MINISTRY OF TRANSPORTATION

ONTARIO

2008 TAC Environmental Achievement Award Submission

SALMON RIVER

FISH HABITAT COMPENSATION PLAN

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Background

Highway 401 is the main highway transportation corridor spanning the entire length of southern Ontario. The Highway 401- Salmon River Bridge is located in south eastern Ontario between Belleville and Napanee. Constructed in 1956, this five span, 126 metre long, by 31 metre wide structure required extensive rehabilitation of both superstructure and substructure elements. Widening of the structure was required to accommodate construction staging and to facilitate future highway expansion requirements.

The project basically involved widening of the deck by 2.9 m on each side, installation of new steel girders, widening of the piers, abutments and approach grades and the installation of a bridge anti-icing system. Construction of this two year project began in September of 2004.

Environmental Significance

The Salmon River, in the vicinity of the highway crossing, is a relatively shallow, slow moving, "warm water" watercourse. Flows and levels are seasonal and highly variable. They tend to exhibit flood conditions in the spring and low channel flow in late summer. Water quality is affected by upstream and adjacent agricultural land uses.

Of particular interest to this project however, was the riverine habitat supporting a warm water fishery. Secondary source information suggested that the Salmon River watershed supports some thirty species of warmwater sport and bait fish. Site specific habitat assessment studies, including electrofishing sampling, indicated some thirteen species of fish were utilizing the available habitat. Northern Pike (Esox lucius) spawning habitat was noted downstream of the bridge.

At the time of the site investigations, the Ministry of Natural Resources (MNR) reported the Salmon River contained three rare species of fish. The first is the River Redhorse (Moxostoma Carinatum), designated vulnerable by MNR and designated as special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The second species is the Greater Redhorse (Moxostoma Valenciennesi) which is considered rare to uncommon provincially by MNR. The other being the Channel Darter (Percina Copelandi), which had been sited only once further up-stream in the Salmon River, is listed as threatened under the Species at Risk Act and COSEWIC. The Channel Darter's main threat to survival is increasing sedimentation and deteriorating water quality associated with agriculture and development as well as the fluctuations in water temperature.

Fisheries Compensation

A project of this scope and magnitude typically affects many environmental features, but for the purposes of this paper, we have focused on the impacts, mitigation and compensation of the fisheries and aquatic habitat. Construction involved significant disturbance and alteration of this habitat in order to access the construction areas and undertake the necessary work.

The total area of fish habitat alteration was estimated to be in the order of 3,633 square metres. It was clearly evident construction impacts would result in a Harmful Alteration Disturbance and Destruction of Fish Habitat (HADD) and therefore trigger a requirement to obtain an "Authorization For Works Or Undertakings Affecting Fish Habitat" from Department of Fisheries and Oceans. The Authorization to proceed was conditional upon a plan to create 7450 square metres of fish habitat with a desire to target the nationally and provincially threatened species at risk.

Presence of suitable habitat for the Channel Darter raised the profile of this project with the regulatory agencies, notably the federal Department of Fisheries and Oceans and the Ontario Ministry of Natural Resources. Extensive consultation and liaison with these agencies occurred throughout all stages of this project. It was acknowledged by all parties that there was a significant opportunity to improve the existing habitat. The ministry was open to consider both new and proven measures to create and enhance the fisheries habitat in this area.

Key elements of the compensation plan included the following (Figure 1):

- a 2:1 compensation ratio
- Installation of five floating log structures- providing in stream cover and enhanced habitat in the backwater embayment areas.
- Placement of a gravel liner between two piers to enhance the habitat for Channel Darter spawning and increase the complexity of habitat for other species of fish.
- Installation of 112 boulders and boulder clusters to augment the gravel liner, providing habitat suitable for Channel Darter spawning and enhancement of the overall habitat structure and diversity for a variety of warmwater species.
- Pike spawning area restoration and enhancement creating spawning channels and rock core hummocks
- Mud flats providing erosion protection and enhancing fish rearing habitat
- A low flow channel improving fish habitat in a backwater embayment area.

Innovation

The two elements of the compensation plan relating to the Channel Darter and pike spawning habitat were quite challenging for the Ministry designers and consultants. Ministry of Natural Resource staff was familiar with the habitat requirements and were able to collaboratively assist with some of the design details. The design goal was to create suitable habitat conditions underneath the structure. This was a first for the Ministry; historically we had not encountered habitat creation for the Channel Darter and were unsure of its success.

