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.

Draft Alternatives Review – Downstream Fish Passage at the Brunswick Project

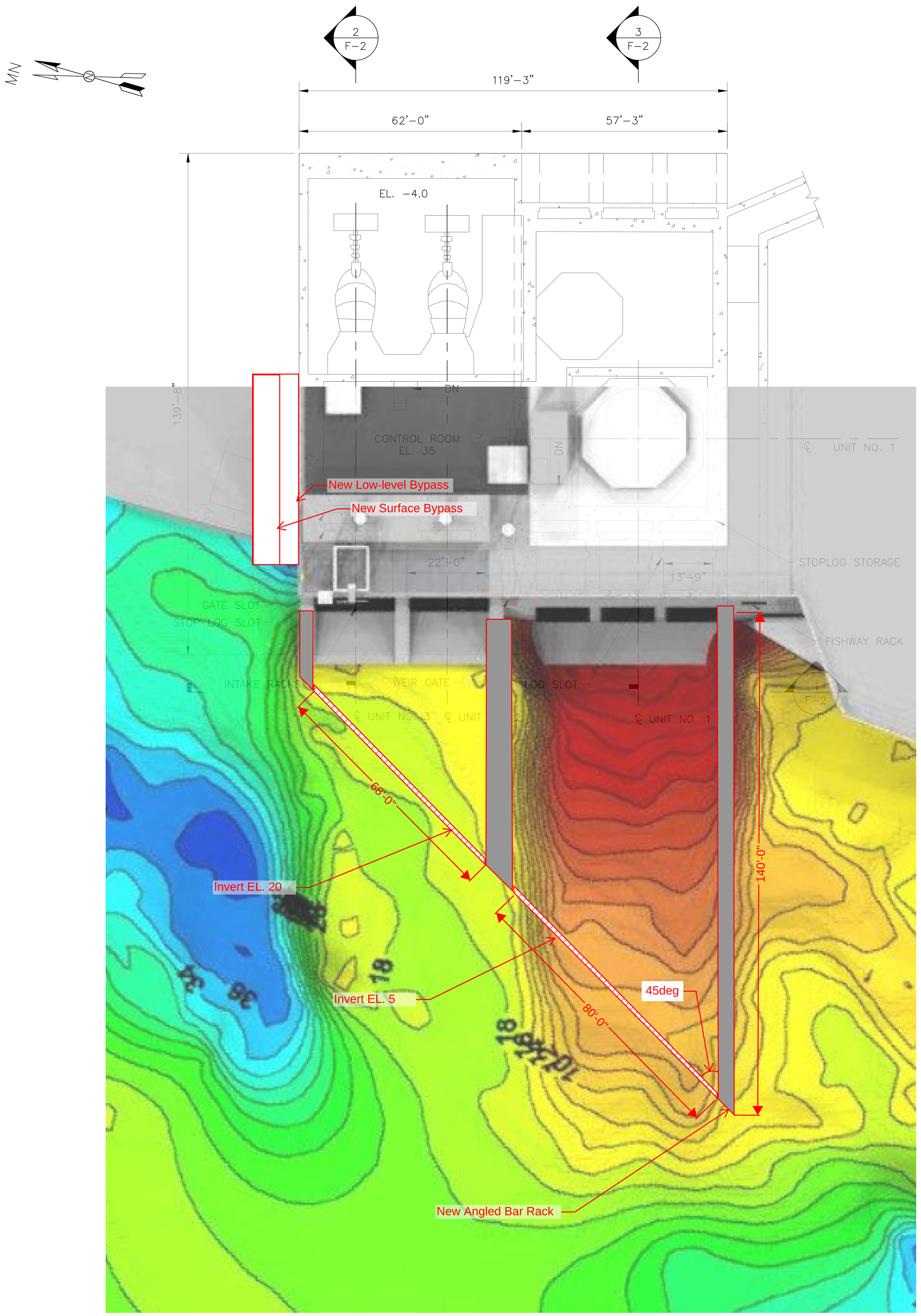
ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
		approximately 35 feet upstream of the existing intake structure resulting in an average approach velocity of approximately 1.8 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.	Low -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.	High Risk -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.	Low -The existing intake racks would remain in place. -The floating guidance boom is more susceptible to damage from high flow, debris, and ice.	Moderate -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.	Moderate -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.	Low -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.	High -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.	High -Additional losses due to increased attraction flow. shutdowns. -Additional losses due to nighttime shutdowns.

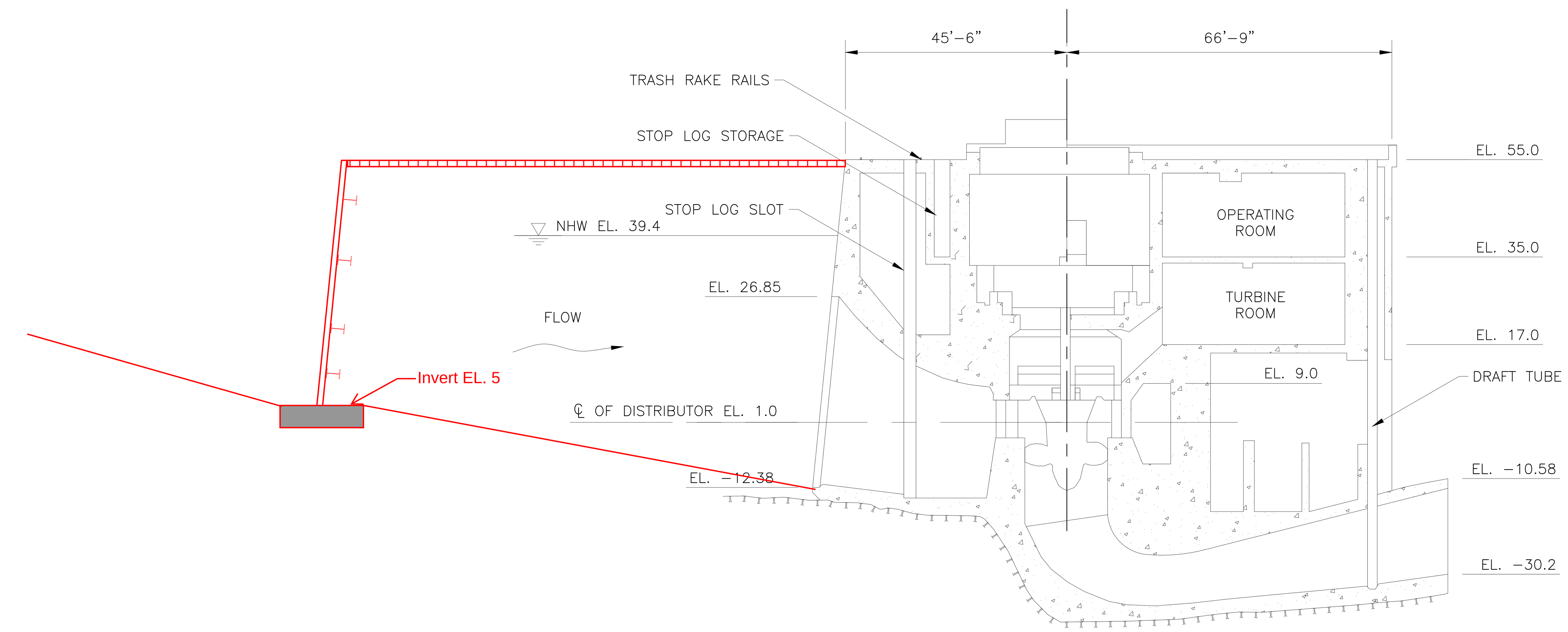
Draft Alternatives Review – Downstream Fish Passage at the Brunswick Project

ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
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	-	-	-	-	-	-	-	-

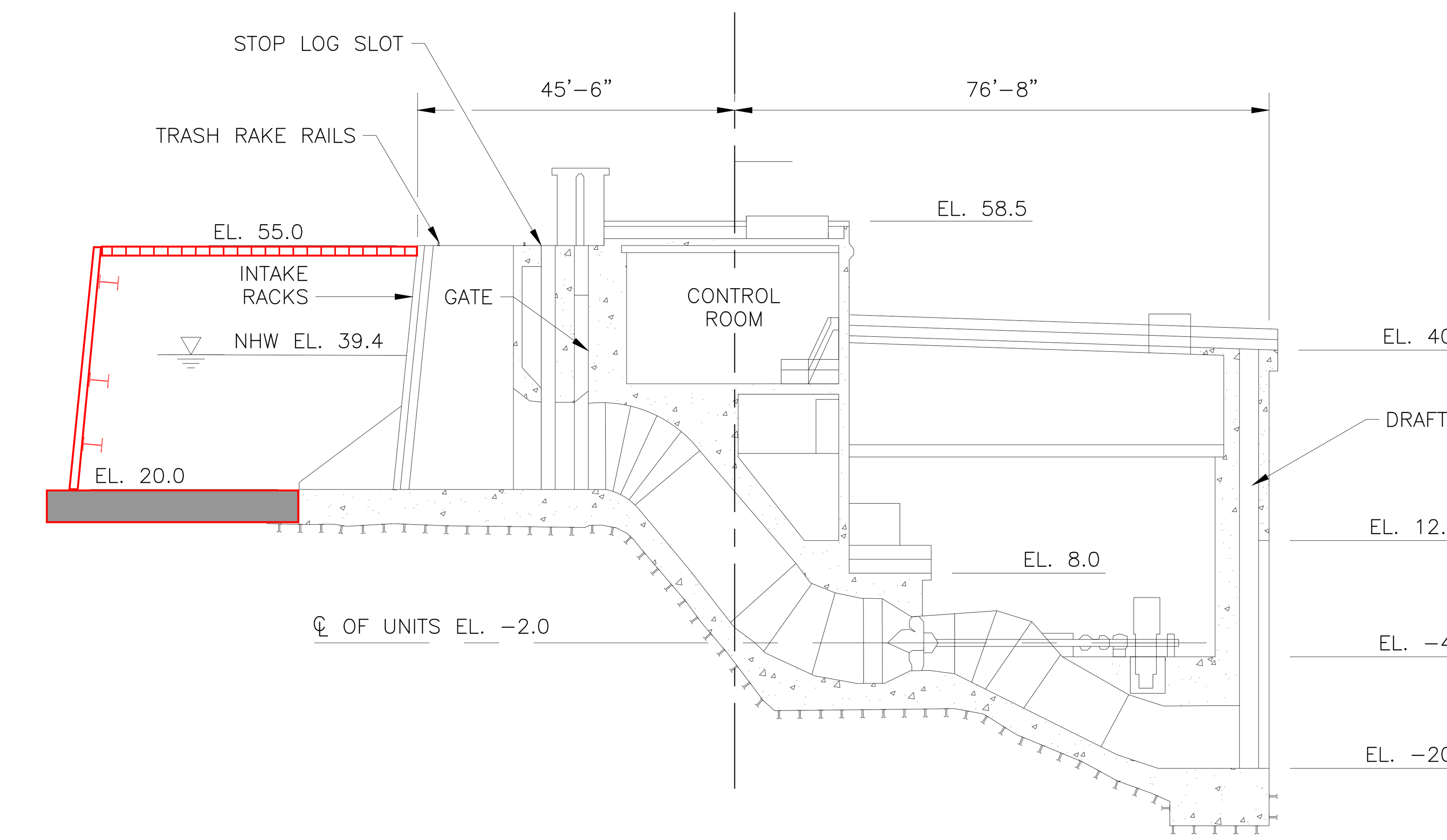
Draft Alternatives Review – Downstream Fish Passage at the Brunswick Project

ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
		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'



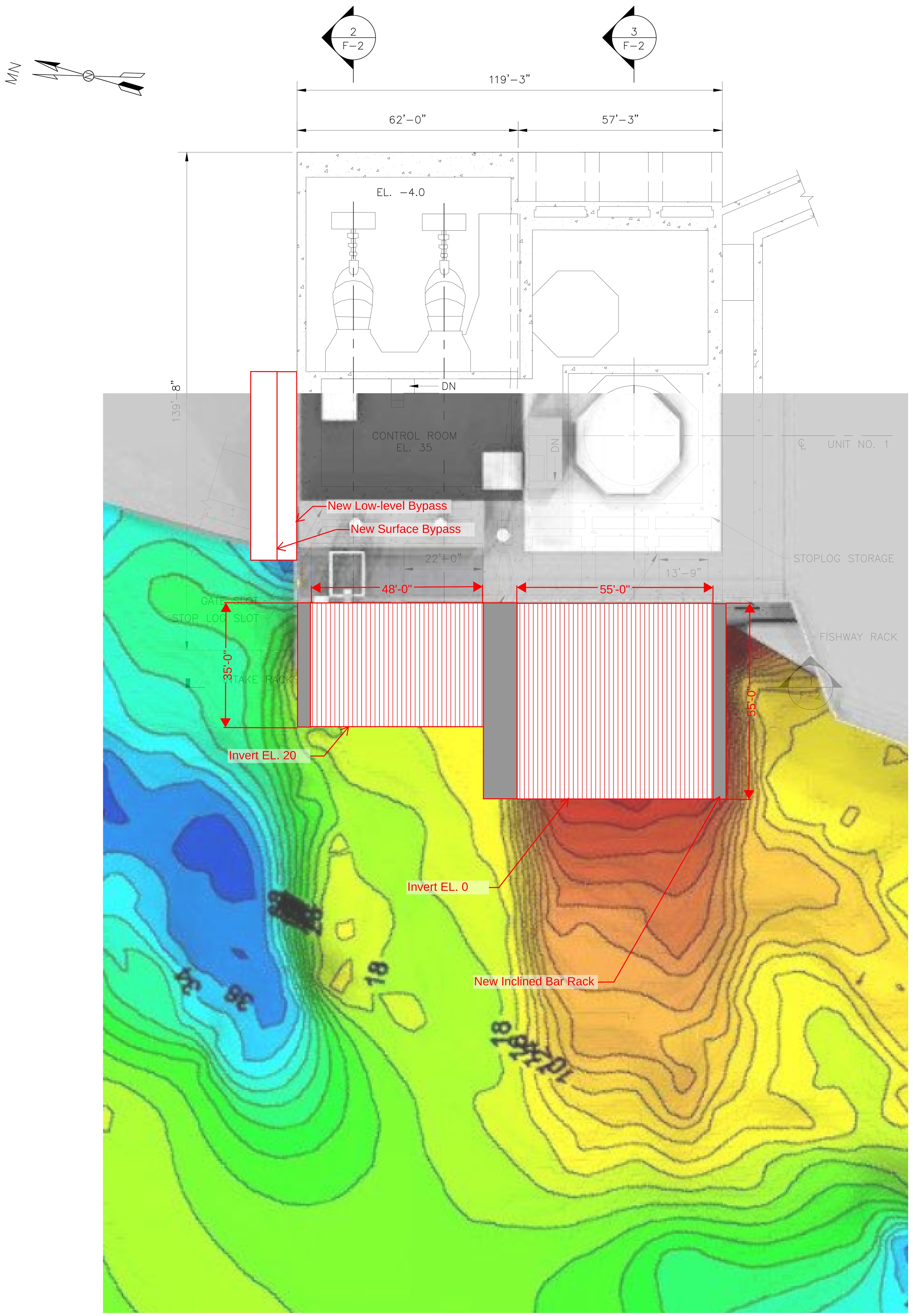
3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

