



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 7, 2020

Mr. Frank R. Payne
Site Vice President
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PO Box 97
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SUBJECT: PERRY NUCLEAR POWER PLANT, UNIT 1 - STAFF ASSESSMENT OF
FLOODING FOCUSED EVALUATION (EPID NO. L-2019-JLD-0020)

Dear Mr. Payne:

The purpose of this letter is to document the staff's evaluation of the Perry Nuclear Power Plant, Unit 1 (Perry) flooding focused evaluation (FE) which was submitted in response to Near-Term Task Force (NTTF) Recommendation 2.1 "Flooding." The U.S. Nuclear Regulatory Commission (NRC) has concluded based on the licensee's evaluation and the staff's independent assessment that no further response or regulatory actions are required to address the reevaluated flood hazard at the site.

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the NRC issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's NTTF report (ADAMS Accession No. ML111861807). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A048).

By letters dated March 10, 2015, December 11, 2015, and March 24, 2016 (ADAMS Accession Nos. ML15069A056, ML15345A343, and ML16084A871, respectively), FirstEnergy Nuclear Operating Company (FENOC, the licensee), now doing business as Energy Harbor Nuclear Corp., responded to the 50.54(f) letter for Perry and submitted the flood hazard reevaluation report (FHRR).

By letter dated July 25, 2016 (ADAMS Accession No. ML16202A350), the NRC issued an interim staff response (ISR) letter for Perry. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Perry that are a suitable input for further assessments as the site's response to the 50.54(f) letter. As stated in the ISR

letter, because the local intense precipitation (LIP), streams and rivers, storm surge, and combined events (storm surge with wind generated waves) at Perry were not bounded by the plant's CDB, additional assessments of those flood hazard mechanisms are expected to be performed by the licensee.

By letter dated November 18, 2019 (ADAMS Accession No. ML19323F020), the licensee submitted an FE for Perry. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on a reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is LIP. The purpose of this letter is to provide the NRC's assessment of the Perry FE. The staff notes that the review of the FE was suspended and then restarted as a result of the licensee's notification and then subsequent withdrawal of its plans to permanently cease operations at Perry in May 2021. An NRC letter dated September 9, 2019 (ADAMS Accession No. ML19248B710), acknowledged the restart of the Perry FE review based on the licensee's decision to withdraw the notification of cessation of operations at the site.

The NRC staff performed its review of the Perry FE in accordance with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). Guidance document NEI 16-05, Revision 1, has been endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16090A140). The NRC staff concludes that, if implemented as described, the licensee has effective flood protection for the unbounded flooding events described in the ISR letter during beyond-design-basis external flooding events at Perry. This closes out the licensee's response for Perry for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with EPID No. L-2019-JLD-0020.

If you have any questions, please contact me at 301-415-3809 or by email at Juan.Uribe@nrc.gov.

Sincerely,

/RA/

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Design-Basis Management Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No: 50-440

Enclosure:
Staff Assessment Related to the
Flooding Focused Evaluation for
Perry

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO THE FOCUSED EVALUATION FOR
PERRY NUCLEAR POWER PLANT, UNIT 1
AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE
RECOMMENDATION 2.1 - FLOODING
EPID NO. L-2019-JLD-0020

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the “50.54(f) letter”). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC’s Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A048). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant’s current design basis (CDB) flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter states that an integrated assessment should be submitted, and describes the information that the integrated assessment should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Project Directorate (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, “Guidance for Performing the Integrated Assessment for External Flooding.”

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant’s CDB. The revised process describes a graded approach in which licensees with hazards exceeding their CDB flood will not be required to complete an integrated assessment, but instead will perform a focused evaluation (FE). As part of the FE, licensees will assess the impact of the hazard(s) on their site and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance.

Nuclear Energy Institute (NEI) 16-05, Revision 1, “External Flooding Assessment Guidelines” (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the FE in response to the 50.54(f) letter. The NRC’s endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in JLD-ISG-2016-01, “Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation” (ADAMS Accession No. ML16162A301). Therefore, NEI 16-05, Revision 1, as endorsed, describes acceptable methods for

demonstrating that Perry Nuclear Power Plant, Unit 1 (Perry, the site) has effective flood protection.

2.0 BACKGROUND

This NRC staff assessment is the last staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter. Therefore, the background section includes a discussion of the reevaluated flood information provided by the licensee and the associated staff assessments. The reevaluated flood information includes: 1) the flood hazard reevaluation report (FHRR); 2) the mitigation strategies assessment (MSA); and 3) the FE.

Flood Hazard Reevaluation Report

By letters dated March 10, 2015, December 11, 2015, and March 24, 2016 (ADAMS Accession Nos. ML15069A056, ML15345A343, and ML16084A871), FirstEnergy Nuclear Operating Company (FENOC, the licensee), now doing business as Energy Harbor Nuclear Corp. responded to the 50.54(f) letter for Perry and submitted the FHRR.

By letter dated July 25, 2016 (ADAMS Accession No. ML16202A350), the NRC issued an interim staff response (ISR) letter for Perry. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the CDB for Perry and parameters that are a suitable input for the MSA, and other assessments associated with NTTF Recommendation 2.1 "Flooding." As stated in the ISR letter, because the LIP, streams and rivers, storm surge, and combined events (storm surge and wind generated waves) flood-causing mechanisms at Perry are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are expected to be performed by the licensee. The staff issued a final staff assessment of the FHRR by letter dated January 24, 2018 (ADAMS Accession No. ML18002A555).

Mitigation Strategies Assessment

By letter dated July 24, 2017 (ADAMS Accession No. ML17205A336), the licensee submitted its MSA for Perry. This submittal also included Revision 2 to the FHRR, included as an attachment. The MSAs were intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events that were put in place to meet NRC Order EA12049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events." The NRC staff's safety evaluation for the licensee's compliance plans for Order EA-12-049 was issued on May 16, 2016 (ADAMS Accession No. ML16056A560). By letter dated May 3, 2018 (ADAMS Accession No. ML18108A694), the NRC issued its assessment of the Perry MSA, which included the revised flood hazards described in Revision 2 of the FHRR and were determined to be suitable input for additional flooding assessments.

