DOWNSTREAM FISH PASSAGE
CONCEPTUAL ALTERNATIVES STUDY - PHASE 1
PRELIMINARY STUDY REPORT
BRUNSWICK HYDROELECTRIC PROJECT
FERC NO. 2284

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LIST OF ABBREVIATIONS AND DEFINITIONS

ASCE	American Society of Civil Engineers
BWPH	Brookfield White Pine Hydro LLC
cfs	Cubic feet per second
CFD	Computational Fluid Dynamics
FERC	Federal Energy Regulatory Commission
fps	Feet per second
ILP	Integrated Licensing Process
kW	Kilowatt
Licensee	Brookfield White Pine Hydro, LLC
ME	Maine
MDMR	Maine Department of Marine Resources
MW	Megawatt
NGVD29	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
O&M	Operations and Maintenance
PAD	Pre-Application Document
PNP	Pacific Netting Products
Project	Brunswick Hydroelectric Project (FERC No. 2284)
RSP	Revised Study Plan
SD1	Scoping Document 1
SPD	Study Plan Determination
sqm	Square mile
3D	Three-dimensional
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1 INTRODUCTION

Brookfield White Pine Hydro LLC (BWPH or Licensee) is licensed by the Federal Energy Regulatory Commission (FERC) to operate the 19-megawatt (MW) Brunswick Hydroelectric Project (Project) (FERC No. 2284). The Project is located on the Androscoggin River in the towns of Topsham and Brunswick, Maine and straddles the border between Cumberland and Sagadahoc counties. The original license was issued on February 9, 1979, and expires on February 28, 2029.

BWPH is using FERC's Integrated Licensing Process (ILP) as established in Title 18 Code of Federal Regulations, Part 5. BWPH filed a Pre-Application Document (PAD) and Notice of Intent (NOI) to seek a new license for the Project on February 21, 2024.[1] The PAD provides a description of the Project, including its structures, operations, and potentially affected environmental resources.

BWPH distributed the PAD and NOI simultaneously to federal and state resource agencies, local governments, Native American tribes, members of the public, and others thought to be interested in the relicensing proceeding. Following the filing of the PAD, FERC prepared and issued Scoping Document 1 (SD1) on April 16, 2024. FERC also held agency and public scoping meetings and a site visit on May 7, 2024. The FERC Process Plan and Schedule provided agencies and interested parties with an opportunity to file comments on the PAD and SD1 and request studies by June 20, 2024. FERC issued Scoping Document 2 on July 29, 2024.

BWPH filed a Proposed Study Plan on August 2, 2024, and held study plan meetings on August 28 and October 9, 2024. The Revised Study Plan (RSP) was filed in accordance with the ILP schedule on December 2, 2024. FERC issued a Study Plan Determination (SPD) on December 30, 2024. Specific to fisheries resources, BWPH proposed in the RSP to conduct an Upstream and Downstream Fish Passage Alternatives Study, which was approved without modification in the SPD.

This report presents the results of Phase 1 of the downstream fish passage alternatives portion of the study, including the goals and objectives, methods, results, summary, and variances (if any) from the FERC approved study plan. Phase 1 consisted of an alternatives analysis, which included agency and other stakeholder consultation and a desktop review of available information. This report summarizes the screening level evaluation of alternatives that was conducted in consultation with resource agencies[2] and other stakeholders (Phase 1).

The results of the downstream passage related studies (Phases 1 and 2) will be used to identify the appropriate protection, mitigation, and enhancement measures, as necessary, for improving downstream fish passage at the Project and will also provide FERC with the information needed to conduct its National Environmental Policy Act analysis, which will inform conditions to be contained in the new FERC license.

[1] https://elibrary.ferc.gov/eLibrary/filelist?accession_Number=20240221-5163.
[2] For the purpose of this study, the term "resource agencies" refers to the Maine Department of Marine Resources (MDMR), National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS).

2 GOALS AND OBJECTIVES

The goal of the study is to determine conceptual options and expected performance for improved downstream passage that will reduce delay, increase passage efficiency, and increase survival for downstream migrating adult American Eel, Blueback Herring, Alewives, American Shad, Atlantic Salmon, and Sea Lamprey (collectively, the "target species").

The Downstream Fish Passage Conceptual Alternatives Study employs a phased approach to assess the viability of alternatives for improvement of downstream migratory fish passage identified by BWPH, resource agencies and other stakeholders. Phase 1 of the evaluation, addressed in this report, presents the initial screening of alternatives to identify, which alternatives warrant a more detailed feasibility-level review in Phase 2.

Phase 1 of the study, presented herein, consists of a conceptual level assessment of layout, functionality, effectiveness, and constructability as a high-level fatal flaw analysis. A draft screening matrix was reviewed with resource agencies and other stakeholders in a virtual meeting on January 27, 2026. The goal of the meeting was to review the downstream alternatives matrix and solicit initial resource agency and stakeholder input to help identify which alternatives will be advanced to a more detailed Phase 2 evaluation.

Phase 2 of the evaluation will develop more detailed conceptual designs, cost estimates, incorporate turbine vendor studies, and include three-dimensional (3D) Computational Fluid Dynamics (CFD) modeling of selected Phase 2 alternatives. The 3D CFD modeling will evaluate the flow field and hydraulic conditions that result from each alternative and its proposed configuration(s). Specifically, the Phase 2 CFD modeling of alternatives is anticipated to inform the following:

- effectiveness of meeting United States Fish and Wildlife Service (USFWS) downstream fish passage design criteria;
- effectiveness of meeting Project passage survival targets for the target species;
- effectiveness of balancing environmental and power generation resources; and,
- identification of red-flag hydraulic conditions.

3 PROJECT DESCRIPTION AND STUDY AREA

3.1 Project Description

The Project is located on the Androscoggin River at the head-of-tide at approximately river mile 6 in the Towns of Brunswick and Topsham, ME. The Project straddles the border between Cumberland and Sagadahoc counties. The Project dam is the first dam on the mainstem of the Androscoggin River. The dam and powerhouse span the Androscoggin River immediately above the U.S. Route 201 bridge connecting Topsham and Brunswick, ME, at a site originally known as Brunswick Falls.

The Project structures include a 830-foot-long and 40-foot-high concrete gravity dam with a gate section containing two Tainter gates and an emergency spillway; an intake and a powerhouse containing three turbine-generating units with an authorized rating of 19.0 MW. The Project also has a vertical slot upstream fishway, a downstream fish bypass, a 21-foot-high fish barrier wall between the dam and Shad Island, and a 3-foot-high by 20-foot-long concrete fish barrier weir across Granney Hole Stream in Topsham. The Project impoundment is approximately 4.5-mile-long and 175-acres, and a gross storage capacity of 125 acre-feet.

The powerhouse, constructed in 1983, is integral with the dam and located on the right bank of the river (Brunswick shoreline). It is approximately 125-feet-wide and 135-feet-long and constructed of concrete and brick masonry. The powerhouse contains one vertical and two horizontal propeller turbine generators.

The concrete intake structure is integral with the dam and powerhouse and is approximately 110 feet long and has a maximum height of 65 feet, and the top elevation of intake structure deck is 55.0 feet, NGVD29.[3]

The trashracks for Unit 1 consist of three separate panels covering the intake openings. Each steel panel has 3.5-inch clear spacing between bars in trashrack. The trashracks panels have a top elevation of 26.85 feet and extend down to an elevation of -12.38 feet. Each panel is approximately 12 feet wide. The trashracks for Units 2 and 3 consist of one panel per unit. Each steel panel has 3.5-inch clear spacing on the trashrack. The trashracks panels have a top elevation of 55.0 feet and extend down to an elevation of 20.0 feet. Each panel is approximately 17 feet wide. The sluice opening for the downstream fish passage facility is located near the Unit 2 and Unit 3 intake. The trashrack over the opening is approximately 3.5-feet-wide with a top elevation of 55.0 feet and a bottom elevation of 33.0 feet. The trashracks are cleaned using a motor-operated trash rake from a concrete deck.

The Project has three turbine generators with a combined installed generator capacity of 19.0 MW with a total combined hydraulic capacity of 7,475 cubic feet per second (cfs). Unit 1 is a vertical propeller turbine/generator rated at 12 MW and has a hydraulic capacity between a minimum of 2,741 cfs to a maximum of 5,075 cfs. Units 2 and 3 are horizontal propellor turbine/generators each rated at 3.765 MW with a hydraulic capacity of 1,200 cfs.

3.2 Project Hydrology

The drainage area at the Project is 3,437 square miles (sqm) while the average annual inflow to the Project is approximately 7,018 cfs.

Flow from the Upper Androscoggin River Storage System, including Mooselookmeguntic Lake (Upper Dam), Richardson Lake (Middle Dam), Aziscohos Lake, and Umbagog Lake (Errol Dam) is used to augment Androscoggin River flow during low flow periods and to provide flood control during high flow

[3] All references to elevations in this Document are to the United States Geological Survey National Geodetic Vertical Datum of 1929 (NGVD29) unless otherwise noted.

periods. Outflow from the Storage System is managed in cooperation with downstream hydroelectric power generators to provide a relatively uniform flow regime.

The U.S. Geological Survey (USGS) operates a streamflow gaging station (No. 01059000 Androscoggin River near Auburn, ME) approximately 21.5 miles upstream of the Project dam. This gage has a drainage area of 3,263 sqm and has been in operation since 1928. Annual and monthly flow duration curves are presented in Figures A-1 to A-5, located in Appendix A. The period of January 1987 – December 2025 was analyzed to reflect current hydrological conditions as affected by upstream hydroelectric project operations. Table 1 shows an annual and monthly summary of this data. The mean annual daily inflow for this period is about 7,002 cfs. The peak streamflow at the Project during this period was approximately 104,911 cfs on April 2, 1987. The peak streamflow for the period of record at the USGS Auburn gage is about 135,000 cfs on March 20, 1936. Streamflow is normally at its peak throughout the spring freshet during snowmelt, while short-term inflow depends in part upon upstream hydropower project storage operations and in part upon numerous intervening tributary river and stream inflows to the mainstem of the river.

Table 1: Daily Average Streamflow (cfs) at Brunswick Dam 1987 – 2025

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	1,675	1,791	1,907	2,876	1,675	1,517	1,348	1,338	1,106	1,296	1,654	1,612
Max	36,340	24,226	44,872	104,911	65,201	61,514	31,073	40,869	48,137	48,348	42,660	74,681
Median	5,014	4,740	6,794	12,851	9,059	4,961	3,455	2,876	2,633	3,718	5,440	5,540
Average	5,820	5,091	8,266	16,090	10,769	6,598	4,846	3,850	3,282	5,374	6,796	7,230

3.3 Fish Passage Season Hydrology

USFWS (2019) guidelines recommend fish passage systems to be designed and operated to provide safe, timely, and effective passage across the full seasonal flow range bounded by approximately the 95% exceedance flow (low flow) and the 5% exceedance flow (high flow).

Fish passage season hydrology was developed for the Project based on analysis of daily flow data from 1987 to 2025, for the April 1 to Dec 31 downstream passage period. This period defines the flow range required for downstream fish passage operation. The data showed that the 95% exceedance flow was 1,852 cfs, the median flow was 4,820 cfs, and the 5% exceedance flow is 21,363 cfs.

4 LITERATURE REVIEW OF POTENTIAL MEASURES

BWPH conducted a literature review to identify downstream passage alternatives, and modifications implemented at other hydroelectric projects for diadromous species present at the Project, and applicable emerging technologies. BWPH summarized the results in a screening matrix. On January 27, 2026, BWPH met with representatives from USFWS, NMFS, MDMR, and other stakeholders to solicit input on the alternatives identified through the literature review, as well as other alternatives that may be applicable to the Project.

A meeting summary is provided in Appendix B. Resource agencies and other stakeholders provided comments on the screening matrix and the proposed alternatives for the next phase of the study. Appendix B also contains a responsiveness matrix summarizing the comments received, BWPH's response, as well as a copy of the resource agency comment letters.

4.1 Alternatives Identified for Further Analysis

Based on the literature review and initial screening level analysis, BWPH identified the following downstream passage alternatives for further analysis as part of the Downstream Fish Passage Conceptual Alternatives Study.

1. Alternative D1- Angled Bar Rack with New Downstream Bypass Structures
2. Alternative D2 - Inclined Bar Rack with New Downstream Bypass Structures
3. Alternative D3 - Floating Guidance Boom with a New Downstream Surface Bypass and Nighttime Shutdowns
4. Alternative D4A - Multiple Fish Friendly Runner Replacements
5. Alternative D4B - Unit 1 Fish Friendly Runner Replacement with Inclined Bar Rack at Units 2 and 3
6. Alternative D4C - Unit 1 Fish Friendly Runner Replacement with Angled Bar Rack at Units 2 and 3

Each alternative identified above is further discussed in Section 6, Alternatives Evaluation.

4.2 Alternatives Eliminated from Further Analysis

Downstream alternatives that were eliminated from further analysis, owing to critical issues identified during the literature review and screening level analysis, included the following.

1. No Action (Maintain the Existing Conditions and Operations): This alternative was eliminated from consideration due to trashrack spacing and approach velocity limitations. The existing trashrack approach velocities at the unit intakes (Unit 1 – 3.2 feet per second (fps), Unit 2 & 3 2.8 fps) and the existing trashrack bar spacing (3-1/2-inch clear spacing) exceeds the guidelines of the USFWS (2019). The attraction flow (20 cfs) for the downstream bypass is also significantly lower than the 5% of station discharge (375 cfs) that is recommended by USFWS guidelines.

2. Modifications to the Existing Downstream Bypass: The existing downstream bypass consists of a 20 cfs capacity, 3.5-foot-wide surface sluice that transitions to an 18-inch diameter pipe routed through the powerhouse to the tailrace. Modifications to this bypass were eliminated from further review as it is not feasible to modify the existing bypass, due to existing infrastructure constraints, to pass the increased attraction flow needed to meet USFWS guidelines.

3. Empty Turbine Bay Bypass: This would involve the shut-down of one Unit, removal of the turbine and components in the path of the flow, so that the water passage could be used as a downstream passage route. This alternative was eliminated due to excessive lost generation, high passage flow velocities, and the need to still provide fish exclusion measures for the other two remaining units.

4. Replace Existing Trashracks with Close-Spaced Racks and Install New Downstream Bypass Structures: This alternative was eliminated since the approach velocities at the existing trashracks (Unit 1 – 3.2 fps, Unit 2 & 3 2.8 fps) exceed maximums recommended by USFWS guidelines (2019).

5. Seasonal Trashrack Overlays: This alternative was eliminated from further considerations as the approach velocities at the existing trashracks (Unit 1 – 3.2 fps, Unit 2 & 3 2.8 fps) exceed maximums recommended by USFWS guidelines (2019).

6. V-Rack with New Downstream Bypass Structures: This alternative was eliminated from further consideration based on recent 3D CFD modeling completed for the West Enfield Hydroelectric Project, which identified an uneven flow distribution. This undesirable condition would likely be further exacerbated by the significantly different sized units at the Brunswick Hydroelectric Project.

7. Behavioral Deterrents: Behavioral deterrents were eliminated from further consideration owing to the experimental nature of these products and limited demonstrated field success.

8. KLAWA / Low Flow Bypass (For DS Eel Passage): The KLAWA system is a bottom-oriented "zig-zag" eel bypass system. This alternative was eliminated from further consideration as this technology is still considered experimental and field studies performed to date have shown low effectiveness.

9. Conte Air Lift Bypass (For DS Eel Passage): This was eliminated from further consideration as this technology has limited application at larger hydroelectric projects.

5 METHODOLOGY AND EVALUATION CRITERIA

To support the Phase 1 screening process, alternatives identified for further analysis as potentially viable to meet downstream migratory fish passage and protection objectives at the Project must be evaluated to determine their suitability for advancement to the Phase 2 feasibility assessment.

Assessing each alternative against common evaluation criteria allows comparison of alternatives on a relative scale.

For the initial screening of alternatives, BWPH examined several key evaluation criteria including:

- Passage Effectiveness
- Safety
- Equipment Longevity
- Risk/Uncertainty
- Constructability
- Construction Costs
- Operation and Maintenance
- Impacts to Generation.

These criteria reflect the Project's key objectives and provide a consistent basis for comparing alternatives. The criteria capture the primary technical, operational, and economic considerations guiding the study and serve as the basis for comparing the relative merits of each alternative. The set of criteria are consistent with those used in similar feasibility investigations for fish passage alternatives at other hydropower projects. The criteria were summarized in a Draft Alternatives Evaluation Matrix, presented to agencies and interested parties on January 27, 2026 (Appendix B). This draft has been updated and finalized and is included in Appendix C. Conceptual sketches of alternative are contained in Appendix D.

These criteria were determined to be important factors that must be considered for any proposed passage and/or protection method. If an alternative does not meet these criteria to an acceptable degree, it is determined to be excluded from an in-depth evaluation under Phase 2. Conversely, if an alternative is expected to satisfy these criteria, it was proposed for advancement to a more in-depth evaluation in the next phase of the process, which may include 3D CFD modeling, preliminary engineering design, and preliminary costing. Each criterion is described below.

5.1 Passage Effectiveness

Estimated overall passage effectiveness is a primary component of selecting passage and protection measures. Specific effectiveness of individual components are equally important criteria, but the criterion of passage effectiveness is intended to consider the overall effectiveness of the collective measures of a given alternative. While the effectiveness of any passage and protection measure(s) will ultimately be a product of many factors (e.g., site conditions, target species behavior, etc.), existing information for each measure was used to provide an opinion of estimated overall effectiveness specific to the Project. Qualitative effectiveness estimates of high, moderate, low and experimental were assigned to each of the various alternatives based on ranges of potential percent effectiveness as follows:

- High: 90-100 percent
- Moderate: 75-90 percent
- Low: <75 percent
- Experimental: not widely implemented in the United States or validated at a large scale

5.2 Safety

The safety of each alternative considers the impact of the alternative on operating and maintenance personnel in addition to dam safety impact considerations. The assessment ranks the risk of change in operations (high, moderate, low) relative to the safety of existing conditions.

Risks to operating and maintenance personnel include:

- Site access risks, immersion, or fall hazard risks
- Sudden water release/surges
- Confined space access requirement
- Mechanical hazards
    - Moving equipment
    - Hoists or lifts
    - Equipment failure or falling loads
- Electrical hazards
    - Electrical components
    - Circuit, wiring, and grounding
- Environmental
    - Weather
    - Night/day access
- Manual handling
    - Moving equipment
    - Net, basket, fish handling
    - Debris handing

Dam safety considerations considered in this evaluation include:

- Hydraulic and Hydrologic safety
    - Impacts to spillway adequacy
    - Spillway hydraulics (capacity, control, tailwater effects)
    - Impacts on flood conveyance and routing
    - Flow transitions and energy dissipation
    - Changes to outlet works discharge characteristics
    - Erosion risk upstream/downstream or along abutments
    - Required storage operations
    - Potential for overtopping under extreme events
- Structural Stability, impact of any modification on structural stability and adequacy

5.3 Equipment Longevity

Qualitative relative rankings of high, moderate, or low equipment longevity were assigned to each passage alternative based on the anticipated service life, durability, and reliability of the primary components required for long-term implementation. These qualitative rankings reflect professional judgment informed by experience with similar downstream passage systems at hydroelectric facilities in the Northeast and elsewhere on the East Coast, and they consider the cumulative effects of hydraulic loading, debris and ice exposure, corrosion, abrasion, operational complexity, the need for seasonal installation and removal, as well as the frequency and intensity of operational demands.

Alternatives involving permanent civil or structural features with limited moving parts generally exhibit longer service lives and greater durability, while systems that rely on mechanical equipment, complex controls, or seasonally installed/removed components may experience accelerated wear and higher replacement needs. Equipment longevity is closely linked to long-term maintenance requirements, life cycle costs, and the likelihood of unplanned outages or repairs and therefore is an important factor in evaluating the overall sustainability and practicality of each downstream passage alternative.

5.4 Risk and Uncertainty

The qualitative ranking of risk and uncertainty (high, moderate, low) is intended to evaluate the degree of technical, biological, operational, and construction-related unknowns associated with each downstream passage alternative. This criterion considers the reliability of expected performance given site-specific hydraulic conditions, debris and ice loading, operational complexity, and interactions with existing powerhouse and dam infrastructure. Alternatives that rely on proven technologies, well-documented performance at similar facilities, and simple biological or engineering principles generally carry lower risk and uncertainty.

In contrast, alternatives involving untested configurations, unknown conditions, complex mechanical systems, or increased O&M demands are more likely to introduce higher levels of risk and uncertainty.

Risk and uncertainty also reflect potential challenges related to permitting, constructability, and the ability to adaptively manage unforeseen conditions, and are therefore important considerations in assessing the overall feasibility and reliability of downstream eel passage alternatives.

Qualitative estimates of high, moderate, and low were assigned to each of the various alternatives to provide a relative comparison of their risk and uncertainty.

5.5 Constructability

Constructability evaluates the feasibility and complexity of constructing a particular downstream passage alternative (difficult, moderate, easy) given site-specific constraints. This criterion considers factors such as access for construction equipment, materials, operations and maintenance (O&M), ownership constraints, worker safety, required river conditions, in-water work limitations, staging and laydown, interferences, temporary works such as cofferdam or dewatering needs, integration with existing dam and powerhouse infrastructure, and the extent of modifications to existing station operation. Alternatives that can be constructed using standard construction methods, minimize in-water work, and avoid interference with critical Project operations are generally considered more constructible (i.e. “easy” effort). In contrast, alternatives requiring complex sequencing, specialized construction techniques, extended outages, significant in-water work, or work in challenging hydraulic or limited-access areas are associated with more difficult construction (i.e. a “difficult” effort). Constructability is an important consideration in evaluating the overall practicality of downstream passage alternatives. Qualitative estimates of difficult, moderate, and easy were assigned to each of the various alternatives to provide a relative comparison of their constructability.

5.6 Construction Costs

Construction cost estimates were not prepared in this Phase 1 effort. Construction costs are based on the following qualitative estimates as high, moderate, and low assigned to each of the various alternatives based on their relative constructability and the potential value of their estimated construction cost.

- High: > $8M
- Moderate: > $5M but < $8M
- Low: < $5M

5.7 Operation and Maintenance Costs

O&M costs, also known as recurring costs, are an important consideration for any permanent downstream passage measure. This is an especially useful category for decision making purposes when combined with equipment longevity and construction costs.

The O&M cost criterion was assessed in relative terms: high, moderate, or low. These opinions were based on professional engineering judgment and experience of deploying various structures and equipment in rivers throughout the United States, along with input from BWPH operations staff. The qualitative estimates of high, moderate, and low were assigned to each of the various alternatives based on the following ranges of potential value of the estimated O&M costs.

- High: > $100,000/year
- Moderate: > $30,000 but < $100,000/year
- Low: < $30,000/year

5.8 Impact to Generation

Impacts to Project generation were assessed in relative terms: high, moderate, or low.

The alternatives evaluated for this study are expected to have varying impacts on Project generation depending on the flows utilized through the generating units or through the fish passage facilities.

- High: > $100,000/year
- Moderate: > $30,000 but < $100,000/year
- Low: < $30,000/year

6 ALTERNATIVES EVALUATION

As part of Phase 1 of the Downstream Fish Passage Conceptual Alternatives Study, BWPH conducted an initial screening of downstream fish passage alternatives described in Section 4.1.

In the following sections, the primary alternatives that were considered for the evaluation are described in detail and assessed for viability to be advanced for further evaluation in Phase 2. Other alternatives that were considered, but did not receive detailed evaluation, are also discussed.

6.1 Alternative D1 Angled Bar Rack with New Downstream Bypass

This downstream fish passage alternative consists of installing a new, full-depth angled bar trashrack with close-spaced (3/4-inch clear) trashracks upstream of the existing intake structures to guide fish safely toward dedicated bypass facilities. The trashrack would extend approximately 140 feet upstream of the intake and be oriented at a 45-degree angle to direct flow and fish movement laterally.

The Unit 1 intake would be approximately 80 feet wide by 35 feet deep, while the combined intake for Units 2 and 3 would be approximately 68 feet wide by 20 feet deep; both configurations would be designed to maintain an average approach velocity of about 1.8 fps. An isolation wall between Units 1 and 2 would be required to allow for the deeper intake in front of Unit 1.

At the downstream end of the angled trashracks, a new surface bypass would be constructed on the south side of the spillway adjacent to the powerhouse to provide safe downstream passage for surface-oriented species. A low-level bypass would be incorporated at the same location to facilitate downstream eel passage, with flows routed to a surface weir adjacent to the surface bypass system. The total bypass flow would be approximately 375 cfs, representing about 5 percent of station discharge. Bypassed fish would be discharged directly into the tailrace downstream of the spillway, provided sufficient depth is available; otherwise, a plunge pool meeting USFWS criteria would be constructed. Debris management would be addressed through installation of a new mechanical trash rake system to maintain trashrack performance and functionality.

6.1.1 Evaluation of Criteria

6.1.1.1 Passage Effectiveness

Passage effectiveness of this alternative for downstream passage is considered high. The close-spaced trashracks would greatly reduce entrainment through the turbine intakes and also improve the protection of upstream migrating fish exiting the existing upstream fish ladder.

6.1.1.2 Safety

Changes in safety compared to existing conditions is considered moderate. The new trashrack will accumulate more debris and more frequent debris raking operations will be required. Periodic dive inspections will be needed for cleaning the new trashracks and the low level bypass.

6.1.1.3 Equipment Longevity

The longevity of equipment for this alternative is considered high, as the new trashracks and new trash rake require normal routine maintenance and will routinely last 30 to 50 years (ASCE 2007).

6.1.1.4 Risks and Uncertainty

Risks and uncertainties associated with operation of this alternative are considered generally low, as the proposed close-spaced trashracks introduce minimal unknowns beyond the potential for increased debris accumulation described previously. However, several design and operational considerations remain. The placement of the bypass structures has the potential to affect overall spillway discharge capacity. As a result, modifications to the spillway may be necessary to ensure that existing discharge capacity is maintained and that neither the 100-year flood elevation nor the Inflow Design Flood (IDF) elevation is adversely impacted.

Additionally, the new intake structure may interfere with the exit conditions of the existing upstream passage facility, and localized modifications may be required to integrate the new intake wall without disrupting passage functionality. There is also a potential for hydraulic "hot spots" to develop near the downstream end of the trashrack, as well as other locations along the trashrack, which could create unfavorable flow conditions. CFD modeling will be conducted as part of the Phase 2 analysis to evaluate these effects and confirm the overall feasibility and performance of this alternative.

6.1.1.5 Constructability

Constructability of this alternative is considered difficult. A large cofferdam will likely be required to facilitate construction activities, which introduces significant complexity in both design, construction access, and installation. In addition, any necessary modifications to the spillway would be particularly challenging, as they would likely require construction from a barge along with the installation of upstream flood protection measures to isolate the work area.

If a plunge pool is required for the downstream passage, its construction would also necessitate the use of a cofferdam, adding to the overall difficulty and cost of implementation.

These factors contribute to a more complex and resource-intensive construction process for this alternative.

6.1.1.6 Construction Costs

Construction costs for this alternative are considered high due to the number of major components and supporting systems required.

Significant costs are associated with construction of the new intake structure, as well as the installation of both low-level and surface bypass structures. Additional expenses include procurement and installation of a new trash rake system, along with the necessary electrical supply infrastructure modifications to operate the bypass gates and trash rake.

Further cost uncertainty is introduced by the potential need for spillway modifications, which could be complex. If a plunge pool is determined to be necessary, its construction would add another substantial cost component.

Collectively, these elements contribute to the overall high costs for this alternative.

6.1.1.7 Operations and Maintenance

O&M costs associated with this alternative are considered high. This is primarily due to the need for more frequent trashrack raking and debris handling, which represents an increase in labor and equipment use. Close-spaced trashracks also present greater potential for icing and frazil ice accumulation during winter operations. The reduced bar spacing increases the likelihood of frazil ice bridging between adjacent bars, allowing blockages to develop more rapidly and increasing the need for winter monitoring and maintenance

(CRREL 1992). Close-spaced trashracks complicate cold-weather operations and may require additional mitigation measures to maintain functionality during periods of ice.

Effectiveness testing will be required to confirm that the system performs as intended, particularly with respect to flow conditions and fish passage. These testing requirements, combined with elevated routine maintenance demands, contribute to the overall higher O&M cost profile for this alternative.

6.1.1.8 Impacts to Generation

The impacts to power generation associated with this alternative are considered high. Generation losses are expected due to the increased attraction flow requirements, which divert water away from power production. Additional energy losses will likely occur due to increased head losses across the close-spaced trashracks, particularly during periods of elevated debris loading. There is also an increased potential for impacts from ice and frazil ice, which could further reduce operational efficiency and generation reliability during colder periods.

6.2 Alternative D2 Inclined Bar Rack with New Downstream Bypass

This downstream fish passage alternative would involve installing new, full-depth inclined bar trashracks with close-spaced (3/4-inch clear) trashracks upstream of the existing intake structures to guide fish toward bypass facilities. Due to the greater water depth in front of Unit 1, separate inclined trashrack structures would be constructed for Unit 1 and for Units 2 and 3, with both trashrack systems oriented at a 45-degree inclination. The Unit 1 intake would be approximately 55 feet wide and extend about 55 feet upstream of the existing intake, resulting in an average approach velocity of approximately 1.7 fps. CFD modeling will be conducted as part of the Phase 2 analysis to further evaluate velocities at the trashracks. The intake for Units 2 and 3 would be approximately 48 feet wide and extend about 35 feet upstream, resulting in an average approach velocity of approximately 1.8 fps.

The new bypass facilities would be constructed with entrances/openings in the face of the inclined trashracks with conduits running behind the trashracks to a discharge on the north side of the powerhouse to provide effective downstream passage. Bypass facilities would include both low-level and surface entrances. The total bypass flow would be approximately 375 cfs, or about 5 percent of station discharge.

Fish passing through the bypass system would be discharged directly into the tailrace downstream of the spillway if adequate depth is available; otherwise, a plunge pool meeting USFWS criteria would be provided. To ensure reliable operation and minimize debris accumulation, a new mechanical trash rake system would be installed as part of the alternative.

6.2.1 Evaluation of Criteria

6.2.1.1 Passage Effectiveness

Passage effectiveness of this alternative for downstream passage is considered high. The close-spaced trashracks greatly reduce entrainment through the turbine intakes and also improves the protection of upstream migrating fish exiting the existing upstream fish ladder.

6.2.1.2 Safety

Changes in safety compared with the existing condition is considered moderate. More frequent debris raking operations are required. Due to higher debris accumulation on the trashracks, more frequent dive inspections will need to be performed on the trashracks, as well as an increased frequency of sediment and large debris removal. Periodic dive inspections will also be needed for cleaning debris from around the low level bypass.

6.2.1.3 Equipment Longevity

The longevity of equipment for this alternative is considered high. New trashracks and trash rake require normal routine maintenance and will routinely last 30 to 50 years (ASCE 2007).

6.2.1.4 Risks and Uncertainty

Risks and uncertainties associated with operation of this alternative are considered moderate. This technology has not been widely used in the United States and is still considered experimental, therefore it has a slightly higher assessed risk than Alternative D1.

Similar to Alternative D1, the inclined close-spaced trashracks introduce few unknowns beyond the potential for increased debris accumulation described previously, however similar design and operational considerations remain. The placement of the bypass structures has the potential to affect overall spillway discharge capacity if modifications impact the spillway. Modifications to the spillway may be necessary to ensure that discharge capacity is maintained and that neither the 100-year flood elevation nor the IDF elevation is adversely impacted.

Additionally, the new intake structure may interfere with the exit conditions of the existing upstream passage facility, and localized modifications may be required to integrate the new intake without disrupting passage functionality. There is also a potential for hydraulic “hot spots” to develop along the trashrack, which could create unfavorable flow conditions. CFD modeling will be conducted as part of the Phase 2 analysis to evaluate these effects and confirm the overall feasibility and performance of this alternative.

6.2.1.5 Constructability

Constructability of this alternative is considered difficult due to several key challenges. A large cofferdam will likely be required to facilitate construction activities, which introduces significant complexity in both design, construction access, and installation.

Surface and low level openings in the close-spaced trashracks will be needed with a downstream conveyance conduit along and behind the trashracks leading to passage over/through the spillway on the north side of the powerhouse, discharging to the tailrace. The trashrack openings, conduits, and discharge to the tailrace add complexity to this alternative. In addition, any necessary modifications to the spillway would be particularly challenging, as they would likely require construction from a barge or behind a cofferdam, along with the installation of upstream flood protection measures to isolate the work area. If a plunge pool is required for the downstream passage, its construction would also necessitate the use of a cofferdam, adding to the overall difficulty and cost of implementation.

The trash rake is anticipated to be a custom rake, required to accommodate the inclined angle, depth, and long reach necessary to maintain the inclined bar trashracks.

These factors collectively contribute to a more complex and resource-intensive construction process for this alternative.

6.2.1.6 Construction Costs

Construction costs for this alternative are considered high due to the number of major components and supporting systems required. Significant costs are associated with construction of the new intake structure, as well as the installation of both low-level and surface bypass structures. Additional expenses include procurement and installation of a new custom trash rake system, along with the necessary electrical supply infrastructure modifications to operate the bypass gates and trash rake.

Further cost uncertainty is introduced by the potential need for spillway modifications, which could be complex. If a plunge pool is determined to be necessary, its construction would add another substantial cost component.

Collectively, these elements contribute to the overall high cost estimate for this alternative.

6.2.1.7 Operations and Maintenance

O&M costs associated with this alternative are considered moderate to high. This is primarily due to the need for more frequent trashrack raking and debris handling, which represents an increase in labor and equipment use. There is an increased potential for impacts from icing and frazil ice, which could complicate operations and require additional monitoring and mitigation measures during colder conditions.

