10.6, an inter-well spacing of approximately 100 feet will provide for a cumulative drawdown of slightly more than 50 feet at locations between the wells. Dewatering wells may be located as shown on Attachment F (Reference 10.6, Figure 20), based on this conceptual design criterion. Approximately 28 dewatering wells appear to be appropriate for conditions at the ESWEMS Pond excavation. Given the large number of wells required and potentially very large initial flows that such a system might develop, individual pumps should be sized for maximum flows of approximately 125 to 200 gpm each considering the revised hydraulic conductivity. The discharge lines should be fitted with throttling valves to control the overall flow rate of the system and avoid overwhelming the body receiving the discharge. A schematic diagram showing a typical dewatering well considered appropriate for conditions at this site is provided as Attachment I (Reference 10.6, Figure 23).

The ESWEMS Pond excavation will likely require a method to control groundwater at the interface of the overburden and weathered shale in the form of a system of vacuum well points positioned as shown on Attachment F (Reference 10.6, Figure 20). Each of the headers shown will draw water from well points that are typically 2-in. diameter that may be drilled, driven or jetted in if conditions allow. Each header will need to be connected to its own vacuum pump. Individual vacuum pumps will need to be sized based on conditions encountered and the length of each header.

Final stages of the dewatering conceptual design for the ESWEMS Pond excavation include the installation of trench drains and sumps into the exposed bedrock surface at the base of the ESWEMS Pond excavation. Such trenches might be excavated 3 to 5 feet wide, and 2 to 3 feet deep, and sloped to collection sumps for ejection from the excavation. Groundwater flow from the bedrock is expected to vary over a wide range, and additional trenches or sumps might be needed at locations to be determined. Three such trenches were incorporated into the digital flow model at the ESWEMS Pond as shown on Attachment F (Reference 10.6, Figure 20). The exact locations of the trenches in the bedrock will be determined during construction.

Groundwater observations at the NI and CW Cooling Towers excavations suggest that little saturated overburden is present in either area. It is therefore expected that groundwater inflows may be controlled using trench drains cut into the bedrock at the locations and elevations suggested on Attachments F (NI) (Reference 10.6, Figure 20) and G (CW Cooling Towers) (Reference 10.6, Figure 21). The trench drains can be sloped to sumps where the water can be pumped to the TGWSP or other disposal points if gravity drainage to the ponds cannot be established. The exact locations of the trenches in the bedrock will be determined during construction.

The effectiveness of the dewatering system should be monitored to compare observed drawdown with the estimates described herein (or more detailed design estimates developed prior to implementation). Water levels may be monitored for this dewatering strategy using existing monitoring well clusters that have been drilled at the site. Additional monitoring wells or piezometers should be installed at select locations to provide further points for comparison. A typical schematic diagram for monitoring wells or piezometers is provided on Attachment J (Reference 10.6, Figure 24).

Operation of this conceptual dewatering system will require an uninterrupted source of power for electrically operated submersible pumps and vacuum pumps, and an uninterrupted source of fuel for internal combustion vacuum pumps if selected for use. Provisions for convenient maintenance should be included for all system elements as needed for a project duration approaching 3 years.

6.8.2 Conceptual Design of a Flow Barrier

Temporary construction dewatering of the site was simulated to evaluate the potential benefits of a flow barrier encompassing the proposed ESWEMS Pond excavation (See Paragraph 6.7.3). Wall boundaries considered in the flow model were a 3-feet thick flow barrier characterized by a hydraulic conductivity of 1×10^{-6} cm/s. The wall boundaries form a continuous flow barrier around the proposed excavation and extend from top to bottom in Layer 1 of the model. This model simulation utilized 14 pump wells, located inside the flow barrier wall to achieve dry conditions in the ESWEMS Pond. The preliminary alignment of the flow barrier and the wells is presented on Attachment H (Reference 10.6, Figure 22).

As discussed in Paragraph 6.6.3 an area of uncertainty is located at the northwest portion of the CW Cooling Towers excavation, where the available boring data is limited. If the overburden extends below the elevation of Walker Run or the associated wetlands, it is likely that the overburden soils are saturated it is likely that excessive groundwater pump rates and subsequent dewatering of the adjacent wetlands and possibly Walker Run occur. If these conditions are present, the installation of a flow barrier wall should be considered in the area of the CW Cooling Towers excavation where the overburden extends below the groundwater table.

The NI excavation will not require a flow barrier.

If a soil-bentonite (S-B) slurry wall is selected for use as a flow barrier, it might be installed along an alignment as shown on Attachment H (Reference 10.6, Figure 22), and should reflect the following guidelines in its final design:

- The slurry wall will be a minimum of three feet thick, and will be at least ½-foot-thick for each 10 feet of hydraulic head across the wall.
- The slurry wall will be keyed into competent shale such that the flow underneath the wall through the shale is less than or equal to the flow directly through the soil-bentonite slurry wall. The minimum depth of penetration of the slurry wall key will be two feet into the shale below any permeable lenses or weathered shale zones.
- The slurry will consist of 4 to 7 percent bentonite in water, and the backfill will contain bentonite at a rate of 3 percent. If the groundwater barrier is also designed to act as a temporary excavation support wall, Portland cement may also be incorporated into the slurry.
- The slurry wall will have a designed in-situ permeability less than or equal to 1×10^{-7} cm/s. A value of 1×10^{-6} cm/s is used to account for any minor imperfections in the wall. Some plastic fines may need to be imported to meet this criterion.
- The slurry wall will have a minimum of a five-foot overlap at corners.
- The slurry wall will be constructed vertically.
- Slurry levels will be maintained at least seven feet above the groundwater table during installation of the wall. Depending upon the groundwater levels (at the time of construction) along the southern leg of the wall for the ESWEMS Pond, this will likely require the construction of a berm to raise the ground level at several locations along the specified alignment. If the construction schedule/sequence allows, it would be advantageous to install the flow barrier walls in the late summer and/or early fall when groundwater levels are typically the seasonal lowest.
- Extensive quality control measures should be taken to assure that the S-B slurry wall is constructed without gaps or windows.
- Because the overburden aquifer contains boulders, it may be necessary to use an orange peel, clamshell, chisel, or other methods to remove or penetrate through them.

If final design incorporates the flow barrier wall into an excavation support structure, sheet piling, concrete diaphragm walls, intersecting caissons or secant piles, or cofferdams should be considered. All aspects of ground support and excavation stability will require extensive additional evaluation and detailed designs beyond the scope of this evaluation.

Appendix D of Reference 10.6, which is attached to this report as Appendix A, estimates potential flux rates through the flow barrier wall when the maximum gradient is established. Assuming that the in-situ hydraulic conductivity will achieve 1×10^{-6} cm/s, flux across the wall is estimated at approximately 8 gpm. If the design criterion of 1 x 10^{-7} cm/s is achieved, the corresponding flux rate is about 1 gpm. If the barrier wall is discontinuous over 1 percent of its vertical surface area due to gaps or windows, excess inflows approaching 5,000 gpm might occur. This finding underscores the need for adequate quality assurance and quality control (QA/QC) during construction. Furthermore, it indicates that if the wall is discontinuous, the presence of discontinuities should be obvious shortly after the initiation of interior dewatering as the excavation proceeds downward.

Operation of the barrier wall and interior dewatering system should include a piezometric monitoring program to compare expected groundwater withdrawals and drawdown rates with those calculated in advance. This program should include continuous monitoring of the existing and proposed monitoring wells or piezometers at select locations. Data logging pressure transducers with remote telemetry are recommended for this purpose so that head levels may be continuously monitored during initial drawdown and later during the extended phase of construction activity. If any windows or gaps in the flow barrier are indicated by the piezometric monitoring program, then pressure grouting or other remedial measures will be necessary to correct these deficiencies. Additional groundwater monitoring wells may be warranted in the immediate vicinity of significant repairs to the flow barrier wall.

6.8.3 Conceptual Dewatering System Design With a Flow Barrier

When determining the spacing between wells within the flow barrier for the ESWEMS Pond, they can be spaced at greater distances than without a barrier, since the flow barrier will effectively prevent inflows.

Considering the use of the flow barrier along the preliminary alignment, dewatering wells may be located as shown on Attachment H (Reference 10.6, Figure 22). A total of approximately 14 dewatering wells appear appropriate when the flow barrier is utilized. Given the number of wells required and potentially very large initial flows that such a system might develop, individual pumps should be sized for no more than approximately 125 to 200 gpm each. Initially the dewatering wells inside the flow barrier will drain the water stored in the saturated pore space of the soils to be excavated. If the dewatering system inside the flow barrier is initially pumped at a rate of about 600 gpm, approximately 226 acre-ft of water will be removed over a period of approximately 85 days. With consideration for increased bedrock upflows within the interior of the flow barrier based on the recalculated bedrock hydraulic conductivity, this period might extend to 105 to 120 days. Digital flow modeling of this dewatering strategy suggests that interior dewatering might yield a steady-state flow on the order of 235 gpm at the ESWEMS pond excavation. With consideration for increased bedrock upflows within the interior of the flow barrier based on the recalculated bedrock hydraulic conductivity, this quantity is expected to increase to a maximum average flow of 310 gpm; however, the actual flow may be less as discussed in paragraph 6.7.3.

A second stage of water table depression to the shale surface or near the shale surface may require the use of vacuum well points positioned as shown on Attachment H (Reference 10.6, Figure 22). Each of the headers shown will draw water from well points that are typically 2-in. diameter that may be drilled, driven, or jetted in if conditions allow. Each header will need to be connected to its own vacuum pump. Individual vacuum pumps will need to be sized based on conditions encountered and the length of each header.

Final stages of the dewatering conceptual design include the excavation of trench drains and sumps into the exposed bedrock surface in front of the toe of the slope at the base of the ESWEMS Pond excavation. Such trenches might be excavated 3 to 5 feet wide, and 2 to 3 feet deep, and sloped to collection sumps for ejection from the excavation. Groundwater flow from the bedrock is expected to vary over a wide range, and additional trenches or sumps might be needed at locations to be determined. Three such trenches were incorporated into the digital flow model at the ESWEMS Pond as shown on Attachment H (Reference 10.6, Figure 22).

Groundwater observations at the NI and CW Cooling Tower excavations suggest that little saturated overburden is present in either area. It is therefore expected that groundwater inflows may be controlled using trench drains cut into the bedrock at the locations and elevations suggested on Attachments H (NI) (Reference 10.6, Figure 22) and G (CW Cooling Towers) (Reference 10.6, Figure 21). The trench drains can be sloped to sumps where the water can be pumped to the TGWSP or other disposal points, if gravity drainage to the ponds cannot be established.

Operation of this conceptual dewatering system should be less sensitive to brief interruptions in electrical power because the flow barrier will retard inflows to the excavation. However, provisions for convenient maintenance should still be included for all system elements as needed for a project duration approaching 3 years.

6.9 Disposal of Groundwater

As stated in Section 6.7.2 above, the steady state discharge from a dewatering system without the use of a seepage cutoff wall would be approximately 1200 to 1350 gpm (approximately 1.7 to 1.9 million gallons per day [mgd]). Considering the use of a seepage cutoff wall around the ESWEMS Pond excavation, the total discharge of pumped groundwater will be reduced to an estimated flow of 355 to 490 gpm (0.5 to 0.7 mgd). For this report, a value of 450 gpm (0.65 mgd) will be considered as the average daily quantity of water that will be discharged with the installation of a competent seepage cutoff wall and after steady state conditions are established.

There are several options for the disposal of the groundwater pumped from the excavations. Bell Bend Nuclear Power Plant may or may not choose to implement any one or more of these options. They include:

- Treatment for human consumption.

  Water obtained from the dewatering activities will not be used for human consumption. A potable water line will be constructed from a local municipality (References 10.7, Section A4.2.1.3 and 10.10, Section 2.3.3.2). Thus, human consumption the water obtained from the dewatering activities is no longer a consideration for water reuse or disposal.

- Injection / infiltration into the overburden (away from the excavation) to replenish the drawdown in groundwater levels.

  The use of injection wells to replenish the drawdown in the groundwater level in the overburden soils can be considered, but these wells have a tendency to clog due to sedimentation or fowling and may require extensive maintenance. Therefore, the potential use of injection wells to maintain the groundwater levels in the nearby wetlands is not feasible or recommended.

- Discharge into the Susquehanna River.

  Several of the other disposal options offer significant potential benefits and ease of implementation that render direct discharge into the Susquehanna River undesirable. Thus, evaluation of the permits required to discharge into the Susquehanna River was not performed and is beyond the scope of this report. However, if considered by others, the anticipated maximum flow which may be discharged to the Susquehanna River during dewatering activities (with proper permitting) could be considered to be the average value of steady state discharge from the dewatering systems for all areas, with a flow barrier wall at the ESWEMS Pond of 0.5 mgd (350 gpm). This flow is well within the design parameters for the 24 inch CWWRP blowdown discharge drain (if used) which will have a flow capacity of 9356 gpm (Reference 10.14, Section 3.4).