In SECY-16-0142, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events [MBDBE] (RIN 3150-AJ49)," (ADAMS Accession No. ML16291A186) provisions were proposed that would have required mitigation strategies to address the reevaluated flood hazard information on a generic basis. As reflected in the Affirmation Notice and Staff Requirements Memorandum (SRM) dated January 24, 2019 (ADAMS Accession No. ML19023A038), associated with SECY-16-0142, the Commission determined that sites addressing the reevaluated hazards on a generic basis was not needed for adequate protection of public health and safety but should instead be assessed on a plant-specific, case-by-case basis under the requirements of 10 CFR Section 50.109, "Backfitting," and Section 52.98, "Finality of combined licenses; information requests."

The January 24, 2019, Affirmation Notice and SRM directed the staff to use the 50.54(f) process to ensure that the NRC and its licensees will take the needed actions, if any, to ensure there is no undue risk to public health and safety due to the potential effects of the reevaluated flood hazards. The SRM further directed that the staff should continue these efforts, utilizing existing agency processes to determine whether an operating power reactor license should be modified, suspended, or revoked considering the reevaluated hazard.

In a letter dated August 20, 2019 (ADAMS Accession No. ML19067A247), the NRC staff provided a path forward to treat the reevaluation of flood hazards in light of the Commission's direction in the January 24, 2019, Affirmation Notice and SRM. The staff assessment documented in this letter was performed in accordance with the information in the August 20, 2019, staff letter including a plant-specific determination on whether additional regulatory actions are warranted to address the reevaluated hazard.

Focused Evaluation

By letter dated November 18, 2019 (ADAMS Accession No. ML19323F020), the licensee submitted the Perry FE. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on a reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is LIP. These three options associated with performing an FE are referred to as Path 1, 2, or 3, respectively, as described in NEI 16-05, Revision 1. The purpose of this staff assessment is to provide the results of the NRC's evaluation of the Perry FE.

The staff notes that the review of the FE was suspended and then restarted as a result of the licensee's notification and then subsequent withdrawal of its plans to permanently cease operations at Perry in May 2021. An NRC letter dated September 9, 2019 (ADAMS Accession No. ML19248B710), acknowledged the restart of the Perry FE review based on the licensee's decision to withdraw the notification of cessation of operations at the site.

3.0 TECHNICAL EVALUATION

This technical evaluation addresses the following topics: characterization of flood parameters; evaluation of flood impact assessments; evaluation of available physical margin (APM); reliability of flood protection features; and overall site response.

The NRC staff notes that the Perry Local datum is originally based on and within the tolerance levels of the National Geodetic Vertical Datum of 1929 (NGVD29). However, FENOC established a plant-specific datum for Perry, referred to as the "Perry Local Datum" (PLD) that was used in several calculations and assessments associated with NTTF Recommendation 2.1 "Flooding" response, and is representative of building elevations. As a result, NGVD29 and PLD are slightly different ($NGVD29 + 0.21 \text{ feet (ft.)} = PLD$). Conversely, $PLD - 0.21 \text{ ft.} = NGVD29$. The NRC staff notes that unless otherwise stated, all elevations in this assessment are provided relative to NGVD29, consistent with the ISR letter.

3.1 Characterization of Flood Parameters

The flooding parameters that are used as inputs to the Perry FE staff's assessment are based on Revision 2 of the FHRR (provided in the licensee's MSA) and the NRC staff's review, as documented in the MSA staff assessment. For reference, Figure 3.1-1 of this report shows the

general site layout as well as site features described below. The nominal site grade elevation at Perry is 620 ft.

For LIP, specific details regarding the licensee's revised analysis can be found in Perry Calculations 50:66.000, Revision 1, "PNPP Site Modifications Local Intense Precipitation (Beyond Design Basis)," and 50:66.001, Revision 0, "PNPP Local Intense Precipitation Sensitivity Study (Beyond Design Basis)." The maximum stillwater elevation in the powerblock area is 621.65 ft., and wave runup is considered minimal.

For the streams and rivers flood mechanism, specific details regarding the licensee's revised analysis can be found in Perry Calculation 50:33.000, Revision 1, "PNPP Stream Modification PMF (Beyond Design Basis)," and site Engineering Change Package (ECP) 13-0802-001. The maximum stillwater elevation is 628.5 ft. at the rail line bridge, and 629.2 ft. at the Diversion Stream for this flood hazard. The location of the powerblock area relative to these locations preclude any wind generated wave effects to occur.

For the storm surge flood mechanism, specific details regarding the licensee's analysis can be found in Perry Calculation 50:47.000, Revision 1, "Surge and Seiche Analysis (Beyond Design Basis)." The maximum stillwater elevation is 582.82 ft. (high-water conditions) and 563.22 ft. (low-water conditions) for this flood hazard. Wind generated waves are evaluated separately under a combined event scenario.

For the combined events (storm surge plus wind generated waves) flood mechanism, specific details regarding the licensee's analysis can be found in Perry Calculations 50:47.000, Revision 1, "Surge and Seiche Analysis (Beyond Design Basis)," and 50:55.000, Revision 1, "PNPP Combined Events." The maximum stillwater elevation for this flood hazard is 609.3 ft.