Effectiveness testing will be required to confirm that the system performs as intended, particularly with respect to flow conditions and fish passage. These testing requirements, combined with elevated routine maintenance demands, contribute to the overall higher O&M cost profile for this alternative.

6.2.1.8 Impacts to Generation

The impacts to power generation associated with this alternative are considered moderate. Generation losses are expected due to the additional attraction flow requirements, which divert water away from power production. Additional energy losses will likely occur due to increased head losses across the close-spaced trashracks, particularly during periods of elevated debris loading.

There is also an increased potential for impacts from ice and frazil ice, which could further reduce operational efficiency and generation reliability during colder periods.

6.3 Alternative D3 - Floating Guidance Boom with a New Downstream Surface Bypass and Nighttime Shutdowns

This downstream fish passage alternative would involve installing a 10-foot-deep floating fish guidance boom (e.g., Pacific Netting Products (PNP) or Worthington) to direct fish away from the powerhouse intake area and toward a controlled surface bypass. The boom would extend from the north side of the powerhouse to the shoreline at approximately a 35-degree angle, guiding surface-oriented fish laterally toward the downstream bypass location.

A new surface bypass would be constructed at the downstream end of the guidance boom on the south side of the spillway adjacent to the powerhouse to provide a safe downstream passage route. Because the floating boom provides only partial-depth guidance, a low-level bypass would not be included as part of this alternative.

To address downstream passage of American eel, nighttime generation shutdowns would be implemented during the peak eel migration season. Downstream eel migration generally occurs during late summer and fall, with movement concentrated during nighttime hours, particularly on dark, rainy, and high-flow nights. Generating units would be shut down from approximately 8:00 p.m. to 5:00 a.m. during the peak migration period. This operation measure would eliminate nighttime turbine mortality risk and would reduce the potential for eel impingement on the trashracks. During the shutdown periods, project inflows would be routed through the downstream bypass facility, spill gates, and/or over the spillway, depending on river flows, providing downstream migrants with non-turbine passage routes. Because the majority of downstream eel passage occurs at night, the shutdown periods are expected to protect most migrating eels passing the Project. The total bypass flow would be approximately 375 cfs, representing about 5 percent of station discharge. Fish utilizing the bypass would be discharged directly into the tailrace downstream of the spillway if adequate depth is available; otherwise, a plunge pool meeting USFWS criteria would be constructed to ensure safe outfall conditions.

6.3.1 Evaluation of Criteria

6.3.1.1 Passage Effectiveness

The passage effectiveness of this alternative is low.

There is the potential for downstream migrants to sound below the guidance boom which would result in lower effectiveness when compared to other full depth exclusion measures. Earlier CFD modeling of a similar alternative developed by Blue Hill Hydraulics, Inc., showed poor guidance at the downstream end of the boom indicating reduced effectiveness.

The boom would be ineffective at influencing downstream migrating eels; therefore nighttime unit shutdowns would be required as part of this alternative.

6.3.1.2 Safety

Changes in safety compared with the existing condition are considered high due to several operational and maintenance challenges.

Because of safety concerns related to installing and managing the boom annually during high-flow conditions, the boom system would be designed for year-round deployment. To mitigate the risk of structural damage under extreme loading conditions, shear pins would be incorporated into the design to fail the boom in a controlled manner to protect the system. The design approach introduces additional maintenance requirements, as periodic boat access would be necessary to reset the boom following extreme loading events.

Further safety considerations arise from the potential for debris accumulation along the catenary of the guidance boom, which would require routine removal using boat access. In addition, periodic dive inspections would be needed to address biofouling on the boom, introducing inherent risks associated with water and underwater work.

These combined factors contribute to the elevated safety risk profile for this alternative.

6.3.1.3 Equipment Longevity

The longevity of this alternative is considered low.

The existing intake and trashracks would remain in place, continuing their service life. The floating guidance boom is more susceptible to damage from high flow, debris, and ice, and as such is considered to have a shorter longevity and higher maintenance requirements.

6.3.1.4 Risks and Uncertainty

The risk and uncertainty of this alternative is considered moderate.

The location of the downstream bypass structure may impact the spillway discharge capacity. Modifications to the spillway may be required to maintain the discharge capacity and prevent impacting the 100-year flood elevation or the IDF elevation.

The guidance boom may impact upstream migrants that would need to sound below the guidance boom as they move upriver. An extension to the existing upstream fishway exit may be required to reduce impacts to upstream passage.

6.3.1.5 Constructability

Constructability of this alternative is considered moderate, with several logistical and site-specific challenges. Installation of the guidance boom will require the use of a crane in combination with personnel working on the water to properly position and secure the boom sections. This introduces coordination requirements and safety considerations associated with in-water construction activities.

Construction of new anchor blocks could result in temporary impacts to mill building parking, requiring coordination to manage site access and minimize disruptions. In-water anchors (in addition to the end anchorage) may be necessary to provide adequate resistance against debris and ice loading, adding complexity to the construction and installation process.

Any required modifications to the spillway would further increase constructability challenges, as such work would likely need to be performed from a barge and may require the installation of temporary flood protection measures.

6.3.1.6 Construction Costs

Construction costs for this alternative are considered low, as the primary cost components are relatively smaller in scope compared to more infrastructure-intensive options. Costs include the supply and installation of the guidance boom, as well as the construction of associated anchorages required to secure the system.

Additional costs are associated with the construction of a new surface bypass structure and the electrical supply required to operate the bypass gate. Some cost uncertainty remains due to the potential need for spillway modifications and the construction of a plunge pool; however, these elements are considered secondary and may not be required depending on final design. Overall, the relatively simple structural requirements contribute to a lower overall construction cost profile for this alternative.

6.3.1.7 Operations and Maintenance

O&M costs associated with this alternative are considered high due to the ongoing and labor-intensive maintenance requirements. Divers will be required for periodic cleaning of the guidance boom to address biofouling and maintain proper functionality, introducing both cost and safety considerations. The boom may need to be removed seasonally or reset following extreme flow events, requiring further intervention and coordination involving crane and barge access.

Routine debris removal will also be necessary to prevent accumulation that could impact performance. Routine O&M may occur as a result of periodic or nighttime shutdowns.

Finally, effectiveness testing will be required to confirm that the system operates as intended.

These combined factors result in a high O&M cost profile for this alternative.

6.3.1.8 Impacts to Generation

Generation impacts associated with this alternative are considered high. Generation losses will occur as a result of seasonal nighttime shutdown of generation during the later summer and fall. Additional generation losses are expected due to increased downstream passage flows and spill, which divert water away from power production.

6.4 Alternative D4, Natel FishSafe™ Turbines

FishSafe™ Fish-friendly turbine passage alternatives were evaluated using equipment developed by Natel. Natel is a U.S. based hydropower technology company that develops high-performance turbines designed to modernize existing facilities while providing fish passage through the generating unit. Natel has patented the FishSafe™ Restoration Hydro Turbine (RHT), which uses thick, forward-swept blades that enable fish to pass safely through the turbine, with independent testing demonstrating 98 to 100 percent downstream fish survival across multiple species, including American Eel, salmonids, and juvenile alosines. The turbines are designed for fish survival during turbine passage by minimizing strike, pressure changes, and shear forces. As such, passage through the turbine is expected to be safe, timely, and effective passage. The turbine design maintains high hydraulic efficiency while reducing the need for fish screens and bypass systems, lowering both environmental impacts and life cycle costs and reducing delay and risks for the downstream migrants.

BWPH has contracted with Natel to conduct a preliminary feasibility study to support evaluation of alternatives in Phase 2 of the downstream studies.

6.5 Alternative D4A - Multiple FishSafe™ Runner Replacements

This downstream fish passage alternative would consist of replacing the existing turbine runners in all three generating units with Natel FishSafe™ runners, The existing intake trashracks, consisting of 3-1/2-inch clear spacing, would remain in place with no modifications required.

No additional downstream fish passage or protection measures, such as guidance structures or bypass systems, would be included as part of this alternative as downstream fish passage would rely entirely on downstream passage through the upgraded FishSafe™ turbine units. Existing debris management systems associated with the powerhouse trashracks would continue to be used without modification to maintain intake performance.

6.5.1 Evaluation of Criteria

6.5.1.1 Passage Effectiveness

The passage effectiveness of this alternative for downstream fish passage is experimental but anticipated to be high. This turbine type is considered experimental, but is gaining preliminary agency acceptance and is anticipated to be highly efficient. Note that the turbine survival rates depend on fish species, size, type of turbine, and site-specific hydraulic conditions.

A preliminary feasibility study by Natel will be required to further assess this alternative and will be addressed in the Phase 2 downstream study.

6.5.1.2 Safety

Changes in safety compared with the existing condition is considered low. There will be little operational changes as a result of implementation of the new units.

6.5.1.3 Equipment Longevity

The longevity of this alternative is considered high. New units are expected to have a normal service life, which is typically a minimum of a 50-year service life (ASCE 2007) with periodic maintenance every 20 to 30 years.

6.5.1.4 Risks and Uncertainty

Risks and uncertainty associated with this alternative are considered high due to the experimental nature of the alternative. While the FishSafe™ technology is gaining preliminary acceptance from regulatory agencies, it has not yet been widely implemented or validated at a large scale. As a result, there remains a significant level of uncertainty regarding its overall effectiveness and performance under varying site conditions. Further large-scale testing and evaluation will be required to better quantify its reliability and long-term viability.

6.5.1.5 Constructability

The runner replacement is anticipated to be a relatively easy conversion. This criterion is anticipated to be evaluated in detail in Phase 2 of the study.

6.5.1.6 Construction Costs

Construction costs for this alternative are considered moderate. Costs will involve the supply and installation costs of new runners with risks to cost and timing dependent on supply chain availability.

The installation of the FishSafe™ units will provide downstream fish passage and additional downstream passage facilities are not required. Modifications to the existing structures and costs for the installation will be evaluated in Phase 2.

6.5.1.7 Operations and Maintenance

O&M costs associated with this alternative are considered low. Maintenance of new units would be similar to maintenance of existing units. The FishSafe™ installation will eliminate the O&M of other downstream bypass structures.

6.5.1.8 Impacts to Generation

Impacts to generation are unknown but likely to be low. These turbine upgrades are expected to perform as well or slightly more efficiently and will eliminate the need for downstream bypass flows, resulting in increased generation. The feasibility study by Natel in Phase 2 will be required to fully assess this criterion.

6.6 Alternative D4B Unit 1 FishSafeTM Runner Replacement, with Inclined Bar Rack at Units 2 and 3

This downstream passage Alternative D4B focuses on targeted turbine and intake modifications to improve fish passage conditions while relying primarily on existing infrastructure. The measure includes replacing the Unit 1 turbine runner with a Natel FishSafe™ runner to enhance downstream fish survival. At Units 2 and 3, an inclined bar trashrack with closely spaced (3/4-inch clear) trashracks would be installed upstream of the existing intake, extending approximately 35 feet upstream and spanning about 48 feet in width. This configuration would result in an average approach velocity of approximately 1.8 fps at the Units 2 and 3 intake. CFD modeling will be conducted as part of the Phase 2 analysis to further evaluate velocities at the trashracks. To support operations and maintain trashrack performance, a new mechanical rake system would be installed for debris management.

The existing 3.5-inch clear intake trashracks at Unit 1 would remain unchanged, and no additional downstream passage or fish protection measures would be incorporated beyond the turbine upgrade and new screening system at Units 2 and 3. As Project inflows exceed the discharge capacity of Unit 1 approximately 48% of the downstream passage season, Units 2 and 3 would be screened, with Unit 1 providing downstream passage.

Planned and unplanned outages of Unit 1 will be evaluated within Phase 2 of the studies. Unit 1 planned maintenance would be scheduled for periods outside of the downstream passage season, having no impact on passage. Unplanned outages of Unit 1 within the fish passage season would likely result in the release of the Unit 1 downstream passage flow through gated releases and/or spill.

6.6.1 Evaluation of Criteria

6.6.1.1 Passage Effectiveness

The passage effectiveness of this alternative for downstream fish passage is experimental but anticipated to be high. This turbine type is considered experimental, but is gaining preliminary agency acceptance and is anticipated to be highly efficient. Note that the turbine survival rates depend on fish species, size, type of turbine, and site-specific hydraulic conditions.

A feasibility study by Natel is being conducted to fully assess this alternative and will be addressed in the Phase 2 downstream study.

The Natel turbine would become the primary downstream passage and other downstream facilities would not be required, boosting effectiveness with Unit 1's large attraction flows.

6.6.1.2 Safety

Changes in safety compared with the existing condition is considered moderate. More frequent debris raking operations will be required for the close-spaced trashracks for Units 2 and 3, contributing to increased safety risks.

6.6.1.3 Equipment Longevity

6.6.1.4 The longevity of this alternative is anticipated to be moderate to high. The new turbine Unit 1 is expected to have a normal service life, which is typically a minimum of a 50-year service life (ASCE 2007) with periodic maintenance every 20 to 30 years. The longevity of new trashracks and a new trash rake require normal routine maintenance and will routinely last 30 to 50 years (ASCE 2007). Risks and Uncertainty

Risks and uncertainty associated with this alternative are considered high due to the experimental nature of the alternative. While the FishSafe™ technology is gaining preliminary acceptance from regulatory agencies, it has not yet been widely implemented or validated on a large scale. As a result, there remains a significant level of uncertainty regarding its overall effectiveness and performance under varying site conditions. Further large-scale testing and evaluation will be required to better quantify its reliability and long-term viability.

The inclined trashracks technology has not been widely used in the United States and is also still considered experimental, therefore it has a slightly higher assessed risk than an angled trashrack. The inclined close-spaced trashracks for Units 2 and 3 introduce few unknowns beyond the potential for increased debris accumulation described previously.

6.6.1.5 Constructability

The constructability of the inclined trashrack is anticipated to be difficult.

Construction of the new intake structure will likely require installation of a large cofferdam to provide a dry and stable work environment, which could increase construction complexity, schedule duration, and overall project costs. The inclined trashrack configuration may necessitate a custom-designed trash rake system to ensure effective debris removal and reliable operation, as standard equipment may not be suitable for the proposed trashrack angle. These factors should be considered during design development and constructability planning to minimize implementation risks.

Replacement of the existing runner is anticipated to be a relatively straightforward conversion with limited constructability concerns. However, the installation approach, required outages, equipment access, and potential modifications to existing components will be evaluated in greater detail during Phase 2 of the study to confirm feasibility and identify any Project-specific constraints or risks.

6.6.1.6 Construction Costs

The construction costs are considered to be moderate to high.

The alternative involves installation of a new Unit 1 and close-spaced trashracks for Unit 2, and 3. The intake costs will include cofferdamming, dewatering and construction costs of a new intake structure and trashracks. The costs will include a new trash rake for the trashracks, as well as new electrical supply for the trash rake. These factors present moderate to high costs to the project.

The powerhouse costs will include the supply and installation cost of new runner. The installation of the FishSafe™ unit will provide downstream fish passage, and additional downstream passage facilities are not required.

6.6.1.7 Operations and Maintenance

The operation and maintenance costs are considered to be moderate.

More frequent raking and debris handling will be required for the close-spaced trashracks at Units 2 and 3. There is an increased potential for ice impacts and frazzle ice impacts on the Unit 2 and 3 trashracks. The new trash rake will need to have a large reach to provide effective debris management.

Maintenance of new Unit 1 would be similar to maintenance of new existing units. The FishSafe™ installation will eliminate other downstream bypass structures requirements.

Effectiveness testing will be required. These factors are likely to create moderate costs for O&M.

6.6.1.8 Impacts to Generation

Impacts to generation are unknown but likely to be low. There will be slightly higher headlosses from the new close-spaced trashracks and more frequent debris accumulation for Units 2 and 3, resulting in a reduction in generation.

The impacts to generation from the Unit 1 replacement are likely to be an energy gain, but are unknown at this time with a feasibility study by Natel in Phase 2 required to fully assess benefits. This alternative will eliminate the need for downstream bypass flows, which will result in increased generation. These factors are anticipated to have little or no risk to generation.

6.7 Alternative D4C Unit 1 FishSafe™ Runner Replacement, with Angled Bar Rack at Units 2 and 3

This alternative is similar to Alternate D4B, with the difference that the Unit 2 and 3 trashrack would be angled. The angle would direct fish toward the Unit 1 FishSafe™ turbine passage.

6.7.1 Evaluation of Criteria

6.7.1.1 Passage Effectiveness

The passage effectiveness of this alternative for downstream fish passage is experimental but anticipated to be high.

The angled trashrack is expected to help guide migrants toward the FishSafe RHT turbine and safer passage. The Natel turbine would become the primary downstream passage route and other downstream facilities would not be required, boosting effectiveness with Unit 1's large attraction flows.

This turbine type is considered experimental, but is gaining preliminary agency acceptance and is anticipated to be highly efficient. Note that the turbine survival rates depend on fish species, size, type of turbine, and site-specific hydraulic conditions. A feasibility study by Natel will be required to fully assess this alternative and will be addressed in the Phase 2 downstream study.

6.7.1.2 Safety

The safety of this alternative is considered to be moderate. More frequent debris raking operations will be required for the close-spaced trashracks for Units 2 and 3, and will have higher O&M contributing to an increased safety risk.

6.7.1.3 Equipment longevity

The longevity of this alternative is anticipated to be moderate to high. The new turbine unit is expected to have a normal service life, which is typically a minimum of a 50-year service life (ASCE 2007) with periodic maintenance every 20 to 30 years.

The longevity of new trashracks and new trash rake require normal routine maintenance and will routinely last 30 to 50 years (ASCE 2007).

6.7.1.4 Risks and Uncertainty

Risks and uncertainty associated with this alternative are considered high due to the experimental nature of the alternative. While the FishSafeTM technology is gaining preliminary acceptance from regulatory agencies, it has not yet been widely implemented or validated on a large scale. As a result, there remains a significant level of uncertainty regarding its overall effectiveness and performance under varying site conditions. Further large-scale testing and evaluation will be required to better quantify its reliability and long-term viability.

CFD modeling is needed to confirm the feasibility of this alternative, as potential velocity "hot spots" may exist on the proposed trashrack structure. This trashrack alternative introduces few unknowns beyond the potential for increased debris accumulation.

6.7.1.5 Constructability

The constructability of this alternative is anticipated to be difficult.

A large cofferdam will be required to facilitate construction of the new intake structure. A new trash rake will be required to accommodate the new trashrack.

Replacement of the existing runner is anticipated to be a relatively straightforward conversion with limited constructability concerns. However, the installation approach, required outages, equipment access, and potential modifications to existing components will be evaluated in greater detail during Phase 2 of the study to confirm feasibility and identify any Project-specific constraints or risks.

6.7.1.6 Construction Costs

The construction costs for this alternative are considered moderate to high. The alternative involves installation of a new Unit 1 and close-spaced trashracks for Unit 2, and 3 which will have high construction costs. The intake costs will include a cofferdam, dewatering and construction costs of a new intake structure and trashracks. The costs will include a new trash rake for the trashracks, as well as new electrical supply for the trash rake.

The powerhouse costs will include the supply and installation cost of the new turbine runner. The installation of the FishSafe™ unit will provide downstream fish passage and additional downstream passage facilities are not required, resulting in a relative costs savings.

6.7.1.7 Operations and Maintenance

The O&M costs are considered to be moderate.

More frequent raking and debris handling will be required for the close-spaced trashracks at Units 2 and 3. There is an increased potential for ice impacts and frazzle ice impacts on the Unit 2 and 3 trashracks. Effectiveness testing will be required. The new trashracks were angled toward Unit 1 to facilitate guidance of fish to the FishSafe™ turbine and downstream passage. The upstream angle may “trap” more debris and increase debris management requirements. The CFD modeling conducted in Phase 2 will inform the design and identify risks.

Maintenance of new Unit 1 would be similar to maintenance of existing units. The FishSafeTM installation will eliminate other downstream bypass structures requirements, resulting in a relative reduction in O&M.

6.7.1.8 Impacts to Generation

Impacts to generation are unknown but likely to be low. There will be slightly higher headlosses from the new close-spaced trashracks and more frequent debris accumulation for Units 2 and 3, resulting in a reduction in generation.

The impacts to generation from the Unit 1 replacement are likely to be an energy gain, but are unknown at this time with a feasibility study by Natel in Phase 2 required to fully assess any benefits.

This alternative will eliminate the need for downstream bypass flows, which will result in increased generation.

7 PHASE 1 SUMMARY AND PHASE 2 EVALUATION

While Phase 1 was initially intended to identify a limited number of downstream alternatives for advancement, the evaluation process identified multiple potential viable alternatives that do not initially exhibit fatal flaws and represent differing approaches to downstream fish passage at the Project. These alternatives include structural guidance and bypass systems, behavioral guidance approaches, and turbine-based passage solutions. Each alternative presents unique advantages, tradeoffs, and uncertainties that cannot be fully resolved through conceptual-level screening.

Phase 1 cost evaluations were not developed, and cost considerations were limited to qualitative rankings (high, moderate, low) based on engineering judgment. These qualitative assessments are not sufficient to support investment-level or FERC licensing decisions. Given the potentially significant differences in capital cost, operation and maintenance costs, and generation impacts among the alternatives, development of preliminary (Class 4 or 5) cost estimates in Phase 2 is necessary to inform decision-making.

Phase 1 evaluations were conducted at a conceptual level and, while sufficient for identifying fatal flaws, cannot reliably predict detailed hydraulic performance. Many of the critical uncertainties identified in Phase 1—such as flow distribution, velocities, guidance effectiveness, attraction efficiency, and potential velocity "hot spots"—are inherently dependent on 3D CFD analysis.

As a result, advancing all remaining viable alternatives into Phase 2 is warranted to ensure a comprehensive, transparent, and technically defensible evaluation process. Eliminating additional alternatives at this stage, based solely on qualitative screening, would risk prematurely excluding options that may ultimately provide the best balance of biological performance, constructability, cost, and operational impacts once evaluated in greater detail. In particular:

- Several alternatives (e.g., angled versus inclined trashracks, hybrid turbine/rack configurations, and turbine-only solutions) exhibit comparable qualitative performance in Phase 1 but differ in design complexity, hydraulic performance, and operational implications.
- Phase 2 will incorporate results of the Natel FishSafe™ turbine feasibility study to further define performance, constructability, and operational considerations.
- Certain technologies (e.g., FishSafe™ turbines and inclined trashracks) are considered promising but carry higher uncertainty, requiring further technical validation and evaluation of associated civil modifications.
- Agency and other stakeholder input emphasized the importance of maintaining a broad range of options going into Phase 2 to support informed decision-making and regulatory acceptance.

Accordingly, advancing the full suite of viable alternatives into Phase 2 aligns with the study objectives and the FERC Integrated Licensing Process. The Phase 2 effort incorporating CFD modeling, Natel FishSafe™ turbine feasibility study, and development of preliminary cost estimates, will provide the technical and economic basis necessary to support a fully informed and defensible selection of a preferred downstream passage alternative.

8 REFERENCES

ASCE (American Society of Civil Engineers). (2007). Civil Works for Hydroelectric Facilities: Guidelines for Life Extension and Upgrade. Reston, VA: American Society of Civil Engineers.

Bell, Milo C. 1990, Fisheries Handbook of Engineering Requirements and Biological Criteria, U.S. Army Corps of Engineers, 1990.

United States Army Corps of Engineers CRREL Report 92-16, Andersson & Daly (1992), "Laboratory Investigation of Trash Rack Freezeup by Frazil Ice"

United States Fish and Wildlife Service (USFWS). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

APPENDIX A–FLOW DURATION CURVES

Figure A-1. Annual Flow Duration Curve (1987-2025)

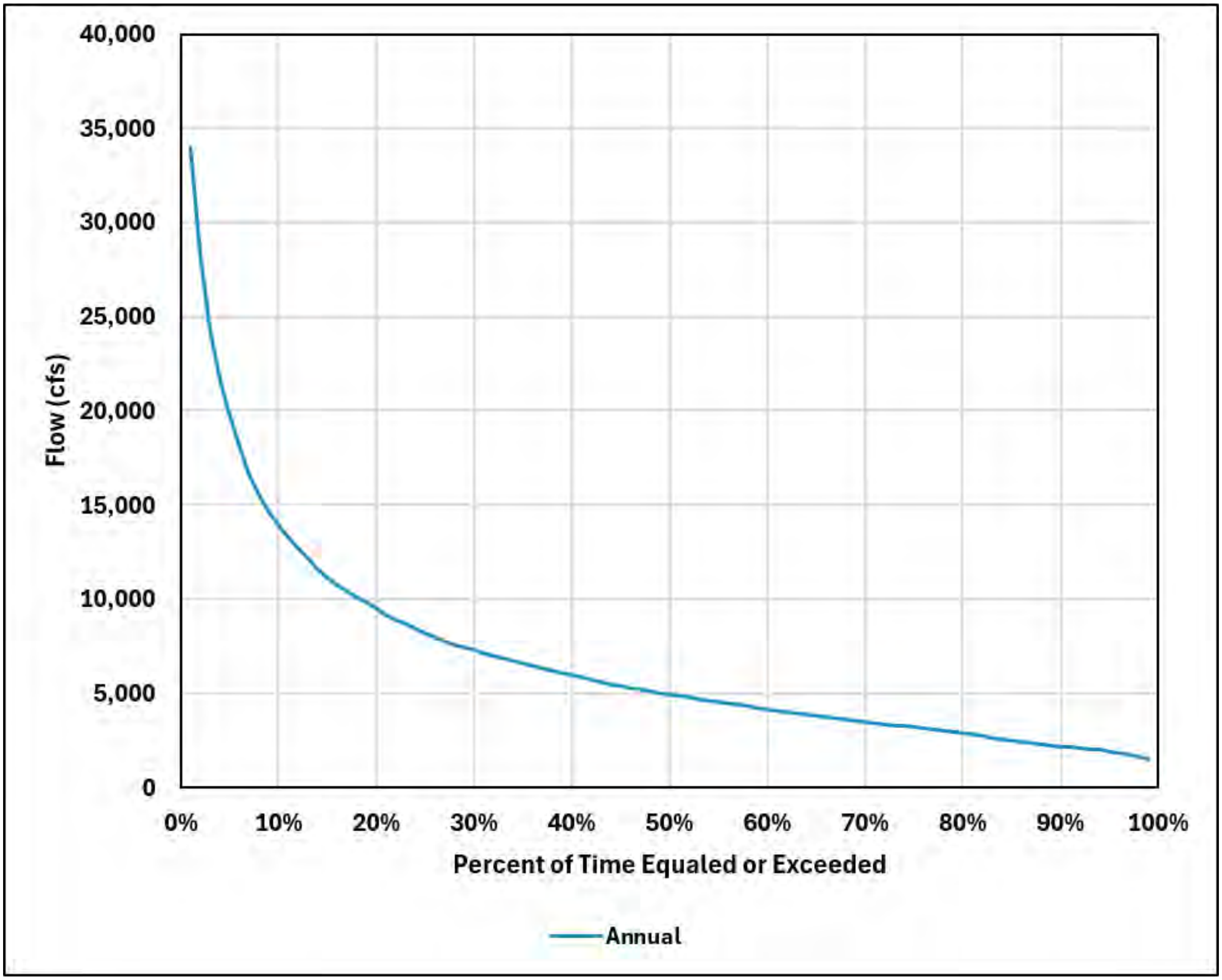


Figure A-2. January, February, and March Flow Duration Curve (1987-2025)

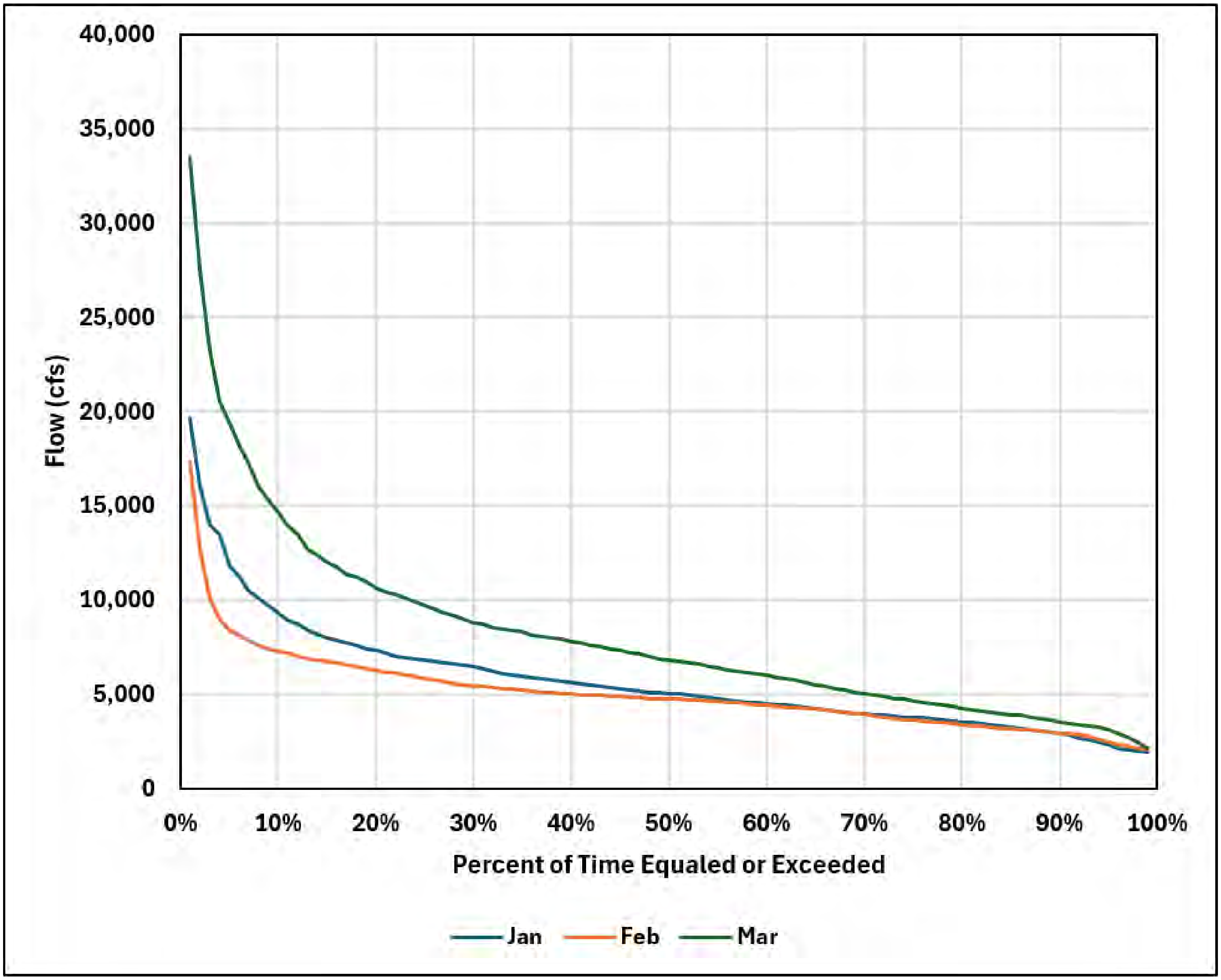


Figure A-3. April, May, and June Flow Duration Curve (1987-2025)

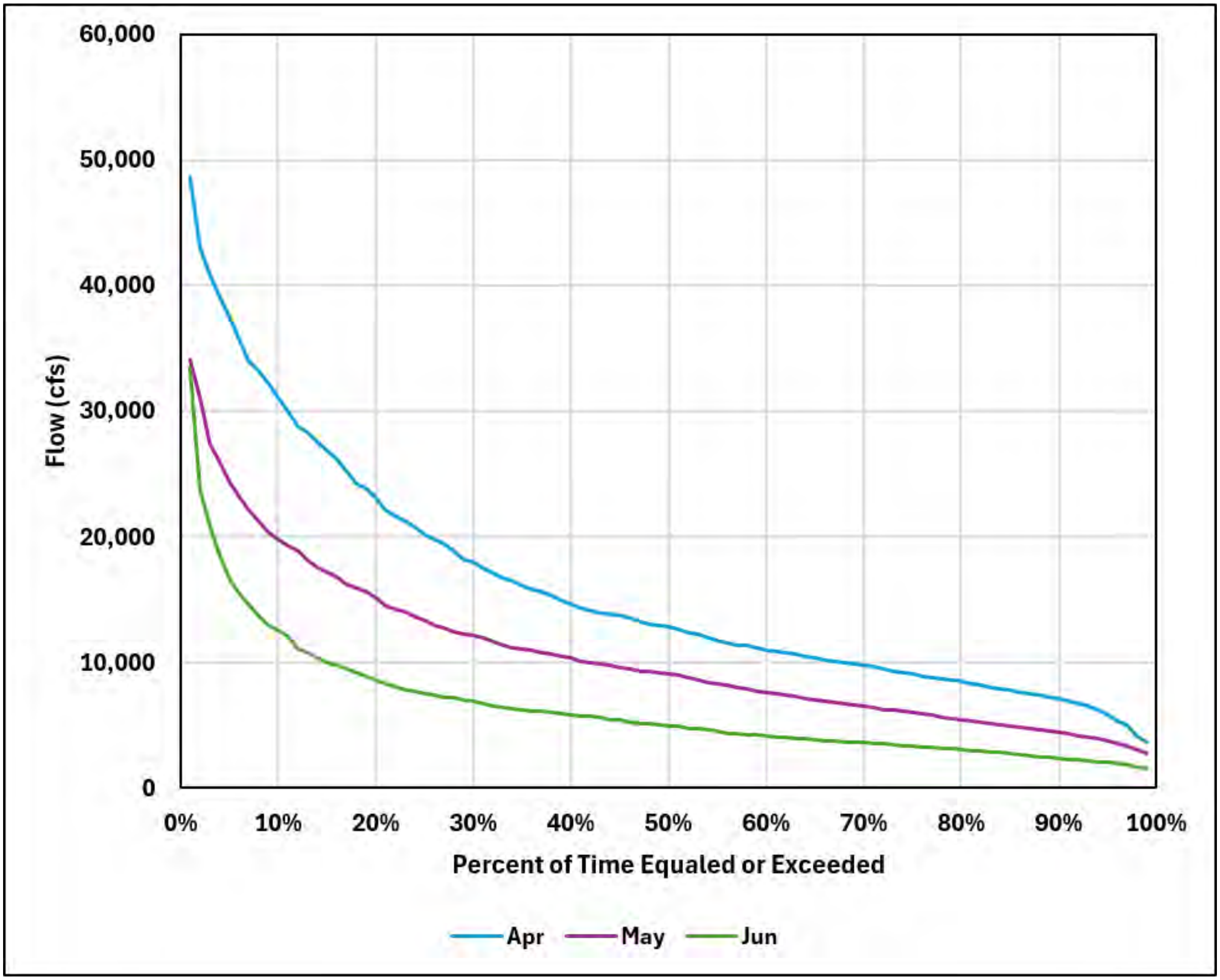


Figure A-4. July, August, and September Flow Duration Curve (1987-2025)