- Used for various construction activities, such as:
  - Dust control;
  - Water for compaction control of fill and backfill; and
  - Concrete mixing.
- Temporary storage/sedimentation in the temporary groundwater storage pond (TGWSP) or other discharge ponds, with or without infiltration into the overburden prior to release into the wetlands.
- Temporary spray irrigation in the wetlands near the ESWEMS Pond to maintain the condition of the wetlands and dispose of the water (Reference 10.18).

Of these disposal options, the most likely beneficial uses are for construction activities and to aid in recharge of the overburden soils and associated wetlands in the vicinity of the ESWEMS Pond excavation. These likely uses are discussed in Section 6.10.

Even with the installation of the seepage cutoff around the excavation, there will be some drawdown of the water within the wetlands south of the NI as noted in Reference 10.6. The use of the pumped water to restore the groundwater level in this wetlands area would be beneficial. The surface water present in the wetlands at the site is hydraulically connected to the groundwater. Therefore, the water chemistry is similar (Reference 10.10, Section 2.3). The various water quality components tested from the shallow bedrock wells also indicated similar values for these components. Thus, the direct discharge of any groundwater pumped from the excavation would not have any anticipated detrimental chemical effect on the water in the wetlands. However, direct discharge would require permits, a sedimentation basin, a suitable area with erosion protection measures, and a controlled outlet. If the discharge water is pumped directly into the TGWSP to be constructed on the southwest side of the ESWEMS Pond, then the outlet facilities of the pond would provide the necessary controlled outlet and erosion protection. Since the in situ soils are granular and permeable, the water pumped from the excavation would naturally infiltrate through the bottom of the pond and replenish the wetlands naturally. Additionally, waters discharged from the TGWSP into Walker Run (if allowed) will aid in the recharge of the wetlands since Walker Run has a granular bottom. It is important to construct this TGWSP as one of the first construction activities for this project.

6.10 Beneficial Water Reuse

The most beneficial uses of the groundwater pumped from the excavations would be reuse as a source of non-potable water for construction use and replenishment of the wetlands.

Construction uses for non-potable water include dust control for the construction roads and water to be used for moisture conditioning of fill during placement and compaction. Approximately 40,000 gallons of water per day will be required for dust control (Reference 10.7, Table 4.2-1, Note d).

Approximately 1.3 million cubic yards (cy) of granular and cohesive backfill will be placed from the top of competent bedrock to the bottom of foundations or plant grade, where applicable (Reference 10.4, Table 3). This fill volume does not include fill placed around the site for general site grading operations or the concrete fill beneath select safety related structures. Estimating an addition of 2 percent (approximately 2.5 pounds of water per cubic foot of material) moisture to material for soil placement and compaction, a total of 10.5 million gallons will be required (1.3×10^6 cy x 27 cf/cy x 2.5 lbs/cf / 8.34 lbs/gal = 10.5×10^6 gallons). Considering 180 days per year for 3 years of work, the daily usage would be approximately 19,000 gallons per day [$10.5 \times 10^6 / (180 \times 3) = 19{,}000$].

Concrete mixing requires the use of potable water to preclude the addition of impurities to the concrete that may result in improper strength in the concrete. Based on the groundwater quality data available from on-site pumping tests (Reference 10.10, Table 2.3-41), the water to be extracted during dewatering appears to be acceptable for concrete mix water; however, test batches should be performed per ASTM C 1602 (Reference 10.11) when non-potable water is used. It is estimated that 2,220,000 gallons of water will be required per year to mix and cure concrete (Reference 10.7, Table 4.2-1). Considering concrete placement 250 days per year, this equates to 8,900 gallons per day (2,220,000 / 250 = 8,900).

The anticipated daily average beneficial water use in construction activities is approximately 68,000 gpd (40,000 [dust control] + 19,000 [soil compaction] + 8,900 [concrete mixing and curing] = 67,900 say 68,000 gallons per day), which is substantially less than the anticipated average daily flow of 650,000 gallons per day anticipated from the dewatering systems. The remaining 582,000 gallons per day could, with proper evaluation and permits, be used to recharge the wetlands near the ESWEMS Pond excavation.

The surface water present in the wetlands at the site is hydraulically connected to the groundwater. Therefore, the water chemistry is very similar (Reference 10.10). The various water quality components tested from the shallow bedrock wells also indicated similar values for these components. Thus, the direct discharge of any groundwater pumped from the excavation would not have any detrimental chemical effect on the water in the wetlands. However, direct discharge would require permits, a sedimentation basin, a suitable area with erosion protection measures, and a controlled outlet.

Following sedimentation in the TGWSP the groundwater from the dewatering systems could be used in a temporary spray irrigation program in the wetlands near the ESWEMS Pond as discussed in Reference 10.18. The use of a properly designed and operated temporary spray system would provide a better distribution of the water, more control in flow and application area, which should result in less potential erosion than direct discharge from a ditch or pipe on the surface of the wetland (flood irrigation).

With proper design and construction, the TGWSP (1.25 acre pond, scaled from Reference 10.8) could act as a natural recharge facility to the wetlands near the ESWEMS Pond excavation. Since the steady state dewatering system flow rate (with a flow barrier) minus the anticipated average beneficial use for construction is approximately 582,000 gallons per day, approximately 1.8 acre-feet/day is available for recharge to the wetlands (582,000 gallons/day / 7.48 gallons/cf / 43,560 sf/acre = 1.8 acre-feet/day). This indicates that if exfiltration rates through the pond floor are established and maintained in excess of 17.3 inches/day (1.8 acre feet/day x 12 inches/foot / 1.25 acres = 17.3 inches/day), under average conditions the dewatering system effluent would not discharge into the wetlands via the discharge structure. If the exfiltration rate is less than 17.3 inches/day, the excess effluent from the dewatering systems, with proper permits, could be released into the adjacent wetlands via the discharge structure.

The final design of the TGWSP should consider both the steady state flow from all three excavations as well as peak flows from the ESWEMS Pond dewatering system startup combined with the flows from the other excavations to the extent they will have concurrent flows based on the construction sequencing. It is important to construct this TGWSP as one of the first construction activities for this project.

In summary, the most prudent approach for the disposal of the water pumped from the excavation would be to pump it directly into the TGWSP located southwest of the ESWESM Pond. This pond could act as a natural recharge facility to the wetlands near the ESWEMS Pond excavation or as a source of water for the proposed spray irrigation system. Water for beneficial use in construction (dust control, fill conditioning and concrete mixing and curing) could be extracted from the TGWSP. A pumping facility could easily be established adjacent to this detention pond for ease of extraction. No additional storage facilities (tanks) would need to be constructed. However, the use of a storage tank for water, if it was to be used for concrete mixing, may be prudent for ease of testing. The water from the TGWSP could then be used in a temporary spray irrigation system to aid in maintaining the condition in the wetlands near the ESWEMS Pond.

6.11 Environmental Effects

Infiltration (from the TGWSP if unlined), flood irrigation or spray irrigation may be required to maintain the wetlands and to dispose of water produced from dewatering activities. Although these waters are the same naturally occurring groundwater that create the wetland conditions, waters discharged into the wetlands through spray irrigation or flood irrigation will require an NPDES Stormwater Discharge Permit. The major components of the permit include:

- Notice of Intent (NOI);
- Erosion and Sediment (E&S) Control Plan;
- Pennsylvania Natural Diversity Inventory (PNDI) Search;
- Post Construction Stormwater Management (PCSM) Plan;
- Thermal Impact Analysis; and
- Antidegradation Analysis.

Walker Run is classified as a wild trout stream by the PA Fish and Boat Commission (PFBC) (Reference 10.21). The wetlands associated with such a stream are considered "exceptional value" by the PA Department of Environmental Protection (PADEP). It may not be possible to obtain a "General NPDES Permit". An Individual NPDES Permit will be required, as referenced in 25 Pennsylvania. Code Chapter 92 (Reference 10.12). Coordination with the Luzerne Conservation District would most likely be required. Water sampling and testing will most likely be required as part of this permit to ensure that the water contains no material detrimental to the environment (Reference 10.12).

The Pennsylvania Department of Environmental Protection does not specify a limit on the flow rate of the discharge. However, they do specify that "Best Management Practices (BMPs) be implemented to maximize infiltration technologies, eliminate (where possible) or minimize point source discharges to surface waters, preserve the integrity of stream channels, and protect the physical, biological and chemical qualities of the receiving surface water." Therefore, high discharge rates that would not preserve the integrity of the stream channel or the physical qualities of the receiving surface water may be restricted. This permit will also require the use of proper erosion control measures and other BMP, such as hay bales and silt fences for any discharges to the surface bodies of water.

Since the groundwater in the overburden aquifer and the shallow bedrock have water quality parameters similar to the existing surficial water in the wetlands and Walker Run, no detrimental effects are anticipated from disposing the pumped water into the wetlands and Walker Run or reusing it for dust control or water content control during compaction operations.

6.11.1 Possible Impacts of Dewatering

The extent and magnitude of groundwater drawdown projected for dewatering without a flow barrier or reintroducing the groundwater to the wetlands via a spray or flood irrigation is shown on Attachment D (Reference 10.6, Figure 15). Review of this figure (without flow barrier) indicates deep drawdown (25 feet or more) at distances of up to 900 feet south and east of the ESWEMS Pond. The extent and magnitude of groundwater drawdown projected from dewatering using the flow barrier is shown on Attachment E (Reference 10.6, Figure 16), which indicates drawdowns of 5 feet extend less than approximately 450 feet south and west of the ESWEMS Pond flow barrier. However, groundwater recharge from the groundwater storage pond (if unlined) and/or irrigation will reduce both the magnitude and areal extent of drawdown.

The majority of residents near the site obtain water from domestic wells. Several industries including the Susquehanna Steam Electric Station (SSES) obtain water from wells. There are six domestic use wells and one commercial use well within one-half to three-quarters of a mile from the site. Given the drawdown projected to occur during dewatering without a flow barrier, some potential exists for negative impact on nearby domestic and industrial water supply wells.

In the case where the flow barrier is utilized, little or no impact to nearby wells is anticipated.

Numerous and extensive wetlands are located both on the BBNPP site and in adjoining areas, particularly to the west, south, and east. Such features are often expressions of the natural water table at or near the surface, and are therefore quite sensitive to impact via water table depression.

If dewatering is implemented without the flow barrier, substantial adverse impact is expected on the levels of surface water and groundwater in the wetland south of the ESWEMS Pond. A very small area to the northwest of the ESWEMS Pond is shown with a drawdown of 5 feet, suggesting a minor potential for adverse impact to the wetland at that location. As stated in Section 6.7.3, the presence of the flow barrier may counteract this drawdown due to a slight mounding effect. A very small area of drawdown of 5 feet is also shown immediately west of the proposed NI excavation. This very small area of drawdown does not appear to extend to the wetland located west of the NI.

If dewatering is implemented utilizing flow barrier(s) around the ESWEMS Pond and any other areas where the overburden soils are saturated, the potential for adverse impact on the wetland is significantly reduced. The actual impact is likely to be less than indicated by the model as depicted on Attachment E (Reference 10.6, Figure 16) because the flow barrier will be keyed several feet into bedrock. The digital model can only simulate the extension of the flow barrier to the top of the bedrock. Potential drawdown to the northwest of the ESWEMS Pond appears to be nearly eliminated. Potential drawdown immediately west of the NI excavation remains unchanged since no flow barrier is used for the NI and is not expected to affect the wetland to the west.

6.11.2 Mitigation of Potential Impact

Potential impacts due to water table drawdown may be mitigated by any method that reduces or eliminates drawdown in areas beyond the excavation. Aquifer recharge is one potential method to reduce drawdown in areas where drawdown of the groundwater is not desired. This might be implemented using spray or flood irrigation and/or by allowing exfiltration from the TGWSP if constructed without a lining. It will be difficult; however, to control extensive drawdown using these means alone if dewatering is undertaken without the flow barrier around the ESWEMS Pond.

Given the physical constraints posed by the location of the site and adjoining wetlands, a vertically-oriented flow barrier, such as a S-B slurry wall, or diaphragm wall appears to be a viable and effective means to mitigate potential impacts due to projected water table drawdown.

Drawdown outside the flow barrier extends mostly west and south of the ESWEMS Pond as shown on Attachment E (Reference 10.6, Figure 16).

