Littlefield Dam Removal
100% Design Report - DRAFT

SUBMITTED TO
The City of Auburn, ME

FEBRUARY 2026

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100% Design Report - DRAFT

SUBMITTED TO
City of Auburn, ME
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1. Introduction

This report provides the basis of design for Littlefield Dam Removal (the Project) in Auburn, Maine at the current 100% design level. The report includes a brief Project background, summarizes the existing conditions at the site and the hydrologic and hydraulic analysis performed for the Project, provides an explanation of the proposed design elements, and provides notes on additional design and construction considerations. The report will be updated for subsequent design phases.

2. Background

The Littlefield Dam (the Dam) sits on the Little Androscoggin River (the River) in Auburn, Maine (the City), approximately four miles upstream of the confluence with the Androscoggin River (Figure 1). The Dam was built in the early 1900s as a hydroelectric generating station. The left embankment of the Dam was breached in the March 1936 flood, which marked the end of its operations. In the 1980s, there was an effort to repair and reactivate the Dam, but the project never came to fruition (Littlefield Hydro Company, 1987). The Dam is currently owned by the Martindale Country Club (the Dam owner), which sits on the right bank of the river and is supportive of the proposed dam removal.

Though it is breached, the Dam continues to block upstream passage of resident fish. According to the Maine Stream Habitat viewer, there are over 200 Atlantic salmon (*Salmo salar*) habitat units and over 8,000 acres of potential river herring ponds upstream of the dam. While there are five dams downstream of the site (two on the Little Androscoggin and three on the Androscoggin), removal of the Littlefield Dam is an important part of a larger restoration effort within the Little Androscoggin watershed as well as across the region. In combination with downstream fish passage efforts, this project has the potential to reconnect habitat for sea run fish species like American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), alewife (*Alosa Pseudoharengus*), Atlantic salmon, American eel (*Anguilla rostrata*), and sea lamprey (*Petromyzon marinus*) (NOAA Fisheries, 2020).

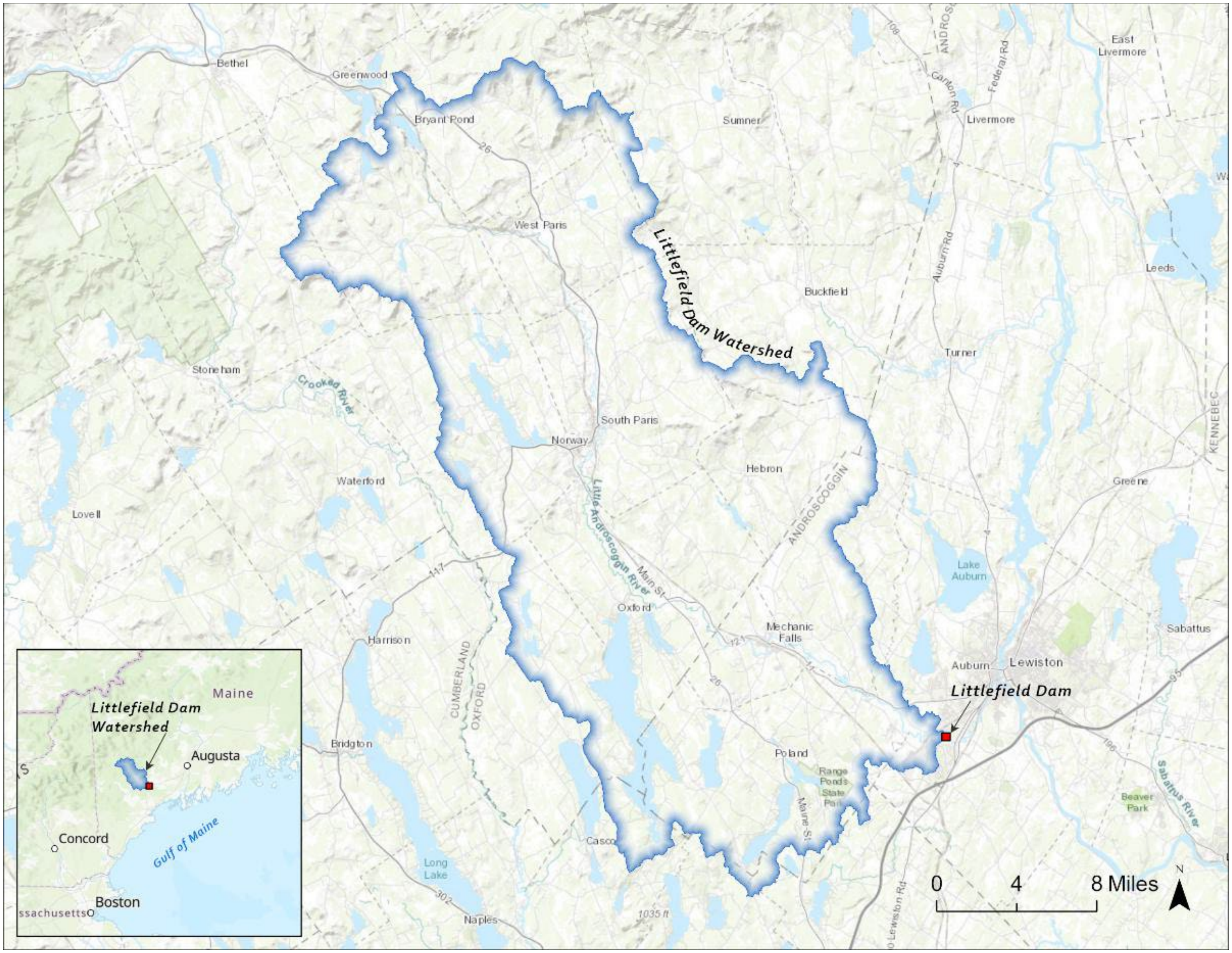

Figure 1. Map of the Little Androscoggin Watershed upstream of the Littlefield Dam.

Due to the importance of Atlantic salmon within the watershed and the Gulf of Maine as a whole, and in recognition of the diversity of aquatic fauna that are present within the larger watershed, reconnecting the Little Androscoggin River at the Littlefield Dam site and restoring aquatic organism passage is a high priority for the project partners.

Project partners for the Project:

- City of Auburn, Maine
- National Oceanic and Atmospheric Administration (NOAA)
- Androscoggin Watershed Council (AWC)
- Martindale Country Club (MCC) (Dam owner)
- Auburn Conservation Commission

3. Project Objectives

The Project partners have contracted with Inter-Fluve for the design of the removal of the Littlefield Dam and associated river channel improvements. Broadly speaking, the Project aims to restore fish passage at the site and relieve MCC of the burdens and liability associated with dam ownership. Through discussions with the Project partners, it was determined that the restoration objectives of the Project include restoring aquatic and riparian connectivity for ecological benefits, restoring effective passage for the species of interest, and improving the overall resilience of the river channel while maintaining the existing infrastructure adjacent to the site. Specific species of interest include Atlantic salmon and river herring.

4. Existing conditions

Inter-Fluve performed a site survey and assessment of the Project area in June and July of 2025, with additional site visits in May and August. The survey included the collection of topographic data of the dam structure and adjacent upland areas using a real time kinematic (RTK) GPS. Bathymetric data of the river channel and dam impoundment was collected using the same methods.

4.1 GEOMORPHIC SETTING

The Littlefield Dam sits at the downstream end of a steep and relatively confined reach of the Little Androscoggin River. This reach stands in contrast to the broad floodplain and meandering channel upstream and downstream of the site (Figure 4 and Figure 5). This localized steepness, known as a knickzone, is caused by the durable granite bedrock that underlies this section of river. Dams have commonly been located along knickzones to harness the increased energy of the stream and take advantage of outcrops of stable bedrock. This geomorphic context is important to consider during a dam removal. The abundance of ledge on the banks and bed of the river provides stability to the channel profile and planform, alleviating concerns over headcutting in the event of a dam removal. This eliminates a common challenge for dam removals, where channel adjustments post-removal can impact upstream infrastructure. However, when bedrock has been historically modified to enhance power utilization it may present challenges for fish passage following dam removal. The extent to which this is an issue won't be known until the dam is removed and will be addressed with an adaptive management approach.

