TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 12
Tessellated Darter Survey

Final Study Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

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EXECUTIVE SUMMARY

The goal of this study was to assess the effects of Wilder, Bellows Falls, and Vernon project operations on populations of Tessellated Darter, specifically to characterize the distribution and relative abundance of Tessellated Darter within project-affected areas by conducting a habitat-based field survey. Study locations were chosen proportional to available substrate types (i.e., sand-silt-clay, gravel-cobble, boulder) within each geographic reach. A total of 45 sites were selected for sampling from Wilder impoundment to the riverine reach downstream of Vernon dam.

Sampling for Tessellated Darters occurred during September 2015 within each of 45 randomly-selected 500-m map units. Within each 500-m map-unit, a total of three cross-river transects were randomly placed. A negatively buoyant 3-m radius count circle was dropped at each of five count locations along each transect. Once each of the five fixed radius count circles were established on the bottom substrate, a SCUBA diver descended down a tether line. Tessellated Darters were quantified immediately upon arrival at a particular fixed-radius count location. The sampler also recorded an estimated proportion of adult to juvenile individuals. Following collection of Tessellated Darter abundance information, each 3-m radius count circle was visually surveyed for freshwater mussel species. If present, Dwarf Wedgemussels were recorded and the total number counted. Substrate, aquatic vegetation, coarse woody debris, available cover, water velocity and water quality parameters were collected at each sampling location.

A total of 675 unique, 3-m radius count circles were sampled within the six river reaches included in the study resulting in 263 observed Tessellated Darters. Most darters (80%) observed were visually determined to be juveniles based on an apparent body length of less than 2.5 inches. The majority of individuals were observed within the Wilder impoundment where count circle estimates ranged from zero to 40 individuals. Total counts of darters decreased with location further downstream within the study area. Observations of darters during this study were consistent with behaviors described in biological accounts of the species which indicate that outside of the breeding season, Tessellated Darter habitat includes sand and mud bottomed areas, slow runs, and backwaters of small to large rivers.

Four (possibly five) freshwater mussel species were identified within the 3-m count circles, although no Dwarf Wedgemussels were found. Darters found in this study and in Study 10 – Fish Assemblage Study were compared to data from Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study. Darters were present within those mussel survey reaches, and were found nearby or in the general vicinity (within approximately 1 to 2 miles up or downstream) of most locations were Dwarf Wedgemussel have been found in recent studies.

This final study report incorporates comments received on the initial study report filed March 1, 2016 and provides additional study data (including revised supporting geodata and attribute tables) not included in the initial study report.

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List of Abbreviations

AOQL	Average Outgoing Quality Limit
CPUA	Catch per unit area
CRWC	Connecticut River Watershed Council
°C	degrees Celsius
DO	dissolved oxygen
DWM	Dwarf Wedgemussel
FERC	Federal Energy Regulatory Commission
FWS	U.S. Department of the Interior – Fish and Wildlife Service
ft/s	foot or feet per second
µS/cm	micro-siemens per centimeter
mg/l	milligrams per liter
NHDES	New Hampshire Department of Environmental Services
NHFGD	New Hampshire Fish and Game Department
NTU	Nephelometric Turbidity Units
RSP	Revised Study Plan
SGCN	Species of Greatest Conservation Need
SSR	Site Selection Report
su	standard units
TransCanada	TransCanada Hydro Northeast Inc.
TU	Trout Unlimited
USR	Updated Study Report
VANR	Vermont Agency of Natural Resources
VDEC	Vermont Department of Environmental Conservation

1.0 INTRODUCTION

This final study report presents the findings of the 2015 Tessellated Darter Survey (ILP Study 12) conducted in support of Federal Energy Regulatory Commission (FERC) relicensing efforts by TransCanada Hydro Northeast Inc. (TransCanada) for the Wilder Hydroelectric Project (FERC Project No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855) and the Vernon Hydroelectric Project (FERC No. 1904). This report revises the initial study report filed March 1, 2016 to respond to comments from stakeholders during the Study Report meeting on March 18, 2016 and written comments received by May 2, 2016. TransCanada provided responses to those comments in a May 31, 2016 FERC filing. This final report also provides additional maps showing darter locations and substrate/habitat in Appendix G, revises Appendix A to add substrate/habitat data, adds Appendix D and E (Excel data from Study 10 – Fish Assemblage Study [Normandeau, 2016]), and provides updated supporting geodata (Appendix D in the initial study report, now Appendix F) that combines darter data from both this study and Study 10. Note that appendices A through E are being filed separately in Excel format, and Appendix F in ArcGIS and kmz formats.

The Tessellated Darter (*Etheostoma olmstedi*) is resident within the upper Connecticut River, and is listed as a New Hampshire Species of Greatest Conservation Need (SGCN). Tessellated Darter is also a confirmed host for Dwarf Wedgemussel (DWM) (*Alasmidonta heterodon*) a freshwater mussel species federally listed as endangered. Existing literature indicates that Tessellated Darters may be found in a variety of habitat types (Scott and Crossman, 1979; Hartel et al., 2002). In their study requests, US Fish & Wildlife Service (FWS), New Hampshire Department of Environmental Services (NHDES), New Hampshire Fish & Game Department (NHFGD), Vermont Agency of Natural Resources (VANR), Connecticut River Watershed Council (CRWC), and The Nature Conservancy (TNC) indicated that project operations may affect the distribution and abundance of the Tessellated Darter within project-affected areas. Habitat may be related to project operations in terms of flow (water depth and velocity, and the timing, duration, frequency, and rate of change), as well as the interactions of flow with other habitat variables such as substrate, vegetation, and cover which may consequently lead to changes in the distribution, abundance, and behavior of Tessellated Darter. Those changes could, in turn, potentially affect DWM.

The RSP, as supported by stakeholders in 2013 and approved by FERC in its February 21, 2014 Study Plan Determination specified that a subset of the project-affected area would be studied for the presence of Tessellated Darter. An initial Site Selection Report (SSR) was posted on TransCanada's relicensing website on December 5, 2014 and comments were received during an aquatics working group meeting held on December 17, 2014. The final sampling locations were randomly selected and presented in the Revised SSR (Normandeau, 2015a) which included modifications that addressed all working group discussion and comments. The Revised SSR was filed with FERC on September 14, 2015 as Volumes II.D of

TransCanada's Updated Study Report (USR), with corresponding geodata of final study site locations filed as Volume II.I of the USR.

2.0 STUDY GOALS AND OBJECTIVES

As stated in the RSP, the goal of this study was to assess the effects of project operations on populations of Tessellated Darter. The specific study objective was to characterize the distribution and relative abundance of Tessellated Darter within project-affected areas by conducting a habitat-based field survey. With this information, some judgments on whether the DWM population may be constrained due to distribution and abundance of Tessellated Darters may be feasible.

3.0 STUDY AREA

Sampling was conducted to characterize the distribution and relative abundance of Tessellated Darter within project-affected areas from the upper extent of the Wilder impoundment to approximately 1.5 miles downstream of Vernon dam. This approximately 120-mile reach of the Connecticut River was divided into six geographic reaches delineated based on a combination of general river morphology and project structures, as follows:

- Wilder impoundment (RM 262.4 - 217.4);
- Wilder downstream riverine corridor (RM 217.4 – 199.7);
- Bellows Falls impoundment (RM 199.7 – 173.7);
- Bellows Falls downstream riverine corridor (RM 173.7 – 167.9);
- Vernon impoundment (RM 167.9 – 141.9); and
- Downstream of Vernon dam to the downstream extent of Stebbins Island (RM 141.9 – 140.4).

3.1 Study Sites

Study sites were selected in accordance with the process described in the Revised SSR and with concurrence from the aquatics working group, and are summarized below.

Habitat characteristics for project-affected areas were recorded as part of Study 7 - Aquatic Habitat Mapping (Normandeau, 2015b). The Revised SSR reviewed all available aquatic substrate/habitat data and selected proposed study locations based on a stratified random sampling design. Study locations were chosen proportional to available substrate/habitat types (i.e., sand-silt-clay, gravel-cobble, boulder) within each geographic reach.

Prior to the selection of study locations, each geographic reach was delineated into 500-meter map-unit segments using ArcGIS. Within each map-unit, the substrate present was quantified. An overall dominant substrate/habitat type was assigned based on the proportions of varying substrates present within each individual unit.

For example, if a particular 500-meter map-unit was determined to contain 70% cobble-gravel, 25% sand-silt-clay, and 5% boulder then a dominant habitat type of cobble-gravel was assigned. For map-units with existing side-scan substrate data (in the impoundment reaches), the dominant substrate type was assigned using that information. For map-units where meso-habitat mapping was conducted (in the riverine reaches), the proportional contribution of meso-habitat units identified in the field during Study 7 in 2013 (i.e., run, riffle, glide, etc.) was first determined. The dominant substrate type identified at the time of the field survey within each meso-habitat unit was then substituted for meso-habitat unit from Study 7, and the resulting proportions of varying substrate types present were used to make the determination of dominant type within the 500-meter map-unit. For example, if 70% of the area of a particular map-unit was represented by one run meso-habitat unit and the remaining 30% was represented by one pool meso-habitat unit, with the run being dominated by cobble-gravel substrate and the pool being dominated by sand-silt-clay, then a dominant type of cobble-gravel was assigned. In some instances, both side-scan substrate data and meso-habitat mapping data were available for a particular map-unit. In those cases, dominant type was determined from the side-scan substrate data.

In accordance with the RSP, the total number of sampling locations within each geographic reach were randomly placed proportional to substrate type frequency (e.g., if 50 percent of a particular geographic reach is cobble-gravel habitat than 50 percent of the total number of sampling locations for that geographic reach would be randomly placed within that type). Within each selected 500-m map-unit, a total of three visual survey sample areas were randomly placed. To accomplish this, a start point (either the upper or lower bound of a particular 500-m map-unit) was randomly selected. Once the start point was determined, three numbers between the values of 1 and 500 were randomly chosen. To ensure that transects were distributed throughout the map-unit, one visual survey area was placed within each third of a selected map-unit (i.e., within 0-166 m of start point, 167-333 m of start point and 334-500 m of start point). Sample areas were then placed at the intervals specified by the three random values with the randomly selected upper or lower bound serving as the start point.

As described in the Revised SSR, a total of 45 sites with 3 transects each were selected for sampling: 14 in the Wilder impoundment, 8 in the riverine section downstream of Wilder, 8 in the Bellows Falls impoundment, 4 in the riverine section downstream of Bellows Falls, 8 in the Vernon impoundment and 3 in the riverine reach downstream of Vernon. The spatial distribution of sampling sites specified in the Revised SSR was accomplished with two exceptions:

1) Map-unit 12-B092 was substituted for map-unit 12-B093. The dominant substrate type within both map-unit blocks was sand-silt-clay. The change was intentionally made to increase the distance upstream of the Bellows Falls dam to allow for increased safety for SCUBA divers conducting the underwater transect evaluations.

2) Within map-unit 12-BR016, the transect specified to be placed 381 m from the start point was inadvertently placed 318 m from the start point.

A full listing of the sample locations visited as part of Study 12 is presented in Table 3.1-1. Final study site map-unit locations and transects are illustrated in Figures 3.1-1 through 3.1-6.

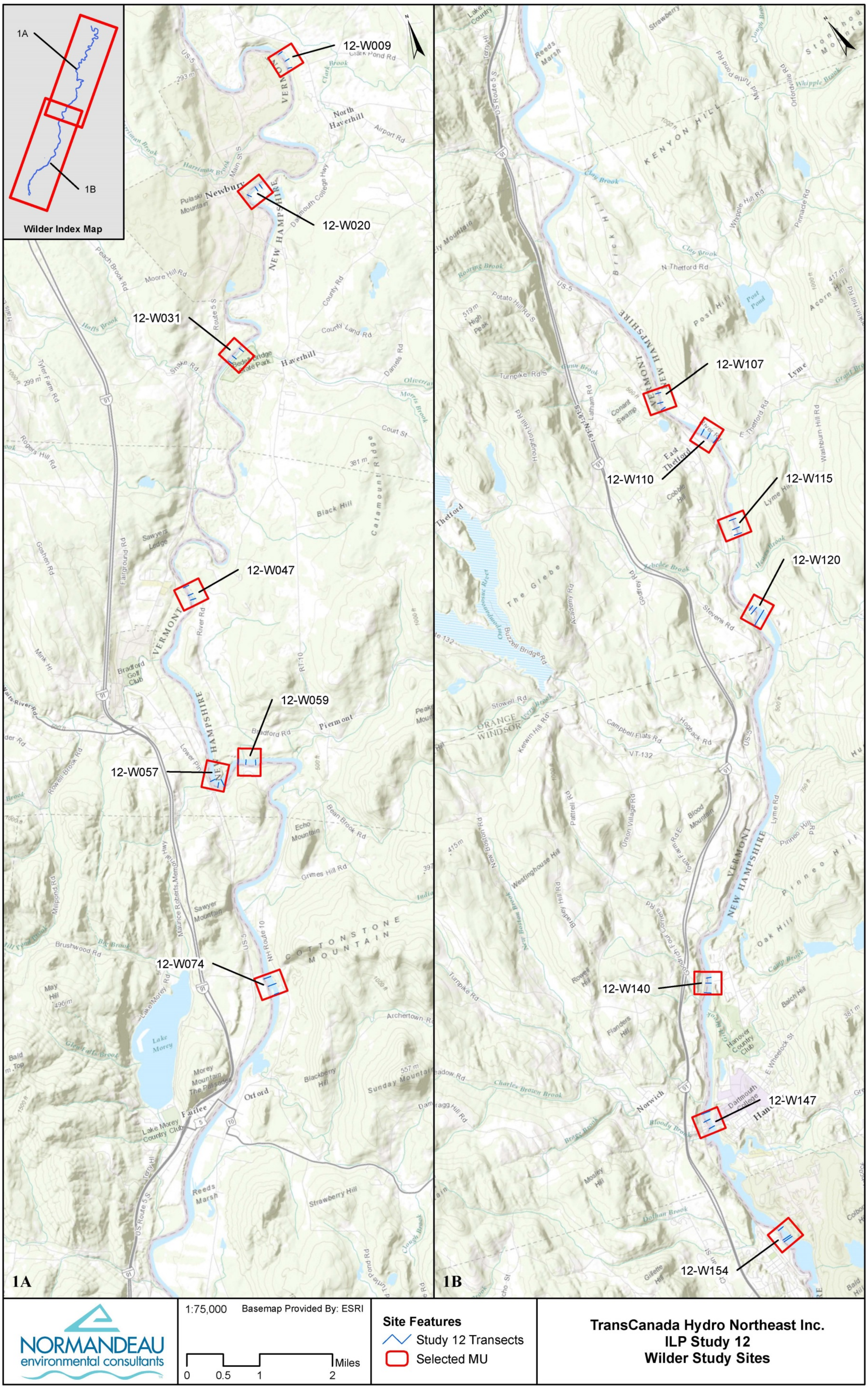


Figure 3.1-1. Map-units sampled within the Wilder impoundment, 2015.

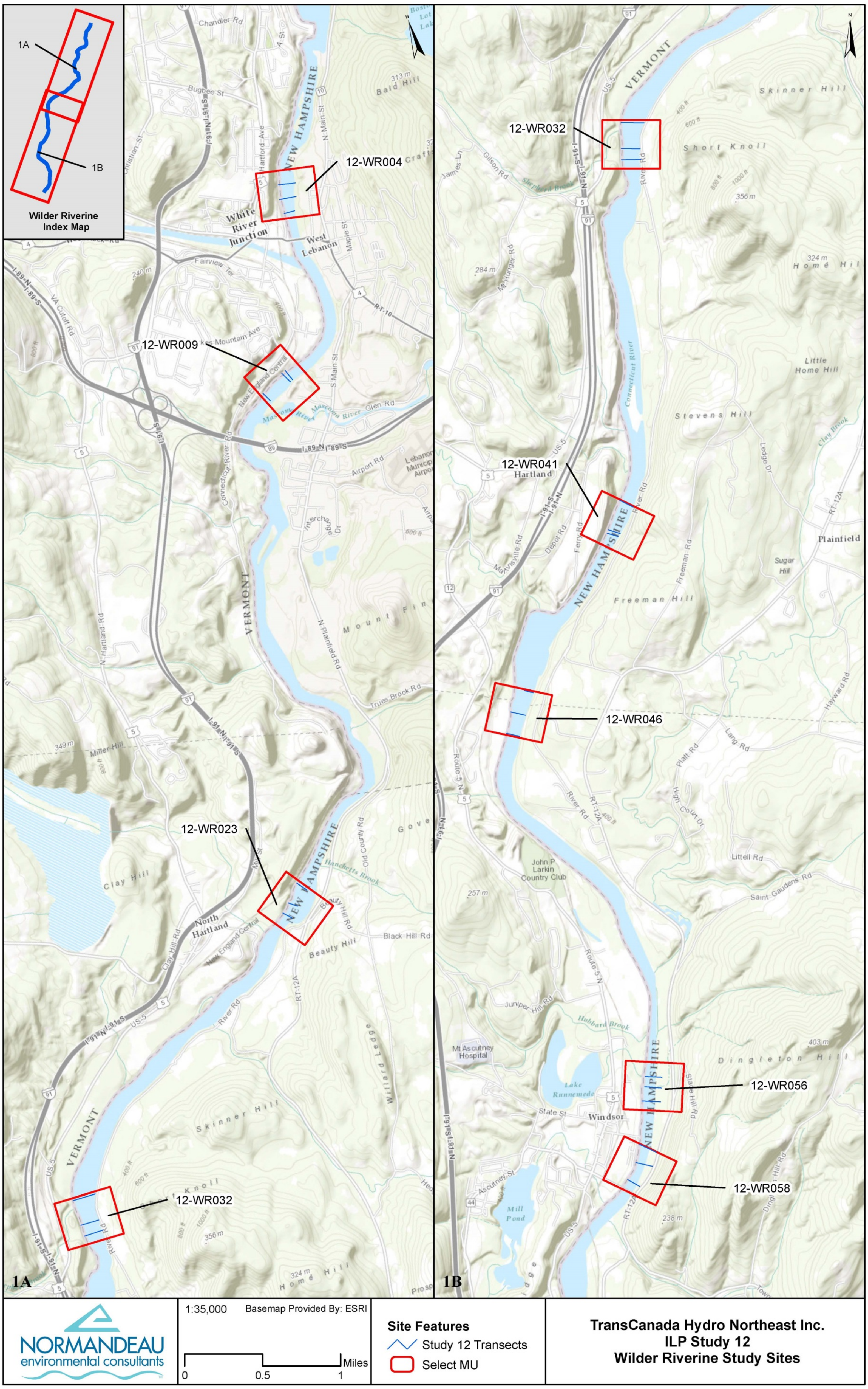


Figure 3.1-2. Map-units sampled within the Wilder riverine reach, 2015.

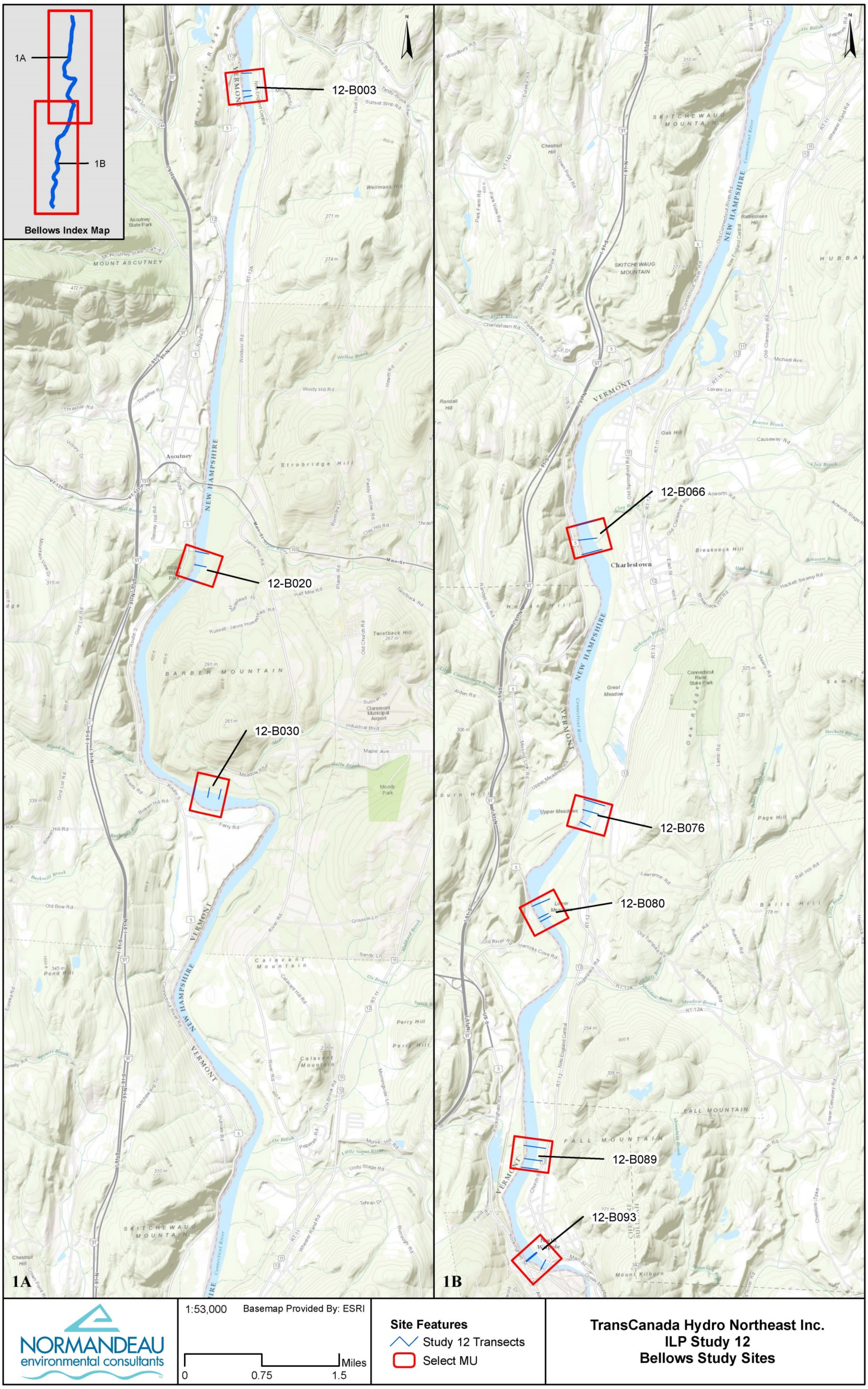


Figure 3.1-3. Map-units sampled within the Bellows Falls impoundment, 2015.