3.2 Evaluation of Flood Impact Assessment for LIP

3.2.1 Description of Impact of Unbounded Hazard

The LIP evaluation generated a maximum ponding level of 621.65 ft. which exceeds the site grade of 620 ft. and the current licensing basis (CLB) LIP value of 620.5 ft. This exceedance may result in the flooding of key SCCs that provide the key safety functions (KSFs) at the site of core cooling, spent fuel pool cooling, and containment integrity. Specifically, the licensee stated in the FE that the emergency service water pumphouse (ESPH), the Unit 1 Auxiliary Building (AB), control complex, fuel handling building, intermediate building, emergency diesel generator (EDG) building, and the Unit 1 Reactor Building may be impacted. As part of the audit discussions, the licensee further clarified that the LIP elevation of 621.65 ft. is the worst-case situation at plant doors (environment/structure interface). Other locations within the LIP domain have higher WSEs due to the underlying topography or overall drainage patterns. However, these locations with higher or deeper floodwaters do not impact the plant and do not require flood protection features.

The NRC staff notes that Perry is undergoing a flooding design basis reconstitution as a result of physical changes at the site and new analyses made as part of the NTTF flooding response. In its FE, the licensee stated that as part of the design basis reconstitution, the Standard Project Flood concept is introduced as the minimum wet weather event to which hardened protection is required for all safety-related systems, structures, and components (SSCs). The Standard Project Storm (SPS) is based on the U.S. Army Corps of Engineers (USACE) methods, and estimates the most severe flood producing rainfall depth-area-duration relationship and

isohyetal pattern of a storm that is considered reasonably characteristic of the Perry site. Based on the revised LIP flooding elevations described above, the licensee stated in the FE that Perry will be protected up to and including the SPS using passive (permanently installed) flood protection features. For any precipitation event larger than the SPS, including the probable maximum precipitation (PMP) event, Perry will utilize temporary flooding protection features, specifically removable flood stop log barriers, which will be stored on site and will be deployed per site operational procedure(s). Finally, the licensee stated that a forthcoming license amendment request (LAR) and related 10 CFR 50.12 exemptions will be submitted to reconstitute the site's design basis. The LAR submittal is expected to occur the fourth quarter of 2020. As a result of the forthcoming LAR submittal, several aspects of the FE review will be deferred and reviewed as part of the LAR activities to avoid redundancy, or because information is not yet readily available. Specific details are described in the following sections.

3.2.2 Description of Flood Protection Features

Current Flood Protection

The CLB provides flood protection to an elevation of 620.5 ft. and was designed to allow all modes of power operations, startup, shutdown, and refueling. In general, the site has incorporated exterior barriers that are permanently in-place, requiring no operator manual actions. These barriers include: site grading, exterior building walls, sealed penetrations in exterior walls, curbing around electrical manholes, a continuous waterproofing membrane on the outside surfaces of all safety structures located below finished grade and extending under the foundation mats, waterstops in the joints between the safety class foundation mats, and floor drain systems. Roof drains are all designed to drain directly to the site stormwater drainage system, and downspouts and roof scupper systems are provided for roof drainage. The current CLB flood protection for Perry is fully described in the Final Safety Analysis Report (FSAR), Section 2.4.

With regards to the CLB protection, the 50.54(f) letter also requested licensees to conduct flooding hazard walkdowns to identify and address degraded, nonconforming, or unanalyzed conditions through the corrective action program, and to verify the adequacy of the monitoring and maintenance procedures. By letter dated June 30, 2014 (ADAMS Accession No. ML14141A460), the NRC staff issued a staff assessment documenting its review of the licensee's walkdown report. This staff assessment concluded that no immediate safety concerns were identified and that FENOC adequately verified the plant configuration with the current flooding licensing basis; addressed degraded, nonconforming, or unanalyzed flooding conditions; and verified the adequacy of monitoring and maintenance programs for protective features.

Subsequent to the walkdowns, several topographical modifications have occurred at Perry associated with the effort by FENOC to reconstitute the flooding design basis at the site. The NRC staff notes that the licensee has modified the site and installed a Diversion Stream, which is located east-northeast of the site adjacent to the Unit 1 and 2 Cooling Towers. The Minor Stream, also located east-northeast of the site, was a significant flooding contributor prior to the site modifications. The Diversion Stream now diverts the Minor Stream contributions directly into Lake Erie, therefore reducing flooding conditions at the site. The remnants of the Minor Stream are now modeled as part of the LIP domain, and analyses show that the Powerblock is not impacted by offsite/stream and river flooding as a result of these modifications. The NRC staff's review of these changes has been documented in the FHRR staff assessment dated

January 24, 2018, and in the MSA staff assessment dated May 3, 2018. Figure 3.3-1 of this report shows an updated topographical representation of the site.

Proposed Flood Protection

To address the LIP hazard exceedance, the licensee will implement additional flood protection measures at the site using a combination of the as-is topography, warning time, permanently installed flood protection barriers, and temporary/removable flood barriers beyond the CLB elevation of 620.5 ft. However, this flood protection has not yet been implemented and will be finalized as part of the forthcoming LAR submittal.

The licensee identified all safety-related buildings that may be impacted by the LIP event, including specific elevation, in Perry Calculations 50:66.000, Revision 1, and 50:66.001, Revision 0. The locations include safety-related buildings, and non-safety-related buildings that communicate with safety-related buildings (where SSCs that perform a KSF are located). As a result, the licensee stated in its FE that additional flood protection will be installed at the environmental/structure interface of the safety and non-safety-related buildings. Lastly, the licensee stated in its FE that all flood protection will be designed to withstand hydrostatic and hydrodynamic effects once all modifications have been completed.

The NRC staff audited calculations 50:66.000, Revision 1, and 50:66.001, Revision 0 and notes that there are approximately 67 susceptible locations which may need additional flood protection to be installed (from Table 5.0.5 of 50:66.000, Revision 1). These locations are based on the critical end-loaded LIP temporal distribution which resulted in the most conservative scenario at the site. In calculation 50:66.001, Revision 0, the licensee evaluated changes made to the FLO-2D software model to ensure that the conclusions made in 50:66.000, Revision 0 have not been adversely changed. Based on the NRC staff's sampling review of these calculations, the NRC staff agrees that the licensee's critical end-loaded temporal distribution scenario results in a conservative scenario to address flooding at the site because the water surface elevations at each door result in the highest flooding elevations when compared to the other temporal loading combinations.

