Rhode Island
Saltwater Anglers
Foundation

P.O. Box 1465, Coventry, RI 02816 www.risaa.org Office: 401-826-2121 Fax: 401-826-3546

## Rhode Island Recreational Fishing Action Plan
## PROJECT APPLICATION

The Rhode Island Saltwater Anglers Foundation, Inc. (Foundation) is a nonprofit 501(c)3 organization, created to preserve our marine fisheries, sponsor educational and public awareness programs, environmental protection, restoration projects, and youth activity programs that foster recreational fishing, safety and conservation for the recreational fishing community in southern New England. For background on RISAA and the RISAA Foundation you may refer to the RISAA website at: www.RISAA.org/

The Foundation is willing to fund a project exclusively, however we encourage applicants to leverage our grant with Federal, State or other such funding to allow these funds to be used as a key part of a larger project. The Foundation may award one or multiple projects. In addition to submitting all application materials to the e-mail address below, the application should be submitted by U.S. mail to the Foundation office.

RISAA reserves the right to reject any or all proposals submitted.

The maximum amount available for an individual project is $15,000. These funds may be used for on-the-ground habitat conservation and improvement projects, research, culture specific to species of recreational interest, or for projects that will in some other way benefit recreational fishermen in Southern New England.

Project Title: **Improving Fish Passage on the Saugatucket River**
Project Location: **Wakefield, South Kingstown**

**Applicant Information**
Last name: **O'Brien** , First: **John,** MI:**F**
Address: **159 Waterman St., Providence RI, 02906**
Phone: (office) **401-214-4526** (cell) **401-835-3011** (fax)_____
E-mail: **jobrien@tnc.org**
University or Company: **The Nature Conservancy**
Department: _____
Name of other key investigator: _____ Phone: _____

**PROJECT CONTACT**
Lead Project Officer (if different from applicant): **Scott Comings**
Address: **159 Waterman St., Providence RI, 02906**
Phone: **401-486-1278** E-mail: **scomings@tnc.org**

**FUNDING INFORMATION**
Funding being sought for: **X** Construction __Design __Planning __Monitoring __Outreach
Funding amount requested: **$15,000** Total cost of project: **$115,000**

**PROJECT ELIGIBILITY** (answer "yes" or "no" to the following)
**No** Will any amount of the requested funds be applied to previous expenditures?
**No** Will the requested funds be used for operation or maintenance of facilities?
**No** Is the project primarily a research study?

**PROJECT DESCRIPTION**
**Describe project** (max 500 characters – attaché separate sheet if necessary)

The Saugatucket River is a small coastal watershed (11,018 acres) that flows into the northern end of Pt. Judith Pond in South Kingstown. It is the largest fluvial system contributing to Block Island Sound. Runs of diadromous fish (alewife, blueback herring, and American eel) were once very plentiful in the Saugatucket River but disappeared from the watershed with the construction of mill dams in the 1800's. Efforts to restore diadromous fish to the watershed began in the 1970's with the construction of the first fish ladder at the Main Street Dam in Wakefield. Shortly after a second fish ladder was constructed at the Palisades Mill in Peacedale providing access for spawning fish into Peacedale Pond. A third ladder was eventually constructed at the outflow of Indian Lake in 2003. The DEM Division of Fish and Wildlife has executed easements with the respective landowners in order to maintain and operate each of the ladders.

Most recent observations and assessments by RIDEM, NOAA, and USFWS fish passage engineers have identified several problems as well as opportunities to improve fish passage performance at both the Palisades Mill and the Indian Lake fish ladders. The Nature Conservancy is working closely with the DEM Division of Fish and Wildlife and is planning to schedule these modifications for improving fish passage at the Palisades Mill ladder and the Indian Lake ladder during the fall of 2018.

**Importance of project to the resource** (max 350 characters – attach separate sheet if necessary)

A healthy Saugatucket River diadromous fish population will provide important ecological services to Pt. Judith Pond, other South Shore Coastal Ponds, and Rhode Island waters. Figure 1 shows the location of each of these fish ladders in the watershed. Diadromous fish provide an important forage base to support sustainable populations of recreational and commercial fish. Based on the extent of the spawning and nursery habitat in the Saugatucket River watershed, this system has the potential to support river herring populations of over 200,000 spawning adults. As part of the ongoing restoration program, the monitoring of up and down stream fish passage through the existing fish ladders continues during each year's annual run.

Proposed improvements to the Saugatucket River fish ladders will improve fish passage and provide access to the critical freshwater habitat of Indian Lake which functions as spawning and nursery grounds supporting self-sustaining populations of important species of diadromous fish. The National Marine Fisheries Service has listed river herring (both alewives and blue backs) as "species of concern" and continues to evaluate the status of Atlantic Coast river herring populations. River herring is listed as NOAA trust resources and are federally managed species through the Atlantic States Marine Fisheries commission (ASMFC). Currently there is a moratorium on the taking of river herring in Rhode Island freshwater and marine waters. Alewife, and blue back herring fall under the ASMFC Coast Wide Management Program. There is a coast wide management program for each

species. In addition, the 2015 Rhode Island Wildlife Action Plan has listed each of these two species as a "Species of Greatest Conservation Need" (GCN).

**Objective of the project with reference to recreational fishing**
(max 350 characters – attach separate sheet if necessary)

Recreational fishing in Rhode Island is an extremely popular and important outdoor recreation activity. Based on the 2011 National Survey, fishing-related expenses in Rhode Island totaled $130 million. Stream restoration—improving connectivity—provides a direct benefit to this important recreational activity both in fresh and salt water. Both adult and juvenile river herring provide an important forage base for freshwater and saltwater game fish such as largemouth bass, chain pickerel, striped bass and bluefish. Increasing the diadromous spawning populations in the Saugatuck River will substantially enrich forage fish populations in the main river as well as the lower river estuary, Point Judith Pond and Block Island Sound

**Proposed methods to be used** (max 500 characters – attach separate sheet if necessary)

The USFWS Fish Passage Engineering Group is under contract with The Nature Conservancy and has surveyed both the Palisades Mill and the Indian Lake fish ladders. Based on the survey work, a number of modifications to each ladder have been recommended to improve fish passage. The following are short paragraphs of the proposed work. A detailed scope of work, design recommendations, engineering drawings, plans, and specifications have been prepared by USFWS and are included as Attachment A, "Survey and Design Recommendations to Improve Fish Passage at the Indian Lake and Palisades Mill Fish Ladders". The modifications to each of these ladders will be scheduled for late summer or early fall of 2018.

Indian Lake Fish Ladder

Each spring, the upstream movement of herring has been delayed. Fish have been observed stacking up in the ladder pools and have had to be manually netted out and released into the head pond (Indian Lake). Based on current USFWS Engineering criteria, modifications (design changes) will be made to the ladder to revise hydraulic conditions and improve the upstream passage of fish through the ladder. These improvements will include increasing the number of concrete weirs in the ladder and revising the orientation of the low flow notches.

Palisades Mill Fish Ladder

Modifications are necessary to improve attraction to the entrance to the ladder as well as decreasing water velocities in the fishway to meet acceptable levels for the passage of river herring. Modifications to the ladder will include revising and installing a new baffle system (48 new wooden baffles) to create a false 1:8 slope and installing a steep pass at the fishway entrance to hydraulically connect the water within the entrance channel to the tail water.

**PROJECT DESIGN** (no character limits – attach separate sheet if necessary)
Include technical design, permits, outreach, etc.

See Attachment A: Survey and Design Recommendations to Improve Fish Passage at the Indian Lake and Palisades Mill Fish Ladders

**EVALUATION QUESTIONS**
If there is more than one project site, and sites are located in more than one region, answer ONLY for the region in which the majority of the project sites reside.

Does the project address current **recreational fish habitat**? Yes.

Does the project address current **recreational fish abundance**? Yes.

