NEW ENGLAND POWER COMPANY
FIFTEEN MILE FALLS HYDROELECTRIC PROJECT

Final Riverine Habitat Report

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BACKGROUND

The New England Power Company (NEP) is in the initial stages of relicensing the Fifteen Mile Falls Hydroelectric Project (FERC No. 2077). As part of the relicensing process, NEP contracted the services of Gomez and Sullivan Engineers to collect information on the characteristics of riverine aquatic habitats associated with the project.

Riverine reaches are located downstream of each of the three project generating stations; McIndoes, Comerford, and Moore Stations. The most significant of these riverine reaches is located downstream of Comerford Station, where riverine conditions extend more than 2 miles downstream of the station before meeting the McIndoes impoundment. The riverine areas downstream of McIndoes and Moore are very limited since these two stations discharge into the upstream ends of the Ryegate and Comerford impoundments, respectively. A fourth riverine area within the project boundary was also identified for study – the portion of the upper Moore impoundment which becomes riverine as the Moore impoundment water surface elevation decreases. The Moore impoundment is gradually drawn down throughout the summer and reaches it's lowest growing season level in the fall. This creates a short riverine area which fish may use throughout the summer and fall.

NEP scheduled a series of site visits in late July and early August with the all the stakeholders in the relicensing process (resource agencies and non-governmental organizations). The evaluations of the riverine habitat areas were conducted at that time with input from all the participating stakeholders. The only exception to this was the evaluation of habitat in the Nine Islands area at a leakage flow from Comerford Station, which was conducted by GSE.

METHODS

Riverine aquatic habitats in the four locations were evaluated over the course of a week with a number of resource agency and NGO participants. A list of the participating stakeholders is included as Appendix 1.

Aquatic habitats were categorized as riffles, runs, or pools. Riffles are low to moderate gradient areas with surface turbulence, hard non-erodible substrates (typically gravel, cobble, and boulders), relatively shallow water depth, and little aquatic vegetation. Runs are low gradient

areas with shallow depth, low to moderate water velocity (lacking standing waves), and potentially a variety of substrates from boulders to sand. Pools are relatively deep, slow moving areas which typically have fine substrates (i.e., mud, sand, or gravel). Pools often have areas of emergent or submerged aquatic vegetation.

Aquatic habitats downstream of the three project generating stations were assessed at several flow conditions (Table 1). Evaluations were conducted by boat and on foot downstream of the Comerford Station, downstream of the Moore Station, and at the upstream end of the Moore impoundment. Participants stopped periodically to discuss habitat conditions, evaluation species, as well as the need for more detailed studies and what methods might be used for such studies. Habitat conditions were recorded on base maps produced from Autocad drawings included in the Initial Consultation Document (ICD). These drawings were based on USGS topographic maps. Habitat data were also recorded with DGPS locations and stored on a Trimble data collector. During the boat based evaluations, periodic depth transects were taken with a Lowrance recording fathometer. The locations of depth transects were fixed with DGPS locations. Still photos were taken at each area and flow – video data were also recorded at some locations.

Table 1: Station operating conditions during the Fifteen Mile Falls riverine habitat mapping field work.

Habitat Location	Date	Flow (cfs)	Generation (MW)	Upstream Pond Elevation (msl)*	Downstream Pond Elevation (msl)*
McIndoes	31 July	leakage	0	452.4 ft.	NA
Station	31 July	2,300	5	452.6 ft.	NA
Tailrace	31 July	5,600	11	452.1 ft.	NA
Comerford	29 July	800	10.5	647.5 ft.	452.1 ft.
Station	29 July	9,400	122	648.2 ft.	450.3 ft.
Tailrace	17 Sep.	leakage	0	648.4 ft.	451.3 ft.
Moore Station	30 July	1,100	10	807.1 ft.	646.0 ft.
Tailrace	30 July	9,400	115	806.9 ft.	646.1 ft.
Upper Moore Impoundment	1 Aug.	4,540	NA	NA	807.5 ft.

*Normal maximum operating pond levels are; McIndoes 454.0 ft., Comerford 650.0 ft., and Moore 809.0 ft.

Downstream of the McIndoes Station, habitat data were collected only on foot and no depth transects were recorded since a boat was not used. Water surface elevation data were collected with temporary staff gauges located on both the east and west shores. Three flows were observed; leakage (zero generation), 2,300 cfs (3 MW generation), and 5,600 cfs (13 MW generation) which is the full station capacity.

Downstream of the Comerford Station, habitat conditions were recorded at a low flow of 800 cfs (10 MW generation) and a high flow of 9,400 cfs (120 MW generation). Riverine habitats extend approximately 2 miles downstream of Comerford Station to the upstream end of the McIndoes impoundment. When the McIndoes impoundment is drawn down, riverine habitats are extended into the McIndoes impoundment. Habitat observations were conducted by boat and on foot with a number of stakeholders participating. In order to collect more detailed substrate information, a second set of field observations were made at a leakage flow on 17 September 1996. The area examined was from just downstream of the Comerford powerhouse to the upstream end of the McIndoes impoundment. The McIndoes impoundment was drawn down approximately 2 to 4 feet during the observations resulting in the extension of riverine habitat conditions into the McIndoes impoundment.

Habitat data collection methods used downstream of Moore Dam duplicated the methods used downstream of Comerford Dam. Observations were made primarily at a low flow of 800 cfs (10 MW generation). Habitat conditions were also observed at a high flow of 9,400 cfs for a short time at the end of observation period. Video data were recorded from a perspective at the midpoint of the dam looking down the center of the tailrace reach. Boats were launched in the Comerford impoundment and motored upstream to the foot of the dam where habitats were initially discussed.

The characterization of aquatic habitats at the upstream end of the Moore impoundment was done using methods similar to those used downstream of the Comerford and Moore dams. The area of concern at the upstream end of Moore impoundment included the part of the river affected by project operations – that is, the area that becomes riverine as the Moore impoundment is drawn from a high pond level down to typical low pond levels. Flows were very high and the Moore impoundment was within several feet of the normal high elevation during these observations. Thus, most of the area of interest was inundated and the lower limit of the riverine reach could not be accurately located. Depth transects were recorded throughout this area.

HABITAT DESCRIPTIONS

Riverine habitats are described below with the general classification as runs, riffles, or pools. The habitat type is noted on the attached Figures 1, 2, 4, and 5. The habitat types were not noted on Figure 3 – rather, the numerous habitats around the Nine Islands were labeled on this figure and described in detail in Table 2 and in the text. Color reproductions of selected photographs of each area are also included to provide a better idea of the characteristics of each habitat area

(Appendix 2). Photographs were selected to provide representative views of each area at each observed flow.

McIndoes Station Tailrace

The McIndoes station discharges directly into the upstream end of the impoundment of the Ryegate Project – a run of the river project which operates with a constant level impoundment. Thus, riverine habitat in this area is limited to the interface between the two impounded river reaches. The small riverine area between the two projects was almost entirely deep, low velocity, pool habitat (Figure 1 and Appendix 2 photos MC1 and MC2).

Along the east shore, downstream of the spillway portion of the dam, there were two pool areas which were adjacent to the main flow of the river (Figure 1). The position of the pools, as well as the shorelines and visible shallow water substrates, suggested that eddy flow patterns occurred in these pools at high flows. The smaller of these two eddy pools was approximately 180 feet in diameter and was located on the east side of the river immediately downstream of the spillway. This area appeared to have a sand and silt bottom with heavy accumulations of dri-ki observed on shore. Downstream of this eddy was a much large eddy which was approximately 600 feet in diameter. This pool also had fine substrates along shore (sand and silt), with heavy accumulations of dri-ki. No water velocity was visible in either of these eddy areas at either the leakage flow or the 2,300 cfs flow. The water surface elevation increased 0.2 to 0.3 feet on both sides of the river as the station flow was increased from leakage to 2,300 cfs. At the full station capacity flow of 5,600 cfs (13 MW generating level), there was some water velocity apparent in the smaller eddy pool. The water surface elevation increased 1.4 feet, relative to the leakage elevation, as the flow was increased to 5,600 cfs. A small sand/silt bar with emergent aquatic vegetation was located just downstream of the station. The water surface elevation changes at this sand bar appeared to be similar to those documented closer to the station. This sand bar is not shown on the base map since it was completely submerged in the early May aerial photos used to produce the base maps.

Just downstream of the tailrace, a shallow area was evident from the turbulence and waves that were created as the 5,600 cfs release began (Figure 1). This area appeared to be a shoal that was probably cobble, boulders, or some other hard non-erodible substrate. The dimensions of this shallow shoal area were estimated to be approximately 100 feet wide and 60 feet long. This shallow area may have been the downstream limit of the tailrace excavation. As the 5,600 cfs flow stabilized this turbulent area was less evident and it appeared that it would not be noticeable once the flow had backwatered the Ryegate impoundment.