In its FE, the licensee did not perform inleakage calculations entering the impacted buildings and instead conservatively assumed that inleakage via unprotected openings would result in key SSCs that provide KSFs being non-functional. Sources of inleakage paths include plant doorways, ventilation intakes, the Fuel Oil Storage Tank Flame Arrestors, tank vent lines, external siding of buildings, and safety-related electrical manholes. The NRC staff notes that this is a conservative assumption because SSCs that provide KSFs (such as pumps, pump motors, and electrical switches) are typically located on pedestals, stands, cabinets, or other configurations higher than ground level. This realistically results in additional time margin before floodwaters impact the SSCs that provide KSFs.

Lastly, the licensee stated that modifications will be made, as necessary, to ensure all impacted locations (as described in Calculations 50:66.000, Revision 1, and 50:66.001, Revision 0) are protected against the reevaluated LIP event. The modifications consist of raised thresholds, permanent ramps, and removable flood panels (stop logs).

Warning Time

In its FE, the licensee stated that the proposed warning time will provide approximately 24 hours before the LIP event impacts the site, and will be initiated by meteorological forecasting. The

licensee also stated that the warning time will be developed in accordance with NEI 15-05, "Warning Time for Local Intense Precipitation Events," (ADAMS Accession No. ML18005A076). The NRC staff notes that NEI 15-05 was originally a white paper titled "Warning Time for Maximum Precipitation Events," (ADAMS Accession No. ML15104A159) which was subsequently endorsed by the NRC by letter dated April 23, 2015 (ADAMS Accession No. ML15110A080). This white paper was subsequently titled NEI 15-05. Because the warning time is being developed consistent with a forthcoming LAR and related 10 CFR 50.12 exemptions, the licensee did not provide a final warning time analysis and as a result the NRC staff did not perform a review of the analysis. The licensee's estimated time to complete the installation of temporary barriers is 12 hours, thus providing significant margin when compared to the available time. Once finalized, the licensee stated that procedure updates will be validated using Perry procedure PAP-0550.3, "Procedure Validation."

The NRC staff audited calculations 50:66.000, Revision 1, and 50:66.001, Revision 0 and notes that there are approximately 67 susceptible locations which may need additional flood protection to be installed within the 12-hour period estimated to be available by the licensee. The final determination of susceptible locations has not yet been determined by the licensee, and will be described as part of the forthcoming LAR activities. The NRC staff agrees that it is appropriate to consider the guidance described in NEI 15-05 as suitable when developing the available warning time. The NRC staff also notes that a review of the validation of the warning time activities will be performed by the NRC staff as part of the forthcoming LAR and will follow the guidance described in Appendix E "Validation Guidance" contained in NEI 12-06, "Diverse and Flexible Coping Actions," as endorsed by JLD-ISG-2012-01, Revision 2 dated February 8, 2017 (ADAMS Accession No. ML17005A182).

In summary, the NRC staff did not review the proposed warning time calculation available at Perry because it has not yet been finalized, but agrees that using the guidance described in NEI 15-05 is a suitable method for its future evaluation. The warning time will be reviewed as part of the LAR submittal, which is expected to be submitted in the fourth quarter of 2020.

Available Physical Margin

In the FE submittal, the licensee provided Table 6 "LIP APM Evaluation" which described the critical elevations at which the impacted buildings would be compromised. The licensee also stated that based on the proposed modifications to be completed, the minimum APM between the LIP elevation and the corresponding location would be 1 inch.

Because the final modifications have not yet been completed, the NRC staff did not perform a detailed review of the as-is APM at the site. However, the NRC staff notes that if implemented as described, the APM of 1-inch minimum (or more), is adequate for Perry. This determination is based on NEI 16-05, Revision 1, Appendix B, Section B.1. This section states that "Negligible or zero APM can be justified as acceptable if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established."

The NRC staff had previously evaluated the licensee's reevaluated LIP hazard and documented its conclusions regarding the assumptions, inputs, and methods in the MSA staff assessment. Specifically, some conservative assumptions included assuming no soil infiltration or evaporation, maximized boundary conditions, and partial obstruction of the storm drain system. In the MSA staff assessment, the NRC concluded that LIP was revised in a manner that is consistent with present-day guidance and methodologies, and therefore are reasonable for use. Because the LIP hazard was not revised in the FE, those conclusions are still valid.

In summary, the NRC staff concludes that, if implemented as described, the APM for the proposed flood protection barriers is reasonable, and consistent with the guidance described in NEI 16-05, as endorsed.

Regulatory Commitment for Temporary Flood Protection

By letter dated December 7, 2018 (ADAMS Accession No. ML18341A046), FENOC notified the NRC its plans to permanently cease operations at Perry on May 2021. Subsequently, the NRC staff issued a request for additional information (RAI) letter dated February 19, 2019 (ADAMS Accession No. ML19035A655), to FENOC in response to the licensee's notification.

Specifically, the RAI letter requested FENOC to describe additional capabilities, temporary or permanent, that would be available at the site which would address the reevaluated LIP hazard (as described in the MSA submittal) until permanent shutdown of plant operations.

In its response by letter dated March 20, 2019 (ADAMS Accession No. ML19080A005), the licensee described a regulatory commitment to implement temporary measures at critical locations that allow gross leakage by way of additional flood barriers and/or sand bags. The licensee implemented these modifications (see Engineering Change (EC) 19-0178-001, 002, and 003) which are based on the "as-found" conditions at the site. Full details are described in Perry Calculation 50:87.000, Revision 0, "PNPP Local Intense Precipitation Study Calculation."

These temporary barriers are deployed upon receipt of a meteorological forecast of 6-inches over a 3-hour period. Specific details on the trigger conditions and installation procedure for the barriers is described in Perry procedure ONI-ZZZ-1, "Tornado or High Winds". The licensee also stated in the FE that these actions have been incorporated into the Prompt Functionality Assessment therefore aligning the interim beyond-design-basis and design-basis functionality requirements. This results in one set of actions and procedures to govern all external flooding requirements.