4.2 DAM STRUCTURES

The extent of Littlefield Dam that remains in the channel is approximately 350 feet long, with a height that varies between approximately 12 and 21 feet, and constructed of approximately 3,500 cubic yards (CY) of concrete. A photo of the Dam is shown in Figure 2 and the layout of the site is show in Figure 6. The concrete poor condition with widespread spalling. The Dam is currently breached on the river left and right side of the dam, with remnant structures associated with the Dam in the overbank areas on both sides of the channel. On the left there is an abutment that amounts to a minimal volume of concrete. On the right, there is a dam structure approximately 140 feet long which ties into an earthen berm connected to the hillslope. This masonry structure amounts to approximately 100 cubic yards of stone and mortar.

Approximately 540 feet upstream of the Dam, we discovered a remnant dam during the site survey (Figure 3). The timber and rock structure creates a drop of approximately 2 feet under low flow conditions. The volume of material is approximately 50 CY The remnant dam may present a fish passage barrier at low flow and is therefore being considered for removal as a part of the Project.

4.3 ACCUMULATED SEDIMENT

As expected, limited accumulated sediment was observed in the impoundment. The scarcity of sediment is a result of two primary factors. Dam breaches shorten impoundments and allow for elevated flow velocities, resulting in low trapping efficiency. Additionally, very little sediment is delivered to the impoundment because the contributing watershed, like much of New England, yields very little sediment. The small pocket of sediment that was observed (Figure 6), was composed of sand with a volume of approximately 50 CY or less.

Figure 2. Drone photo of the Littlefield Dam. Photo taken May 1, 2025.

Figure 3. Looking upstream at the remnant dam. Photo taken August 28, 2025.

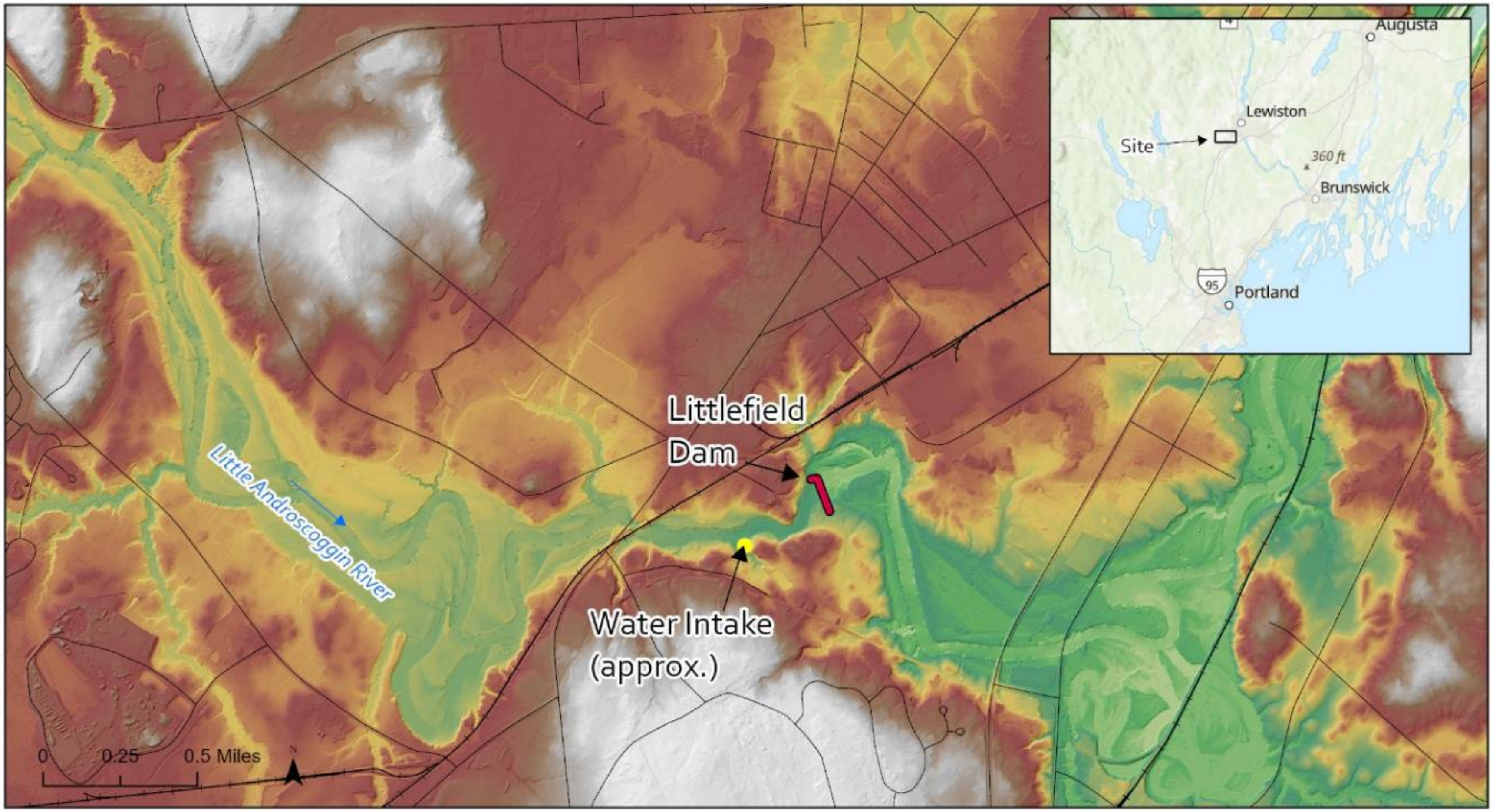

Figure 4. Lidar elevation model of the site and surrounding landscape. The steep and confined reach that the Dam sits along is apparent in contrast to the broad floodplain and meandering planform upstream and downstream of the site. Lidar collected by NOAA, 2020.

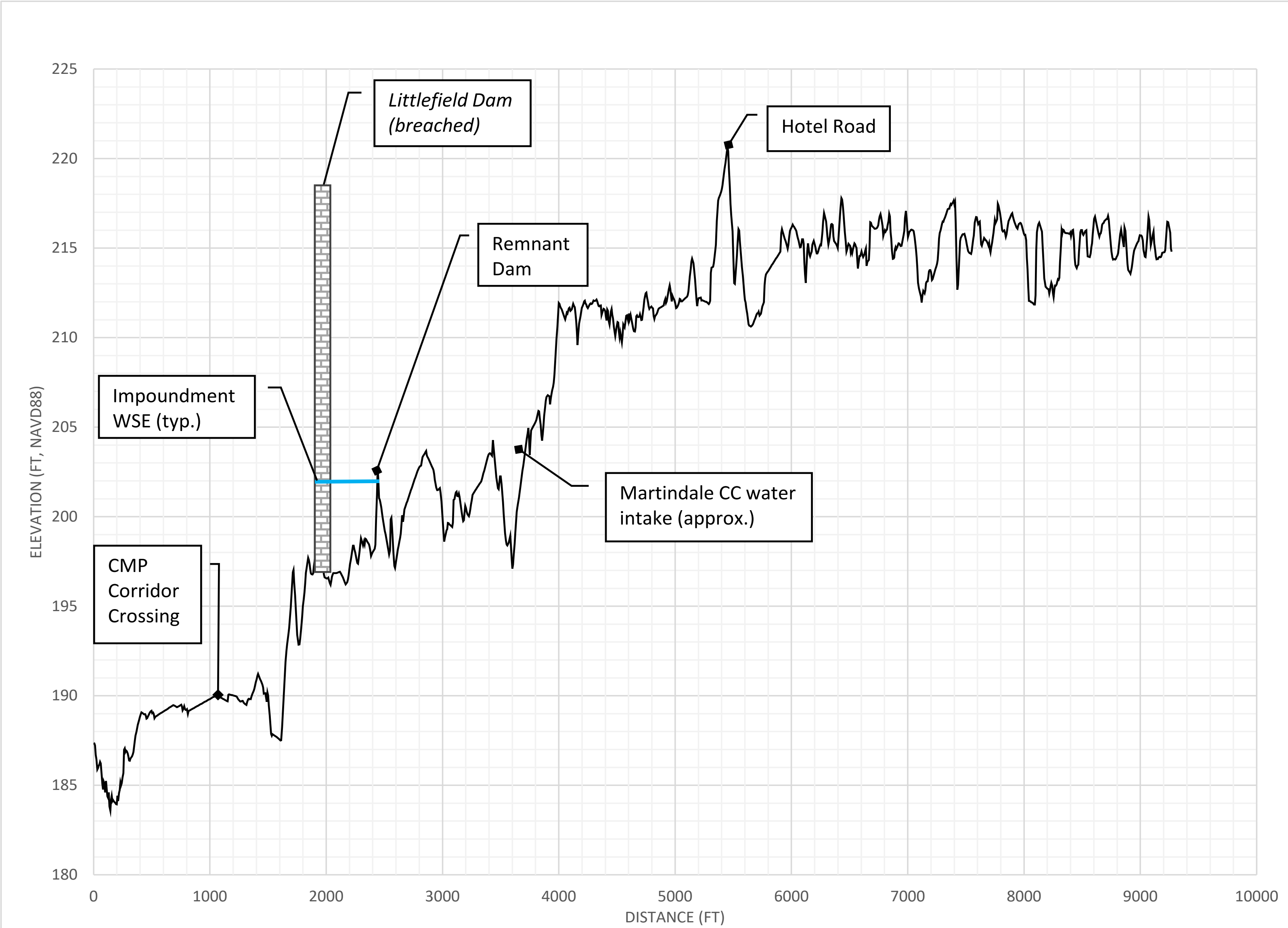

Figure 5. Longitudinal profile of the Little Androscoggin River. Elevation data is from survey data between station 0 and 4000. Upstream of station 4000 elevation is derived from lidar (NOAA, 2020)