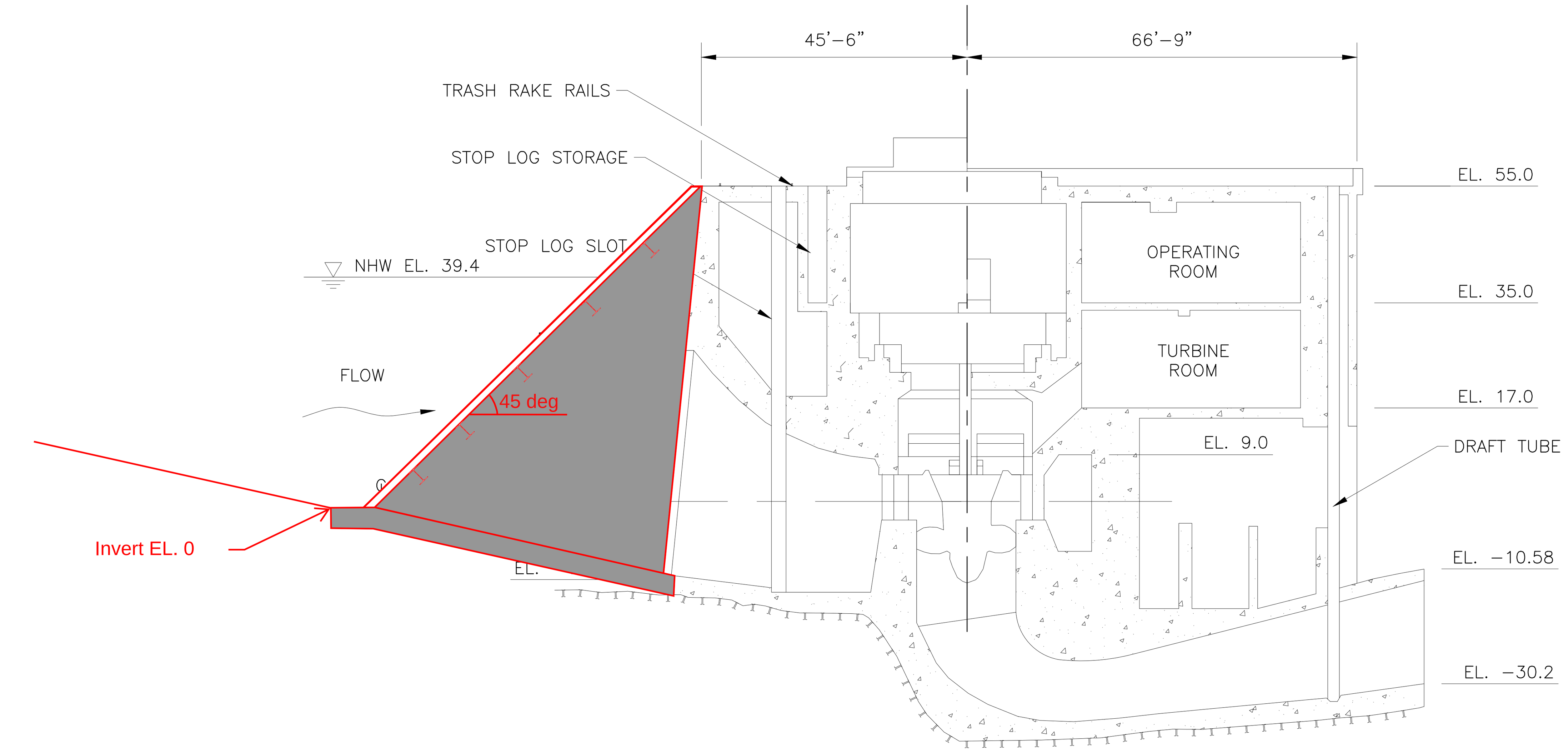
Alternative D1 - Angled Bar Rack with New Downstream Pass Structures