Subsequently, the licensee submitted a letter dated August 30, 2019 (ADAMS Accession No. ML19246A004), formally withdrawing the December 7, 2018, shutdown letter and requesting resumption of actions associated with the Fukushima flooding submittals. In its FE, the licensee stated that the interim protection measures described above will remain in place until final modifications are complete and the proposed LAR and related 10 CFR 50.12 exemptions are approved and implemented.

The NRC staff agrees that relying on commitments as part of the focused evaluation response is acceptable. This determination is based upon NRC guidance described in:

- COMSECY-15-0019 describes that "licensees will submit letters providing a summary of the evaluation and, if needed, regulatory commitments to implement and maintain appropriate programmatic, procedural or plant modifications to protect against the LIP hazard." The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682).
- By letter dated September 1, 2015 (ADAMS Accession No. ML15174A257), the NRC staff issued a letter titled "Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events." This letter describes a graded approach to complete the actions associated with the 50.54(f) letter. Specifically, this letter stated that for plants screening out of an integrated assessment, "Where additional measures are necessary to protect against a

flooding mechanism, licensees may include in their submittals regulatory commitments to implement procedural or hardware changes.”

Defense-in-Depth

Although no longer a proposed requirement, the staff concludes that FLEX strategies can be implemented assuming a LIP event of the magnitude described in the MSA staff assessment. The staff concludes that implementation of FLEX strategies assuming the FE flood conditions provide an important defense-in-depth function should the installed SSCs be unable to maintain the KSFs during the conditions associated with the flood levels found in the MSA staff assessment. In its FE, the licensee also confirmed that FLEX capabilities are available at the site as a defense-in-depth option.

3.2.3 Conclusion – Local Intense Precipitation

The NRC staff has concluded that, if implemented as described, the licensee’s evaluation meets the Path 2 guidance described in NEI 16-05, Revision 1, for the LIP event. This determination is based upon demonstration of a plan to implement effective flood protection that has APM, and is reliable. The proposed overall site response at Perry provides reasonable assurance that SSCs that provide KSFs will be protected against a LIP event. Furthermore, the licensee has a regulatory commitment in place that provides temporary flood protection at the site that will be maintained until final modifications are completed.

Because the forthcoming LAR plans to reconstitute the flooding design-basis at Perry using information developed as part of the 50.54(f) letter response, the NRC staff notes that implementation of the plans for additional flood protection will be evaluated during the staff’s review of the LAR.

In addition, the NRC staff also agrees that as a defense-in-depth strategy, the FE evaluation also meets Path 3 guidance for this event by demonstrating a feasible flood response for LIP. The feasible flood response for this LIP event was evaluated by the staff and found to be acceptable as documented in the MSA staff assessment dated May 3, 2018.

3.3 Evaluation of Flood Impact Assessment for Streams and Rivers

3.3.1 Description of Impact of Unbounded Hazard

As a result of the topographical modifications performed at Perry, the licensee stated (and the NRC staff confirmed) that the reevaluated streams and rivers flood-causing mechanism will not flood the powerblock. This determination is primarily based upon the top of the Diversion Stream berm being 631.15 ft., which is higher than the expected 629.2 ft. of water for this event; and the minimum elevation of the rail line bridge being 630.93 ft., which is higher than the expected 628.5 ft. of water at this location for this event. Based on this, no SSCs that provide KSFs are impacted. Furthermore, the NRC staff concluded in the MSA staff assessment dated May 3, 2018, that the licensee had developed an appropriate response strategy to ensure that the FLEX response at Perry can be implemented with due consideration of the streams and rivers reevaluated hazard.

3.3.2 Description of Flood Protection Features

Effective flood protection at Perry is provided by the plant grade, the Diversion Stream berm, and other site topographical features. This flood protection is permanently installed, and inherently passive. In order to ensure that this feature remains functional and reliable, the licensee stated in the FE that an inspection/monitoring procedure will be implemented to inspect for erosion and degradation and ensure that the berm structural integrity is not adversely affected over time. In addition, the licensee stated that preventive maintenance guidelines for debris clearing/vegetative groundcover maintenance are being developed. As part of the Diversion Stream/berm construction permits, the FE described that a 10-year monitoring program has been established at the site and includes trending of settlement or slope changes and periodic reviews of vegetative growth.

Similarly, for the elevated roadway (embankment) which contains the PMF profile for the Major Stream, a maintenance plan will be developed which will inspect the roadway and underlying surface for evidence of failure mechanism initiators. These maintenance and inspection plans will ensure the reliability of the embankments and provide further assurance that they will be available when needed to function as flooding barriers.

Demonstrating reliability of the flood protection features is described in NEI 16-05, Appendix B, for both passive and active features. The features that the NRC staff credited in its analysis include earthen berms and embankments. The NRC staff notes that there is a considerable amount of APM when considering the 1.95 ft. of existing freeboard that can be credited in the berm. This results in additional capacity for the Diversion Stream to handle flow, should it be needed.

Furthermore, the licensee analyzed a postulated failure of the Diversion berm and determined that the resulting water would flow toward the Minor Stream. This volume of water was added to the LIP domain analysis, and therefore LIP protection strategies inherently account for the effects of the Diversion Stream failure. The NRC staff agrees that this results in further assurance that a failure of the berm would not significantly impact the site, because a postulated failure of the Diversion berm has been analyzed.

Finally, the NRC staff agrees that a periodic surveillance and inspection program of the berm and associated flood protection features will further ensure that the berm is reliable, and will provide reasonable assurance that it can perform its credited flood protection function. The proposed maintenance and surveillance program is also expected to identify early signs of degradation that can be expeditiously resolved, and is consistent with NEI 16-05, Section B.2.1.6.