If the overburden soils in the northwestern quadrant of the CW Cooling Towers excavation extend below the groundwater level, an additional flow barrier wall should be implemented to reduce the adverse impacts of the planned excavation.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The following conclusions are based on this evaluation of the conceptual dewatering system for the construction of the BBNPP utilizing a qualitative approach considering the revised hydraulic conductivities for the glacial overburden and underlying bedrock:

a. An active dewatering system will be required to lower the groundwater for the excavation to allow for construction of the below grade elements of the ESWEMS Pond and ESWEMS Pump House to be performed under dry conditions. The dewatering system will consist of deep wells penetrating the overburden soils down to the top of the bedrock and collector trenches or well points near the interface of the soil overburden and weathered bedrock.

b. A passive dewatering system (collection trenches) will be required to excavate the area where the NI and the CW Cooling Towers are to be located. Extensive excavation of both overburden soils and bedrock will be required. Based on the available data, trenches and ditches at the soil/rock interface and at select locations in the bedrock excavations can be designed to collect and divert any groundwater from the NI and CW Cooling Tower excavations. The exact locations of the trenches in the bedrock will be determined during construction.

c. The radius of influence of dewatering wells for the ESWEMS Pond and ESWEMS Pump House excavation would extend significant distances to the south and east from the site. Anticipated drawdown of 25 feet being experienced approximately 900 feet from the wells if a flow barrier is not utilized. This would result in a significant impact on the nearby wetlands. Some of the nearby wetlands could become fully dewatered.

d. With the use of a flow barrier, such as a soil-bentonite slurry wall, around the ESWEMS Pond and ESWEMS Pump House excavation would greatly reduce the drawdown effect of the dewatering wells since the wells would be located within the limits of the flow barrier. Considering a groundwater barrier wall around the ESWEMS Pond and ESWEMS Pump House, the model forecasts drawdowns will be much less than the simulation without the flow barrier. Drawdown greater than 5 feet is focused within 450 feet of the flow barrier (south and west). Given the natural groundwater flow direction and the future flow barrier wall around the ESWEMS Pond some groundwater mounding, upgradient of these impermeable barriers may occur. This groundwater mounding may result in a rise in the groundwater level and subsequent expansion of the wetlands into the 50 foot buffer zone. Thus, there will be a need to monitor the water level fluctuation in this wetland area. These impacts should be characterized in the Environmental Assessment and the Permanent and Temporary Wetland Impact Report.

e. There is the potential for significant water seepage through the bedrock in the bottom of the NI, CW Cooling Towers and ESWEMS Pond and ESWEMS Pump House excavations. The flow collected from the rock portion of the three excavations to be approximately 310 gpm. However, this calculated flow rate is based on the mean value of hydraulic conductivity from pump tests, which were considered conservative and resulted in higher forecast flow rates than if the values for hydraulic conductivity had been chosen. Trenches and ditches will most likely be required in the bottom of the excavation to direct this upward flow through the rock away from the center of the excavation to the perimeter ditches. Sumps and pumps will be utilized to remove this water from the excavation.

f. The total anticipated pump and trench collection flow rates from the bedrock and the water bearing soils (without a flow barrier at the ESWEMS Pond or ESWEMS Pump House), to facilitate simultaneous construction of the NI, CW Cooling Towers, ESWEMS Pond and ESWEMS Pump House is not expected to exceed 1350 gpm, under steady state conditions. Higher flow rates will be required to drain the water stored in the saturated soils. The flow rate required to establish the steady state conditions is inversely proportional to the time allowed to establish the dewatered conditions.

g. With a competent flow barrier around the ESWEMS Pond and ESWEMS Pump House excavation and no barrier around the NI and CW Cooling Tower excavations, average inflow into the three excavations considered (through the flow barrier and up through the bedrock) is anticipated to be 450 gpm. The initial flow rate, to remove the groundwater from within the flow barrier, will be contingent upon the time period allowed. If 120 days are scheduled to remove the water from within the flow barrier of the ESWEMS Pond and ESWEMS Pump House (not considering initial flow from NI and CW Cooling Tower excavations), an average flow rate of approximately 600 gpm would be required from within the ESWEMS Pond and ESWEMS Pump House flow barrier wall.

h. Direct discharge of the groundwater into Walker Run or its tributaries will most likely not be permitted. The use of a detention/sedimentation pond and the use of Best Management Practices to reduce the total solids in the runoff will be required. Disposal of water produced from dewatering activities will most likely be accomplished by allowing infiltration from the TGWSP and possibly other ponds provided bottom liners are not installed to prevent infiltration. During periods of excessive flows from the excavations due to precipitation or at the start of pumping, the excess water will likely be allowed to settle and thermally stabilize before it is disposed of via spray and/or flood irrigation or possibly discharge directly into the Susquehanna River via the Combined Waste Water Retention Pond blowdown pipeline if the pipeline has been installed. If disposal in surface water or wetlands is implemented, an NPDES permit will be required at a minimum.

i. There is the possibility that the amount of water extracted during dewatering will trigger the need for a Susquehanna River Basin Commission (SRBC) Groundwater Withdrawal Permit. Also, Pennsylvania DEP Regulation §110.201 defines the filing requirements.

j. The water removed from the excavation should be suitable for reuse as dust control, soil compaction, and concrete mixing and curing based on the available water quality information. Some testing of the water will be required if it is to be used for concrete mixing.

k. The ESWEMS Pipeline will be constructed above the groundwater level, thus a dewatering system is not required.

l. The Temporary Groundwater Storage Pond will likely be constructed above the groundwater level, thus a dewatering system will not be required.

m. The Combined Waste Water Storage Pond will most likely be constructed above the groundwater level, thus a dewatering system will not be required. Trenches to divert the groundwater in the northwest corner where bedrock is present may be needed.

7.2 Recommendations

The following recommendations for a dewatering system are based on this evaluation of the conceptual dewatering system for the construction of the BBNPP:

a. A flow barrier, such as a soil-bentonite slurry wall should be installed around the ESWEMS Pond and ESWEMS Pump House excavation. One continuous wall is recommended for the portions of the excavation where water bearing overburden (sand and gravel) will be encountered. The flow barrier would be installed by keying it into the underlying bedrock. The minimum design permeability of the flow barrier is 1×10^{-7} cm/s with an approximate thickness of three feet.

b. With a flow barrier around the ESWEMS Pond and ESWEMS Pump House excavation, a total of 14 dewatering wells, as shown on Attachment H (Reference 10.6, Figure 22), will be required to create and maintain a dry condition at the bottom of the excavation. These wells should have a capacity of up to 200 gpm. If a build up of groundwater occurs on the north side of the ESWEMS Pond and ESWEMS Pump House excavation or extreme levels of seepage are encountered, additional pumping wells can be integrated into the pumping system. To control seepage at the interface of the soil and rock, a series of well points is also shown on Attachment H.

c. Sufficient ditches and trenches should be installed at the soil/rock interface in the NI and CW Cooling Tower excavations to preclude groundwater from flowing into the excavations. Based on the available data, flow barriers are not required for the NI and CW Cooling Tower excavations.

d. Trenches may be required in the underlying bedrock in the bottom of the NI, CW Cooling Towers and ESWEMS Pond and ESWEMS Pump House excavations to direct any up flow of groundwater through the bedrock to the perimeter ditches where it can be removed with sumps and pumps.

e. The Temporary Groundwater Storage Pond, to be located west of the ESWEMS Pond and ESWEMS Pump House should be constructed prior to any dewatering activity. This pond can be utilized as the detention, sedimentation, infiltration (if not lined) and release point for the discharge from the dewatering systems established for the ESWEMS Pond, ESWEMS Pump House, NI and CW Cooling Towers.

f. The Combined Waste Water Retention Pond, the Temporary Sediment Basins and possibly the ESWEMS Pond could be used as depositories for dewatering outflow, if they are constructed prior to the completion of all on site dewatering activities.

g. To maintain the conditions in the wetlands near the ESWEMS Pond and ESWEMS Pump House, a system of spray and/or flood irrigation should be considered and implemented to reduce the effect of dewatering and any groundwater depression that may result from the flow barrier blocking recharge into the wetlands down gradient.

h. The existing monitoring wells should be utilized to monitor the effectiveness of the temporary construction dewatering program. Additional monitoring wells should also be installed to provide adequate monitoring on all four sides of each excavation. The monitoring program should include recording water levels on both the inside and outside of the flow barrier at the ESWEMS Pond and ESWEMS Pump House excavation.

i. If the monitoring wells indicate an open window within the flow barrier, remedial measures, such as pressure grouting, will be required to mitigate this condition.

j. Prior to implementation of dewatering using the conceptual designs provided with this evaluation, the subsurface conditions along the alignment of the proposed flow barrier and along the horizontal limits of the planned excavations should be better defined using soil borings advanced several feet into the underlying competent bedrock. Such borings should be advanced on 100 foot centers (or less) along the flow barrier alignment for the ESWEMS Pond and ESWEMS Pump House excavation and at 200 foot centers (or less) along the perimeter of the excavations for the NI and CW Cooling Towers, and if significant variations in bedrock elevation or groundwater conditions are encountered, additional borings or wells should be advanced to assess conditions in such areas.

k. Groundwater conditions at the northwest corner of the CW Cooling Towers excavation should be defined by advancing additional borings and by installing monitoring groundwater monitoring wells in the overburden and upper bedrock. The required extent of excavation for the CW Cooling Towers should also be reevaluated once the additional data is available.

l. The groundwater model was constructed using the available data. Since the exploratory testing to date is based on low flow pump and packer tests along with slug tests, this testing may not have stressed the aquifer sufficiently to allow a complete understanding of the flow regime in the fractured bedrock. To further evaluate the potential fractured flow regime and the potential areal extent of dewatering in the fractured bedrock, a long-term high-flow-rate pump test program can be implemented.

m. The digital model was not updated (for Revision 4 of this report) to quantitatively consider the changes in the hydraulic conductivity values for the glacial overburden and underlying bedrock. When additional subsurface information is obtained in the vicinity of the northwest portion of the cooling towers and the groundwater barrier wall alignment for the ESWEMS, prior to construction, the model could be updated if the new information dramatically changes the model inputs.

8. LIMITATIONS

This conceptual construction dewatering evaluation was performed consistent with the principles of hydrogeology in accordance with the prevailing standards for professionals practicing under similar circumstances in the same geographical area. This warranty is in lieu of all other warranties either expressed or implied.

This evaluation is conceptual in nature, and the conceptual evaluations presented herein will require confirmation and refinement prior to development of final designs for the purposes stated herein. The input data and information considered during this evaluation were developed primarily by others. The soil and groundwater conditions in areas between soil borings and wells are interpolated or extrapolated, and the actual soil and groundwater conditions may differ from those considered in this report.

The following specific technical qualifications and limitations should be considered by the users of this report:

a. The "Non-Safety Related" status of this report is contingent on sequencing the construction such that safety related structures founded on soil (i.e. the pipeline from the ESWEMS Pump House to the NI) will not be constructed until the dewatering system has achieved the maximum vertical and horizontal extent of the dewatering. If this sequencing is not achieved, the increased effective stress resulting from dewatering could influence the soil supported, safety related structures.

b. This evaluation was prepared using subsurface characterization data that are limited in several respects. Relatively few exploratory borings were drilled in the areas of the CW Cooling Towers and ESWEMS Pond. Actual subsurface conditions, including the depth to bedrock, are therefore uncertain in these areas and may differ significantly from the interpolations and extrapolations used to develop the excavation plans and groundwater potentiometric surface maps (prepared by others), which were used in this evaluation.

c. Groundwater mass budgets, flow rates, projected drawdowns, and projected dewatering system yields are estimated based on digital flow models and manual calculations using available hydraulic conductivity and specific yield data. The actual groundwater flow system may therefore differ from the conceptual models used in the digital and manual calculations.

d. The dewatering operations, without a flow barrier and to a lesser extent with a flow barrier, evaluated herein will locally stress the groundwater flow system. The aquifers' actual response to such stress (e.g., actual dewatering system flow rates, basin drawdown, and changes in the mass flow budgets) has not been verified at high rates of test pumping and may therefore vary significantly from the estimates projected herein.

9. ATTACHMENTS AND APPENDICES

This report includes the following Attachments and Appendices.

Attachment A – Reduced Scale SUPP (SK-12198-400-001) and Site Utilization Plot Plan (SK-12198-400-002) Sheet 5 of 5, Reference 10.1 (2 Pages)

Attachment B – Construction Excavation Plan, Reference 10.6 - Figure 3, which is based on Reference 10.4 (4 Pages)

Attachment C – Location of Groundwater Monitoring Wells, Reference 10.17 - Figure 1 (1 Page)

Attachment D – Drawdown in Overburden Aquifer Without Flow Barrier at ESWEMS, Reference 10.6 - Figure 15 (1 Page)

Attachment E – Drawdown in Overburden Aquifer With Flow Barrier at ESWEMS, Reference 10.6 - Figure 16 (1 Page)

Attachment F – Conceptual Dewatering Strategy Power Block and ESWEMS Without Flow Barrier, Reference 10.6 - Figure 20 (1 Page)

Attachment G – Conceptual Dewatering Strategy Cooling Towers, Reference 10.6 - Figure 21 (1 Page)

Attachment H – Conceptual Dewatering Strategy Power Block and ESWEMS With Flow Barrier, Reference 10.6 - Figure 22 (1 Page)

Attachment I – Typical Dewatering Well Schematic, Reference 10.6 - Figure 23 (1 Page)

Attachment J – Typical Monitoring Well (Piezometer) Schematic, Reference 10.6 - Figure 24 (1 Page)

Appendix A – Weaver Boos Consultants North Central, LLC, "Evaluation of Temporary Construction Dewatering Strategies Proposed Bell Bend Nuclear Power Plant Berwick, Pennsylvania", Dated October 27, 2011, on DVD.