To address the channel darter's habitat requirements, a clean beach stone liner was placed along the bottom of the river for the full length of the structure (Figure 10). The stone material ranged from coarse sand (0.5 mm) to large cobbles (256 mm). The material was also mixed with an angular stone to prevent the material from being moved out of place by the current. Due to the length of the bridge the material was placed by a telescoping conveyor system utilizing a slinger with a pipe trunk system (Figure 7 & 9). Boulders ranging in size from 512 metres to 1024 millimetres were then placed randomly at a 4.0 metre to 6.0 metre centre spacing. The boulder clusters were comprised of two to three boulders piled against one another on top of the liner. The boulder clusters created deep pools and sluggish riffles.

Pike spawning area restoration and enhancement was something that the Ministry had experience designing. However on this project, the site conditions invited new innovative measures to enhance spawning habitat. Fish biologists at DFO and MNR were very supportive and assisted the Ministry and their design consultants in developing pike channel designs and enhanced embayment areas. Habitat enhancement techniques such as "peat pots" and rock core vegetated hummocks were experimental in comparison to typical Ministry applications.

The first technique was the placement of peat pots filled with soil and staked upside down to the river bed (Figure 4 & 6). A vegetated rock berm was created to protect this area, forming a backwater embayment area. The organic and silt materials were excavated and replaced with topsoil graded to an inward sloping elevation to prevent ponding and entrapment of fish. A large number of peat pots were filled with soil and staked upside down in a cluster. Old trees with their root wads were then interspersed throughout the area (Figure 12). Approximately 30,000 aquatic plants were planted on top and throughout the sides of the peat pots. During the early spring the backwater embayment would become naturally flooded. This new habitat provides important spawning and rearing location for a diversity of fish, especially pike. This design was placed in the north-east and south-west quadrants of the bridge.

The other technique used to develop spawning habitat was the construction of hummocks with a rock core base (Figure 5 &11). Rock material was used to form the shape of a 2 metre x 1 metre mound with soil placed over top of the rock and vegetated with aquatic plants. The nine hummocks were symmetrically placed with a 0.6 metre channel between them. An erosion blanket that would dissolve over winter was placed over the hummocks and a temporary rock berm was placed around them to prevent the material from being washed away over the winter months. During high water conditions, the hummocks were to allow several species of fish including pike to spawn along their vegetated sides.

Other Features

Downstream of the bridge, there are two backwater embayment areas. These areas provided an opportunity for additional fish habitat enhancement (Figure 8). Five floating log clusters were anchored to steel pilings driven into the riverbed. The log clusters were established in this area to provide habitat diversity. Numerous minnow species and fresh water clams (Figure 3) were observed as well as 50 painted turtles, resting and sunning themselves.

Other features of the plan presented an opportunity to address poor site conditions. In the northwest quadrant an existing bank erosion problem was corrected with the installation of rock protection. Also, in this location as part of the site restoration activities, a mud flat was created. The rocky shoreline and mudflats provided protection, feeding and rearing habitat for young fish.

In the northeast quadrant, there was a backwater embayment area with limited fish utilization. It provided another opportunity to enhance fish habitat diversity. A low flow channel was created and log clusters were introduced providing new areas for feeding and rearing habitat.

Mitigation

The key mitigation measures used in the construction staging activities are summarized as follows:

- Suspended working platforms and non-motorized water crafts were used to prevent saw cutting effluent and debris from entering the river and avoid in water disturbance.
- isolation of the work using coffer dams and other techniques.
- installation and maintenance of erosion and sedimentation control measures such as silt fence, sediment bags and turbidity curtains.

The use of construction equipment access roads and working platforms/pads providing access to the piers was a difficult challenge for the designers. In addition to the standard mitigation measures, other key mitigation techniques were put in place to minimize the duration and footprint impacts to the river when intrusive access was required. The use of "clean" aggregate was placed over a geomembrane base to create access roads and construction pads. This minimized disturbance to the organic substrate and prevented the rock material from "disappearing". It also greatly facilitated the removal and restoration of the work areas.

All of the above construction activities were regulated by an Operational Constraint that prohibited in water work from March 16 to June 30. This is the standard "warm water" timing constraint imposed by the Ministry of Natural Resources in this area. Given the presence of Northern Pike spawning habitat this was an important mitigation measure that imposed significant controls on construction staging options. This resulted in many activities occurring in the late fall and winter seasons.

Monitoring

A weekly environmental monitoring report with supportive photos was submitted to Department of Fisheries and Oceans throughout construction. These reports captured the installation of the compensation work and conditions of the site as it was being constructed. The daily monitoring of the site documented the preliminary success of the rock core hummocks after one year of its installation. Warm water bait fish and sport fish were observed surrounding the rock core hummocks including young-of-the-year Pike.

The Ministry was required to monitor the compensation work for 2 years after construction was completed. This spanned the period 2007 and 2008. Given some of the unique features of the compensation plan and the successful results, the Ministry intends to extend the monitoring exercise into 2009.