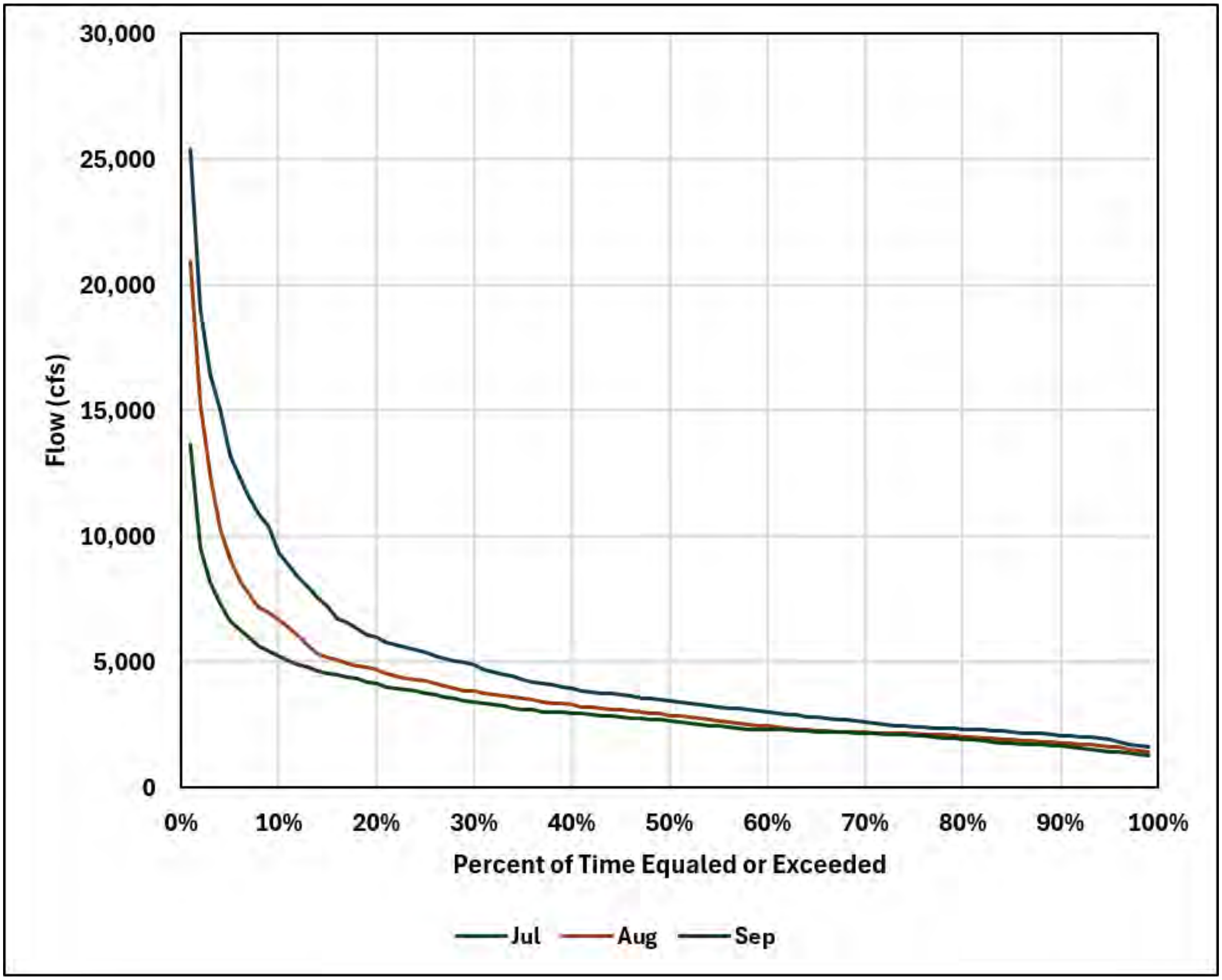
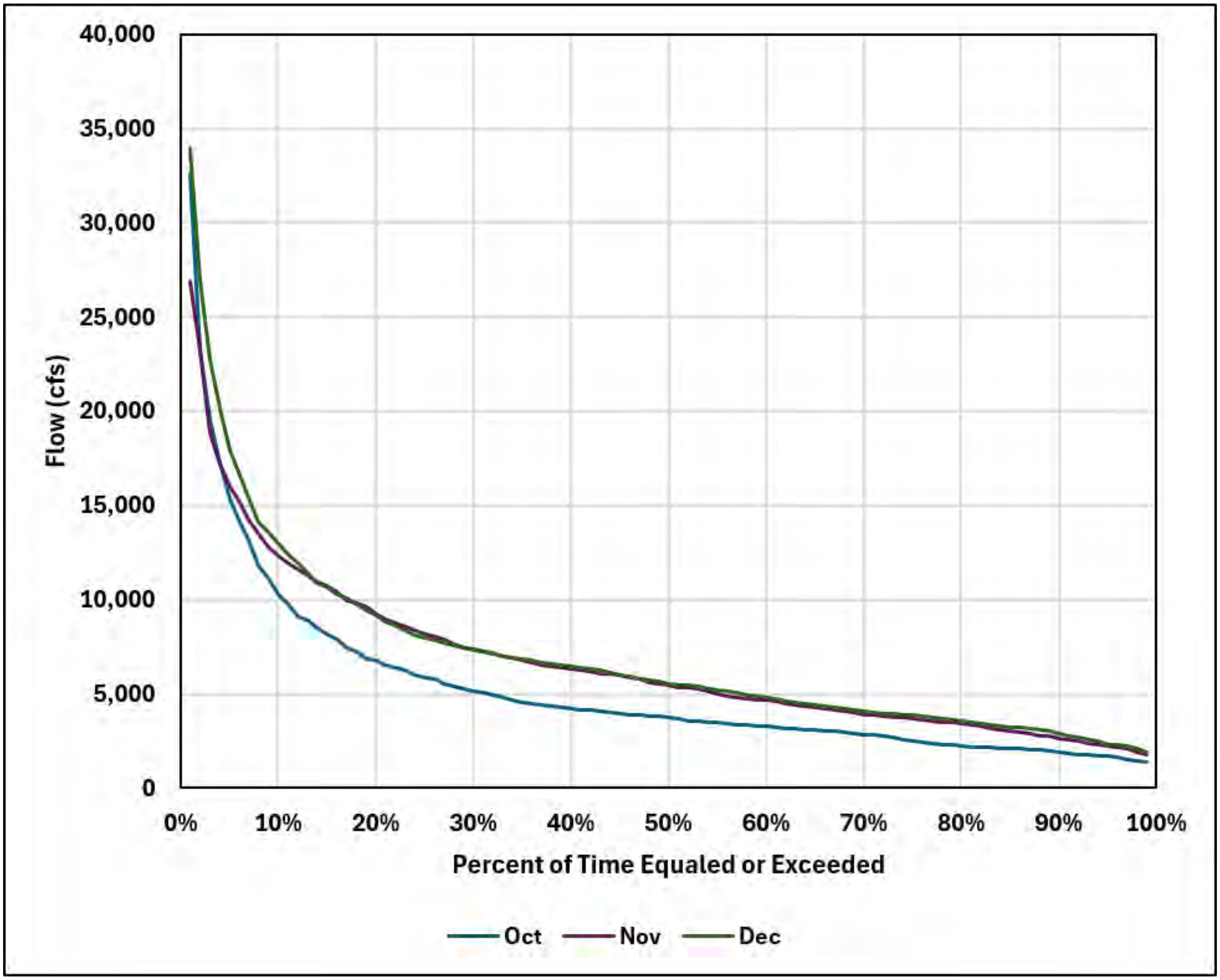


Figure A-5. October, November, and December Flow Duration Curve (1987-2025)



APPENDIX B-CONSULTATION RECORD

MEETING SUMMARY

BRUNSWICK HYDROELETRIC PROJECT

FERC NO. 2284

DOWNSTREAM FISH PASSAGE ALTERNATIVES MEETING

January 27, 2026

ATTENDEES:

Mike Scarzello	Brookfield Renewable
Lucas Stiles	Kleinschmidt Associates
Ralph Nelson	Kleinschmidt Associates
Kirk Smith	Gomez and Sullivan
Lars Hammer	Maine Department of Marine Resources (MDMR)
Casey Clark	MDMR
Don Dow	National Marine Fisheries Service (NMFS)
Matt Buhyoff	NMFS
Patrick Dockens	United States Fish and Wildlife Service (USFWS)
Kimberly Spiller	USFWS
Ed Friedman	Friends of Merrymeeting Bay
Chip Spies	Free the Andro Coalition
Vladamir Douhovnikoff	Free the Andro Coalition
John Lichter	Free the Andro Coalition

Kirk Smith opened the meeting and set out the agenda and objectives. The meeting is being held to review aspects of the Upstream and Downstream Fish Passage Alternatives Study. The discussion will focus on the initial screening of potential downstream fish passage alternatives, with the discussion of upstream fish passage alternatives to follow at a future meeting anticipated to occur in February (date TBD).

Prior to the meeting, a downstream fish passage alternatives matrix and bathymetry mapping of the lower Project impoundment was distributed (Attachment 1). The downstream fish passage alternatives matrix was developed by Brookfield based on a literature review of potential applicable technologies that have been implemented at other hydroelectric projects, as well as any applicable new technologies. The literature review resulted in the identification of approximately 12 alternatives for downstream passage, which have been preliminarily narrowed down by Brookfield to 5 alternatives to be analyzed in a more detailed feasibility assessment to be conducted over the course of 2026.

The objective of this meeting is to consult with resource agencies, review the downstream fish passage alternatives matrix, and obtain concurrence on the alternatives to be carried forward for further detailed evaluation in the feasibility assessment.

Don Dow asked if Brookfield was able to acquire the previous hydraulic modeling and bathymetry data developed by Blue Hill Hydraulics in 2011. Kirk Smith replied that this information was collected and reviewed as part of this on-going study.

Lucas Stiles led a discussion of the alternatives contained in the downstream fish passage matrix. Lucas began by providing an overview of the Project features and layout (i.e., powerhouse, spillway, impoundment, etc.).

- **Alternative D1: Angled Bar Rack with New Downstream Bypass Structures**

Lucas stated that the first alternative was a traditional full depth angle bar rack structure with bar spacing of ¾-inches (see Attachment 1). The bar rack would be full depth in front of both the intake for Unit 1 (larger vertical propellor unit) and Units 2 and 3 (smaller horizontal propeller units). Unit 1 has a maximum flow of 5075 cfs and Units 2 and 3 have a maximum flow of 1200 cfs each. Lucas said that because the intake depths are significantly different between the units (i.e., Unit 1 is deeper than Unit 2), there are slightly different configurations that would be needed for each intake structure. This would also result in the need for an isolation wall between the two intake structures. Lucas said this alternative would also include new surface and low-level bypass structures located adjacent to the new rack structure and adjacent to the powerhouse at the spillway and those would discharge either downstream of the spillway apron or into a plunge pool below the spillway apron with depths required by the USFWS engineering guidelines.

Don Dow asked why the rack was angled toward the spillway, rather than in the opposed direction toward the exit of the upstream fish ladder. Lucas replied that it was easier to place a bypass on the spillway near the north side of the powerhouse, and when the Project is spilling putting the bypass and angling the intakes over to the spillway side will be better from an attraction and guidance perspective. Don Dow stated that from a constructability perspective it would be easier to orient in the other direction but also agreed with Lucas's logic. Lars Hammer asked if the conceptual sketches being presented could be shared with meeting participants. Kirk Smith replied that the sketches would be shared after any Critical Energy Infrastructure Information (CEII) restrictions were clear with Brookfield. Lars Hammer asked what the source of the bathymetry in the sketches was. Lucas replied that the bathymetry was from the 2011 Blue Hill Hydraulics analysis, noting the differences in bathymetry data for the Blue Hill data, which was elevations, and the recent bathymetry data which was in terms of depth.

Lucas proceeded through the evaluation criteria ratings used in the screening of this alternative. Effectiveness would be high as it provides full depth exclusion for all the target species, and guidance to the bypass structure. The bypass structure would be designed to pass up to 5% of station discharge. There would be an increased frequency of debris cleaning operations, trashrack raking and the potential need for divers to go in periodically to clean the low-level bypass. Lucas stated that there is the potential for high-velocity areas to develop (i.e., hotspots) that are outside of the preferred velocity range (two feet per second [fps]). For this alternative, as well as others, modifications to the spillway will be required for the bypass structure, which will likely have some impact on the spillway discharge capacity. Lucas said constructability would be difficult and require a very large cofferdam to be installed. Any modifications to the spillway will likely require some level of work from barges. Cofferdams would likely be required for construction of any plunge pool below the spillway. Overall, the expected cost for this alternative would be high. This alternative would require a new trash rake system as well because of the angled nature of the rack. The new bypass would have substantially more attraction flow at 375 cfs, which results in lost generation. There will be slightly higher generation losses due to the closer spaced tracks rack as well.

Don Dow stated that if there were a few velocity hotspots that developed, he could be accepting of that. He would expect velocities to be high over the entire face of the racks based on previous hydraulic modeling but that could be minimized by turning down the units.

Ed Friedman suggested that the rack spacing should be closer ½ inch to be protective of young-of-year fish and was wondering how a change could impact the other evaluation criteria. Lucas stated that such a change would have a substantial impact on operations and generation. Substantially, more manpower would be needed to keep the racks clean during the spring and fall. In the winter, impacts from frazil ice could be problematic to operations.

Don Dow stated that the criteria for salmon has been 1-inch clear spacing, which was conceived by USFWS back in the 1980s. More recently, USFWS has adopted ¾-inch clear spacing to be protective of American eel. Don Dow further stated that NMFS research has indicated that most downstream migrating wild and hatchery smolts in Maine range in size between ½-inch and one inch. Don said he is unsure what the smolts reaction would be to 3/4-inch rack spacing especially at higher velocities, but he would feel secure that ½-inch would physically exclude smolts.

Lars Hammer asked if there was flexibility in the feasibility analysis to modify the configuration of an alternative if circumstances dictated it. Lucas replied that if CFD modeling or some other part of the analysis showed that a better outcome could achieved, then the configuration (e.g., angle of the racks, etc.) could be reconsidered.

Alternative D2: Inclined Bar Rack with New Downstream Bypass Structures

Lucas stated that the 2nd alteratnive is an inclined (45 degrees) rack structure, similar to the angle rack in Alternative 1 (see Attachment 1). This alternative uses a full depth rack with 3/4-inch clear spacing. Because of the significant difference in depth of the Units, this alternative would also require two separate intakes. A new bypass structure would be located at the spillway, just north of the powerhouse, with both surface and low-level bypass options. The total attraction flow would be 5% of station discharge. This alternative would also require a new mechanical rake and would likely require a more costly custom rake design due to the angle of the incline rack, and the greater distance to the bottom of the steep rack section. The estimated velocities in front of the racks would be approximately 1.8 and 1.7 fps, below the 2.0 fps threshold in the USFWS engineering guidelines. Lucas stated that this would need to be confirmed with future CFD modeling.

Casey Clark asked about the potential downstream bypass location and how that would be routed. Lucas replied that this alternative considered a bypass structure located just north of the powerhouse with a surface gate and then a low-level inlet. Lucas said it would be preferable to integrate the bypass into the rack face structure, but the layout of the intake did not lend itself to this type of solution. Casey Clark also asked about the infrastructure on river right (i.e., upstream fishway) and whether the river right training wall on the shore side of Unit 1 could be moved any further to the right to address potential velocity issues to prevent fish from being falsely attracted to the area. Lucas replied that the current layout tries to minimize impacts to upstream fishway, and a modification like moving a training wall could present design challenges if the upstream fish passage remains on river right.

Lucas proceeded through the evaluation criteria ratings used in the screening of this alternative. Effectiveness would be high as it provides full depth exclusion for all the target species, and guidance to the bypass structure. This alternative would require additional debris removal effort. Shallow inclined rack structures in this region are still somewhat experimental. CFD modeling of the alternative configuration would be needed to examine approach velocities and determine if there are any hotspots. For this alternative, modifications to the spillway will be required for the bypass structure, which will likely have some impact on the spillway discharge capacity. Lucas said constructability would be difficult and require a very large cofferdam to be installed. A custom trash rake would also be required. Any modifications to the spillway will likely require some level of work from barges. Cofferdams would likely be required for construction of any plunge pool below the spillway. Overall, the expected cost for this alternative would be high. The new bypass would have substantially more attraction flow at 375 cfs, which results in lost generation associated. There will be slightly higher generation losses due to the closer spaced tracks rack as well.

Vladimir Douhovnikoff asked if it would make sense to examine the 1/2-inch rack spacing with this alternative. Lucas replied that the CFD modeling would not be able to assess changes in rack spacing from ¾-inch to ½-inch. Vladimir Douhovnikoff stated that it may be helpful to know if closer spacing could be effective, and what the impact would be on generation. Kirk Smith stated that the selection of ¾-inch clear spacing was being driven by the USFWS engineering guidelines, which reflects the protective spacing for American eel, and that examining closer spacing would begin to have significant impacts on generation likely making the alternative unfeasible relative to other options. Matt Buhyoff stated the results of the alternatives analysis will be filed with FERC, who will be developing their own license recommendations, and it would be premature to dismiss closer-spaced rack alternatives from the analysis, and their technical feasibility should be investigated. Mike Scarzello stated that Brookfield is following USFWS engineering guidelines with the ¾-inch clear spacing described in the alternatives.

Alternative D3: Floating Guidance Boom with a New Downstream Surface Bypass and Nighttime Shutdowns

Lucas stated that the 3rd alternative consists of a partial depth floating guidance boom that would angle upstream from the north side of the powerhouse toward the commercial building near the river bank (see Attachment 1). The depth of the panels would be approximately 10 feet, like the Worthington booms that are located on the Kennebec River at the Lockwood and Hydro Kennebec Projects. A new bypass structure would be located at the spillway, just north of the powerhouse, with a surface bypass.

Don Dow stated this option is similar to the option that was analyzed by the 2011 Blue Hill Hydraulics study. The 2011 CFD modeling indicated velocities that were exceedingly high. If that remained the case, then this alternative would likely need to include unit turndowns. Don Dow also indicated that the panel should be rigid rather than employ some kind of netting, which in his experience does not stand up well to high flows. Lucas replied that the intent here was to use rigid panels. Don Dow stated the 2011 Blue Hill Hydraulic study configuration had two booms; one stretched from the north side of the powerhouse to the easterly side of the island upstream of the powerhouse, and the other stretched from the westerly side of the island to the shore. The modeling of this configuration showed a hotspot on the boom closer to the dam, so the alternative ultimately was not pursued.

Lucas added that this option also includes nighttime shutdowns for American eel. Lucas proceeded through the evaluation criteria ratings used in the screening of this alternative. Effectiveness would be rated as low, as it is a partial depth boom, so there is going to be the potential for some migrants sounding below the boom and potential for migrants to pass through the units. There would likely be difficulty in installing the boom during a spring freshet, so it is assumed that the boom would remain in place year-round. As such, there is potential for failures due to ice and debris loading.

There is also a potential impact to the upstream fishway exit with the boom in place. It's going to require the fish to sound below the boom as they migrate upstream. Otherwise, some kind of exit flume extension may be required.

For this alternative, modifications to the spillway will be required for the bypass structure, which will likely have some impact on the spillway discharge capacity. Lucas said constructability would be moderate and would not require a cofferdam, but divers would be required to help install and maintain the anchor points for the boom. Any modifications to the spillway will likely require some level of work from barges. Cofferdams would likely be required for construction of any plunge pool below the spillway. Overall, the expected cost for this alternative would be low. The new bypass would have substantially more attraction flow at 375 cfs, which results in lost generation. Operations and maintenance costs would be high as removal of debris would need to be done via boat, and periodic repositioning of the boom after any extreme load events. Divers may be required for periodic boom cleaning and debris removal. Lastly, impacts to generation would be high considering the nighttime shutdowns.

Lars Hammer asked why this alternative only includes a surface bypass option. Lucas Stiles replied that since units would be shutdown all flow would be bypassed as spill and through the bypass and eels would pass that way. However, a low-level bypass could be included like Alternatives 1 and 2.

Alternative D4A: Multiple Fish Friendly Runner Replacements

Lucas stated that the 4th alternative consists of the installation of fish friendly runners on all three turbine units using the Natel technology (see Attachment 1). A companion feasibility study would need to be completed by Natel for this alternative as well. The existing 3 ½-inch clear space racks would remain in place and there would be no other downstream passage measures or protection measures, as the fish would pass through the turbines with an expected very high rate of survival. Don Dow indicated that he thought the Natel turbine runner was good option in general.

Matt Buhyoff commented that the 3 1/2-inch spacing would exclude approximately 30% of adult salmon kelts, and it made him apprehensive that we could be relying on modeling to assess survival, and modifying the clear spacing might be necessary to protect kelts from entrainment. Matt Buhyoff stated the spacing on the rack does not need to get much finer to prevent entrainment of kelts. Don Dow added that clear spacing of 2 1/2 inches might be the appropriate threshold.

Lucas Stiles stated that he was thinking from the perspective that the rack clear spacing should be increased so kelts could pass through the turbines, as this alternative does not consist of a bypass and spillage occurs approximately 30 to 40% of the time. Don Dow stated that without effectiveness testing it would be difficult to assess the impact of passing kelts through Natel runner turbines.

Vladimir Douhovnikoff asked if alternatives could be combined, and specifically whether Alternatives 1 and 4 could be combined. Lucas Stiles replied that there would not be a reason to combine the two, since the concept of the Natel runner is for fish to pass through the turbines with a very high rate of survival, therefore, there would be no need to exclude fish from entrainment with an angled rack.

Ed Friedman asked about a scenario where the Natel turbine runners did not work as anticipated. Lucas Stiles stated that it is a new technology that is just emerging and it's effectiveness is going to require additional evaluation and study. If this alternative were pursued, then Natel would need to do an analysis on expected turbine survival for the various species. That's not something that is being proposed as part of this initial study, but it's something that could be looked at in the future.

Ed Friedman asked if punch plates were going to be considered. Lucas Stiles stated that punch places are used on some West Coast projects, but not typically used for intakes on the East Coast. In addition, punch plates create many issues from an operations perspective, as punch plates cannot be cleaned with a trash rake very easily. Ed Friedman stated that punch plates are used in Gardner (perhaps seasonally), but that is a smaller facility. Don Dow stated that KEI has been using punch plates at a few sites in the Northeast. Lucas noted use as a seasonal overlay, noting that cleaning requires temporary removal of the overlay panels.

Casey Clark stated that downstream telemetry study data would clarify the impacts of alternatives such as the Natel type turbines. Casey said information is lacking on what other potential pieces of infrastructure (i.e., wicket gates), could impact fish as they are migrating through those routes.

Alternative D4B: Unit 1 Fish Friendly Runner Replacement with Inclined Bar Rack at Units 2 and 3

Lucas stated that the 5th alternative consists of the installation of a fish friendly runner on Unit 1 using the Natel technology, and an inclined rack in front of Units 2 and 3 (see Attachment 1).

Patrick Dockens asked if the inclined rack was placed on Units 2 and 3, rather than Unit 1 for cost reasons and ease of construction. Lucas Stiles stated more flow goes through Unit 1 so there would be more benefit from the Natel turbine runner, and this configuration is likely the lower cost alternative.

Casey Clark requested that a flow duration analysis of the site be conducted to understand how often the capacity of all three units is exceeded during the upstream and downstream passage season, and to understand any type of unit prioritization that is currently occurring. Casey said there is some unit prioritization occurring for upstream passage and it would be helpful to see how this alternative looked under those different operational scenarios. Casey said it would also be helpful to understand the service life of the current units to see how it aligns with the overall cost for the licensee during the license term.

Casey Clark commented that for the Natel turbine runner options there would be times when spill is occurring and that would provide a downstream passage route, and that an evaluation of the spillway for safe passage should be conducted.

Don Dow stated that a dam removal alternative should be added to the analysis, so that it can be used as a comparative analysis for effectiveness and cost.

Patrick Dockens asked about the training wall river left with this alternative and whether there is a chance fish get stuck in that area. Lucas Stiles stated there is some possibility of delay, but theoretically fish should be able to find the intended passage route through Unit 1.

Chip Spies expressed a desire to examine the dam removal alternative as well and also stated that it would be important to have an analysis of a nature-like fishway on river left. Chip Spies stated that he has seen some rough designs and would like to understand if it's technically feasible. Kirk Smith suggested that the discussion of a nature-like fishway be tabled for the upstream passage alternatives discussion.

Casey Clark asked if a zigzag passage device combined with a downstream bypass was evaluated. Lucas Stiles said this was considered and that it is the Klawa/Low Flow Bypass alternative in the matrix (see Attachment 1). However, it was ruled out because it's experimental and not suitable for a larger project.

Kirk Smith stated that he would send out a meeting poll to schedule the discussion of the upstream passage alternatives matrix for some time in February. It was agreed that the meeting participants would submit written comments on the downstream alternatives discussion by March 2nd with their ISR comment filing.

Attachment 1-Downstream Fish Passage Alternatives Matrix and Bathymetry Mapping

Draft Alternatives Review – Downstream Fish Passage at the Brunswick Project

ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
D1	**Angled Bar Rack with New Downstream Bypass Structures**	-This alternative would include the installation of a new, full-depth angled bar rack with close-spaced trash racks (3/4-inch clear) upstream of the existing intake structures. -The angled bar rack would extend approximately 140 feet upstream of the existing intake structure and would be angled at 45 degrees. An isolation wall between Unit 1 and 2 would be provided to allow for a deeper intake in front of Unit 1. The intake for Unit 1 would be approximately 80 feet wide by 35 feet deep resulting in an average approach velocity of approximately 1.8 fps. The intake for Units 2 and 3 would be approximately 68 feet wide by 20 feet deep resulting in an average approach velocity of approximately 1.8 fps. -A new surface bypasses would be provided at the downstream end of the racks located on the south side of the spillway adjacent to the powerhouse. -A new low-level bypass would be provided at the downstream end of the racks for the downstream eel passage. The bypass would be routed to a surface weir located adjacent to the surface bypass. -Total bypass flow would be approximately 375 cfs (5% of station discharge). Fish would be discharged directly into the tailrace downstream of the spillway if it is shown to be deep enough, otherwise a plunge pool that meets USFWS criteria would be provided. -A new mechanical trash rake would be installed for debris management.	<u>High</u> -Reduced passage mortality through the turbine intakes. -Improves protection of fish exiting upstream fish ladder.	<u>Moderate Risk</u> -More frequent debris raking operations required. -Periodic dive inspections needed for cleaning low level bypass.	<u>High</u> -All new intake structure, downstream bypass structures, and a new trash rake.	<u>Low</u> -The location of the bypass structures may impact the spillway discharge capacity. Modifications to the spillway may be required to maintain the discharge capacity and prevent impacting the 100-year flood elevation or the IDF elevation. -The new intake structure may impact the exit of the upstream passage facility. Some modification may be required to accommodate new intake wall. -Possible hot spots at the downstream end of the rack. CFD modeling is needed to confirm the feasibility of this alternative.	<u>Difficult</u> -A large cofferdam will likely be required to facilitate construction. -If required modifications to the spillway would be challenging requiring work from a barge and installation of flood protection upstream of the work area. -A cofferdam would likely be required to facilitate construction of a plunge pool if required.	<u>High</u> -Construction costs of the new intake structure. -Construction costs of the new low-level and surface bypass structures. -New trash rake costs. -Electrical supply for the new bypass gates and trash rake. -Possible spillway modification costs. -Possible plunge pool construction costs.	<u>Moderate-High</u> -More frequent raking and debris handling required. -Increased potential for frazil ice impacts. -Effectiveness testing required.	<u>Moderate</u> -Additional losses due to increased attraction flow. -Slightly higher energy loss due to close-spaced racks and increased debris loading. -Increased potential for frazil ice impacts.
D2	**Inclined Bar Rack with New Downstream Bypass Structures**	-This alternative would include the installation of a new, full-depth inclined bar rack with close-spaced trash racks (3/4-inch clear) upstream of the existing intake structures. -Separate inclined rack structures would be provided for Unit 1 and Units 2 and 3 due to the increased water depth in front of Unit 1. Both intake structures would have a rack inclination of 45 degrees. The intake for Unit 1 would be approximately 55 feet wide and would extend approximately 55 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.7 fps. The intake for Units 2 & 3 would be approximately 48 feet wide and would extend	<u>High</u> -Reduced passage mortality through the turbine intakes. Improves protection of fish exiting upstream fish ladder.	<u>Moderate Risk</u> -More frequent debris raking operations required. -Periodic dive inspections needed for cleaning low level bypass.	<u>High</u> -All new intake structure, downstream bypass structures, and a new trash rake.	<u>Moderate</u> -The location of the bypass structures may impact the spillway discharge capacity. Modifications to the spillway may be required to maintain the discharge capacity and prevent impacting the 100-year flood elevation or the IDF elevation. -The new intake structure may impact	<u>Difficult</u> -A large cofferdam will be required to facilitate construction. -A custom trash rake may be required to accommodate the inclined rack angle and additional reach. -If required modifications to the spillway would be challenging requiring work from a barge	<u>High</u> -Construction costs of new intake structure. -Construction costs of new low-level and surface bypass structures. -New trash rake costs. -Electrical supply for new bypass gates and trash rake.	<u>Moderate-High</u> -More frequent raking and debris handling required. -Increased potential for frazil ice impacts. -Effectiveness testing required.	<u>Moderate</u> -Additional losses due to increased attraction flow. -Slightly higher energy loss due to close-spaced racks and increased debris loading. -Increased potential for frazil ice impacts.

ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
		approximately 35 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.8 fps. -A new surface bypasses would be provided on the south side of the spillway adjacent to the powerhouse. -A new low-level bypass would be provided for downstream eel passage. The bypass would be routed to a surface weir located adjacent to the surface bypass. -Total bypass flow would be approximately 375 cfs (5% of station discharge). Fish would be discharged directly into the tailrace downstream of the spillway if it is shown to be deep enough, otherwise a plunge pool that meets USFWS criteria would be provided. -A new mechanical trash rake would be installed for debris management.				the exit of the upstream passage facility. Some modification may be required to accommodate new intake wall -This technology has not been widely used in the U.S. and is still considered experimental. -Possible hot spots on the proposed rack structure. CFD modeling is needed to confirm the feasibility of this alternative.	and installation of flood protection upstream of the work area. -A cofferdam would likely be required to facilitate construction of a plunge pool if required.	-Possible spillway modification costs. -Possible plunge pool construction costs.		
D3	**Floating Guidance Boom with a New Downstream Surface Bypass and Nighttime Shutdowns**	-This alternative would include the installation of a new 10-foot-deep floating fish guidance boom (e.g., PNP or Worthington). -The boom would extend from the north side of the powerhouse to the shoreline at approximately a 35-degree angle. -A new surface bypass would be provided at the downstream end of the guidance boom located on the south side of the spillway adjacent to the powerhouse. -Due to the boom only being partial depth, a low-level bypass would not be provided. -Total bypass flow would be approximately 375 cfs (5% of station discharge). Fish would be discharged directly into the tailrace downstream of the spillway if it is shown to be deep enough, otherwise a plunge pool that meets USFWS criteria would be provided.	<u>Low</u> -There is the potential for downstream migrants to sound below the guidance boom which would result in reduced efficiency when compared to other full depth exclusion measures. -Modeling of a similar alternative by Blue Hill Hydraulics Inc. showed poor guidance at the downstream end of the boom. -Nighttime shutdowns required for protection of out-migrating American eels.	<u>High Risk</u> -Due to safety concerns with trying to install the boom annually during high flow conditions the boom would be designed to be installed year-round. Shear pins that are designed to fail under extreme loads would be provided to prevent excessive damage to the boom. This will require boat access to reset the boom periodically. -Debris accumulation in the catenary of the guidance boom may occur which would require periodic boat access to remove. -Periodic dive inspections will be needed to clean biofouling from the guidance boom.	<u>Low</u> -The existing intake racks would remain in place. -The floating guidance boom is more susceptible to damage from high flow, debris, and ice.	<u>Moderate</u> -The location of the bypass structure may impact the spillway discharge capacity. Modifications to the spillway may be required to maintain the discharge capacity and prevent impacting the 100-year flood elevation or the IDF elevation. -This alternative may impact upstream migrants that would need to sound below the guidance boom. An extension to the upstream fishway exit may be required.	<u>Moderate</u> -Installation of the boom will require a crane and personnel on the water to position the boom sections. -In-water anchors may be required to resist debris and ice loading. -If required modifications to the spillway would be challenging requiring work from a barge and installation of flood protection. -New anchor block construction may temporarily impact mill building parking.	<u>Low</u> -Cost of boom supply and installation. -Cost of boom anchorages -Construction costs of new surface bypass structure. -Electrical supply for new bypass gate. -Possible spillway modification costs. -Possible plunge pool construction costs.	<u>High</u> -Divers required for periodic cleaning of the guidance boom. -Boom may need to be reset after extreme flow events. -Periodic debris removal. -Effectiveness testing required.	<u>High</u> -Additional losses due to increased attraction flow. shutdowns. -Additional losses due to nighttime shutdowns.