10. REFERENCES

10.1 Sargent & Lundy LLC drawings SK-12198-400-001, Rev. 5, "Reduced Scale SUPP" and SK12198-400-002, Sheet 5 of 5, Rev. 5.

10.2 Paul C. Rizzo Associates, Inc. Response to RFI SL-BBNPP-234, Approved for Use by UniStar January 15, 2014 (Final Boring Logs).

10.3 Paul C. Rizzo Associates, Inc., Response to RFI SL-BBNPP-153, Approved for Use by UniStar May 25, 2011 (12-Month Groundwater Monitoring Data Report).

10.4 Paul C. Rizzo Associates, Inc., Response to RFI SL-BBNPP-149, Approved for Use by UniStar September 13, 2010 (Excavation Plans). Validity confirmed by RFI SL-BBNPP-234, Approved for Use by UniStar January 15, 2014.

10.5 BBNPP, Final Safety Analysis Report, Section 2.4.12 – Groundwater, Rev. 4.

10.6 Weaver Boos Consultants North Central, LLC, "Evaluation of Temporary Construction Dewatering Strategies Proposed Bell Bend Nuclear Power Plant Berwick, Pennsylvania", Revision 1, Dated October 27, 2011 (also see Reference 10.17, which amends this report).

10.7 Areva, Response to RFI SL-BER-069, Approved for Use by UniStar August 19, 2008 (Water Use).

10.8 Sargent & Lundy LLC drawings:

- SK-12198-400-015, Sheet 1, Rev. 6, "Conceptual Grading & Drainage Plan, Sheet 1".
- SK-12198-400-015, Sheet 2, Rev. 6, "Conceptual Grading & Drainage Plan, Sheet 2".
- SK-12198-400-015, Sheet 5, Rev. 6, "Conceptual Grading & Drainage Plan, Sheet 5".
- SK-12198-400-015, Sheet 6, Rev. 6, "Conceptual Grading & Drainage Plan, Sheet 6".

10.9 BBNPP, Final Safety Analysis Report, Section 2.5.4 – Stability of Subsurface Materials and Foundations, Revision 4.

10.10 BBNPP, Environmental Report, Section 2.3 – Water, Revision 4.

10.11 ASTM International C 1602 – 06, "Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete".

10.12 Paul C. Rizzo Associates, Inc., Response to RFI SL-BER-070, Approved for Use by UniStar September 9, 2008 (Water Discharge).

10.13 Black and Veatch, Response to RFI SL-BBNPP-143, Approved for Use by UniStar July 27, 2010 (ESWEMS Pipeline).

10.14 Sargent & Lundy, LLC, Report No. SL-0009498, "Conceptual Design of the Circulating Water System, Bell Bend Nuclear Power Plant, UniStar Nuclear Energy", Dated October 28, 2010, Revision 6.

10.15 Sargent & Lundy, LLC, Report No. SL-0009446, "Conceptual Design of Stormwater Management, Bell Bend Nuclear Power Plant, UniStar Nuclear Energy", Dated September 30, 2011, Revision 6.

10.16 Sargent & Lundy LLC drawing SK-12198-400-CWS-003, Rev. 0, "Conceptual Combined Waste Water Retention Pond General Arrangement".

10.17 Weaver Boos Consultants North Central, LLC, Letter, "Construction Dewatering Evaluation – 2011 (2013)", January 20, 2014 with Attachment A, which is an addendum to Reference 10.6.

10.18 Pennoni Associates, Inc, Response to RFI SL-BBNPP-216, Approved for Use by UniStar October 6, 2011 (Temporary Spray Irrigation of Wetlands). Validity confirmed by RFI SL-BBNPP-235, Approved for Use by UniStar January 7, 2014.

10.19 Paul C. Rizzo Associates, Inc., Response to RFI SL-BBNPP-210, Approved for Use by UniStar September 11, 2011 (Confirmation of validity of RFI SL-BBNPP-149 [Excavation Plans]).

10.20 Black and Veatch, Response to RFI SL-BBNPP-211, Approved for Use by UniStar September 14, 2010 (Confirmation of validity of RFI SL-BBNPP-143 [ESWEMS Pipeline]).

10.21 Pennsylvania Fish and Boat Commission, "Notice Classification of Wild Trout Streams Addition of Walker Run, Luzerne County, downloaded from internet address "http://www.fishandboat.com/rulemakings/notices/2009_12_15_walker_appr.pdf" on November 9, 2011

ATTACHMENT A
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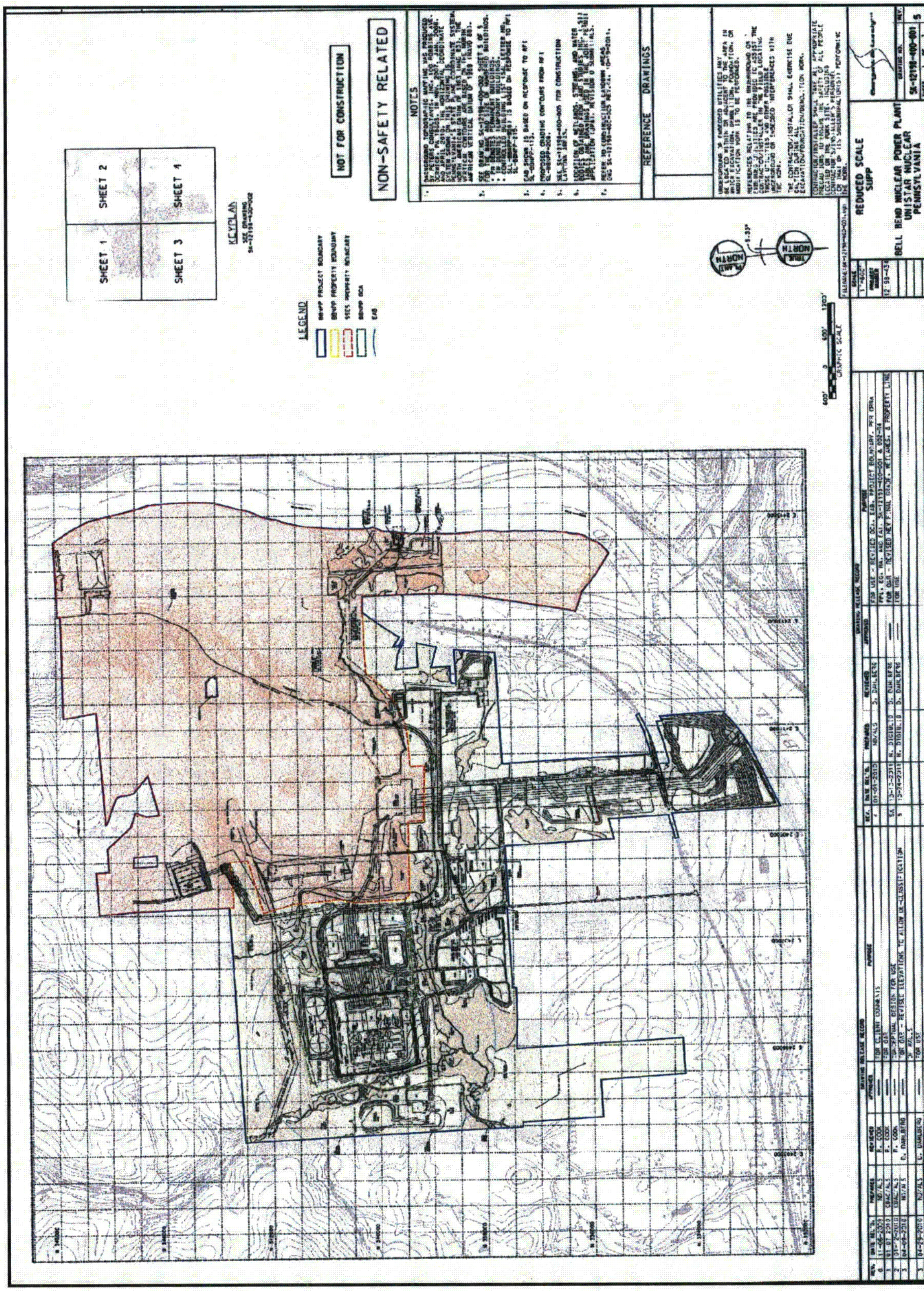

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BUILDING NAME	KKS DESIGNATOR	DRAWING SK-12198-400-002 (SHEETS 1 THRU 4) PAGE / LOCATION	DRAWING SK-12198-400-001 IDENTI-FICATION NUMBER	SAFETY CLASSIFICATION	PARTIAL SIZE (FT)	TOTAL SIZE (FT)	COMMENTS
Permanent Buildings (Note 4)							
Fire Protection Storage Tanks	USG	Sheet 1 / H6	P35	Non-Safety-Related-Supplemental Grade			
Fire Protection Building	USG	Sheet 1 / D6	P36	Non-Safety-Related-Supplemental Grade			
Security Access Facility	UYP	Sheet 1 / B5	P37	Non-Safety-Related			
Switchgear Building	UBA	Sheet 1 / H5	P38	Non-Safety-Related			
500 kV GIS Switchyard Building	UAA	Sheet 1 / H5	P39	Non-Safety-Related			
Circulating Water System Cooling Towers	URA	Sheet 1 / C5	P40	Non-Safety-Related		3600 X 475	EL. 700.00
Circulating Water System Pumphouse	UQA	Sheet 1 / C5	P41	Non-Safety-Related			
BBNPP Intake Structure	UPC	Sheet 2 / H1	P42	Non-Safety-Related			
Water Treatment Building	Note 1	Sheet 1 / C4	P45	Non-Safety-Related			
Demineralized Water Tanks	UGC	Sheet 1 / C5	P43	Non-Safety-Related			
Workshop & Warehouse Building	UST	Sheet 1 / H5	P44	Non-Safety-Related			
General Warehouse	Note 1	Sheet 3 / E3	P5	Non-Safety-Related		250 X 400	COMBINED TWO 125 X 400 WAREHOUSES, ONE A DRIVE THROUGH
General Warehouse	Note 1	Sheet 4 / F8	P6	Non-Safety-Related		125 X 400	FOR WAREHOUSING ENVIRONMENTAL CONTROLLED EQUIPMENT
Office-Field Construction	Note 1	Sheet 3 / F5	P10	Non-Safety-Related		200 X 400	TEMPORARY TWO-STORY BUILDING, TRANSITION TO PERMANENT TWO-STORY BUILDING FOR PERMANENT STAFF PLACE AT ENTRANCE TO THE PLANT.
Office - Safety and First Aid					40 x 30		
Office - Security					24 x 60		
Office - Time Keeping					24 x 60		
Training Facility					60 x 100		
Drug Testing					24 x 50		
Potable Water Meter House	Note 1	Sheet 3 / E4	P11	Non-Safety-Related	40 x 100		
Permanent Training and Simulation	UYR	Sheet 1 / B6	P14	Non-Safety-Related		200 X 200	PERMANENT TWO STORY BUILDING
Bechtel Construction Office Building	Note 1	Sheet 1 / D6	P17	Non-Safety-Related		200 X 400	TWO-STORY BUILDING
Hazardous Waste Storage Building	Note 1	Sheet 4 / F6	P18	Non-Safety-Related		30 X 60	PLACE BY PAINT SHOP.
Central Gas Supply Building	UTG	Sheet 4 / E6	P19	Non-Safety-Related		150 X 350	PLACE OXYGEN AND NITROGEN STORAGE IN THIS YARD.
Meteorological Tower	UZE	Sheet 4 / E6	P21	Non-Safety-Related		400 X 400	GUYED TOWER. IF A SELF-SUPPORTING TOWER IS USED THIS SPACE REDUCES TO 100' X 100'.
Hydrogen Storage	Note 1	Sheet 4 / E6	P20	Non-Safety-Related		175 x 175	HYDROGEN STORAGE SHOULD BE SEPARATED FROM THE GAS STORAGE YARD.
Emergency Power Generating Buildings	UBP	Sheet 1 / D5	P23	Safety-Related			
Fuel Building	UFA	Sheet 1 / B5	P24	Safety-Related			
Reactor Building	UJA	Sheet 1 / B5	P25	Safety-Related			
Safeguard Buildings Mechanical	UJH	Sheet 1 / D5	P26	Safety-Related			
Safeguard Buildings Electrical	UJK	Sheet 1 / B5	P27	Safety-Related			
Nuclear Auxiliary Building	UKA	Sheet 1 / B5	P28	Non-Safety-Related			
Access Building	UKE	Sheet 1 / B5	P29	Non-Safety-Related			
Vent Stack	UKH	Sheet 1 / D5	P30	Safety-Related			
Radioactive Waste Processing Building	UKS	Sheet 1 / B5	P31	Non-Safety-Related			
Turbine Building	UMA	Sheet 1 / B5	P32	Non-Safety-Related			
Essential Service Water Pump Buildings	UQB	Sheet 1 / H5	P33	Safety-Related			
Essential Service Water Cooling Tower Structures	URB	Sheet 1 / D5	P34	Safety-Related			
Essential Service Water Emergency Makeup System Retention Pond	Note 1	Sheet 1 / B4	P46	Safety-Related		400 X 700	T.O.DIKE EL. 700.00
Essential Service Water Emergency Makeup System Pump House	Note 1	Sheet 1 / D4	P47	Safety-Related			
Combined Waste Water Retention Pond	Note 1	Sheet 1 / B4	P8	Non-Safety-Related			