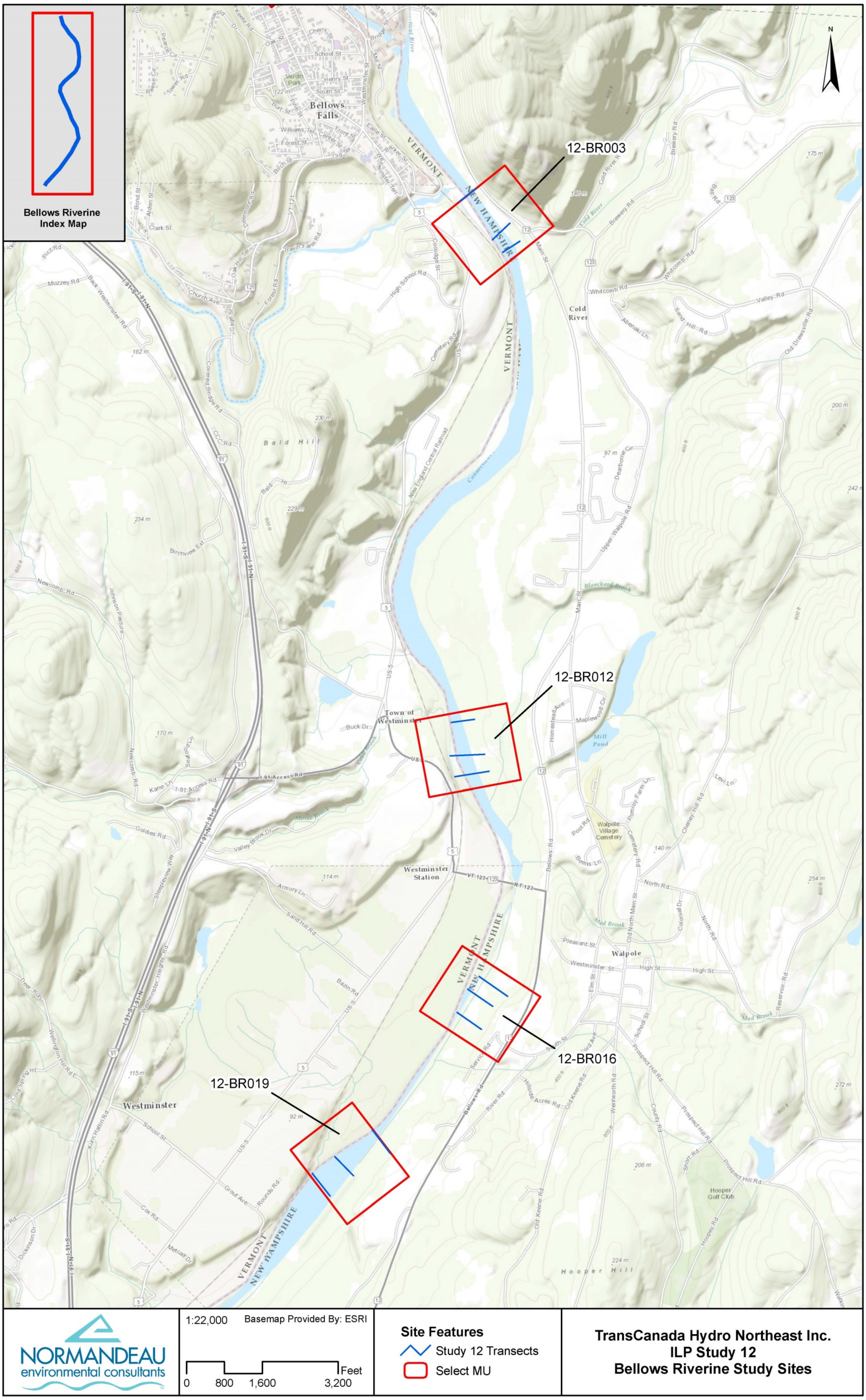


Figure 3.1-4. Map-units sampled within the Bellows Falls riverine reach, 2015.

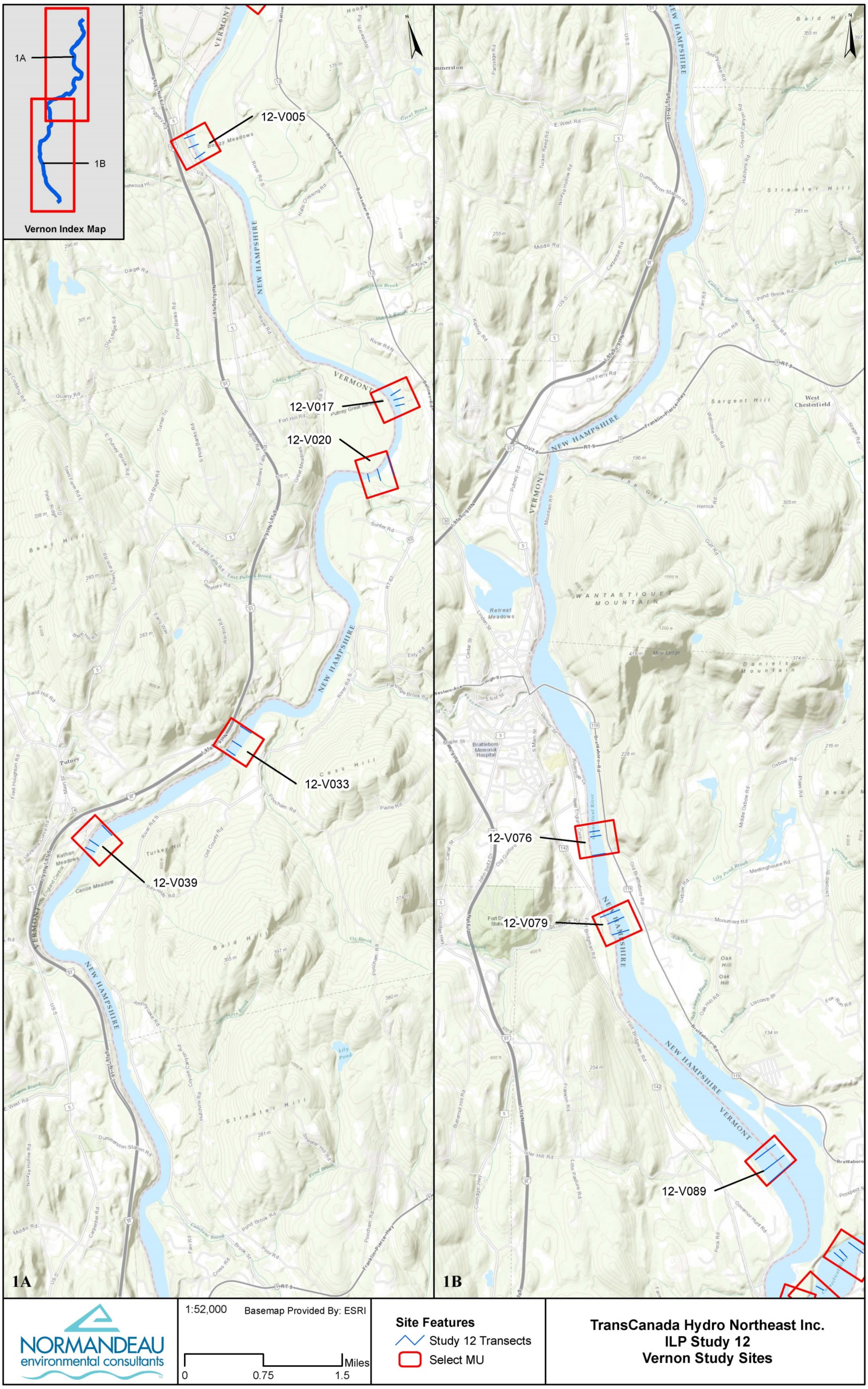
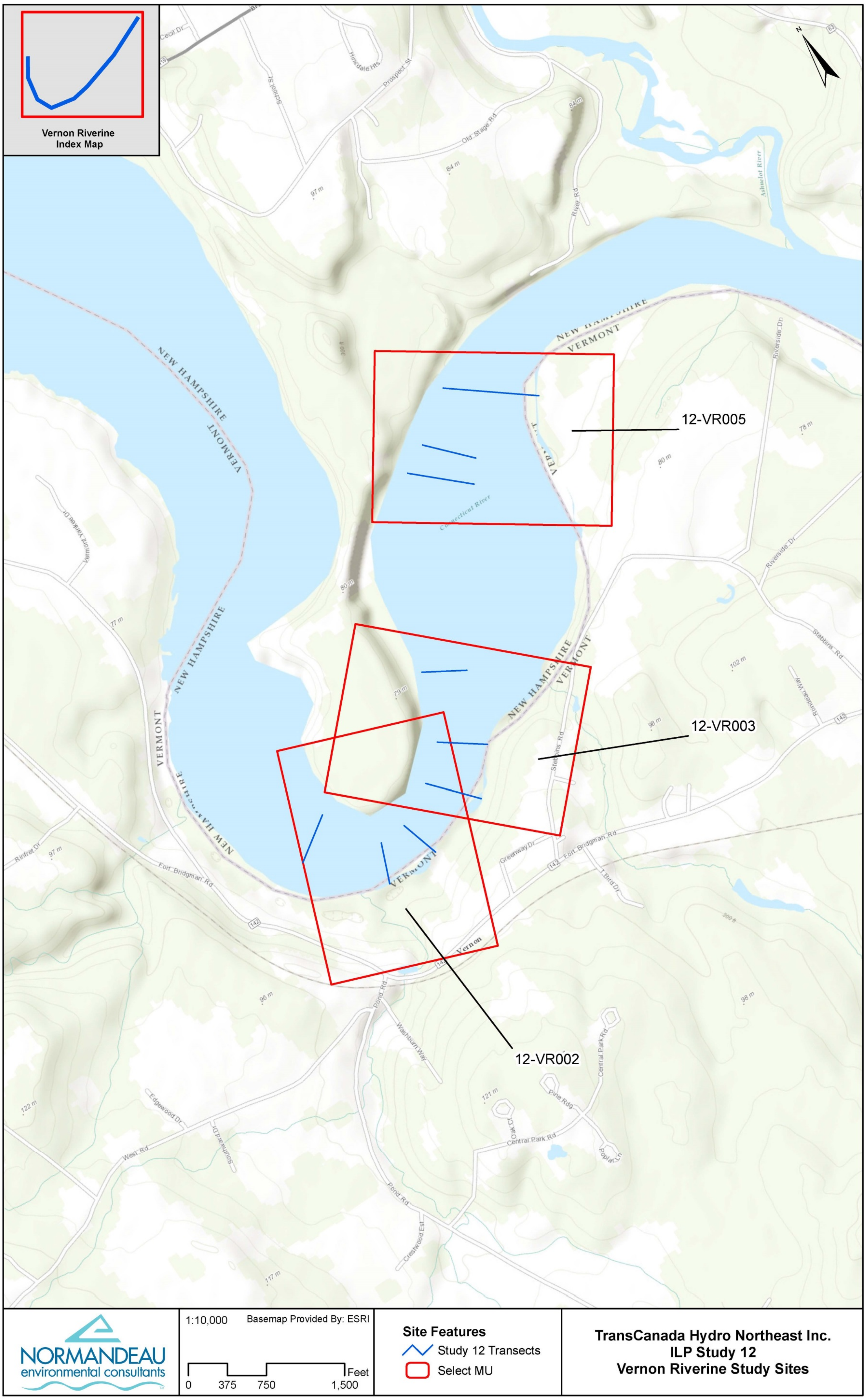


Figure 3.1-5. Map-units sampled within the Vernon impoundment, 2015.



Note: Transects span the river width from bank to bank but the topographic base map distorts the projection and appearance of transects in the map scale used here (refer to study supporting geodata).

Figure 3.1-6. Map-units sampled within the Vernon riverine reach, 2015.

Table 3.1-1. Starting boundary, transect increments (in meters from starting boundary) and coordinates for randomly selected map-units sampled in 2015.

Map Unit	Starting Boundary	Selected Increment	Location (DD NAD83 UTM Z18N)	
			X	Y
12-W009	Upper	57	-72.031328	44.101167
		268	-72.030183	44.099418
		450	-72.030153	44.097755
12-W020	Upper	128	-72.048404	44.077367
		239	-72.049727	44.077164
		462	-72.052244	44.076338
12-W031	Lower	44	-72.072068	44.046255
		182	-72.070574	44.046874
		406	-72.068089	44.047831
12-W047	Lower	136	-72.102904	44.004072
		258	-72.103145	44.005149
		463	-72.103284	44.005607
12-W057	Lower	137	-72.111501	43.967634
		254	-72.112892	43.967547
		409	-72.113925	43.968736
12-W059	Lower	113	-72.101151	43.969366
		326	-72.103641	43.970051
		497	-72.105646	43.970601
12-W074	Lower	21	-72.116267	43.924555
		245	-72.116621	43.926491
		427	-72.117262	43.928167
12-W107	Upper	95	-72.186660	43.824826
		313	-72.187878	43.823067
		456	-72.188225	43.821799
12-W110	Upper	138	-72.183705	43.813273
		296	-72.183018	43.811941
		473	-72.182409	43.810414
12-W115	Lower	56	-72.193397	43.793014
		190	-72.192856	43.794139
		400	-72.192099	43.795956
12-W120	Lower	146	-72.203073	43.777304
		328	-72.202984	43.779062
		411	-72.203196	43.779842
12-W140	Lower	37	-72.277734	43.725081
		251	-72.275920	43.726483
		371	-72.274967	43.727307
12-W147	Upper	19	-72.298485	43.706579
		205	-72.299571	43.705179
		386	-72.299636	43.703529
12-W154	Upper	74	-72.301862	43.679255
		312	-72.302125	43.677128
		356	-72.302093	43.676734
12-WR004	Lower	63	-72.313852	43.653202
		207	-72.313481	43.654489
		357	-72.313011	43.655760
12-WR009	Upper	144	-72.320613	43.638900
		181	-72.321043	43.638774

Map Unit	Starting Boundary	Selected Increment	Location (DD NAD83 UTM Z18N)	
			X	Y
		464	-72.324186	43.637642
12-WR023	Upper	28	-72.339998	43.593598
		235	-72.341803	43.592272
		363	-72.342906	43.591467
12-WR032	Upper	26	-72.379016	43.572765
		291	-72.379368	43.570364
		405	-72.379326	43.569334
12-WR041	Upper	9	-72.381345	43.537465
		322	-72.382991	43.534900
		359	-72.383209	43.534598
12-WR046	Upper	16	-72.394513	43.520295
		268	-72.395991	43.518302
		485	-72.396715	43.516345
12-WR056	Lower	96	-72.380560	43.481961
		240	-72.380273	43.483249
		350	-72.380166	43.484226
12-WR058	Lower	108	-72.383150	43.474442
		331	-72.381720	43.476135
		494	-72.381181	43.477620
12-B003	Upper	38	-72.390882	43.460724
		311	-72.390942	43.458243
		401	-72.390783	43.457441
12-B020	Upper	42	-72.402360	43.393575
		249	-72.402757	43.391748
		493	-72.404293	43.389764
12–B030	Lower	94	-72.400371	43.359601
		271	-72.402539	43.359898
		491	-72.405235	43.360179
12-B066	Upper	8	-72.436895	43.242284
		257	-72.436499	43.240047
		472	-72.435757	43.238205
12-B076	Lower	97	-72.438624	43.200007
		312	-72.437538	43.201744
		470	-72.436780	43.203031
12-B080	Lower	158	-72.446853	43.186898
		216	-72.447228	43.187336
		411	-72.447628	43.189201
12-B089	Lower	33	-72.451327	43.151923
		174	-72.450659	43.153127
		378	-72.450229	43.154915
12-B093	Upper	157	-72.45407	43.14316
		170	-72.45403	43.14311
		385	-72.4529	43.14137
12-BR003	Lower	67	-72.432993	43.121371
		182	-72.433746	43.122277
		500	-72.436276	43.124449
12-BR012	Upper	59	-72.437949	43.094039
		280	-72.437678	43.092059
		404	-72.437364	43.090953
12-BR016	Upper	108	-72.436175	43.078632
		219	-72.437250	43.078005

Map Unit	Starting Boundary	Selected Increment	Location (DD NAD83 UTM Z18N)	
			X	Y
		318	-72.437796	43.077212
12-BR019	Upper	4	-72.445413	43.069860
		286	-72.448403	43.068502
		481	-72.450254	43.067470
12-V005	Lower	96	-72.465945	43.048572
		272	-72.466630	43.050062
		424	-72.466874	43.051467
12-V017	Upper	152	-72.442555	43.009831
		268	-72.442293	43.008889
		359	-72.442397	43.008025
12-V020	Lower	119	-72.451749	42.999527
		285	-72.449708	42.999541
		498	-72.447101	43.000309
12-V033	Lower	53	-72.490571	42.968149
		217	-72.489042	42.969093
		473	-72.486732	42.970643
12-V039	Lower	82	-72.520942	42.960496
		198	-72.519875	42.961246
		468	-72.516896	42.962434
12–V076	Upper	120	-72.545933	42.831736
		198	-72.545772	42.831062
		485	-72.545254	42.828517
12-V079	Upper	69	-72.543525	42.820340
		202	-72.542506	42.819347
		400	-72.541629	42.817688
12-V089	Lower	8	-72.513057	42.783864
		191	-72.514244	42.785232
		402	-72.515734	42.786813
12-VR002	Upper	71	-72.513489	42.766139
		241	-72.511819	42.764532
		366	-72.510314	42.764567
12-VR003	Lower	101	-72.506255	42.767863
		312	-72.507153	42.766027
		425	-72.508366	42.765115
12-VR005	Lower	112	-72.499316	42.773287
		304	-72.501745	42.772597
		398	-72.502538	42.772125

4.0 METHODOLOGY

4.1 Field Sampling

Sampling for Tessellated Darters occurred within each of the randomly-selected 500-m map units presented in Table 3.1-1. Within each 500-m map-unit, a total of three cross-river transects were randomly placed. Once the start point was located, each transect contained five fixed-radius count locations spaced evenly across the channel (i.e., west bank, ~1/3rd channel width, ~channel midpoint, ~2/3rd channel width, east bank). The RSP included two potential field sampling techniques to evaluate darter distribution and relative abundance: visual surveys conducted via SCUBA or snorkel; or beach seine/backpack electrofish sampling. This approach was refined within the Revised SSR where it was stated that all sampling was to be conducted using the visual survey method. That decision was made to provide continuity among all samples and eliminate potential biases associated with multiple sampling approaches.

Upon arrival at a particular sampling transect, a negatively buoyant 3-m radius count circle was dropped at each of the five count locations along the transect. Count circles were constructed from perforated ¾ inch PVC electrical conduit. Coordinates for each of the five fixed-radius count locations were recorded prior to sampling. Once all of the five fixed-radius count circles were established on the bottom substrate, a SCUBA diver descended down the surface tether line.

Tessellated Darters were quantified immediately upon arrival at a particular fixed-radius count location. If feasible, a total count of individuals within the 3-m circle was made while also recording an estimated proportion of adult to juvenile individuals. The proportion of adult to juvenile individuals was determined visually by size. Upon arrival at the count circle, it was up to the discretion of the sampler whether an accurate count of darters within a particular circle could be made based on abundance at that location. In the event that abundance of individuals within the circle was too great to visually enumerate, an index of abundance was recorded instead. To determine the index of abundance, the total number of Tessellated Darters (as well as proportion of adult to juvenile individuals) was recorded for a randomly placed ½-m square quadrat. This sub-sample could later be extrapolated to represent the entire 3-m radius count circle.

Following collection of Tessellated Darter abundance information, each 3-m radius count circle was visually surveyed for freshwater mussel species. Substrate within each 3-m circle was noted and the proportion among five classifications (organics, sand-silt-clay, cobble-gravel, boulder-rip-rap, or bedrock) recorded. If present, the percentage of the circle containing aquatic vegetation was estimated and an average height of plants present was recorded. If present, the abundance of coarse woody debris was estimated as a percentage of the entire circle. An overall estimate of available cover (i.e., boulders, woody debris, etc.) was recorded.

Water quality parameters were collected at each sampling location using a YSI Model 6920. Recorded parameters included temperature (°C), dissolved oxygen concentration and dissolved oxygen percent saturation, conductivity, pH, and turbidity. Water quality measurements were taken at each 3-m radius count circle.

Mean column water velocities were measured using a Marsh-McBirney flowmeter on a top-setting wading rod or flow bomb at each 3-m radius count circle. For depths less than 2.5 ft, mean column velocity was estimated by a single measurement at 0.6 of the total depth. For depths of 2.5-4.0 ft, measurements were taken at 0.2 and 0.8 of the total depth and averaged to estimate mean column velocity. Velocities at locations over 4 ft deep were measured at 0.2, 0.6, and 0.8 of the total depth, with mean column water velocity (v) calculated as (0.2v+0.8v+2*0.6v)/4.

4.2 Data Analysis

Data sheets containing all field recorded observations (e.g., darter counts, substrate and/or habitat parameters, water quality, etc.) were collected and data was keypunched and then subjected to a QC inspection to assure a 1% Average Outgoing Quality Limit (AOQL) according to a lot sampling plan (ASQL, 1993). This procedure ensures that ≥99% of the observations in a data file agree with the original data sheets. The number of observations to be checked, and the number of those that must be within tolerance are presented in Table 4.2-1. If more than the acceptable number of failures is found then the data set must be inspected 100%.

Table 4.2-1. Lot sampling plan for QC inspection at less than 1% AOQL.

Lot Size* (range of observations recorded)	Sample Size (number of observations QC'd)	Number of Failures	
		Accept if ≤	Reject if ≥
1-32	ALL	0	1
33-500	32	0	1
501-3,200	125	1	2
3,201-10,000	200	2	3
10,001-35,000	315	3	4
35,001-150,000	500	5	6
150,001-500,000	800	7	8
500,001 and over	1,250	10	11

* Lot size represents the total number of observations for the category being evaluated

Relative abundance, the number of fish "captured" with known sampling effort and indexed as catch per unit area (CPUA)[1] was calculated for each 3-m radius count circle. CPUA values were calculated as the number of individuals per 25 m^2. CPUA values were standardized to #/25 m^2 using the following equation:

Visual Survey CPUA for taxon j in sample i = ("catch" $_{ji}$ / area) * 25 m^2

Where: area is the calculated area of the 3-m radius count circle (i.e., 28.26m^2)

Where average CPUA values were calculated for within a particular map-unit or river reach, all zero catch samples (i.e., those count circles with no darter observations) were included in the matrix.

5.0 RESULTS AND DISCUSSION

5.1 Sampling Effort

Sampling effort is presented in Table 5.1-1. A total of 675, 3-m radius count circles were sampled within the six geographic reaches included in the study. All sampling was conducted during September, 2015.

Table 5.1-1. Summary of Tessellated Darter sampling areas by river reach.

Description	Total Number of 500-m Map-units	Selected Number of 500-m Map-units	Number of 3-m Radius Count Circles per Map-unit	Total Number of Visual Survey Areas
Wilder Impoundment	156	14	15	210
Wilder Riverine	60	8	15	120
Bellows Falls Impoundment	93	8	15	120
Bellows Falls Riverine	20	4	15	60
Vernon Impoundment	93	8	15	120
Vernon Riverine	5	3	15	45
Total	**427**	**45**	**-**	**675**

5.2 Distribution and Relative Abundance of Darters

A total of 263 Tessellated Darters were observed during visual assessments of the 675, 3-m radius count circles randomly placed throughout the study area (Table 5.2-1). Most darters (80%) observed were visually determined to be juveniles based on an apparent body length of less than 2.5 inches. The majority of

[1] The RSP states that darter catch would be expressed as Catch-per-unit-effort (CPUE). For the purposes of this study, Catch-per-unit-area (CPUA) is presented. With regard to the area based sampling approach employed during this study, the two terms are interchangeable.

individuals were observed within the Wilder impoundment where count circle estimates ranged from 0 to 40 individuals. Total counts of darters decreased with location further downstream within the study area.