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ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
D4A	**Multiple Fish Friendly Runner Replacements**	-This alternative would include replacing the existing turbine runners of all three units with Natel FishSafe runners. -The Existing 3-1/2 inch clear intake racks to remain. -No other downstream passage or protection measures would be provided. -The existing debris management systems for the powerhouse trash racks would continue to be used.	Experimental -Turbine survival rates depend on species, type of turbine, and site-specific hydraulic conditions. -A feasibility study by Natel will be required to fully assess this alternative.	Low Risk -No changes to existing operating procedures.	Moderate -New runners will extend the service life of existing units.	Experimental -This technology is gaining preliminary agency acceptance; however, it is still considered experimental due to the lack of large-scale effectiveness testing.	Easy -Assuming runner replacement is feasible and that full turbine replacement is not required.	Moderate -Supply and installation cost of new runners.	Low -Maintenance of new units would be similar to existing units. -Eliminates O&M associated with downstream bypass structures. -Effectiveness testing required.	Unknown -Impacts to generation are likely to be low but a feasibility study by Natel will be required to fully assess this.
D4B	**Unit 1 Fish Friendly Runner Replacement with Inclined Bar Rack at Units 2 and 3**	-This alternative would include replacing the existing turbine runner for Unit 1 with a Natel FishSafe runner and installing an inclined bar rack with close-spaced trash racks (3/4-inch clear) upstream of the existing intake structure for Units 2 & 3. Note flows exceed discharge capacity of Unit 1 48% of the downstream passage season. -The Existing 3-1/2 inch clear intake racks at Unit 1 would remain. -The intake for Units 2 & 3 would be approximately 48 feet wide and would extend approximately 35 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.8 fps. -No other downstream passage or protection measures would be provided. -A new mechanical rake would be installed for debris management.	Experimental -Turbine survival rates depend on species, type of turbine, and site-specific hydraulic conditions. -A feasibility study by Natel will be required to fully assess this alternative.	Moderate Risk -More frequent debris raking operations will be required for Units 2 & 3.	Moderate-High -New runners will extend the service life of existing units. -New intake structure and new trash rake for Units 2 & 3.	Experimental -FishSafe runner technology is gaining preliminary agency acceptance; however, it is still considered experimental due to the lack of large-scale effectiveness testing. -Inclined trash racks have not been widely used in the U.S. and is still considered experimental. -Possible hot spots on the proposed rack structure. CFD modeling is needed to confirm the feasibility of this alternative.	Difficult -A large cofferdam will be required to facilitate construction of the new intake structure. -Custom trash rake may be required to accommodate incline angle.	Moderate-High -Construction costs of new intake structure. -Supply and installation cost of new runner. -New trash rake costs. -Electrical supply for new trash rake.	Moderate -More frequent raking and debris handling required at Units 2&3 -Increased potential for frazzle ice impacts on Units 2 and 3 racks. -Effectiveness testing required.	Unknown -Impacts to generation are likely to be low but a feasibility study by Natel will be required to fully assess this. -Slightly higher energy loss due to close-spaced racks and increased debris loading on Units 2 & 3.
ALTERNATIVES RULED OUT										
-	**No Action (Maintain Existing Conditions)**	This was eliminated due to the approach velocities (Unit 1 – 3.2 fps, Unit 2&3 2.8 fps) and bar spacing (3-1/2 inch clear spacing) of the existing trash racks which exceeds maximums recommended by USFWS. The attraction flow (20cfs) for the downstream bypass is also significantly lower than the 5% of station discharge (375 cfs) that is recommended by USFWS.	-	-	-	-	-	-	-	-
-	**Modifications to the Existing Downstream Bypass**	The existing downstream bypass consists of a 3.5-foot-wide surface sluice that transitions to an 18-inch diameter pipe that is routed through	-	-	-	-	-	-	-	-

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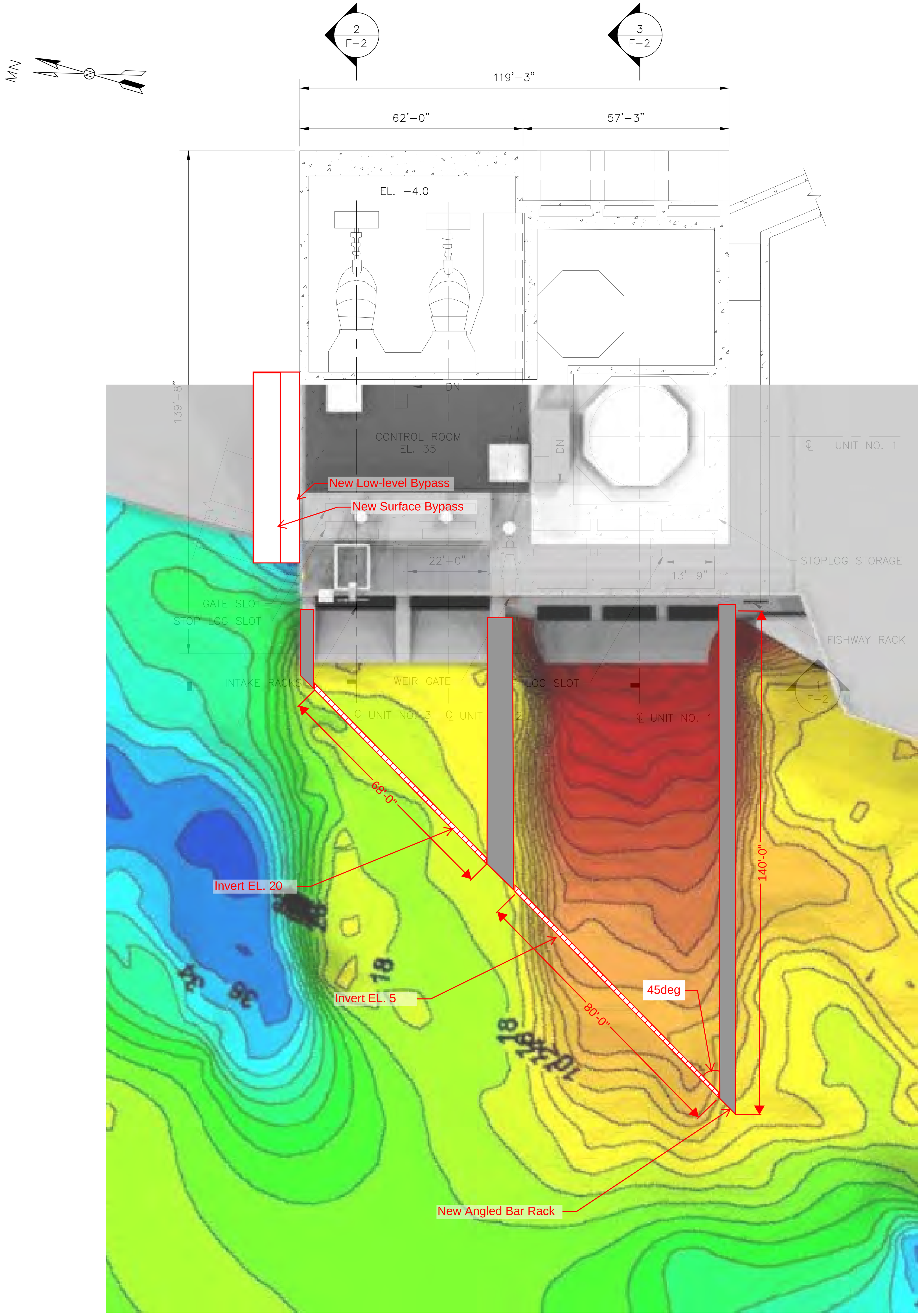
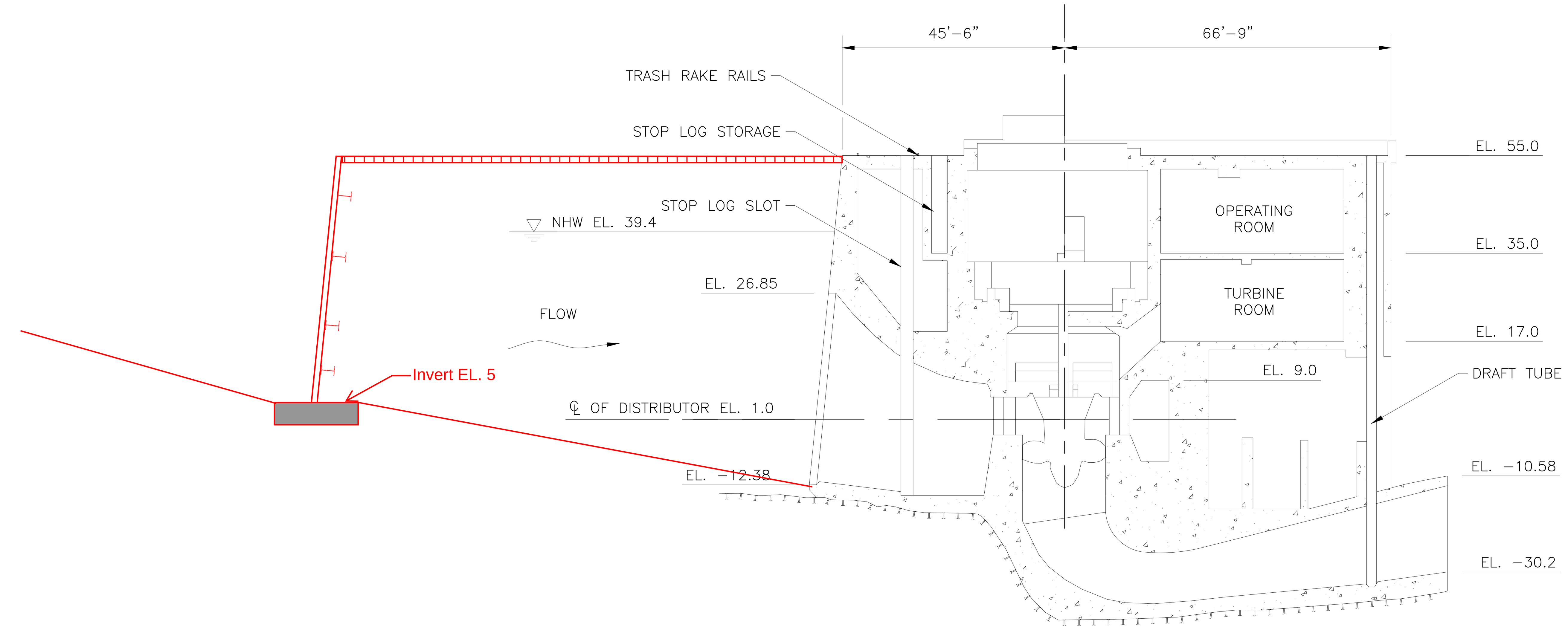
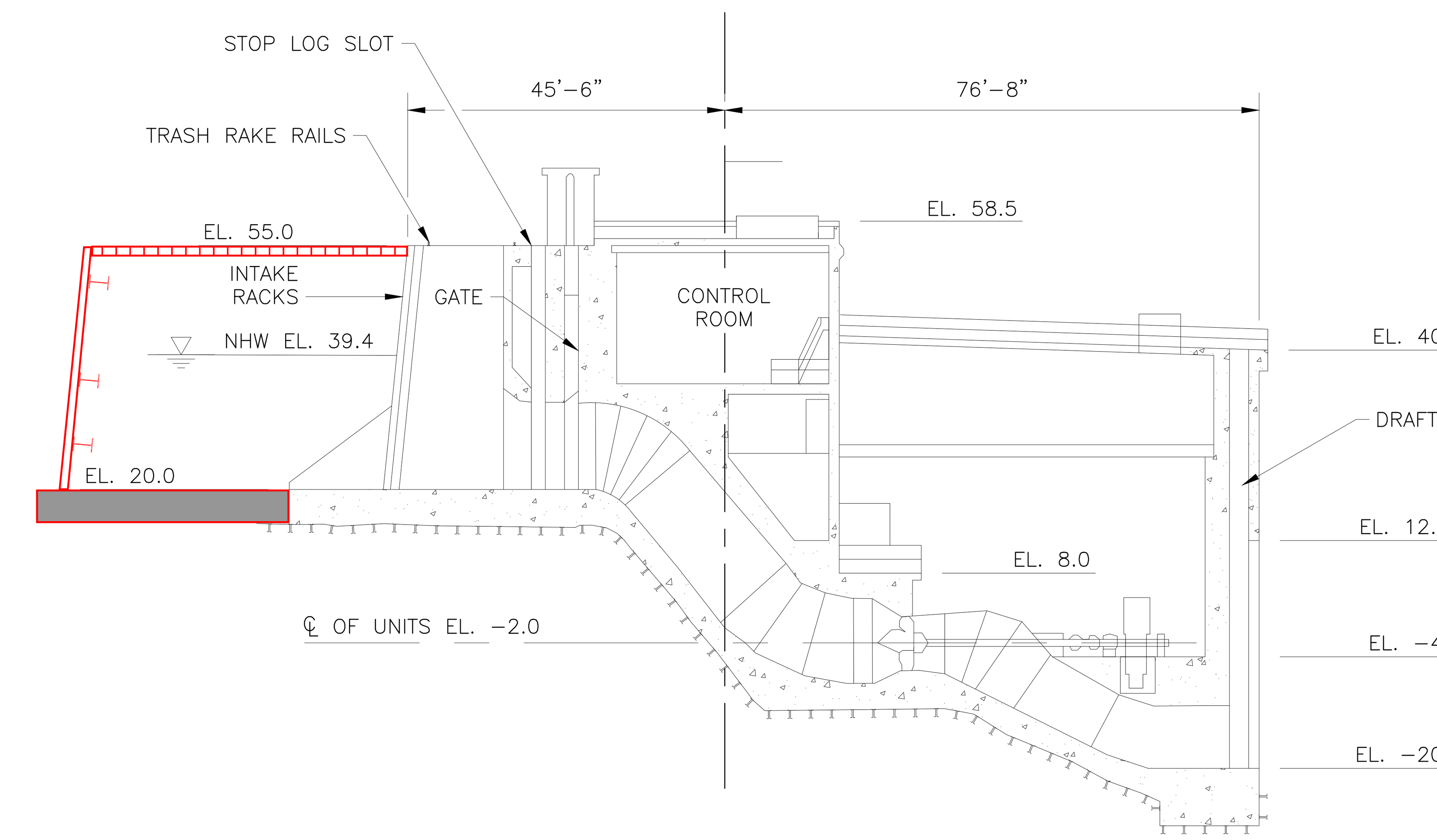
ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
		the powerhouse. The bypass discharges 20 cfs. This was eliminated because it is not likely feasible to modify the existing bypass to pass the increased attraction flow that will be required.								
-	**Shutdown One Unit and use it as a Bypass Route**	This was eliminated due to the lost generation and the need to provide fish exclusion measures for the other two units.	–	–	–	–	–	–	–	–
-	**Replace Existing Racks with Close-Spaced Racks and Install New Downstream Bypass Structures**	This was eliminated since the approach velocities (Unit 1 – 3.2 fps, Unit 2&3 2.8 fps) exceed maximums recommended by USFWS.	–	–	–	–	–	–	–	–
	Seasonal Overlays	This was eliminated since the approach velocities (Unit 1 – 3.2 fps, Unit 2&3 2.8 fps) exceed maximums recommended by USFWS.	–	–	–	–	–	–	–	–
-	**V-Rack with New Downstream Bypass Structures**	This was eliminated based on CFD modeling completed at West Enfield which showed uneven flow distribution. This would likely be exacerbated by the significantly different sized units at Brunswick.	–	–	–	–	–	–	–	–
-	**Behavioral Deterrents**	These were eliminated due to the experimental nature of these products and limited field success.	–	–	–	–	–	–	–	–
-	**Klawa / Low Flow Bypass (For DS Eel Passage)**	This was eliminated since this technology is still experimental and field studies to date have shown low effectiveness.	–	–	–	–	–	–	–	–
-	**Conte Air Lift Bypass (For DS Eel Passage)**	This was eliminated since this technology is still experimental with limited field use and testing.	–	–	–	–	–	–	–	–





2 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 1
1" = 20'



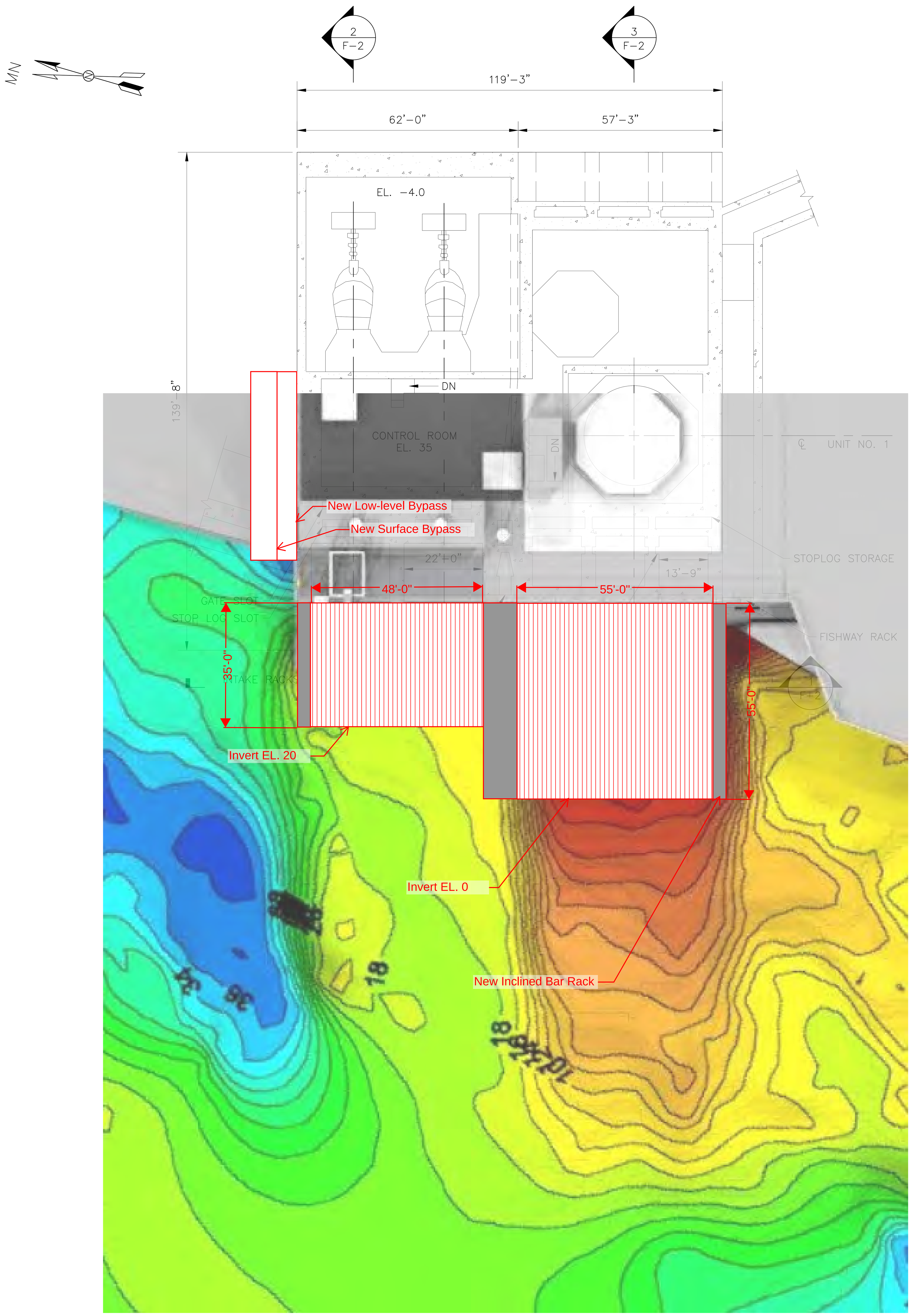
3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

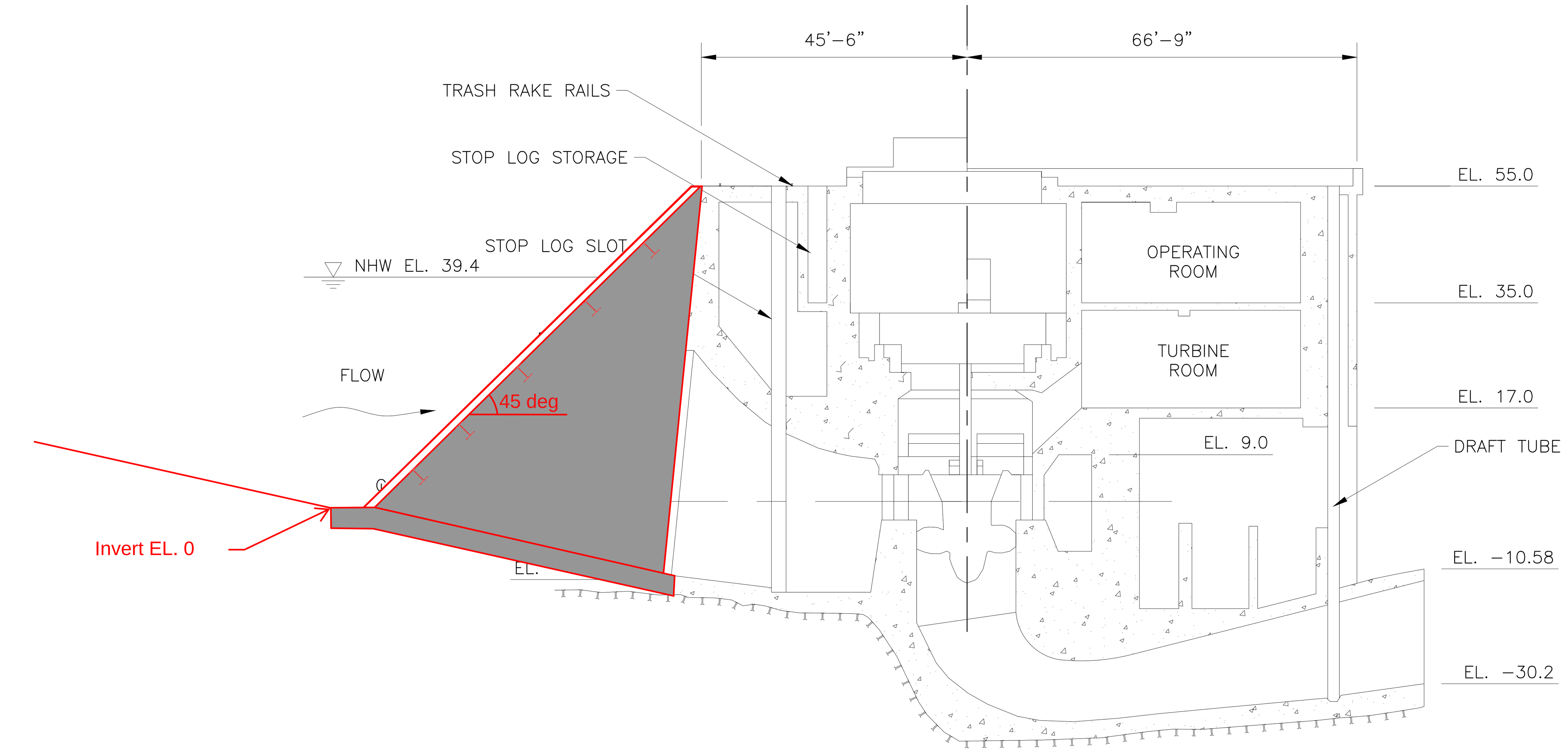
Alternative D1 - Angled Bar Rack with New Downstream Pass Structures

20' 0 20' 40'
SCALE: 1" = 20'

NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).





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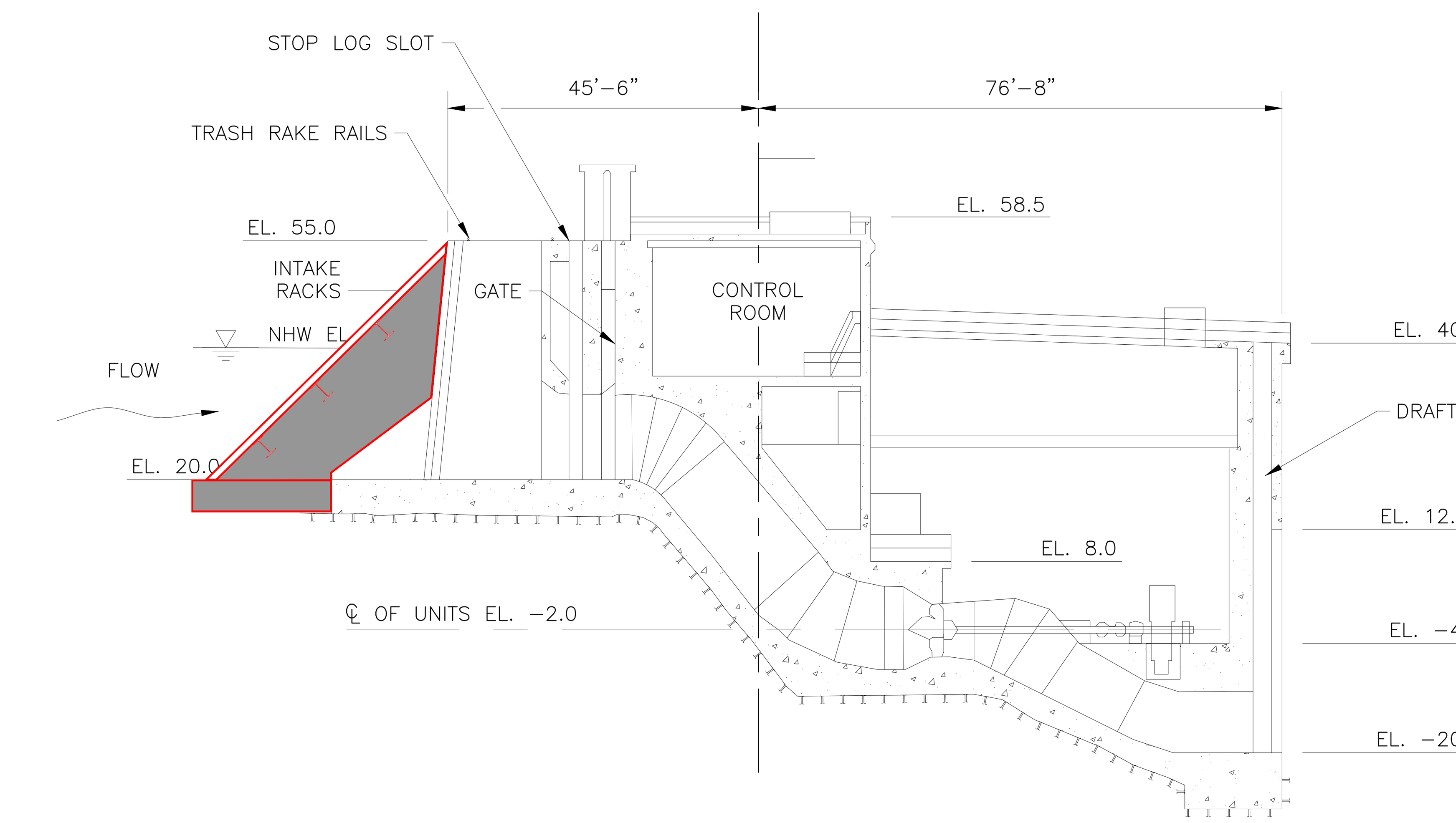


3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

Alternative D2 - Inclined Bar Rack with New Downstream Bypass Structures

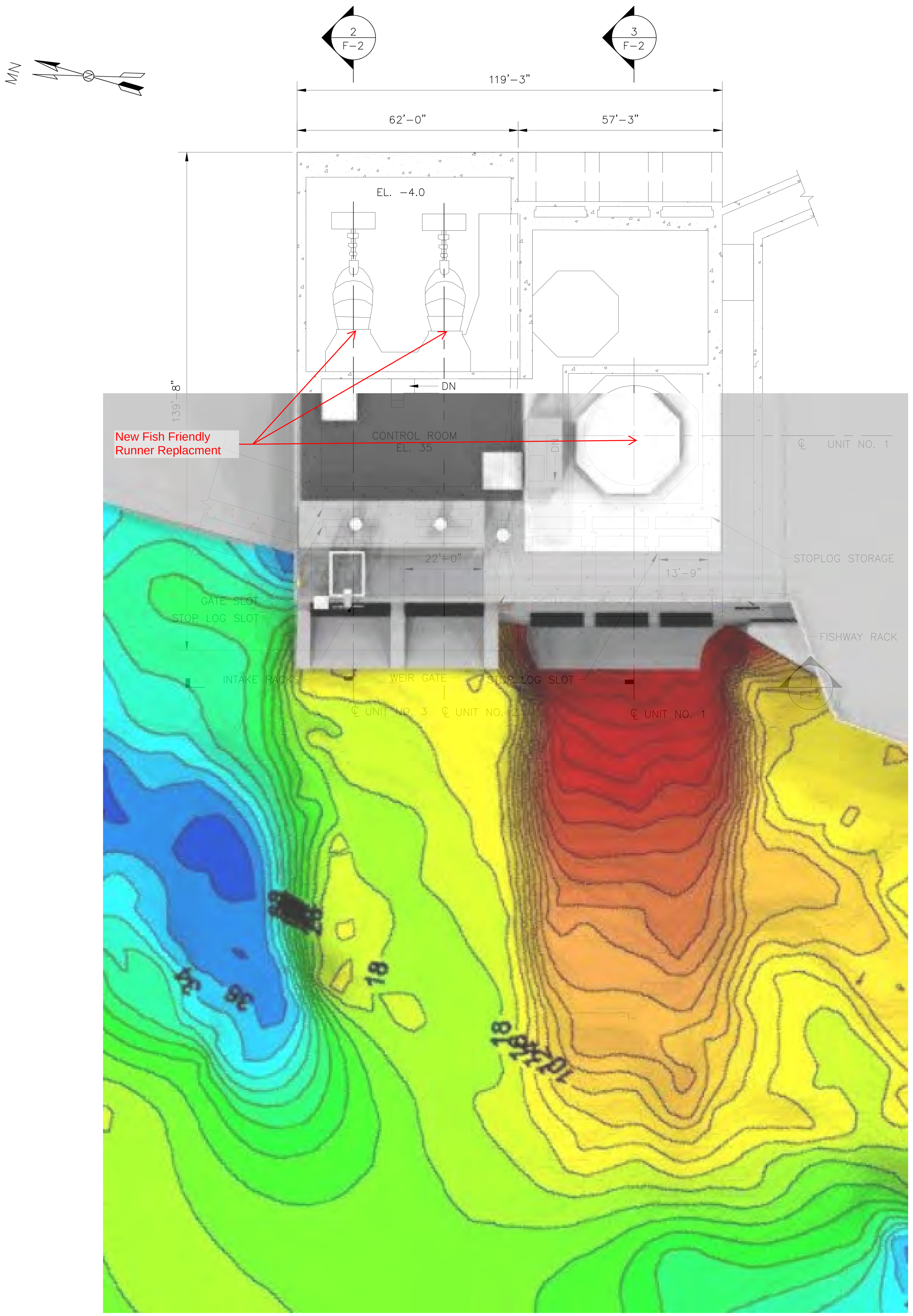
20' 0 20' 40'
SCALE: 1" = 20'