Does the project address the current understanding of **recreational fish abundance, behavior and/or environmental conditions**? Yes?

Will the project address a **current problem(s) in the recreational fishery**? Yes.

**QUALIFICATIONS**
Provide a brief abstract of relevant qualifications of applicant, project lead and most important team members. (attach additional info as necessary, not to exceed one page)

The Nature Conservancy is the largest worldwide conservation organization. The Rhode Island Chapter Field Office is staffed with habitat restoration specialists including administrators, biologists, and a conservation engineer. The Chapter is supported by a regional grant service network that includes grant specialist, fiscal officers, and legal staff. The Conservancy is currently involved in a number of marine and freshwater habitat restoration projects in Rhode Island that are providing important deliverables on time and on budget. The Chapter has a reputation for being experienced, responsible, and effective, working with grant opportunities that have short time frames. Scott Comings, Associate Director of the RI TNC Chapter will be the TNC Project Manager for the Saugatucket River project. Scott led the White Rock Dam and Bradford Dam removal projects on the Lower Pawcatuck, which finished on time and under budget. He will be assisted by John O'Brien, who is now the Partnership Specialist at TNC, and has many prior years of experience at DEM, Division of Fish and Wildlife, where he led the diadromous fish program. They will partner with Phil Edwards, who is a Principal Fisheries Biologist with DEM Division of Fish and Wildlife and is now in charge of their diadromous fish program. In addition, the project team will include engineering personnel from the USFWS Fish Passage Engineering Group.

**Budget Table** (the budget table below is an example; please add/change line items as needed):

| Item | Total Cost | Requested Funds | Partner Funding |
|---|---|---|---|
| Design & Construction Oversight | $ $25,000 | | $25,000 |
| Construction | $ 80,000 | $15,000 | $65,000 |
| Monitoring | $ 10,000 | | $10,000 |
| | | | |
| | | | |
| **Total Costs** | $115,000 | $15,000 | $100,000 |

**Partners** (the partner table below is an example; please add/change line items as needed:

| Project Partner | Amount | Cash/In-Kind | Federal or Non-Federal | Pending/Received |
|---|---|---|---|---|
| RIDEM | $10,000 | In-Kind | Federal | Received |
| RICEHRF | $50,000 | Cash | Non-Federal | Pending |
| TNC | $20,000 | Cash | Federal | Received |
| TNC | $20,000 | Cash | Non-Federal | Pending |
| Total | $100,000 | | | |

**Timeline of Project Activities** (the table below is an example; please add/change line items as needed):

| Project Activity | Anticipated Dates of Implementation |
|---|---|
| Project design | Completed |
| Construction | September 2018 |
| Monitoring | Spring of 2019 and 2020 |
| | |
| Final report to RISA Foundation | December 2018 |
| | |

## BUDGET NARRATIVE

### Design and Construction Oversite

Funding for design and construction oversight will be provided by The Nature Conservancy (TNC). The TNC Conservation Engineer as well as the USFWS Fish Passage Engineers (under contract with TNC) will provide all of the required services for design, bid specifications, selection of contractors, and construction oversight.

### Construction

Attachment A. (see below) contains a scope of work and detailed designs and drawings for necessary modifications to each of the fish ladders. Preliminary estimates for the costs of modifications for both ladders is $80,000. This cost estimates were developed by TNC and USFWS engineers and were confirmed with onsite reviews by local contractors. The total request from RISAA is $15,000. The $65,000 balance will be supported by a grant from RICEHRF and from TNC through foundations and TNC donor support.

**Monitoring**

Funding for monitoring performance, maintenance, and adjustments of the fish ladders will be provided by the DEM Division of Fish and Wildlife. These facilities are incorporated into their diadromous restoration program and are serviced on a routine basis. During both the spring and the fall run periods, the ladders are check frequently to evaluate returns and outmigrants and adjusted as necessary. This will be an in-kind contribution to the project with an estimated value of $10,000.

## Attachment A

## United States Fish and Wildlife Service
## Division of Fisheries
## Fish Passage Branch

# Survey and Design Recommendations to Improve Fish Passage at the Indian Lake and Palisades Mill Fish Ladders

**Scope of Work for Indian Lake Fish Ladder**

The intent of this section is to clarify the proposed design alterations provided by the Northeast Region R5 U.S. Fish and Wildlife Service (USFWS) Fish Passage Engineering Group (Engineering). The recommended changes to the existing design are based on current USFWS fish passage criteria (USFWS, 2017) as well as visual inspections of fish behavior within the fishway.

***Background***

The existing fishway at the outlet of Indian Lake is a pool and weir design consisting of six concrete weirs that step down or lower the water surface from the headpond (Indian Lake) to the tailwater (Fresh Meadow Brook). The intent of this design type is to dissipate the kinetic energy of the flow within each of the pools, allowing fish to rest before passing over the weir. The hydraulics at the weir must provide the appropriate conditions with relation to velocity and depth in order to achieve successful upstream passage.

Multiple site inspections performed by USFWS Engineering and Rhode Island Department of Environmental Management (RIDEM) personnel have revealed an excessive amount of delay of river herring within the fishway (river herring have been documented stacking up in several of the pools on multiple occasions). For several years the local community and lake association have been netting the stranded fish from within the fishway into Indian Lake to ensure spawning can occur. This is not an ideal condition in that handling of fish increases the risk of injury with unknown long-term effects. USFWS Engineering personnel conducted a survey of the existing fishway structure in April 2017 to verify original design plans and collect the pertinent data needed to develop a hydraulic model of the system. This information was utilized to examine the existing conditions and make the following proposed recommendations based on current USFWS Engineering criteria (

***Fish Passage facility Evaluation***

The hydraulic analyses developed by USFWS Engineering personnel exposed several parameters that did not meet current Engineering Criteria. These discrepancies are described in detail below followed by a list of recommended design changes to improve upstream fish passage.

**Issues:**

1. Weir Submergence – Current Criteria recommends that the low flow notches within each of the weirs be submerged at a minimum level of two times the body depth of the associated target species. For river herring the minimum level of submergence is 9 inches. This means the tailwater (water surface within the pool) is recommended to be 9 inches above the invert of the low flow notch. It must be noted that under low flows this condition may not be achievable. The operating range for the Indian Lake fishway is on the order of 1 to 15 cubic feet per second (cfs). At 1 cfs, the submergence level of 9 inches is not feasible. Yet, it is important that some level of submergence is provided at all flows. The results of the hydraulic model of existing conditions demonstrated there was no submergence for a flow of 1 cfs at the upper four weirs (the same location fish were witnessed becoming stranded). The recommended level of submergence (9 inches) does not occur until a flow of 20 cfs.
2. Low Flow Notch Orientation – The existing low flow notches are staggered (i.e., not in line with each other) which forces the flow to route from one side of the fishway to the other within the pools. Under certain flow conditions the flow can become "torqued" (i.e., twists) through the low flow notch which creates a hydraulic that is not conducive to upstream fish passage.
3. Energy Dissipation Factor (EDF) – EDF is used to quantify the amount of energy dissipation that occurs within the pools of a pool and weir system and directly correlates to the level of turbulence and aeration. A specific criterion for river herring is under development but a value of 3 ft-lb/s/ft$^3$ is typically used as a conservative value. EDF values for a range of flows within the existing fishway were calculated and found to not be an issue (values less than 3 ft-lb/s/ft$^3$) until a flow of 10 cfs. Therefore, the EDF values were deemed less significant to the poor passage that has been witnessed.

**Recommendations:**

Note: these recommendations are based on a low tailwater elevation of 76 feet (NGVD29) as shown on the original design plans and maintaining the existing footprint. The proposed recommendations may change once this value is verified in the field.