Table 5.2-2 presents a summary of the relative abundance (i.e., CPUA; # of individuals/25 m^2) of darters by river reach. Mean CPUA values calculated for each of the six river reaches were compared using an Analysis of Variance (ANOVA). Comparisons were conducted using the general linear model (GLM) procedure within SAS (Version 9.3). A significant difference among the mean CPUA values for the six riverine reaches was detected (ANOVA, f = 3.72, p = 0.0025). The mean CPUA value was significantly greater in the Wilder impoundment than was observed in Wilder riverine, Bellows Falls riverine, Vernon impoundment, and Vernon riverine reaches. The mean CPUA value in the Bellows Falls impoundment did not differ significantly from the other five reaches examined. A summary of darter counts and CPUA values for all count circles is provided in Appendices A, D and E (filed separately in Excel format).

Table 5.2-1. Summary statistics for Tessellated Darter observations by river reach.

Description	Total Count of Darters	Mean Number of Darters/ 25 m^2	Standard Deviation	Min Number of Darters / 25 m^2	Max Number of Darters / 25 m^2
Wilder Impoundment	208	1	4.4	0	40
Wilder Riverine	9	0.1	0.3	0	1
Bellows Falls Impoundment	37	0.3	1.1	0	9
Bellows Falls Riverine	6	0.1	0.4	0	3
Vernon Impoundment	2	<0.1	0.1	0	1
Vernon Riverine	1	<0.1	0.2	0	1
Total	**263**	**0.4**	**2.5**	**0**	**40**

Table 5.2-2. Summary statistics for Tessellated Darter CPUA by river reach.

Description	Total Count of Darters	Mean CPUA of Darters/ Count Circle	Standard Deviation	Min CPUA of Darters / Count Circle	Max CPUA of Darters / Count Circle
Wilder Impoundment	208	0.9	3.9	0	35.4
Wilder Riverine	9	0.1	0.2	0	0.9
Bellows Falls Impoundment	37	0.3	0.9	0	8.0
Bellows Falls Riverine	6	0.1	0.4	0	2.7
Vernon Impoundment	2	<0.1	0.1	0	0.9
Vernon Riverine	1	<0.1	0.1	0	0.9
Total	**263**	**0.3**	**2.2**	**0**	**35.4**

Within the Wilder impoundment, darters were detected within each of the 14 map-units selected for sampling. The majority of individuals (92%) were detected within the 3-m radius count circles placed along the eastern or western banks with lower numbers observed towards mid-channel (Table 5.2-3). Tessellated Darters were observed at five of the eight map-units selected for sampling within the Wilder riverine reach. Similar to observations for Wilder impoundment, the majority of darters (66%) were observed within the near-bank count circles. Within the Bellows Falls impoundment, darters were detected within seven of the eight map-units selected for sampling, with the majority (62%) detected within the near-bank count circles. Observations of Tessellated Darters within the Bellows Falls riverine, Vernon impoundment and Vernon riverine reaches were limited spatially and confined to near-bank count circles.

The spatial distribution for the presence/absence of Tessellated Darters as determined using the visual survey approach is depicted in Figures 5.2-1 – 5.2-6.

Table 5.2-3. Cross channel distribution of Tessellated Darter observations by river reach.

Description	Total Count of Darters	Subtotal: west bank	Subtotal: 1/3 channel	Subtotal: 1/2 channel	Subtotal: 2/3 channel	Subtotal: east bank
Wilder Impoundment	208	111	4	8	5	80
Wilder Riverine	9	4	1	1	1	2
Bellows Falls Impoundment	37	6	14	0	0	17
Bellows Falls Riverine	6	4	0	0	0	2
Vernon Impoundment	2	0	0	0	0	2
Vernon Riverine	1	1	0	0	0	0
Total	**263**	**126**	**19**	**9**	**6**	**103**

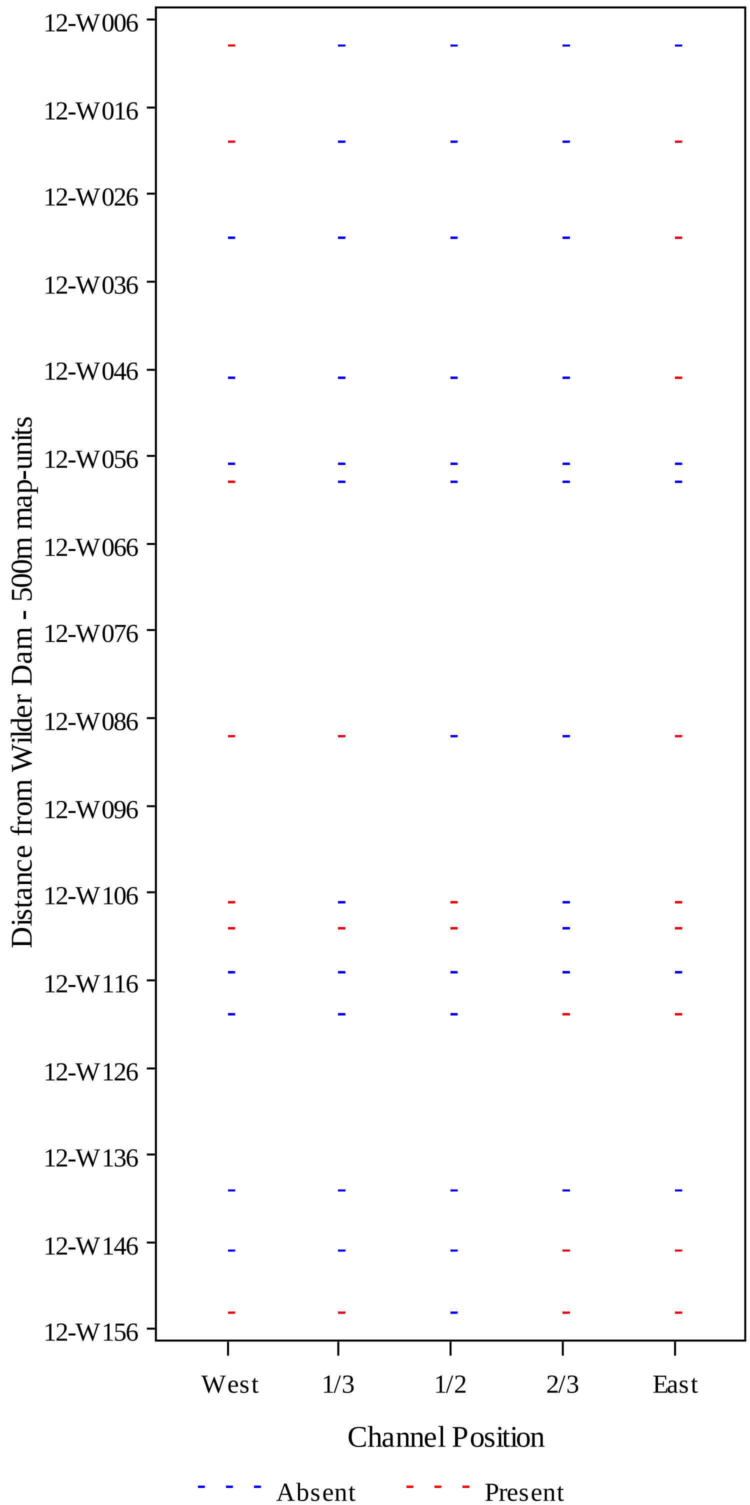


Figure 5.2-1. Sampled map-units where Tessellated Darters were observed within the Wilder impoundment.

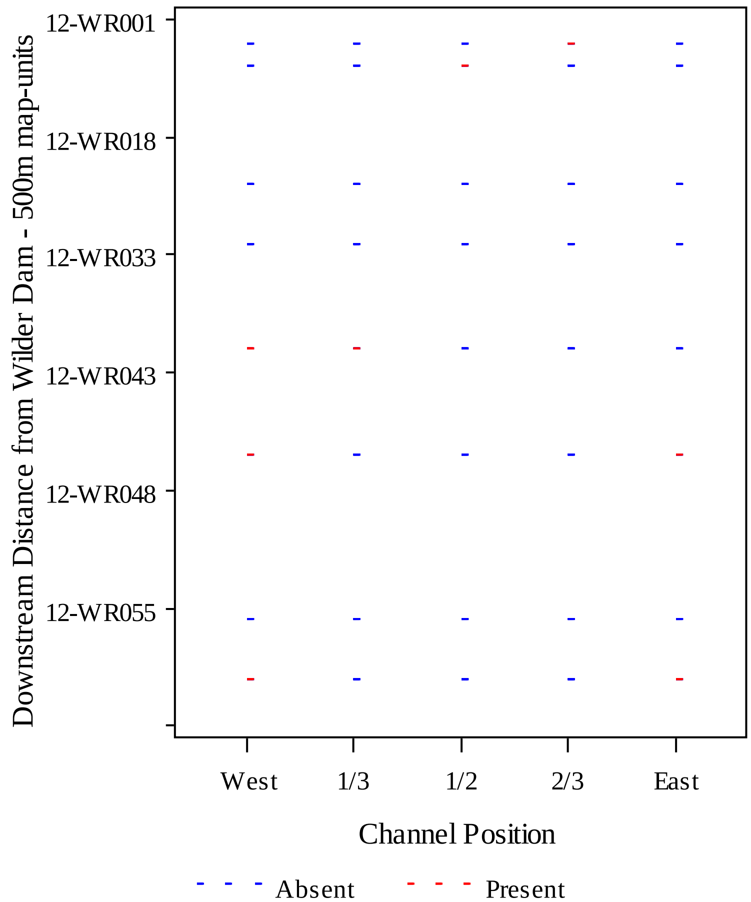


Figure 5.2-2. Sampled map-units where Tessellated Darters were observed within the Wilder riverine reach.

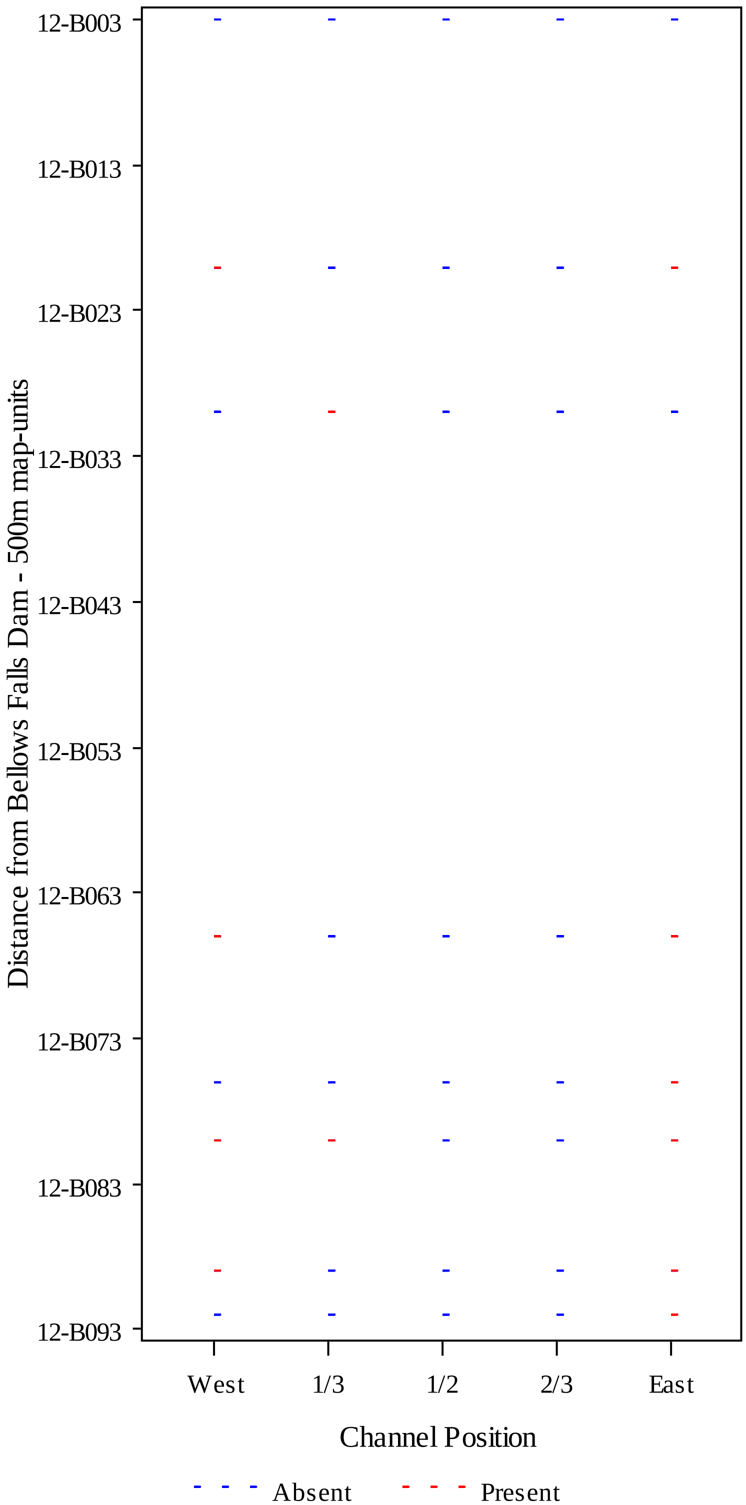


Figure 5.2-3. Sampled map-units where Tessellated Darters were observed within the Bellows Falls impoundment.

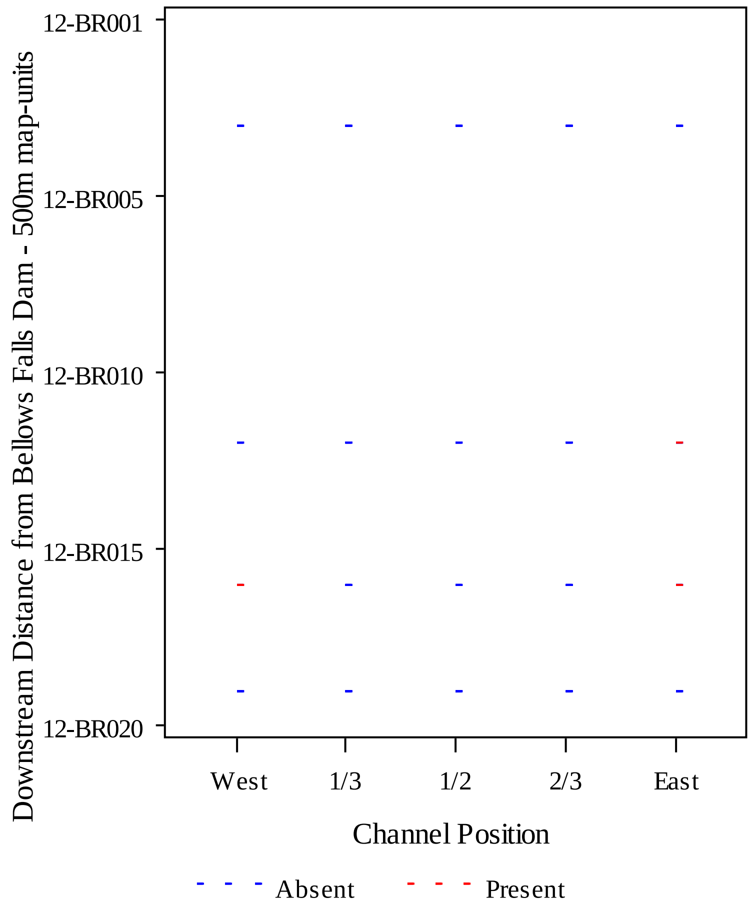


Figure 5.2-4. Sampled map-units where Tessellated Darters were observed within the Bellows Falls riverine reach.

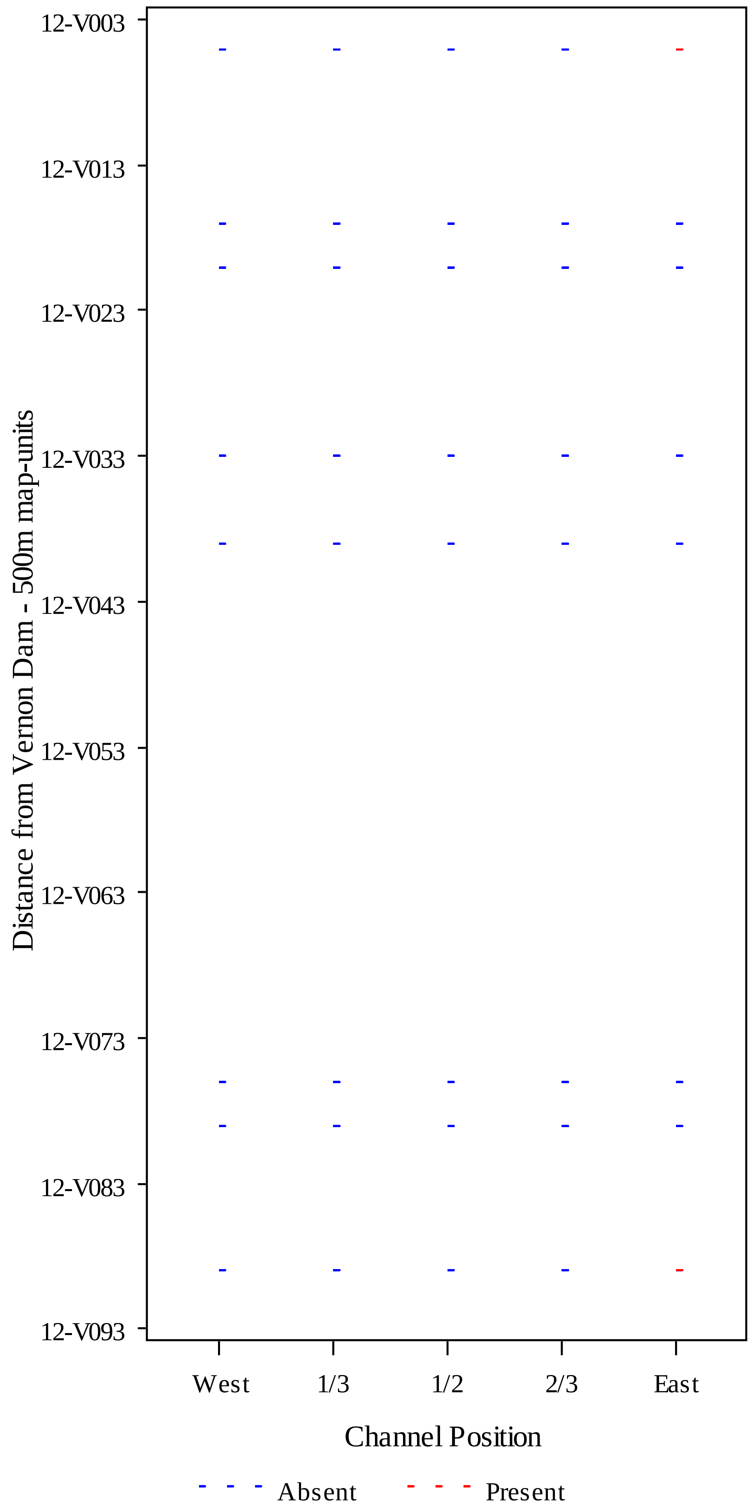


Figure 5.2-5. Sampled map-units where Tessellated Darters were observed within the Vernon impoundment.

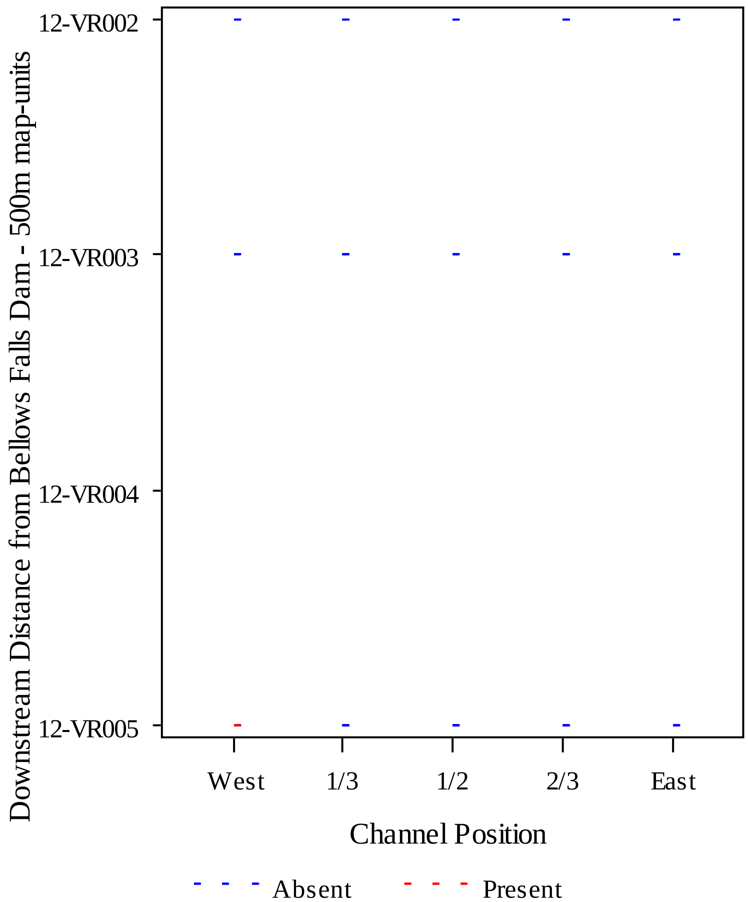


Figure 5.2-6. Sampled map-units where Tessellated Darters were observed within the Vernon riverine reach.

5.3 Habitat Parameters

A number of physical habitat variables were recorded at each of the 3-m radius count circles surveyed. These variables included water depth (ft), mean column velocity (ft/s), substrate composition, availability of submerged aquatic vegetation, and availability of woody debris.

Water Depth

Average sampling depth across river reaches ranged from 3.4 to 14.6 ft (Table 5.3-1). Mean sampling water depths for each of the six river reaches were compared using an ANOVA. Comparisons were conducted using the general linear model (GLM) procedure within SAS (Version 9.3). A significant difference among the mean sampling depth values for the six riverine reaches was detected (ANOVA, f = 35.73, p = <0.0001). The mean sampled depths were significantly deeper in Wilder and Vernon impoundments than other reaches. The mean sampling depths were significantly shallower in the Wilder and Bellows Falls riverine reaches than other reaches. No difference in mean sampling depth was detected between Bellows Falls impoundment and the Vernon riverine reach. However, those two reaches were significantly shallower than locations sampled in the Wilder and Vernon impoundments and significantly deeper than locations sampled in the Wilder and Bellows Falls riverine reaches.

Most Tessellated Darters were observed in water depths of less than eight feet (Figure 5.3-1). No individuals were observed in depths greater than 32 feet.