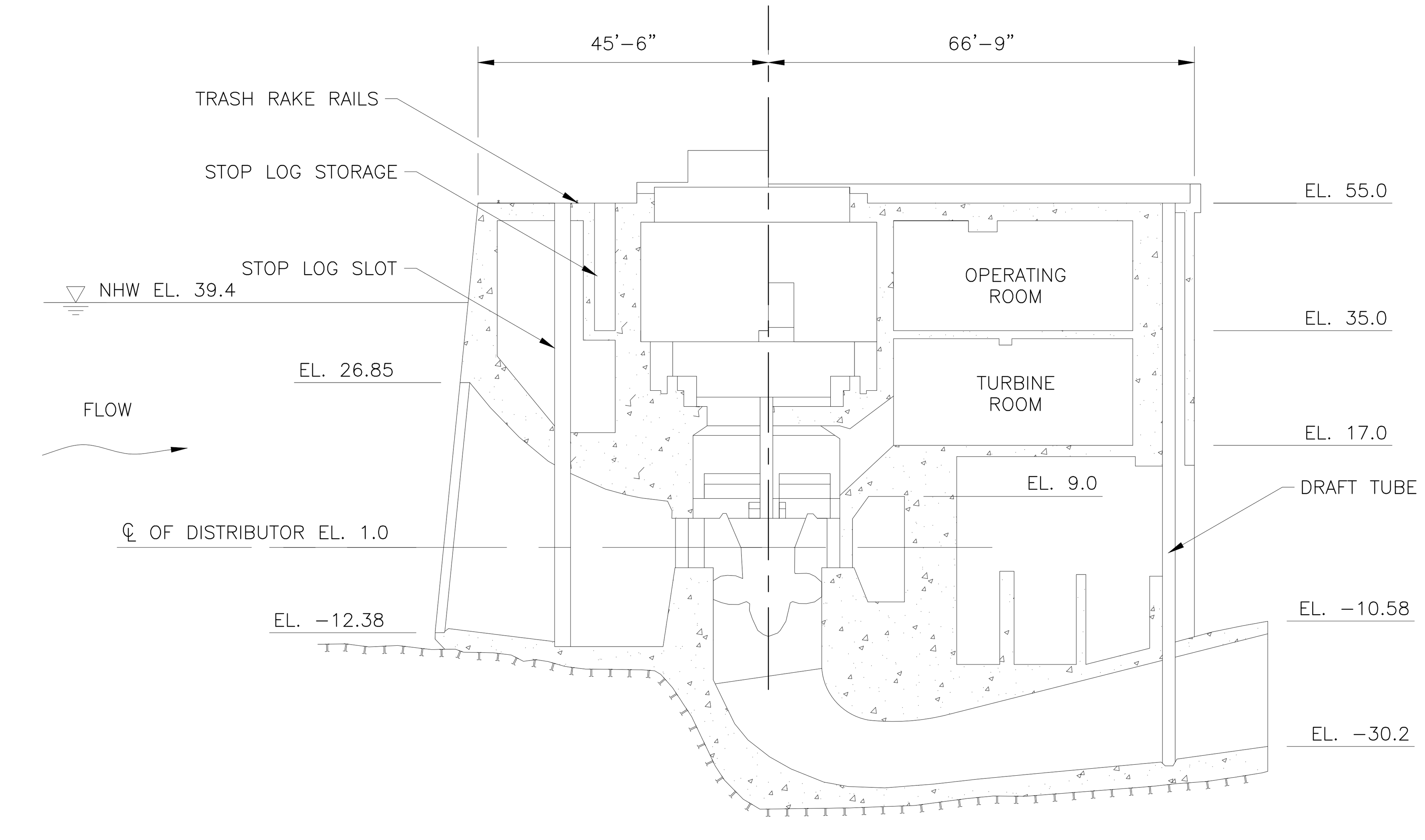
NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

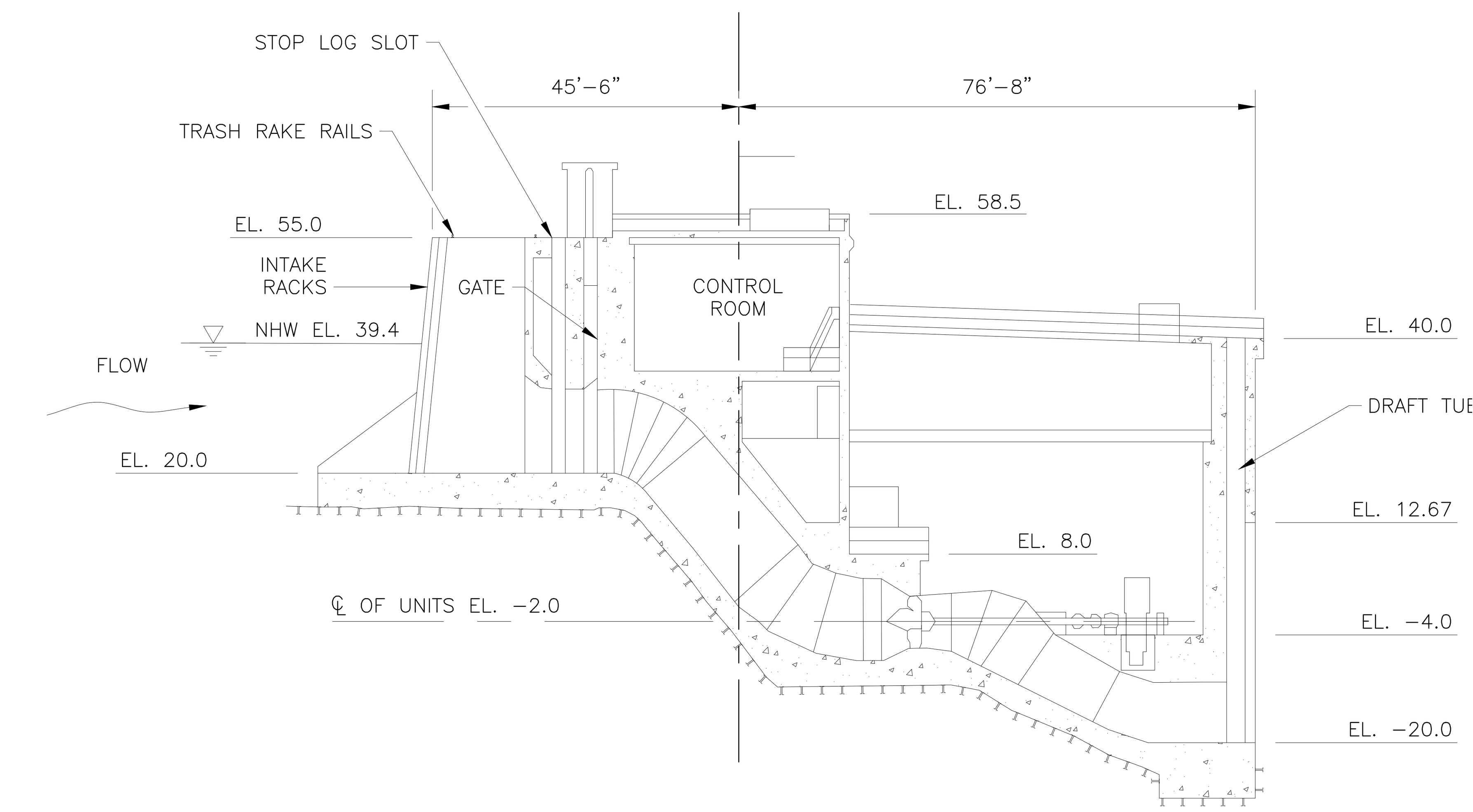
PROJECT PLAN
SCALE: 1"=80'

Alternative D3 - Floating Guidance Boom with New Downstream Surface Bypass Structure





2 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 1
1" = 20'



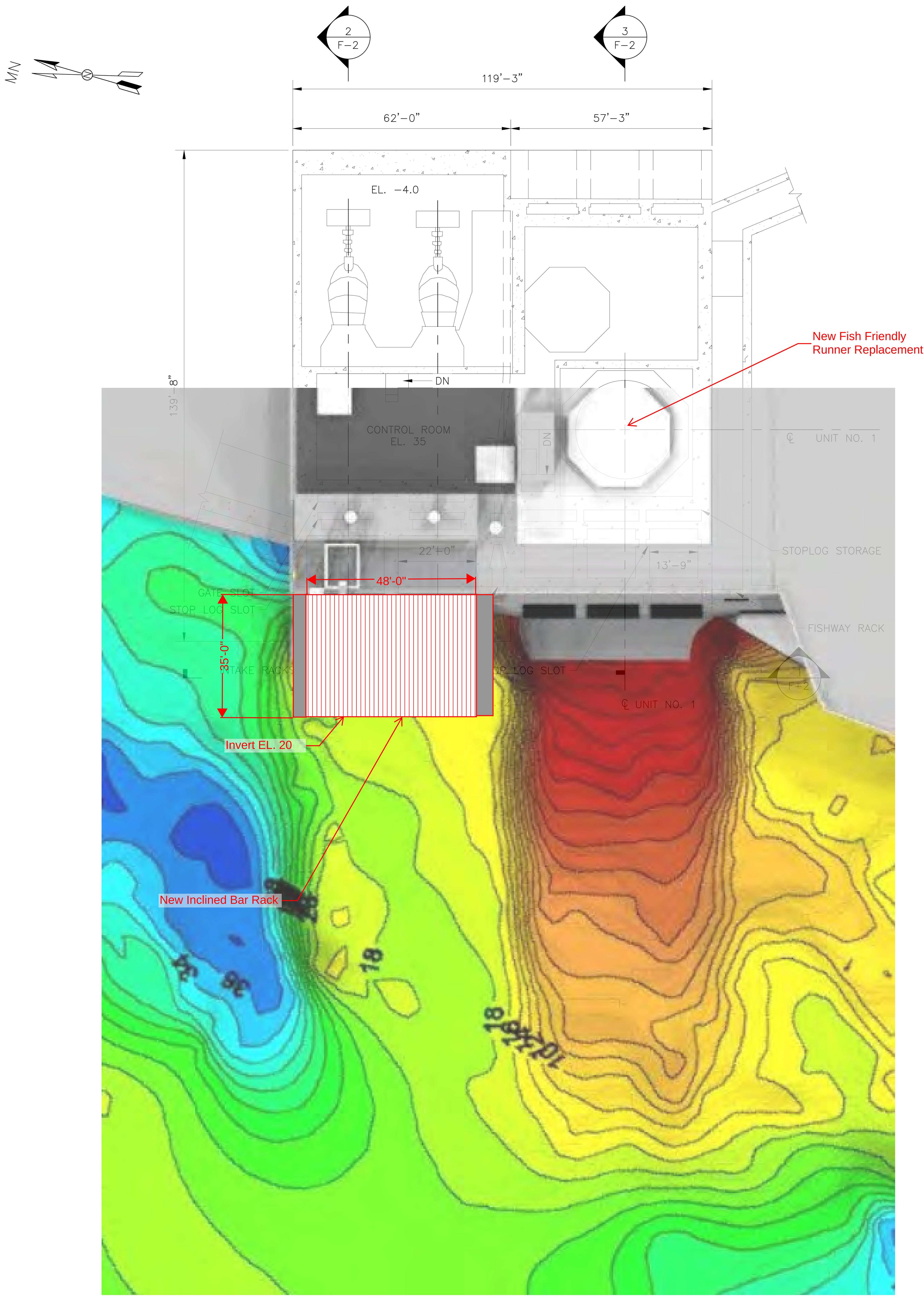
3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

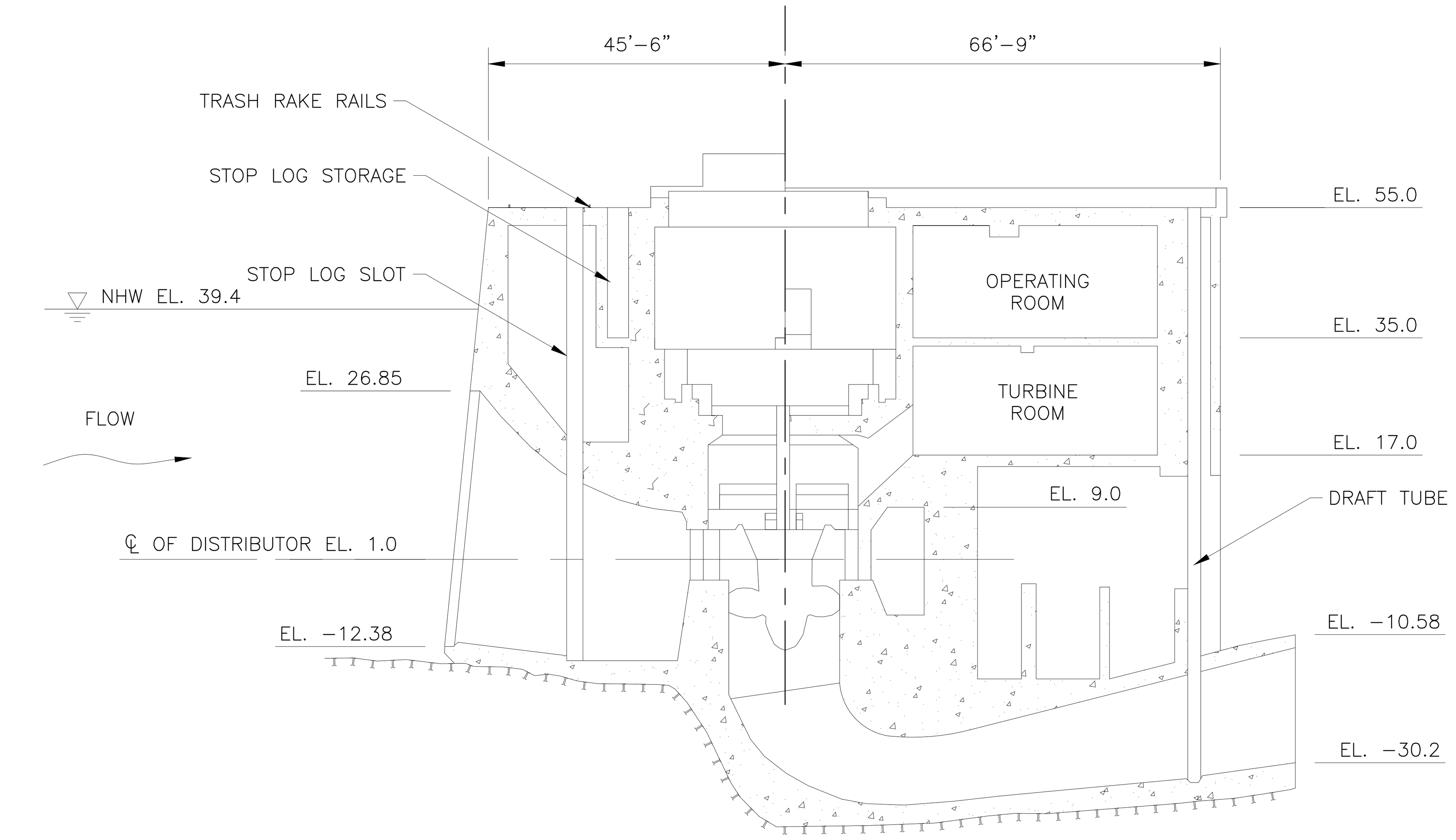
Alternative D4A - Multiple Fish Friendly Runner Replacements

20' 0 20' 40'
SCALE: 1" = 20'

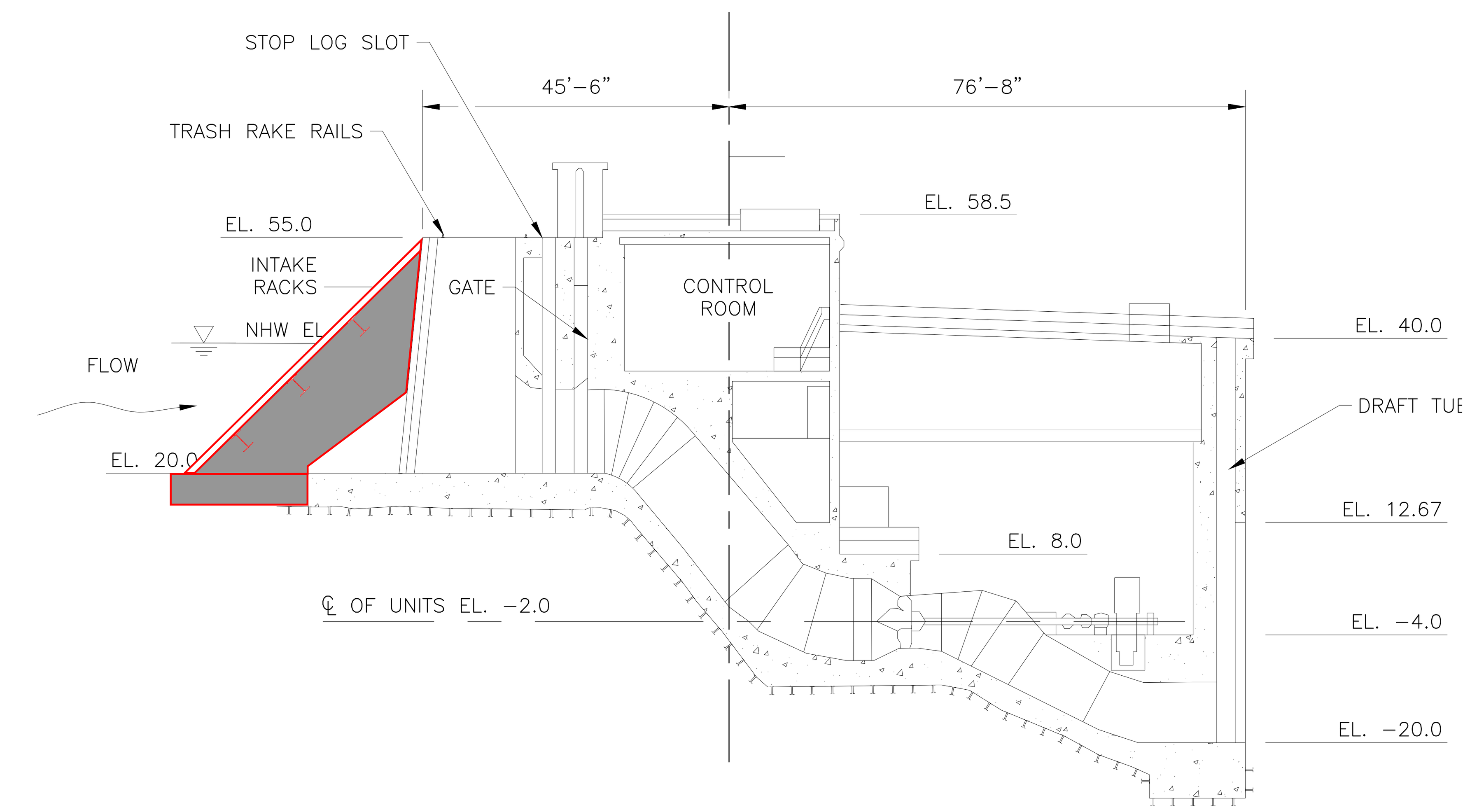
NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).





2 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 1
1" = 20'



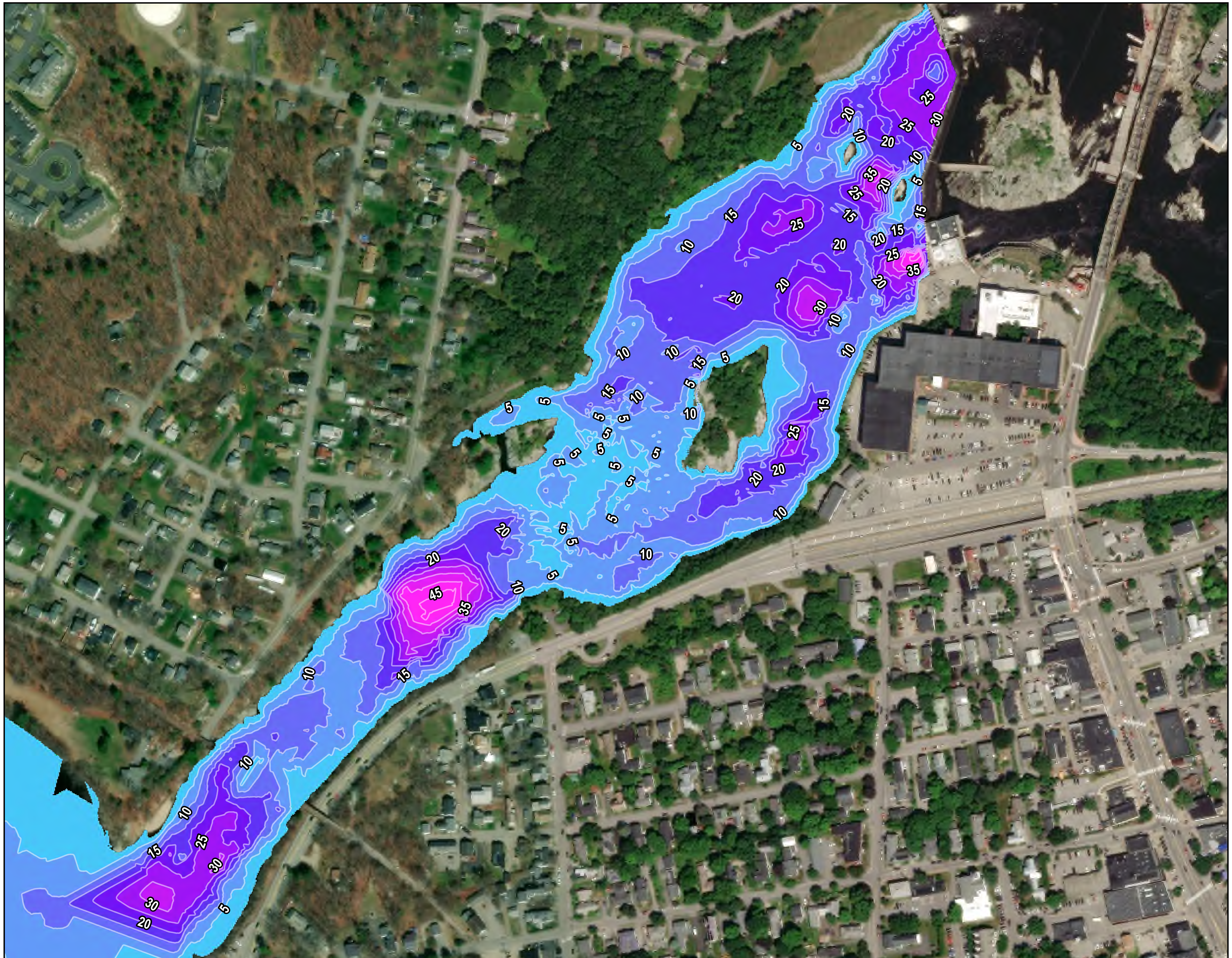
3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

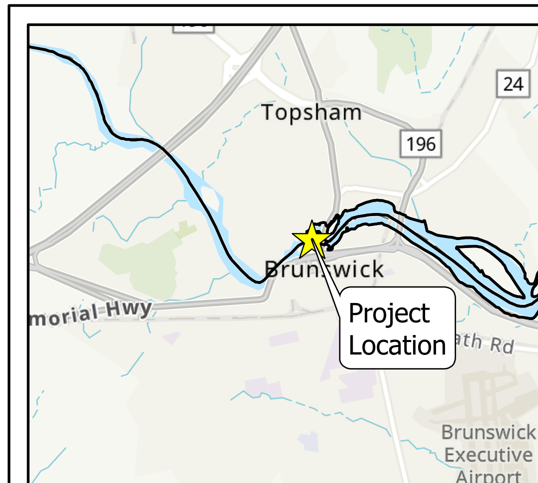
Alternative D4B - Single Fish Friendly Runner Replacement with Inclined Rack

20' 0 20' 40'
SCALE: 1" = 20'

NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).





Brunswick Hydroelectric Project
(FERC No. 2284)

Brunswick Impoundment
Water Depth in Feet

Legend

Depth

- < 5 ft
- 5 to 10 ft
- 10 to 15 ft
- 15 to 20 ft
- 20 to 25 ft
- 25 to 30 ft
- 30 to 35 ft
- 35 to 40 ft
- >40 ft

Service Layer Credits: World Imagery: Microsoft, Vantor
ME County Boundaries: MaineIT GIS
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

N

0 137.5 275 550 Feet

GOMEZ AND SULLIVAN ENGINEERS

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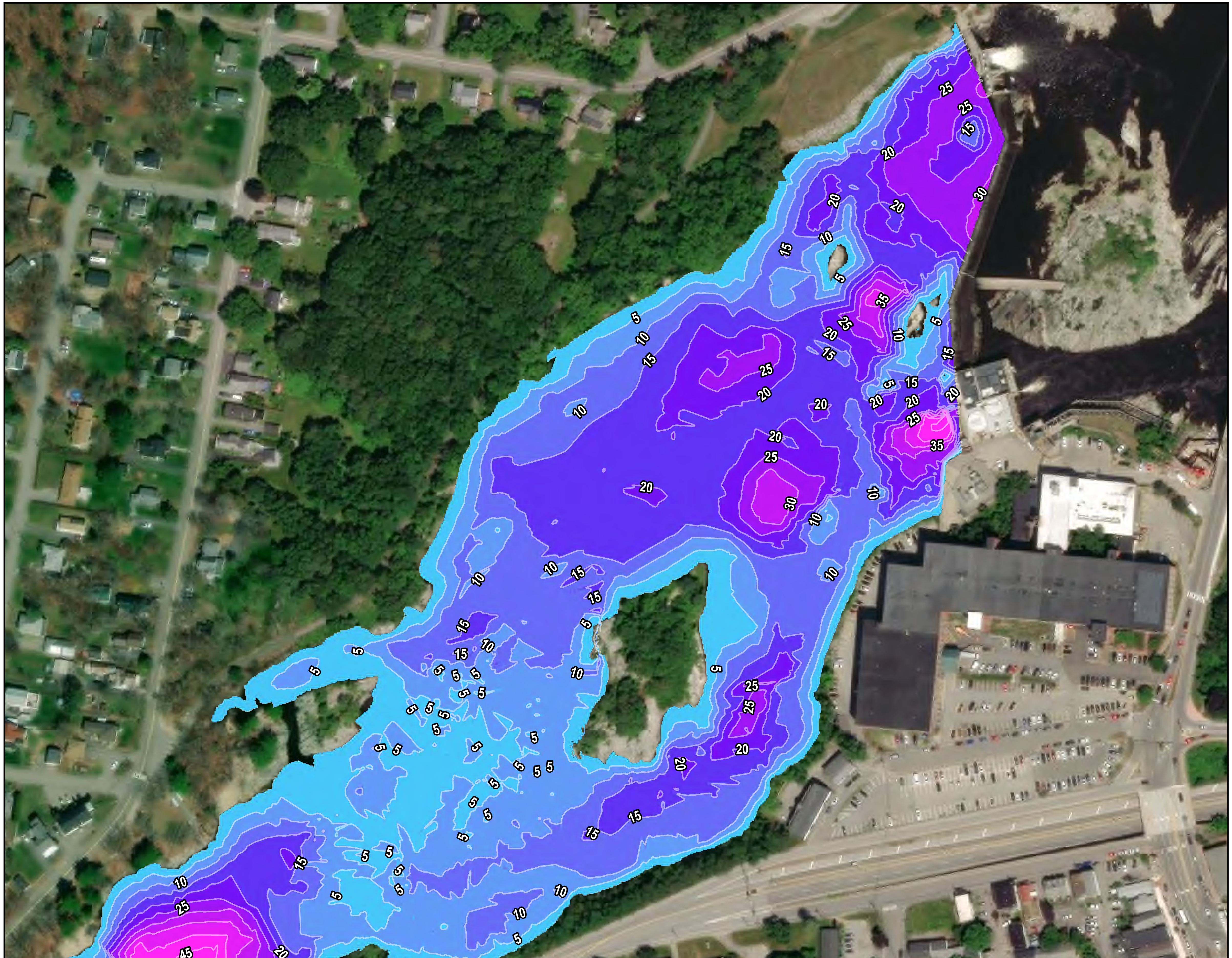

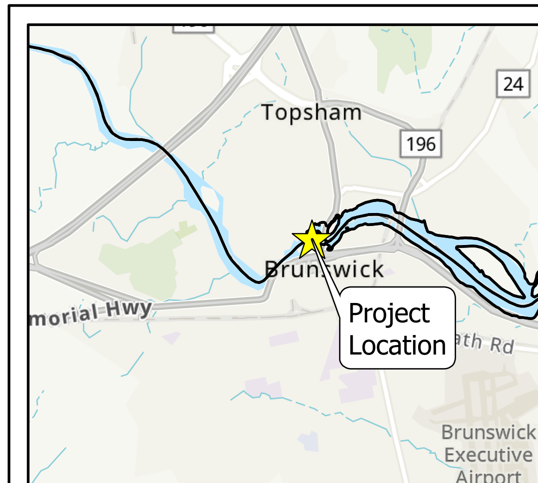

Brunswick Hydroelectric Project
(FERC No. 2284)

Brunswick Impoundment
Water Depth in Feet

Legend

Depth

- < 5 ft
- 5 to 10 ft
- 10 to 15 ft
- 15 to 20 ft
- 20 to 25 ft
- 25 to 30 ft
- 30 to 35 ft
- 35 to 40 ft
- >40 ft

Service Layer Credits: World Imagery: Microsoft, Vantor
ME County Boundaries: MaineIT GIS
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

N

0 85 170 340
Feet

GOMEZ AND SULLIVAN ENGINEERS

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Response to Comments Received at the January 26, 2026 Downstream Fish Passage Alternatives Study Meeting

Stakeholder	Comments	BWPH Response
Upstream and Downstream Fish Passage Alternatives Study		
MDMR-1	Downstream Alternative D1: Angled Bar Rack with New Downstream Bypass The current conceptual sketches of the angled bar racks include an isolation wall that separates Unit 1 and Unit 2/3 because the Unit 1 intake is deeper. Please describe why this isolation wall is required at the project and whether it could have windows or gaps in it to allow for equalization of velocities between the two intakes. During the call, engineers from Kleinschmidt indicated that there may be issues with high velocity hot spots in certain areas where the racks are close to the powerhouse. If this is the case, turbine turndowns could be one potential solution to address this issue. Another option for reducing velocities could be to extend the length of the racks such that a larger rack area interacts with the flow.	The isolation wall is required to provide structural support to the angled bar racks in front of each unit, as there is an approximately 32-foot difference in the bottom elevation between Unit 1 and Units 2/3, and an approximate 15-foot difference in the bottom of the angled rack structure. The need for any measures to equalize velocities between the two intakes will be informed by the CFD modeling study. Similarly, the velocity characteristics at the intakes for this alternative will be analyzed as part of the CFD modeling study, which will inform the need for any structural or operational changes (i.e., orientation, length, unit turndowns, etc.) to the conceptual design/layout to address high velocity. The results of this analysis will be described in the Upstream and Downstream Fish Passage Alternatives Study report.
MDMR-2	Downstream Alternative D2: Inclined Bar Rack with New Downstream Bypass The current conceptual sketch includes surface and low-level bypasses on the river side of the Unit 2/3 racks. Unlike the angled rack alternative, the inclined racks do not provide lateral guidance for fish to find a bypass location in that area and MDMR has concerns that the current design would not effectively attract fish. MDMR would recommend designing multiple surface and low level bypasses along the face of the racks so that turbine flow through the units serves as additional far field attraction. During the call, the licensee posited that fish would utilize the upstream fish passage as a downstream bypass. While some fish may use the upstream fishway, in MDMR's experience route of passage studies rarely report fish using the upstream fishway for downstream passage. Thus, MDMR would not recommend the upstream fishway to take the place of a dedicated downstream bypass unless there is guidance to the upstream fishway and the upstream fishway meets attraction flow and other criteria for a downstream bypass.	Based on the analysis to date, while it might be preferable to integrate the downstream bypass into the rack face structure, the existing layout of the intake structures does not allow for this type of solution. The velocity characteristics at the intakes for this alternative will be analyzed as part of the CFD modeling study. BWPH stated that fish may use the upstream fishway as a route of passage if that fishway were to remain in a similar configuration. However, BWPH was not recommending that the upstream fishway be used in lieu of the dedicated downstream bypasses described as part of this alternative.
MDMR-3	Downstream Alternative D3: Floating Guidance Boom with New Downstream Surface Bypass Structure MDMR agrees with the licensee's assessment that this alternative would have low effectiveness. In our experience, even surface oriented migrants (i.e., Atlantic salmon, river herring) often sound below guidance booms, making them ineffective at preventing fish from becoming entrained in the turbines. Entrainment is even more likely for fish that approach at depth (i.e., American eel and American shad), hence the need for additional measures to protect American shad and nighttime shutdowns to protect American eel. However, nighttime shutdowns have their own shortcomings, namely in diel and seasonal operation timelines and the need for adequate bypass flows while the turbines are shut down. In addition, the current alternative does not include a bypass structure that MDMR would consider adequate for attracting and conveying fish safely downstream in a timely and effective manner. For these reasons, MDMR is not supportive of this alternative in its current form. While a boom would require a flume extension to reduce impacts to upstream passage, that may not be the case if a new upstream passage facility was constructed at the project in a different location.	Several eel migration studies have been conducted in the Northeast and Mid-Atlantic regions to establish the diel and seasonal movement patterns of downstream migrating American eel. BWPH does see this as a significant limitation to the effectiveness of nighttime shutdowns. This alternative provides a new surface bypass with an attraction flow of approximately 375 cfs (5% of station discharge), as well as a plunge pool meeting USFWS design criteria at the base of the dam.
MDMR-4	Downstream Alternative D4A: Multiple Fish Friendly Runner Replacement Please provide information related to the service life of all three units. MDMR is supportive of investigating this alternative. However, as the licensee indicates, this technology is still experimental and as such, the licensee must be prepared to implement additional measures in a timely manner should this technology fail at the project. At this point in the process, it does not make sense to exclude additional downstream protective measures from this alternative. Modeling of similar alternatives at other projects has shown potential for higher injury and mortality for large fish (i.e., Atlantic salmon kelts, American shad). Thus, appropriate exclusion and guidance systems may be needed to ensure safe, timely, and effective passage at this site.	Information related to the service life of the turbine units will be provided in the Upstream and Downstream Fish Passage Alternatives Study report. Comment noted. The purpose of the Upstream and Downstream Fish Passage Alternatives Study is analysis of each alternative individually, if there is an advantage to combine alternatives that would be done as part of any PM&E proposal by BWPH.
MDMR-5	Downstream Alternative D4B: Unit 1 Fish Friendly Turbine with Inclined Bar Rack at Units 2 and 3 In the current configuration, there is no downstream bypass associated with Units 2/3. When those units are operating, it is reasonable to assume that fish will be attracted to the flow	See response to MDMR-3.