BUILDING NAME	KKS DESIGNATOR	DRAWING SK-12198-400-002 (SHEETS 1 THRU 4) PAGE / LOCATION	DRAWING SK-12198-400-001 IDENTI-FICATION NUMBER	SAFETY CLASSIFICATION	PARTIAL SIZE (FT)	TOTAL SIZE (FT)	COMMENTS
Temporary Buildings (Note 4)							
Main Access Facility	Note 1	Sheet 4 / G7	T22	Non-Safety-Related		50 X 50	
Shops - All One Building	Note 1	Sheet 3 / F3	T12	Non-Safety-Related		150 x 600	PLACE PARTITIONS IN ONE BIG BUILDING FOR THE VARIOUS SHOPS.
Rigging Loft					50 x 80		
Boilermaker					24 x 60		
Carpenter					50 x 60		
Cement Mason					12 x 60		
Electrician					40 x 100		
Heavy Equipment / Tool Maintenance					60 x 200		
Iron Worker					30 x 60		
Laborer					50 x 100		
Millwrights					24 x 60		
Pipe Fitter					30 x 100		
Sheet Metal Worker					12 x 60		
Teamsters					24 x 60		
Welder Test					40 x 100		
Tool Room - Main					50 x 200		
Lab - Material and Test Equipment					30 x 60		
Shop-Paint and Sandblast	Note 1	Sheet 4 / F6	T13	Non-Safety-Related		60 X 150	DIRTY FACILITY. PLACE IN REAR OF PLANT AWAY FROM EVERYTHING ELSE.
Guardhouse and Badge Alley	Note 1	Sheet 3 / F4	T6	Non-Safety-Related		40 X 50	PLACE AT THE PLANT ENTRANCE
Construction Emergency Generator	Note 1	Sheet 4 / F6	T15	Non-Safety-Related		12 X 40	FOR THE BATCH PLANT IN CASE POWER IS LOST DURING CONCRETE PRODUCTION
Lab - QC Civil and Non-Destructive Test	Note 1	Sheet 4 / F6	T9	Non-Safety-Related		50 X 60	PLACE BY THE BATCH PLANT
Lab - Civil Testing	Note 1	Sheet 4 / F6	T7	Non-Safety-Related		40 X 50	PLACE AT THE BATCH PLANT
Shop - Heavy Equipment/Tool Maintenance	Note 1	Sheet 4 / F6	T3	Non-Safety-Related		60 X 200	INCLUDES EQUIPMENT AND VEHICLE CLEANING FACILITY
Craft Break Rooms	Note 1	Sheet 1 / D5	T2	Non-Safety-Related		150 x 250	TWO-STORY BUILDING
Comfort Stations	Note 1	Various	T1	Non-Safety-Related		50 x 60	
Fire Brigade / First Aid Building	Note 1	Sheet 1 / B8	T16	Non-Safety-Related		100 X 100	

NOTES

1. THERE IS NO DESIGNATED KKS CODE AVAILABLE FOR THIS STRUCTURE IN US EPR FSAR SECTION 3.2.
2. POTENTIALLY UQN OR UQU KKS DESIGNATORS. OTHERWISE USE NOTE 1. TO BE DETERMINED BY UNISTAR.
3. THIS LIST WAS DEVELOPED BASED ON THE FOLLOWING REFERENCES:
   A) TABLE 3.2.2-1 "CLASSIFICATION SUMMARY" FROM THE US EPR FSAR REV 1 (PAGE 3.2-160).
   B) RAI-97 RESPONSE; SNL LETTER NO. SL-BBNPP-067 DATED 1/25/2010.
4. PERMANENT BUILDINGS WILL REMAIN DURING COMMERCIAL OPERATION, AND TEMPORARY BUILDINGS WILL BE REMOVED PRIOR TO FUEL LOAD.
5. FOOTPRINTS OF ALL BUILDINGS SHOWN WITHOUT DIMENSIONS WERE PROVIDED BY AREVA.

REFERENCE DRAWINGS

UNDERGROUND OR EMBEDDED UTILITIES MAY BE LOCATED WITHIN OR ADJACENT TO THE AREA IN WHICH EXCAVATION, DEMOLITION, FOUNDATION, OR MODIFICATION WORK IS TO BE PERFORMED.

REFERENCES RELATING TO THE UNDERGROUND OR EMBEDDED UTILITIES ARE PROVIDED TO ASSIST THE CONTRACTOR/INSTALLER IN THE FIELD LOCATING THOSE UTILITIES AND OTHER POSSIBLE UNDERGROUND OR EMBEDDED INTERFERENCES WITH THE WORK.

THE CONTRACTOR/INSTALLER SHALL EXERCISE DUE CAUTION DURING ALL EXCAVATION/FOUNDATION/DEMOLITION WORK.

CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.

NOT FOR CONSTRUCTION

NON-SAFETY RELATED

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE
5A	10-10-2011	N. DIGIULIO	D. DAHLBERG	—	FOR OAR - REVISED NEW FINAL GRADE, WETLANDS, & PROPERTY LINE
5	10-24-2011	N. DIGIULIO	D. DAHLBERG	—	FOR USE