The monitoring program was established to determine what type of species were present and how they were using the newly created habitat. It also provided feedback on the survival rate of the vegetative plantings and overall conditions of the habitat structure.

The monitoring program involved field surveys undertaken in the spring, summer and fall seasons. The monitoring techniques involved fish sampling using gill nets, fyke nets, and windermere traps. Direct observation of the spawning habitat created for the Channel Darter, using snorkelling techniques, was also used. Several photos and specimens of captured fish were taken for positive identification, in particular the Channel Darter.

The first year of compensation monitoring*:*

During the spring of 2007, warm water sport and bait fish species in various stages of development were observed around all of the compensation features.

During the summer monitoring period the peat pot embayment area showed considerable fish use. Nine different species of fish were identified including young-of-the-year for species such as Pumpkinseed, Johnny Darter, White Sucker and Banded Killifish were observed.

Other compensation measures, such as the gravel liner under the bridge, were monitored through a snorkelling survey. Ten warm water sport and bait fish species were observed. The floating log structures and offline connecting channel had seven other fish species at different stages of the life cycle. The results of the field investigation both in the spring and summer did not report the sighting of the Channel Darter or Northern Pike.

It was not until September 4th, 2007, when the consultant had started their fall monitoring program that all the research, planning and actual construction of the compensation was to totally reach expectations. The Channel Darter, listed as threatened under SARA, was found over the gravel liner underneath the bridge.

The second year of compensation monitoring:

In 2008, the same monitoring methodology was carried out in the 2nd year of field investigations. The compensation measures had been in place for 2 years and appeared to be generally stable. The extensive vegetative plantings were well established. The results of the spring surveys were more than we could possibly hope for. The May surveys had captured 4 channel darters (Figure 2) underneath the bridge, which included a female with roe. The June survey also confirmed at least 12 more channel darters under the structure. The experimental design of the pike spawning channels revealed 3 young-of-the-year Pike in 2 quadrants of the bridge.

Cost

The original cost of the fisheries compensation plan was estimated to be 1.22% of the overall $14 million dollar contract. Minor adjustments occurred during construction but actual cost increases are not considered significant. The material for the compensation was constructed of native and natural materials such as earth, rock, peat pots, plants and trees. Some of the measures were labour intensive, (e.g. peat pots) and some required special equipment (the gravel liner). Difficult construction access and stringent environmental protection measures came with a cost premium.

Applicability to Transportation

Expansion and rehabilitation of highway transportation corridors have varying degrees of impact on our ecological systems. In particular, the construction impacts to our valuable fisheries and aquatic habitat necessitate the need to develop effective measures to compensate and enhance habitat. This project enabled the Ministry to implement some of the innovative designs such as the gravel liner and pike spawning channels and monitor its success for use on other applications. The materials used within the project are environmentally friendly, natural and can be easily utilized and sourced.

The mitigation and compensation measures utilized also provide easy and effective ways for others in the industry to protect fish and enhance aquatic habitat.

Acknowledgements

The Ministry of Transportation would like to acknowledge the following for their contributions and efforts towards this project:

Ecotec Environmental Consulting
LGL Limited Environmental Research Assoc.
LEA Engineering
G.D. Jewel Engineering Inc.
Aecon Construction
Ministry of Natural Resources
Department of Fisheries & Oceans

Background Reports

As part of the Environmental Assessment and Habitat Monitoring the following are the environmental reports conducted during the study.

Clark, Douglas. 2007. One Year Fish Habitat Monitoring Report. Highway 401 Salmon River Bridge Rehabilitation, Salmon River Fish Habitat Compensation Measures. Ecotec Environmental Consultants Inc. 15pp, Tables & Drawings.

LGL Limited Environmental Research Associates. 2004. CEAA Environmental Screening Report, Highway 401 Rehabilitation of the Salmon River Bridge. 8, 27, 41pp

LGL Limited Environmental Research Associates. 2003. Fisheries Report Existing Conditions. Highway 401, Salmon River Bridge Rehabilitation.

LGL Limited Environmental Research Associates. 2003. Existing Conditions. Highway 401, Salmon River Bridge Rehabilitation.

Kauffman, Grant & Fitzgerald, Constance. 2004. Environmental Screening Document. Salmon River Bridge. LGL Limited Environmental Research Associates. 17, 18, & 25.

G.D. Jewell Engineering Inc. 2006. Report Summarizing Results of Construction Phase Environmental and Fisheries Monitoring. Hwy 401. Salmon River Bridge.