1. Weir Submergence – The existing drop per pool (difference between the top of one weir to the next) is 0.75 feet with a low flow notch depth of 0.67 feet. This geometry leads to a level of zero submergence at low flows. It is recommended that the drop per pool be altered to 0.45 feet in order to achieve a level of 0.3 feet (~4 inches) of submergence at low flows. This change forces the need for a total of ten weirs, an additional four from existing conditions. The proposed recommendation would provide the ideal level of submergence of 9 inches at a flow of 10 cfs, a 50% reduction in the required flow from existing conditions.
2. Low Flow Notch Orientation – The proposed orientation of low flow notches is an in-line layout. All weirs are recommended to align with the existing low flow notch in the upper most weir. This will alleviate the risk of the flow becoming torqued and provide hydraulics within the pools that are conducive to resting (i.e., the flow is not sweeping across the pool).
3. EDF – Although this factor was deemed not significant, it was analyzed as part of the hydraulic analysis. With the proposed ten weirs the EDF values do not exceed a level of 3 ft-lb/s/ft$^3$

until flows around 20 cfs. This is a 100% increase in the flow level that would cause conditions within the pools to be excessively turbulent.

## Scope of Work for Palisades Mill Fish Ladder

The intent of this section is to clarify the proposed design alterations provided by the Northeast Region R5 U.S. Fish and Wildlife Service (USFWS) Fish Passage Engineering Group (Engineering). The recommended changes to the existing design are based on current USFWS fish passage criteria (USFWS, 2017) as well as visual inspections of fish, and velocity measurements taken within the existing fishway during multiple site visits.

### *Background*

The existing fishway located at the Palisades Mill is a standard Denil design which consists of a 3 foot wide prismatic concrete channel. Baffles (in this case made of wood) act as roughness elements along the sloped sections to dissipate the kinetic energy of the water, creating a low velocity zone of passage for migratory fish species. The current slope of the Palisades Denil is 16.7% or 1:6 (Vertical:Horizontal). Current USFWS Engineering criteria (Criteria) recommends that a 16.7% slope is applied only to fishways designed specifically for Salmonids (e.g., Atlantic salmon, brook trout). A slope no steeper than 12.5% (1:8) is recommended for Alosines (e.g., river herring, American shad) in order to maintain velocities through the baffles that are within the species swimming capabilities. Fish passage of Alosines, since the Palisades fishway was constructed in the 1970s, has not been successful based on the fact that in multiple years river herring have been witnessed stacking up near the entrance of the fishway (an indicator of a poorly functioning entrance and/or velocities within the fishway forcing them back out). After many years of the fish having to be manually lifted over the Palisades Mill Dam, an attempt was made to remedy the situation. Five additional baffles were added within the exit channel of the fishway in 2013. The purpose of these baffles was to reduce the amount of flow into the fishway and in turn, reducing the velocities through the baffles. USFWS Engineering personnel conducted several site visits post installation of the five baffles. It was determined that the reduction in flow did not decrease velocities within the fishway to acceptable (meeting Engineering Criteria) levels for Alosines (based on measurements taken on site), and fish continued to be delayed at the entrance (personal communication with RIDEM personnel).

### *Fish Passage Facility Evaluation*

Several design issues were discovered during multiple site visits by USFWS Engineering personnel at the Palisades fishway. These concerns are described in detail below followed by a list of recommended design changes to improve upstream fish passage.

**Issues:**

1. Entrance Conditions – Current Criteria recommends several critical parameters to be met at a fishway entrance in order to achieve successful upstream passage:
   - 1a. First, the entrance should be submerged by a minimum of 2 feet. Submerged in this case, meaning the tailwater should reside 2 feet above the entrance channel floor.
   - 1b. Second, the entrance should maintain an entrance jet with a maximum velocity (specifically for Alosines) of 6 feet per second (ft/s).

1c. Third, the velocities within the entrance channel (horizontal channel leading to the lowermost baffle) should remain within 1-1.5 ft/s to allow the fish to stage (i.e., rest) prior to traversing the sloped section of the fishway.

Measurements taken by USFWS Engineering personnel found that the entrance was not properly submerged, velocities at the entrance exceeded 7 ft/s, and velocities within the entrance channel were upwards of 3-4 ft/s. Video footage of actively migrating river herring was taken during the 2017 season which validated velocities exceeded the swimming capabilities, and upstream passage was being hindered. Fish were witnessed falling back and generally struggling to maintain position within the entrance channel.

2. Slope – Current Criteria recommends a slope no steeper than 12.5% (1:8) for passage of Alosines. The existing fishway maintains a slope of 16.7% (1:6). The high velocities within the entrance channel are due to a transfer of momentum from the sloped sections (i.e., the kinetic energy is not being dissipated appropriately to achieve velocities within the recommended range of 1-1.5 ft/s).

**Recommendations:**

1. It is recommended that the slope be altered to conform to a 12.5% slope. This is intended to be done by modifying the geometry of the baffles to create a "false" 1:8 slope (i.e., the 12.5% slope is created via the invert of the baffles rather than the concrete floor). Most baffles will have a different geometry in order to achieve this recommendation. The baffles within the lower leg of the fishway will be rather large to translate the 12.5% slope into the entrance channel. The baffles could consist of two halves (i.e., the top half would include the v-notch geometry and lower half would simply be a spacer) if weight limitations are an issue.
2. A steep pass is recommended to be installed at the fishway entrance (exact location and elevations to be determined once tailwater data is collected). This is necessary to hydraulically connect the water within the entrance channel to the tailwater, once the slope is changed to 12.5%, in an appropriate manner for fish passage. If originally designed to a 12.5% slope, the overall footprint would have been longer in order to for the fishway flow to properly meet the tailwater (i.e., without an excessive drop). The proposed design recommendations aim to utilize the existing footprint. Therefore, the water surface within the entrance channel will reside 2-3 feet higher than the current water surface, due to the location where the 12.5% slope will be forced to end.
3. Stop logs adjacent to the steeppass are recommended in order to control the amount of flow entering the steeppass. The hydraulic capacity of the steeppass is less than that of the Denil and therefore excess water will be discarded over the section of stop logs. The excess water will be utilized as attraction flow. Engineering will provide RIDEM with an Operations and Maintenance (O&M) plan once tailwater data is collected and the proposed design is finalized.