Shallow Area

N

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Connecticut River Basin
Riverine Habitat Map
McIndoes Station Tailrace

FIGURE 1

Comerford Station Tailrace and Nine Islands Area

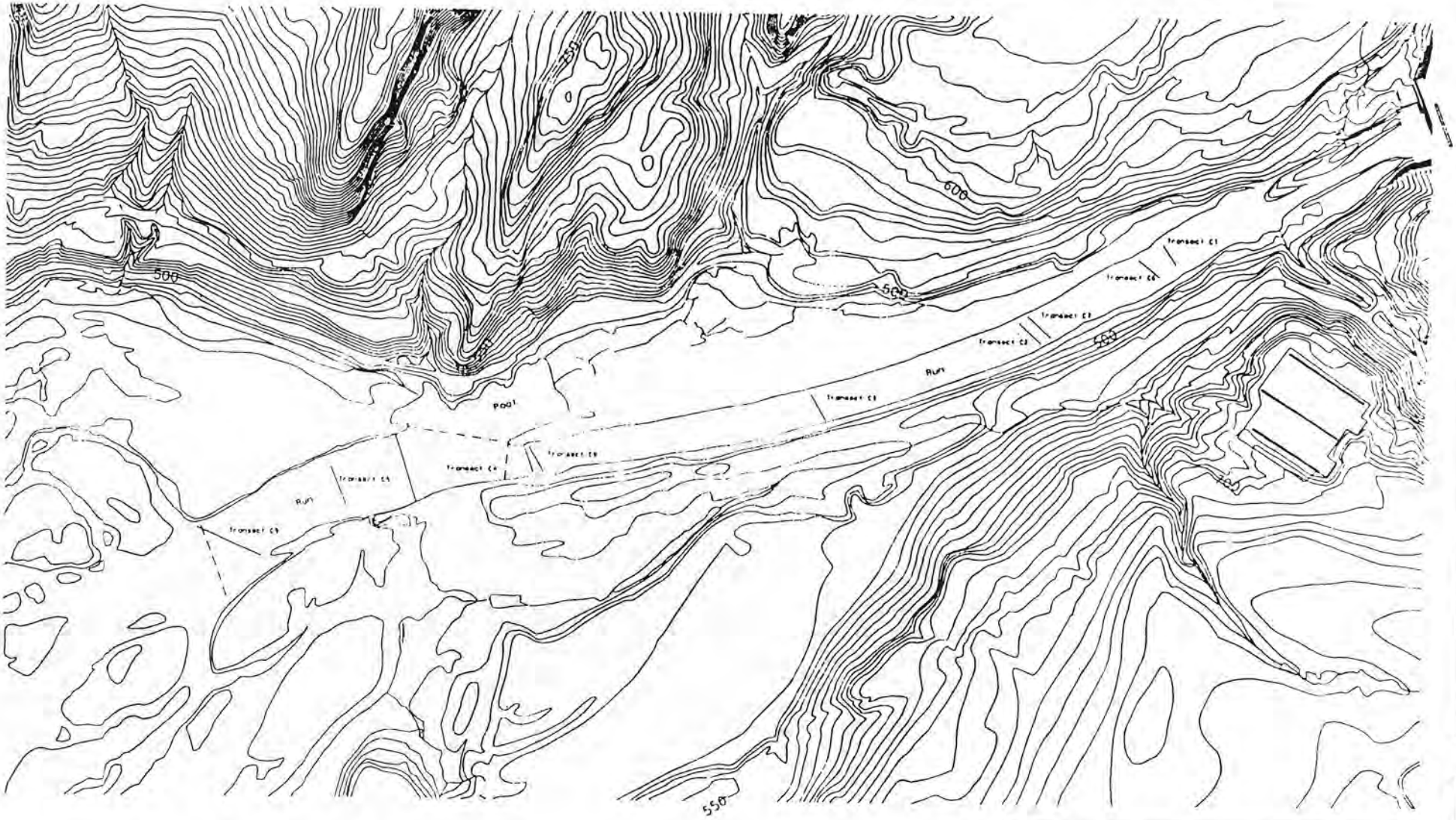
Immediately downstream of the powerhouse was a narrow, deep, channel which was relatively homogeneous run habitat (Figure 2 and Appendix 2 photos C1 and C2). This deep run was approximately 4800 ft. long and included all of the tailrace area that was excavated as part of the original project construction. Exposed substrates on the shorelines, as well as visible underwater substrates (near shore), were generally cobble and small boulders. Fathometer strip charts in this deep run showed a hard, irregular, bottom with few features greater than 2 feet, indicating the deep water substrates were similar to the near shore substrates (i.e., cobbles and small boulders). The banks were steep, dropping quickly to 5 to 10 feet deep (Appendix 3, transects C1-C4 for low flow cross sections and C6-C8 for high flow cross sections). Maximum depths in this run were 16 feet at the 800 cfs flow and 20 feet at the 9400 cfs flow. The water surface elevation increase, going from the low flow to the high flow, appeared to be approximately four feet throughout this deep run.

There were very few velocity refuges for adult fish in this run – the fathometer strip charts showed very few large features (greater than 2 feet) that might provide adult refuges. However, the cobbles and small boulders in this reach provided abundant velocity refuges for small fish. Instream cover was abundant by virtue of the relatively deep water and low water clarity. There was some bank vegetation (brush and trees) which provided overhead cover, particularly on the east shore. Water velocities in this run were low at the 800 cfs flow and relatively high at the 9,400 cfs flow. There was general agreement among the stakeholders present during the evaluation that water velocities were the dominant physical feature of the aquatic habitat in this reach.

From the end of this deep run to the beginning of the McIndoes impoundment, the river channel was wider and shallower with a combination of riffles, runs, and several pools. This area included numerous side channels around the Nine Islands as well as a portion of the Passumpsic River which was influenced by Connecticut River flows.

On the west shore, immediately downstream of the deep run, was a small off-channel pool which was backwatered by main stem flows (Figure 2). This area was 1 to 2 ft. deep at the low flow, 4 to 5 ft. deep at the high flow, and had no discernable water velocity at either flow. Substrates were silt and sand with emergent aquatic vegetation along the shoreline. A gravel and cobble bar partially separated this area from the main channel at the 800 cfs flow. This bar was submerged by several feet at the 9,400 cfs flow.

Adjacent to the off-channel pool, and downstream of the deep run, the main channel was a shallow run (Figure 2). This run continued downstream for approximately 1500 feet. The dominant substrates were cobble and small boulders. The latter provided velocity refuges and instream cover. Water velocities were similar to the deep run located upstream – low at the 800 cfs flow and high at the 9,400 cfs flow – although this area was wider and shallower than the run habitat in the excavated channel. Water depths were approximately 2 to 4 feet at the low flow



-------- Habitat boundary

N

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Connecticut River Basin
Riverine Habitat Map
Comerford Station Tailrace

FIGURE 2

and 3 to 6 feet at the high flow (Appendix 3, transects C5 and C9). Trees and brush provided some overhead cover, primarily along the east shore.

Riffle habitats dominated the Nine Islands area. Detailed information on these habitats is presented in Table 2. Photographs C1 through C10 show representative areas of several of these habitats. Approximately 2100 feet of the main channel was riffle habitat (Figure 3, area M). Nearly all of the 800 cfs release flowed through this riffle. One side channel (area K), was separated by a gravel bar/island (not shown) which diverted some of the 800 cfs flow through this area. The wetted habitat at this low flow can best be described as shallow riffle, with unconsolidated cobble substrates, moderate water velocity, few velocity refuges, and very little cover. The lower Passumpsic River habitat (area L) was a deep pool, with low water velocity, and embedded sand and gravel substrates. Passumpsic River flows also backwatered areas G and F and portions of H and E. The Connecticut River flows appeared to have a backwater influence in the Passumpsic River upstream to a hydraulic drop which bounded the upstream end of area L. The other adjacent side channels in the Nine Islands (areas A, C, D, and I) had cobble bars at their upstream ends which prevented any of the 800 cfs flow from reaching these channels. Although these areas had no flow, they did have some small areas of standing water.