Available Physical Margin

The NRC staff agrees that there is adequate APM at the site for the streams and rivers event. This determination is based on the available freeboard in the Diversion berm, as well as NEI 16-05, Revision 1, Appendix B, Section B.1. This section states that "Negligible or zero APM can be justified as acceptable if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established." Several conservative assumptions are included in the analysis, such as no soil infiltration is credited in the rainfall to runoff analysis, and the use of conservative methodology. Additional details of the staff's streams and rivers flood hazard review are described in the May 3, 2018, MSA staff assessment.

Defense-in-Depth

Although no longer a proposed requirement, the staff concludes that FLEX strategies can be implemented assuming a streams and rivers event of the magnitude described in the MSA staff assessment. The staff concludes that implementation of FLEX strategies assuming the FE flood conditions provide an important defense-in-depth function should the installed SSCs be unable to maintain the KSFs during the conditions associated with the flood levels found in the MSA staff assessment. In its FE, the licensee also confirmed that FLEX capabilities are available at the site as a defense-in-depth option.

3.3.3 Conclusion – Streams and Rivers

The NRC staff has concluded that the licensee's evaluation meets the Path 2 guidance described in NEI 16-05, Revision 1, for the streams and rivers event. This determination is based upon demonstration of effective flood protection that is permanent, does not rely on manual actions for implementation, has APM, and is reliable. The overall site response and strategy at Perry provides reasonable assurance that SSCs that provide KSFs will be protected against a streams and rivers flooding event.

In addition, the NRC staff also agrees that as a defense-in-depth strategy, the FE evaluation adequately describes availability of FLEX strategies at the site. The feasible flood response for this streams and rivers event was evaluated by the staff and found to be acceptable as documented in the MSA staff assessment dated May 3, 2018.

3.4 Evaluation of Flood Impact Assessment for Storm Surge (Stillwater)

3.4.1 Description of Impact of Unbounded Hazard

For the storm surge flood-causing mechanism, the maximum stillwater elevation is 582.82 ft. (high-water conditions) and 563.22 ft. (low-water conditions). As stated in Section 3.1 of this assessment, the combined event (storm surge plus wind generated waves) is evaluated separately. Because the nominal site grade is 620 ft., no SSCs that provide KSFs are impacted.

3.4.2 Description of Flood Protection Features

The NRC staff notes that Perry is physically located on a bluff overlooking Lake Erie. This topographical feature provides flood protection against the reevaluated storm surge event for the high and low-water conditions for all SSCs that provide KSFs which are not hydraulically connected to Lake Erie.

For high-water conditions, the licensee described the ESPH as the only structure hydraulically connected to Lake Erie. The licensee stated that the operating floor (the lowest elevation where flood-sensitive equipment is located) is at elevation 586.5 ft. Additional details regarding the ESPH design can be found in Perry Drawing 015-0002-00000, Revision F, "Final Plant Layout, Emergency Service Water Pumphouse, Plans and Elevations."

Since the ESPH is hydraulically connected to Lake Erie via the intake tunnels, the NRC staff agrees with the licensee that the storm surge stillwater elevation (high-water conditions) would determine the water level inside the building, and since it remains below the ESPH operating floor, activities associated with that elevation (or above) would not be adversely impacted by the

storm surge lake elevation. The NRC staff also notes that this elevation provides approximately 2.7 ft. of additional APM before floodwaters could potentially impact flood-sensitive equipment. This credited passive protection is permanent, and does not require any manual actions or advanced warning time.

With regard to other sources of potential water ingress, the NRC staff notes that the ESPH is designed to preclude ground water leakage with sealed penetrations. Any incidental leakage from ground water or system failures would be drained below the 586.5 ft. floor level by grating openings above the suction bay of the pump house and back to the lake via the intake structure. As a result of the above, the NRC staff agrees that there is reasonable assurance that the ESPH is protected from the storm surge high-water event.

For low-water conditions, the licensee described in its FE that in addition to the low-water level of 563.22 ft., simultaneous start of the Emergency Service Water (ESW) and the Service Water Pumps will result in an additional draw down of 3.17 ft. as a result of the forebay level drop. Therefore, a low-water elevation of 560.05 ft. was considered in the FE analysis. The licensee then compared this elevation against the minimum ESW pump submergence depth, and depth to prevent vortexing, of this key SSC. Specifically, the licensee evaluated the ESW pumps A, B, and C, and the Screen Wash, and determined that the most limiting scenario would be in the Screen Wash. The suction bell flange elevation (554.88 ft.) and the required submergence (1.5 ft.) for this component results in a required minimal (low-water) elevation of 556.38 ft. When comparing 556.38 ft. against the low-water conditions of 560.05 ft., the licensee concluded that there is approximately 3.67 ft. of APM, and that sufficient water is available to ensure safe operation of the ESW pumps. Additional information regarding this analysis is described in Perry site calculations 50:47.000, Revision 1, "Surge and Seiche Analysis (Beyond Design Basis)," and P45-081, Revision 0, "Evaluation of Net Positive Suction Head (NPSH) and Submergence Requirements for the Emergency Service Water (ESW) System Pumps." In addition, Perry Drawing 015-0002-00000, Revision F, "Final Plant Layout, Emergency Service Water Pumphouse, Plans and Elevations," and Table 9 of the FE submittal provide further information.

With regard to ESW pump NPSH available, the licensee compared the vendor-provided required NPSH against the storm surge minimum elevation of 560.05 ft. Specifically, the licensee evaluated the ESW pumps A, B, and C, and the Screen Wash, and determined that the most limiting scenario would be in the Screen Wash. Based on the analysis, the licensee concluded that there is a minimum margin value of approximately 4.9 ft. available, and therefore proper operating conditions are expected for these pumps.

Additional details regarding this analysis, and other considerations factored by the licensee, can be found in Perry Drawing 726-0210-00000, Revision M, "Offshore Multiport Intake Structure," and P45-081, Revision 0, "Evaluation of Net Positive Suction Head (NPSH) and Submergence Requirements for the Emergency Service Water (ESW) System Pumps."