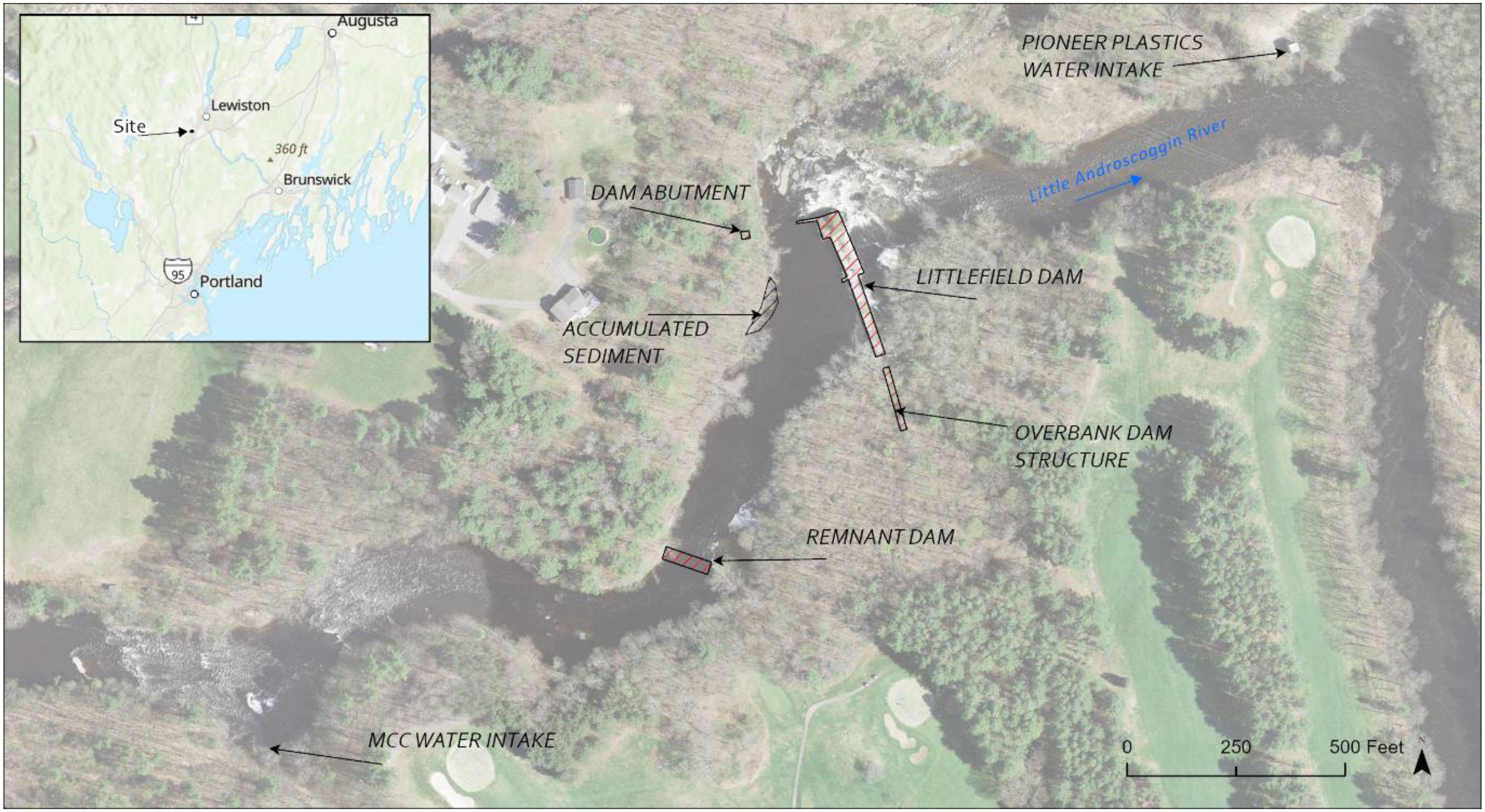

Figure 6. Aerial image of site with key features labeled.

4.4 WATER INTAKES

There are water intakes upstream and downstream of the Dam (Figure 6). The water intake for irrigation at the Martindale Country Club is located approximately 1,300 feet upstream of dam. The Pioneer Plastics water intake is approximately 1,100 feet downstream of the Dam. Neither intake will be affected by the removal of the Littlefield Dam or remnant dam. The analysis supporting this finding is presented in the following sections.

5. Hydrology

5.1 WATERSHED CHARACTERISTICS

Inter-Fluve used the web-based software application, Unites States Geological Survey (USGS) StreamStats (USGS, 2021), to determine the characteristics of the contributing watershed. StreamStats is a web-based tool that generates watershed characteristics and estimates flows for ungauged sites on streams in the United States. See Attachment A for a complete list of watershed characteristics utilized and the values generated by StreamStats.

5.2 PEAK FLOW AND MONTHLY FLOW STATISTICS

Inter-Fluve completed a hydrologic analysis of the Little Androscoggin River at the Littlefield Dam Site that included reviewing historical hydrologic analyses completed for the river and performing independent calculations of peak flow and monthly flow statistics.

First, Inter-Fluve reviewed the results of the historical hydrologic and hydraulic analysis for the Little Androscoggin River reported in the July 8, 2013 Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Androscoggin County, Maine (FIS Number 23001CV001A; FEMA, 2013). Inter-Fluve then performed independent analyses of annual peak flow and monthly flow conditions. This combination was also inclusive of fish passage flow estimates. The associated estimates were derived by two methods using 1) the USGS StreamStats online application and 2) USGS streamgage data.

The StreamStats application generates watershed characteristics and estimates flows for ungaged sites utilizing the most-recently released regional regression equations developed by USGS and simultaneously generates estimates of key input metrics for use in calculations. Peak flow magnitudes were estimated using the Hodgkins and Lombard (2020) regional regression equations as implemented through the USGS StreamStats online application (Table 1). Monthly flow estimates were similarly generated within the StreamStats application using the Dudley (2015)regional regression equations (Table 2).

A historical USGS streamgage was located on the Little Androscoggin River near Auburn ME (gage 01058500), approximately 0.5 miles upstream of the Littlefield Dam. Since the gage location is so close to the dam and their respective watershed areas are nearly identical, no scaling of the gage data was necessary for the hydrologic analyses. The contributing watershed to the historic gage is approximately 328 square miles. The period of record (POR) for the gage begins on October 1, 1940 and ends on October 5, 1982, resulting in 42 years of discharge data.

Inter-Fluve used the available daily average discharge data at this gage to inform the statistical analysis of streamflow at the Project Site. Peak flow estimates were calculated using the USGS Bulletin 17C methodology (England et al., 2018). Monthly flow estimates were also estimated through exceedance-duration statistical methods.

Table 1. Peak-flow estimates for the Little Androscoggin River at the Littlefield Dam Site, Auburn, ME.

Average Return Period (Years)	Annual Exceedance Probability (%)	FEMA, 2013 (cfs)	Lombard & Hodgkins, 2020 (cfs)	Little Androscoggin Gage, 17C (cfs)
2	50%	--	7,010	3,741
5	20%	--	9,940	5,502
10	10%		12,000	6,924
25	4%	--	14,600	9,049
50	2%		16,600	10,892
100	1%	11,698	18,600	12,980
500	0.2%		22,900	18,985

Table 2. Monthly flow estimates for the Little Androscoggin River at the Littlefield Dam Site, Auburn, ME.