At 9,400 cfs, water flowed through all the channels on both the east and west side of the main channel. These side channels were primarily riffle habitat, but also contained some runs and pools on the west side. Areas A, B, C, D, and I were all shallow riffle habitats, which generally had cobble substrates, areas of vegetation, some cover, few velocity refuges, and moderate to high water velocity depending on the relative amount of flow they received. Riffle habitats A and I had somewhat higher flow and water velocity, riffles B and D were intermediate, while area C received less flow and had lower water velocity relative to the other side channel riffle habitats. Area K, the riffle habitat which was wetted at the low flow, had a much larger wetted area at the high flow (inundating much of the gravel bar which separated it from the main channel), and much higher water velocity. Area J was a cobble and ledge pool with lower water velocity, abundant cover, and areas up to six feet deep. Several channels connected in area H where the energy dissipated and the habitat took on run characteristics, although the habitats were still similar (predominantly cobbles) to the upstream areas. Moving downstream, the energy dissipated further in the sand/gravel run in area F and the sand/gravel pool in area G. The water flowed from there into the lower Passumpsic River (area L) which was almost identical to the low flow conditions except that the higher Connecticut River flow had a greater backwater effect, raising the water level by about one foot. Habitat in area E, was a shallow pool with emergent aquatic vegetation, silt substrates, and little or no water velocity since it is backwatered by Passumpsic and Connecticut River flows. It probably receives some groundwater input and may receive upstream flow at very high Connecticut River flows via the west side pool described earlier.

Immediately downstream of the Nine Islands area, the main channel changed from riffle to run. Substrates were similar to those upstream, primarily cobble and small boulders. At the low flow, water velocity was moderate in this run while at the high flow, velocities were relatively high.

--------- Habitat boundary

A-L=Habitat label
(see text for details)

N

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Connecticut River Basin
Riverine Habitat Map
Nine Islands Area

FIGURE 3

Table 2: Aquatic habitat characteristics of the river channels in the Nine Islands area of the Connecticut River. Depths at the two flows are a combination of fathometer measurements and visual estimates. The wetted perimeter of these areas was mapped from aerial photos taken on May 7, 1996. See Figure 3 for area locations.

Area	Habitat Type	Substrates (dominant/secondary)	Substrate Embeddedness	Estimated Depth (ft) 800 cfs	Estimated Depth (ft) 9400 cfs	Velocity Refuge	Instream Cover	Overhead Cover
A	Riffle	Cobble/Gravel	0-25%	0	0.5-4	Few	Boulders	Brush
B	Riffle	Cobble/Gravel	25-50%	0	1-2	Few	Banks	Brush
C	Riffle	Vegetation/Gravel	50-75%	0	0.5-1.5	Few	Banks	Brush
D	Riffle	Cobble/Vegetation	25-50%	0	1-3	Few	None	Brush/Trees
E	Pool	Vegetation/Silt	75-100%	0.5-1	1-3	Few	Banks	Brush/Trees
F	Run	Sand/Gravel	50-75%	0.5-1	2-3	Few	Trees	Brush/Trees
G	Pool	Sand/Gravel	50-75%	2-3	4-5	None	Banks	Trees
H	Run	Cobble/Gravel	25-50%	0-1	2-5	Few	None	Trees
I	Riffle	Cobble/Vegetation	0-25%	0	0.5-2	None	None	Brush
J	Pool	Cobble/Ledge	25-50%	1-3	3-6	Few	Ledge	Trees
K	Riffle	Cobble	0-25%	0.5-4	1.5-6	None	None	None
L	Pool	Sand/Gravel	75-100%	2-9	3-10	None	Depth/Clarity	Bank/Trees
M	Riffle	Cobble/Small Boulders	25-50%	1.5-3	3-5	Few	Boulders	None

Below this run, the high water mark on the shorelines indicated that this was the approximate location of the upstream end of the McIndoes impoundment at the high McIndoes impoundment level. On the day the observations were made, with McIndoes pond down approximately four feet, it did not appear the be the end of the riverine section. The shallow riverine nature of the upper McIndoes impoundment made it difficult to assess the location of the beginning of McIndoes impoundment effects. Thus, the extent of riverine habitat at the upstream end of the McIndoes impoundment appears to be significantly affected by McIndoes impoundment levels.

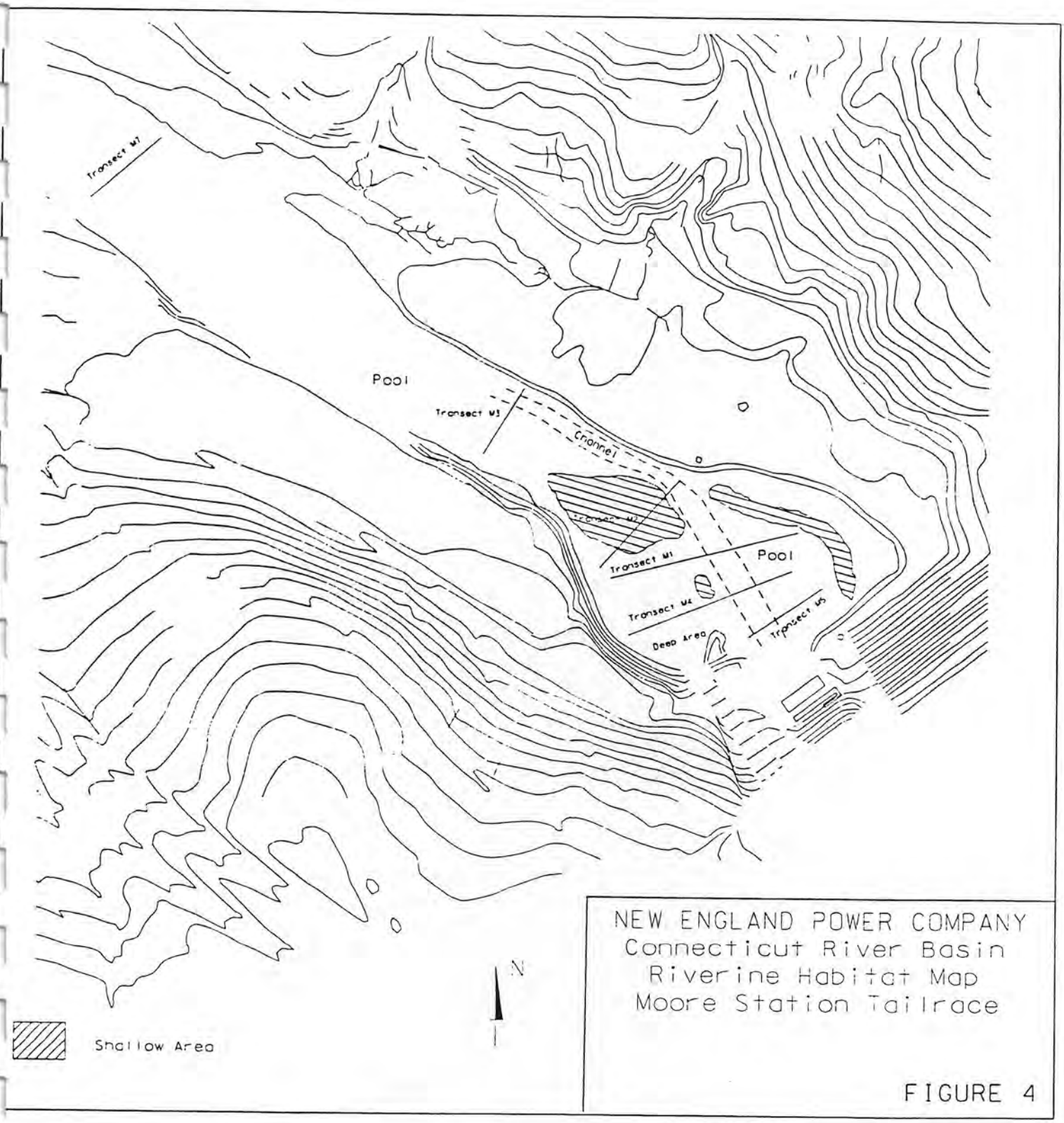
Moore Station Tailrace

There was a general consensus among all the participants in the field evaluation that the aquatic habitats downstream of Moore Dam were affected by Comerford pond levels all the way to the foot of Moore Dam, and that the effects of Moore Station discharges were most pronounced in the immediate vicinity of the dam. Aquatic habitats immediately downstream of the dam were dominated by several large cobble/boulder shoals separated by deeper areas (Figure 4 and Appendix 2 photos M1 and M2). The deepest area was immediately below the spillway discharge, where there was a large pool which was approximately 25 feet deep (Appendix 3, transects M1 and M4).

The largest cobble/boulder shoal was on the east (New Hampshire) side, beginning immediately downstream of the deep pool and extending downstream approximately 600 feet to the power line crossing. This shoal was partially exposed at the observed Comerford impoundment elevation. A transect across the northern portion of this shoal documented the very shallow depth there (Appendix 3, transect M2). Due to the shallowness of this area, a large portion of this shoal could be exposed at a low Comerford Pond elevation.