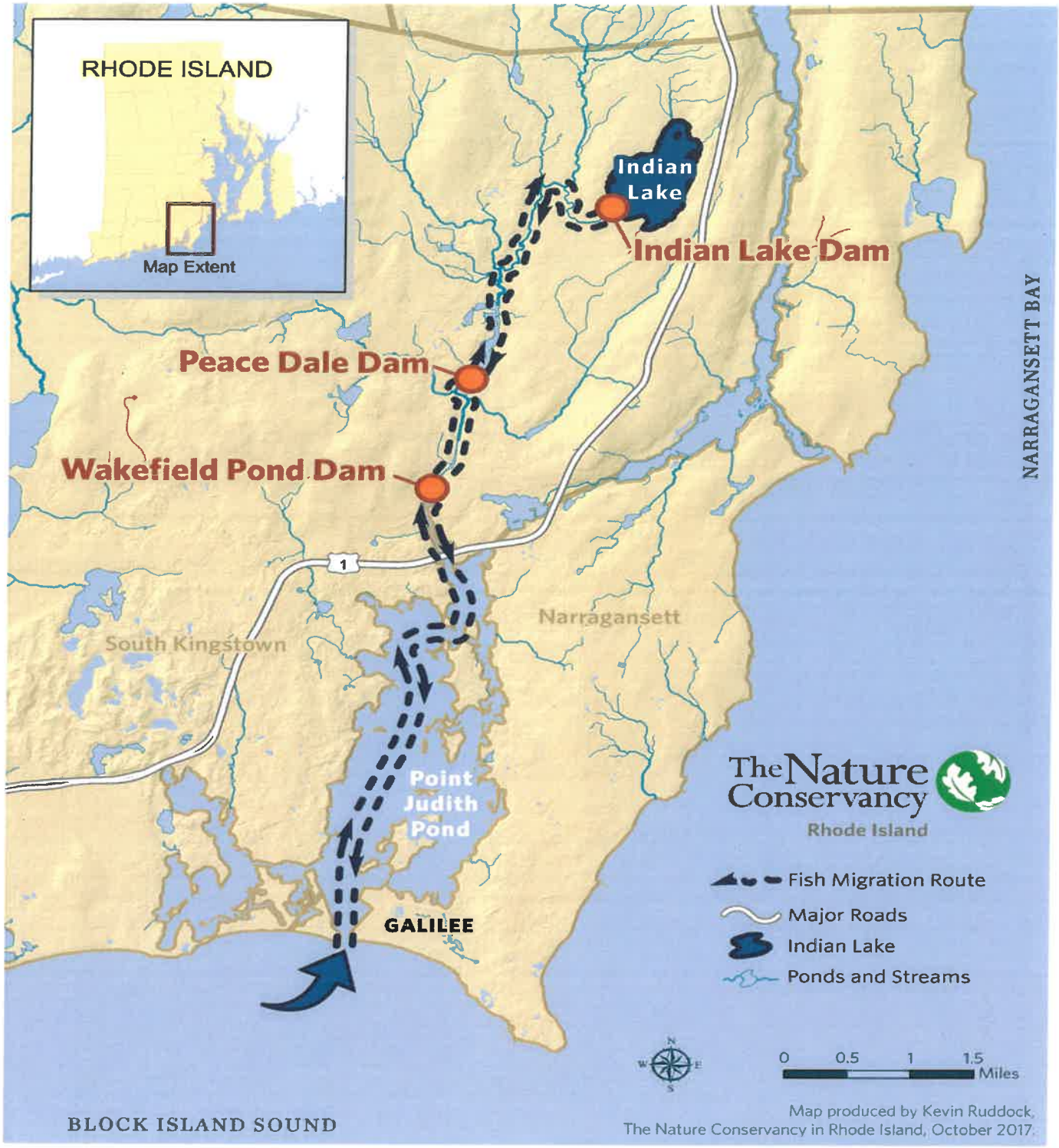
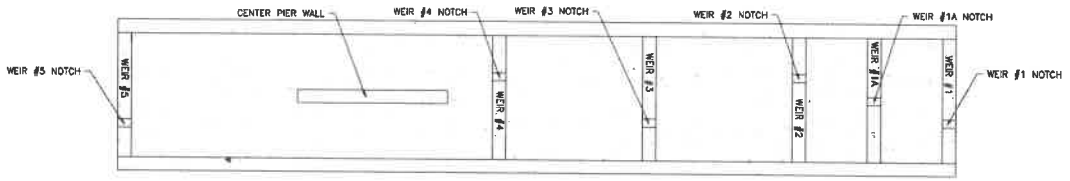


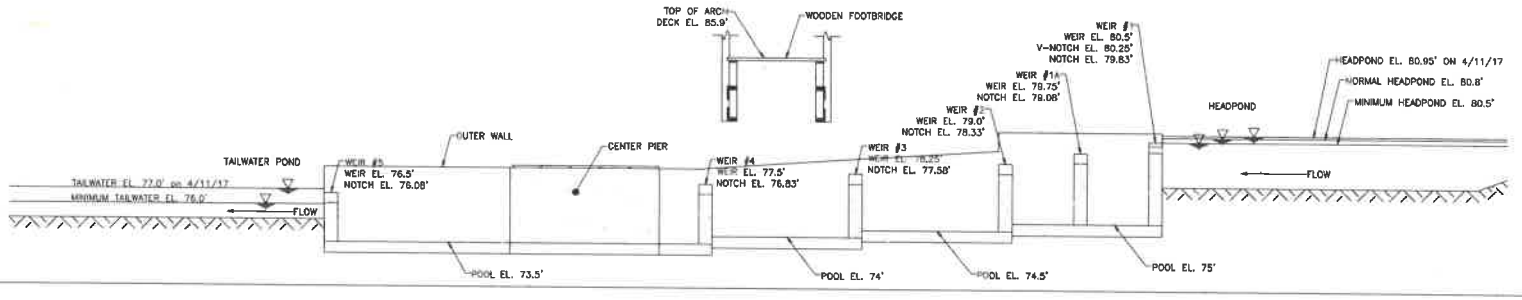

**Figure 1. A location map showing the position of the Palisades Mill and Indian lake Fish Ladders on the Saugatucket River.**




EXISTING PLAN VIEW

1" = 4'

0 4' 6' 8'




EXISTING PROFILE VIEW

1" = 4'

0 4' 6' 8'

**NOTES:**

1. **PLAN AND PROFILE VIEWS DRAWN ACCORDING TO DIMENSIONS DISPLAYED ON KLEINSSCHMIDT NOVEMBER 2004 RELEASED FOR BID DESIGN PLANS (ASSUMED TO BE FINAL PLANS WITH A VERTICAL DATUM OF NGVD29) WITH SUPPLEMENTAL SURVEY CONDUCTED ON APRIL 11, 2017 TO VERIFY.**

| No. | REVISIONS: | DATE: | BY: |
|---|---|---|---|
| | | | |

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DIVISION OF FISHERIES
FISH PASSAGE BRANCH

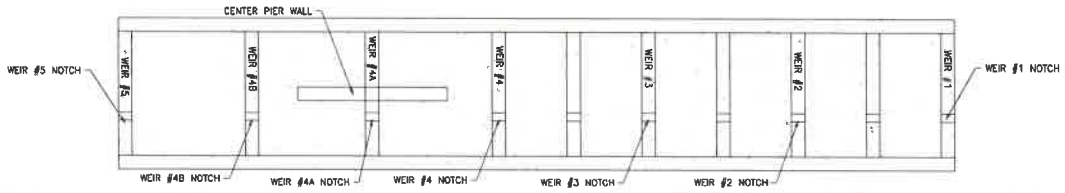
CERTIFIED:
SUBMITTED:
REVIEWED:
RECOMMENDED:
W.O. APPROVAL: DATE:

INDIAN LAKE SITE
SOUTH KINGSTON, RI

FISHWAY IMROVEMENTS
EXISTING PLAN AND PROFILE

SURVEYED: --- | DESIGNED: BRS | DRAWN: JEP | CHECKED: BRS
DATE: SEPTEMBER 2017 | DRWG. NO:

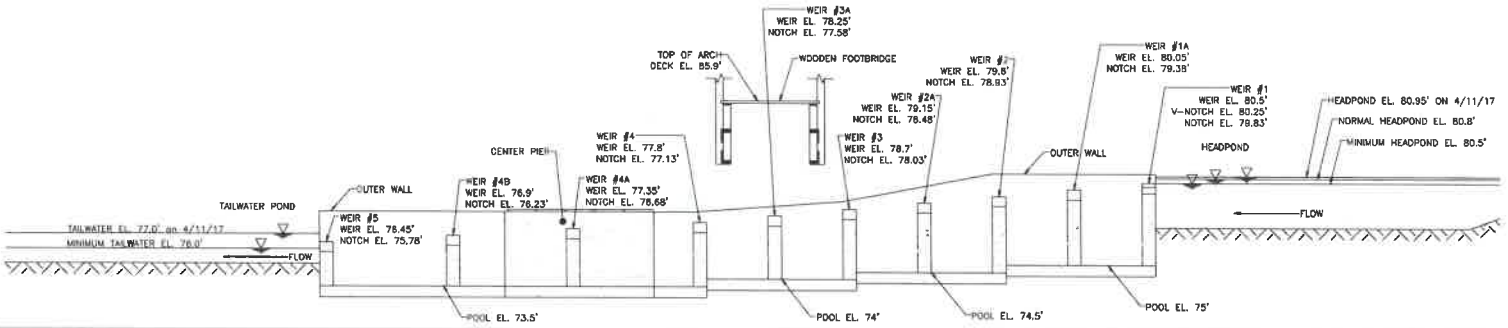
SHEET 1 OF 3




PROPOSED PLAN VIEW

1" = 4'