Monthly Exceedance (%)	Dudley (2015) Seasonal Discharge Estimates (cfs)	Little Androscoggin Gage, Duration Analysis (cfs)
May 5%	2,990	2,017
May 50%	1,070	695
May 95%	365	275
June 5%	1,530	1,140
June 50%	414	360
June 95%	155	128

6. Hydraulics

Inter-Fluve developed a hydraulic model of the Little Androscoggin River in Augusta, ME to evaluate the performance of the proposed Project with respect to the design objectives.

6.1 METHODS

To facilitate design of the Project, Inter-Fluve developed a 1-dimensional, steady-flow hydraulic model of the Little Androscoggin River using U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center River Analysis System (HEC-RAS) software version 6.6.

6.2 DATA

Inter-Fluve compiled a variety of data to build the hydraulic model of the Little Androscoggin River which is summarized in the table below (Table 3Table 3. Data Used to Populate the Hydraulic Model). Flow data was attained using the methods described in the hydrology section above. Inter-Fluve conducted topographic and bathymetric field surveys as described above.

Table 3. Data Used to Populate the Hydraulic Model

Data Type	Source
Flow	Hydrologic Analysis
Topography and Dam Structure	Field Survey by Inter-Fluve (June – July 2025) Lidar collected by NOAA (May 2020) accessed by Inter-Fluve (May 2025)
Bathymetry	Field Survey by Inter-Fluve (June – July 2025)

6.3 MODEL DOMAIN

Inter-Fluve developed a hydraulic model of the Little Androscoggin River from a downstream limit located approximately 1,700 feet downstream of the Littlefield Dam, to an upstream limit located approximately 1,550 feet upstream of the Dam. The model is georeferenced horizontally to Maine State Plane, West Zone, NAD83 (2011) US Survey Feet, and vertically to the North American Vertical Datum of 1988, in units of feet.

6.4 GEOMETRY

Inter-Fluve developed the model geometry utilizing HEC-RAS geometry creation tools, including the RAS Mapper Geographic Information System (GIS) tools, to locate the river centerline and to sample the cross-section geometry from the composite topographic/bathymetric surface developed following completion of the survey. For the existing conditions model, the Littlefield Dam is simulated as an inline structure at River Station 1,798. Gates were used in the inline structure to simulate the existing leakage through the Dam spillway. The remnant rock and timber dam is simulated using cross sections, including one just upstream of the dam, one along the "spillway", and one just downstream of the dam.

For the proposed conditions model, the Littlefield Dam inline structure was removed and replaced with a cross section that represents the expected bathymetry post Dam removal. Similarly, the remnant dam cross-section was updated to represent the expected channel geometry after its removal.

6.5 BOUNDARY CONDITIONS

Both the upstream and downstream boundary conditions were set to reflect the normal depth at a given slope. The upstream normal depth slope was set at 0.003 feet per foot, while the downstream normal depth slope was set at 0.0185 feet per foot. These values were estimated from site observations and measurements.

6.6 MANNING'S "N"

Hydraulic roughness values (Manning's "n") for the channel and floodplain were assigned based on field observations, and through consideration of published reference materials (Arcement & Schneider, 1989). Selected Manning's "n" values are shown in Table 4.

Table 4 Mannings "n" Values Used in the Hydraulic Model

Location	Value	Description of Project Site
Channel	0.055	Typical channel roughness in the area at the downstream portion of the model domain. Channel bed made of cobbles, gravels, and bedrock. Moderate depth of flow relative to substrate size.
Channel	0.065	Typical channel roughness immediately downstream of the existing Dam. Channel bed made up of boulders and cobble with bedrock and other obstructions. Shallow depth of flow relative to substrate size.
Channel	0.07	Typical channel roughness in the overflow area on river left adjacent to the Dam and just downstream. Bedrock feature. Shallow depth of flow relative to substrate size.
Channel	0.055	Existing channel roughness in the area of the Dam impoundment. Moderate depth of flow relative to substrate size.
Channel	0.06	Proposed channel roughness in the area just upstream of the Dam. Channel bed made of cobbles, gravels, and bedrock. Shallow depth of flow relative to substrate size.
Channel	0.065	Typical channel roughness at the upstream portion of the model. Channel bed made of cobbles, gravels, and bedrock. Shallow depth of flow relative to substrate size.
Overbank	0.11	Typical overbank areas. Forested.

6.7 HYDRAULIC MODEL RESULTS

Hydraulic modeling shows that the proposed Project will result in decreased flood profiles upstream of the Littlefield Dam (Figure 7). For existing conditions, the Littlefield Dam creates an impoundment that extends approximately 860 feet upstream. The model predicts that the proposed Project will not change water surface elevations downstream of the Dam.

Flood velocities are expected to increase in the proposed conditions upstream of the Littlefield Dam (Figure 8). We see a similar pattern when examining shear forces during flooding events, with an increase in shear force upstream of the Dam when comparing proposed conditions to existing conditions (Figure 9). Increased velocities and shear forces upstream of the Dam are expected after dam removal due to the restoration of the deeper, slow-moving impoundment back into a free-flowing channel with shallower, faster-moving water.

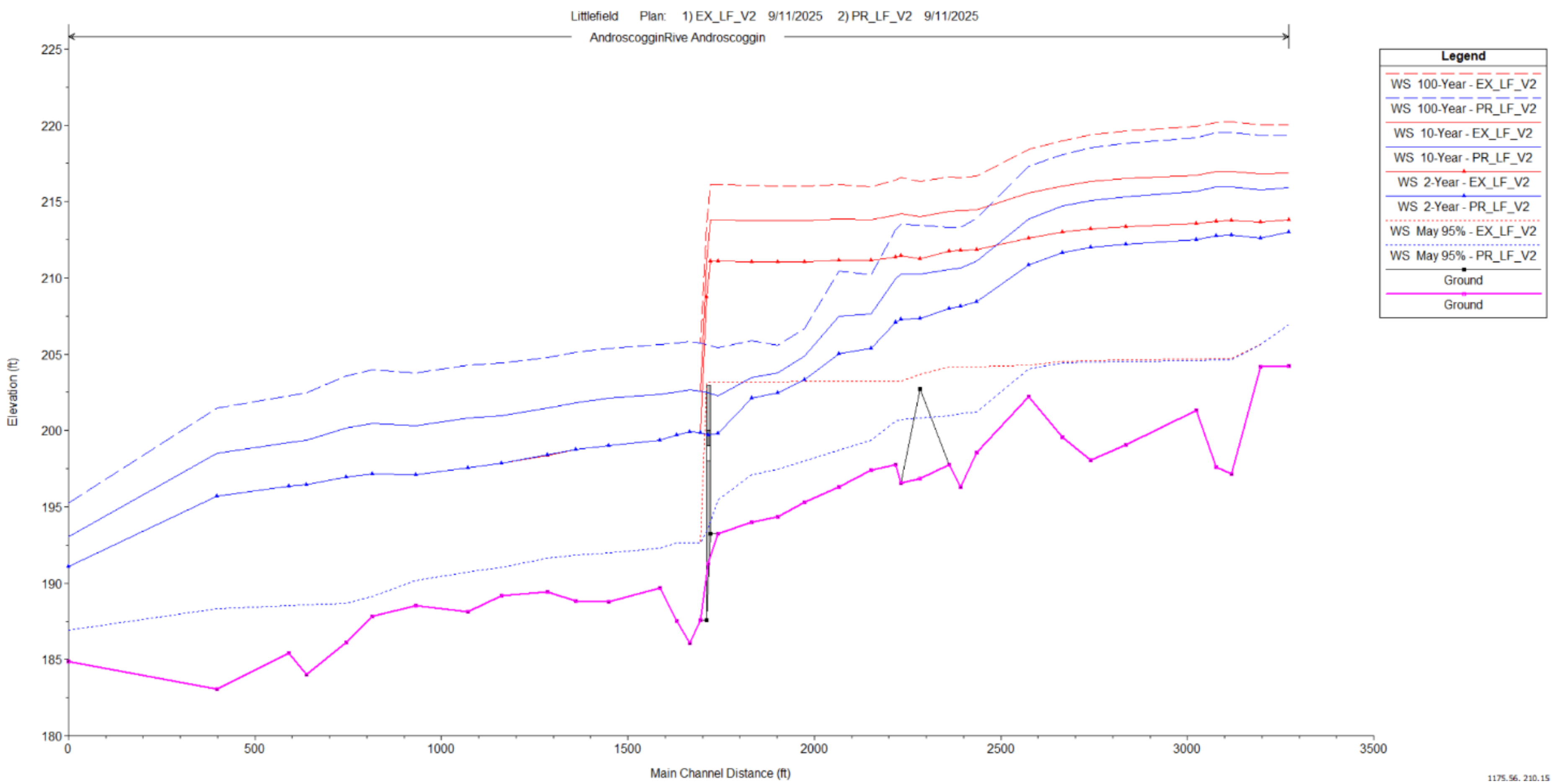

Figure 7. Existing (Red) and Proposed (Blue) Condition Hydraulic Model Results. 100-Yr, 10-Yr, and 2-Yr Flood Profiles.