West of the powerhouse tailrace flows, there were several other cobble shoals which were partially exposed at the observed Comerford pond elevation. The exposed portions were primarily small and large boulders. Between these shoals on the west side and the larger cobble/gravel shoal on the east side there was a well defined channel which extended from the powerhouse tailrace downstream to the west bank and continued along this bank to the location of a powerline crossing. Downstream of the powerline crossing, the entire channel depth (i.e., bank to bank) became more uniform with depths of approximately 7 to 12 feet (Appendix 3, transect M7).

In the area downstream of the power lines, there was a consensus among the participants that the aquatic habitats were primarily influenced by the Comerford pond impoundment levels and secondarily by the Moore Station discharge. Water velocities in this area were imperceptible at the observed low flow. At the high station discharge, the observed water velocities were still low to moderate. Moving downstream, the water depths in this area became progressively deeper and more characteristic of an impoundment. The effects of Moore Station discharges were attenuated by the greater depth of the area. The depth increase, from the 1,100 cfs Moore Station discharge to the 9,400 cfs discharge, was only 0.1 feet at the Route 18 bridge abutment about 4,000 feet



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Connecticut River Basin
Riverine Habitat Map
Moore Station Tailrace

FIGURE 4

downstream of the dam. This was identical to the Comerford pond elevation change measured at the Comerford Dam during the observations (Table 1). The Moore Station discharge had little or no effect on the water surface elevation except in the immediate tailrace area. Water level changes in this area are primarily due to fluctuations of the Comerford Impoundment.

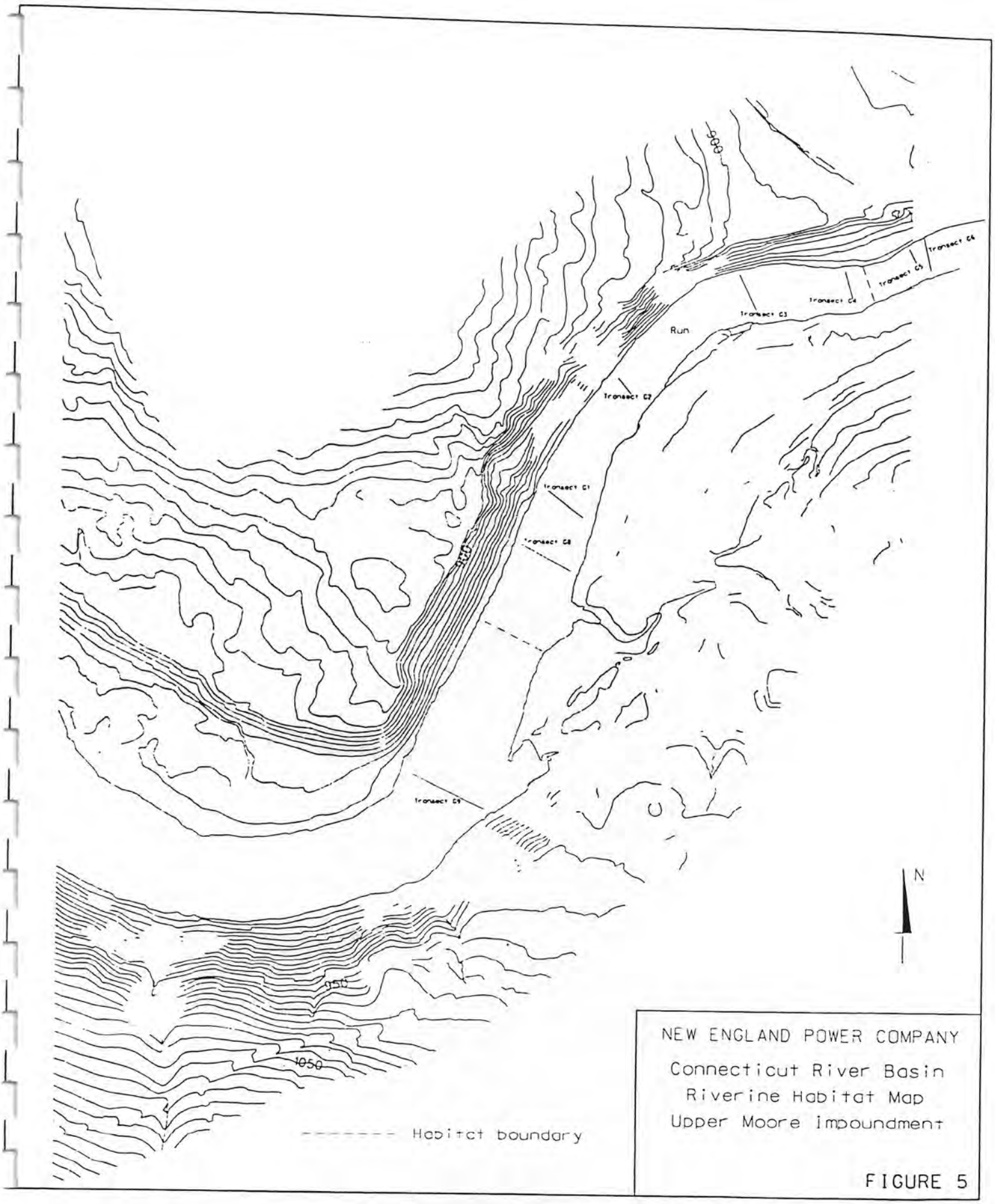
Upper Moore Impoundment

Since inflow to the Moore Station impoundment is not regulated at the next dam, the river flow during the habitat evaluation could not be controlled. On the date of the field work, inflow to the project was 4,540 cfs (USGS Dalton gauge), an unusually high flow with an exceedence of only about 5% for this time of year. In addition, the impoundment was at an elevation of 807.5 feet, 1.5 feet below the maximum operating level of 809.0 feet. As a result of this high flow and moderately high impoundment level, the habitat in the upper end of the Moore impoundment was somewhat inundated and conditions were atypical (see photos G1 and G2, Appendix 2). In particular, the observed water velocities and documented depths should be taken as maxima that might be expected to occur in this area in mid to late summer.

The maximum upstream extent of the Moore impoundment was clearly defined by a hydraulic control located between depth transects G4 and G5 (Figure 5). This hydraulic control is a relatively narrow ledge outcrop which restricts the flow, backwaters the upstream reach, and creates a very short riffle area. On the date of the evaluation, the water surface elevation appeared to drop more than two feet through this hydraulic control. This hydraulic feature is clearly visible on the May 1996 full pond aerial photos used to create the base maps, demonstrating that it is not inundated under high water level and high flows conditions. The actual location of the beginning of the Moore impoundment may be a short distance downstream of this hydraulic control. Upstream of this hydraulic control, almost to the foot of the Simpson Paper Company dam, was a pool with maximum depths of about 25 feet and low water velocity.

Downstream of the hydraulic control feature, in the vicinity of transects G4 and G3, was a run with depths of 2 to 8 feet (Appendix 3, transects G4 and G3). The run characteristics continued further downstream where the water depths were 5 to 12 feet at transect G2 (with a distinct channel near the west shore), 7 to 9 feet at transect G1, and 9 to 12 feet at transect G8 (Appendix 3). Substrates throughout this run were cobble, small boulders, and large boulders near shore and similar substrates in deeper water, as evidenced by the size of the bottom features on the depth transects. The abundance of large boulders provided instream cover and velocity refuges. Large trees along each shore provided overhead cover. One of the participants noted that this general area was known as horse race rapids prior to the construction of Moore Dam.

Downstream of transect G8, on the New Hampshire shore, was a small stream which several of the participants described as the location of the upstream end of the Moore impoundment at typical low summer water levels. The water velocity decrease near this stream and downstream at transect G9 the characteristics of the river changed – there was emergent aquatic vegetation on the west shore, finer substrates, and a wider channel. The channel profile at transect G9 appeared



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Connecticut River Basin
Riverine Habitat Map
Upper Moore Impoundment

FIGURE 5

to be an older channel that was flooded by about 10 feet. The small tributary is probably the approximate downstream location of the riverine channel created by maximum Moore Impoundment drawdown during the growing season. The distance from this stream to the hydraulic control described above is approximately 2,600 feet.

FUTURE STUDY RECOMMENDATIONS

In the course of the habitat assessments, the participants (NEP staff, consultants, resource agencies, and NGO's) discussed fish species of interest and potential future goals and study methods. While these discussion did not constitute formal study requests, they were informative with regard to the resource management goals of the various stakeholders. The discussions of resource goals, study species, and study methods for each reach are summarized below.

McIndoes Station Tailrace

Potential evaluation species for this area included smallmouth bass and yellow perch. Walleye are not currently found in this reach of the Connecticut River but are found downstream of the Ryegate Project. They were noted as a possible evaluation species since they may be stocked in this area in the future. The primary recommendation for future studies was to collect better physical habitat information. Several of the participants requested transects to map depths and document substrates. In particular, a better physical habitat description of the bar downstream of the tailrace was requested.