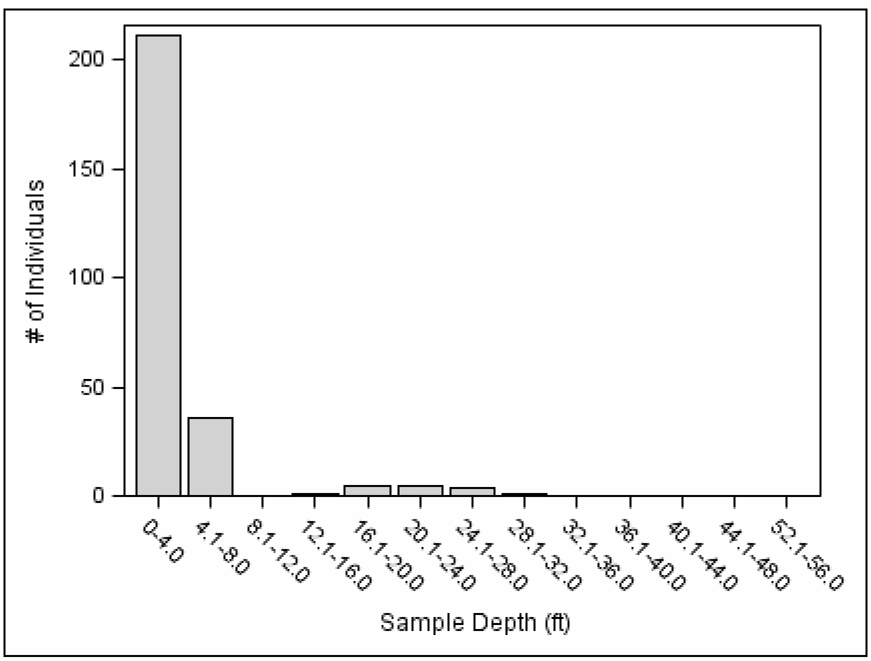


Figure 5.3-1. Number of observations of Tessellated Darters in various depth intervals between 0 and 60 feet, all river reaches combined.

Mean Column Velocity

Average mean water column velocities across river reaches ranged from 0.1 to 0.9 ft/s (Table 5.3-1). Average mean column water velocities for each of the six river reaches were compared using an ANOVA (SAS Version 9.3; GLM). A significant difference among the average mean column water velocities for the six riverine reaches was detected (ANOVA, f = 67.70, p = <0.0001). The average mean column water velocity was greatest in the Bellows Falls riverine reach, followed by the average mean column water velocity in the Wilder riverine reach. No significant difference in the average mean column water velocity for locations sampled within the Wilder, Bellows Falls, and Vernon impoundments was detected.

All Tessellated Darters were observed at 3-m radius count circles with a measured mean water column velocity of 0.6 ft/s or slower (Figure 5.3-2).

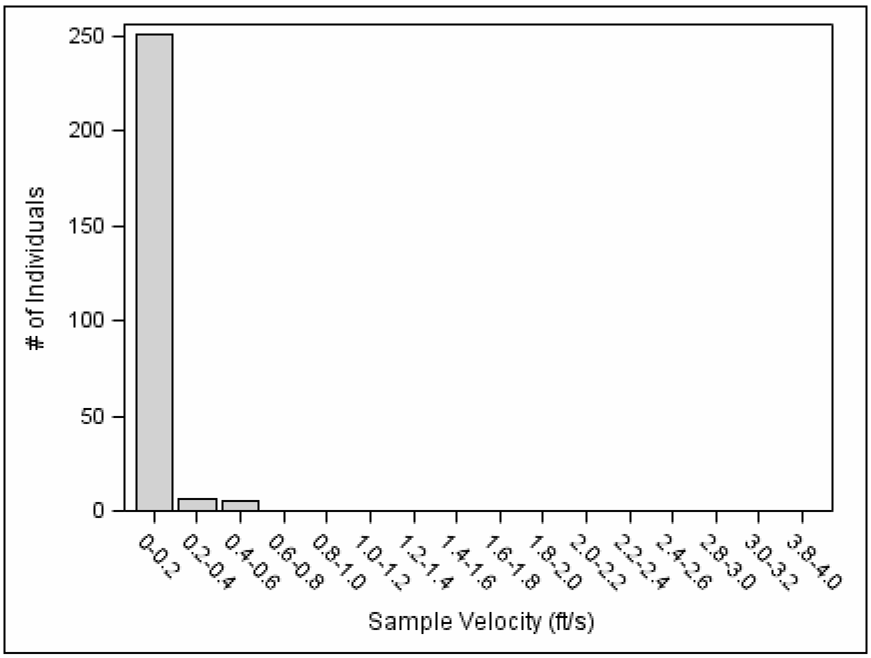


Figure 5.3-2. Number of observations of Tessellated Darters in various mean water column velocity intervals between 0.0 and 4.0 ft/s, all river reaches combined.

Substrate Composition

The proportion of substrate types within each 3-m radius count circle was recorded among five categories: organics (ORG), sand-silt-clay (SSC), cobble-gravel (CG), boulder-rip rap (BLD), and bedrock (BED). A dominant substrate was assigned to each count circle based on the observed proportions at that location. In a number of cases, available substrate within a particular count circle was estimated at equal proportions of sand-silt-clay and cobble-gravel. In those instances, a sixth substrate type was created and the dominant substrate was classified as a mix of the two (SSCCG). Of the total number of count circles, 57% (386 of the 675) were categorized as SSC, 33% (223 of the 675) were categorized as CG, 7% (47 of the 675) were categorized as SSCCG, 2% (11 of the 675) were categorized as BLD, 1% (6 of the 675) were categorized as BED, and <1% (2 of the 675) were categorized as ORG.

Figure 5.3-3 presents the number of observations by substrate type for all darters observed during Study 12. In an effort to evaluate substrate selection, the observed distribution for the count of individuals observed in each substrate type was compared to the distribution that would be expected if no selection preference was shown by an individual (i.e., the same proportions as were recorded for the distribution of count circles among the six substrate categories – 57% SSC, 33% CG, 7% SSCCG, 1% BED, 2% BLD, and <1% ORG). A significantly greater number of individuals were observed in count circles with sand-silt-clay (SSC) substrate than would be expected based on the proportion available ($\chi 2 = 127.3$; $p = <0.0001$). This finding agrees with what would be expected based on available life history and habitat preference information for the species (Scarola 1987; Langdon et al. 2006).

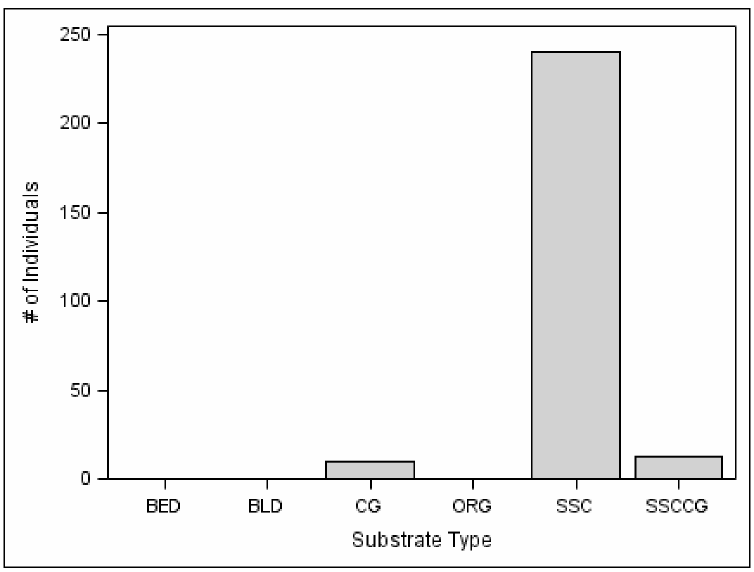


Figure 5.3-3. Number of observations of Tessellated Darters in various substrate types, all river reaches combined.

Substrate/habitat data collected from Study 10 (Normandeau, 2016) for Tessellated Darter differs from the overwhelming number of observations of darter in sand/silt/clay made in this study due to differences in study design, and sampling gear/technique used in the two studies. Table 5.3-1 summarizes the substrate/habitat types in which darter were found in Study 10, and illustrates that darter are found in a variety of substrates/habitats within the study area. Appendix G includes maps that illustrate substrate/habitat where darter were found in both studies.

Table 5.3-1. Substrate/habitat types were Tessellated Darter were collected in Study 10, 2015.

Study 10 Sampling Season	Substrate/Habitat Type[a]									
	SSC		CG		BLD		TRB		BW	
	N	%	N	%	N	%	N	%	N	%
Spring	133	8.1	136	9.2	43	8.5	34	10.9	0	0
Summer	83	5.3	143	12	115	15.1	60	24.3	0	0
Fall	108	7.3	148	12.3	45	7.1	43	8.4	0	0
TOTAL	**324**	**29.7%**	**427**	**39.1%**	**203**	**18.6%**	**137**	**12.6%**	**0**	**0.0%**

a. SSC=sand-silt-clay; CG=cobble-gravel; BLD=boulder; TRB=tributary; BW=backwater

Submerged Aquatic Vegetation

The percentage of each 3-m radius count circle covered with submerged aquatic vegetation (SAV) was recorded. Count circles were categorized as 0-25%, 26-50%, 51-75% and 76-100% coverage. Of the total number of count circles, 85% (579 of the 675) were categorized as having 0-25% SAV coverage, 7% (44 of the 675) had 26-50% SAV coverage, 3% (19 of the 675) had 51-75% SAV coverage, and 5% (33 of the 675) had 76-100% SAV coverage.

Figure 5.3-4 presents the number of observations by percent coverage of SAV for all darters observed. In an effort to evaluate selection of areas with SAV coverage, the observed distribution for the count of individuals observed in each SAV classification was compared to the distribution that would be expected if no selection preference was shown by an individual (i.e., the same proportions as were recorded for the distribution of count circles among the four categories – 86% in the 0-25% category, 7% in the 26-50% category, 3% in the 51-76% category, and 5% in the 76-100% category). A significantly greater number of individuals were observed in count circles with a percent coverage of SAV between 26-50% than would be expected based on the proportion available ($\chi 2$ = 1033.4; p = <0.0001).

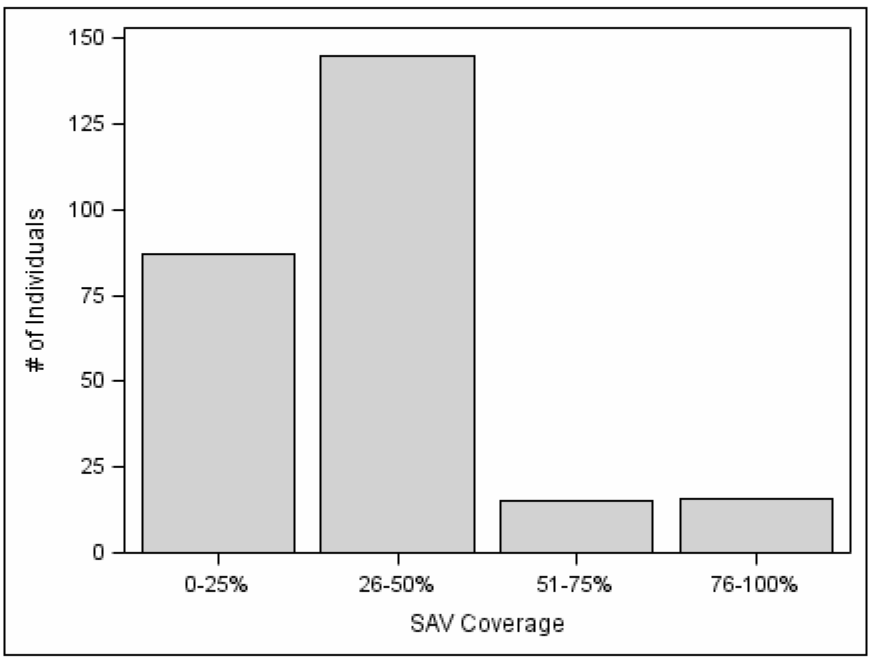


Figure 5.3-4. Number of observations of Tessellated Darters in count circles among percent coverage classifications for submerged aquatic vegetation, all river reaches combined.

Woody Debris

The percentage of each 3-m radius count circle covered with woody debris was recorded. The majority of count circles (98%; 660 of the 675) had 25% or less coverage by wood debris and the majority of Tessellated Darters were recorded from those locations (Figure 5.3-5).

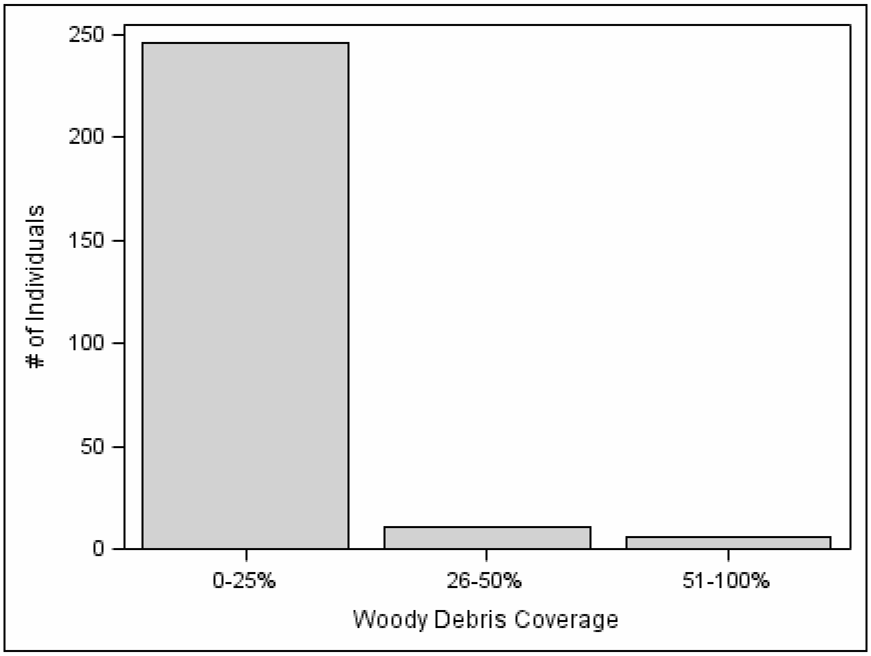


Figure 5.3-5. Number of observations of Tessellated Darters in count circles among percent coverage classifications for wood debris, all river reaches combined.

5.4 Water Quality

Water quality parameters were collected at each study site and included temperature (°C), pH (standard units, su), conductivity (µS/cm), turbidity (NTU), DO (mg/l), and DO saturation (%). All measurements were taken with handheld field meters and data represent instantaneous readings. The study included collection and reporting of limited grab samples of water quality data from a single visit to each of the study sites. As a result, the data should not be used to characterize general site conditions or trends. Study 6 - Water Quality Monitoring Study (Louis Berger Group and Normandeau, 2016) data provides the best data on overall water quality within the project-affected area. In addition, due to meter problems encountered while in the field on one day (September 24, 2015), there is no water quality data for some study sites.

Both New Hampshire and Vermont have numeric water quality standards for pH and DO, but only narrative criteria for the other parameters measured. Results of water quality sampling are summarized below and detailed in Appendix B (filed separately in Excel format).

Temperature across all locations ranged from 18.8–25.8°C, typical of temperatures expected during the September 2015 study season and consistent with temperature data from other studies. PH ranged from 6.7 to 9.7 su with all but two readings within both New Hampshire and Vermont water quality standards. At Site 12-BR019 pH was 8.2 at only one of 15 count circles (within Vermont but not New Hampshire standards) while all other readings at the site were within both state standards. Conductivity measurements ranged from 109 to 881 µS/cm, with all but four measurements less than 200 µS/cm. Conductivity at Site 12-V-076 was measured to be 881 µS/cm in one count circle; it was the only outlying value but the cause for the high value is unknown. All fourteen other readings at that site ranged from 144-146 µS/cm. Turbidity measurements ranged from 0 to 8.2 NTU across all study sites, indicating good water clarity at the study sites (e.g., all measurements less than 10 NTU). Dissolved oxygen measurements ranged from 4.8 to 11.6 mg/l and were within New Hampshire and Vermont Class B water quality standards with two exceptions (Sites 12-WR-004 and 12-WR009) which each had some but not all count circle DO readings less than both states' instantaneous standard and less than the Vermont standard of 70% DO saturation for cold water habitat. New Hampshire's 75% DO saturation standard is a daily average numerical standard, while the data collected in this study was instantaneous, so the New Hampshire DO % saturation standard is not applicable for this study.

5.5 Freshwater Mussel Distribution

Visual surveys also assessed the presence of freshwater mussel species at each of the 3-m count circles within the study area. Four and possibly five species were detected (Table 5.5-1) and included Eastern Elliptio (*Elliptio complanata*), Eastern Lampmussel (*Lampsilis radiate*), Triangle Floater (*Alasmidonta undulata*), and Alewife Floater (*Anodonta Implicata*) some of which were possibly Eastern Floater (*Pyganodon cataracta*). Alewife and Eastern floaters are difficult to distinguish without sacrificing the individual and Alewife Floater are more common within the study area (Biodrawversity and LBG, 2012; 2014).

Similar to previously reported results from freshwater mussel surveys within the three project areas (Biodrawversity and LBG, 2012), Eastern Elliptio and Eastern Lampmussel were found at survey sites in all six river reaches. Alewife and/or Eastern Floaters were detected in a limited number of count circles in the Vernon impoundment and the Bellows Falls and Vernon riverine reaches. The presence of these species within these three riverine reaches was previously reported by Biodraversity and LBG in their 2011 and 2013 surveys (Biodrawversity and LBG, 2012; 2014). Two individual Triangle Floaters were observed during this study, one in the Bellows Falls riverine reach and the other in the Vernon riverine reach. Biodrawversity and LBG (2012) reported Triangle Floaters to be present within each of the three impoundments and two of the three riverine reaches (not the Vernon riverine reach). The presence/absence for each freshwater mussel species for each count circle is provided in Appendix C (filed separately in Excel format).

Table 5.5-1. Freshwater mussel species presence within 3-m radius count circle areas surveyed, September 2015.

Description	Number of Count Circles	Percentage of Count Circles with Mussels Present			
		ElCo	LaRa	AnIm and/or PyCa	AlUn
Wilder Impoundment	210	49.5%	21.4%	0.0%	0.0%
Wilder Riverine	120	19.2%	9.2%	0.0%	0.0%
Bellows Falls Impoundment	120	69.2%	50.8%	0.0%	0.0%
Bellows Falls Riverine	60	61.7%	50.0%	5.0%	1.7%
Vernon Impoundment	120	85.0%	34.2%	9.2%	0.0%
Vernon Riverine	45	95.6%	8.9%	2.2%	2.2%
Total	**675**	58.1%	28.4%	2.2%	0.3%
Number of Individuals Counted		**392**	**192**	**15**	**2**

Species Abbreviations:
ElCo = *Elliptio complanata* (Eastern Elliptio)
LaRa = *Lampsilis radiata* (Eastern Lampmussel)
AnIm = Anodonta Implicata (Alewife Floater)
PyCa = *Pyganodon cataracta* (Eastern Floater)
AlUn = *Alasmidonta undulata* (triangle Floater)

Locations where Tessellated Darters were found during this study and Study 10 during 2015 were compared to data collected on Dwarf Wedgemussels observed in 2011 (Biodrawversity and LBG, 2012), in 2013 as part of Phase 1 of Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Survey (Biodrawversity and LBG, 2014), and in 2014 as part of Phase 2 of Study 24 (Biodrawversity and LBG, 2015). In general, Tessellated Darters were distributed within the mussel survey reaches and were found nearby or in the general vicinity (within 1 to 2 miles up or downstream) of most locations were Dwarf Wedgemussels were found. Darters were present near some mussel survey sites where no Dwarf Wedgemussels were found (e.g., near Sumner Falls which was surveyed in 2014). Locational data for Dwarf Wedgemussel is considered privileged data; therefore, detailed information comparing darter and mussel locations is not included in this non-privileged report but will be available within the Study 24 report.

5.6 Project Operations

The temporal distribution of sampling events relative to project operations (i.e., total discharge) is presented in Figures 5.6-1 through 5.6-3 for Wilder, Bellows Falls and Vernon. Surveys were conducted during periods of non-spill to ensure optimal viewing conditions.

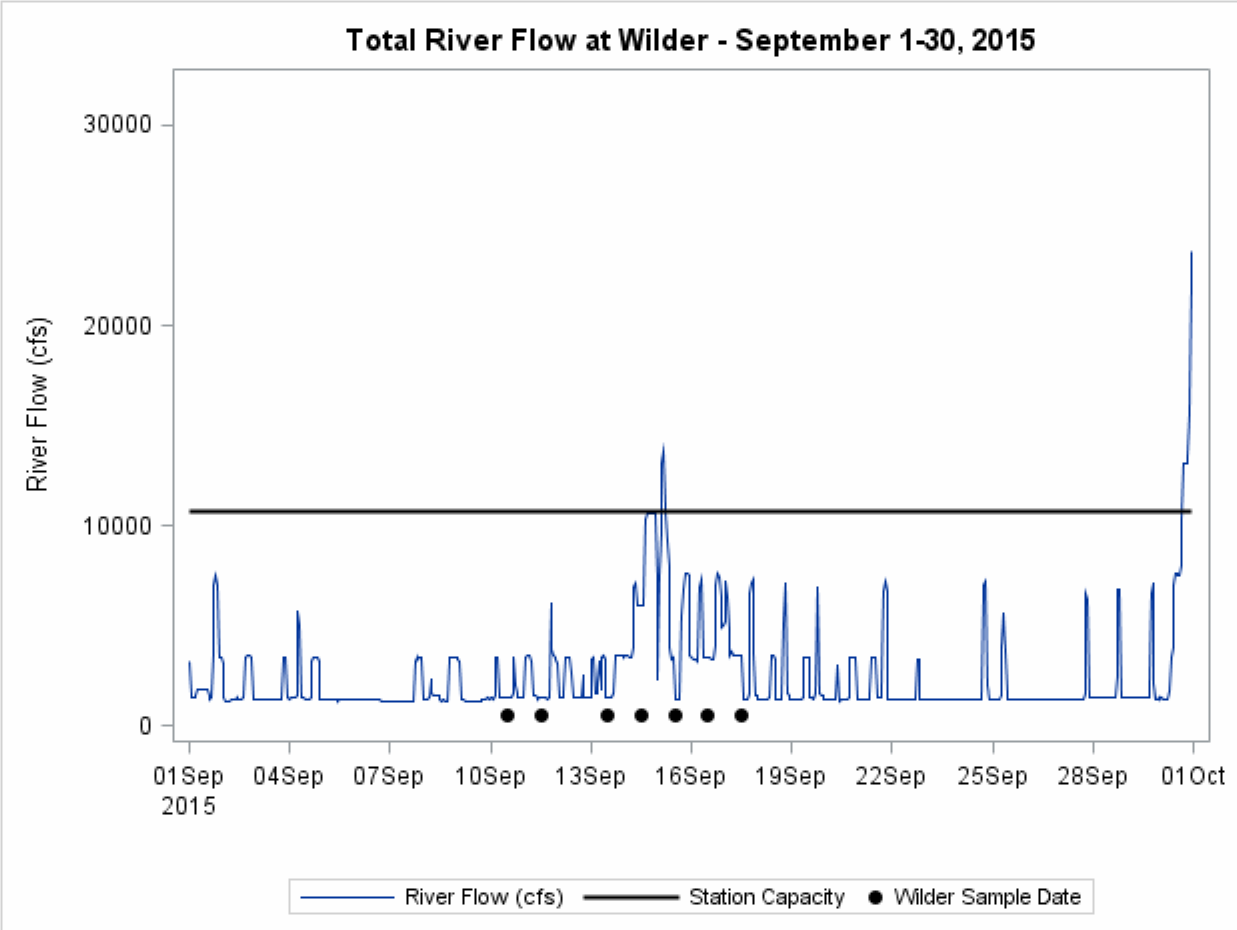


Figure 5.6-1. Total river flow at Wilder dam during surveys in September 2015.