0 4' 6' 8'




PROPOSED PROFILE VIEW

1" = 4'

0 4' 6' 8'

NOTES:

1. THE PROPOSED CONDITIONS DISPLAY THE FOLLOWING ALTERATIONS TO IMPROVE FISH PASSAGE EFFECTIVENESS AT INDIAN LAKE:
   A. ADD WEIRS #2A, #3A, #4A, AND #4B THROUGHOUT THE POOL AND WEIR.
   B. WITH THESE MODIFICATIONS THE FISHWAY OUTER WALLS WILL HAVE TO BE RAISED IN THE AREA OF WEIRS #2, #2A, AND #3. AN APPROXIMATE ELEVATION WILL BE DETERMINED WHEN MORE DATA IS COLLECTED.
   C. STAFF GAGES SHOULD BE IMPLEMENTED TO PROVIDE AN EASY METHOD OF MEASURING THE ENTRANCE WATER SURFACE ELEVATIONS.
2. THE TAILWATER AND HEADPOND FLUCTUATION IS UNKNOWN. THIS INFORMATION WILL BE GATHERED BY RIDEM AND UTILIZED TO DEVELOP AN ACCURATE OPERATIONS AND MAINTENANCE PLAN FOR THIS FISHWAY TO ENSURE APPROPRIATE HYDRAULICS.
3. THIS IS A PRELIMINARY DESIGN FOR THE MODIFICATIONS AT THE INDIAN LAKE FISHWAY. PLANS WILL BE FINALIZED ONCE SUFFICIENT TAILWATER AND HEADPOND WATER SURFACE ELEVATIONS ARE COLLECTED.

| No. | REVISIONS: | DATE: | BY: |
|---|---|---|---|

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DIVISION OF FISHERIES
FISH PASSAGE BRANCH

CERTIFIED:
SUBMITTED:
REVIEWED:
RECOMMENDED:
U.S. APPROVAL: DATE:

INDIAN LAKE SITE
SOUTH KINGSTON, RI

FISHWAY IMROVEMENTS
PROPOSED PLAN AND PROFILE

SURVEYED: --- | DESIGNED: BRS | DRAWN: JEP | CHECKED: BRS
DATE: SEPTEMBER 2017 | DRWG. NO:

HYDRAULIC MODELING WAS CONDUCTED USING THE US ARMY CORPS OF ENGINEERS HYDROLOGICAL ENGINEERING CENTER'S (HEC) RIVER ANALYSIS SYSTEM (RAS) TO COMPARE EXISTING AND PROPOSED CONDITIONS OF THE INDIAN LAKE FISHWAY. FIVE DIFFERENT FLOW SCENARIOS WERE INVESTIGATED (1, 5, 10, 15, AND 20 CFS) TO REPRESENT THE RANGE OF FLOW SEEN DURING THE FISH MIGRATION SEASON.

GOALS FOR THE PROPOSED FISHWAY MODIFICATIONS WERE TO MAINTAIN EXISTING HEAD POND WATER SURFACE ELEVATIONS, INCREASE WEIR SUBMERGENCE, AND DECREASE THE ENERGY DISSIPATION FACTOR. ALL OF THESE WERE ACHIEVED AS SHOWN IN THE BELOW TABLES.

**Head Pond Elevation**

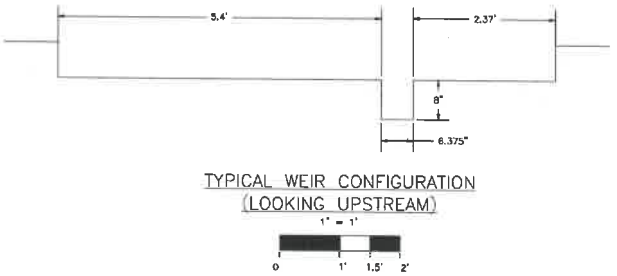
| | 1 cfs | | 5 cfs | | 10 cfs | | 15 cfs | | 20 cfs | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EX | PR | EX | PR | EX | PR | EX | PR | EX | PR |
| RS 156 | 80.58 | 80.58 | 80.81 | 80.81 | 81.01 | 81.01 | 81.18 | 81.17 | 81.33 | 81.33 |

**Submergence**

| | 1 cfs | | 5 cfs | | 10 cfs | | 15 cfs | | 20 cfs | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EX | PR | EX | PR | EX | PR | EX | PR | EX | PR |
| Weir 1 | 0.01 | 0.30 | 0.23 | 0.53 | 0.43 | 0.73 | 0 | 0.9 | 0.75 | 1.05 |
| Weir 1A | 0.01 | 0.30 | 0.23 | 0.53 | 0.43 | 0.73 | 0.6 | 0.9 | 0.75 | 1.05 |
| Weir 2 | 0.01 | 0.30 | 0.23 | 0.53 | 0.43 | 0.73 | 0.6 | 0.9 | 0.75 | 1.05 |
| Weir 2A | | 0.30 | | 0.53 | | 0.73 | | 0.9 | | 1.05 |
| Weir 3 | 0.01 | 0.30 | 0.23 | 0.53 | 0.43 | 0.73 | 0.6 | 0.9 | 0.75 | 1.05 |
| Weir 3A | | 0.30 | | 0.53 | | 0.73 | | 0.9 | | 1.05 |
| Weir 4 | 0.17 | 0.30 | 0.23 | 0.53 | 0.43 | 0.73 | 0 | 0.9 | 0.75 | 1.05 |
| Weir 4A | | 0.33 | | 0.53 | | 0.73 | | 0.9 | | 1.05 |
| Weir 4B | | 0.77 | | 0.78 | | 0.8 | | 0.9 | | 1.05 |
| Weir 5 | 0.92 | 1.22 | 0.92 | 1.22 | 0.92 | 1.22 | 0.92 | 1.22 | 0.92 | 1.22 |

**Energy Dissapation Factor**

| | 1 cfs | | 5 cfs | | 10 cfs | | 15 cfs | | 20 cfs | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EX | PR | EX | PR | EX | PR | EX | PR | EX | PR |
| Weir 1 | 0.29 | 0.17 | 1.43 | 0.81 | 2.75 | 1.56 | 3.99 | 2.22 | 5.18 | 2.95 |
| Weir 1A | 0.35 | 0.19 | 1.68 | 0.88 | 3.21 | 1.70 | 4.64 | 2.47 | 5.99 | 3.20 |
| Weir 2 | 0.16 | 0.18 | 0.78 | 0.87 | 1.49 | 1.68 | 2.15 | 2.44 | 2.77 | 3.17 |
| Weir 2A | | 0.20 | | 0.96 | | 1.84 | | 2.67 | | 3.45 |
| Weir 3 | 0.18 | 0.20 | 0.83 | 0.95 | 1.58 | 1.82 | 2.27 | 2.64 | 2.93 | 3.42 |
| Weir 3A | | 0.22 | | 1.06 | | 2.01 | | 2.91 | | 3.75 |
| Weir 4 | 0.05 | 0.12 | 0.33 | 0.55 | 0.63 | 1.05 | 0.90 | 1.52 | 1.16 | 1.96 |
| Weir 4A | | 0.13 | | 0.66 | | 1.25 | | 1.80 | | 2.31 |
| Weir 4B | | 0.00 | | 0.29 | | 1.09 | | 1.89 | | 2.42 |
| Weir 5 | | | | | | | | | | |