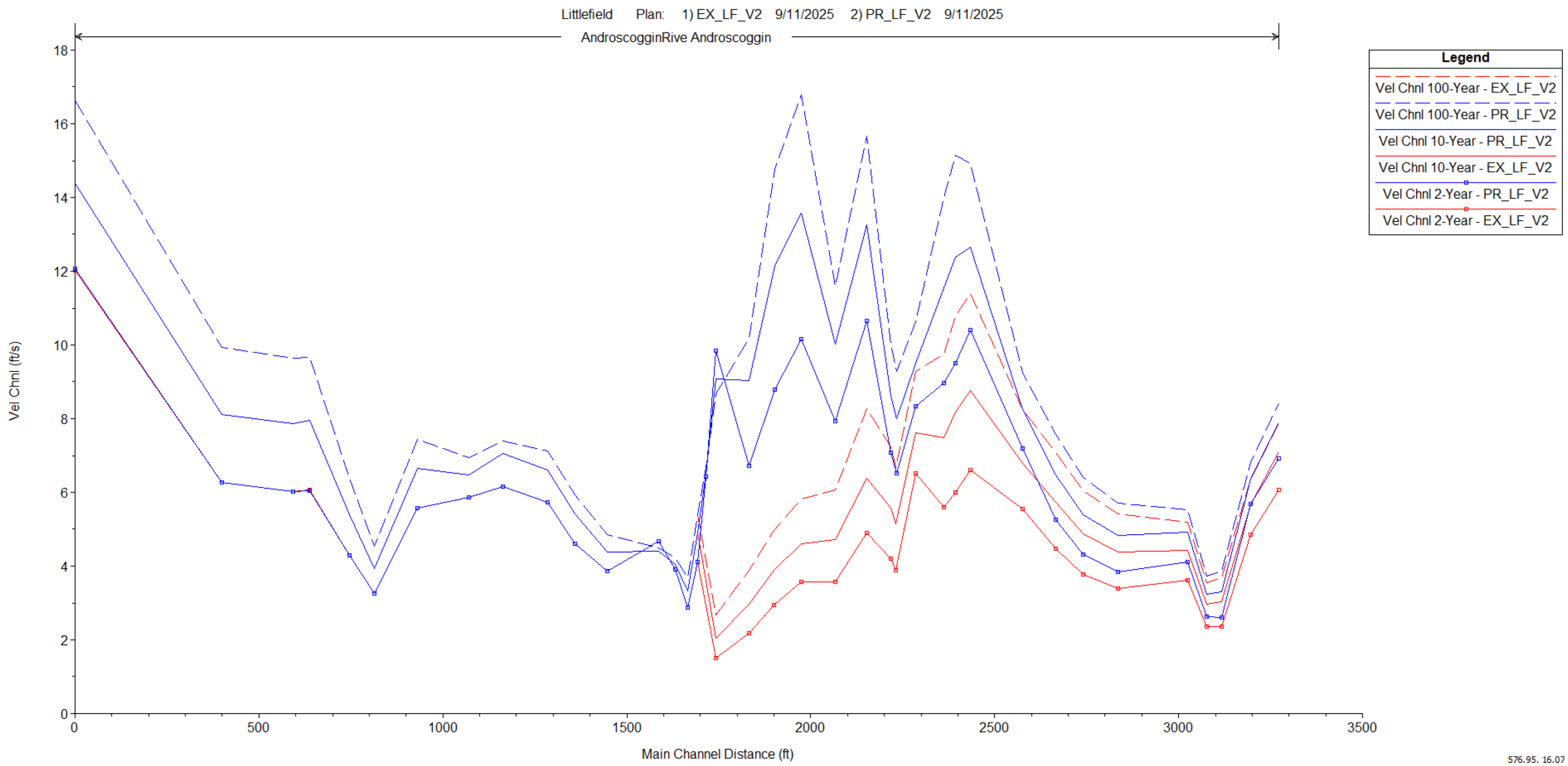

Figure 8. Existing (Red) and Proposed (Blue) Condition Hydraulic Model Results. Velocity Profiles During Flood Flows

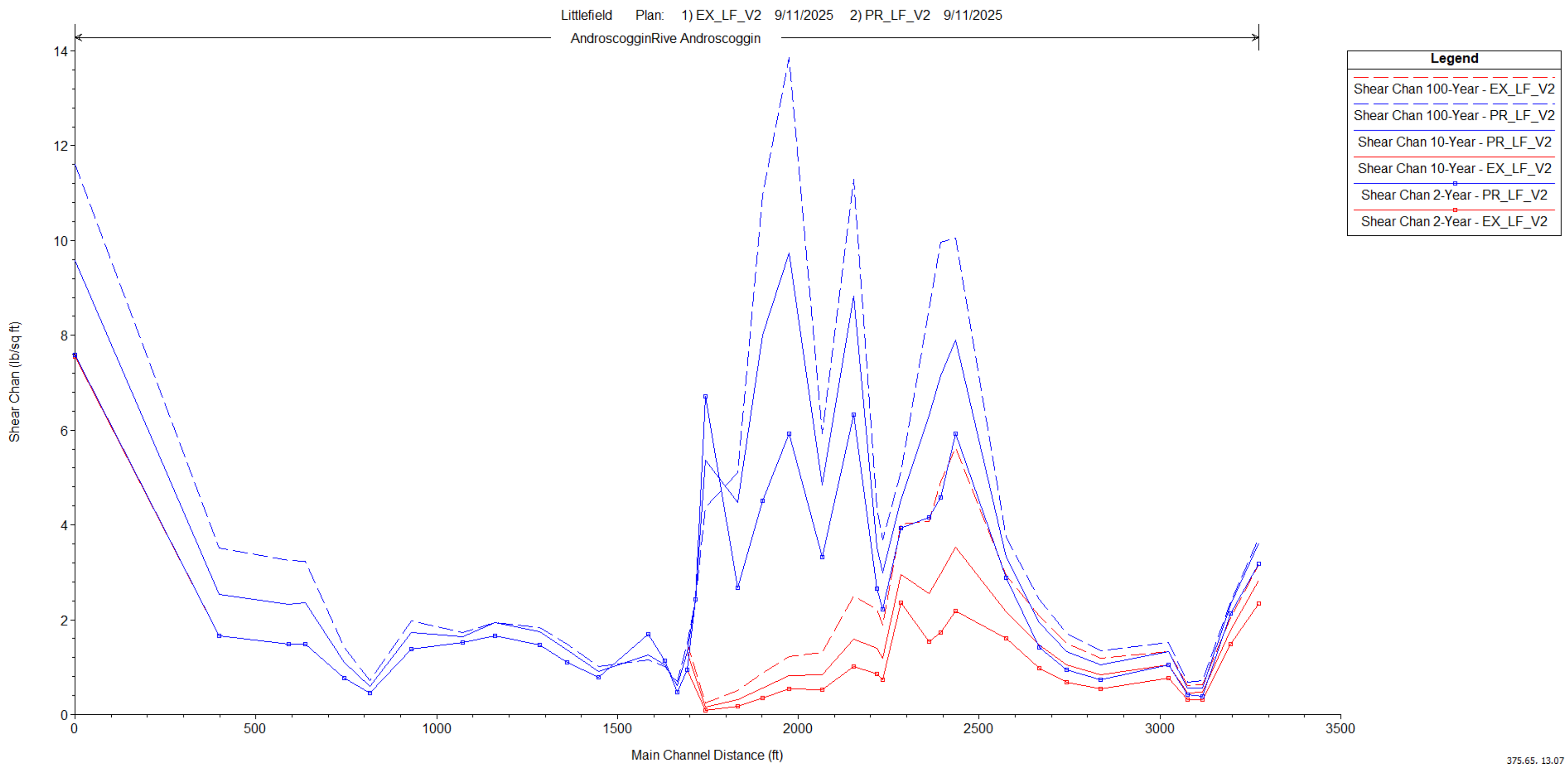

Figure 9. Existing (Red) and Proposed (Blue) Condition Hydraulic Model Results. Shear Profiles During Flood Flows.