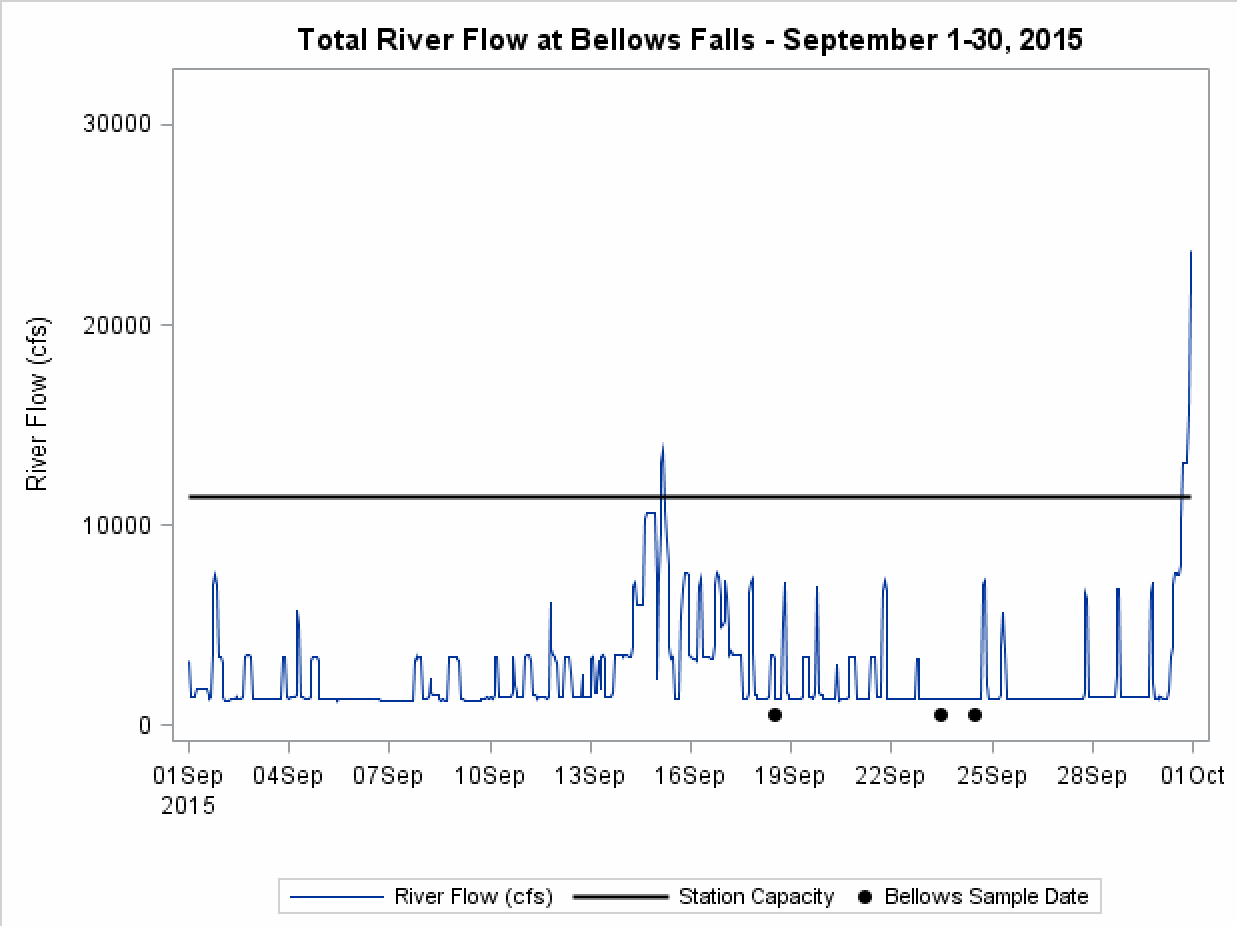


Figure 5.6-2. Total river flow at the Bellows Falls project during surveys in September 2015.

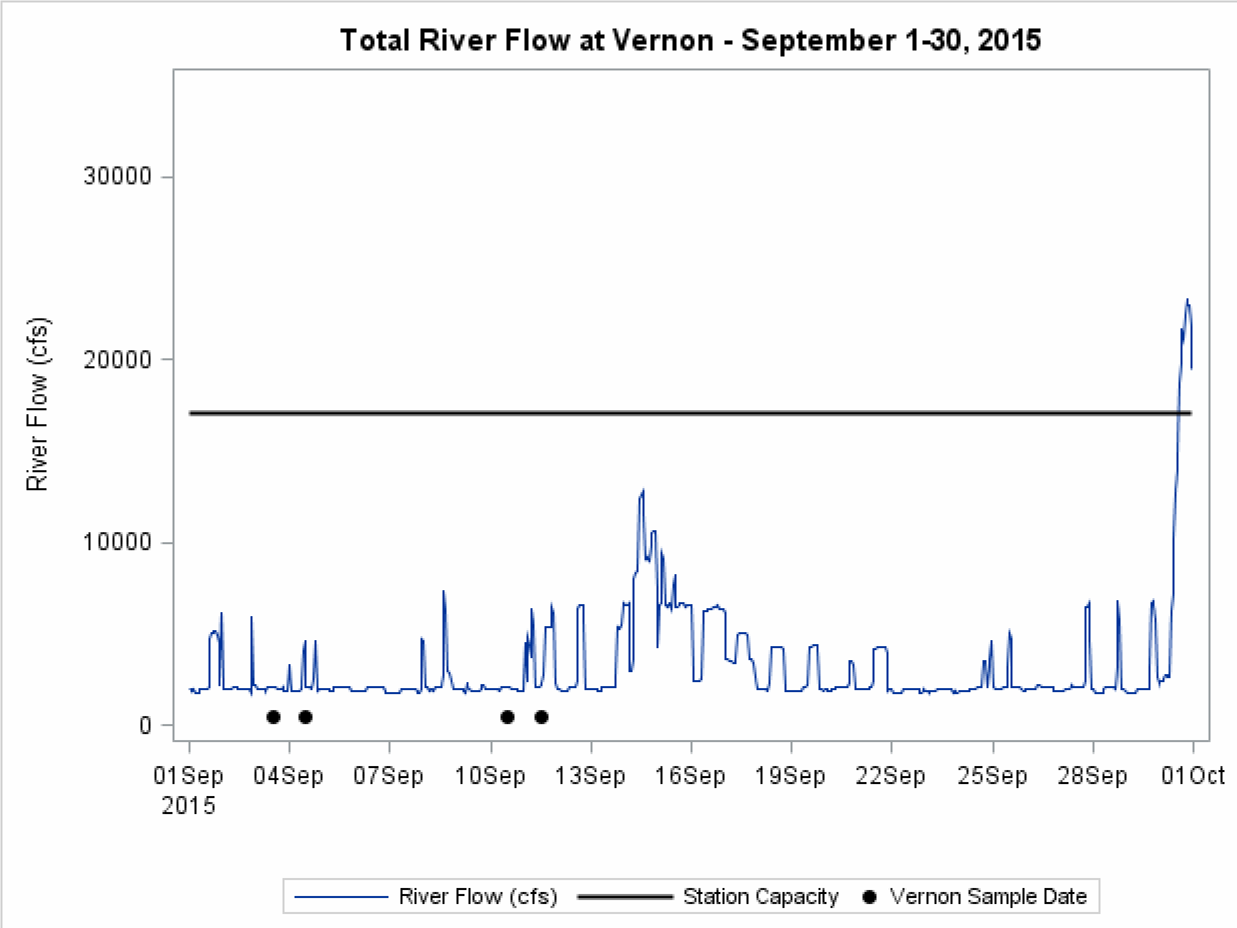


Figure 5.6-3. Total river flow at Vernon dam during surveys in September 2015.

6.0 STUDY CONCLUSIONS

The specific objective for this study specified in the RSP was to characterize the distribution and relative abundance of Tessellated Darters within the project-affected areas. To accomplish this objective, a total of 675 visually surveyed, 3-m radius count circles were randomly placed in a manner proportional to available substrate types throughout the Wilder impoundment and riverine reach, Bellows Falls impoundment and riverine reach and Vernon impoundment and riverine reach. Sampling was conducted during September, 2015.

A total of 263 Tessellated Darters were observed during the surveys and the majority of individuals were observed within the Wilder impoundment. Total counts of darters decreased with location further downstream within the study area. Observations of Tessellated Darters occurred most frequently in count circles located along the river bank with fewer individuals observed towards the center portion of the channel. As would be expected given the proportion of observations of darters in near-bank habitat, most individuals were observed in less than 8 feet of water. Water velocities measured at locations where darters were observed were always equal to or less than 0.6 ft/sec with the vast majority of observations occurring at water velocities equal to or less than 0.2 ft/sec. The majority of Tessellated Darters observed occurred over sand-silt-clay substrate. Observations of Tessellated Darters during this study are consistent with behaviors described in biological accounts of the species which indicate that outside of the breeding season, Tessellated Darter habitat includes sand and mud bottomed areas, slow runs, and backwaters of small to large rivers (Scarola 1987; Langdon et al. 2006).

In addition to Tessellated Darters observed as part of sampling conducted during this study, the species was also observed in the field catch associated with Study 10 - Fish Assemblage Study. A total of 1,091 individuals, representing 9.4% of the total catch, were collected during Study 10 (Table 6.0-1). The majority of Tessellated Darters recorded during Study 10 were captured during either boat or portable electrofish sampling (1,087 of the 1,091 individuals) with the remaining four individuals collected during beach seine sampling. Tessellated Darters were among the five most frequently captured fish species in the Wilder impoundment, Wilder riverine reach, Bellows Falls riverine reach, and the Vernon impoundment.

The mean CPUA value for Tessellated Darter was significantly greater in the Wilder impoundment than in the Wilder riverine, Bellows Falls riverine, Vernon impoundment, and Vernon riverine reaches. The mean CPUA value in the Bellows Falls impoundment did not differ significantly from the other five reaches examined. Whereas the mean CPUA value (#/25 m^2) calculated for Tessellated Darters observed during this study were significantly greater in the Wilder impoundment than four of the five other river reaches, sampling associated with Study 10 indicated a somewhat different pattern. The mean CPUA value (#/100 m^2) of Tessellated Darters calculated in Study 10 was significantly greater in the Wilder riverine reach than in four of the other five reaches (Bellows Falls riverine reach was similar to Wilder riverine). The mean CPUA value for Tessellated Darters captured during Study 10 did not differ among the Wilder impoundment, Bellows Falls impoundment, Vernon impoundment or Vernon riverine reach.

When observations of Tessellated Darters from both Studies 10 and 12 are considered, the species appears to be distributed throughout the three project impoundments and downstream riverine reaches. Individuals were regularly observed in areas of appropriate habitat (shallow, relatively slow moving, sand-mud substrates) and were also distributed within reaches with populations of Dwarf Wedgemussel.

Table 6.0-1. Total catch and percentage of overall fish catch by river reach for Tessellated Darter captured during Study 10 – Fish Assemblage Study.

Description	Total Count of Darters in Study 10	% of Study 10 Total Catch
Wilder Impoundment	231	10.8
Wilder Riverine	397	16.7
Bellows Falls Impoundment	50	1.9
Bellows Falls Bypassed Reach	15	7.3
Bellows Falls Riverine	282	16.3
Vernon Impoundment	114	5.5
Vernon Riverine	2	0.6
Total	**1091**	**9.4**

7.0 LITERATURE CITED

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Scott, W.B., and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada, Bulletin 184. 966 pp.

Appendices A – E filed separately as Excel worksheets in a single workbook:

Appendix A - Darter Counts and CPUA Values
Appendix B - Water Quality Data
Appendix C - Freshwater Mussel Counts
Appendix D - Study 10 Darter Counts
Appendix E - Study 10 Darter CPUA

Appendix F filed separately in kmz (zipfile) and ARC shapefile (zipfile) format.

Appendix G follows herein

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APPENDIX G

Darter Locations and Substrate/Habitat Maps

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NORMANDEAU ASSOCIATES Environmental Consultants	1:18,000 Data Provided By: U.S. Imaging 0 500 1,000 2,000 Feet	**Darter Presence** Study 10 Study 12 **Habitat Type** Boulder Gravel, Cobble Ledge Rip Rap Sand, Silt, Clay Woody Debris	**TransCanada Hydro Northeast Inc.** **ILP Study 10 and12** **Darter Presence** *Wilder Impoundment*

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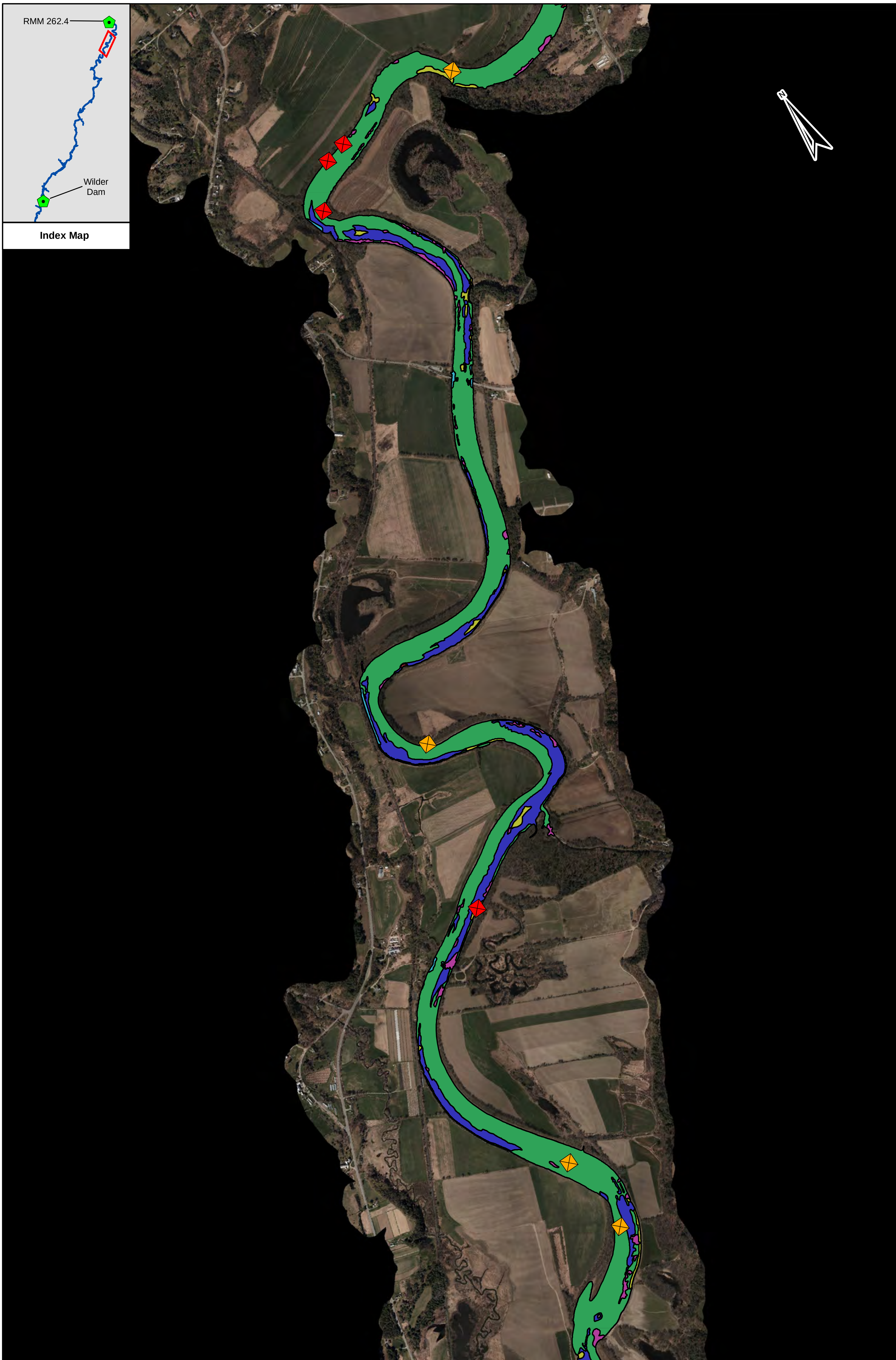

NORMANDEAU ASSOCIATES
Environmental Consultants

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U.S. Imaging

0 500 1,000 2,000
Feet

Darter Presence
- Study 10
- Study 12

Habitat Type
- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Wilder Impoundment

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U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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Darter Presence
Wilder Impoundment

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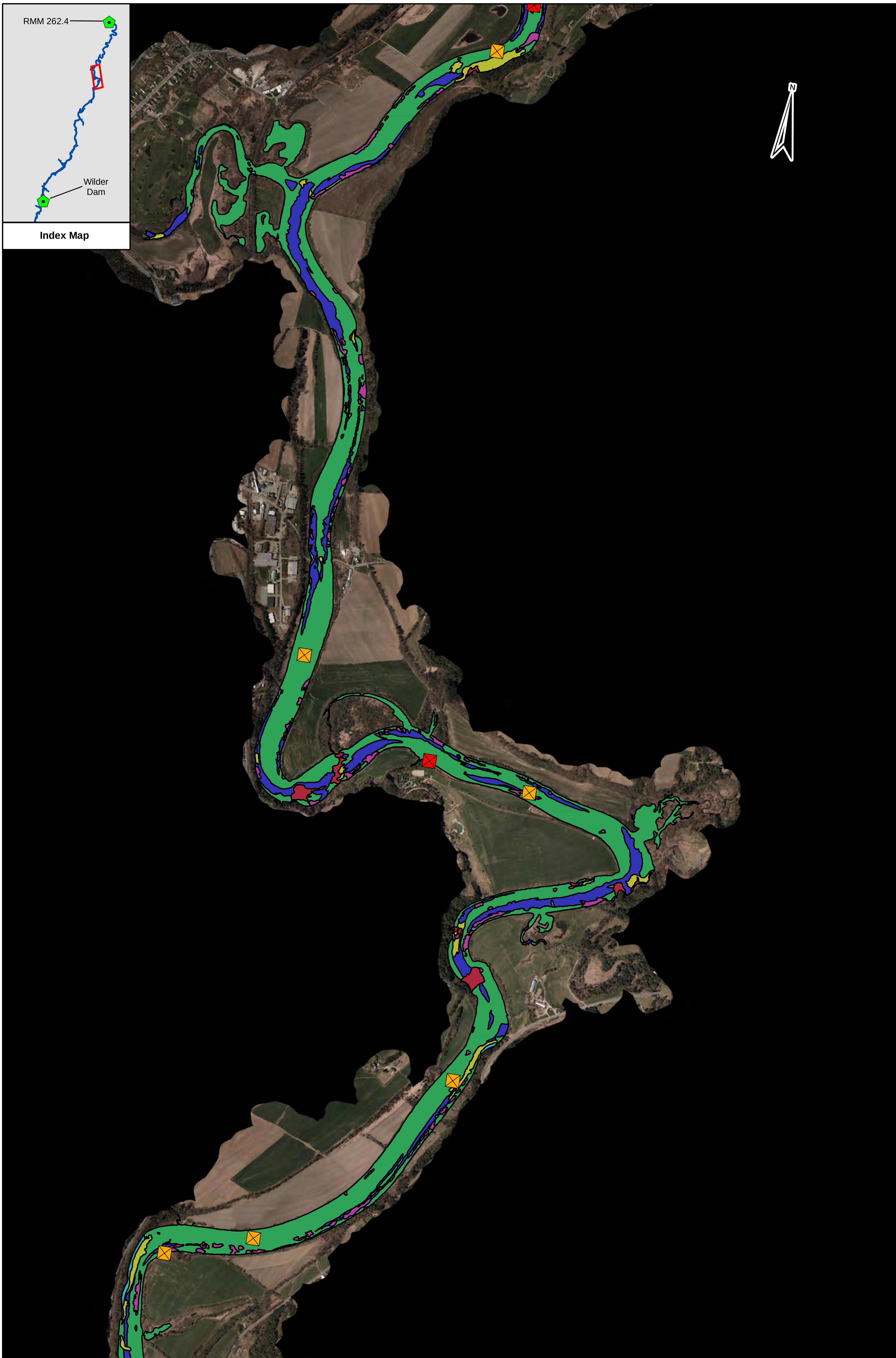

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Environmental Consultants

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Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Wilder Impoundment

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Environmental Consultants

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U.S. Imaging

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Darter Presence
- Study 10
- Study 12

Habitat Type
- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Wilder Impoundment

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Environmental Consultants

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Data Provided By:
U.S. Imaging

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Wilder Impoundment

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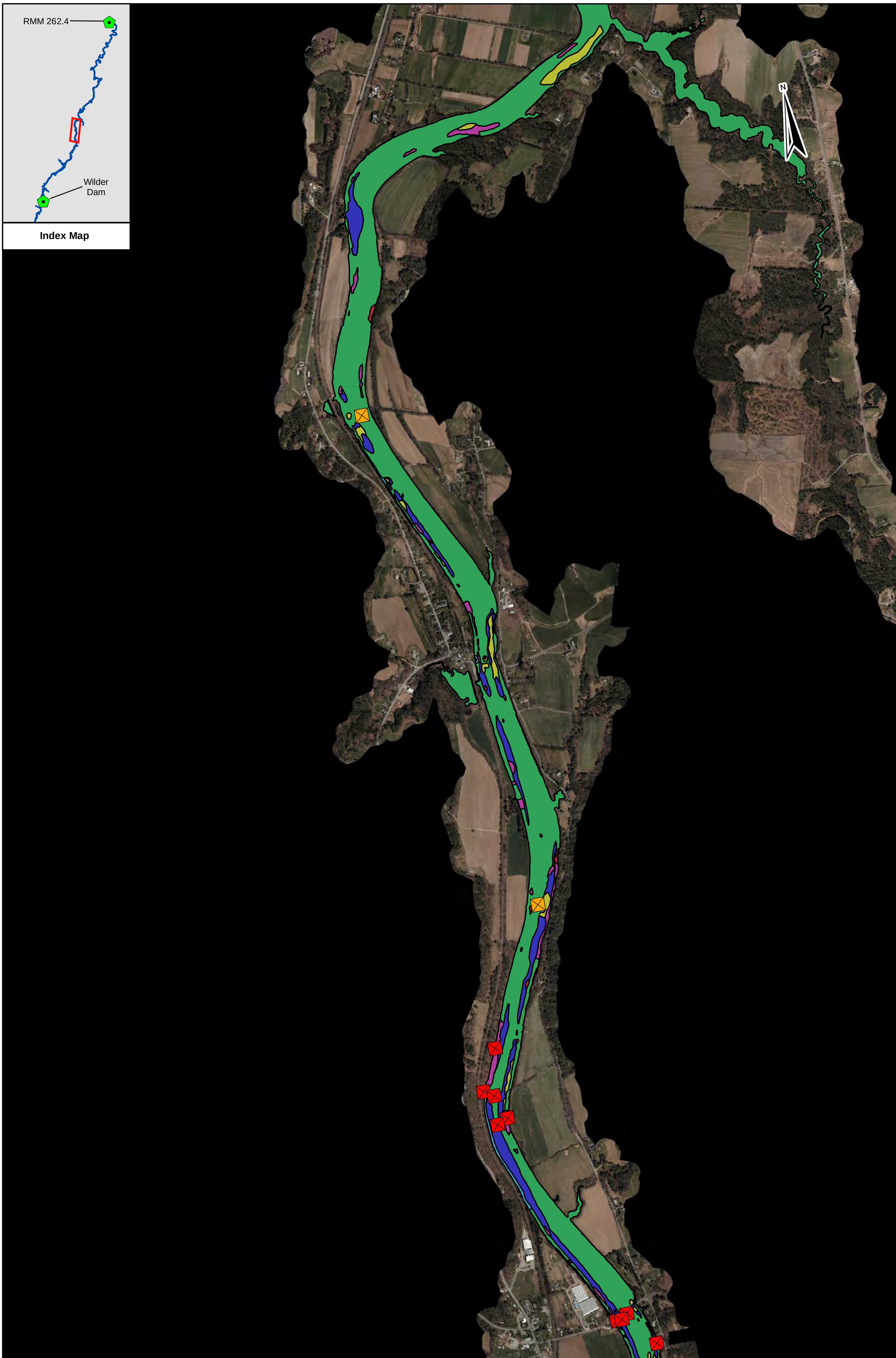