Comerford Station Tailrace

The discussion of future studies focused on physical habitat descriptions, demonstration flows, potential modeling methods, and priorities among the different habitat types in this reach of the river. This reach of the river was felt to be important since it was the largest of the four riverine areas and contained a greater diversity of aquatic habitats. More importantly, this area was important for local recreational fisheries since it reportedly supports significant natural (i.e., not stocked) rainbow trout and brown trout populations.

The deep run in the excavated channel was felt to be relatively homogeneous and habitat/flow relationships could be modeled relatively easily. However, the consensus was that this area contained low value aquatic habitat (in comparison to adjacent areas), and therefore, rigorous modeling of flow versus habitat relationships would not be warranted.

The main channel and side channels in the Nine Islands area were felt to be of greater value. The feasibility of modeling the flow/habitat relationships in this area was discussed. There was general agreement that the main channel habitat/flow relationship could be modeled with IFIM methods. However, the NEP consultants noted the logistical difficulty and safety considerations of collecting hydraulic information on a river of this size. They suggested that habitat/flow relationships in this reach could be modeled with full hydraulic data sets collected at a low flow,

and only water surface elevations at higher flows.

Quantitative evaluations of habitat in the various side channels in the Nine Islands area were also discussed. However, there was a consensus that quantitative habitat/flow relationships through this area could not be modeled due to the difficulty of modeling braided channels. There was a discussion of locating transects at representative locations in the channels around Nine Islands to define habitat versus flow relationships using a field based consensus approach.

Moore Station Tailrace

Potential evaluation species for any future studies of the riverine habitat downstream of Moore Station included stocked rainbow trout and stocked brown trout. These two species are occasionally stocked as surplus brood stock fish taken from NHFG hatcheries. Surplus brook trout brood stock were also stocked in 1996. However, brook trout brood stock are not typically stocked in this area. In addition to these two species, smallmouth bass were also mentioned as a potential evaluation species for any future studies.

The participants discussed potential study methods for the area downstream of the Moore Dam. It was agreed that the critical component of any studies of this reach was the level of the Comerford impoundment. The NEP consultants noted that a hydraulic analysis of the backwater effects of the Comerford impoundment could be conducted. Due to effects of the Comerford impoundment, the short length of this reach, and the complexity of the flows in and around the gravel bars and bolder fields, quantitative modeling was not deemed to be possible in this area. Rather, there was agreement that demonstration flows, combined with the backwater analysis described above, are a reasonable approach to determining suitable flows in this area. In addition to demonstration flows several, participants requested a better physical description of the habitat downstream of the dam, particularly in the area of the boulder fields and the large gravel bar on the east side.

Upper Moore Impoundment

Potential evaluation species for this area included juvenile and adult smallmouth bass, and all life stages of rainbow trout. Brown trout were also mentioned as an evaluation species, however it was not clear if these could be present as naturally reproducing fish or only as stocked adults and juveniles. Macroinvertebrates were also mentioned as an evaluation species. However, no specific species were described, just general macroinvertebrate community habitat suitability data.

Potential future evaluation methods focused on a better physical habitat description for this area. Modeling of flow versus habitat relationships was also discussed. The consensus of the participants was that this could be done by traditional IFIM hydraulic modeling methods using various starting water surface elevations at Moore Reservoir. It was noted that NEP had very little control over flow in this reach.

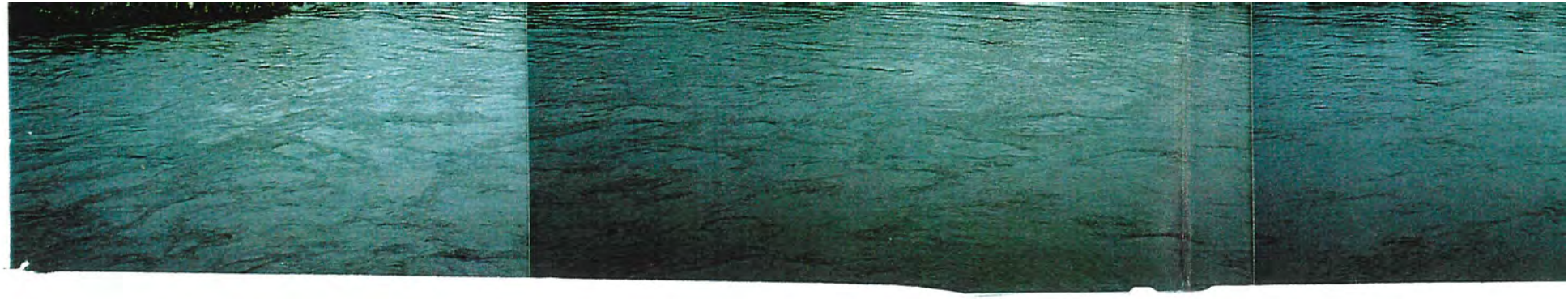
APPENDIX I

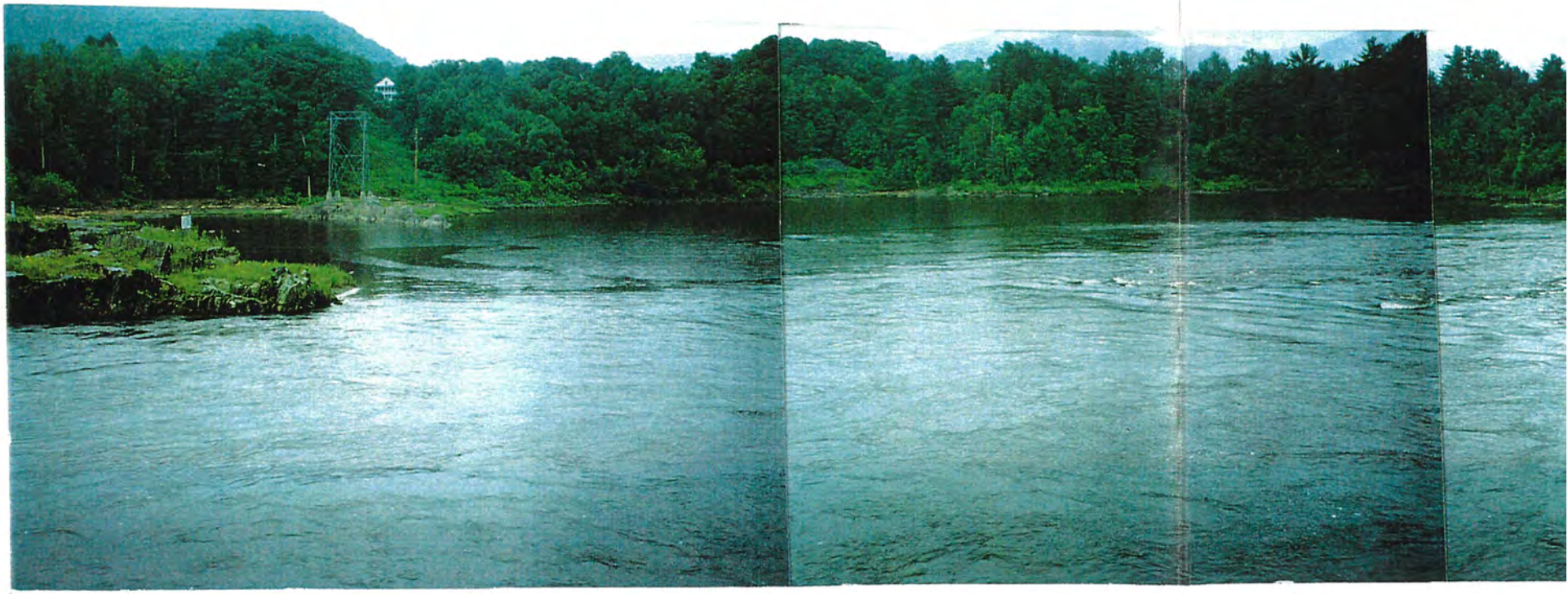
Participants in the field evaluation of riverine aquatic habitats associated with the Fifteen Mile Falls Hydroelectric Project, 29 July through 1 August, 1996. Individuals participated in the evaluation of all four areas unless otherwise noted.