SCALE: N/A
PROJECT NUMBER: 12198-434

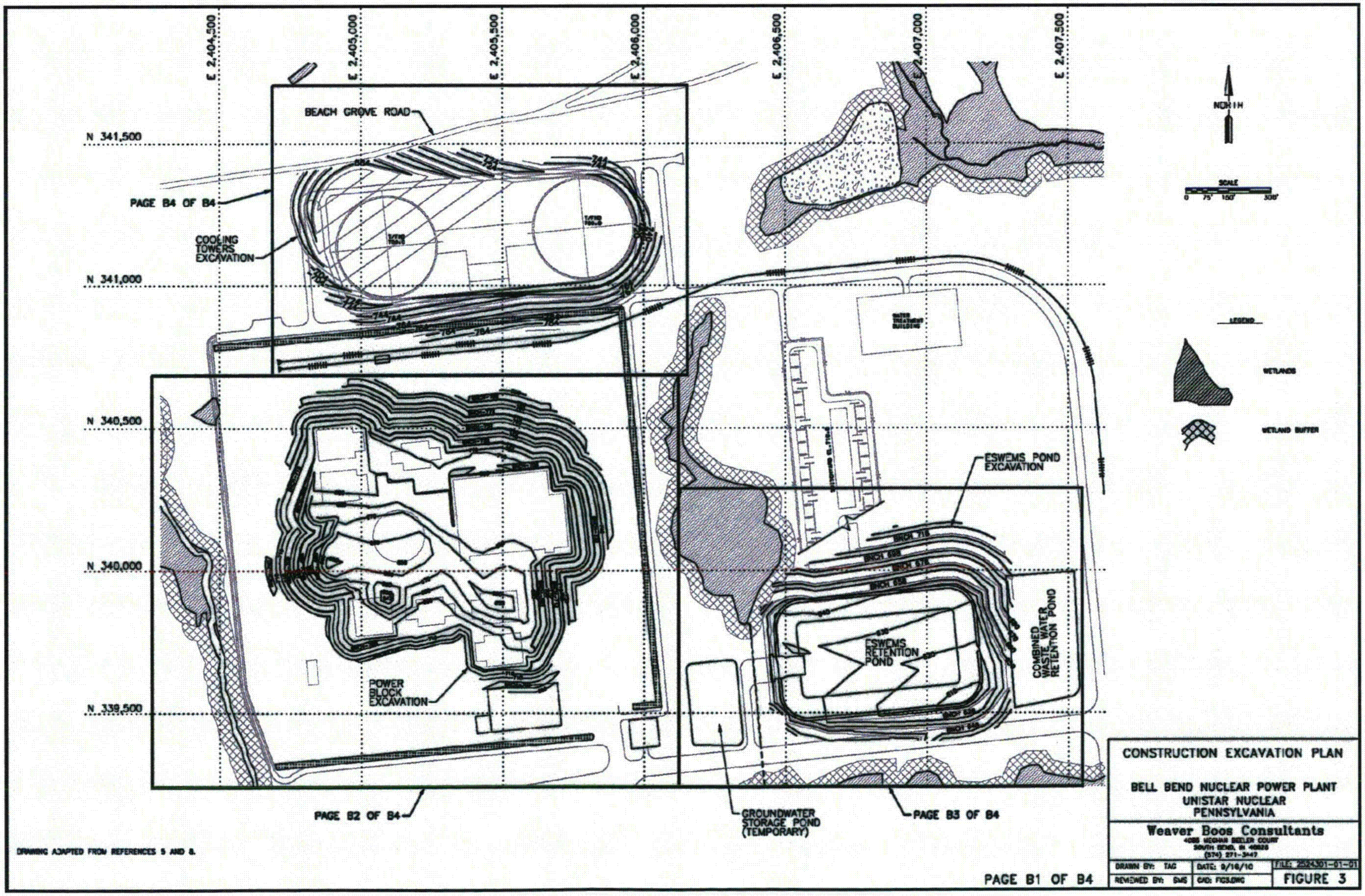
SITE UTILIZATION PLOT PLAN SHEET 5 OF 5

BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

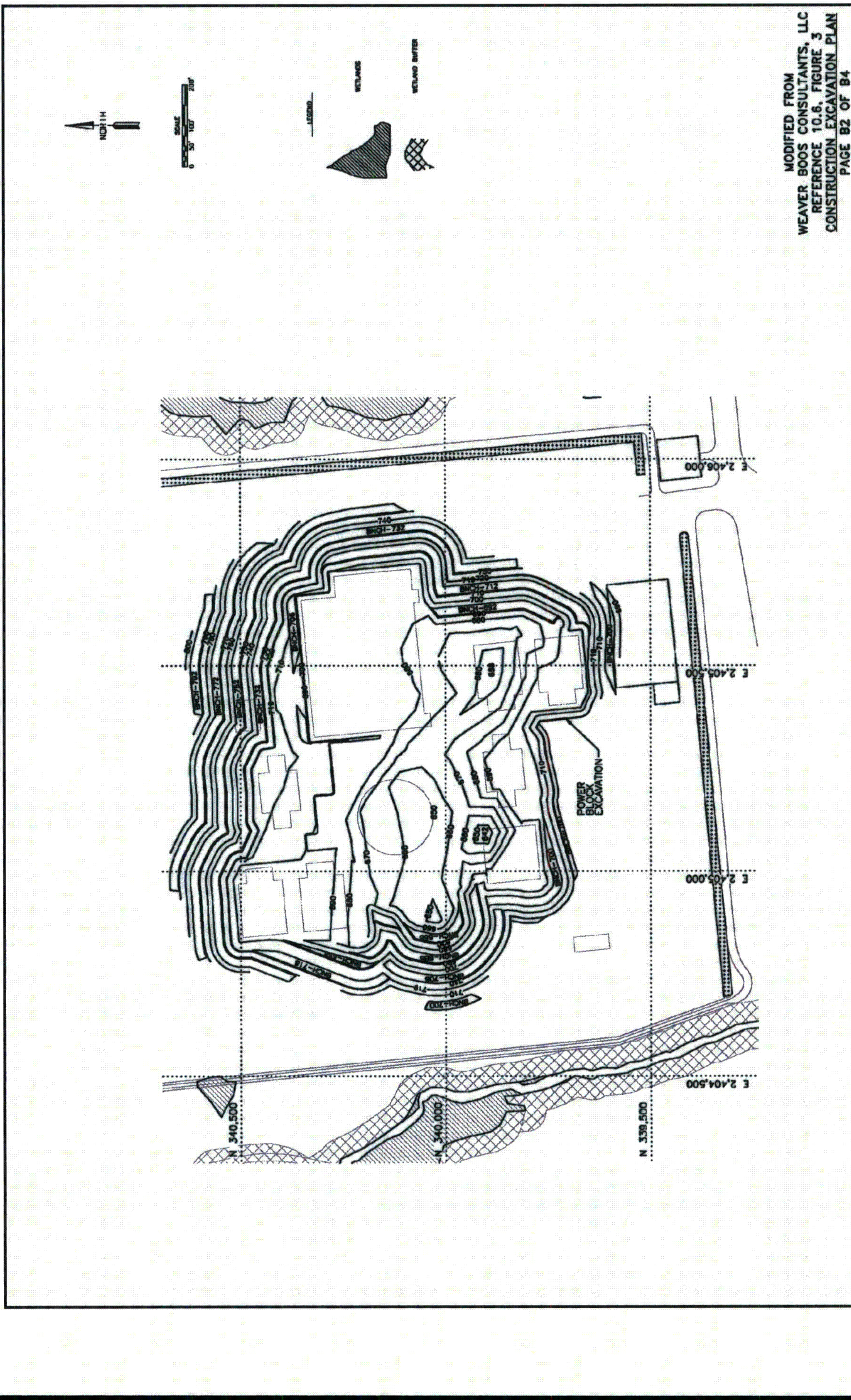
Sargent & Lundy

DRAWING NO. SK-12198-400-002 REV. 5
SHEET 5 OF 5

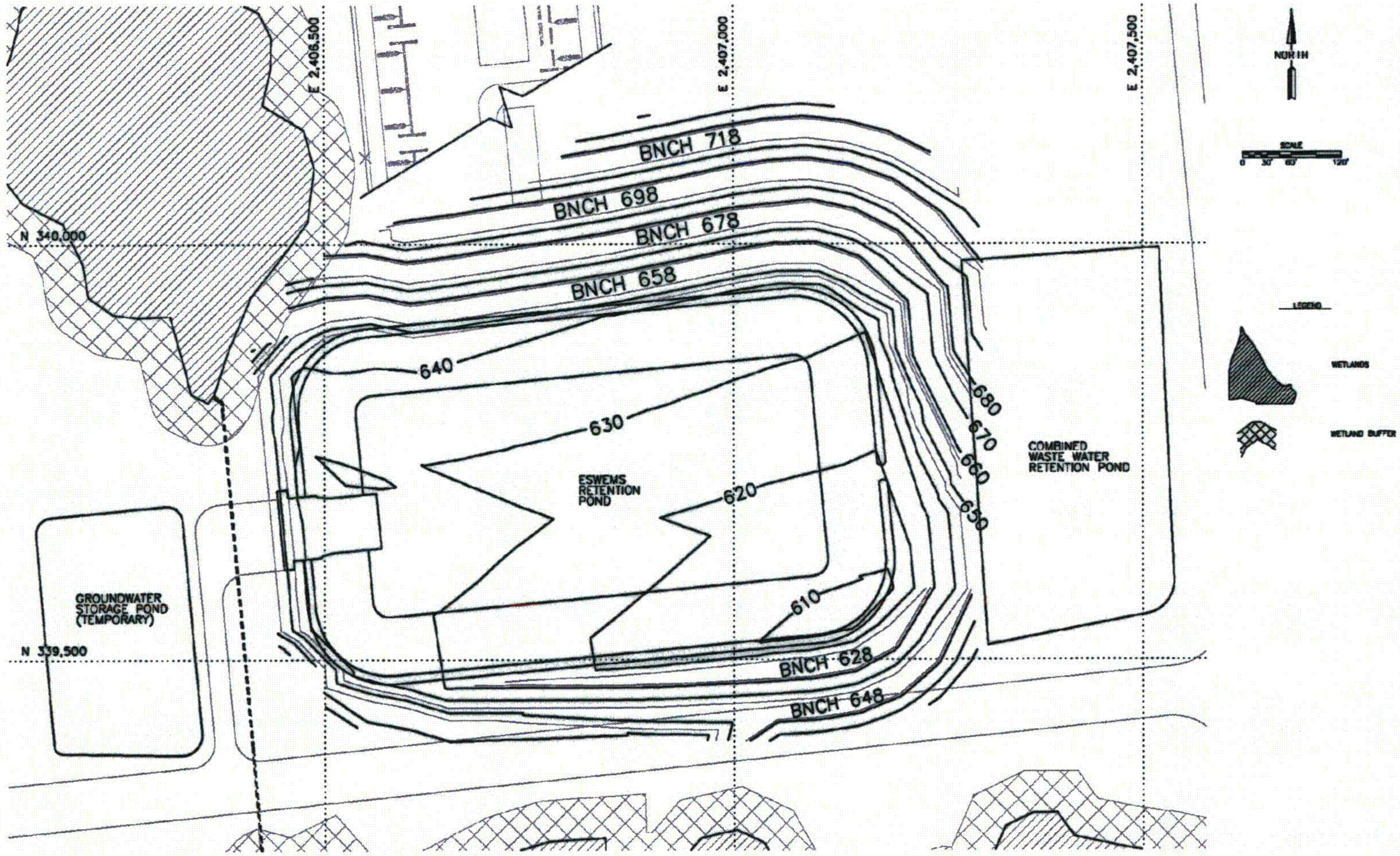
ATTACHMENT B
B1 of B4



ATTACHMENT B
B2 of B4

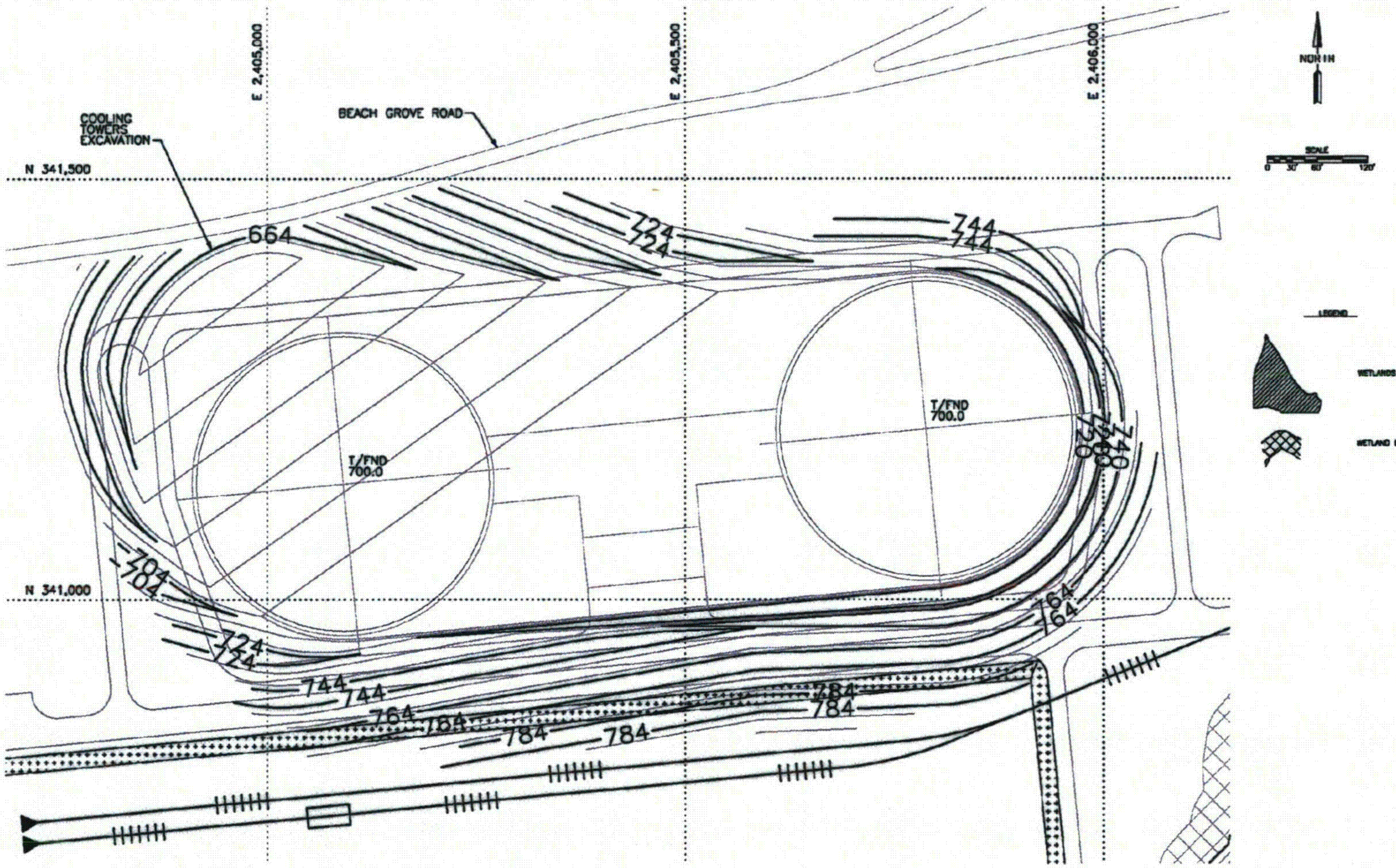


ATTACHMENT B
B3 of B4



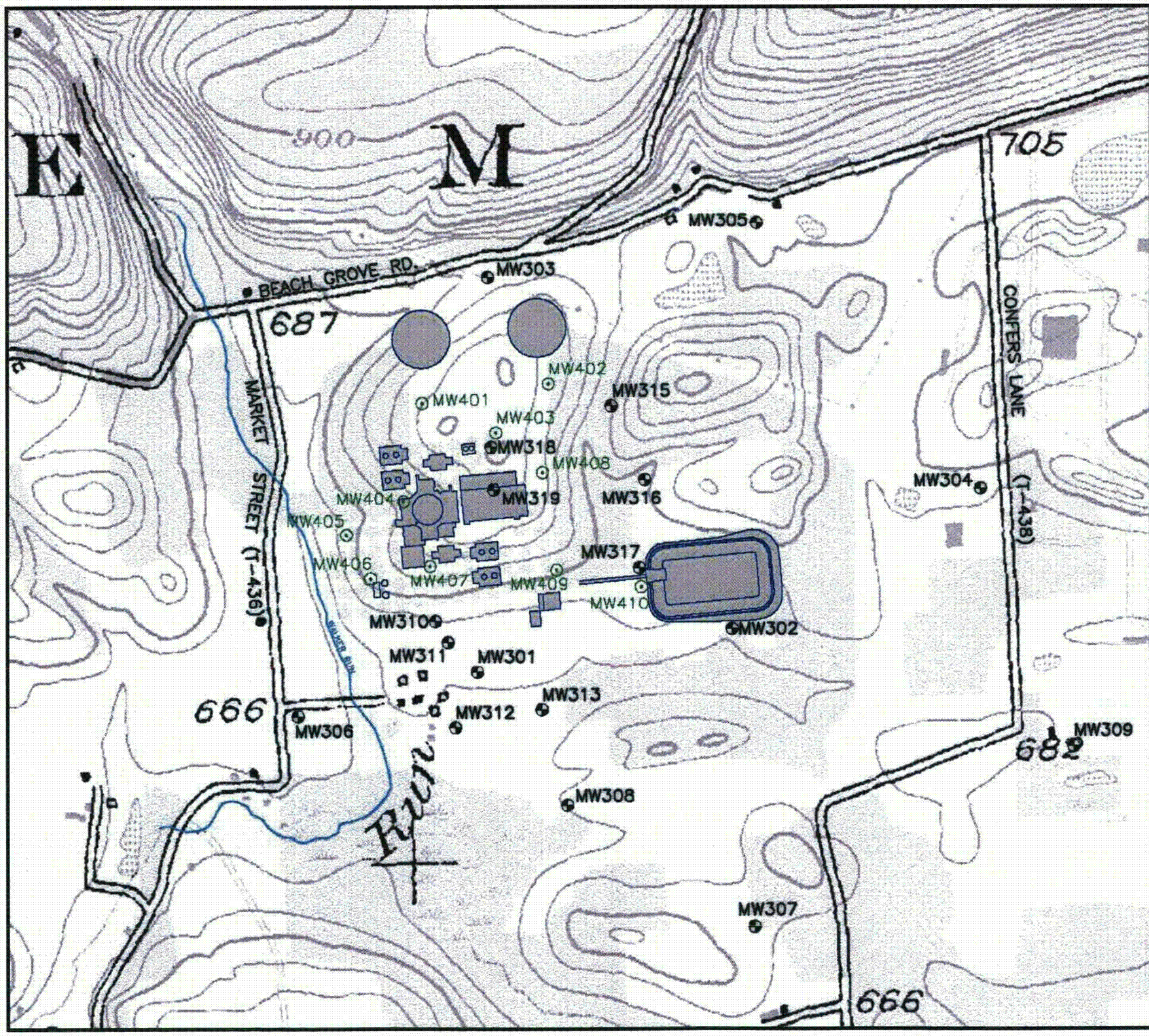
MODIFIED FROM
WEAVER BOOS CONSULTANTS, LLC
REFERENCE 10.6, FIGURE 3
CONSTRUCTION EXCAVATION PLAN
PAGE B3 OF B4

ATTACHMENT B
B4 of B4



MODIFIED FROM
WEAVER BOOS CONSULTANTS, LLC
REFERENCE 10.6, FIGURE 3
CONSTRUCTION EXCAVATION PLAN
PAGE B4 OF B4

ATTACHMENT C
Taken From Reference 10.3, Figure 1



LEGEND:

- 2007/2008 MONITORING WELL/WELL CLUSTER
- 2010 MONITORING WELL
- NPP BUILDING OR STRUCTURE

REFERENCES:

1. SARGENT AND LUNDY DRAWING TITLED, "REDUCED SCALE SUPP" FOR BELL BEND NUCLEAR POWER PLANT, UNISTAR NUCLEAR, PENNSYLVANIA; DRAWING NO. SK-12198-400-001; PROJECT NO. 12198-415. SCALE: 1"=600'
2. U.S.G.S. 7.5-MINUTE SERIES TOPOGRAPHIC MAP, BERWICK, PA QUADRANGLE. DATED 1955, PHOTOGRAVURE 1989.