Stakeholder	Comments	BWPH Response
	through those turbines as opposed to the Unit 1 intake. Once those fish are attracted to that flow they will either be entrained in the units (some juvenile alosines) or will be guided vertically up the rack until at the surface. Without a clear downstream passage route in the vicinity of the Unit 2/3 rack, fish may experience unnecessary delay upstream of the project. Thus, this alternative should include a surface and low level bypass on the river left side of the racks to provide an additional downstream passage route for fish attracted to that location. The same comment from Alternative D4A about additional downstream protections applies to this alternative as well. Perhaps this should be considered "Downstream Alternative D4C," but constructing an angled rack over Units 2/3 could provide more effective guidance to a downstream bypass than an inclined rack. It is MDMR's understanding that certain unit prioritization measures are practiced at the project to attempt to improve upstream passage. Please evaluate this alternative and others as appropriate based on existing and proposed operational scenarios at the project.	The intent of this alternative is to provide the downstream passage route through a new fish friendly runner in Unit 1 and alleviate the need for a dedicated downstream fish bypass. Unit 1 has a hydraulic capacity of 5,075 cfs, which exceeds the USFWS criteria of approximately 375 cfs (5% of station discharge), as well as the combined capacity of 2,400 cfs for Units 2/3. With the larger Unit 1 adjacent to Units 2/3 it would provide similar attraction cues to any surface and low-level bypass located on the spillway side of the powerhouse. BWPH implements unit prioritization during the downstream Atlantic Salmon smolt passage season (~May) with the exact timing determined annually through resource agency consultation. This is a condition of the final Atlantic Salmon Species Protection Plan that was incorporated into the Project license in 2022. However, BWPH is not aware of any unit prioritization during the upstream fish passage season.
MDMR-6	Alternatives Not Considered MDMR supports comments made by NOAA and other meeting participants during the January 27th meeting regarding the need to fully evaluate a comprehensive range of alternatives during this phase of the study. The Brunswick Dam is the first dam on the Androscoggin River and is located at the head of tide. Its position in the watershed means it affects all upstream migrating fish approaching the project, as well as those that successfully pass upstream and must later migrate downstream to the ocean. Given the ecological importance of head of tide locations and lessons learned from other Maine systems, including the Kennebec River, Penobscot River, St. Croix River, and Presumpscot River, MDMR recommends that the alternatives analysis rigorously evaluate the full spectrum of potential structural and operational approaches capable of providing safe, timely, and effective upstream and downstream passage at this critical river location. A comprehensive analysis will ensure that decision makers understand the biological performance, engineering feasibility, cost considerations, and long-term maintenance implications of each option. Public comments during the January 15th and January 27th meetings referenced the potential construction of a nature-like channel on river left near the existing tainter gates. MDMR supports evaluation of a nature like fishway alternative as part of the broader alternatives analysis for upstream and downstream passage. However, MDMR notes that while a nature like channel may improve upstream passage conditions, it may not alone provide adequate downstream passage, as a substantial portion of river flow, and therefore migrating fish, would continue to pass through the powerhouse. Accordingly, the study should also assess the need for complementary downstream passage measures, such as intake racks, operational curtailments, surface guidance structures, and fish friendly turbine technologies, to ensure a holistic and effective passage solution.	Comment noted. Discussion of the nature-like fishway alternative was the subject of a separate meeting held on March 5, 2026. Participants were asked to provide any written comments on that discussion by April 6, 2026. BWPH will provide responses at that time.
MDMR-7	No Action (Maintain Existing Conditions) MDMR was pleased to see this alternative excluded from further analysis as it is clear from the information available at this time that existing facilities do not meet USFWS guidelines and do not provide safe, timely, and effective passage for downstream migrants.	Comment noted.
MDMR-8	Additional Comments Please include a flow duration analysis to investigate how often flows exceed the capacity of all three units during the downstream passage season. Given the height and configuration of the dam's spillway, spillway passage may not provide a safe route for downstream migrants. Each alternative should include an approach to 1) study where spill occurs at the project and the impacts of spill passage on injury and mortality of migrating fish or 2) provide a proposal to concentrate spill under most conditions in an area that provides an appropriate receiving water for downstream migrants. This additional flow could be concentrated near the entrance of an upstream fishway to bolster far-field attraction.	BWPH will include a flow duration analysis in the Upstream and Downstream Fish Passage Alternatives Study report. Comment noted. Where appliable, several alternatives provide for a new surface and/or low-level bypass flow with an attraction flow of approximately 375 cfs (5% of station discharge), as well as a plunge pool meeting USFWS design criteria at the base of the dam.
FOMB-1	Our comments are brief at this time and are primarily that the full range of upstream and downstream fish [and eel] passage possibilities need to be on the table including: A. Dam decommissioning and removal with site restoration B. Nature-like passage on the north side of river heading up in vicinity of the tainter gates. If there is a lack of real estate on shore, an instream construction may need to be investigated. C. ½" clear spacing on any fish exclusion grates Unless the cost/benefit of these possibilities are investigated and made known, any analysis will be woefully incomplete.	BWPH will not be analyzing a dam decommissioning alternative as part of the Upstream and Downstream Fish Passage Alternatives Study report. In its December 30, 2024 Study Plan Determination as well as the July 29, 2024 Scoping Document 2, FERC determined that neither a decommissioning study nor the analysis of project decommissioning as a reasonable alternative in the NEPA document was warranted as part of the relicensing proceeding.

Stakeholder	Comments	BWPH Response
		In the Study Plan Determination FERC stated that "*BWPH does not propose decommissioning, nor does the project record demonstrate that there are serious resource concerns that cannot be mitigated if the project is relicensed with appropriate resource protection measures. Information from other studies (Computational Fluid Dynamics Modeling; Upstream and Downstream Fish Passage Alternatives Study; Visual Surveys of Upstream American Eel Movements; Diadromous Fish Behavior, Movement, and Project Interaction Study; and the Evaluation of Stranding Risk/Bathymetry Study) should provide the information needed to identify potential passage improvements. Therefore, because decommissioning has been eliminated as a reasonable alternative to relicensing, there is no justification for recommending a study of decommissioning the Brunswick Dam.*" Discussion of the nature-like fishway alternative was the subject of a separate meeting held on March 5, 2026. Participants were asked to provide any written comments on that discussion by April 6, 2026. BWPH will provide responses at that time. BWPH will be applying USFWS fish passage engineering guidelines to the selection of trashrack spacing. Currently, those guidelines recommend ¾-inch spacing for American eel and 1-inch spacing for salmon smolts.
FTA-1	Please note that there is a factual error in that the follow-on meeting held on January 27 included only a discussion of matrices for downstream fish passage. It was agreed that an additional meeting to discuss upstream passage would be scheduled. As of this writing that meeting has not occurred. It is now scheduled for March 5, 2026. Therefore, stakeholders have not had the opportunity to review or discuss any upstream fish passage alternatives being considered or not being considered.	A meeting to discuss upstream passage alternatives was held on March 5, 2026. Participants were asked to provide any written comments on that discussion by April 6, 2026. BWPH will provide responses at that time.
FTA-2	The FTA wants the record to reflect that both dam removal and analyses of nature like fishway designs should be considered for technical feasibility. Otherwise, the matrices for both Upstream and Downstream design analyses will be missing important components. Further, at one point during the January 27th meeting a downstream fishway design consultant mentioned that Brookfield did not want a certain design considered. It was then noted by a representative of the Maine Department of Marine Resources, that a licensee cannot make unilateral decisions to preclude analyses based on internal assumptions about feasibility.	See response to FOMB-1.
FTA-3	FTA concurs that the fishways alternatives analysis must consider more options to determine technical feasibility. This is not unreasonable or outside the scope of the current suggested study plan because all parties understand that these will ultimately lead into later discussions about costs and benefits as also included in the Revised Study Plan (RSP) as filed December 2, 2024. Having these alternatives considered will take into consideration a full range of designs, including dam removal and nature-like fish passage that can be compared when cost and benefits are analyzed. This separation of alternative fishway technical feasibility and cost analyses is something FTA commented on and supported with its February 19, 2024, filing. In good faith this needs to be followed as described in the RSP.	See response to FOMB-1.
FTA-4	Regarding other designs included in the downstream fishway analysis, the FTA agrees with comments from NOAA Fisheries and others that effective downstream fish passage using Natel's Fish Safe designs for improved turbine runners would be a very powerful solution for effective, low mortality downstream fish passage if they meet theoretical design criteria for passage. However, it is noted in the matrix provided that these designs are experimental and would require further feasibility analyses by Natel. FTA notes that other "experimental and untested" alternatives were considered and rejected on those grounds. Therefore, if the Natel alternatives are pursued, FTA would like to see strongly stated support from participating federal and state agencies based on their respective assessment about the likelihood that this type of downstream passage will be effective. Given the unique nature of every dam location, we believe any option pursued would be an experiment. So, while we are certainly open to innovation, it should have attached license contingencies that require goal setting for fish passage, monitoring of efficacy, and further adaptation if passage goals are not met.	FTA suggests that some alternatives in the downstream fish passage matrix were considered and rejected solely on their experimental nature. This is inaccurate. The experimental technologies that were rejected were previously implemented at other sites and have empirical data showing limited success in achieving fish passage objectives, hence the reason for their elimination for further consideration. To date the Natel FishSafe runners have not been implemented extensively, and limited empirical data exists on their effectiveness. However, their potential application at this Project appears to be worth additional consideration.

Stakeholder	Comments	BWPH Response
FTA-5	A FERC license is a privilege and not a right. In this case, it allows users of a public resource, like the Androscoggin, to produce profits for private industry. The dam is owned by a subsidiary of Brookfield Renewable Partners which is a publicly traded Canadian-based, multinational company that generates electricity for sale on the open market. It has been broadly reported that Brookfield and its subsidiaries own more than 80 percent of the hydro-electric production capacity in Maine. This heavily weighted presence by one owner needs to be considered because of the potential for its operations to impact not only Brunswick but nearly every other major river in Maine. Recognizing and enforcing the fact that the right to operate hydroelectric facilities by privately held entities is a privilege and that the river systems they use are a public and not a private resource is imperative. Proper management of diadromous fish passage at the first dam on this river inland from the ocean and a demonstrated impasse to federally protected species like the Atlantic Salmon and keystone ecological species like Alewives is also an imperative. Again, it is the intent of the Free the Andro coalition work with the licensee, FERC, authorized regulatory agencies, and other stakeholders in consultation to arrive at a well-researched and stakeholder supported solution that removes diadromous fish passage problems at the Brunswick Dam site.	Brookfield hydroelectric assets in Maine are regulated by FERC. Under the authority of the Federal Power Act (FPA), FERC may issue licenses for terms ranging from 30 to 50 years for the construction, operation, and maintenance of non-federal hydroelectric projects. This applies to all Brookfield owned hydroelectric assets in Maine. The National Environmental Policy Act (NEPA) of 1969, the Commission's regulations, and other applicable laws require that FERC independently evaluate the environmental effects of relicensing the project and consider reasonable alternatives to mitigate identified environment impacts. FERC conducted a site visit of the Project and held scoping meetings on May 7, 2024, to hear the views of all interested resource agencies and other stakeholders on the scope of issues that should be addressed in the NEPA document. Additionally, there are also numerous other opportunities in the relicensing process for relicensing stakeholders to provide input to FERC. FERC will prepare either an environmental assessment or an environmental impact statement that describes and evaluates the probable effects, including an assessment of the site-specific and cumulative effects, if any, of the alternatives. The NEPA analysis will be supported by the twelve (12) environmental studies that BWPH is conducting as part of the relicensing process, as well as other relevant readily available information. The NEPA document will be prepared after BWPH submits its Final License Application in February 2027. Through this process FERC will determine under what terms and conditions to issue a new license for the Project to balance both energy generation and environmental interests.

STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
21 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0021

JANET T. MILLS
GOVERNOR

CARL J. WILSON
COMMISSIONER

March 2, 2026

Debbie-Anne Reese, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington D.C. 20426

Re: MDMR Comments on Initial Study Report (ISR) for the Brunswick Hydroelectric Project (P-2284)

Dear Secretary Reese:

On December 31, 2025, Brookfield White Pine Hydro LLC (Licensee) filed their Initial Study Report with the Federal Energy Regulatory Commission.

MDMR looks forward to continued collaboration with the Licensee on diadromous fish passage at the Brunswick project. Please contact Casey Clark (casey.clark@maine.gov; 207-350-9791) or Lars Hammer (lars.hammer@maine.gov; 207-557-1564) if you have any questions.

Sincerely,

Sean Ledwin

Sean Ledwin
Director, Bureau of Sea Run Fisheries and Habitat

Cc: DEP. Laura Paye, Rob Wood
MDIFW, Jim Pellerin, Nicholas Kalejs
MOCA: Erin Wilson
NMFS, Matt Buhyoff, Don Dow
USFWS, Patrick Dockens, Kimberly Spiller

OFFICES AT 32 BLOSSOM LANE, MARQUARDT BUILDING, AUGUSTA, MAINE
http://www.Maine.gov/dmr
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Executive Summary

Brookfield White Pine Hydro (Licensee) submitted an Initial Study Report (ISR) for the Brunswick Hydroelectric Project (P-2284) on December 31, 2025. The ISR reported on study progress for 13 studies conducted at the project during 2025. The licensee also held an ISR meeting on January 15, 2026, and additional follow-up meetings to discuss downstream passage alternatives at the project (January 27, 2026) and the diadromous fish movement, behavior, and interaction study (January 28, 2026). Enclosed are specific comments from the Maine Department of Marine Resources (MDMR) related to five of the studies conducted by the Licensee.

Computational Fluid Dynamics Study (page 87)

MDMR looks forward to reviewing additional data and results from the tasks identified for this study as they are completed.

Upstream and Downstream Fish Passage Alternatives Study (page 92)

The licensee provided a draft downstream alternatives matrix to MDMR on January 20, 2026 and a draft upstream alternatives matrix on March 2, 2026 (today's date). Given the dates these documents were provided in relation to the ISR comment deadline (March 2, 2026), MDMR has only been able to review the downstream alternatives matrix. Thus, our comments focus solely on downstream passage at this time.

Downstream Alternative D1: Angled Bar Rack with New Downstream Bypass

The current conceptual sketches of the angled bar racks include an isolation wall that separates Unit 1 and Unit 2/3 because the Unit 1 intake is deeper. Please describe why this isolation wall is required at the project and whether it could have windows or gaps in it to allow for equalization of velocities between the two intakes.

During the call, engineers from Kleinschmidt indicated that there may be issues with high velocity hot spots in certain areas where the racks are close to the powerhouse. If this is the case, turbine turndowns could be one potential solution to address this issue. Another option for reducing velocities could be to extend the length of the racks such that a larger rack area interacts with the flow.

Downstream Alternative D2: Inclined Bar Rack with New Downstream Bypass

The current conceptual sketch includes surface and low-level bypasses on the river side of the Unit 2/3 racks. Unlike the angled rack alternative, the inclined racks do not provide lateral guidance for fish to find a bypass location in that area and MDMR has concerns that the current design would not effectively attract fish. MDMR would recommend designing multiple surface and low level bypasses along the face of the racks so that turbine flow through the units serves as additional far field attraction.

During the call, the licensee posited that fish would utilize the upstream fish passage as a downstream bypass. While some fish may use the upstream fishway, in MDMR's experience route of passage studies rarely report fish using the upstream fishway for downstream passage. Thus, MDMR would not recommend the upstream fishway to take the place of a dedicated downstream bypass unless there is guidance to the upstream fishway and the upstream fishway meets attraction flow and other criteria for a downstream bypass.

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http://www.Maine.gov/dmr

Downstream Alternative D3: Floating Guidance Boom with New Downstream Surface Bypass Structure

MDMR agrees with the licensee's assessment that this alternative would have low effectiveness. In our experience, even surface oriented migrants (i.e., Atlantic salmon, river herring) often sound below guidance booms, making them ineffective at preventing fish from becoming entrained in the turbines. Entrainment is even more likely for fish that approach at depth (i.e., American eel and American shad), hence the need for additional measures to protect American shad and nighttime shutdowns to protect American eel. However, nighttime shutdowns have their own shortcomings, namely in diel and seasonal operation timelines and the need for adequate bypass flows while the turbines are shut down. In addition, the current alternative does not include a bypass structure that MDMR would consider adequate for attracting and conveying fish safely downstream in a timely and effective manner. For these reasons, MDMR is not supportive of this alternative in its current form.

While a boom would require a flume extension to reduce impacts to upstream passage, that may not be the case if a new upstream passage facility was constructed at the project in a different location.

Downstream Alternative D4A: Multiple Fish Friendly Runner Replacement

Please provide information related to the service life of all three units.

MDMR is supportive of investigating this alternative. However, as the licensee indicates, this technology is still experimental and as such, the licensee must be prepared to implement additional measures in a timely manner should this technology fail at the project.

At this point in the process, it does not make sense to exclude additional downstream protective measures from this alternative. Modeling of similar alternatives at other projects has shown potential for higher injury and mortality for large fish (i.e., Atlantic salmon kelts, American shad). Thus, appropriate exclusion and guidance systems may be needed to ensure safe, timely, and effective passage at this site.

Downstream Alternative D4B: Unit 1 Fish Friendly Turbine with Inclined Bar Rack at Units 2 and 3

In the current configuration, there is no downstream bypass associated with Units 2/3. When those units are operating, it is reasonable to assume that fish will be attracted to the flow through those turbines as opposed to the Unit 1 intake. Once those fish are attracted to that flow they will either be entrained in the units (some juvenile alosines) or will be guided vertically up the rack until at the surface. Without a clear downstream passage route in the vicinity of the Unit 2/3 rack, fish may experience unnecessary delay upstream of the project. Thus, this alternative should include a surface and low level bypass on the river left side of the racks to provide an additional downstream passage route for fish attracted to that location. The same comment from Alternative D4A about additional downstream protections applies to this alternative as well.

Perhaps this should be considered "Downstream Alternative D4C," but constructing an angled rack over Units 2/3 could provide more effective guidance to a downstream bypass than an inclined rack.

It is MDMR's understanding that certain unit prioritization measures are practiced at the project to attempt to improve upstream passage. Please evaluate this alternative and others as appropriate based on existing and proposed operational scenarios at the project.

No Action (Maintain Existing Conditions)
MDMR was pleased to see this alternative excluded from further analysis as it is clear from the information available at this time that existing facilities do not meet USFWS guidelines and do not provide safe, timely, and effective passage for downstream migrants.

Alternatives Not Considered

MDMR supports comments made by NOAA and other meeting participants during the January 27th meeting regarding the need to fully evaluate a comprehensive range of alternatives during this phase of the study. The Brunswick Dam is the first dam on the Androscoggin River and is located at the head of tide. Its position in the watershed means it affects all upstream migrating fish approaching the project, as well as those that successfully pass upstream and must later migrate downstream to the ocean. Given the ecological importance of head of tide locations and lessons learned from other Maine systems, including the Kennebec River, Penobscot River, St. Croix River, and Presumpscot River, MDMR recommends that the alternatives analysis rigorously evaluate the full spectrum of potential structural and operational approaches capable of providing safe, timely, and effective upstream and downstream passage at this critical river location. A comprehensive analysis will ensure that decision makers understand the biological performance, engineering feasibility, cost considerations, and long-term maintenance implications of each option.

Public comments during the January 15th and January 27th meetings referenced the potential construction of a nature-like channel on river left near the existing tainter gates. MDMR supports evaluation of a nature like fishway alternative as part of the broader alternatives analysis for upstream and downstream passage. However, MDMR notes that while a nature like channel may improve upstream passage conditions, it may not alone provide adequate downstream passage, as a substantial portion of river flow, and therefore migrating fish, would continue to pass through the powerhouse. Accordingly, the study should also assess the need for complementary downstream passage measures, such as intake racks, operational curtailments, surface guidance structures, and fish friendly turbine technologies, to ensure a holistic and effective passage solution.

Additional Comments

Please include a flow duration analysis to investigate how often flows exceed the capacity of all three units during the downstream passage season. Given the height and configuration of the dam's spillway, spillway passage may not provide a safe route for downstream migrants. Each alternative should include an approach to 1) study where spill occurs at the project and the impacts of spill passage on injury and mortality of migrating fish or 2) provide a proposal to concentrate spill under most conditions in an area that provides an appropriate receiving water for downstream migrants. This additional flow could be concentrated near the entrance of an upstream fishway to bolster far-field attraction.

<u>Visual Surveys of Upstream American Eel Movements Study (page 95)</u>

PDF Page 106: "The temporary eel ramps were operated once weekly, concurrent with each visual survey. Temporary eel ramps were installed during the daylight hours prior to each nighttime survey and viewed (as allowable from vantage points defined in Section 4.1) during the survey."

MDMR Comment: Deployment and removal of eel ramps/traps required a headpond drawdown. Please describe the changes in operations required to install and remove ramps/traps and how that may have impacted the numbers and locations in which eels were found.

PDF Page 106: "BWPH and Normandeau staff met onsite with representatives from the Maine Department of Marine Resources (MDMR) on May 30, 2025. At that time, three prospective locations for the placement of the temporary eel ramps were identified in the portion of the spillway bypass area in the vicinity of the Tainter gate structures."

MDMR Comment: MDMR appreciates the opportunity to participate in the May 30, 2025 site visit in connection with the stranding study demonstration. However, we would like to clarify that MDMR staff were not notified in advance that placement of temporary eel ramps would be discussed during that visit. During a brief conversation onsite with Normandeau staff, three potential locations adjacent to the Tainter gates were identified. Additional areas were also discussed, including locations on both sides of the barrier wall between the dam and Shad Island.

Given the limited and informal nature of that discussion, MDMR does not consider it to have constituted adequate consultation on temporary eel ramp placement. A dedicated meeting, or at minimum prior notice that ramp placement would be discussed, would have allowed for more thorough evaluation and input.

PDF Page 108: "Survey crews noted observations indicating small amounts of observable flow over the spillway structure that was associated with slight overtopping at full pond."
MDMR Comment: Please describe whether overtopping flows were concentrated in particular locations. Also please describe any other sources of flow and variations in those flows in the bypass reach other than minimal flow over the spillway and eelway attraction.

PDF Page 124: "Upon further evaluation in the field, the third location identified during the May 30, 2025 site visit was determined to be too steep and slippery to safely install and maintain a temporary eel ramp (Figure 5-12)."
MDMR Comment: If the licensee had consulted with MDMR, we would have suggested an alternative location for this temporary ramp.

PDF Page 131: "As demonstrated during this 2025 study, juvenile eels are present in significant numbers downstream of the Project during the expected upstream passage period (e.g., June to August)."
MDMR Comment: Given the very high numbers of eels observed at the project (58,272) across 12 survey dates, lack of upstream passage facilities for eels at the project, and availability of temporary eel passage structures, MDMR would request that Brookfield White Pine Hydro voluntarily operate and maintain a temporary eel trap at the project until subsequent license issuance and implementation of permanent upstream eel passage at the site.

<u>Diadromous Fish Behavior, Movement, and Project Interaction Study (page 136)</u>

On January 28, MDMR met with the licensee to further discuss the study plan for Phase II of the Diadromous Fish Behavior, Movement, and Project Interaction study. On February 2, the licensee provided a revised draft of the study plan in response to comments received during the January 28 meeting, and an additional draft on February 10. MDMR provides additional comments below related to the revised study plan.

PDF Page 1: “Transmitters”
MDMR Comment: During the January 28 call, MDMR requested that all fish be tagged with SS300 tags (i.e., pressure tags) to maximize the amount of 3D data collected during the study. The licensee initially agreed to this request, however on February 10, they provided information from the tag manufacturer that indicated many tags detected simultaneously could interfere with accurate data analysis, particularly with the pressure data. The licensee’s updated proposal is to tag 20% of each species with SS300 tags and the rest with SS400 tags. MDMR notes that this approach is consistent with the original study plan. Based on the new information from the manufacturer, MDMR supports this approach.

PDF Page 3: “Lastly, to address agency interest in tagged fish presence in the region downstream of the ledge habitat located at the outlet of the spillway bypass area up to two additional stationary receivers will be installed in that region.”
MDMR Comment: MDMR appreciates the inclusion of these receivers in the study plan. Based on what we heard from the consultant team, it is MDMR’s impression that a minimum of 2 receivers will be needed to adequately cover this area.

Evaluation of Stranding Risk/Bathymetry Study (page 225)

PDF Page 236: “The environmental conditions allowed for a period when the study could be scheduled in May when river herring and other anadromous species would likely be present in the vicinity of the Project.”
MDMR Comment: Please edit this sentence to specify adult river herring as the survey was likely too early to see any juvenile river herring.

PDF Page 239: “One juvenile American Eel and one juvenile Smallmouth Bass were observed in one of the Area 2 pools.”
MDMR Comment: As noted during the call, MDMR staff observed one lamprey ammocoete in Area 2. Please include that observation in this report.

PDF Page 244: “The Shad Falls ledges appear adequate at excluding non-anguillid fish from moving upstream into the river left channel under normal spring/summer flow conditions.”
MDMR Comment: MDMR agrees that it is unlikely for upstream migrating adult alosines to be able to pass the ledges in their current modified configuration. However, it is MDMR’s opinion that Atlantic salmon could potentially leap over the falls, particularly at higher flow conditions than were observed (i.e., no inflow to river left channel) while the field crew was downstream of the dam during the stranding study.

February 27, 2026

VIA E-FILING

Debbie-Anne A. Reese, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Brunswick Hydroelectric Project (FERC No. 2284). Free the Andro coalition Comments on the Initial Study Report Meeting Summary and the Downstream Passage Alternatives Meeting.

Dear Secretary Reese:

Free the Andro is using these comments to follow and build on the comments filed by the Merrymeeting Bay Chapter of Trout Unlimited on the Notice of Intent (NOI)/Pre-application Document for the Brunswick Project (Docket: P-2248) on February 19, 2024 and comments filed on the Revised Study Plan: Brunswick Hydroelectric Project (FERC No. 2284 on December 14, 2024. Since the earlier filings, Merrymeeting Bay Trout Unlimited has joined with other founding members: Maine Rivers, American Rivers, Restore the North Woods, and Friends of Merrymeeting Bay along with their individual members to form the Free the Andro coalition (FTA). FTA respectfully submits these comments on the Brookfield Initial Study Report (ISR) Meeting Summary filed January 30, 2026 and its subsequent Downstream Alternatives Meeting Summary provided to agencies and interested parties on February 9, 2026 in conformance with the Commission's Criteria for Modification of Approved Study (18 C.F.R. § 5.15(d))

Introduction and Basis for Action:

The Brunswick Dam is the first dam inland from the Atlantic Ocean located on the Androscoggin River at a site also known as Brunswick Falls. The Androscoggin is Maine's third largest river with a length of 178 miles, draining a watershed of 3,450 square miles. The Brunswick Dam's location is at the head of tide and the key barrier relative to the health of diadromous species that access the river as part of their life cycle, including the Atlantic Salmon which are listed under the Endangered Species Act.

The dam is now being considered for relicensing by the Federal Energy Regulatory Commission (FERC). It has been 47 years since the current license was issued in 1979. This process represents a rare opportunity to take aggressive steps at a critical juncture in the history of the river's use for human welfare and the natural riverine communities it supports.

The FTA was formed with the mission to seek removal of obstacles to upstream and downstream passage of sea-run fish (diadromous species) in the Androscoggin River at the site of the Brunswick Dam. The groups' primary goal is to achieve changes in the FERC license terms that will allow remnant populations of diadromous fish to again ascend the falls to reach their historical spawning grounds and complete their respective life cycles with effective volitional upstream and downstream passage. The FTA has been actively participating in the relicensing process to work with all interested parties to review and apply the best available science and engineering applications to fix the problems created by the dam to restore truly effective volitional diadromous fish passage.

A key tenet supporting our action as stakeholders in this process is that the use of a publicly held, common resource like the Androscoggin River to produce hydro-electric power for sale by for-profit entities on open markets is a privilege and not a right. Per the Federal Power Act, key the elements of the river's human and ecological uses must be balanced by FERC when it is considering license renewal. Specifically, FERC is an independent federal agency with a mission to regulate and oversee energy industries in the economic, environmental, and safety interests of the American public. This mandate requires FERC to consider public input which is key to making changes in how the dam is operated and fish passage improved.

Further As codified in Section 10(a)(1) of the Federal Power Act, a hydropower project must serve the public interest, not just the Licensee's interest in power generation. Per the "Androscoggin River Watershed Comprehensive Plan for Diadromous Fishes" published by NOAA Fisheries Greater Atlantic Regional Fisheries Office in 2020[1]:

"The Androscoggin River produces 257 MW of electrical generation. The associated dams and project operations are a significant contributor to the severe depletion or extirpation of the diadromous fishery to levels unsustainable without the intervention of resource agencies. This lack of balance between energy and fishery resources – a public trust resource - suggests that the development of the Androscoggin River does not meet a comprehensive development standard." Page 71.

Members of the FTA joined the two meetings noted and have the following comments on each:

1) **Initial Study Report Meeting Summary for 1/15/26 Meeting filed with FERC on 1/30/26:**

Per the Section entitled "Upstream Downstream Fish Passage Studies, subsection Task 1 Summary: Phase 1-Alternatives Analysis" it is stated that BWPH developed upstream and downstream screening matrices as follows:

- Identified ~12 initial alternatives for each passage route.
- Narrowed each list to ~4 potentially applicable alternatives.
- Matrices include descriptions, evaluation criteria, costs, operations, and conceptual sketches.
- Stakeholder meeting scheduled for January 27, 2026, to review and finalize alternatives.
- Phase 1 Alternatives Analysis Report to be completed in Q1 2026.

[1] NOAA Fisheries. 2020. Androscoggin River Watershed Comprehensive Plan for Diadromous Fishes. Greater Atlantic Region Policy Series 20-01. NOAA Fisheries Greater Atlantic Regional Fisheries Office - www.greateratlantic.fisheries.noaa.gov/policyseries/. 136 pp.

Please note that there is a factual error in that the follow-on meeting held on January 27 included only a discussion of matrices for downstream fish passage. It was agreed that an additional meeting to discuss upstream passage would be scheduled. As of this writing that meeting has not occurred. It is now scheduled for March 5, 2026. Therefore, stakeholders have not had the opportunity to review or discuss any upstream fish passage alternatives being considered or not being considered.

2) February 9, 2026, Brookfield Summary of Downstream Alternatives for Meeting held on 1/27/26:

As noted in subsequent summary provided by Brookfield on the January 27th downstream fish passage alternatives a representative from NOAA Fisheries, Donald Dow, stated that a dam removal alternative should be added to the analyses matrix, so that it can be used as a comparative analysis for effectiveness and cost.

Also as noted, Chip Spies of Free the Andro expressed a desire to examine the dam removal alternative as well and also stated that it would be important to have an analysis of a nature-like fishway on river left. Chip Spies stated that he has seen some rough designs and would like to understand if it's technically feasible. Kirk Smith of Gomez and Sullivan suggested that the discussion of a nature-like fishway be tabled for the upstream passage alternatives discussion.

The FTA wants the record to reflect that both dam removal and analyses of nature like fishway designs should be considered for technical feasibility. Otherwise, the matrices for both Upstream and Downstream design analyses will be missing important components. Further, at one point during the January 27th meeting a downstream fishway design consultant mentioned that Brookfield did not want a certain design considered. It was then noted by a representative of the Maine Department of Marine Resources, that a licensee cannot make unilateral decisions to preclude analyses based on internal assumptions about feasibility.

FTA concurs that the fishways alternatives analysis must consider more options to determine technical feasibility. This is not unreasonable or outside the scope of the current suggested study plan because all parties understand that these will ultimately lead into later discussions about costs and benefits as also included in the Revised Study Plan (RSP) as filed December 2, 2024. Having these alternatives considered will take into consideration a full range of designs, including dam removal and nature-like fish passage that can be compared when cost and benefits are analyzed. This separation of alternative fishway technical feasibility and cost analyses is something FTA commented on and supported with its February 19, 2024, filing. In good faith this needs to be followed as described in the RSP.

We stated the same in our December 14, 2025, comments and clarified what we understood and appreciated about the RSP revisions at the time as follows:

Comments on Revised Study Plan form FTA 12/14/2024 filing:

"After review of the RSP, the Coalition welcomes certain changes that have been made in response to its comments and those of others.

Specifically, the new inclusion of 2D hydraulic modeling to the spillway area as discussed in Section 5.2 of the RSP and depicted in Figure 5.2.1.5-2. This change and Brookfield's comments in Table 1.2-1: PSP Comment Responsiveness Summary under USFWS-1 are helpful. Brookfield's commentary in that section references back to the PSP comments filed by MMBTU on the need for some baseline data from that area to credibly consider multiple Alternative Fishway designs, including Nature-Like Fishways (NLF). We appreciate Brookfield's willingness to include these study elements at the behest of MMBTU and the US Fish and Wildlife Service

(USFWS) and its affirmative statements about including Nature-like-Fishway designs when alternative fishway analyses are undertaken.

Further, in section 5.2.2 entitled 'Upstream and Downstream Fish Passage Alternatives Study", the fourth bullet in the introduction states:

> *'Implementation of a phased alternatives analysis whereby Phase I provides a comprehensive report of potential measures for upstream and downstream passage at the Project without discussion of costs or implied preferences.'*

This is another welcome clarification of the study methodology being proposed. It is in response to requests by the National Marine Fisheries Service (NMFS), the Maine Department of Marine Resources (MDMR) and the USFWS to use methodology adopted for alternative fishway analysis at the upstream Worumbo Dam site as part of its relicensing process (FERC Docket 3428). Separating analysis of best alternatives for passage efficacy from cost comparisons creates a more objective initial review of the options when looking at what is best for the migratory fishes as a public resource."

Please require that all parties remain on track with what is described in the RSP.

Regarding other designs included in the downstream fishway analysis, the FTA agrees with comments from NOAA Fisheries and others that effective downstream fish passage using Natel's Fish Safe designs for improved turbine runners would be a very powerful solution for effective, low mortality downstream fish passage if they meet theoretical design criteria for passage. However, it is noted in the matrix provided that these designs are experimental and would require further feasibility analyses by Natel. FTA notes that other "experimental and untested" alternatives were considered and rejected on those grounds. Therefore, if the Natel alternatives are pursued, FTA would like to see strongly stated support from participating federal and state agencies based on their respective assessment about the likelihood that this type of downstream passage will be effective. Given the unique nature of every dam location, we believe any option pursued would be an experiment. So, while we are certainly open to innovation, it should have attached license contingencies that require goal setting for fish passage, monitoring of efficacy, and further adaptation if passage goals are not met.