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

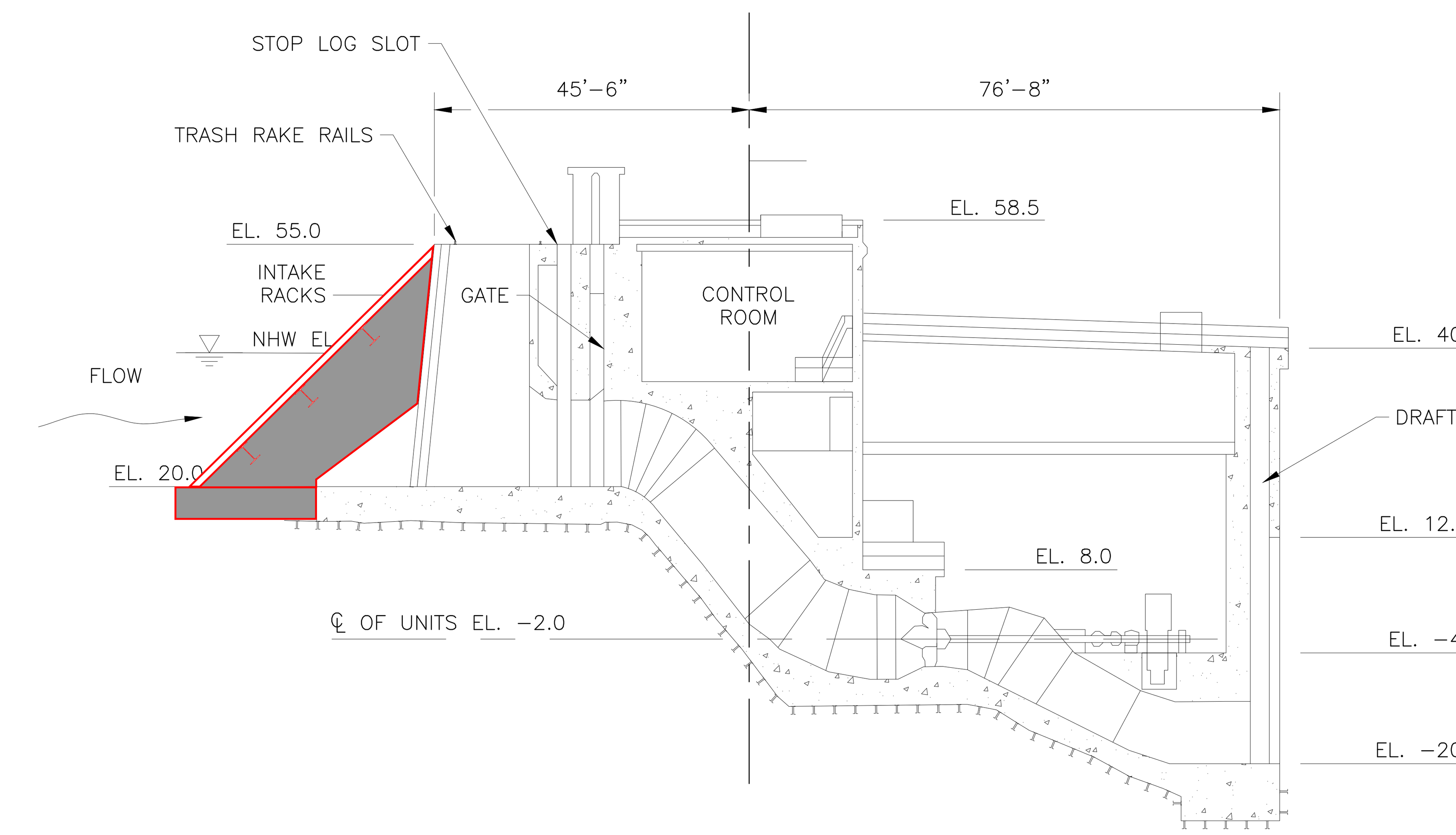
NOTE:

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





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



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

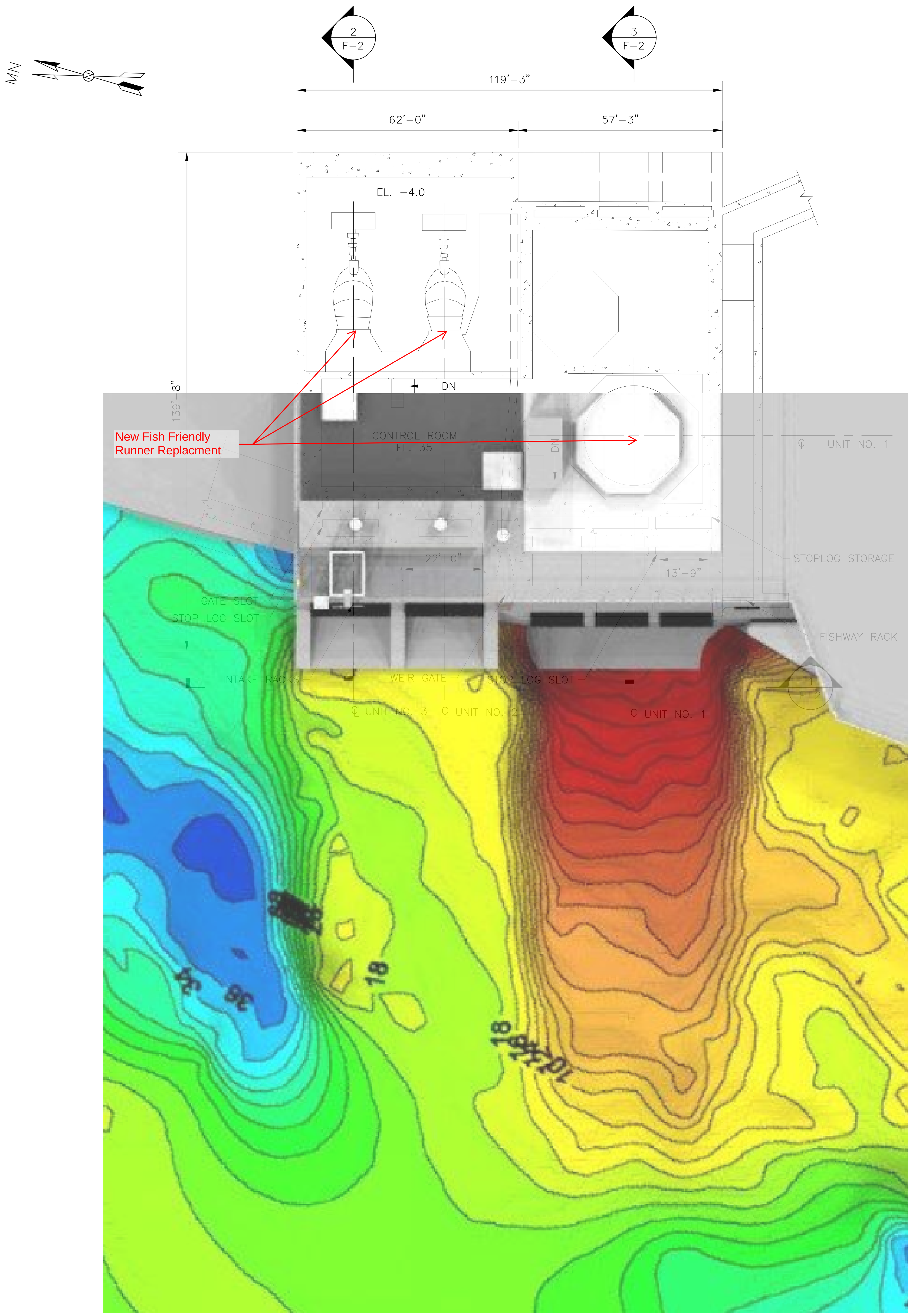
Alternative D2 - Inclined Bar Rack with New Downstream Bypass Structures