TYPICAL WEIR CONFIGURATION
(LOOKING UPSTREAM)

| NO. | REVISIONS: | DATE: | BY: |
|---|---|---|---|

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DIVISION OF FISHERIES
FISH PASSAGE BRANCH

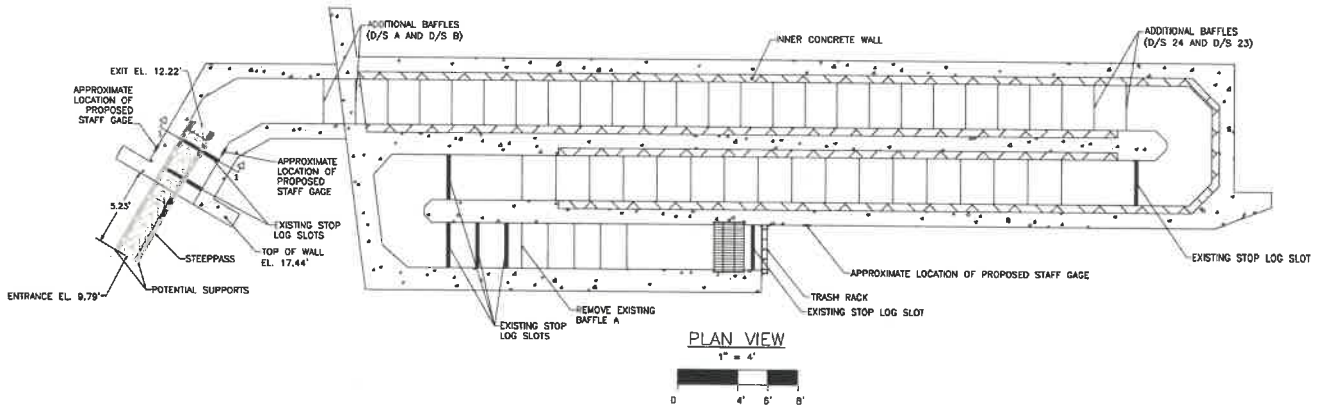
CERTIFIED:
SUBMITTED:
REVIEWED:
RECOMMENDED:
W.O. APPROVAL: DATE:

INDIAN LAKE SITE
SOUTH KINGSTON, RI

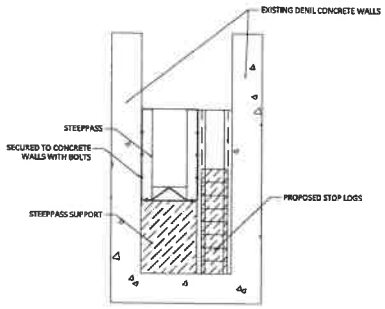
FISHWAY IMROVEMENTS
DETAILS

SURVEYED: ---- DESIGNED: BRS DRAWN: JEP CHECKED: BRS
DATE: SEPTEMBER 2017 DRWG. NO:

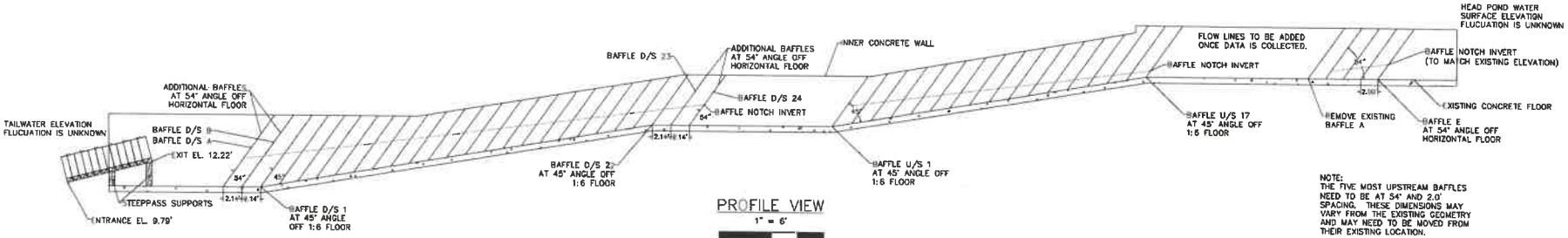
SHEET 3 OF 3




PLAN VIEW
1" = 4'




STEEPPASS CROSS-SECTION 1-1
1" = 2'




PROFILE VIEW
1" = 6'

**NOTES:**

1. PLAN AND PROFILE VIEWS DRAWN ACCORDING TO DIMENSIONS DISPLAYED ON STATE OF RHODE ISLAND DIVISION OF PLANNING AND DEVELOPMENT AUGUST 1968 AND THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION RESTORATION CENTER AND RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT (RIDEM) MARCH 2013 DESIGN PLANS (ASSUMED TO BE FINAL PLANS). THE EXISTING DENIL IS 3' WIDE AT A 1:6 SLOPE WITH 22 BAFFLE SLOTS IN THE LOWER LEG AND 17 BAFFLE SLOTS IN THE UPPER LEG. MODIFICATIONS IN 2013 RESULTED IN AN ADDITIONAL 5 BAFFLES IN THE EXIT CHANNEL. THE INNER CONCRETE WALLS OF THE FISHWAY VARY IN HEIGHT FROM THE OUTER WALLS AND INCLUDE THE BAFFLE SLOTS.

2. THE PROPOSED CONDITIONS DISPLAY THE FOLLOWING ALTERATIONS TO IMPROVE FISH PASSAGE EFFECTIVENESS AT PALISADES:

   A. IMPLEMENT 48 WOODEN BAFFLES TO CREATE A 1:8 SLOPE. FOUR ADDITIONAL WOODEN BAFFLES ARE PROPOSED IN ADDITION TO THE CURRENT 44 AND WILL BE ANCHORED TO THE CONCRETE VIA ANGLE IRON. ONE EXISTING BAFFLE WILL BE REMOVED (A). BAFFLE SPACING WILL REMAIN UNCHANGED (I.E. EXISTING BAFFLE SLOTS WILL BE UTILIZED).

   B. IMPLEMENT A MODEL A40 STEEPPASS (DEEPENED) AT A 1:4 SLOPE AT THE ENTRANCE OF THE EXISTING FISHWAY. THE STEEPPASS WILL BE BOLTED TO THE CONCRETE OF THE ENTRANCE CHANNEL AS WELL AS FIXED TO A WOODEN STRUCTURE TO BE DETERMINED WITH CORRESPONDENCE FROM RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT. THE ENTRANCE INVERT WILL BE POSITIONED AT ELEVATION 9.79' (NAVD88) AND MAY NEED TO BE SUPPORTED IN THE WATER VIA ANGLE IRON OR OTHER SUCH SUPPORT. THE EXIT ELEVATION WILL BE POSITIONED AT ELEVATION 12.22' (NAVD88).

   C. STOP LOGS WITHIN THE EXISTING ENTRANCE CHANNEL OF THE FISHWAY (1' WIDE SECTION ADJACENT TO STEEPPASS EXIT) WILL BE NECESSARY TO ENSURE CONTROL OF FLOW THROUGH THE STEEPPASS (AS SHOWN IN SECTION 1-1).

   D. STAFF GAGES SHOULD BE IMPLEMENTED TO PROVIDE AN EASY METHOD OF MEASURING THE ENTRANCE WATER SURFACE ELEVATIONS.

3. THE TAILWATER AND HEADPOND FLUCTUATION IS UNKNOWN. THIS INFORMATION WILL BE GATHERED BY RIDEM AND UTILIZED TO DEVELOP AN ACCURATE OPERATIONS AND MAINTENANCE PLAN FOR THIS FISHWAY TO ENSURE APPROPRIATE HYDRAULICS.