Inter-Fluve evaluated flow conditions of the Little Androscoggin River during monthly flow events to help determine the passage effectiveness of the proposed conditions during fish passage periods. Inter-Fluve reviewed regional nature-like fishway design guidelines (Turek et al., 2016a) for the safe, timely, and effective passage of juvenile salmonid (i.e. juvenile Atlantic salmon), American shad, blueback herring, alewife, and sea lamprey (Table 5).

Table 5. Select design guidelines *(Turek et al., 2016a)* ***for target species for Littlefield Dam Removal proposed design.***

Species	Minimum Pool/Channel Depth (ft)	Minimum Pool/Channel Length (ft)	Minimum Weir Opening Width (ft)	Minimum Weir Opening Depth (ft)	Maximum Weir Opening Velocity (ft/sec)	Maximum Fishway Channel Slope
Sea Lamprey	2.00	20.00	0.75	0.75	6.00	3.33%
Blueback Herring	2.00	10.0	2.25	1.00	6.00	5.00%
Alewife	2.25	10.0	2.50	1.00	6.00	5.00%
American Shad	4.00	30.0	5.00	2.25	8.25	3.33%
Juvenile Salmonid	1.75	10.0	1.25	0.50	2.25	5.00%

The recommended maximum fishway weir opening velocity for juvenile salmonid and Alewife (a type of river herring) is 2.25 ft/s and 6 ft/s, respectively (Turek et al., 2016b). In practice, no single threshold velocity prevents fish from being able to pass, as multiple other factors should be considered when determining if predicted velocities are suitable for fish passage. The guideline cited above is not a velocity that fish can swim against for extensive distances, but rather for intermittent periods of elevated effort. Providing a diversity of flow conditions within the channel over a range of anticipated design flows allows migrating fish opportunities for rest and is an important consideration (USFWS, 2019).

The relationship between flow velocity and distance was explored using a computer model developed by the U.S. Fish and Wildlife Service (USFWS, 2016) which estimates a proportion of fish successfully passing a high velocity zone of a given length. The 'survivorship' function that the model implements was originally presented in Haro et al. (2004) and summarizes the ability of fish to ascend a high velocity zone before having to fall back to slower waters due to fatigue. Because the empirical data that the Haro study reported was based on fish that had been handled repeatedly in the experiment, common practice uses the 60% survivorship range as an approximate threshold for fish passage potential (USFWS (2019)). The model was executed for river herring assuming a range of lengths and velocities to result in the series of curves organized by velocity barrier length. This analysis helped guide the fish passage evaluation of the proposed conditions for the Project.

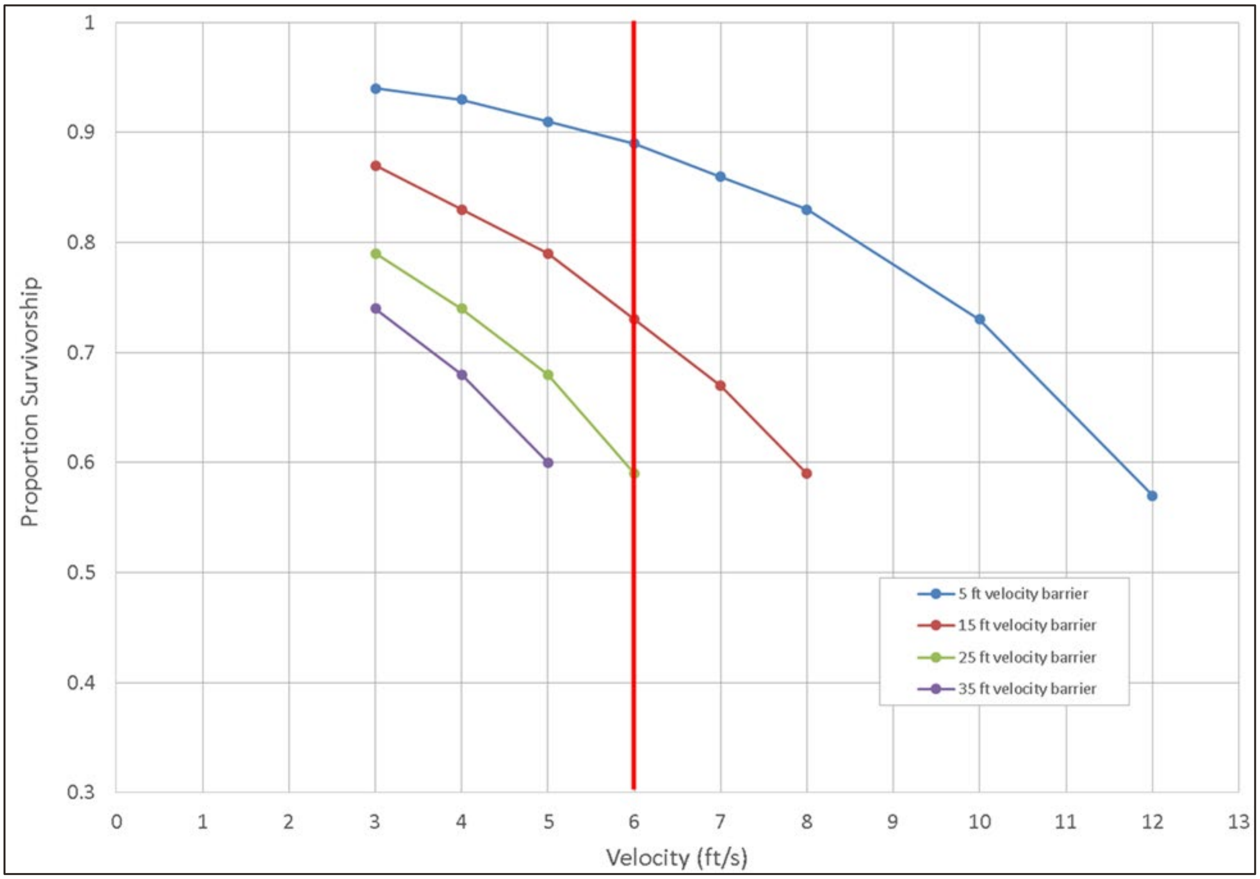

Figure 10. Proportion of survivorship of 22 cm Alewife for velocity barriers of varying lengths. Assumed water temperature of 18 degrees Celsius.

Model results indicate that estimated average velocities in the proposed channel do not meet the regional guidelines for juvenile salmonids. Velocities during the May and June 5% exceedance probability discharges also exceed the Alewife guidelines. Velocities in the proposed channel do meet the guidelines for Alewife during the May and June 95% and 50% exceedance probability discharges (Figure 5).

While the model results suggest that velocities in the proposed channel will exceed the thresholds for juvenile salmonoid and Alewife during various flows, the model does not accurately represent the expected diversity of flow conditions within the proposed channel that will increase the ability for fish to pass. The 1-D model produces model results that are cross-sectional averages and do not assess variations in flow velocities across the channel. The proposed channel alignment is expected to be slightly longer during low flow conditions than during high flows, as a result of the increased sinuosity of the low flow channel. The increased length and reduced channel slope of the low flow channel will result in decreased channel velocities. Additionally, the expected low flow channel will include intermittent pools that will allow migrating fish to rest between periods of elevated effort. Furthermore, a lack of data regarding the channel conditions below the Dam adds significant uncertainty to the model results at that critical location. This will be assessed further in future design iterations. As described in the following sections, ledge modification will be undertaken during construction through an adaptive management approach if it is deemed necessary to achieve fish passage objectives.