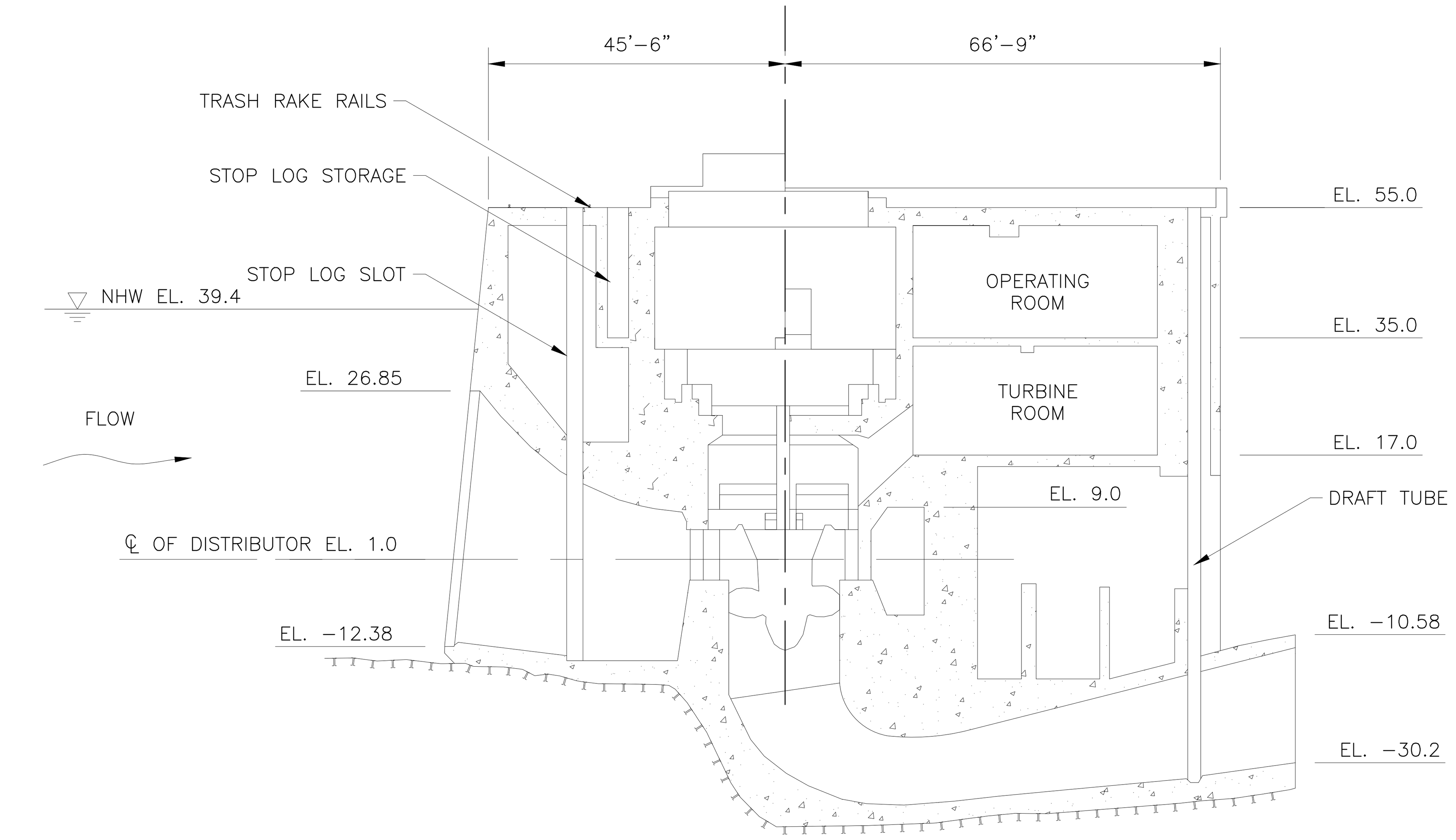
20' 0 20' 40'
SCALE: 1" = 20'

NOTE:

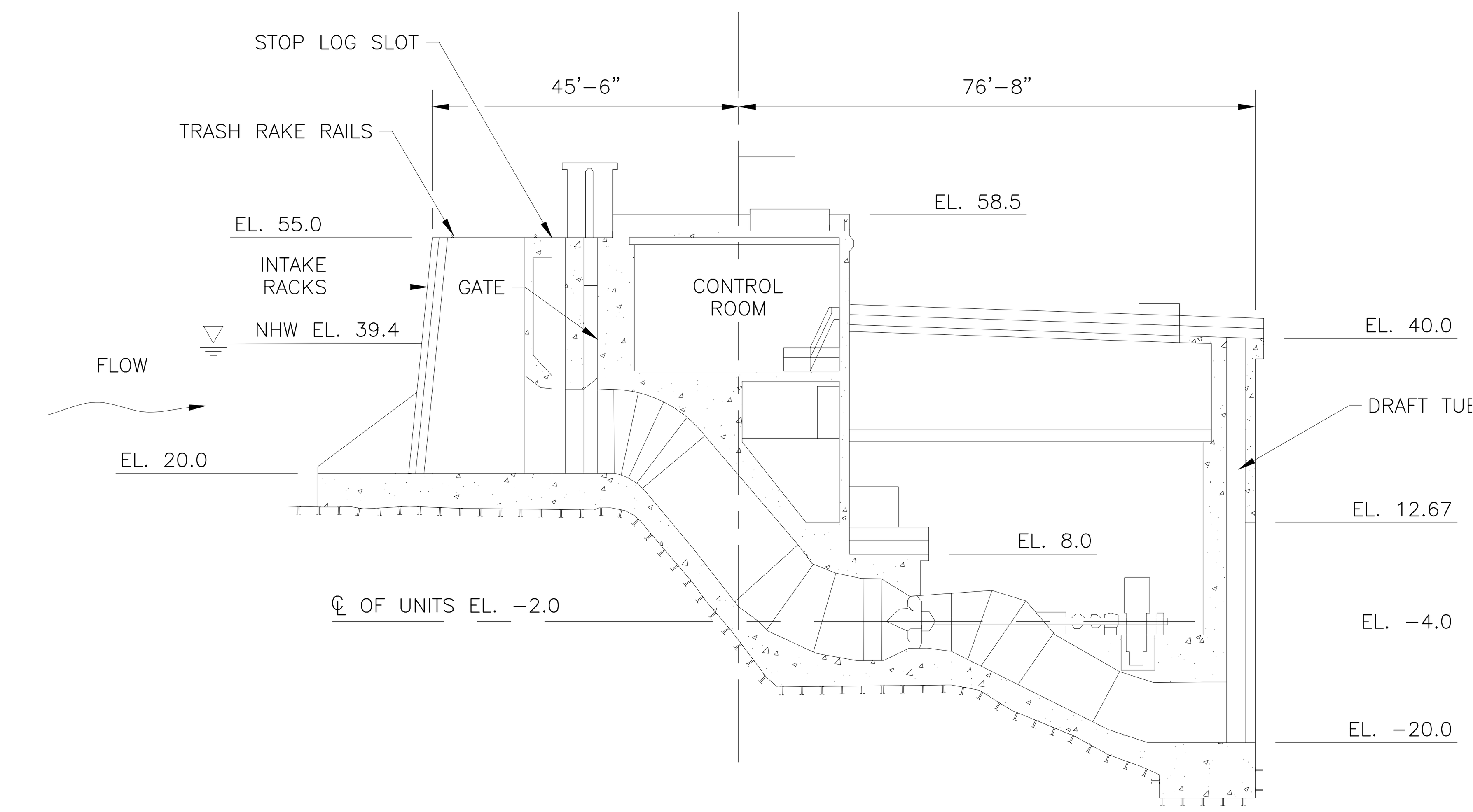
1. ELEVATIONS SHOWN IN THIS DRAWING SET ARE REFERENCED TO THE NORTH AMERICAN GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