**NOT FOR CONSTRUCTION**

| No. | REVISIONS | DATE: | BY: |
|---|---|---|---|

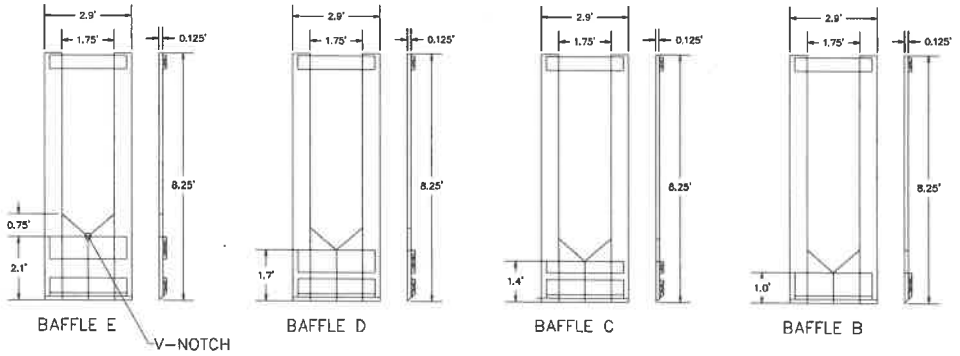
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DIVISION OF FISHERIES
FISH PASSAGE BRANCH

IDENTIFIED:
SUBMITTED:
REVIEWED:
RECOMMENDED:
W.O. APPROVAL: DATE:

PALISADES MILL SITE
SOUTH KINGSTON, RI

FISHWAY IMROVEMENTS
PLAN AND PROFILE

SURVEYED: ---- DESIGNED: BRS DRAWN: JEP CHECKED: BRS
DATE: MAY 2017 DRWG. NO.:



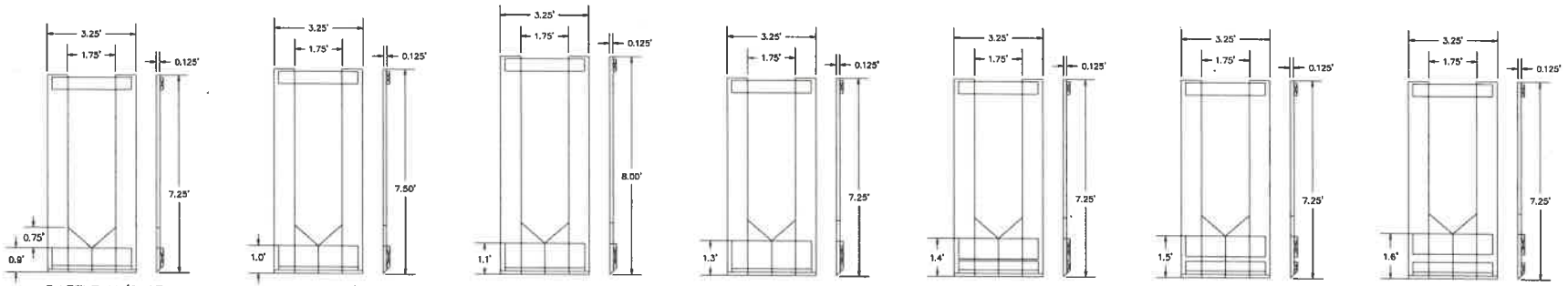

BAFFLE E | BAFFLE D | BAFFLE C | BAFFLE B

**NOTES:**

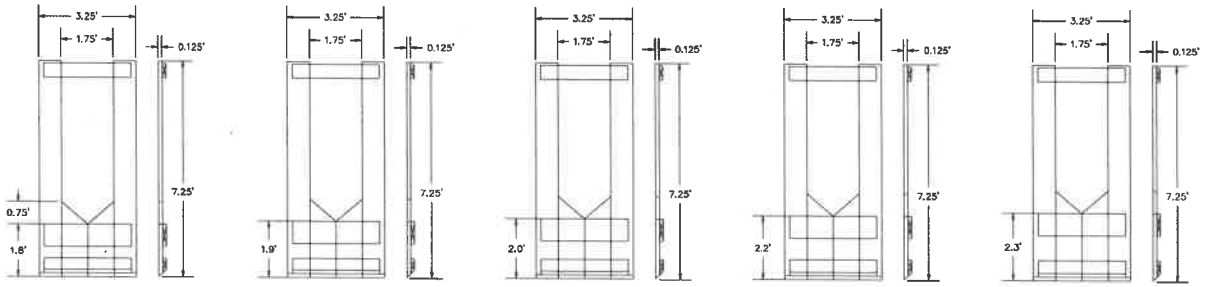
**ALL BAFFLES SHOULD BE MARKED WITH THEIR CORRESPONDING LETTER OR NUMBER.**

**BAFFLES E THROUGH B ARE AFFIXED TO CONCRETE VIA ANGLE IRON AND THEREFORE THE WIDTH EQUALS 2.9'.**

**BAFFLE LENGTHS SET TO ENSURE THEY REACH TOP OF INNER WALL.**




BAFFLE U/S 17 | BAFFLE U/S 16 | BAFFLE U/S 15 | BAFFLE U/S 14 | BAFFLE U/S 13 | BAFFLE U/S 12 | BAFFLE U/S 11




BAFFLE U/S 10 | BAFFLE U/S 9 | BAFFLE U/S 8 | BAFFLE U/S 7 | BAFFLE U/S 6

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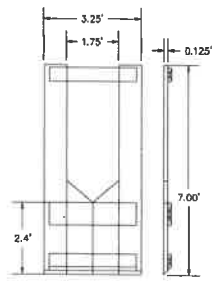
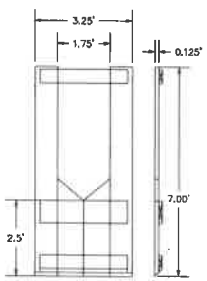
|---|---|---|---|
| | | | |

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DIVISION OF FISHERIES
FISH PASSAGE BRANCH

| | |
|---|---|
| CERTIFIED: | PALISADES MILL SITE<br>SOUTH KINGSTON, RI |
| SUBMITTED: | |
| REVIEWED: | FISHWAY IMROVEMENTS<br>BAFFLE DETAILS |
| RECOMMENDED: | |
| W.O. APPROVAL: DATE: | SURVEYED: ---- DESIGNED: BRS DRAWN: JEP CHECKED: BRS<br>DATE: MAY 2017 DRWG. NO: |



BAFFLE U/S 5



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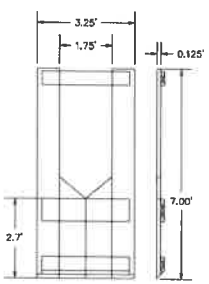

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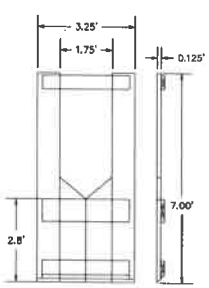
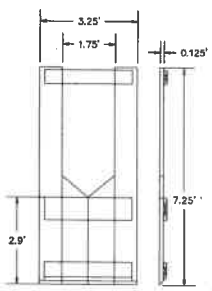


BAFFLE U/S 2



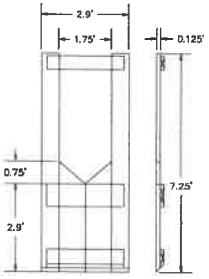
BAFFLE U/S 1

**NOTES:**

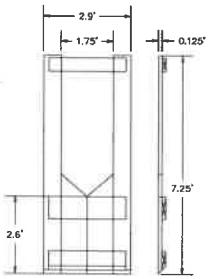
**ALL BAFFLES SHOULD BE MARKED WITH THEIR CORRESPONDING LETTER OR NUMBER.**

**BAFFLES D/S 24 AND D/S 23 WILL BE AFFIXED TO CONCRETE VIA ANGLE IRON AND THEREFORE THE WIDTH EQUALS 2.9'.**

**BAFFLE LENGTHS SET TO ENSURE THEY REACH TOP OF INNER WALL.**



BAFFLE D/S 24
(ADDITIONAL)