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Environmental Consultants

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U.S. Imaging

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Feet

Darter Presence
- Study 10
- Study 12

Habitat Type
- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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ILP Study 10 and12
Darter Presence
Wilder Impoundment

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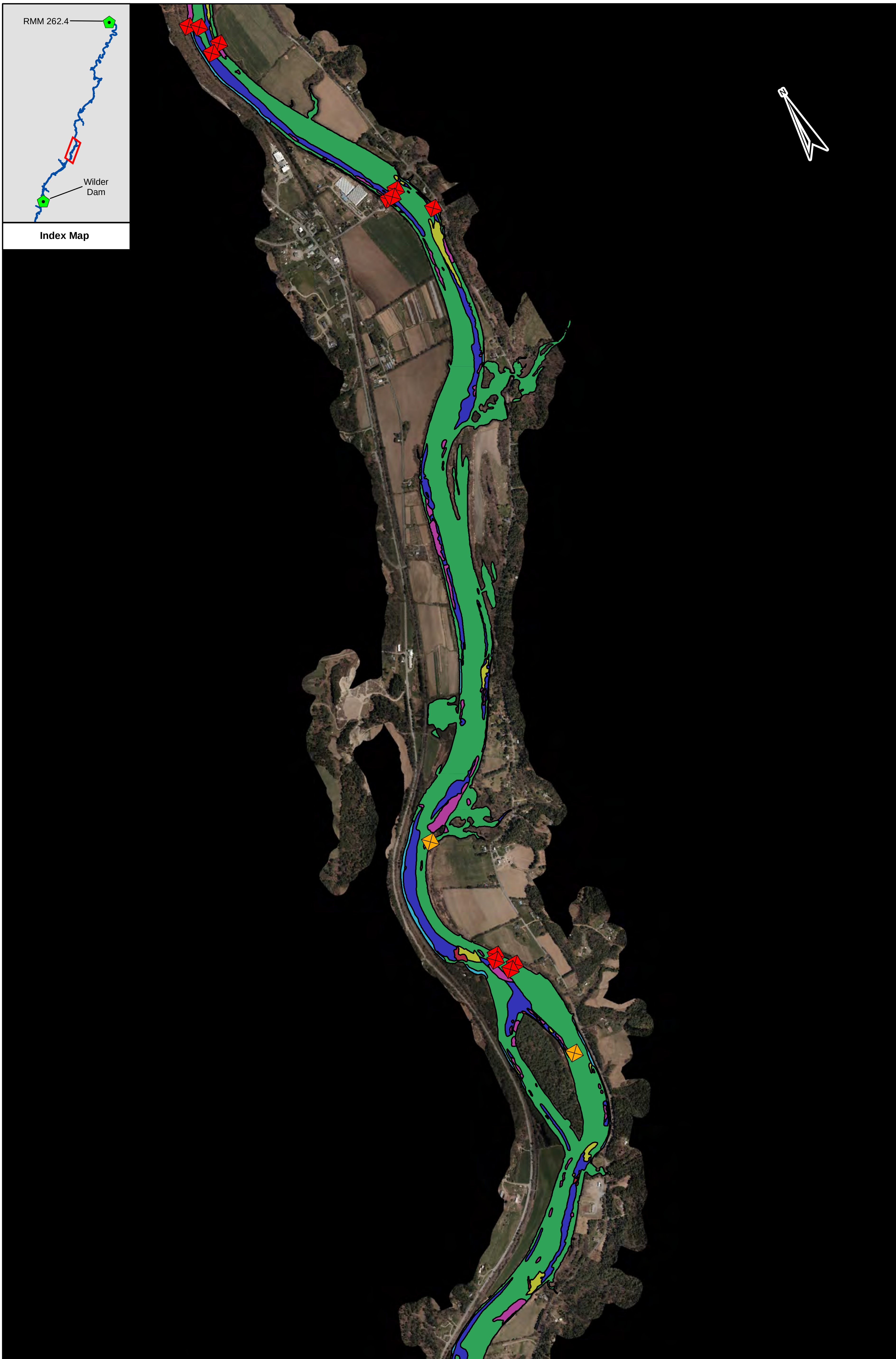

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Environmental Consultants

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U.S. Imaging

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Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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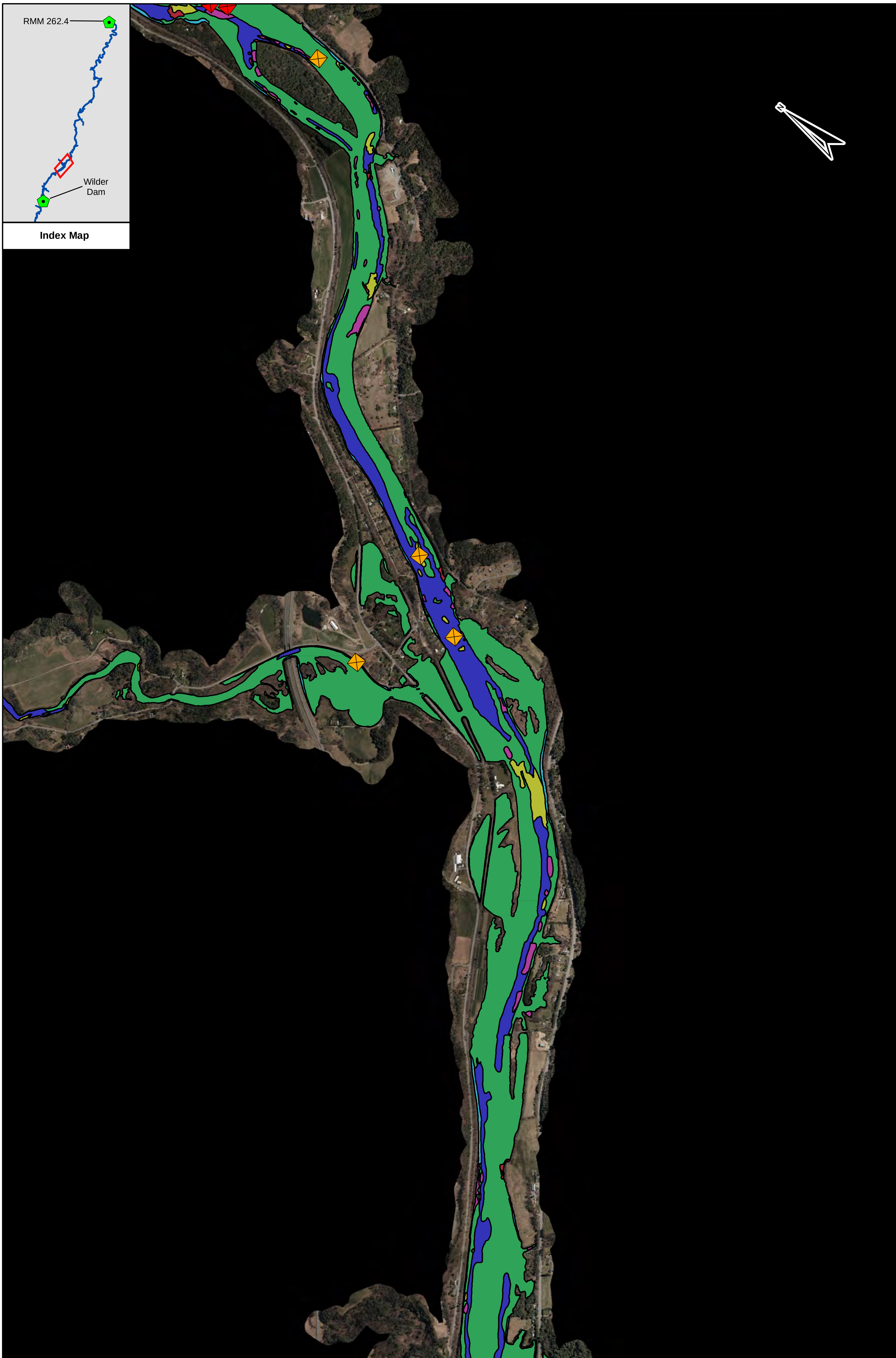
ILP Study 10 and12
Darter Presence
Wilder Impoundment



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Environmental Consultants

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U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
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Darter Presence
Wilder Impoundment

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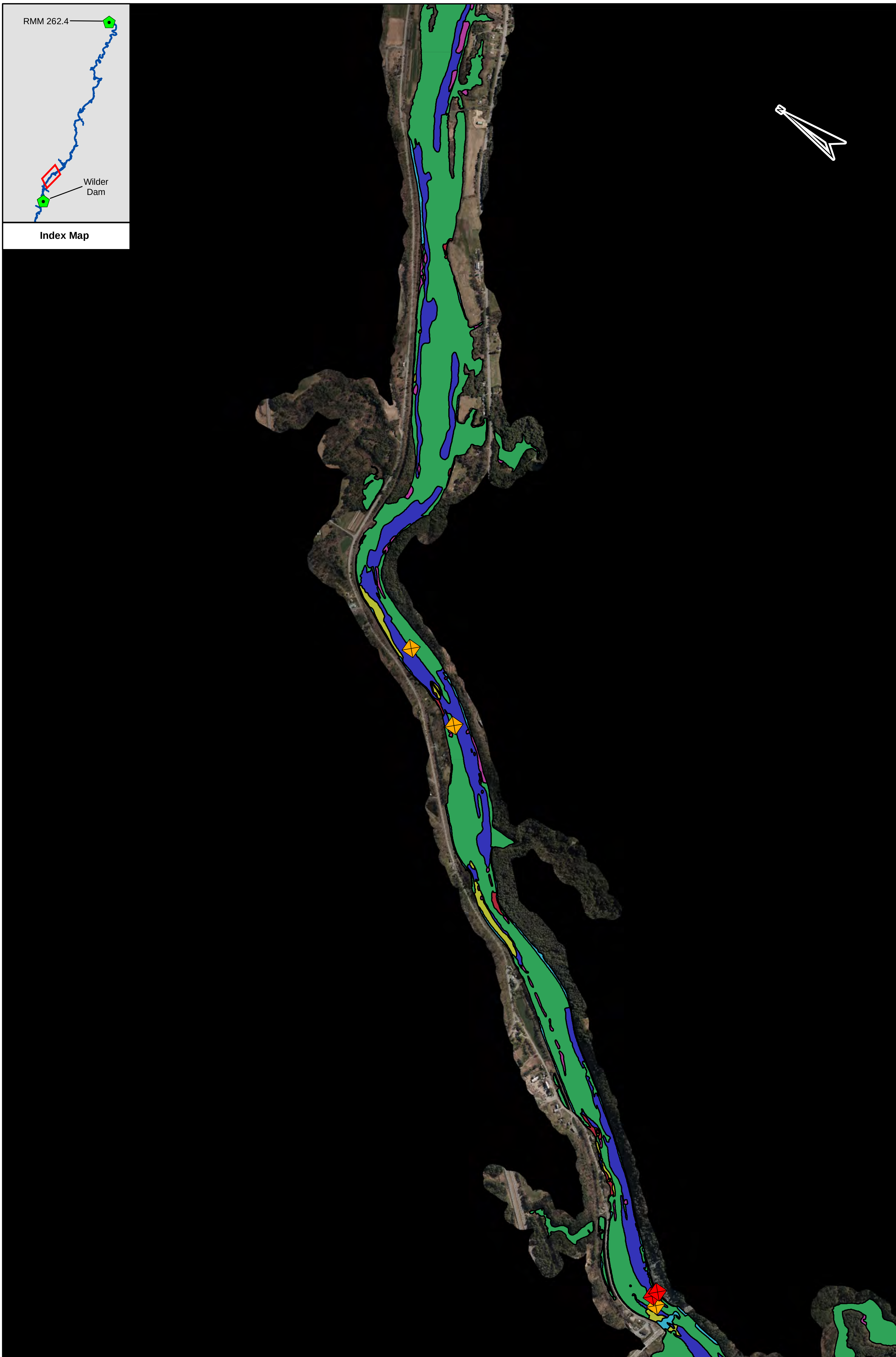

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0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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Darter Presence
Wilder Impoundment

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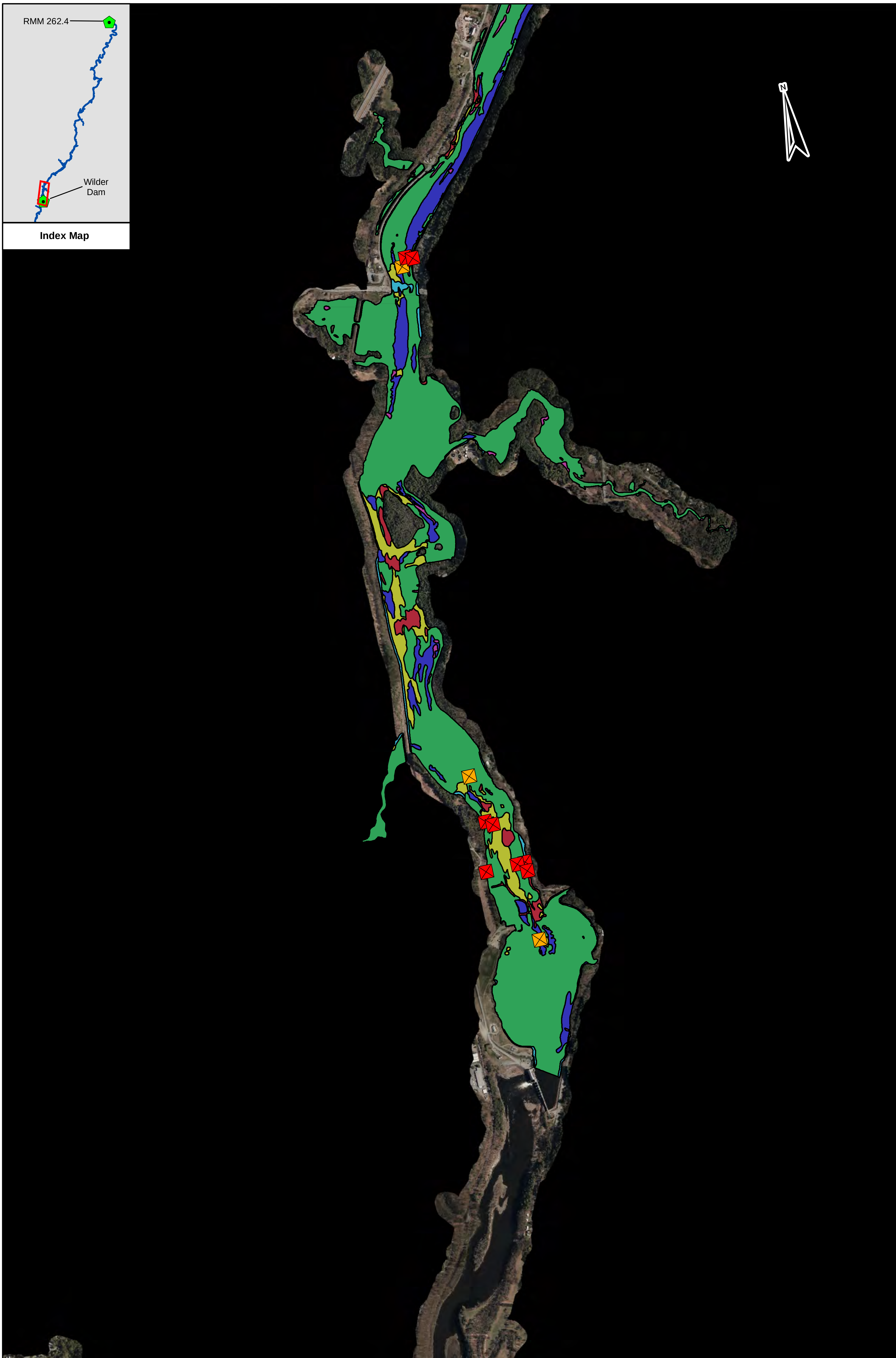

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0 500 1,000 2,000 Feet

Darter Presence
- Study 10
- Study 12

Habitat Type
- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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Darter Presence
Wilder Impoundment

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U.S. Imaging

0 600 1,200 2,400 Feet

Darter Presence
- Study 10
- Study 12

Meso-Habitat
- Glide
- Pool
- Rapid
- Riffle
- Run

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ILP Study 10 and12
Darter Presence
Wilder Riverine

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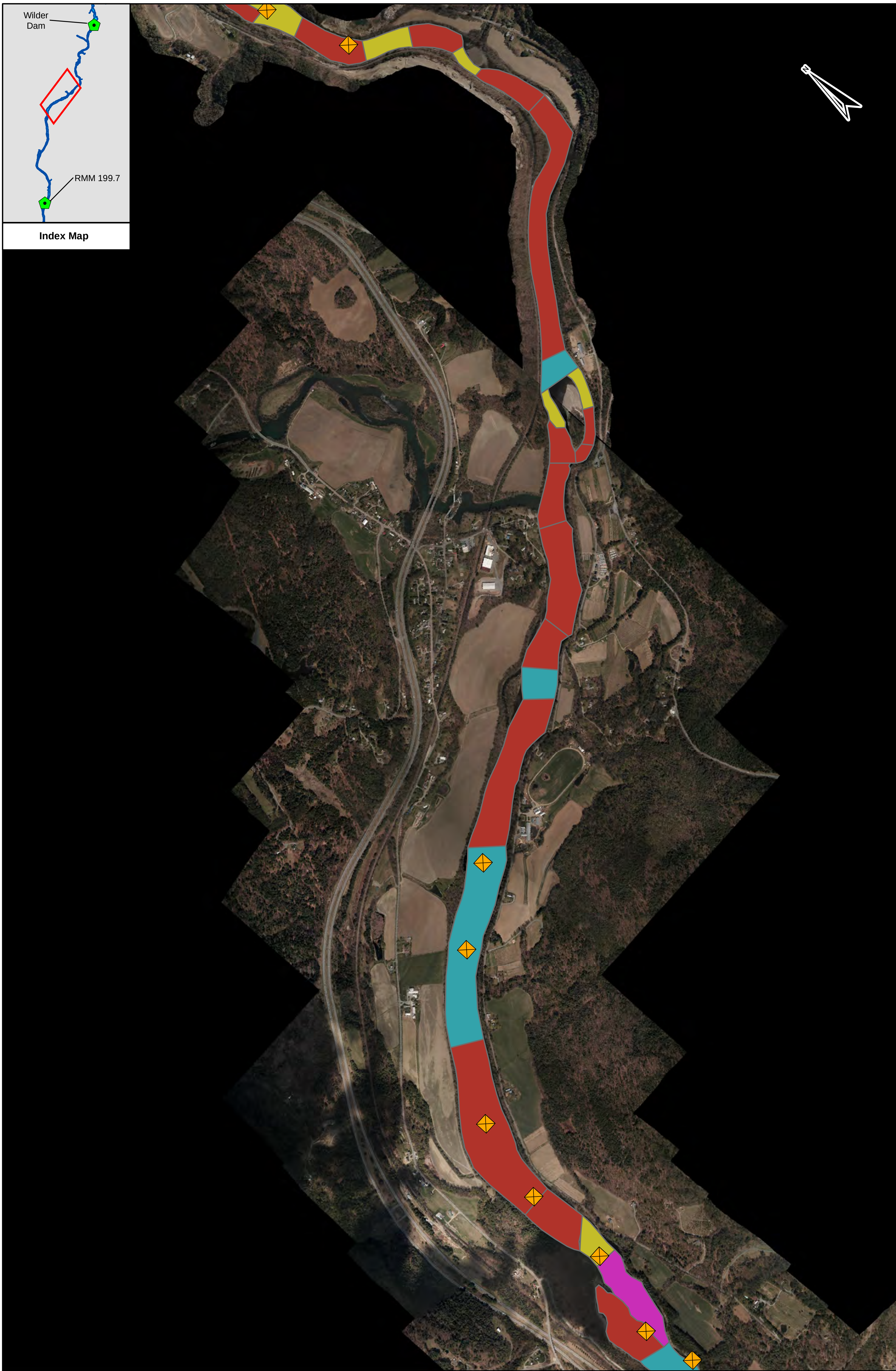

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ILP Study 10 and12
Darter Presence
Wilder Riverine

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Data Provided By:
U.S. Imaging

0 600 1,200 2,400 Feet

Darter Presence

Study 10

Study 12

Meso-Habitat

Glide

Pool

Rapid

Riffle

Run

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Wilder Riverine

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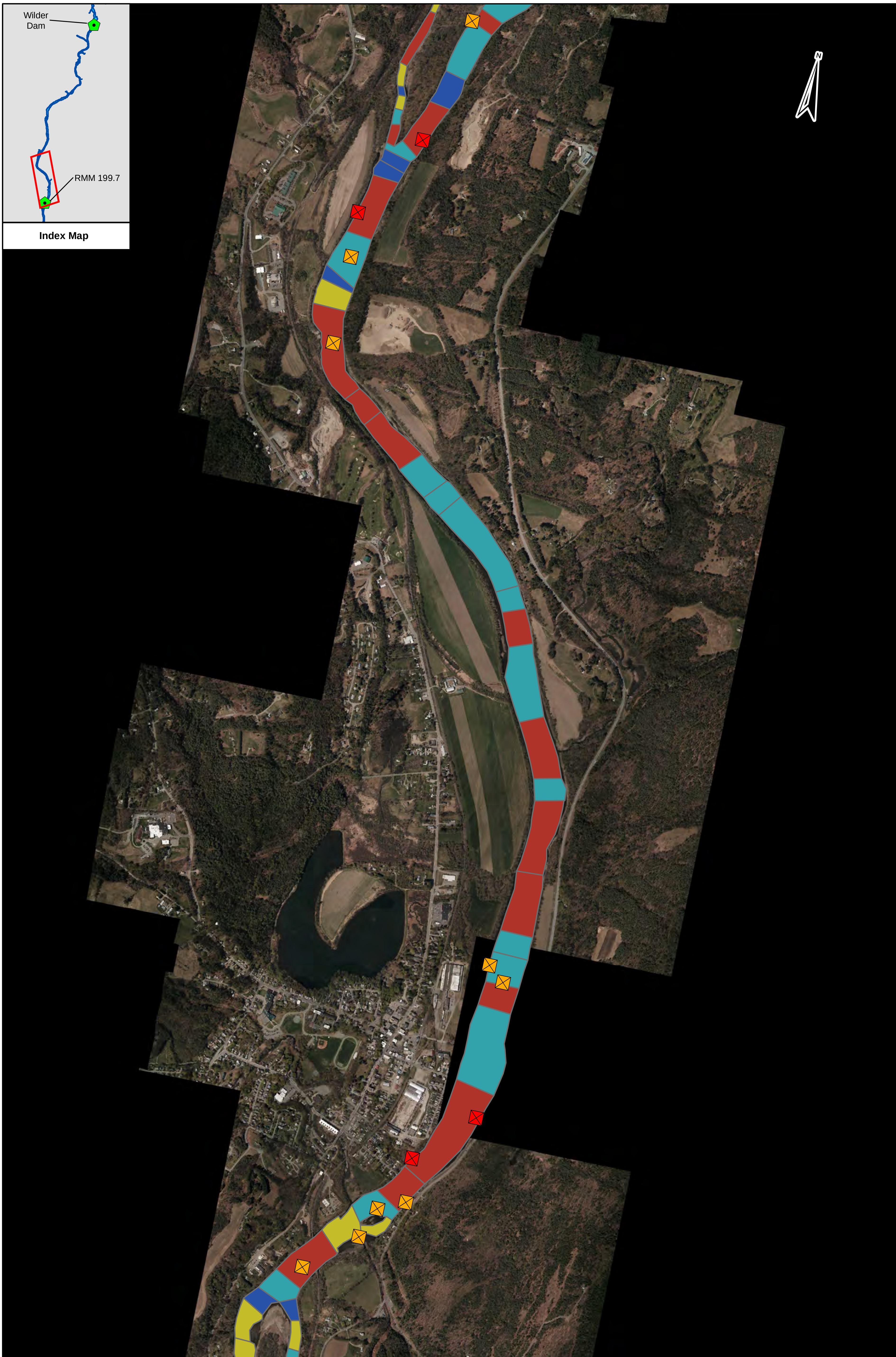