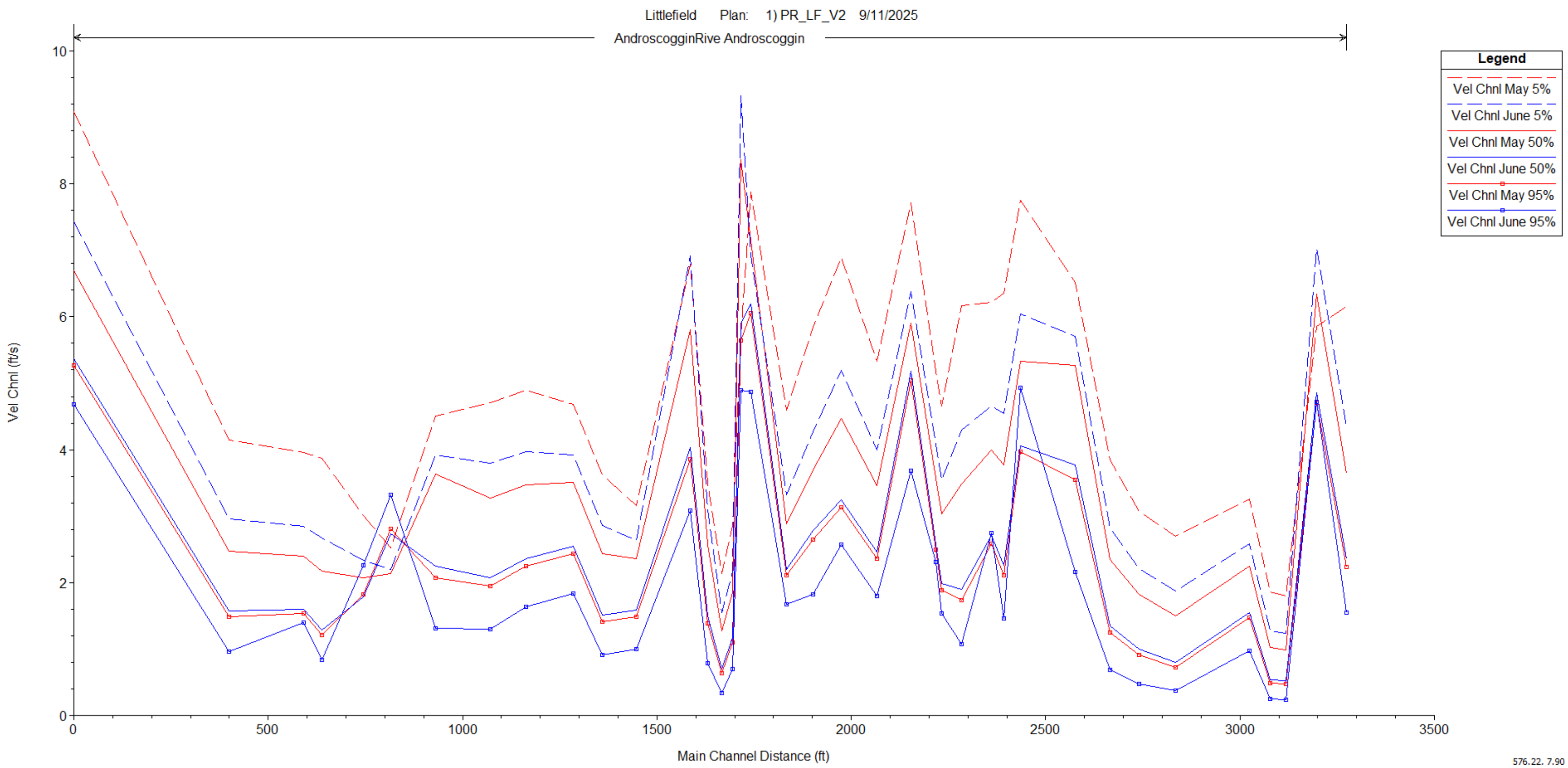

Figure 11. Proposed Condition Hydraulic Model Results. Velocity Profiles During Fish Passage Flows

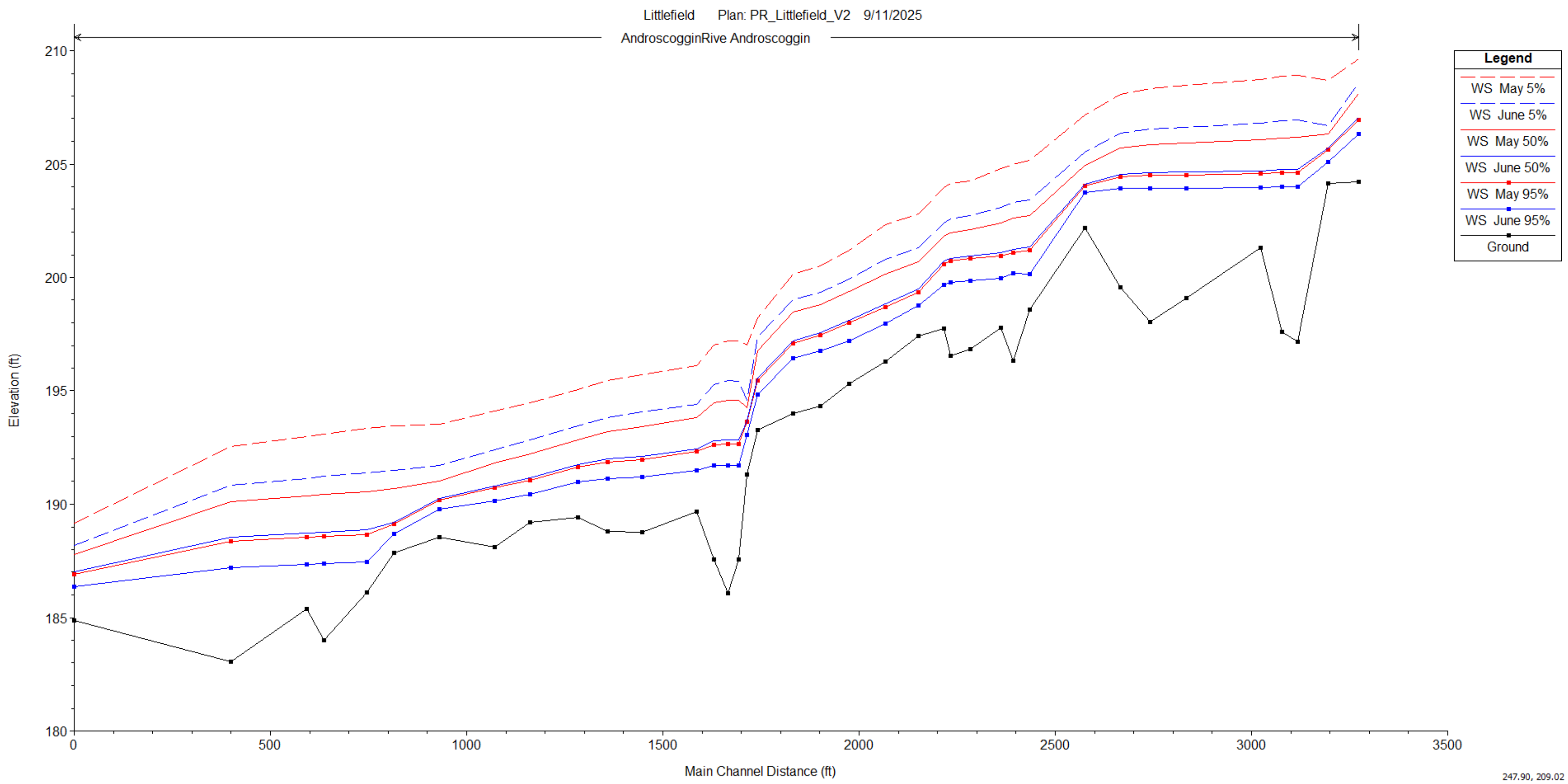

Figure 12. Proposed Condition Hydraulic Model Results. Water Surface Elevations During Fish Passage Flows.

7. Proposed Design

The proposed designs are shown in the accompanying 100% Design Plan Set. This section provides a description of the designs along with rationale for design decisions.

7.1 DAM REMOVAL

In accordance with the objectives of the project, the design calls for the complete removal of the Littlefield Dam structure from the Little Androscoggin River. The Dam materials will be disposed of offsite in accordance with all applicable laws and regulations. Associated structures in the overbank area will be left in place. With the dam out, they will no longer influence the hydraulics of the river, making their removal an unnecessary cost and impact.

The design also calls for the removal of the remnant rock and timber dam, which was discovered during field visits and sits approximately 400 feet upstream of the Littlefield Dam. With the Littlefield Dam removed and its impoundment eliminated, the remnant dam would likely impair fish passage. This is shown in the modeling and was evident during field visits at low water levels. The remnant dam is constructed of timbers and stone. The timbers will be disposed of offsite. The rock component of the dam will be dismantled and redistributed onsite in a manner that will not impact site hydraulics.