Steve Damiano, NEP (Comerford Tailrace and McIndoes Tailrace only)
Scott Decker, N.H. Fish and Game
Laura Eaton, U.S. Fish and Wildlife Service (Comerford Tailrace only)
Alec Giffen, Land and Water Associates
Dayton Goudi, Trout Unlimited
Mike Hill, Atlantic Salmon Federation (Comerford Tailrace and McIndoes Tailrace only)
Bill Ingham, N.H. Fish and Game (Comerford Tailrace only)
Cleve Kapala, NEP (Comerford Tailrace and Upper Moore Impoundment only)
Eric Palmer, Vermont Department of Fish and Wildlife (VDFW)
John Ragonese, NEP
Cheryl Ryder-Keiffer, VDFW
Steve Shepard, Gomez and Sullivan Engineers (GSE)
Kirk Smith, GSE (Comerford Tailrace only)
Tom Sullivan, GSE
Nat Tripp, Connecticut River Joint Commission
John Warner, USFWS
Rod Wentworth, VDFW

APPENDIX 2

Reproductions of photographs of the river reaches adjacent to the McIndoes, Comerford, and Moore hydroelectric generating stations of the Fifteen Mile Falls Project. Photo labels denote locations downstream of McIndoes Station (MC), Comerford Station (C), Moore Station (M) and upstream of Moore Station (G).

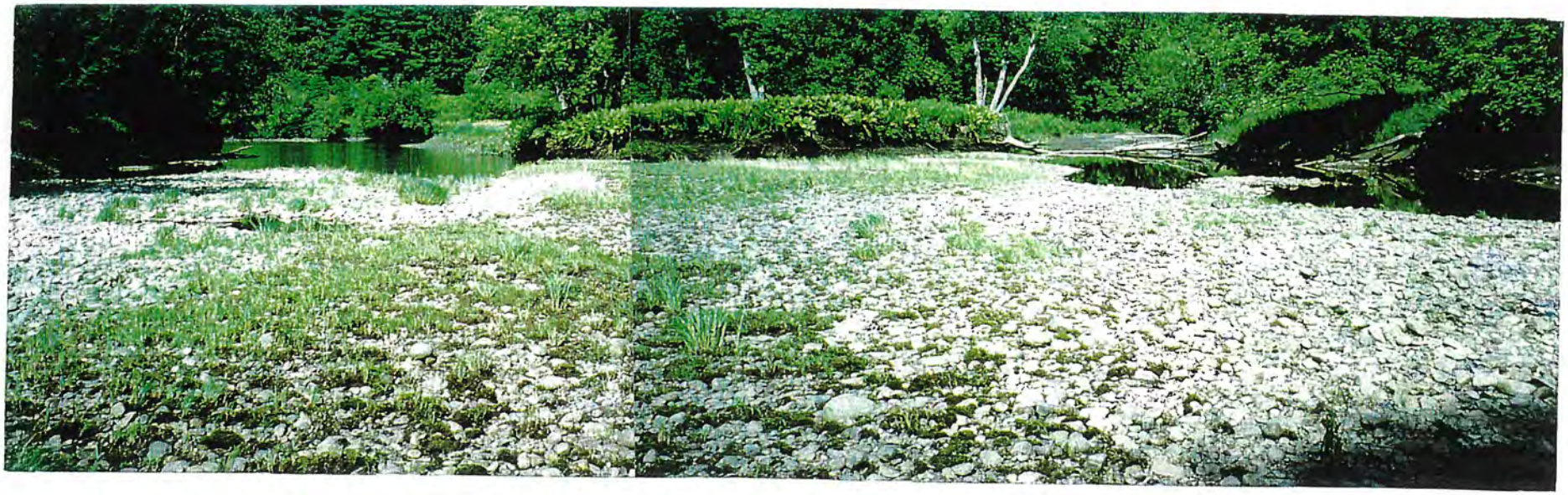




Photos MC1 and MC2: McIndoes tailrace at flows of 2,300 cfs (photo MC1, upper) and 5,600 cfs (photo
1996. The shallow area noted in the text is evident in the center of photo 2. The larger eddy described in t
background, with the smaller eddy in the left background. The photo location and orientation is shown on

Photo C1: Comerford tailrace excavated channel looking upstream. Flow of 800 cfs on 29 July 1996. See Figure 2 for photo location.

Photo C2: Comerford tailrace excavated channel looking upstream. Flow of 9,400 cfs on 29 July 1996. See Figure 2 for photo location.



Photos C3 and C4: Nine Islands habitat area H at a leakage flow (photo C3, upper) on 17 September 1996, and a flow of 800 cfs (photo C4, lower) on 29 July 1996. The cobble and vegetation substrates are also typical of portions of habitat areas A-D and I. The photo location and orientation is shown on Figure 3.

Photo C5: Nine Islands habitat area J looking south. Leakage flow on 17 September 1996. See Figure 3 for photo location.

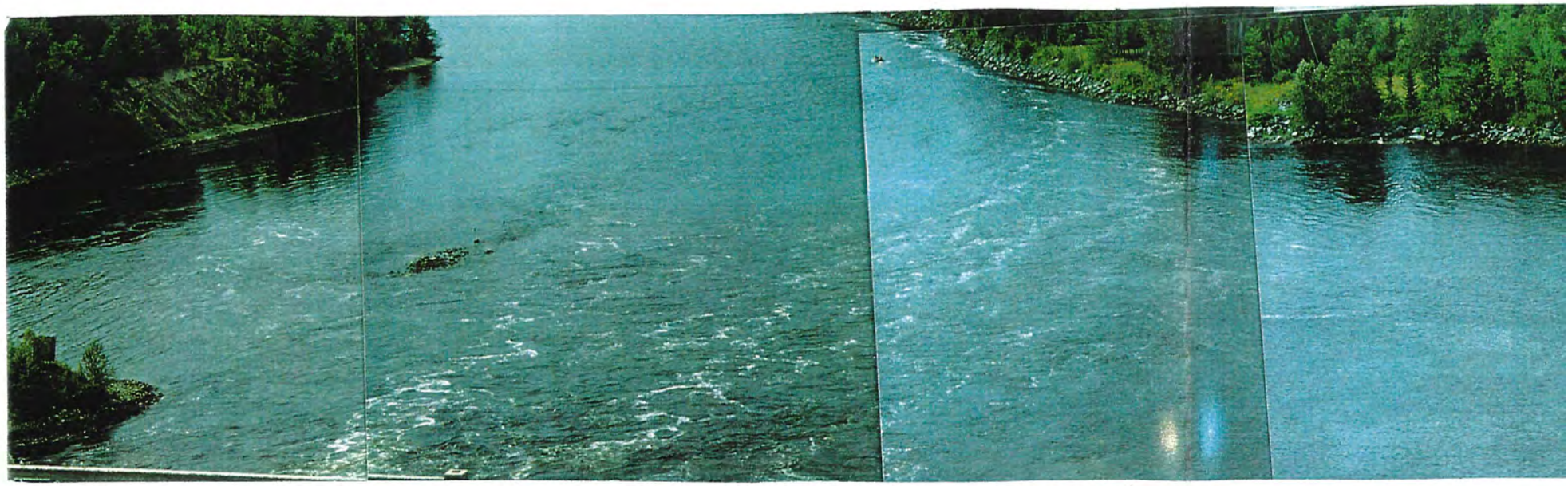
Photo C6: Nine Islands habitat area J looking north. Flow of 800 cfs on 29 July 1996. See Figure 3 for photo location.

Photo C7: Nine Islands habitat area M looking downstream. Leakage flow, 17 September 1996. See Figure 3 for photo location.

Photo C8: Nine Islands habitat area M looking downstream. Flow of 800 cfs on 17 September 1996. See Figure 3 for photo location.

Photo C9: Nine Islands habitat area A looking downstream. Leakage flow, 17 September 1996. See Figure 3 for photo location.

Photo C10: Nine Islands habitat area C looking downstream. Leakage flow, 17 September 1996. See Figure 3 for photo location.



Photos M1 and M2: Moore tailrace at flows of 1,100 cfs (photo M1, upper) and 9,400 cfs (photo M2, lo
shallow areas described in the text and noted on Figure 4 are exposed in photo M1, with the largest shal
scattered exposed rocks in the left background. The photo location and orientation is shown on Figure 4

Photo G1: Upper Moore impoundment looking upstream. Flow of 4,540 cfs on 1 August 1996. See Figure 5 for photo location.