The NRC staff reviewed the information provided by the licensee, as well as supporting documentation and agrees that the licensee has appropriately considered the APM for the low-water conditions before floodwaters could potentially impact flood-sensitive equipment. This credited passive protection is permanent, and does not require any manual actions or advanced warning time. Furthermore, in SECY-16-0074, "Assessment of Fukushima Tier 2 Recommendation Related to Evaluation of Natural Hazards other than Seismic and Flooding" (ADAMS Accession Nos. ML16102A301 and ML16102A303), the NRC staff evaluated potential low water conditions as a Tier 2 Fukushima activity pursuant to Section 402 of Public Law 112-

07 4, "Consolidated Appropriations Act, 2012." In the evaluation of other external hazards contained in SECY-16-0074, the NRC staff reviewed potential low water conditions at sites such as Perry located along the Great Lakes and concluded that further assessments of low water conditions were not warranted. Based on the information provided in the Perry FE submittal, the NRC staff finds that the conclusions of SECY-16-0074 remain valid regarding potential low water conditions at Perry.

As a result of the above, the NRC staff agrees that there is reasonable assurance that the ESPH is protected from the storm surge low-water event.

3.4.3 Conclusion – Storm Surge (Stillwater)

The NRC staff has concluded that the licensee's evaluation meets the Path 2 guidance described in NEI 16-05, Revision 1, for the storm surge (stillwater) event. This determination is based upon demonstration of effective flood protection that is permanent, does not rely on manual actions for implementation, has APM, and is reliable. The overall site response and strategy at Perry provides reasonable assurance that SSCs that provide KSFs will be protected against a storm surge (stillwater) flooding event.

In addition, the NRC staff also agrees that as a defense-in-depth strategy, the FE evaluation adequately describes availability of FLEX strategies at the site. The feasible flood response for this storm surge event was evaluated by the staff and found to be acceptable as documented in the MSA staff assessment dated May 3, 2018.

3.5 Evaluation of Flood Impact Assessment for Storm Surge (wind and wave included)

3.5.1 Description of Impact of Unbounded Hazard

For the combined events (storm surge plus wind generated waves) flood mechanism, the licensee stated in its FE that the maximum wave run-up elevation for this flood hazard is 609.3 ft. The NRC staff notes that the licensee's MSA submittal (which was based on a subsequent revision of the FHRR), specifies a maximum wave runup elevation of 609.5 ft. However, the discrepancy had been previously evaluated by the NRC staff and is due to a numerical rounding error. Specifically, a transposition error between beyond design basis calculations related to Lake Erie flood hazards (wave runup) resulted in a slightly higher value which was reported in the Perry FHRR and MSA. The error was identified during the preparation of responses to a supplemental information needs as summarized in Section 4 of the MSA staff assessment. The licensee subsequently entered this error identified into Perry Condition Report 2017-10103, "Error Identified in Beyond Design Basis Calculation 50:55.000, Rev. 0," dated October 3, 2017. The elevation of 609.3 ft. is therefore the updated value following correction of the transposition error and is the information used in the Perry FE analyses.

Because the nominal site grade is 620 ft., the licensee concludes (and the NRC staff agrees) that no SSCs that provide KSFs are impacted.

3.5.2 Description of Flood Protection Features

In its FE, the licensee stated that protection at Perry around the north shore bluff consists of armor stone and steel sheet piling installed with a top of steel elevation of approximately 580.25 ft. Additional information related to the design of this flood protection feature can be found in Section 2.4 of the Perry FSAR. Because the maximum wave run-up elevation will exceed the

top of the top of the sheet pile, the licensee considered the effects of bluff erosion. In its analysis, the licensee concluded that the event is isolated and has a relatively short duration, therefore adverse effects are minimal. Furthermore, the licensee stated that periodic inspections/surveys are performed regularly to measure bluff erosion/recession, and that the site is committed to taking remedial action before the bluff recedes to a point which can impact important to safety structures. Additional details on the site's inspection procedure is described in Perry FSAR Section 2.4.5.5. Finally, the licensee concluded that based on the passive and permanent flood protection, in addition to the inspection/maintenance program, the site has reliable flood protection that ensures key SSCs will continue to perform their intended function.

In the MSA staff assessment, the NRC staff determined that the methodology used to determine the revised storm surge flood levels is adequate, and concluded that the final flood level of 609.5 ft. is well below the plant grade and is not expected to result in inundation. Because the storm surge flood hazard was not revised from that analysis, the NRC staff agrees that the conclusions from the MSA staff assessment are still valid.

Furthermore, the NRC staff reviewed the relevant information related to the bluff characteristics, and the maintenance/inspection program. Specifically, FSAR Section 2.5.5.5 states that "Since plant grade is approximately 45 feet above the normal lake level and there are no safety-related structures within 380 ft. of the lake shoreline (toe of bluff), damage to the shoreline bluff by an individual storm would not affect operation or the safety of PNPP [Perry]." The licensee also described that the range of bluff recession in the vicinity of the ESPH is less than 2 ft. per year since 1937.

With regard to the inspection/maintenance performed in and around the bluff, the FSAR states that it is performed on an annual basis (spring) at several locations around the bluff. Figure 3.5-1 of this report shows the locations inspected. As part of the FE audit review (see additional details on Section 4 of this report), the NRC staff audited Perry procedure EMARP-0005, Revision 2, "Monitoring of Shoreline Recession and Bluff Erosion" which is part of the Perry Operations Manual. The NRC staff confirmed that proper procedures are in place, that clear guidance is provided to personnel responsible, and that remedial measures are unambiguously described such that any deterioration can be corrected and/or repaired in a timely manner. In addition, the procedure specifies the qualifications that personnel must have to conduct the inspection and scope of work to be performed. This determination by the NRC staff is consistent with the guidance described in NEI 16-05, Section B.2.1.1.