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0 600 1,200 2,400 Feet

Darter Presence

- Study 10
- Study 12

Meso-Habitat

- Glide
- Pool
- Rapid
- Riffle
- Run

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Darter Presence
Wilder Riverine

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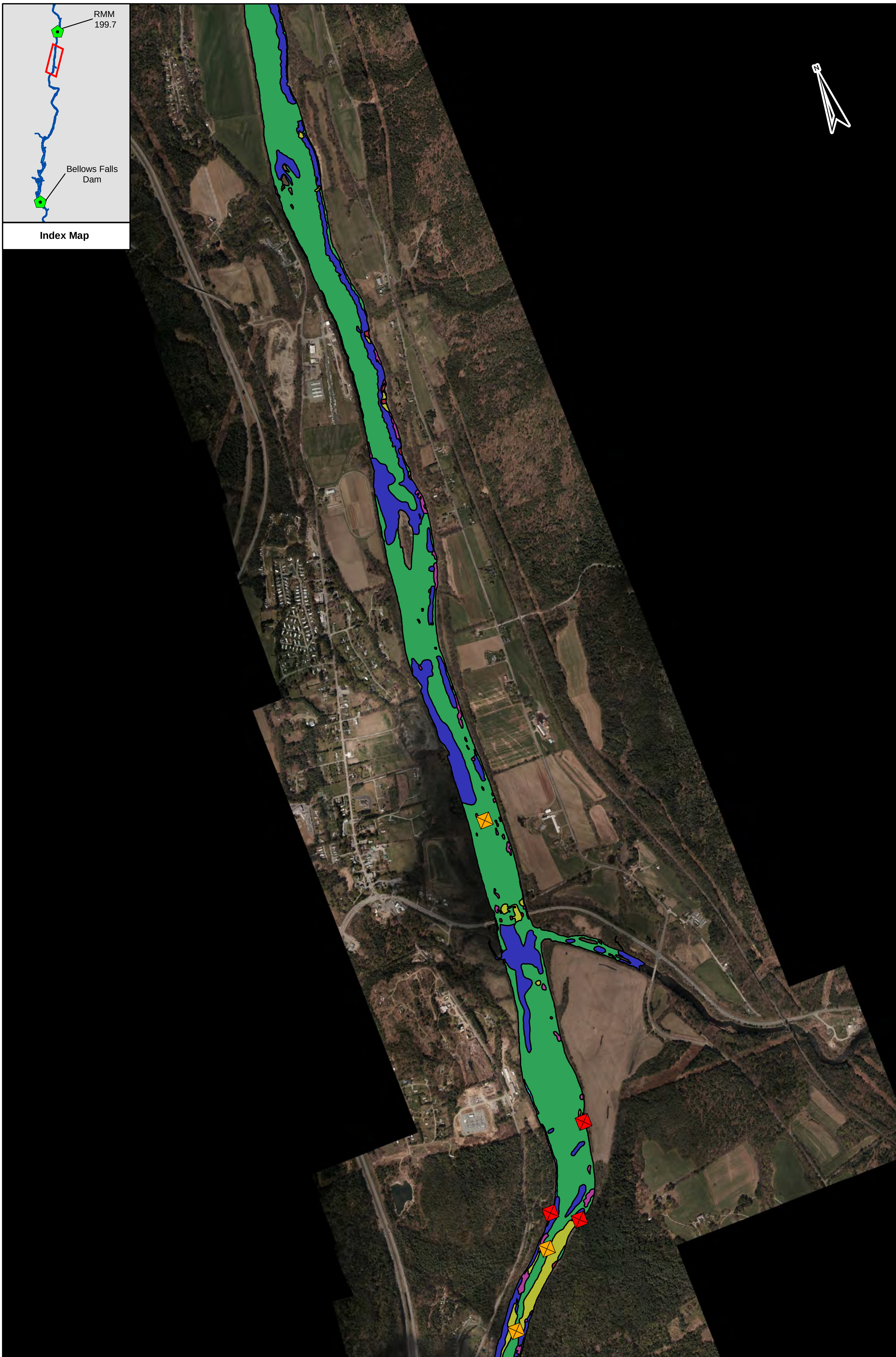

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Environmental Consultants

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0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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ILP Study 10 and12
Darter Presence
Bellows Impoundment

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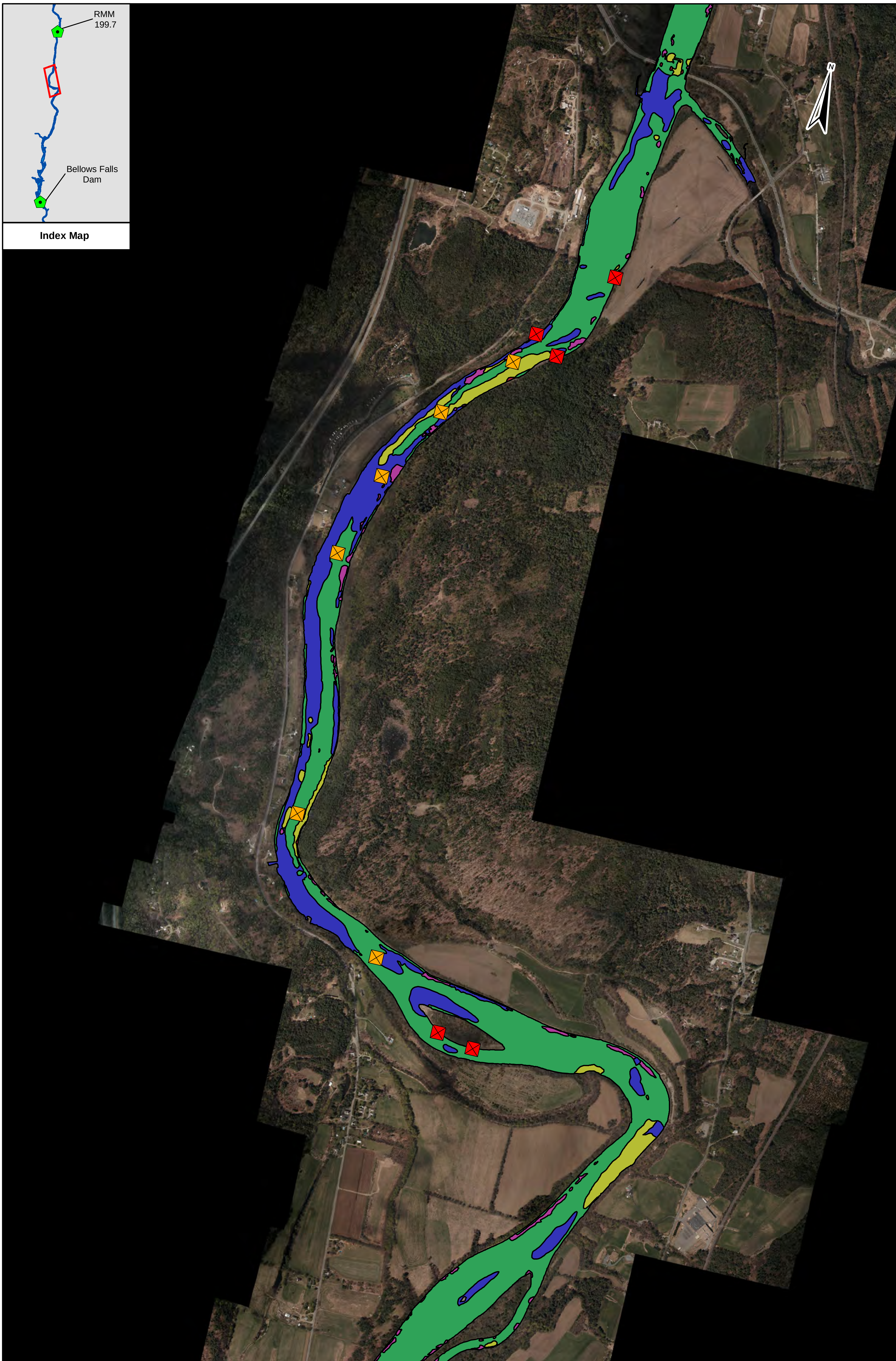

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Environmental Consultants

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0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
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- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Bellows Impoundment

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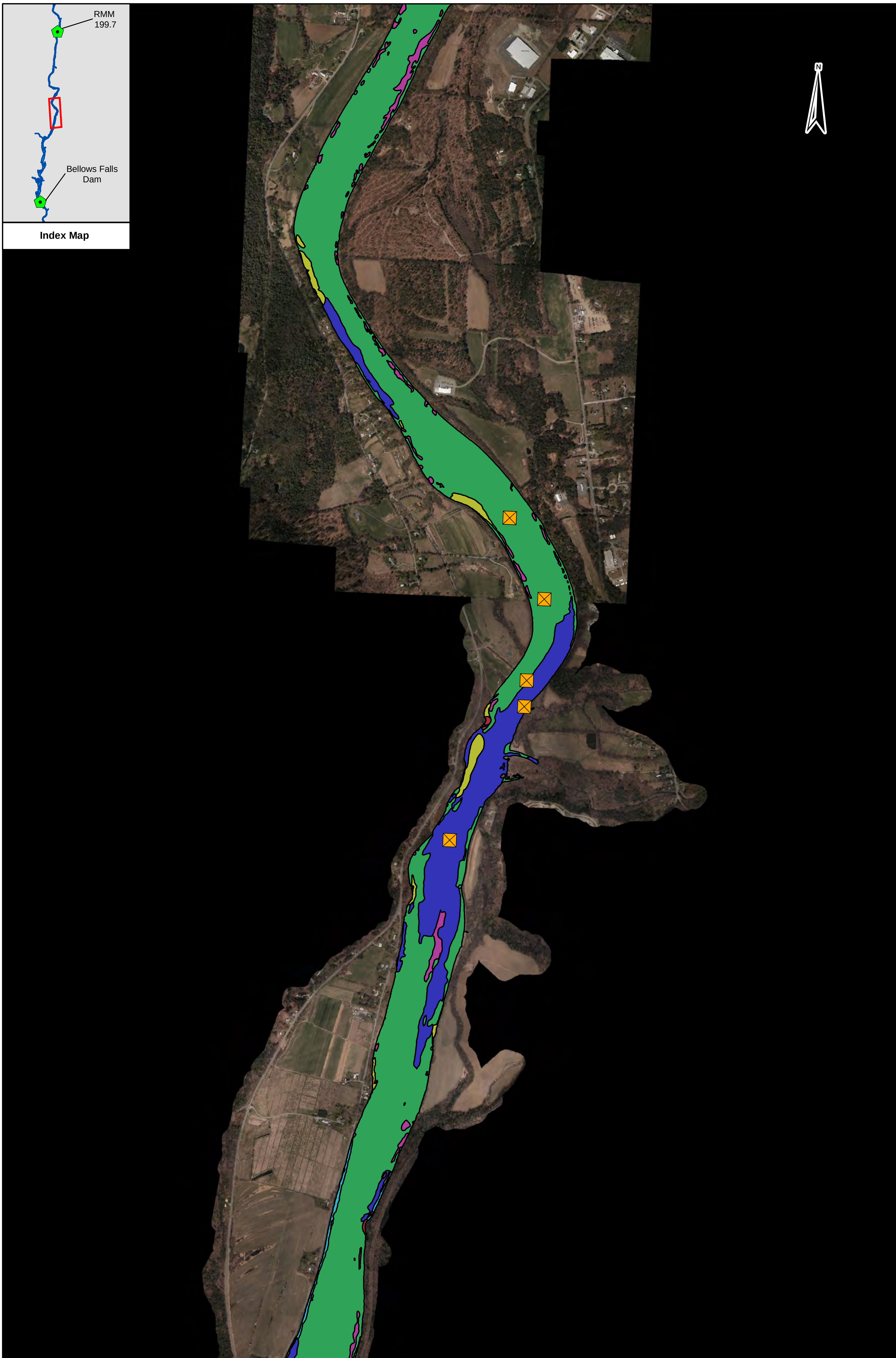

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Data Provided By:
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0 500 1,000 2,000 Feet

Darter Presence

Study 10

Study 12

Habitat Type

Boulder

Gravel, Cobble

Ledge

Rip Rap

Sand, Silt, Clay

Woody Debris

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TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Bellows Impoundment

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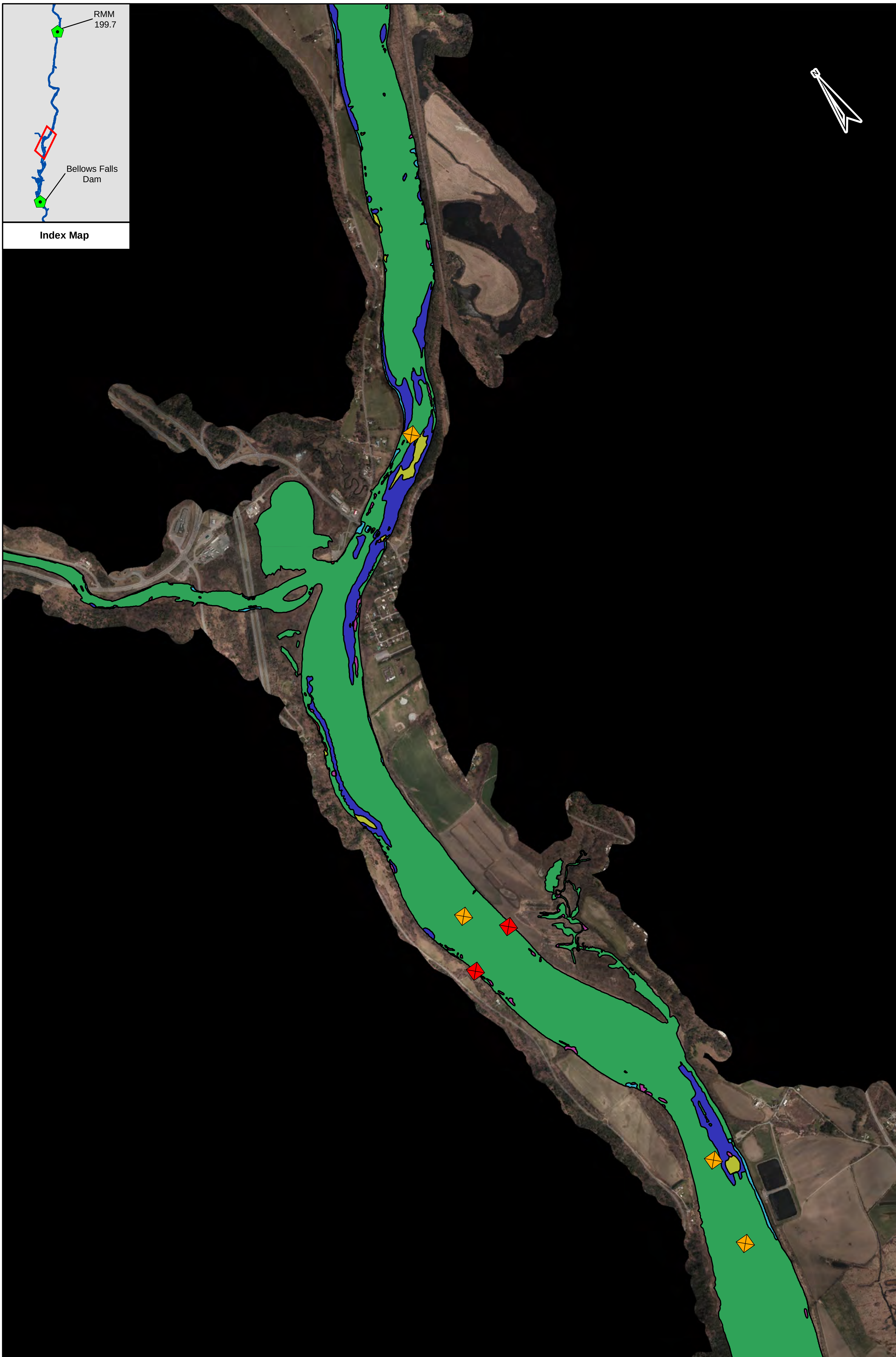

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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ILP Study 10 and12
Darter Presence
Bellows Impoundment

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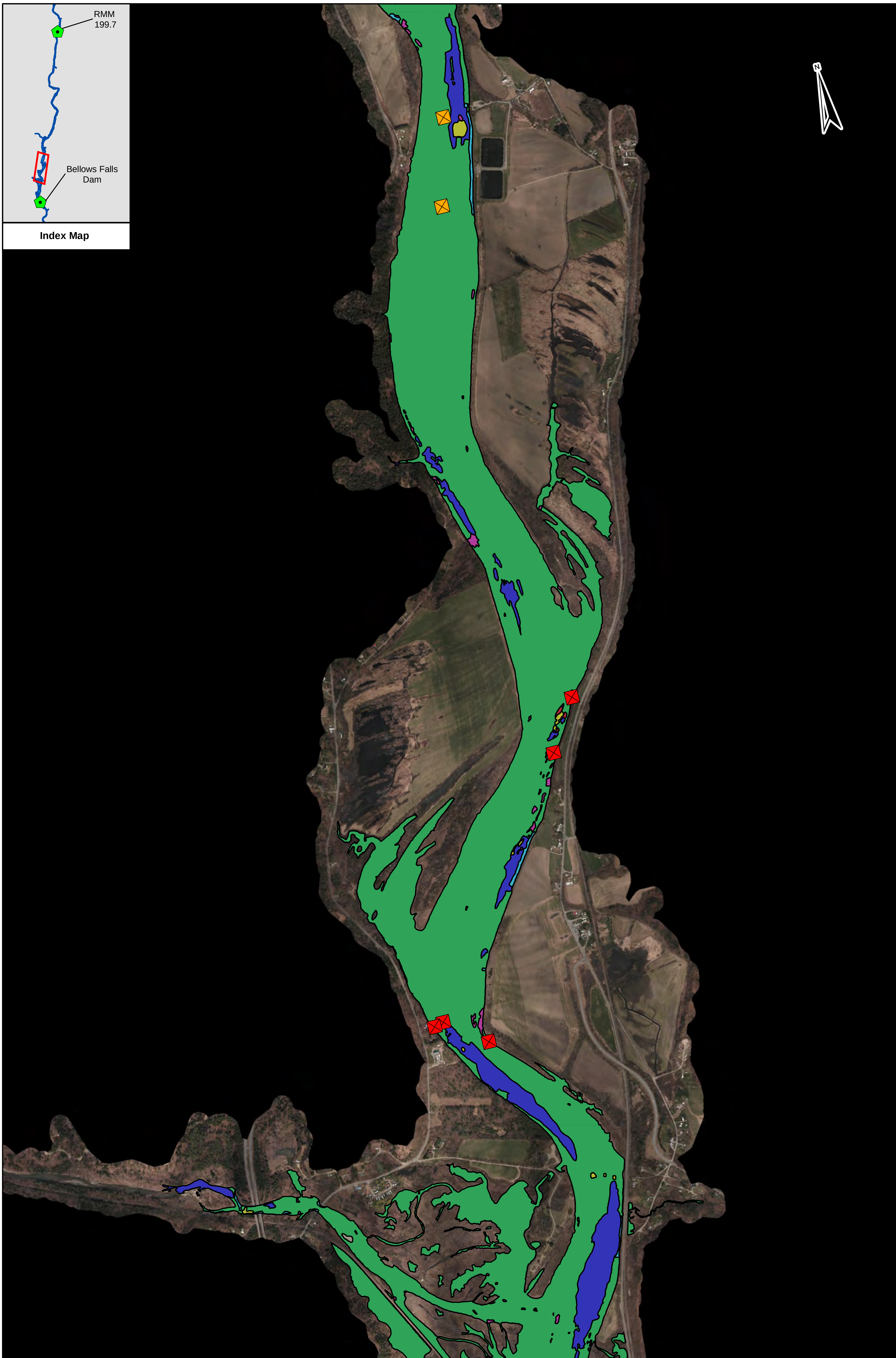

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Environmental Consultants

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence
Study 10
Study 12

Habitat Type
Boulder
Gravel, Cobble
Ledge
Rip Rap
Sand, Silt, Clay
Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Bellows Impoundment