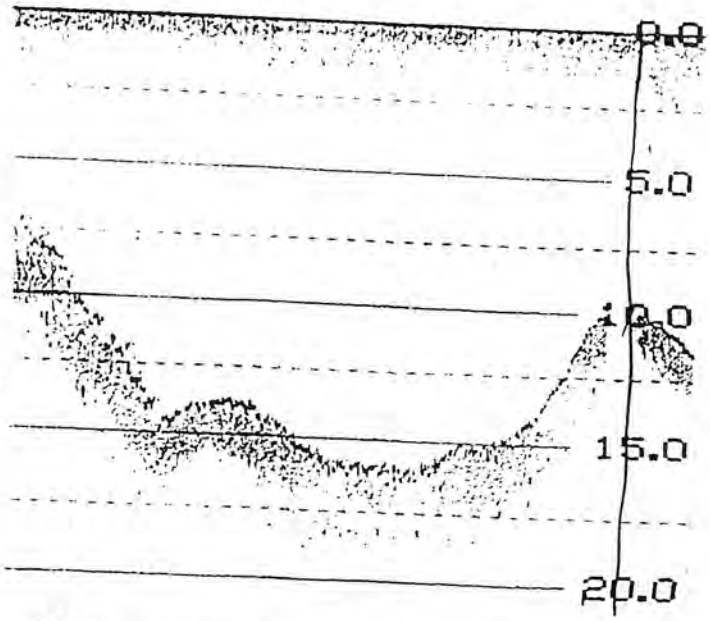
Photo G2: Upper Moore impoundment looking downstream. Flow of 4,540 cfs on 1 August 1996. See Figure 5 for photo location.

APPENDIX 3

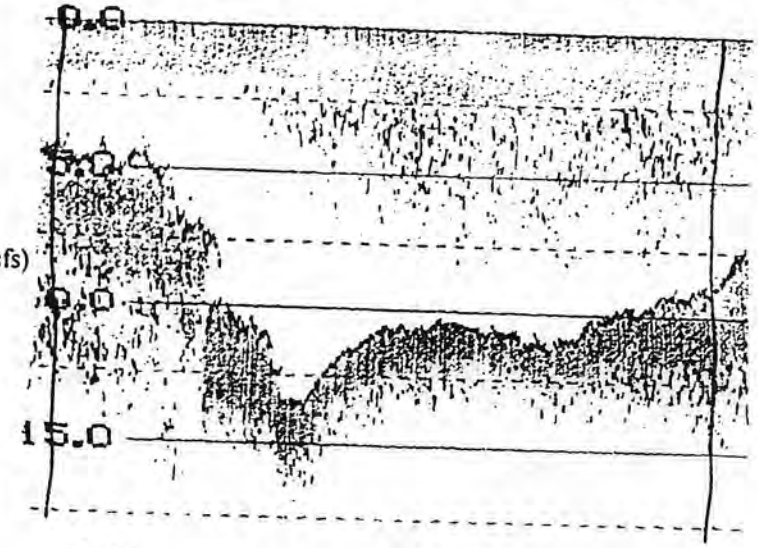
Strip chart depth profiles of habitat in riverine areas of the Fifteen Mile Falls Hydroelectric Project.

- Depth transects were recorded with a Lorantz model X16 fathometer.
- Depth transect end points were located with a Trimble DGPS.
- Depth transect locations are noted on Figures 1 through 5 in the body of the report.
- Transects were recorded from west to east unless otherwise noted.
- Vertical scales vary and are shown on each transect.
- Transect labels denote Comerford Tailrace (C), Moore Tailrace (M), or Upper Moore impoundment (G).
- Depth transects are shown from upstream to downstream within each habitat area.

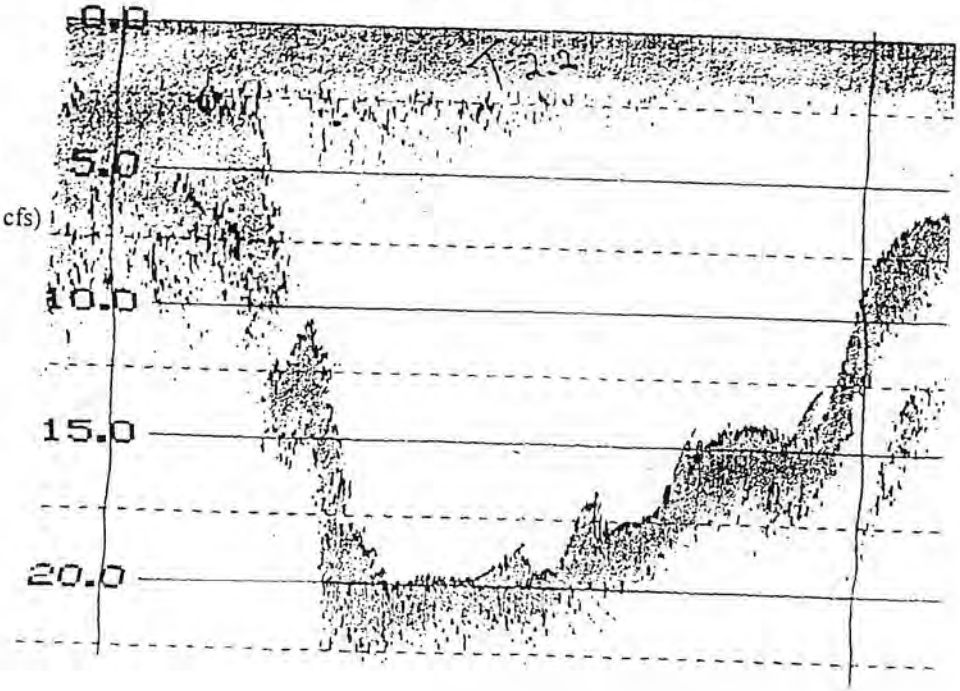
C1
(800 cfs)



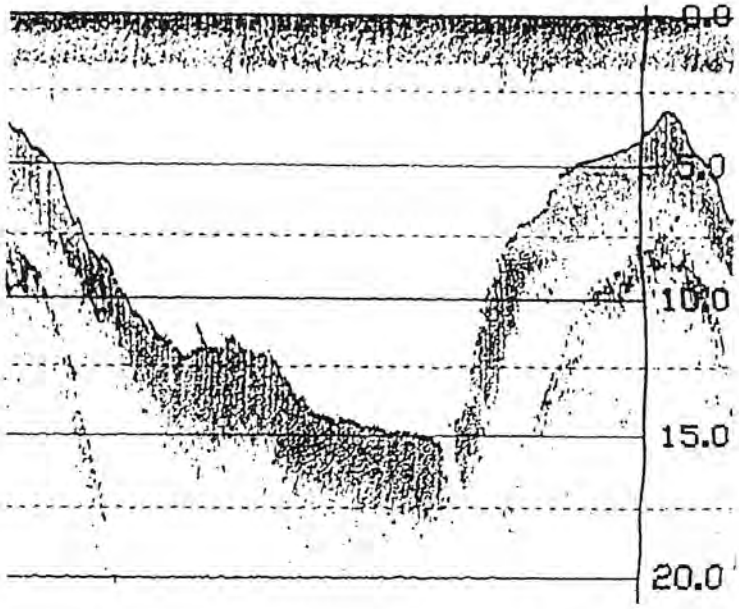
C6
(9,400 cfs)



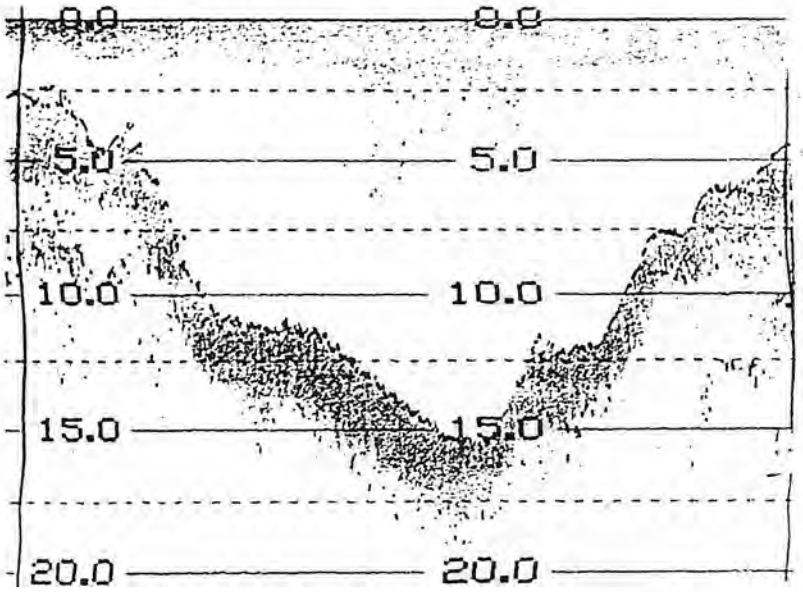
C7
(9,400 cfs)