As a result of the above, the NRC agrees that an annual maintenance/inspection program should provide further assurance that the licensee will identify any potential signs of slope stability, seepage, erosion, and/or groundwater effects such that remedial actions can be undertaken.

3.4.3 Conclusion – Storm Surge (Combined Event)

The NRC staff has concluded that the licensee's evaluation meets the Path 2 guidance described in NEI 16-05, Revision 1, for the storm surge (combined event) flood mechanism. This determination is based upon demonstration of effective flood protection that is permanent, does not rely on manual actions for implementation, has APM, and is reliable. The overall site response and strategy at Perry provides reasonable assurance that SSCs that provide KSFs will be protected against a storm surge (combined event) flooding mechanism.

In addition, the NRC staff also agrees that as a defense-in-depth strategy, the FE evaluation adequately describes availability of FLEX strategies at the site. The feasible flood response for this storm surge event was evaluated by the staff and found to be acceptable as documented in the MSA staff assessment dated May 3, 2018.

4.0 AUDIT REPORT

By letter dated July 18, 2017 (ADAMS Accession No. ML17192A452), the NRC staff issued a generic audit plan describing the NRC staff's intention to conduct an audit of the FE submittals, as necessary, and to issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's submittal. The NRC staff's audit for the Perry FE included a sampling review of the referenced procedures and calculations described above. Because this staff assessment appropriately summarizes the results of the audit, the NRC staff concludes a separate audit report is not necessary, and that this document serves as the audit report described in the NRC staff's letter dated July 18, 2017.

5.0 CONCLUSION

The staff has inspected, audited, and reviewed, as appropriate, pertinent provisions of the licensee's strategy and found it acceptable. The NRC staff expects that the licensee will maintain the temporary protection at the site described in Perry commitments L-19-068-1 and L-19-068-2 and address the regulatory commitments consistent with NEI 99-04, "Guidelines for Managing NRC Commitment Changes," Revision 0, dated July 1999 (ADAMS Accession No. ML003680088).

Based on the staff's review that was performed in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, the staff concludes that the Perry site has effective flood protection (if implemented as described) for the reevaluated LIP, streams and rivers, storm surge, and combined events flood hazard mechanisms. Furthermore, the staff concludes that Perry screens out for an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, the staff concludes that in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard are not warranted at the site. The staff further concludes that the licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

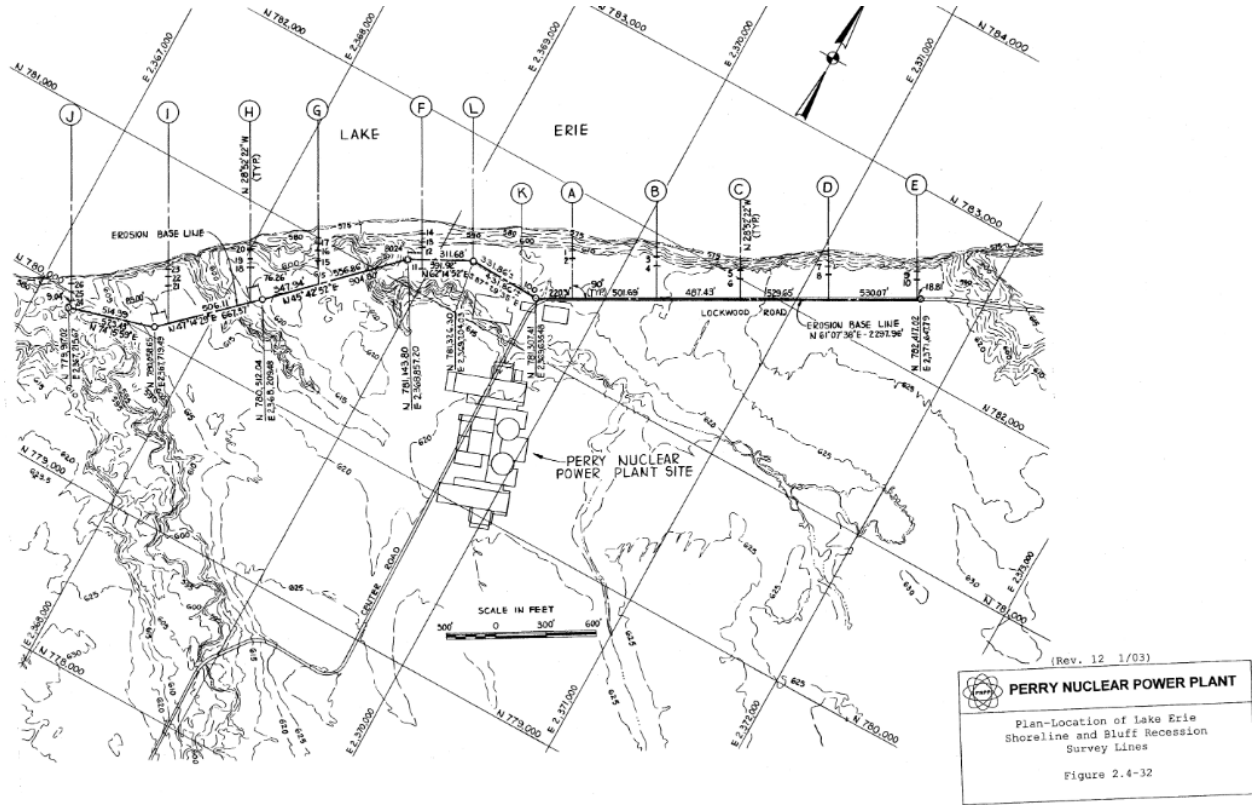


Figure 3.5-1 Locations of the annual inspection/maintenance performed at the North East bluff in the vicinity of the site. (Source: Perry FSAR Figure 2.4-32).

SUBJECT: PERRY NUCLEAR POWER PLANT, UNIT 1 - STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (EPID NO. L-2019-JLD-0020) DATED MAY 7, 2020

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