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

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Environmental Consultants

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Bellows Impoundment

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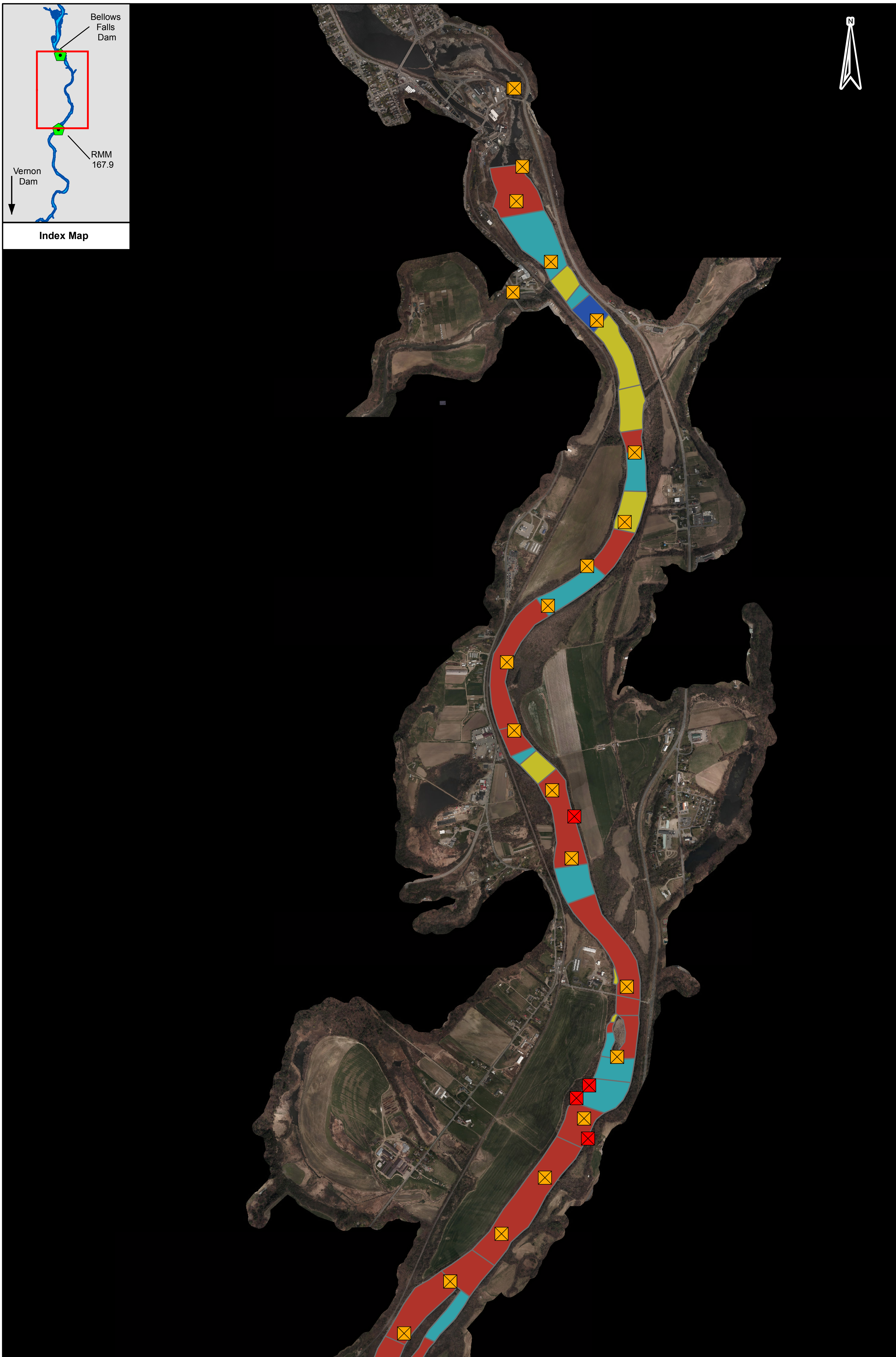

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U.S. Imaging

0 750 1,500 3,000 Feet

Darter Presence

Study 10
Study 12

Meso-Habitat

Glide
Pool
Rapid
Riffle
Run

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Environmental Consultants

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Bellows Riverine

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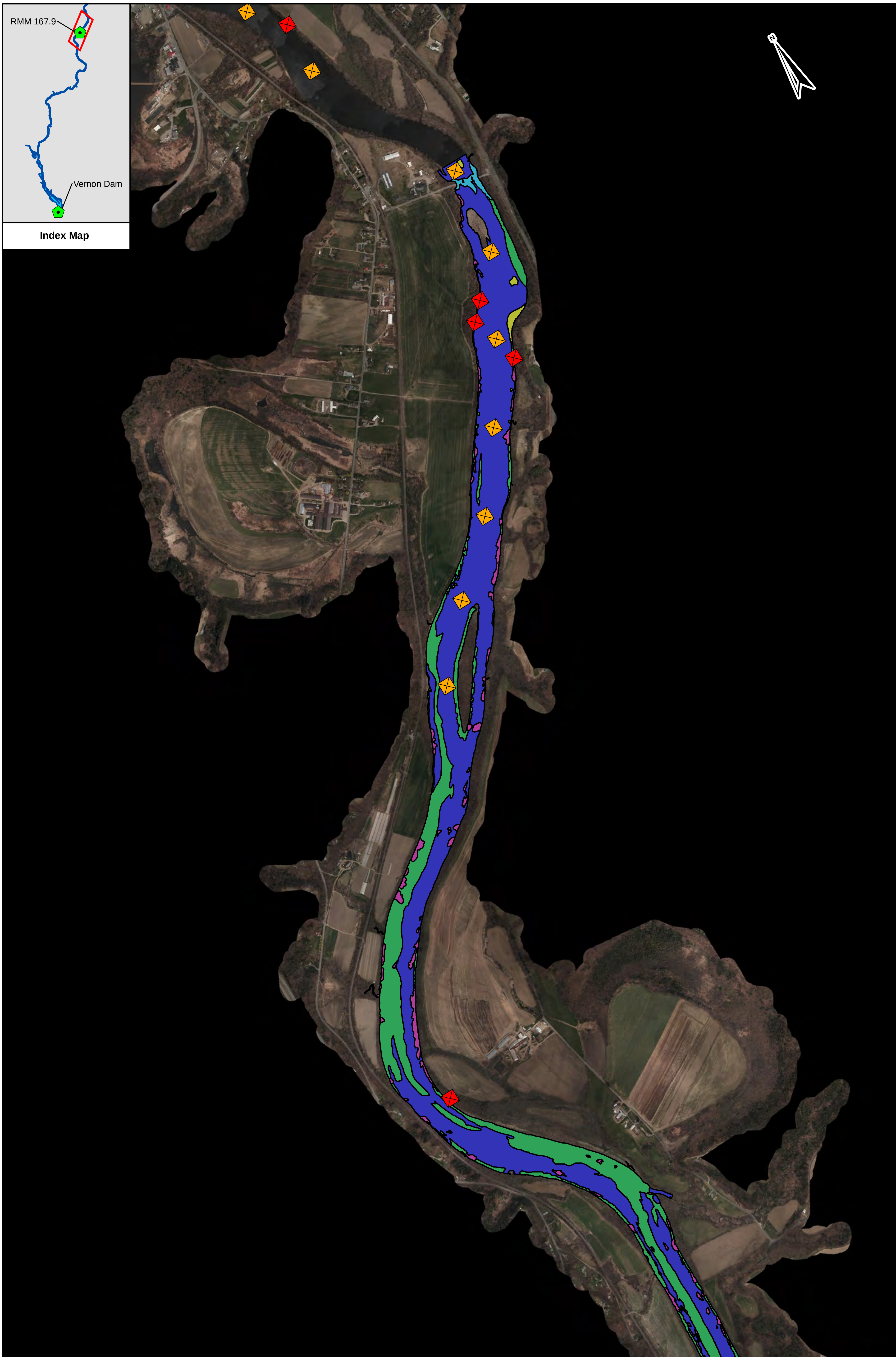

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Environmental Consultants

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000
Feet

Darter Presence

Study 10
Study 12

Habitat Type

Boulder
Gravel, Cobble
Ledge
Rip Rap
Sand, Silt, Clay
Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Vernon Impoundment

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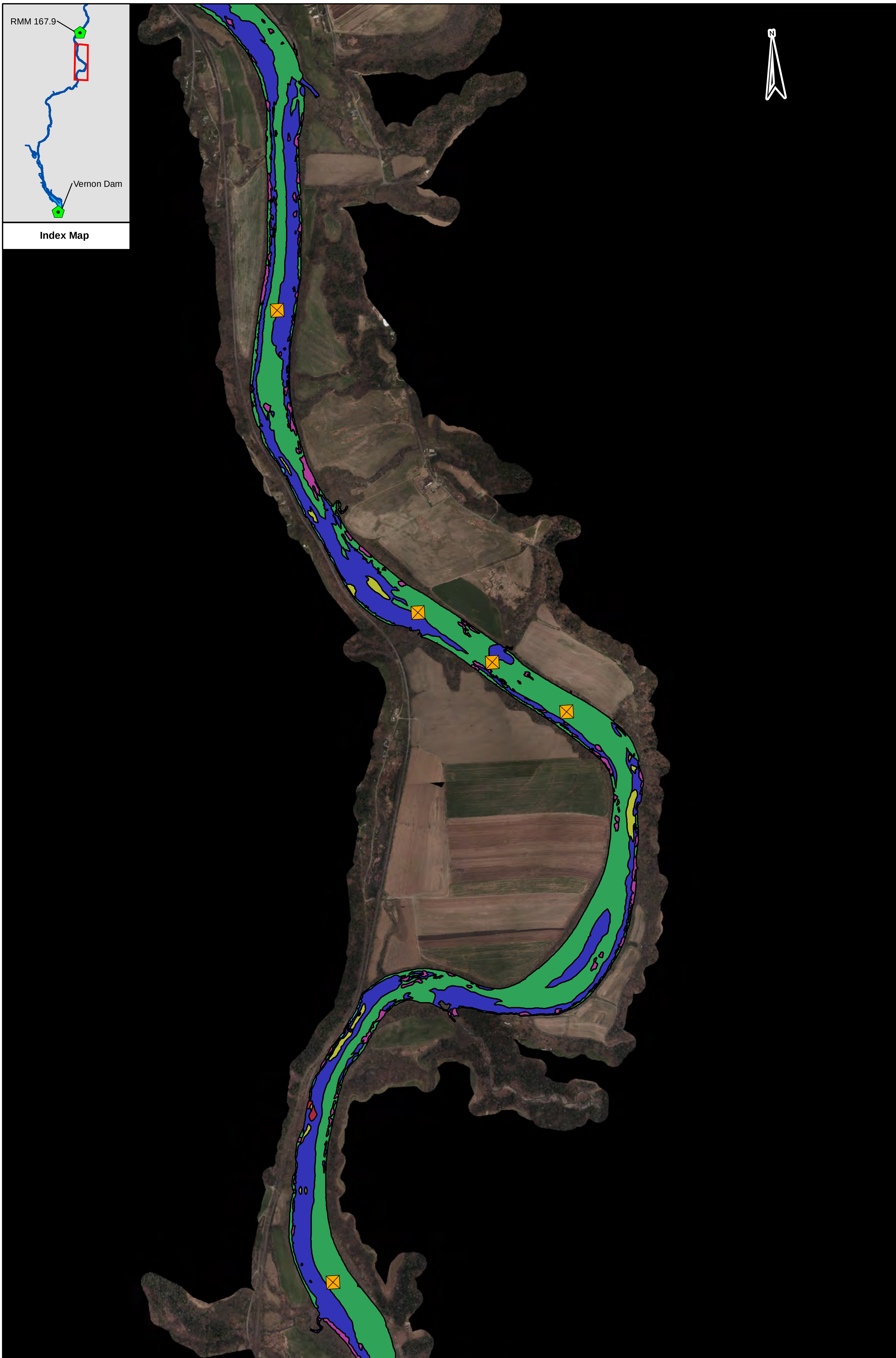

NORMANDEAU ASSOCIATES
Environmental Consultants

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Rip Rap
- Gravel, Cobble
- Sand, Silt, Clay
- Ledge
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Vernon Impoundment

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NORMANDEAU ASSOCIATES
Environmental Consultants

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence
- Study 10
- Study 12

Habitat Type
- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Vernon Impoundment

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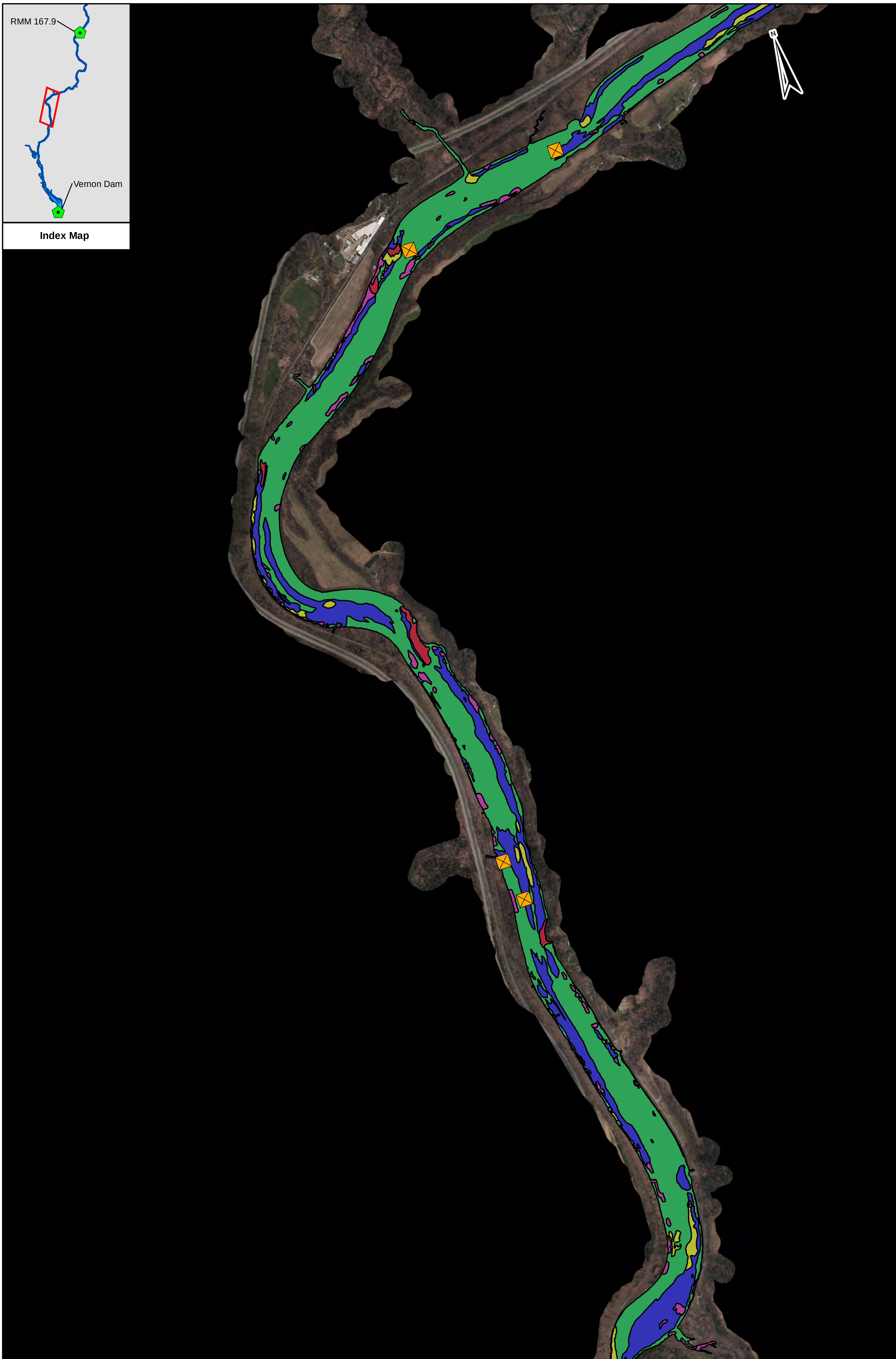

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

NORMANDEAU ASSOCIATES
Environmental Consultants

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Vernon Impoundment

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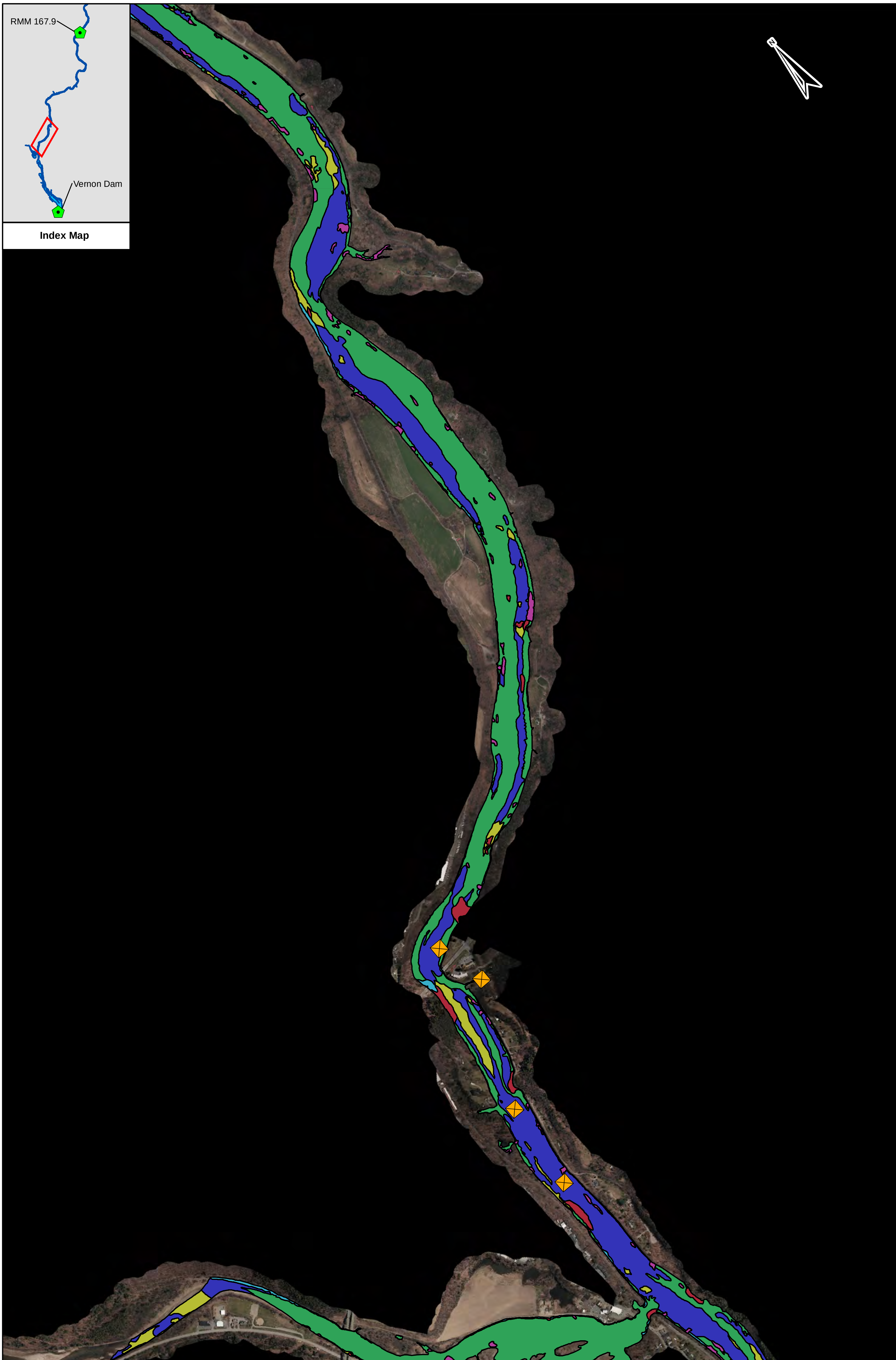

NORMANDEAU ASSOCIATES
Environmental Consultants

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence

- Study 10
- Study 12

Habitat Type

- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Vernon Impoundment

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NORMANDEAU ASSOCIATES
Environmental Consultants

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Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence
- Study 10
- Study 12

Habitat Type
- Boulder
- Gravel, Cobble
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TransCanada Hydro Northeast Inc.
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Vernon Impoundment

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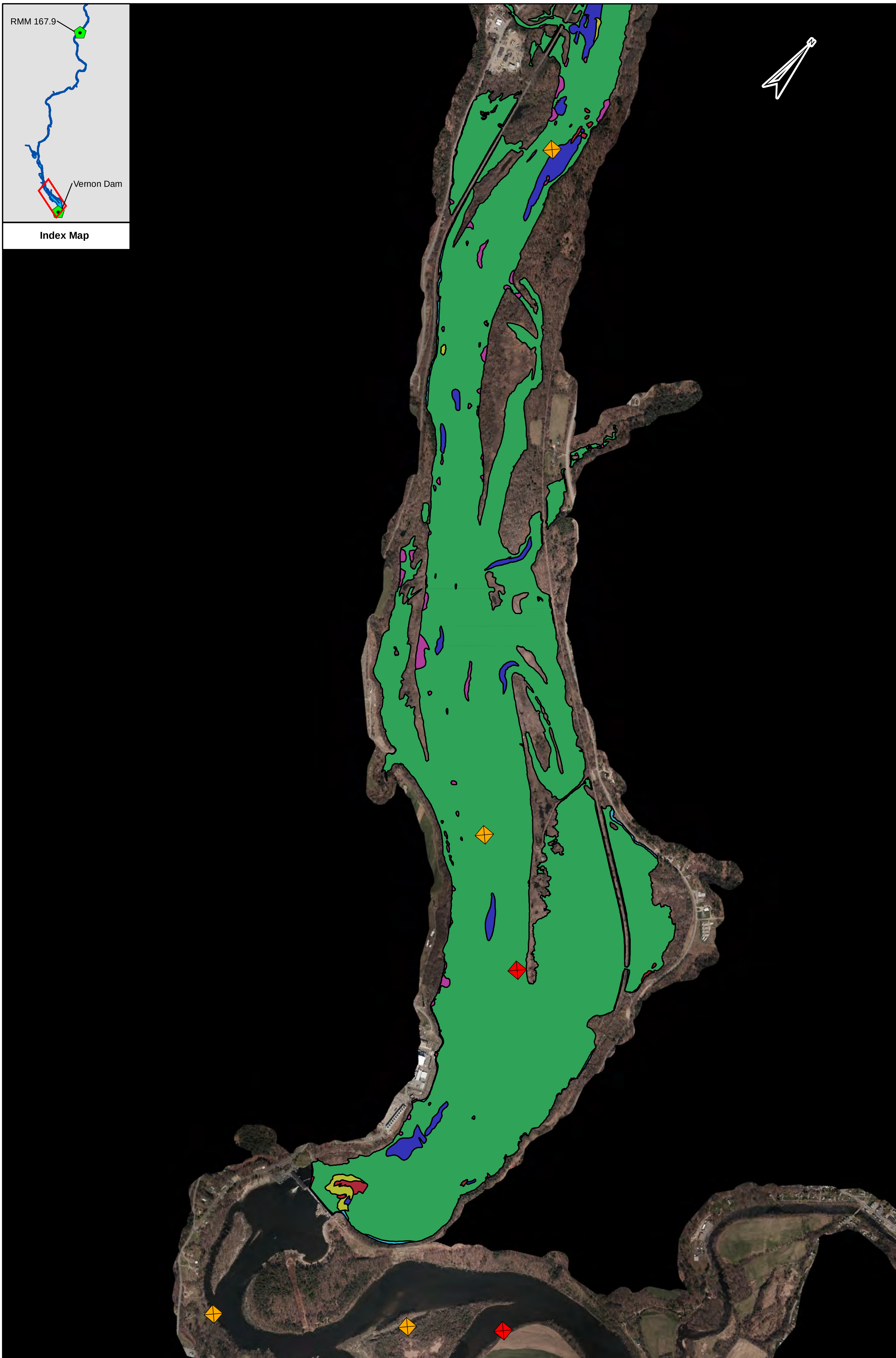

NORMANDEAU ASSOCIATES
Environmental Consultants

1:18,000

Data Provided By:
U.S. Imaging

0 500 1,000 2,000 Feet

Darter Presence
- Study 10
- Study 12

Habitat Type
- Boulder
- Gravel, Cobble
- Ledge
- Rip Rap
- Sand, Silt, Clay
- Woody Debris

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Vernon Impoundment

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NORMANDEAU ASSOCIATES
Environmental Consultants

1:7,000

Data Provided By:
U.S. Imaging

0 250 500 1,000 Feet

Darter Presence

- Study 10
- Study 12

Meso-Habitat

- Glide
- Riffle
- Pool
- Run
- Rapid

TransCanada Hydro Northeast Inc.
ILP Study 10 and12
Darter Presence
Vernon Riverine

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