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





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



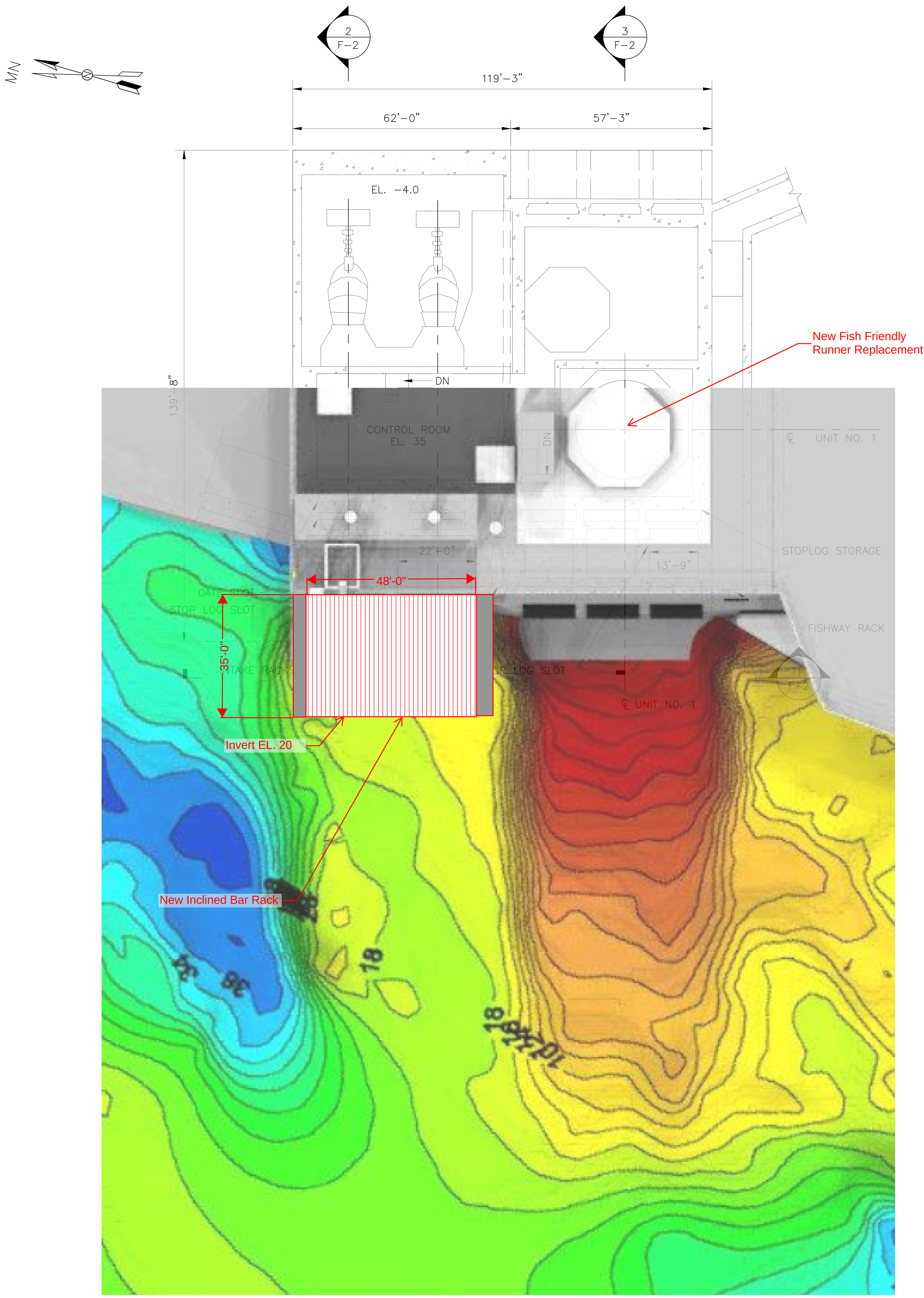
3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

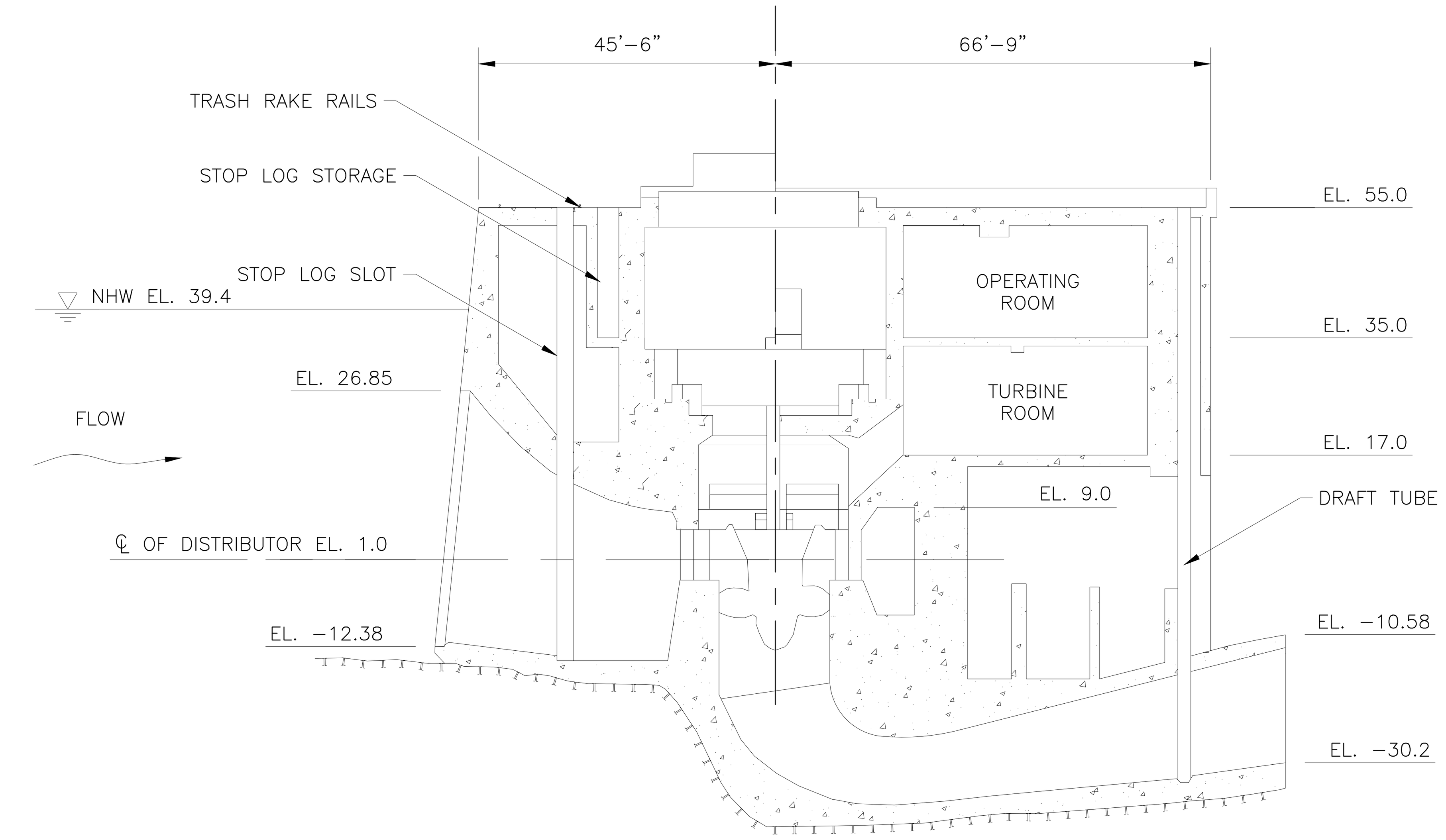
Alternative D4A - Multiple Fish Friendly Runner Replacements