SCALE
600 0 600 FEET

FIGURE 1
Location of
Groundwater Monitoring Wells

10-4310-CADD-B073

ATTACHMENT D
Taken From Reference 10.6, Figure 15

FIGURE 15
Drawdown in Overburden Aquifer Without Flow Barrier at ESWEMS

WEAVER BOOS CONSULTANTS
4085 Meghan Beeler Court
South Bend, Indiana 46628

Bell Bend Nuclear Power Plant - Non Safety Related
Berwick, Pennsylvania

ATTACHMENT E
Taken From Reference 10.6, Figure 16

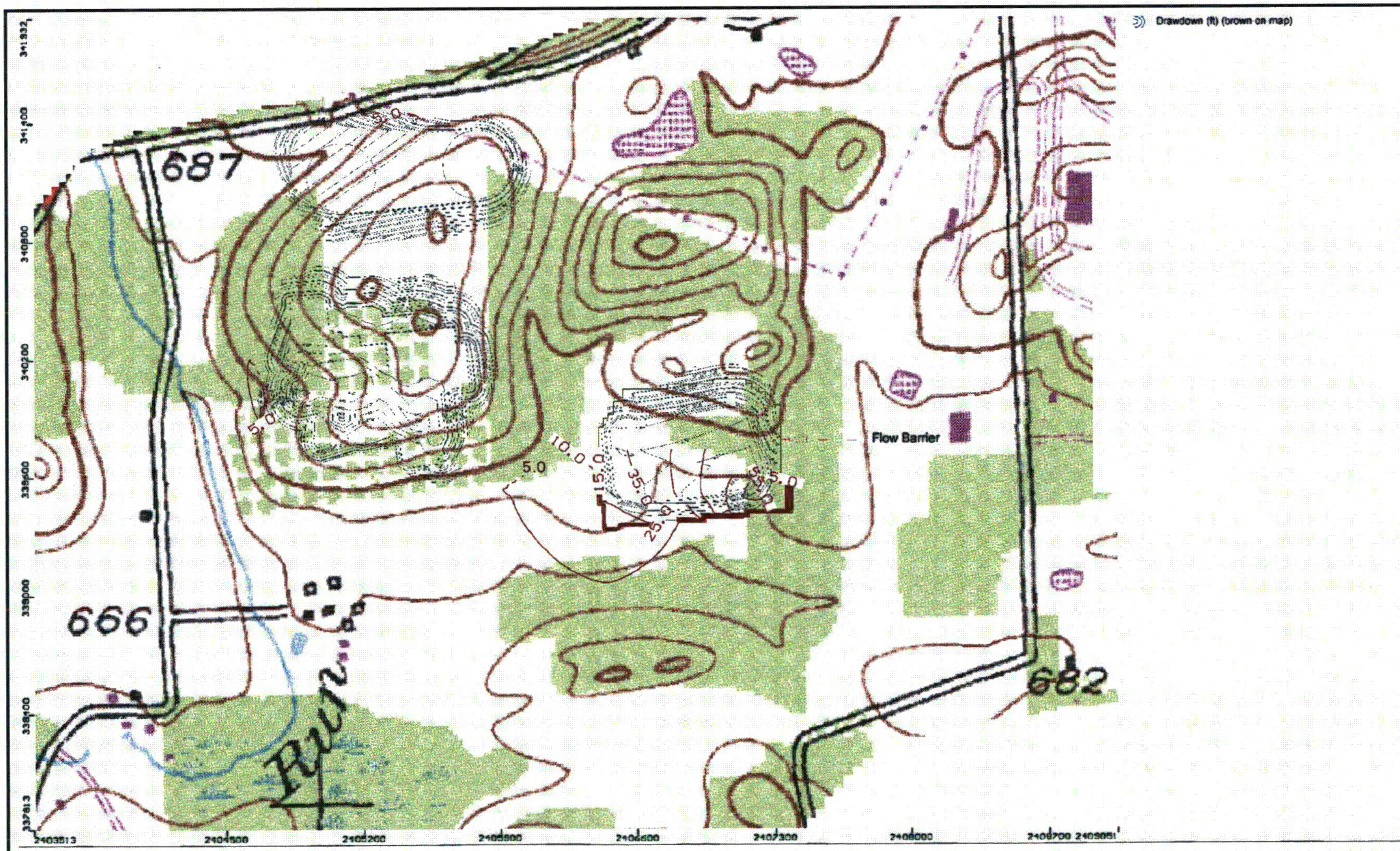


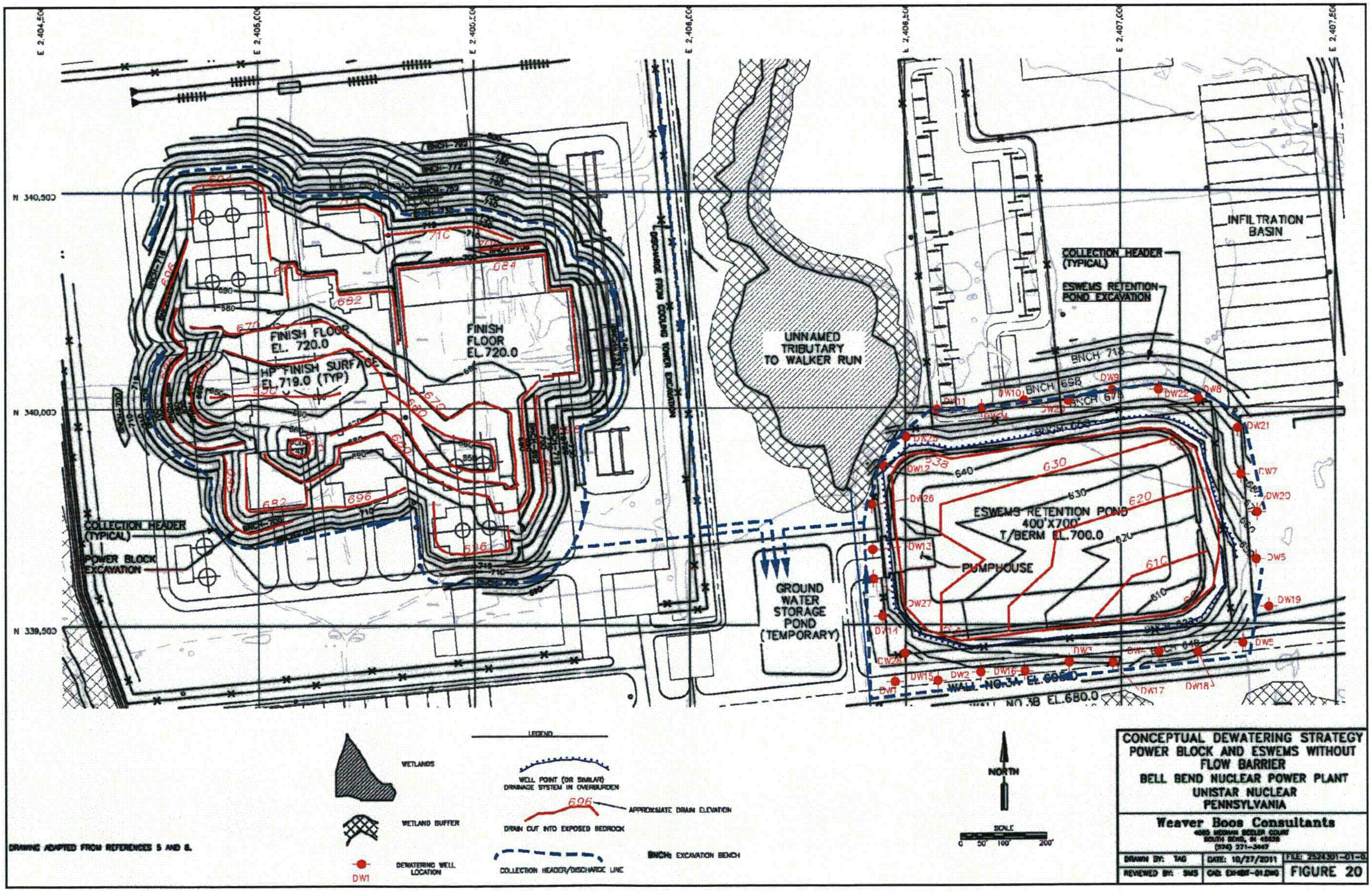
FIGURE 16
Drawdown in Overburden Aquifer With Flow Barrier at ESWEMS