A FERC license is a privilege and not a right. In this case, it allows users of a public resource, like the Androscoggin, to produce profits for private industry. The dam is owned by a subsidiary of Brookfield Renewable Partners which is a publicly traded Canadian-based, multinational company that generates electricity for sale on the open market. It has been broadly reported that Brookfield and its subsidiaries own more than 80 percent of the hydro-electric production capacity in Maine[2]. This heavily weighted presence by one owner needs to be considered because of the potential for its operations to impact not only Brunswick but nearly every other major river in Maine. Recognizing and enforcing the fact that the right to operate hydroelectric facilities by privately held entities is a privilege and that the river systems they use are a public and not a private resource is imperative. Proper management of diadromous fish passage at the first dam on this river inland from the ocean and a demonstrated impasse to federally protected species like the Atlantic Salmon and keystone ecological species like Alewives is also an imperative.

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[2] Carpenter, Murray, "Brookfield: The Dam King of Maine", The Maine Monitor, June 2, 2024 (https://themainemonitor.org).

Again, it is the intent of the Free the Andro coalition work with the licensee, FERC, authorized regulatory agencies, and other stakeholders in consultation to arrive at a well-researched and stakeholder supported solution that removes diadromous fish passage problems at the Brunswick Dam site.

FTA appreciates the opportunity to comment on the relicensing of the Brunswick Project so key to the restoration of the Androscoggin River.

Questions concerning this submission be directed to Chip Spies, President, Free the Andro. He can be reached at chipspies@gmail.com.

Respectfully submitted,

Charles James Spies III
President
Free the Andro
Resident of Water Street, Brunswick, Maine

Friends of Merrymeeting Bay

P.O. Box 233, Richmond, ME 04357 www.fomb.org

Comments on Initial Study Report (ISR), Brunswick, Hydroelectric Project, Androscoggin River, Maine P-2284

3/2/26

VIA E-FILING

Debbie-Ann A. Reese, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Secretary Reese,

Brookfield has held a couple of remote meetings in January to review the Initial Study Report (ISR) for Brunswick/Topsham. The first was a general review. This was followed by a meeting to delve into downstream fish passage alternatives they were considering. Upstream alternatives are to be discussed a couple of days after the deadline for these comments. Brookfield just sent out a matrix of upstream passage possibilities today in preparation for Thursday's meeting.

Our comments are brief at this time and are primarily that the full range of upstream and downstream fish [and eel] passage possibilities need to be on the table including:

A. Dam decommissioning and removal with site restoration

B. Nature-like passage on the north side of river heading up in vicinity of the tainter gates. If there is a lack of real estate on shore, an instream construction may need to be investigated.

C. ½" clear spacing on any fish exclusion grates

Unless the cost/benefit of these possibilities are investigated and made known, any analysis will be woefully incomplete.

Lastly as MDIFW has mentioned it appears the mussel survey was only done in the shallows with mask and snorkel. Having done quite a few mussel survey (and harvests for biomonitoring) ourselves, we agree that species such as the tidewater mucket may be unaccounted for but present. However unlike IFW, we would like to see the addition of several bivalve survey transects in deeper water using SCUBA.

Thank you for your consideration.

Sincerely,

Ed Friedman, Chair

APPENDIX C-EVALUATION MATRIX

Appendix C - Alternatives Review Matrix – Downstream Fish Passage at the Brunswick Project

ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
D1	**Angled Bar Rack with New Downstream Bypass Structures**	-This alternative would include the installation of a new, full-depth angled bar rack with close-spaced trash racks (3/4-inch clear) upstream of the existing intake structures. -The angled bar rack would extend approximately 140 feet upstream of the existing intake structure and would be angled at 45 degrees. An isolation wall between Unit 1 and 2 would be provided to allow for a deeper intake in front of Unit 1. The intake for Unit 1 would be approximately 80 feet wide by 35 feet deep resulting in an average approach velocity of approximately 1.8 fps. The intake for Units 2 and 3 would be approximately 68 feet wide by 20 feet deep resulting in an average approach velocity of approximately 1.8 fps. -A new surface bypasses would be provided at the downstream end of the racks located on the south side of the spillway adjacent to the powerhouse. -A new low-level bypass would be provided at the downstream end of the racks for the downstream eel passage. The bypass would be routed to a surface weir located adjacent to the surface bypass. -Total bypass flow would be approximately 375 cfs (5% of station discharge). Fish would be discharged directly into the tailrace downstream of the spillway if it is shown to be deep enough, otherwise a plunge pool that meets USFWS criteria would be provided. -A new mechanical trash rake would be installed for debris management.	<u>High</u> -Reduced passage mortality through the turbine intakes. -Improves protection of fish exiting upstream fish ladder.	<u>Moderate Risk</u> -More frequent debris raking operations required. -Periodic dive inspections needed for cleaning low level bypass.	<u>High</u> -All new intake structure, downstream bypass structures, and a new trash rake.	<u>Low</u> -The location of the bypass structures may impact the spillway discharge capacity. Modifications to the spillway may be required to maintain the discharge capacity and prevent impacting the 100-year flood elevation or the IDF elevation. -The new intake structure may impact the exit of the upstream passage facility. Some modification may be required to accommodate new intake wall. -Possible hot spots at the downstream end of the rack. CFD modeling is needed to confirm the feasibility of this alternative.	<u>Difficult</u> -A large cofferdam will likely be required to facilitate construction. -If required modifications to the spillway would be challenging requiring work from a barge and installation of flood protection upstream of the work area. -A cofferdam would likely be required to facilitate construction of a plunge pool if required.	<u>High</u> -Construction costs of the new intake structure. -Construction costs of the new low-level and surface bypass structures. -New trash rake costs. -Electrical supply for the new bypass gates and trash rake. -Possible spillway modification costs. -Possible plunge pool construction costs.	<u>High</u> -More frequent raking and debris handling required. -Increased potential for frazil ice impacts. -Effectiveness testing required.	<u>High</u> -Additional losses due to increased attraction flow. -Slightly higher energy loss due to close-spaced racks and increased debris loading. -Increased potential for frazil ice impacts.
D2	**Inclined Bar Rack with New Downstream Bypass Structures**	-This alternative would include the installation of a new, full-depth inclined bar rack with close-spaced trash racks (3/4-inch clear) upstream of the existing intake structures. -Separate inclined rack structures would be provided for Unit 1 and Units 2 and 3 due to the increased water depth in front of Unit 1. Both intake structures would have a rack inclination of 45 degrees. The intake for Unit 1 would be approximately 55 feet wide and would extend approximately 55 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.7 fps. The intake for Units 2 & 3 would be approximately 48 feet wide and would extend	<u>High</u> -Reduced passage mortality through the turbine intakes. Improves protection of fish exiting upstream fish ladder.	<u>Moderate Risk</u> -More frequent debris raking operations required. -Periodic dive inspections needed for cleaning low level bypass.	<u>High</u> -All new intake structure, downstream bypass structures, and a new trash rake.	<u>Moderate</u> -The location of the bypass structures may impact the spillway discharge capacity. Modifications to the spillway may be required to maintain the discharge capacity and prevent impacting the 100-year flood elevation or the IDF elevation. -The new intake structure may impact	<u>Difficult</u> -A large cofferdam will be required to facilitate construction. -A custom trash rake may be required to accommodate the inclined rack angle and additional reach. -If required modifications to the spillway would be challenging requiring work from a barge	<u>High</u> -Construction costs of new intake structure. -Construction costs of new low-level and surface bypass structures. -New trash rake costs. -Electrical supply for new bypass gates and trash rake.	<u>Moderate-High</u> -More frequent raking and debris handling required. -Increased potential for frazil ice impacts. -Effectiveness testing required.	<u>Moderate</u> -Additional losses due to increased attraction flow. -Slightly higher energy loss due to close-spaced racks and increased debris loading. -Increased potential for frazil ice impacts.

ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
		approximately 35 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.8 fps. -A new surface bypasses would be provided on the south side of the spillway adjacent to the powerhouse. -A new low-level bypass would be provided for downstream eel passage. The bypass would be routed to a surface weir located adjacent to the surface bypass. -Total bypass flow would be approximately 375 cfs (5% of station discharge). Fish would be discharged directly into the tailrace downstream of the spillway if it is shown to be deep enough, otherwise a plunge pool that meets USFWS criteria would be provided. -A new mechanical trash rake would be installed for debris management.				the exit of the upstream passage facility. Some modification may be required to accommodate new intake wall -This technology has not been widely used in the U.S. and is still considered experimental. -Possible hot spots on the proposed rack structure. CFD modeling is needed to confirm the feasibility of this alternative.	and installation of flood protection upstream of the work area. -A cofferdam would likely be required to facilitate construction of a plunge pool if required.	-Possible spillway modification costs. -Possible plunge pool construction costs.		
D3	**Floating Guidance Boom with a New Downstream Surface Bypass and Nighttime Shutdowns**	-This alternative would include the installation of a new 10-foot-deep floating fish guidance boom (e.g., PNP or Worthington). -The boom would extend from the north side of the powerhouse to the shoreline at approximately a 35-degree angle. -A new surface bypass would be provided at the downstream end of the guidance boom located on the south side of the spillway adjacent to the powerhouse. -Due to the boom only being partial depth, a low-level bypass would not be provided. -Total bypass flow would be approximately 375 cfs (5% of station discharge). Fish would be discharged directly into the tailrace downstream of the spillway if it is shown to be deep enough, otherwise a plunge pool that meets USFWS criteria would be provided.	<u>Low</u> -There is the potential for downstream migrants to sound below the guidance boom which would result in reduced efficiency when compared to other full depth exclusion measures. -Modeling of a similar alternative by Blue Hill Hydraulics Inc. showed poor guidance at the downstream end of the boom. -Nighttime shutdowns required for protection of out-migrating American eels.	<u>High Risk</u> -Due to safety concerns with trying to install the boom annually during high flow conditions the boom would be designed to be installed year-round. Shear pins that are designed to fail under extreme loads would be provided to prevent excessive damage to the boom. This will require boat access to reset the boom periodically. -Debris accumulation in the catenary of the guidance boom may occur which would require periodic boat access to remove. -Periodic dive inspections will be needed to clean biofouling from the guidance boom.	<u>Low</u> -The existing intake racks would remain in place. -The floating guidance boom is more susceptible to damage from high flow, debris, and ice.	<u>Moderate</u> -The location of the bypass structure may impact the spillway discharge capacity. Modifications to the spillway may be required to maintain the discharge capacity and prevent impacting the 100-year flood elevation or the IDF elevation. -This alternative may impact upstream migrants that would need to sound below the guidance boom. An extension to the upstream fishway exit may be required.	<u>Moderate</u> -Installation of the boom will require a crane and personnel on the water to position the boom sections. -In-water anchors may be required to resist debris and ice loading. -If required modifications to the spillway would be challenging requiring work from a barge and installation of flood protection. -New anchor block construction may temporarily impact mill building parking.	<u>Low</u> -Cost of boom supply and installation. -Cost of boom anchorages -Construction costs of new surface bypass structure. -Electrical supply for new bypass gate. -Possible spillway modification costs. -Possible plunge pool construction costs.	<u>High</u> -Divers required for periodic cleaning of the guidance boom. -Boom may need to be reset after extreme flow events. -Periodic debris removal. -Effectiveness testing required.	<u>High</u> -Additional losses due to increased attraction flow. shutdowns. -Additional losses due to nighttime shutdowns.

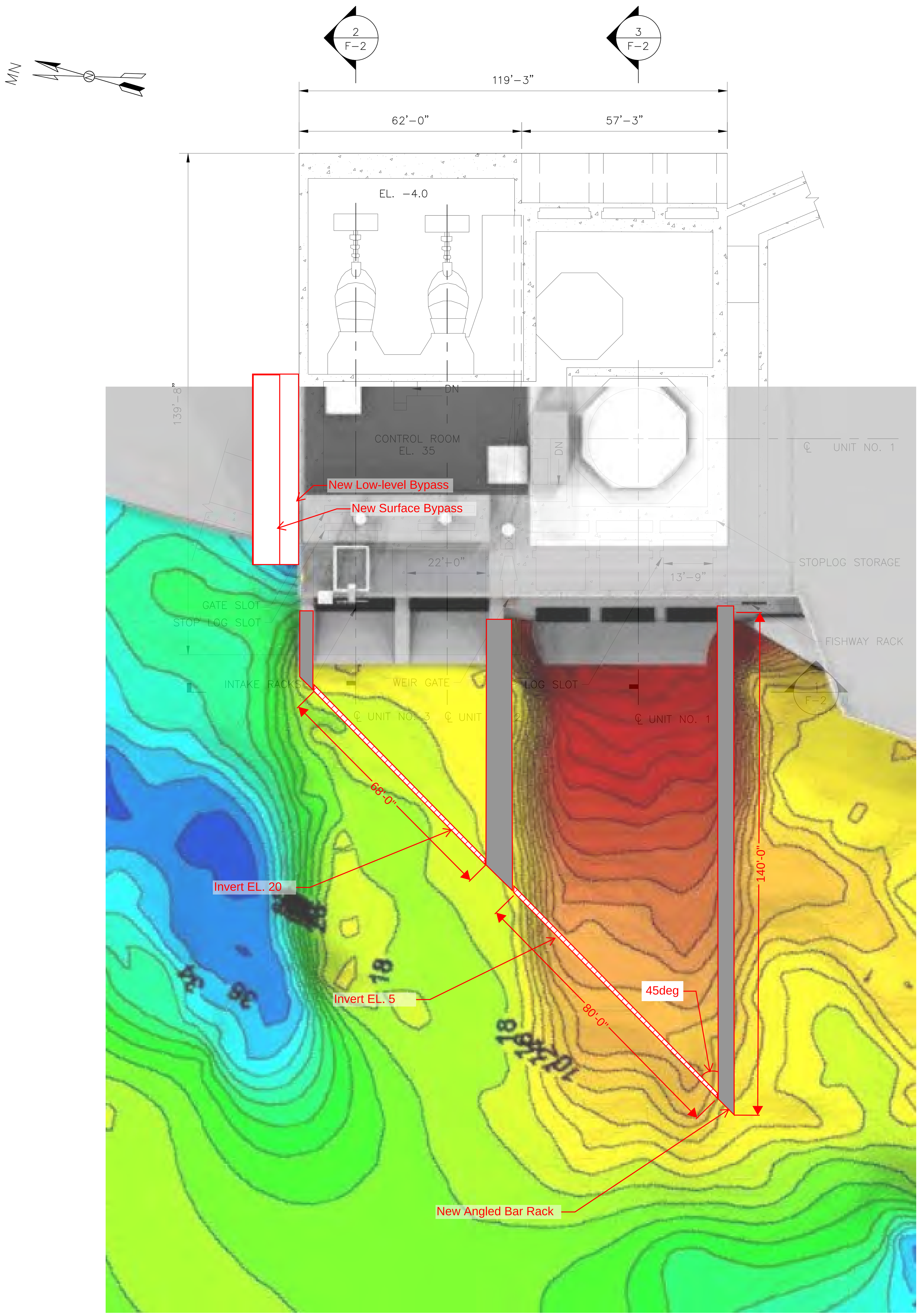
Appendix C - Alternatives Review Matrix – Downstream Fish Passage at the Brunswick Project

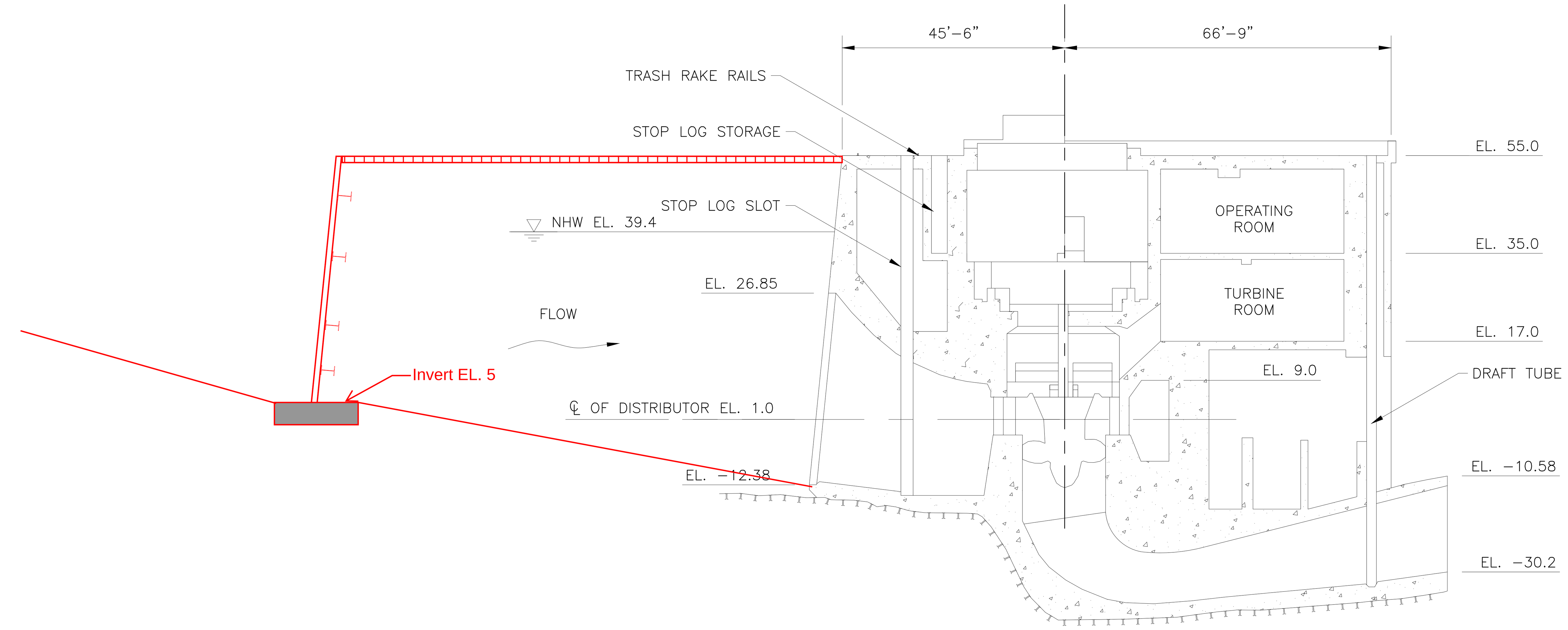
ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
D4A	**Multiple Fish Friendly Runner Replacements**	-This alternative would include replacing the existing turbine runners of all three units with Natel FishSafe runners. -The Existing 3-1/2 inch clear intake racks to remain. -No other downstream passage or protection measures would be provided. -The existing debris management systems for the powerhouse trash racks would continue to be used.	<u>High</u> -Turbine survival rates depend on species, type of turbine, and site-specific hydraulic conditions. -A preliminary feasibility study by Natel will be required to fully assess this alternative.	<u>Low Risk</u> -No changes to existing operating procedures.	<u>High</u> -New runners will extend the service life of existing units.	<u>High</u> -This technology is gaining preliminary agency acceptance; however, it is still considered experimental due to the lack of large-scale effectiveness testing.	<u>Easy</u> -Assuming runner replacement is feasible and that full turbine replacement is not required.	<u>Moderate</u> -Supply and installation cost of new runners.	<u>Low</u> -Maintenance of new units would be similar to existing units. -Eliminates O&M associated with downstream bypass structures. -Effectiveness testing required.	<u>Unknown</u> -Impacts to generation are likely to be low but a feasibility study by Natel will be required to fully assess.
D4B	**Unit 1 Fish Friendly Runner Replacement with Inclined Bar Rack at Units 2 and 3**	-This alternative would include replacing the existing turbine runner for Unit 1 with a Natel FishSafe runner and installing an inclined bar rack with close-spaced trash racks (3/4-inch clear) upstream of the existing intake structure for Units 2 & 3. Note flows exceed discharge capacity of Unit 1 48% of the downstream passage season. -The Existing 3-1/2 inch clear intake racks at Unit 1 would remain. -The intake for Units 2 & 3 would be approximately 48 feet wide and would extend approximately 35 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.8 fps. -No other downstream passage or protection measures would be provided. -A new mechanical rake would be installed for debris management.	<u>High</u> -Turbine survival rates depend on species, type of turbine, and site-specific hydraulic conditions. -A preliminary feasibility study by Natel will be required to fully assess this alternative.	<u>Moderate Risk</u> -More frequent debris raking operations will be required for Units 2 & 3.	<u>High</u> -New runner will extend the service life of existing unit 1. -New intake structure and new trash rake for Units 2 & 3.	<u>High</u> -FishSafe runner technology is gaining preliminary agency acceptance; however, it is still considered experimental due to the lack of large-scale effectiveness testing. -Inclined trash racks have not been widely used in the U.S. and is still considered experimental. -Possible hot spots on the proposed rack structure. CFD modeling is needed to confirm the feasibility of this alternative.	<u>Difficult</u> -A large cofferdam will be required to facilitate construction of the new intake structure. -Custom trash rake may be required to accommodate incline angle.	<u>Moderate-High</u> -Construction costs of new intake structure. -Supply and installation cost of new runner. -New trash rake costs. -Electrical supply for new trash rake.	<u>Moderate</u> -More frequent raking and debris handling required at Units 2&3 -Increased potential for frazzle ice impacts on Units 2 and 3 racks. -Effectiveness testing required.	<u>Unknown</u> -Impacts to generation are likely to be low but a feasibility study by Natel will be required to fully assess this. -Slightly higher energy loss due to close-spaced racks and increased debris loading on Units 2 & 3.
D4C	**Unit 1 Fish Friendly Runner Replacement with Angled Bar Rack at Units 2 and 3**	-This alternative would include replacing the existing turbine runner for Unit 1 with a Natel FishSafe runner and installing an angled bar rack with close-spaced trash racks (3/4-inch clear) upstream of the existing intake structure for Units 2 & 3. (Note flows exceed discharge capacity of Unit 1 48% of the downstream passage season.) -The Existing 3-1/2 inch clear intake racks at Unit 1 would remain.	<u>High</u> -Turbine survival rates depend on species, type of turbine, and site-specific hydraulic conditions. -A Phase 2 feasibility study by Natel will be required to fully assess this alternative.	<u>Moderate Risk</u> -More frequent debris raking operations will be required for Units 2 & 3.	<u>Moderate-High</u> -New runner will extend the service life of existing unit 1. -New intake structure and new trash rake for Units 2 & 3.	<u>High</u> -FishSafe runner technology is gaining preliminary agency acceptance; however, it is still considered experimental due to the lack of large-scale effectiveness testing. -Angled trash racks more widely used.	<u>Difficult</u> -A large cofferdam will be required to facilitate construction of the new intake structure. New intake and trash rack required.	<u>Moderate-High</u> -Construction costs of new intake structure. -Supply and installation cost of new runner. -New trash rake costs. -Electrical supply for new trash rake.	<u>Moderate</u> -More frequent raking and debris handling required at Units 2&3 -Increased potential for ice impacts and frazzle ice impacts on Units 2 and 3 racks. -Effectiveness testing required.	<u>Unknown</u> -Impacts to generation are likely to be low but a feasibility study by Natel will be required to fully assess this. -Slightly higher energy loss due to close-spaced racks and increased debris

Appendix C - Alternatives Review Matrix – Downstream Fish Passage at the Brunswick Project

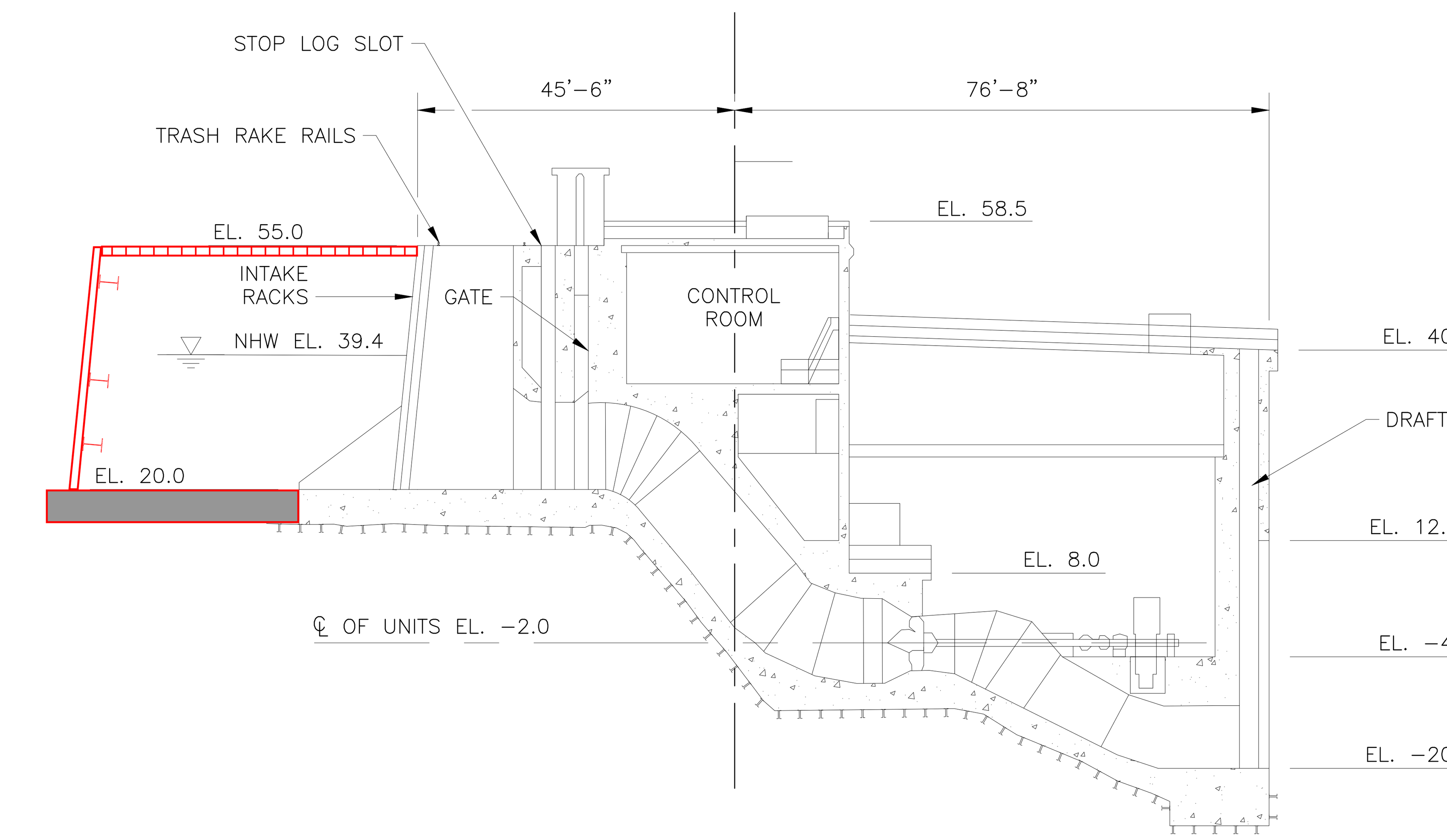
ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
		-The intake for Units 2 & 3 would be approximately 73 feet wide and would extend approximately 52 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.8 fps. -No other downstream passage or protection measures would be provided. -A new mechanical rake would be installed for debris management.				-Possible hot spots on the proposed rack structure. CFD modeling is needed to confirm the feasibility of this alternative.				loading on Units 2 & 3. <u>No downstream bypass passage flow aside from Unit 1 flows will reduce energy loss from bypass.</u>

APPENDIX D-CONCEPTUAL FIGURES OF DOWNSTREAM PASSAGE ALTERNATIVES





2 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 1
1" = 20'



3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

Alternative D1 - Angled Bar Rack with
New Downstream Pass Structures

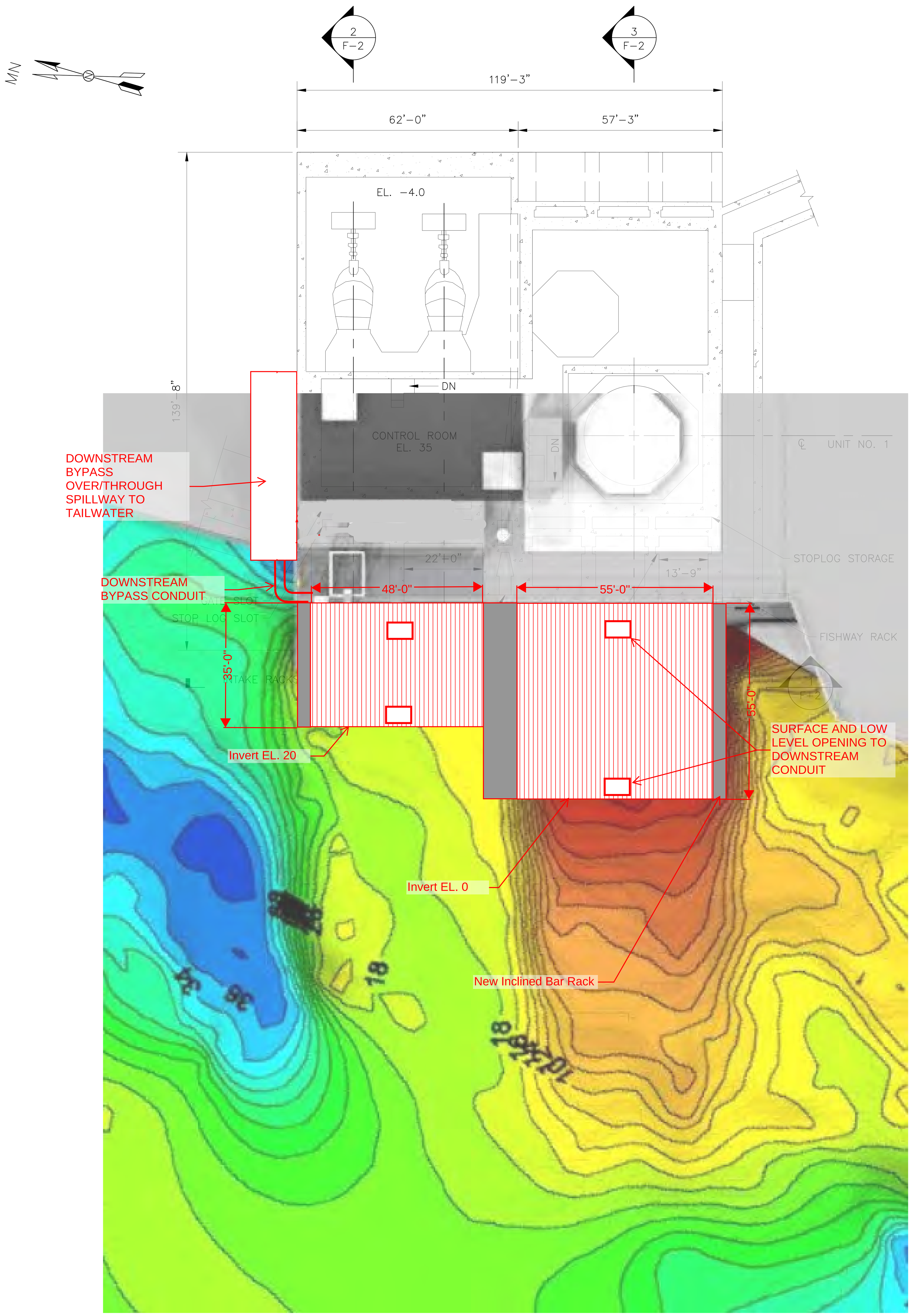
NOTE:

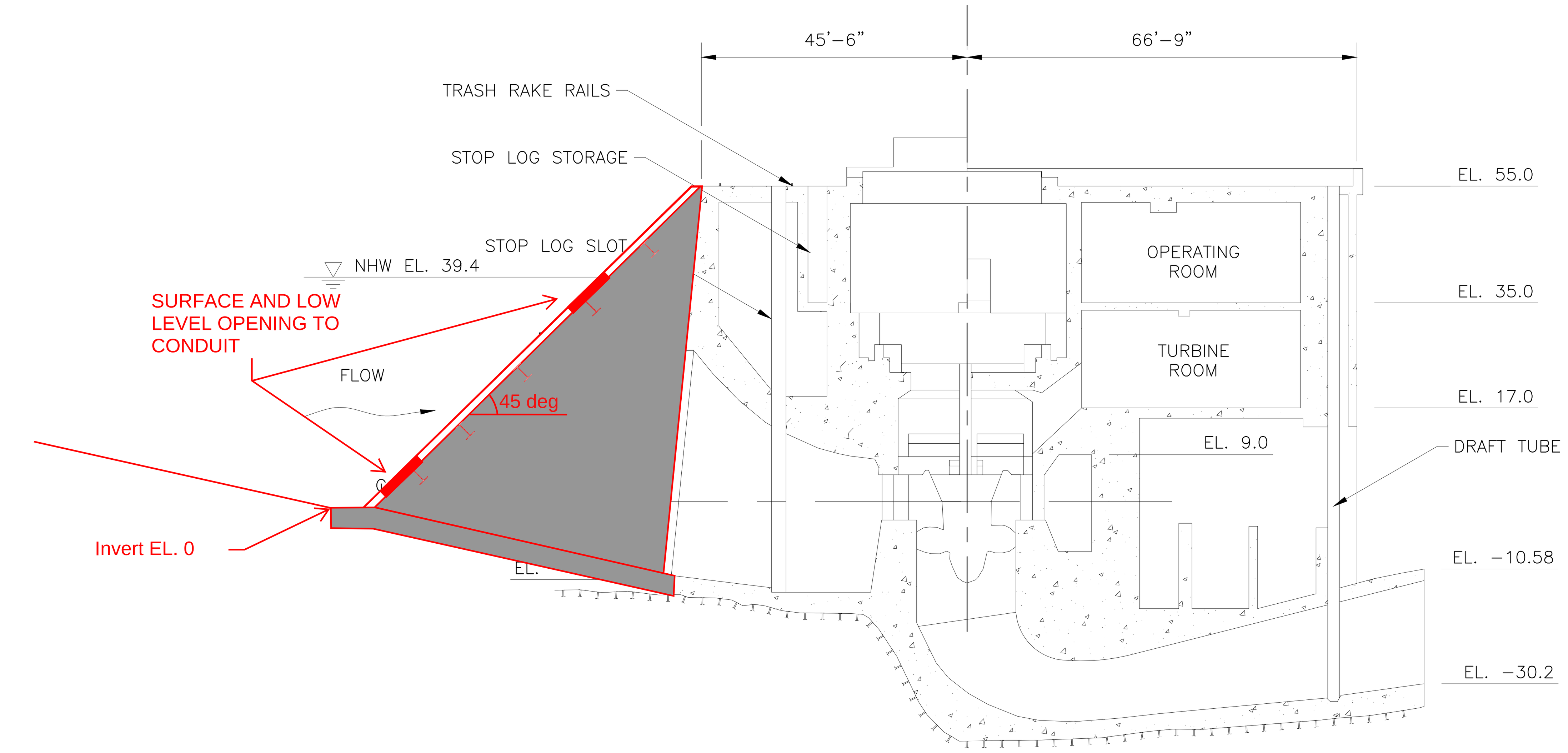
1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