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

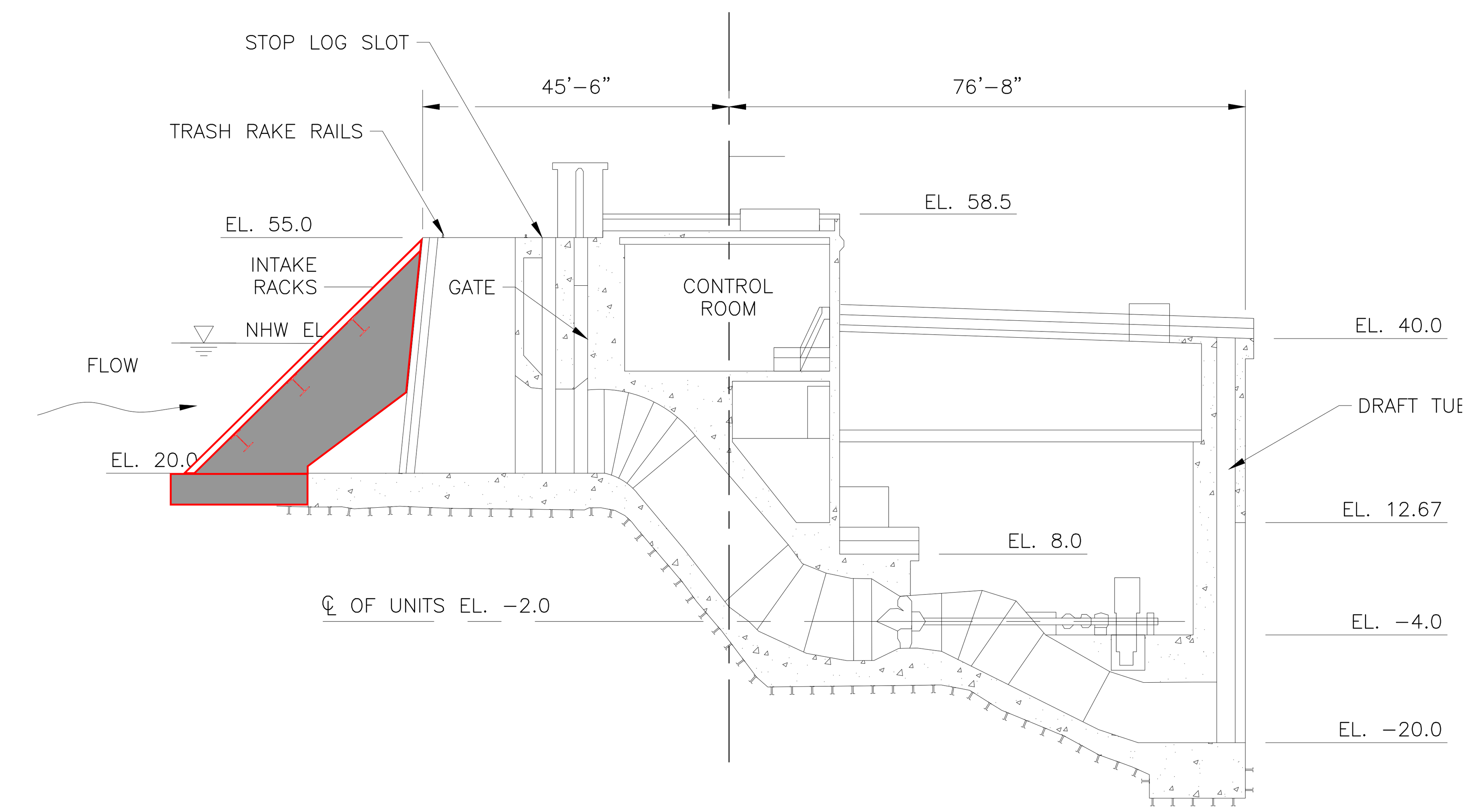
NOTE:

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'



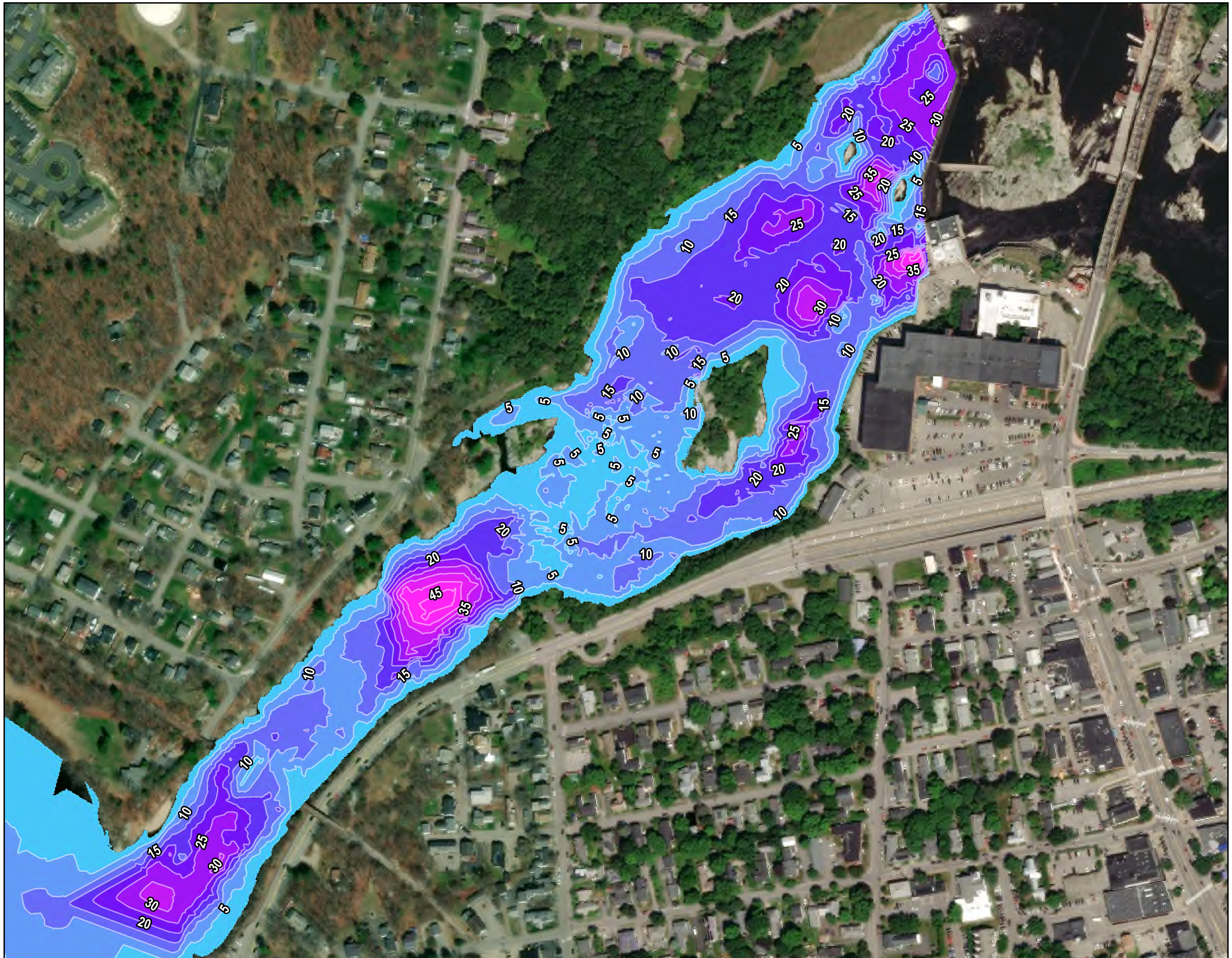
3 F-2 SECTION THROUGH CENTERLINE OF UNIT NO. 3
1" = 20'