WEAVER BOOS CONSULTANTS
4085 Meghan Beeler Court
South Bend, Indiana 46628

Bell Bend Nuclear Power Plant - Non Safety Related
Berwick, Pennsylvania

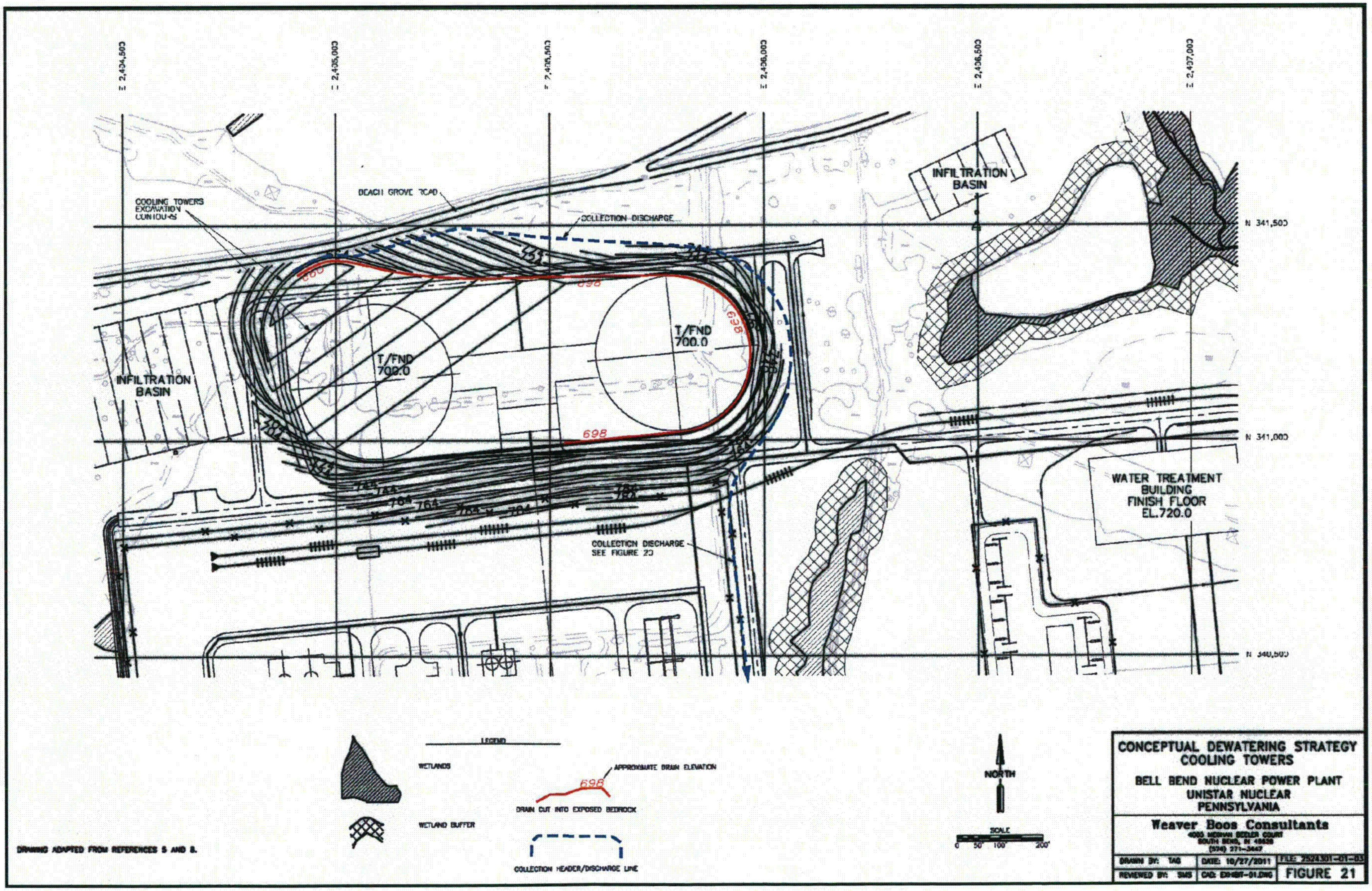
ATTACHMENT F

Taken From Reference 10.6, Figure 20



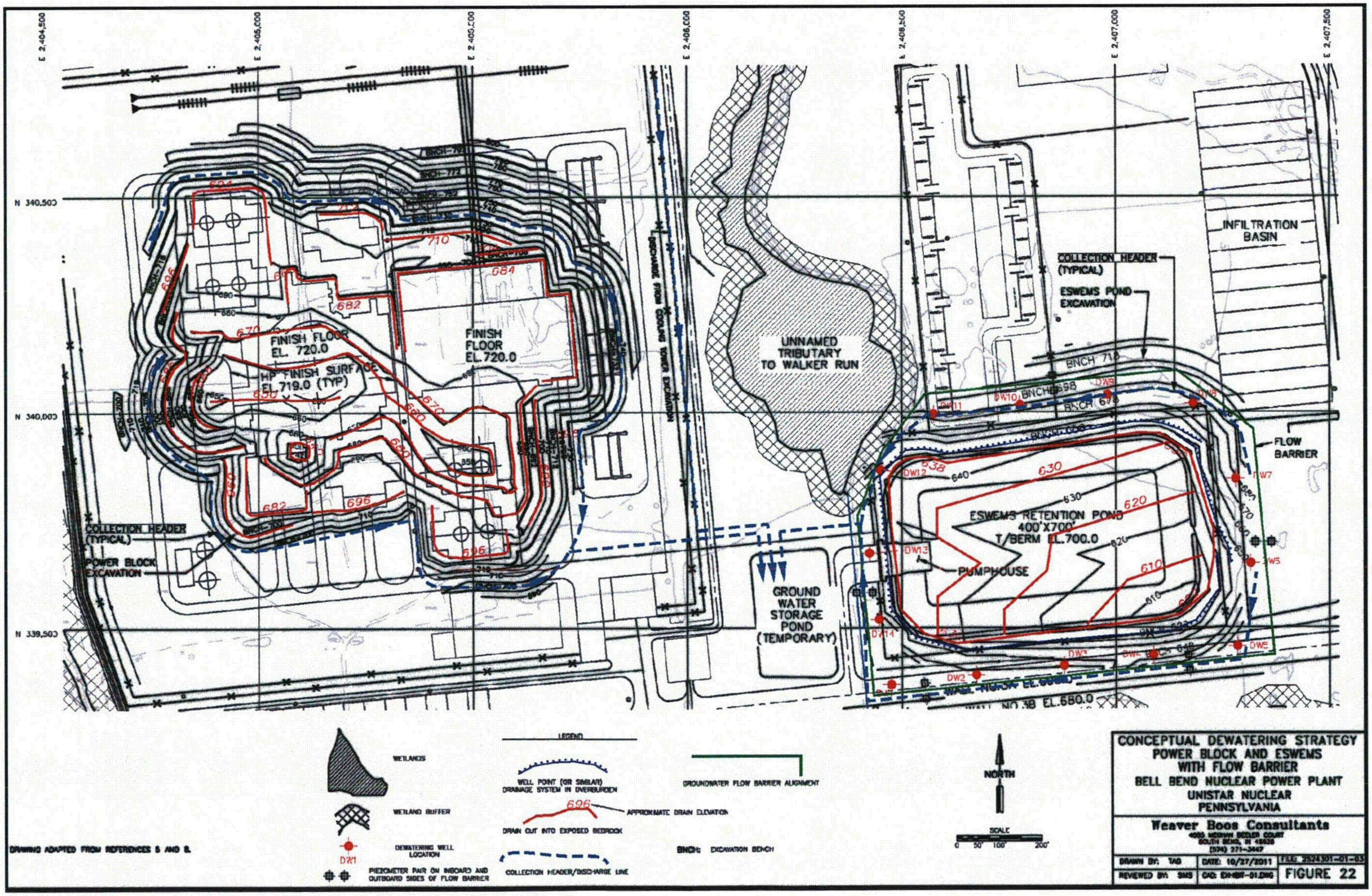
ATTACHMENT G

Taken From Reference 10.6, Figure 21

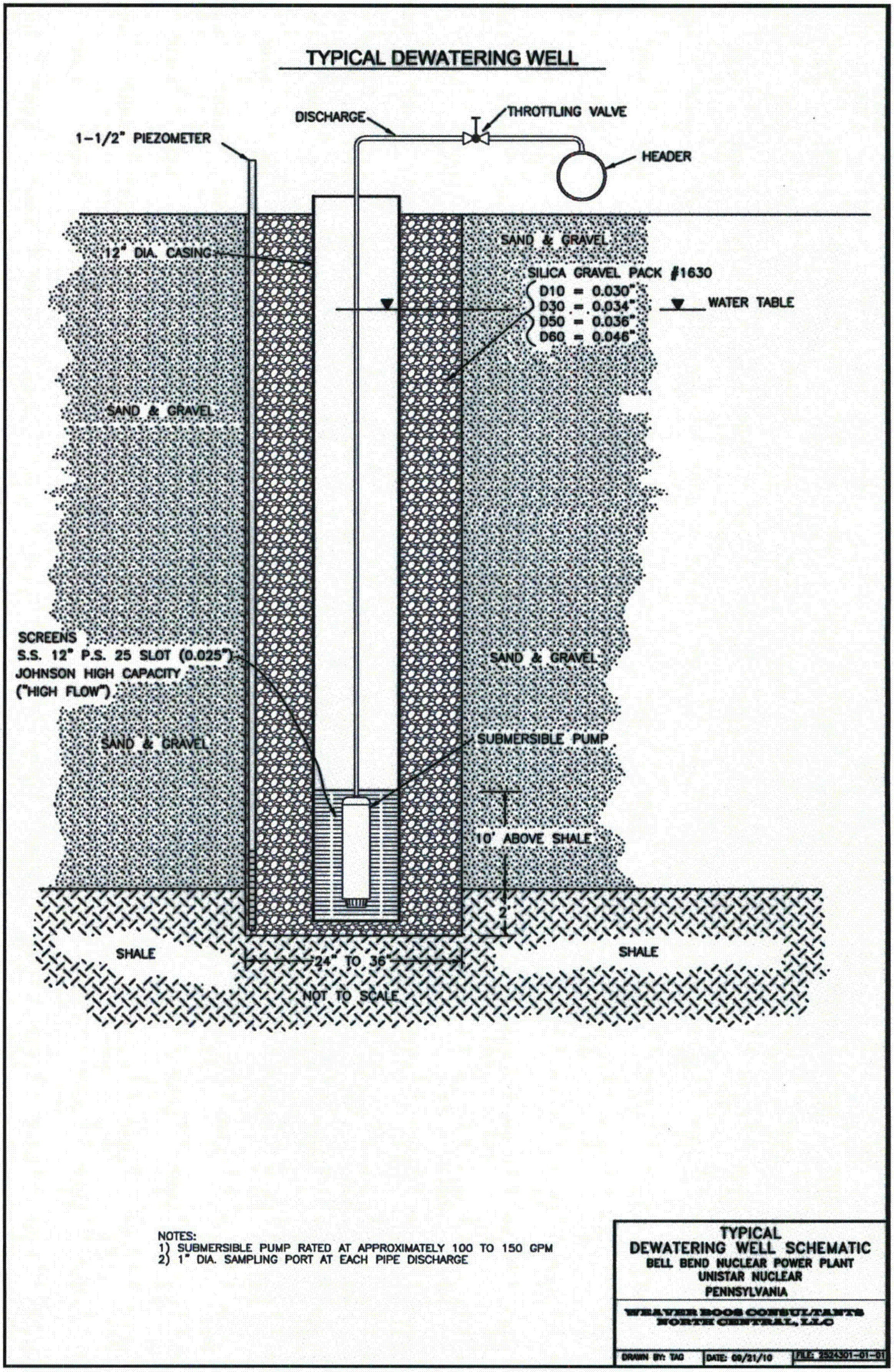


ATTACHMENT H

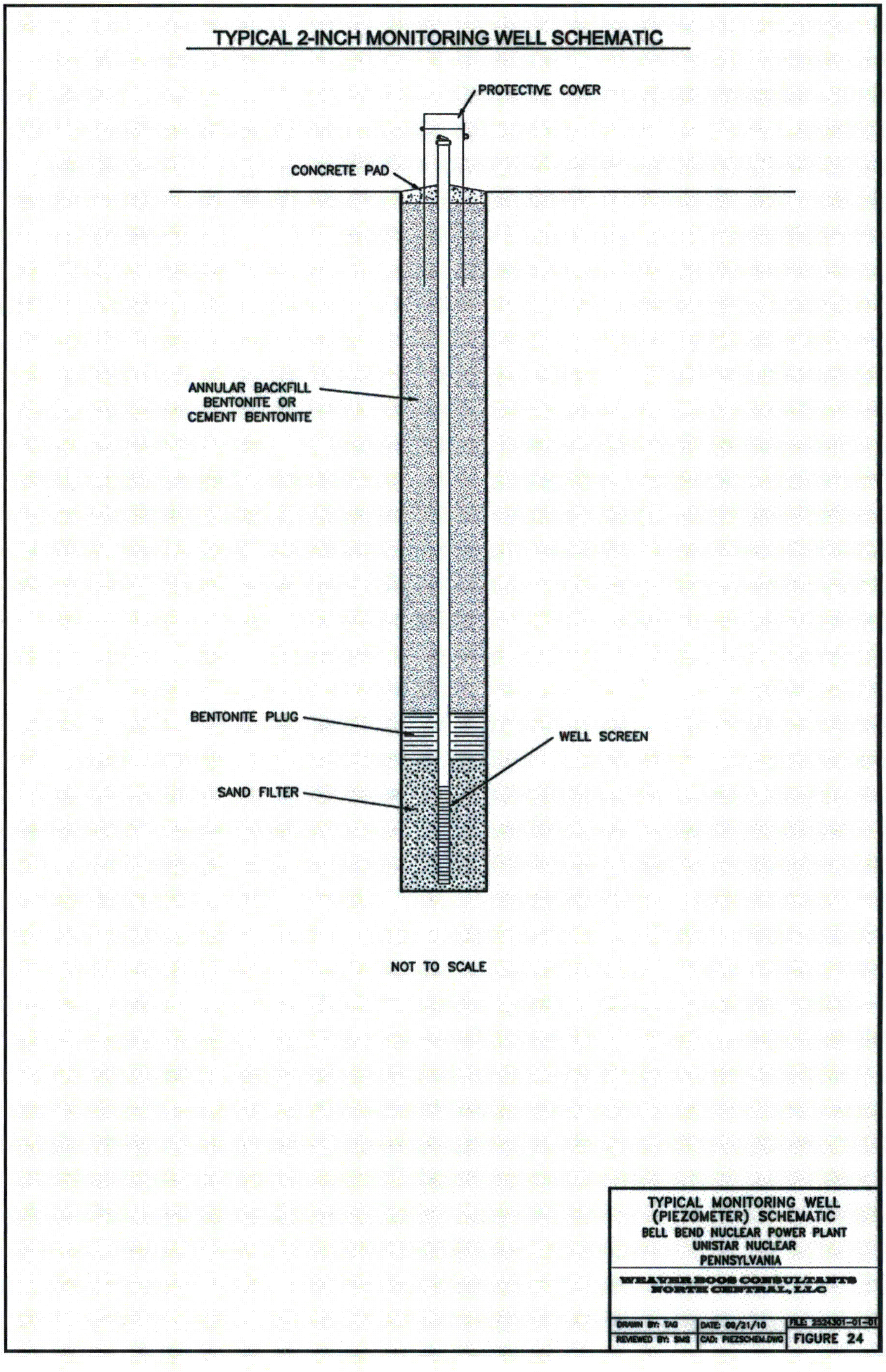
Taken From Reference 10.6, Figure 22



ATTACHMENT I
Taken From Reference 10.6, Figure 23



ATTACHMENT J
Taken From Reference 10.6, Figure 24



APPENDIX A

(On Two CDs)

Weaver Boos Consultants North Central, LLC
Letter, "Construction Dewatering Evaluation – 2011 (2013)",
January 20, 2014

Weaver Boos Consultants North Central, LLC
Evaluation of Temporary Construction Dewatering Strategies
Proposed Bell Bend Nuclear Power Plant Berwick, Pennsylvania
Revision 1, Dated: October 27, 2011

Evaluation of Temporary Construction Dewatering Strategies Revision 1
Visual MODFLOW Project Files