7.2 FISH PASSAGE

Restoring fish passage for target species is a key objective of the proposed design. The exact condition of the channel bed under the Dam is unknown, which leaves some uncertainty around fish passage following the dam removal. It is not uncommon to find that dam builders have modified the ledge during construction, which can sometimes impair fish passage. With the conditions below the dam unknowable, the design calls for an assessment of the hydraulic conditions after the dam is removed. If needed, bed conditions can be modified to achieve fish passage conditions. We expect passable conditions to be achieved with the removal of the remnant dam, but we suggest taking a similar adaptive management approach there.

7.3 CHANNEL DESIGN

Dam removal alters the hydraulics of the upstream channel and increases flow velocity and shear stress in former impoundment. Depending on the site's geomorphology and channel characteristics, these hydraulic changes can lead to unwanted erosion following a dam removal. Upstream of the Dam, ledge forms the bed and banks in many locations, providing robust vertical and lateral channel stability. In the 50% designs, bank treatment was called for in two locations. Upon further analysis, this bank treatment was deemed unnecessary because it was either protecting a thin layer of accumulated sediment or areas determined to be ledge. The bank treatment is not included in the final design.

7.4 SEDIMENT MANAGEMENT

The small volume (estimated at <50 CY) and sandy composition of the deposit provide little concern for contamination. Sandy substrates are generally considered low risk for contamination. Sand is composed primarily of quartz, which is chemically inert and has little capacity for binding metals or organic pollutants. Due to the small volume of sand and lack of organic material that may carry pollutants, we recommend a passive release sediment management option. Some fraction of the sand will likely mobilize during higher flows following the removal of the Dam and deposit in the Barker Mills Dam impoundment downstream.

7.5 ACCESS AND STAGING

Access to the site is a major project constraint. We understand that accessing the site from either Littlefield Road is not an option. The site will therefore be accessed from Rodman Road via Pionite Road on the Pioneer Plastics Property. Temporary access will need to be constructed from where Pionite Road ends at the Pioneer Plastics water intake to the staging area. Access will run along the existing snowmobile trail across the southern edge of the adjacent parcel (179-021) owned by Central Maine Power and terminate at the staging area on Pioneer Plastics property (parcel 179-018). Access and staging are shown on Sheet 3 of the 100% designs. The contractor may access the remnant dam from the Martindale Country Club (MCC) property if using a small excavator.

7.6 CONSTRUCTION SEQUENCING

While the construction sequencing is ultimately up to the contractor, we recommend the following construction sequence:

1. Mobilize to the site.
2. Establish erosion and sediment control measures at the site.
3. Establish upland access and staging areas.
4. Establish in-water temporary access. Access should maintain downstream river flow and minimize impediment to flow. All in-water work to be completed between July 15th and September 30th.
5. Notch river right (south) side of dam to draw down impoundment.
6. Establish localized work area exclusion, as needed.
7. Remove river right side of dam.
8. Adjust work area isolation measures as needed and remove river left side of dam.
9. Allow access for engineers to survey and evaluate streambed for fish passage.
10. Adjust work area isolation measures and modify streambed for fish passage, if needed.
11. Decommission all work area isolation measures and in-water temporary access at Littlefield Dam.
12. Establish access to dam remnant, either along river right (south) overbank area or from Martindale Country Club.
13. Establish work area isolation measures and remove remnant dam.
14. Decommission work area isolation measures at the remnant dam.
15. Restore staging and access areas.
16. Remove erosion and sediment control measures at the site.
17. Demobilize from the site.

8. Additional Design Elements

8.1.1 Water Intakes

The water intake for irrigation at the Martindale Country Club is located approximately 1,300 feet upstream of dam. Our analysis shows that the pool the water intake draws from is unaffected by the Littlefield Dam and remnant dam and will experience no changes if the structures are removed. The pool is formed by a ledge outcrop that provides grade control at the pool outlet. There are multiple riffle sections and ledge grade controls separating the pool dam impoundment, which will provide long term stability to the river profile, including the water intake pool, with or without a dam.

There is also a water intake approximately 1,100 feet downstream of the dam, serving the Pioneer Plastics facility. The Dam has no influence on downstream water levels, being a breached, run-of-the-river structure. The Pioneer Plastics water intake draws water from the impoundment formed the downstream Barker Mills Dam and will be unaffected by the Project.

9. Permitting

Inquiries have been made with the following agencies:

- US Army Corps of Engineers (USACE)
- State Historic Preservation Office (SHPO)
- Tribal Historic Preservation Offices (THPOs)
- United States Fish and Wildlife Service (USFWS), via the IPaC system
- Maine Department of Inland Fisheries and Wildlife (MDIFW)
- Maine Department of Environmental Protection (DEP)
- Maine Natural Areas Program (MNAP)

We are in the process of submitting applications with USACE and DEP.

The SHPO reported that the project would not impact any historic properties, with no further consultation required.

MNAP reported that the project is unlikely to impact any rare, threatened, endangered or sensitive species, or sensitive and protected habitat.

MDIFW reported no mapped essential habitat in the project area and provided additional feedback on potential project impacts that will be considered in subsequent design phases.

10. Engineer's Opinion of Probable Cost

The Engineer's Opinion of Probable Costs (EOPC) assumes the site-specific approaches discussed above. According to the definitions developed by the Advancement of Cost Engineering (AACE International, 2020), the goal for the cost analysis fits in the range of Class 1 estimates, with a published accuracy range of -10% to +15%. The EOPC was prepared in 2026 dollars. The cost opinion was developed based on review of construction costs for similar items in past projects, consultation with construction contractors and material suppliers, and applicable reference cost data. The actual cost of implementation of the Project may vary from the cost opinions due to heavy construction market fluctuations and other unforeseen factors. In particular, recent bid results have seen substantial escalation in bid pricing due to labor shortages in the state of Maine and in the broader region, continued market volatility post COVID Pandemic, tariffs, and supply chain pressures for materials and equipment. While construction costs seem to be stabilizing, it is important to account for any potential variation, so a construction cost contingency of 15% has been included in the cost opinion.

11. References

AACE International. (2020). *Cost Estimate Classification System-as Applied in Engineering, Procurement, and Construction for the Process Industries*.

Arcement, G. J., & Schneider, V. R. (1989). Guide for selecting Manning's roughness coefficients for natural channels and flood plains. In *US Geological Survey Water-Supply Paper* (Vol. 2339). https://doi.org/10.3133/wsp2339

Dudley, R. W. (2015). Regression Equations for Monthly and Annual Mean and Selected Percentile Streamflows for Ungaged Rivers in Maine. *Scientific Investigations Report*, 48. http://pubs.er.usgs.gov/publication/sir20155151

England, J. F., Cohn, T. A., Faber, B. A., Stedinger, J. R., Thomas Jr., W. O., Veileux, A. G., Kiang, J. E., & Mason, R. R. (2018). *Guidelines for Determining Flood Flow Frequency Bulletin 17C Book 4, Hydrologic Analysis and Interpretation Techniques and Methods 4-B5* (1.1). U.S. Geological Survey Techniques and Methods, book 4.

Haro, A., Castro-Santos, T., Noreika, J., & Odeh, M. (2004). Swimming performance of upstream migrant fishes in open-channel flow: a new approach to predicting passage through velocity barriers. *Canadian Journal of Fisheries and Aquatic Sciences*, *61*(9), 1590–1601. https://doi.org/10.1139/f04-093

Littlefield Hydro Company. (1987). *Application for FERC License - Littlefield Hydro*.

Lombard, P. J., & Hodgkins, G. A. (2020). Estimating Flood Magnitude and Frequency on Gaged and Ungaged Streams in Maine Scientific Investigations Report 2020 – 5092. *Scientific Investigations Report*.

NOAA Fisheries. (2020). *Androscoggin River Watershed Comprehensive Plan for Diadromous Fishes. Greater Atlantic Region Policy Series 20-01*.

Turek, J., Haro, A., & Towler, B. (2016a). Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes. *Interagency Technical Memorandum*, *May*, 47 p.

Turek, J., Haro, A., & Towler, B. (2016b). Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes. *Interagency Technical Memorandum*, *May*, 47 p.

USFWS. (2019). Fish Passage Engineering Design Criteria. *Report*, *June*, 248.

USGS. (2021). *StreamStats National Application 4.6.2*. https://streamstats.usgs.gov/ss/

Appendix A| Littlefield Dam Removal Designs (100%)

Appendix B| Littlefield Dam Removal Engineer's Opinion of Probable Cost (100%)