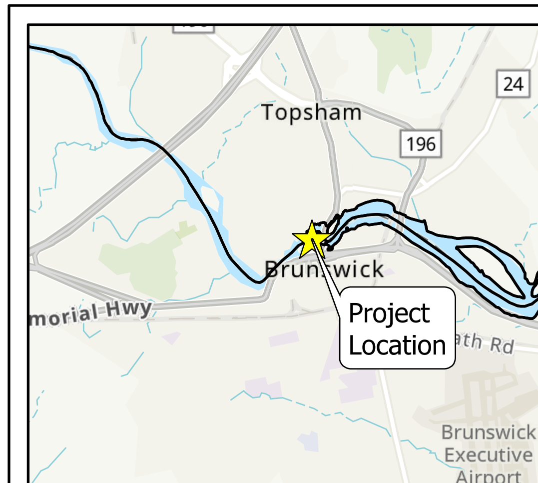
Alternative D4B - Single Fish Friendly Runner Replacement with Inclined Rack

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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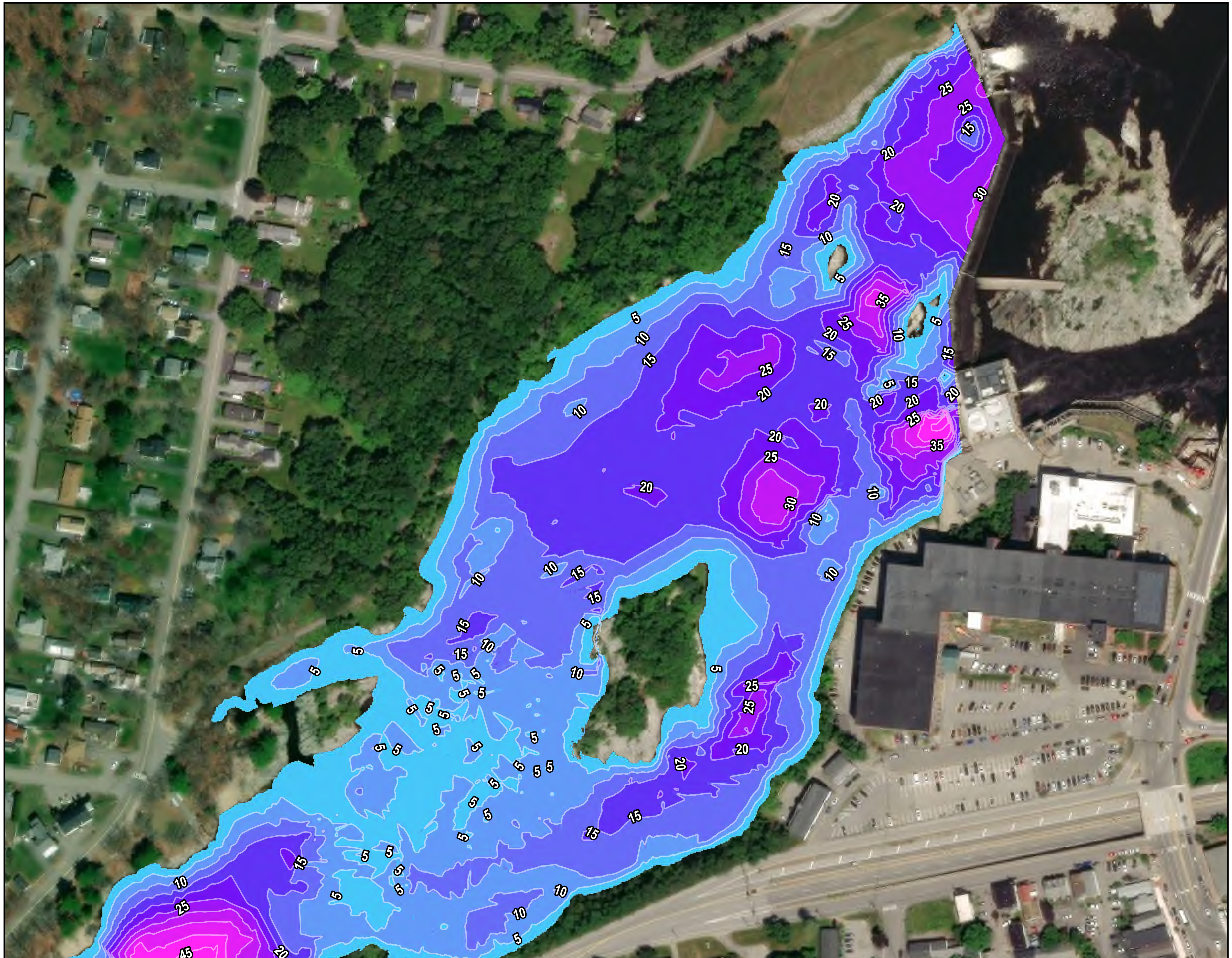

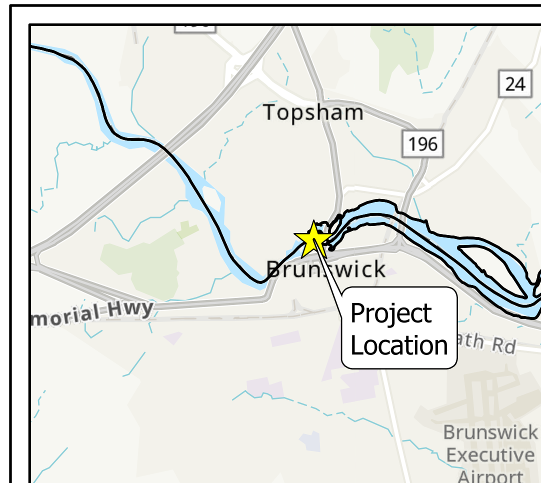

Brunswick Hydroelectric Project
(FERC No. 2284)

Brunswick Impoundment
Water Depth in Feet

Legend

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- 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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