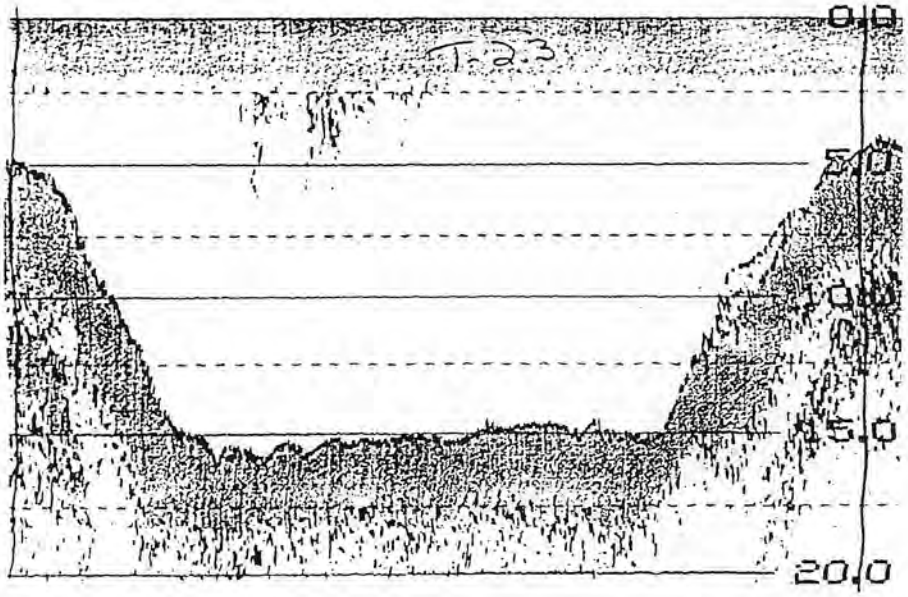
C2
(800 cfs)



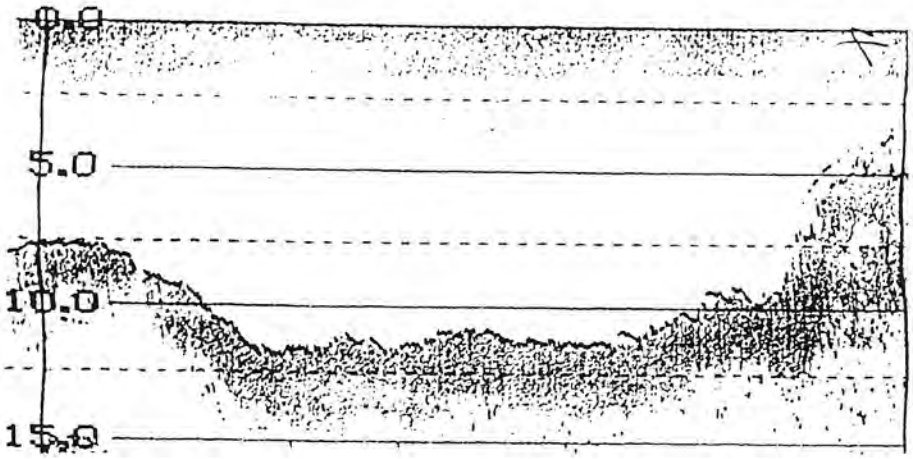
C3
(800 cfs)



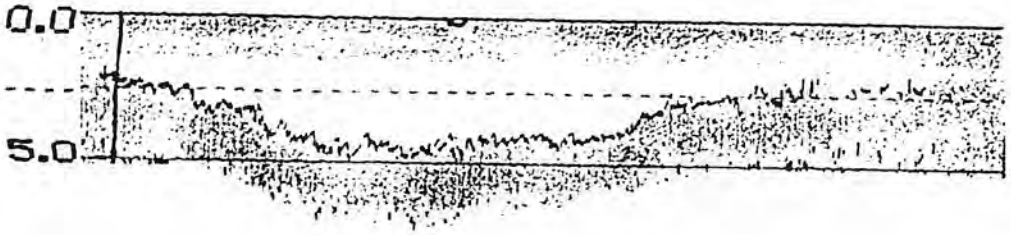
C8
(9,400 cfs)



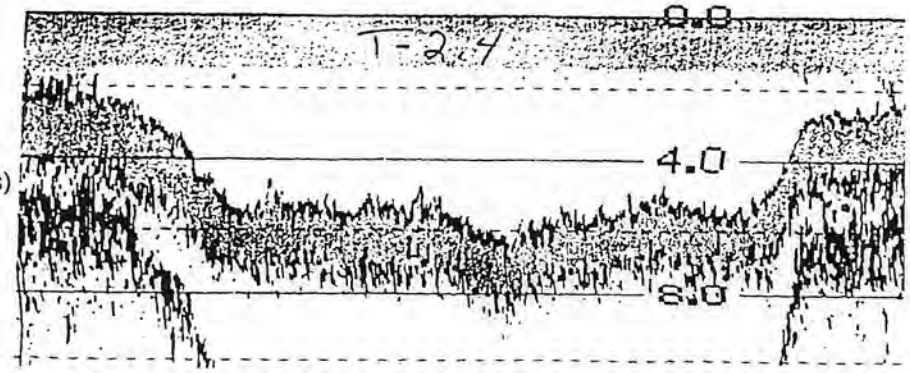
C4
(800 cfs)

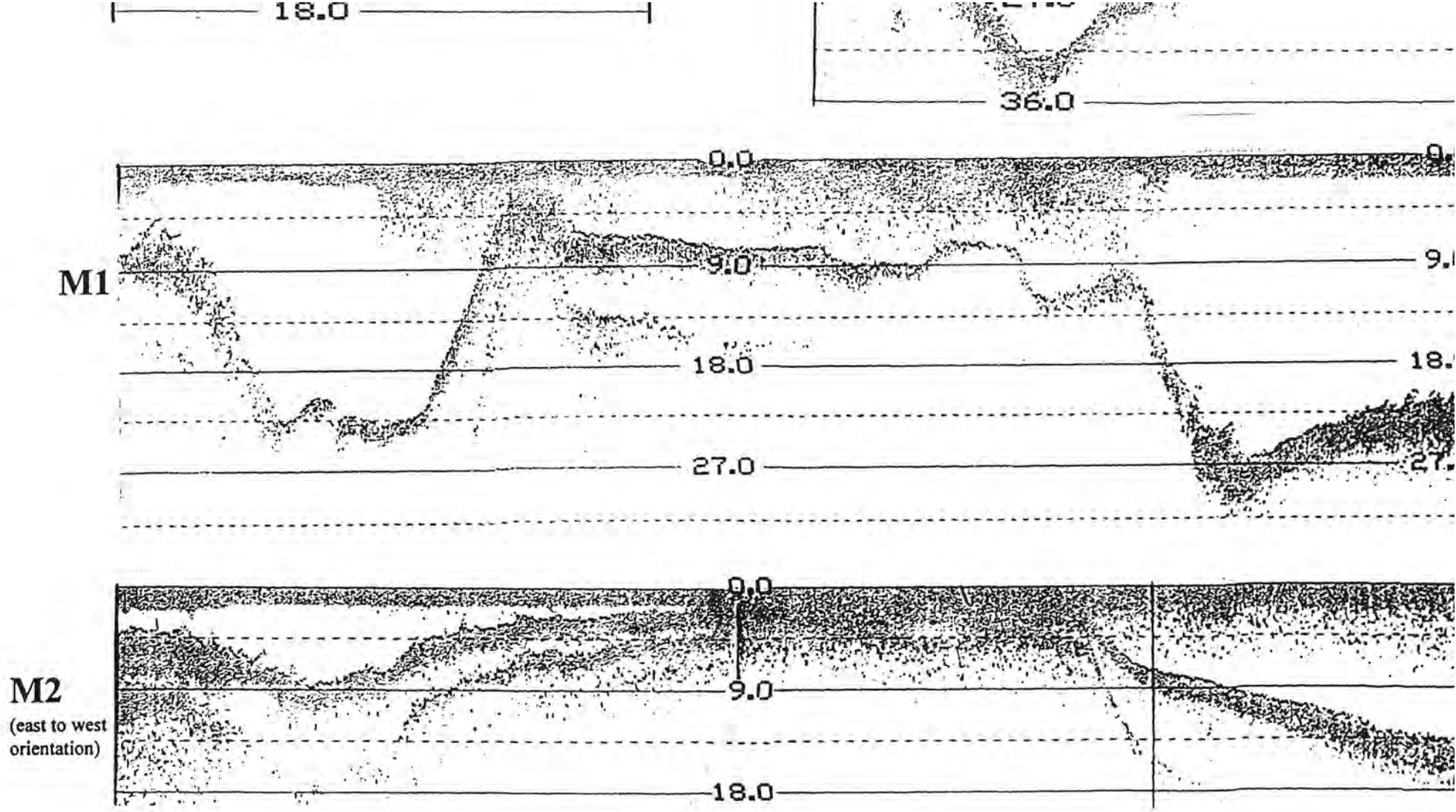


C5
(800 cfs)



C9
(9,400 cfs)




18.0
36.0
M1
0.0
9.0
18.0
27.0
M2
(east to west orientation)
0.0
9.0
18.0