BRUNSWICK HYDROELECTRIC PROJECT
BROOKFIELD WHITE PINE HYDRO LLC
FERC NO. 2284

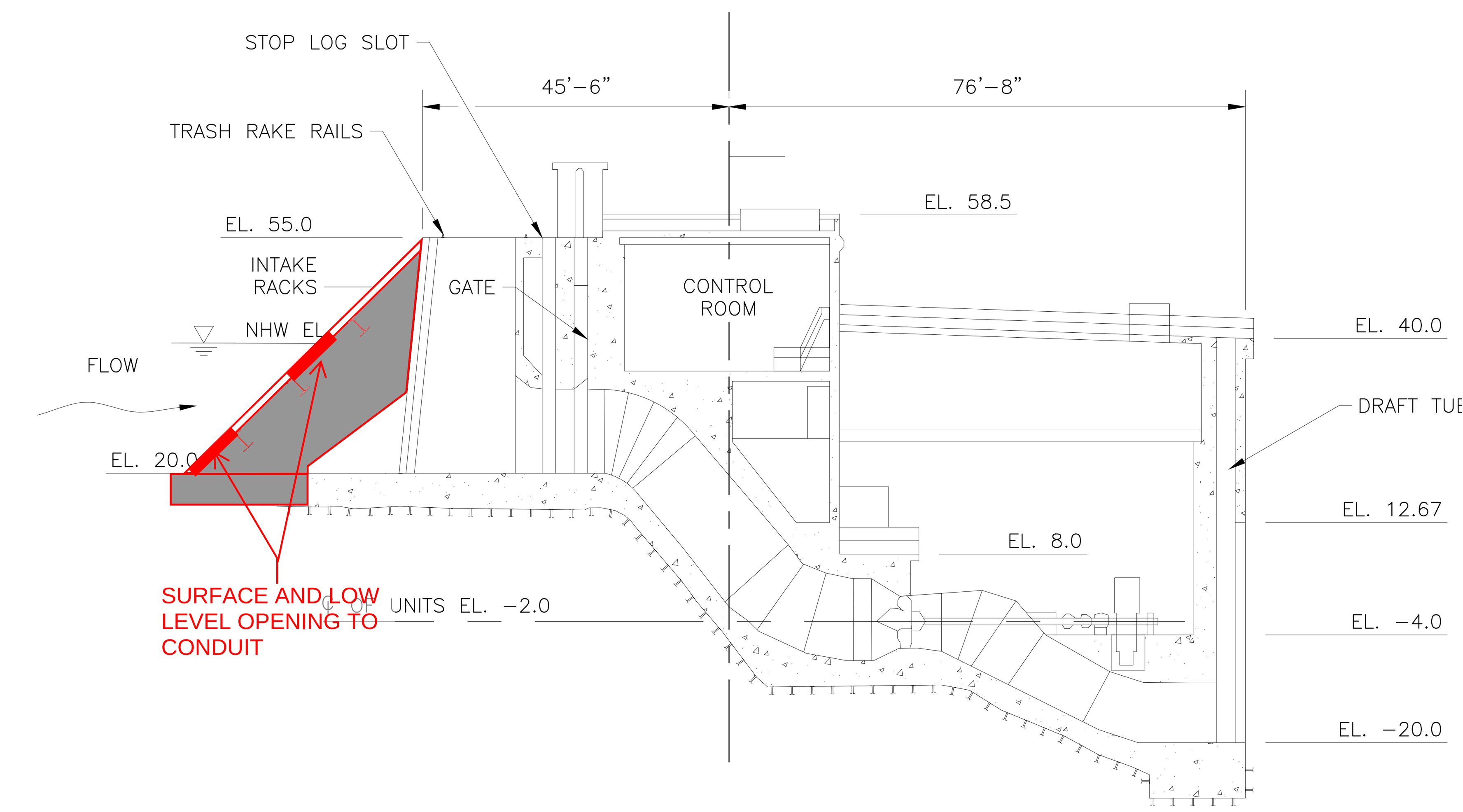
F-2
POWERHOUSE PLAN, SECTIONS & ELEVATION

20' 0 20' 40'
SCALE: 1" = 20'





2 F–2 SECTION THROUGH CENTERLINE OF UNIT NO. 1
1" = 20'



3 F–2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

Alternative D2 - Inclined Bar Rack with
New Downstream Bypass Structures

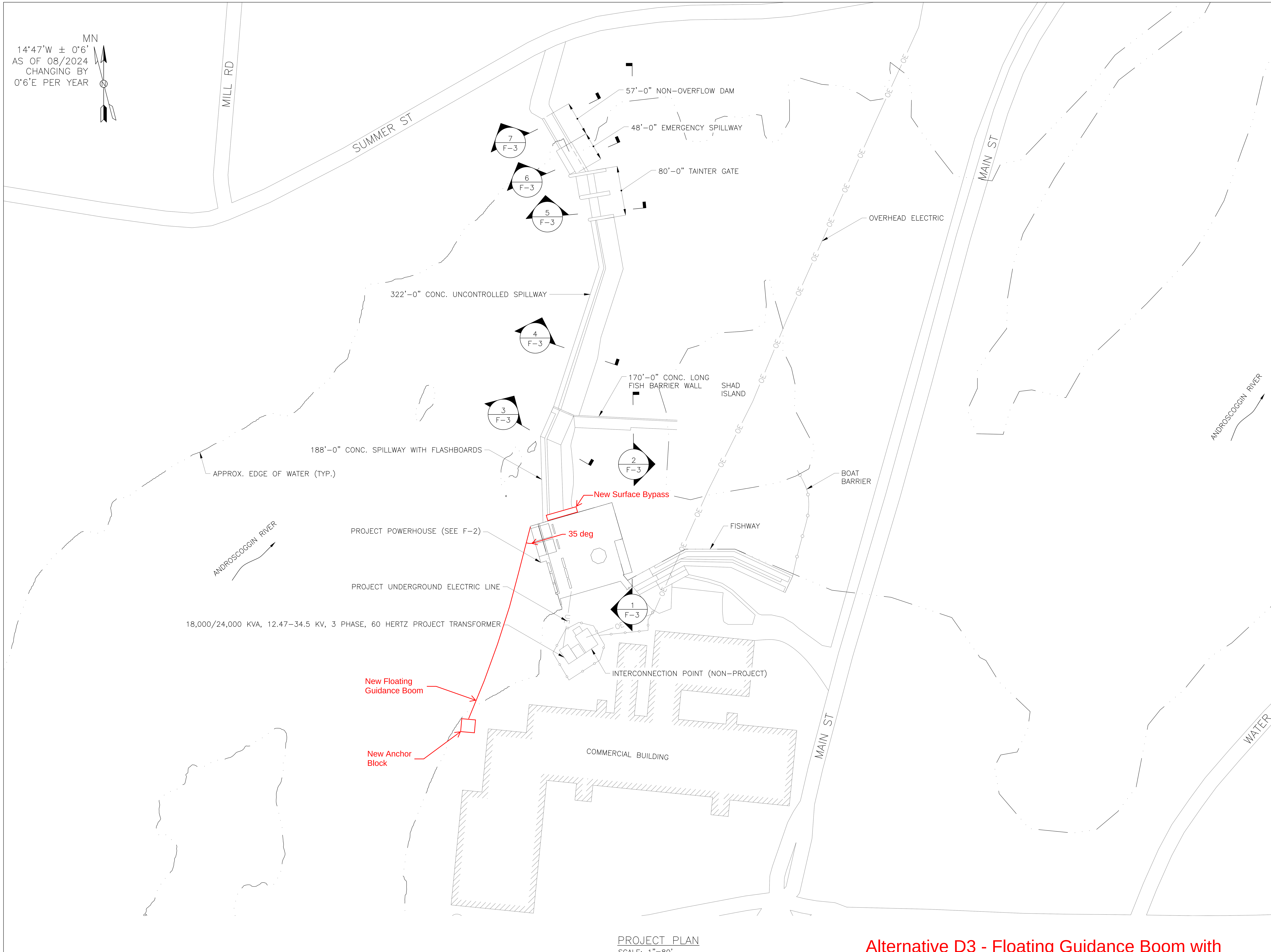
NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

BRUNSWICK HYDROELECTRIC PROJECT
BROOKFIELD WHITE PINE HYDRO LLC
FERC NO. 2284

F-2
POWERHOUSE PLAN, SECTIONS & ELEVATION

20' 0 20' 40'
SCALE: 1" = 20'

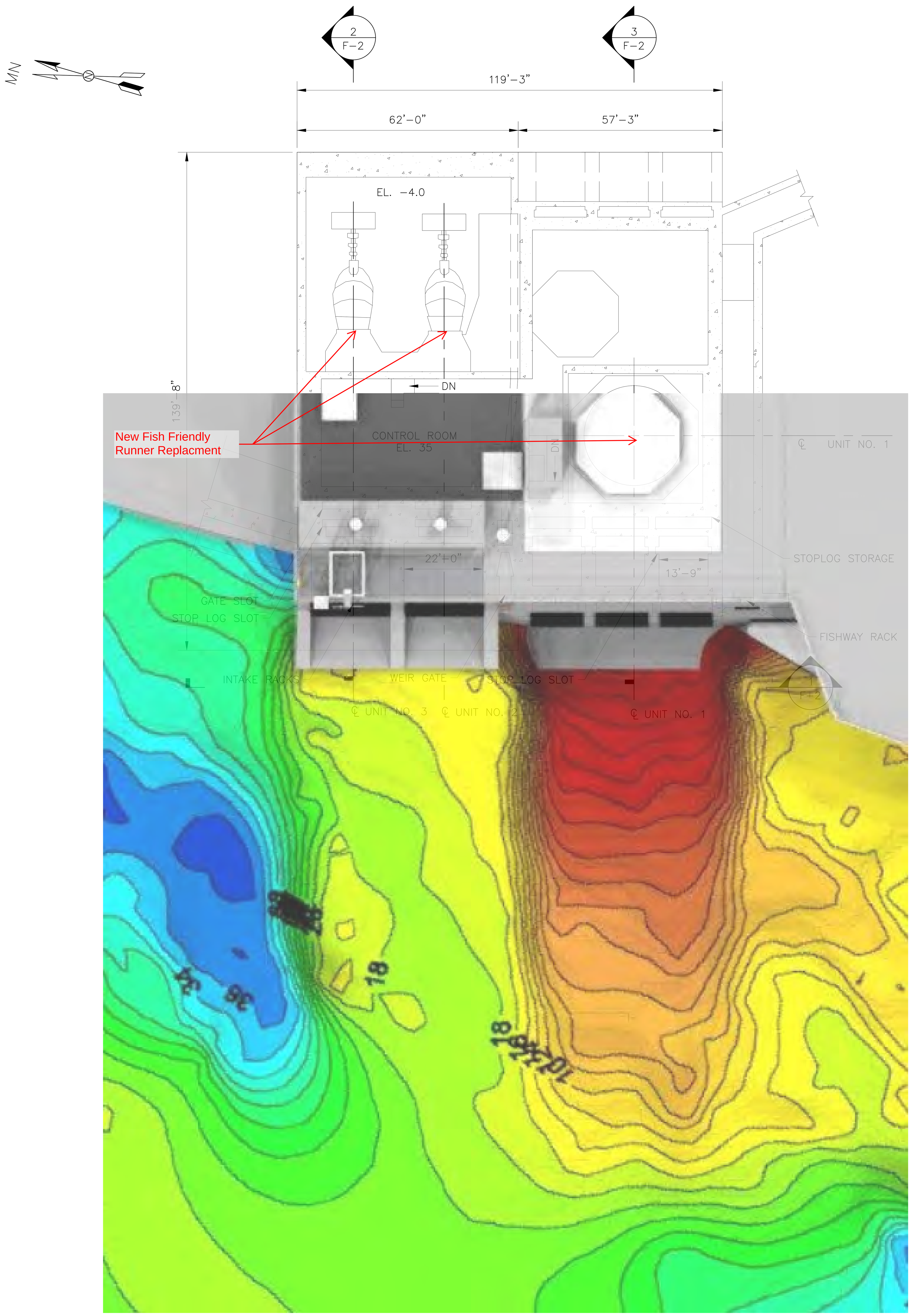


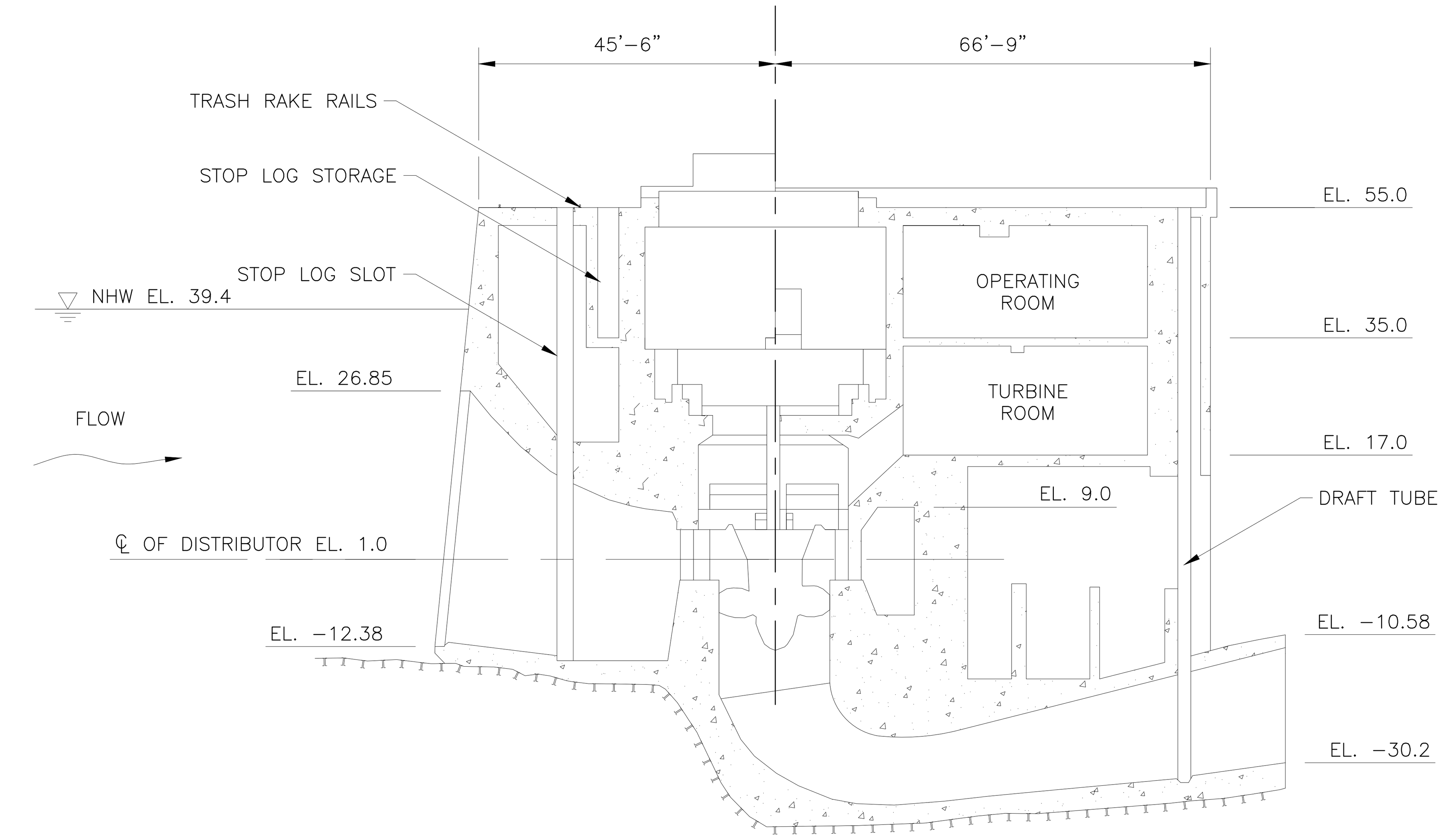
Alternative D3 - Floating Guidance Boom with New Downstream Surface Bypass Structure

BRUNSWICK HYDROELECTRIC PROJECT
BROOKFIELD WHITE PINE HYDRO LLC
FERC NO. 2284

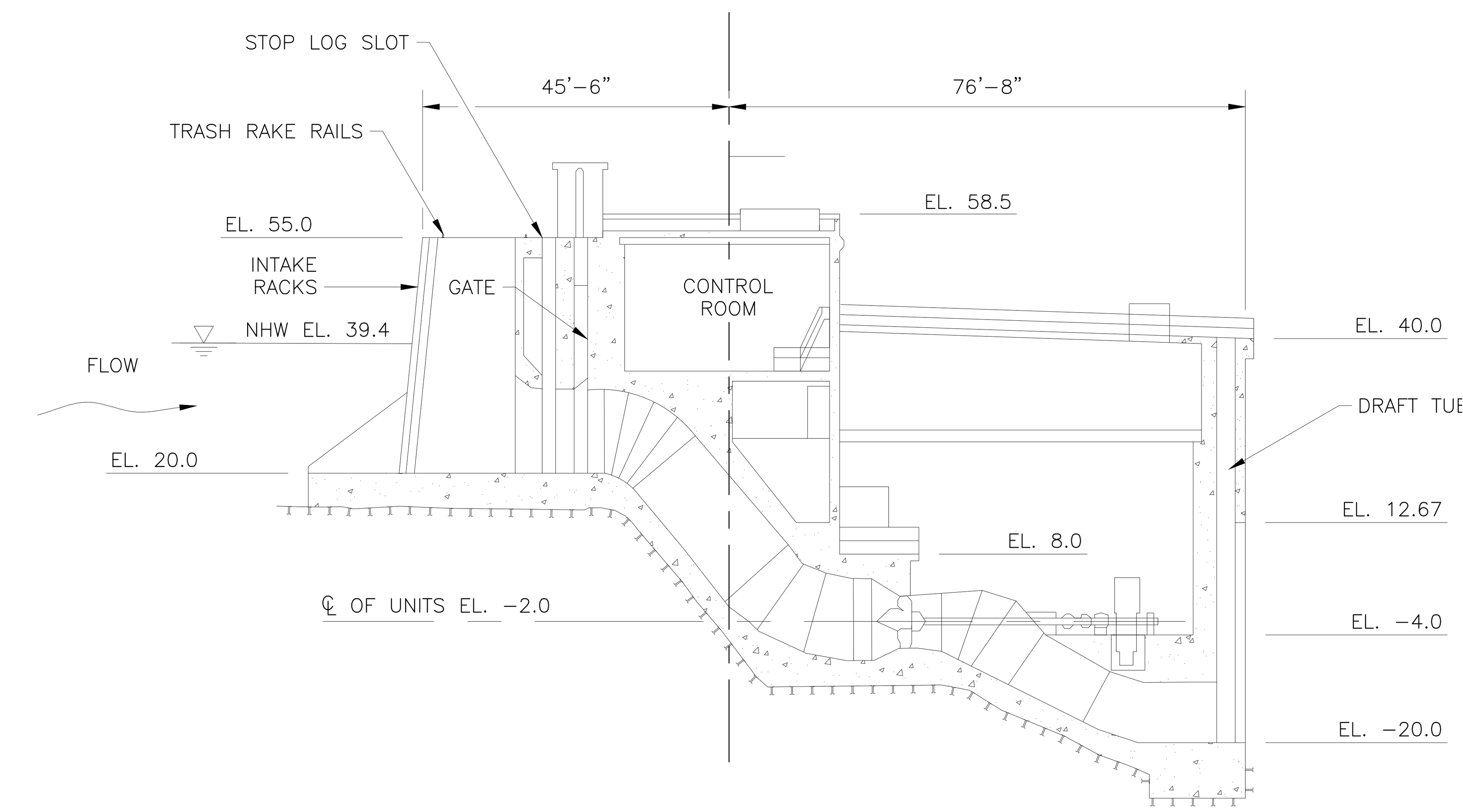
F-1
PROJECT PLAN

80' 0 80' 160'
SCALE: 1" = 80'





2
F-2
SECTION THROUGH CENTERLINE OF UNIT NO. 1
1" = 20'



3
F-2
SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

Alternative D4A - Multiple FishSafe Runner Replacements

NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

BRUNSWICK HYDROELECTRIC PROJECT
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FERC NO. 2284

F-2
POWERHOUSE PLAN, SECTIONS & ELEVATION

20' 0 20' 40'

SCALE: 1" = 20'

Alternative D4B - Single Fish Friendly Runner Replacement with Inclined Rack

NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

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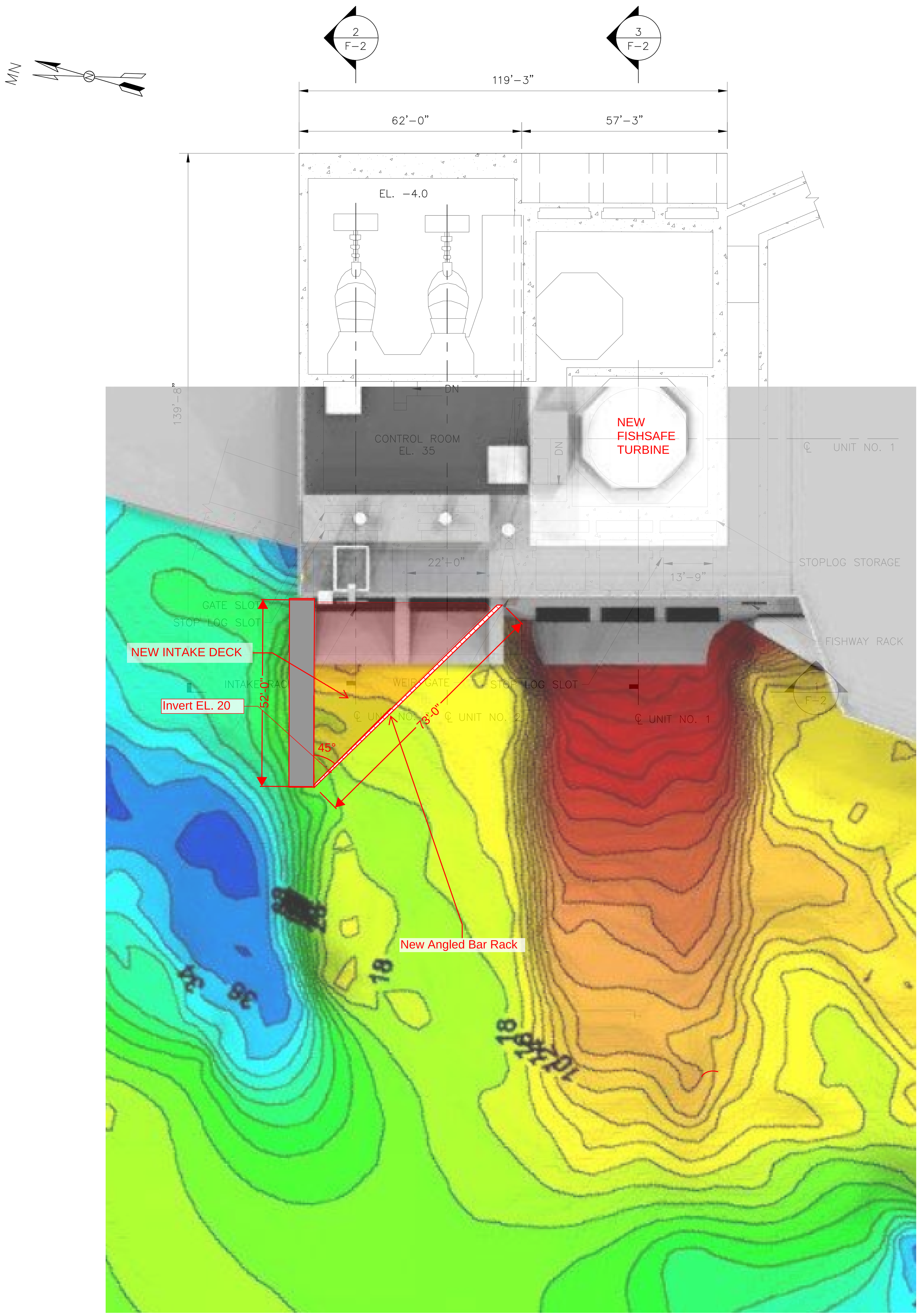
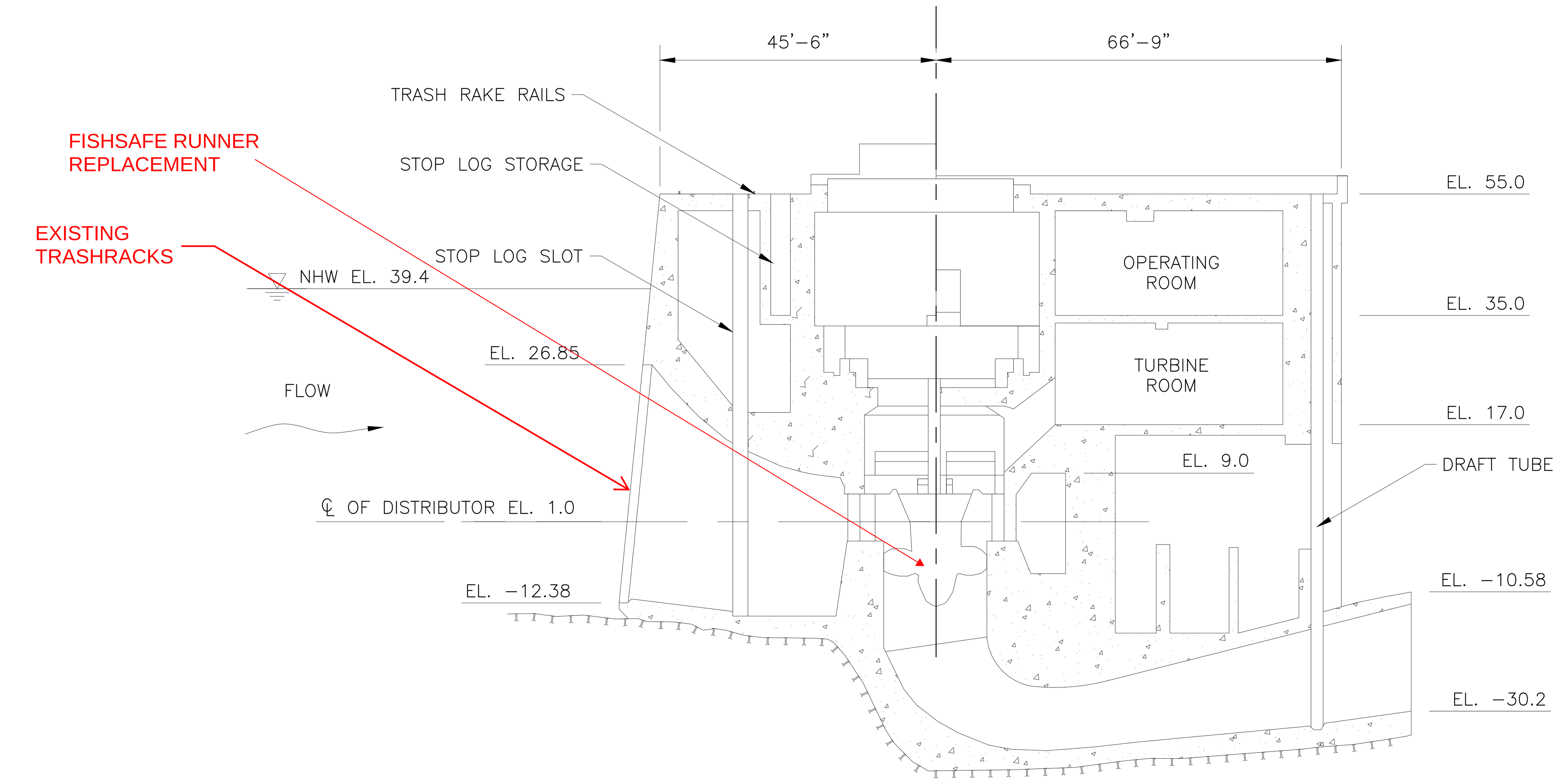
FERC NO. 2284

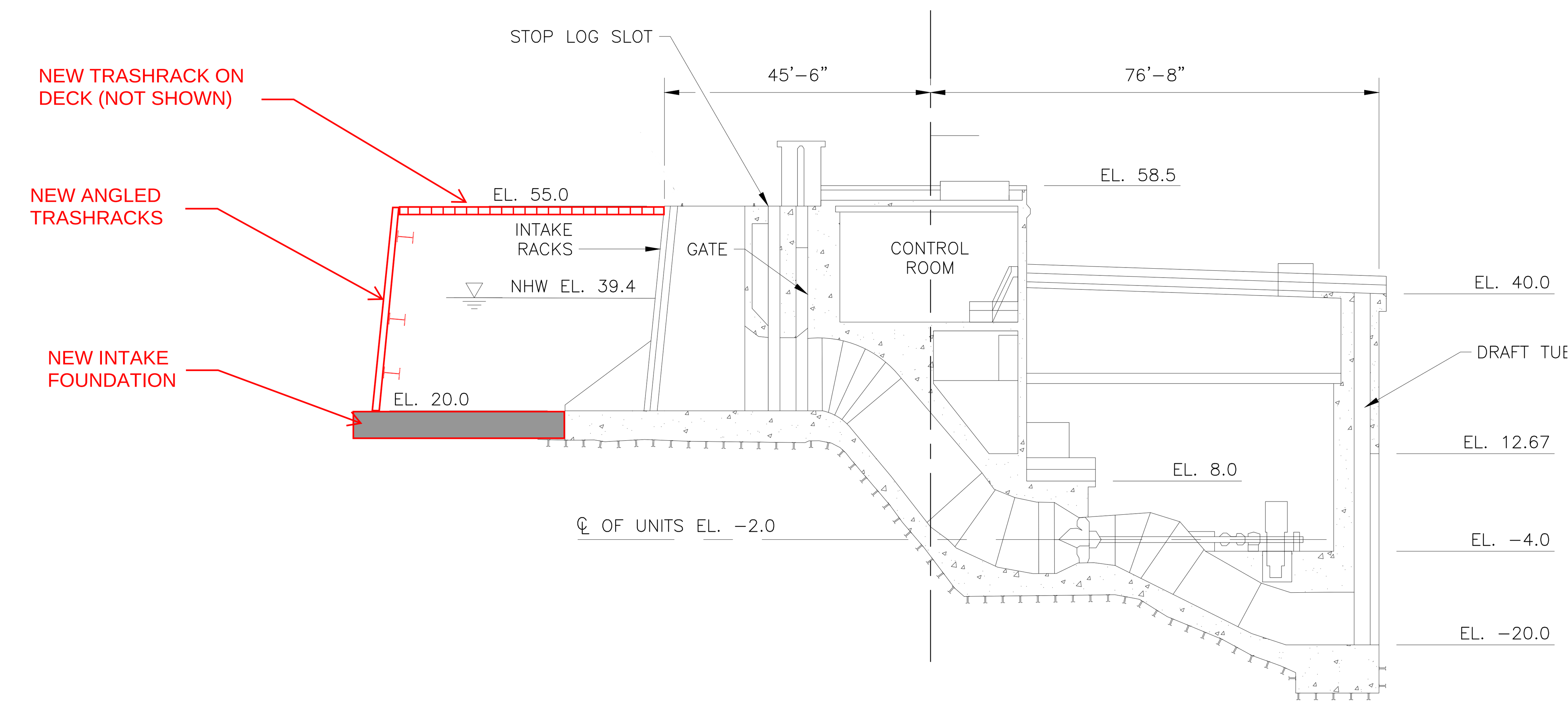
F-2
POWERHOUSE PLAN, SECTIONS & ELEVATION

SCALE: 1" = 20'





2 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 1
1" = 20'



3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

Alternative D4C - Single FishSafe Runner Replacement, with Angled Rack

BRUNSWICK HYDROELECTRIC PROJECT
BROOKFIELD WHITE PINE HYDRO LLC
FERC NO. 2284

F-2
POWERHOUSE PLAN, SECTIONS & ELEVATION

20' 0 20' 40'
SCALE: 1" = 20'

NOTE:

1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).