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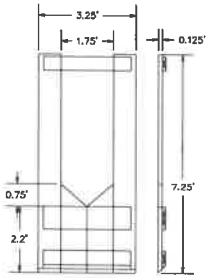
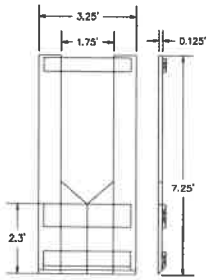
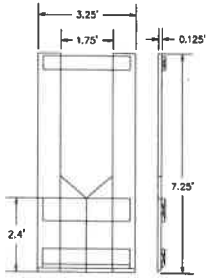
(ADDITIONAL)



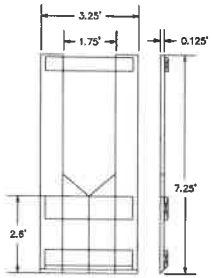
BAFFLE U/S 22



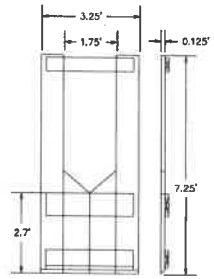
BAFFLE U/S 21



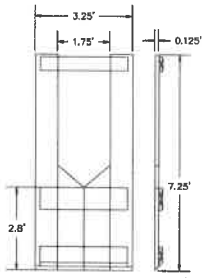
BAFFLE D/S 20



BAFFLE D/S 19



BAFFLE D/S 18



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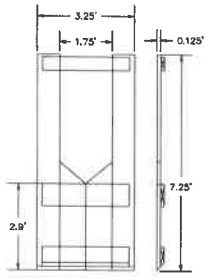

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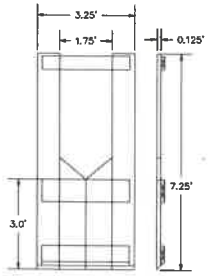

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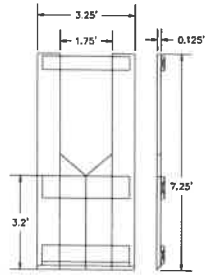
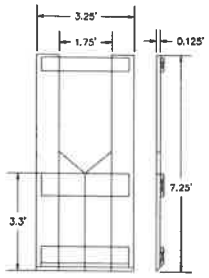


BAFFLE D/S 14



BAFFLE D/S 13

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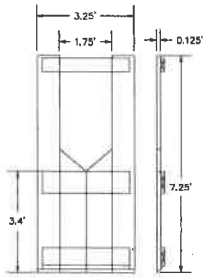
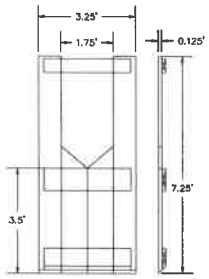
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DIVISION OF FISHERIES
FISH PASSAGE BRANCH

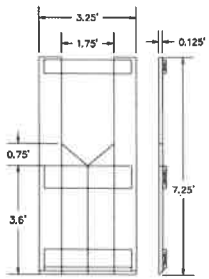
| | |
|---|---|
| CERTIFIED: | PALISADES MILL SITE<br>SOUTH KINGSTON, RI |
| SUBMITTED: | |
| REVIEWED: | FISHWAY IMROVEMENTS<br>BAFFLE DETAILS |
| RECOMMENDED: | |
| W.O. APPROVAL: DATE: | SURVEYED: ---  DESIGNED: BRS  DRAWN: JEP  CHECKED: BRS<br>DATE: MAY 2017  DRWG. NO: |



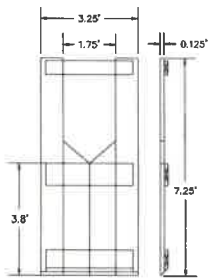
BAFFLE D/S 12



BAFFLE D/S 11



BAFFLE D/S 10



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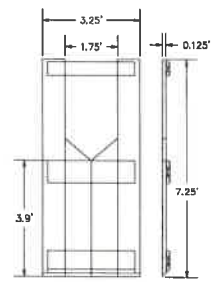
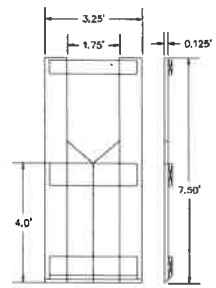
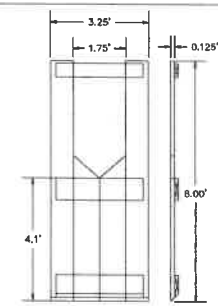


BAFFLE D/S 8



BAFFLE D/S 7



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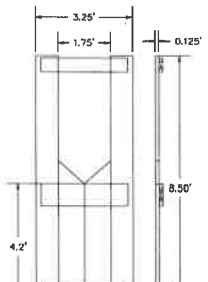
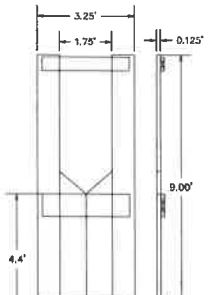


BAFFLE D/S 5



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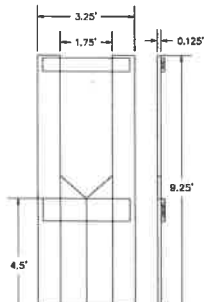

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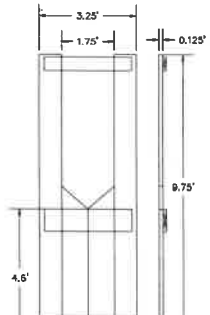

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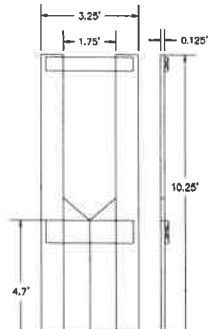
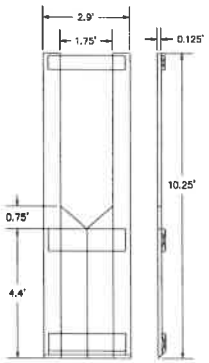
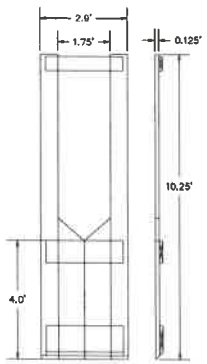


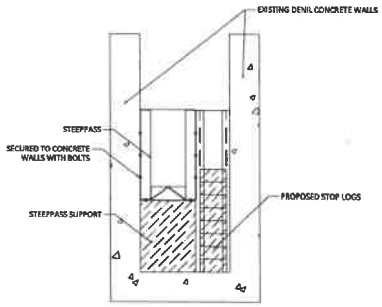
BAFFLE D/S 1



BAFFLE D/S B
(ADDITIONAL)



BAFFLE D/S A
(ADDITIONAL)



STEEPPASS SECTION 1-1

**NOTES:**

**ALL BAFFLES SHOULD BE MARKED WITH THEIR CORRESPONDING LETTER OR NUMBER.**

**BAFFLES D/S A AND D/S B WILL BE AFFIXED TO CONCRETE VIA ANGLE IRON AND THEREFORE THE WIDTH EQUALS 2.9'.**

**BAFFLE LENGTHS SET TO ENSURE THEY REACH TOP OF INNER WALL.**

**THE NUMBER OF PROPOSED STOP LOGS TO BE DETERMINED ONCE HEAD POND AND TAILWATER DATA IS COLLECTED.**

**NOT FOR CONSTRUCTION**

| NO. | REVISIONS: | DATE: | BY: |
|---|---|---|---|

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DIVISION OF FISHERIES
FISH PASSAGE BRANCH

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|---|---|
| CERTIFIED: | PALISADES MILL SITE<br>SOUTH KINGSTON, RI |
| SUBMITTED: | |
| REVIEWED: | FISHWAY IMROVEMENTS<br>BAFFLE DETAILS |
| RECOMMENDED: | |
| W.O. APPROVAL: DATE: | SURVEYED: ---- DESIGNED: BRS DRAWN: JEP CHECKED: BRS<br>DATE: MAY 2017 DRWG. NO: |