Government of Canada. Species Profile. www.sararegistry.gc.ca/species/speciesDetails

Martin, Spencer. 2004. Department of Fisheries and Oceans. Authorization for Works or Undertakings affecting Fish Habitat for the Salmon River.

King, Jeff. Memorandum. Habitat Monitoring, Salmon River. McIntosh Perry Consulting. 2008.

Figure 4: Planting peat pots for pike spawning. Photo by Jewel Eng.

Figure 5: Rock core hummocks. Photo by Jewel Eng.

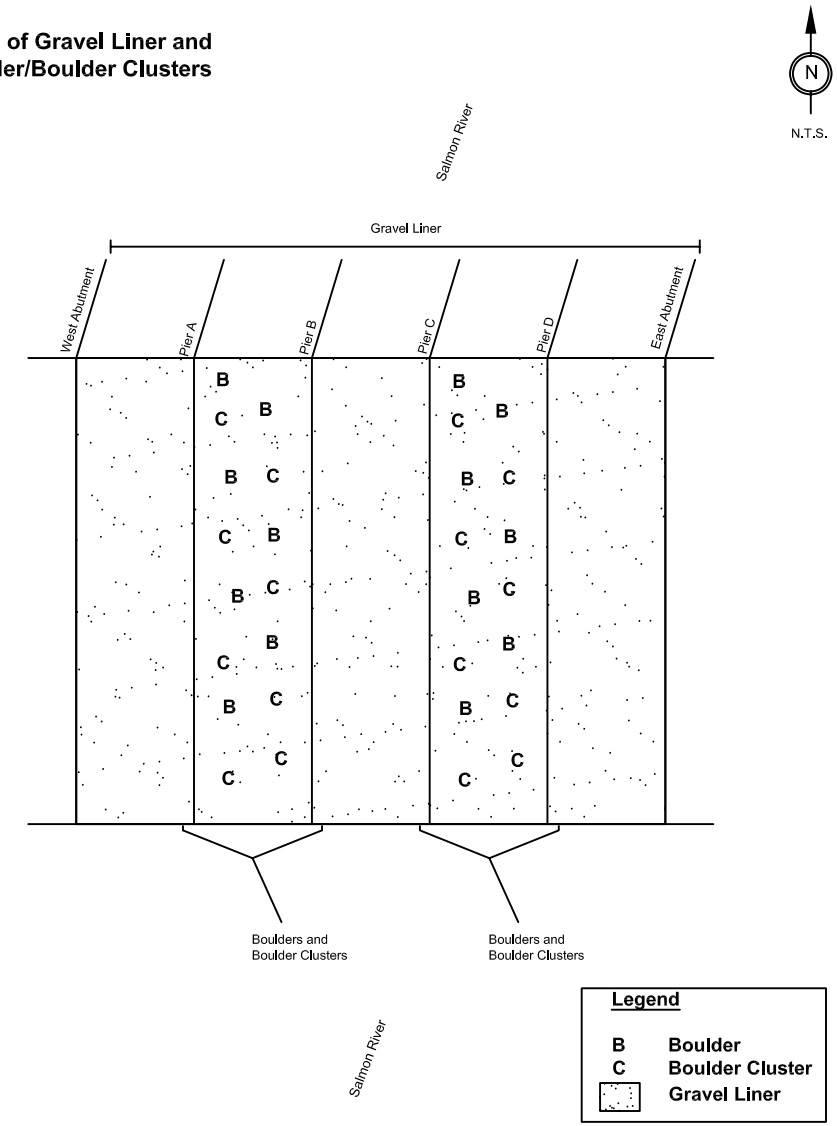
Figure 6: NW quadrant of Bridge. Completed pike spawning habitat design. Photo by Jewel Eng.

Figure 7: Installing rock liner under structure. Photo

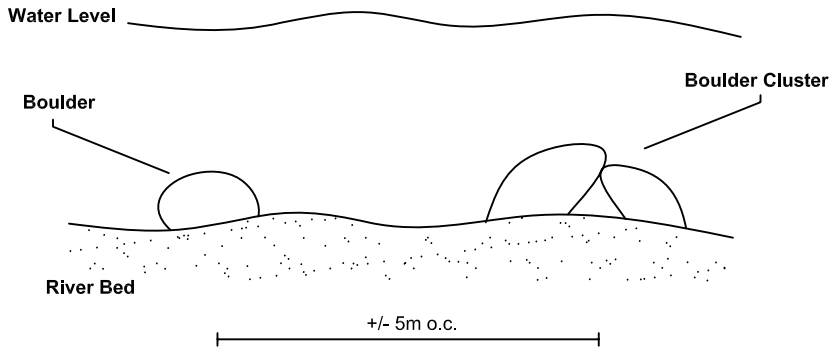
Figure 8:Anchored log clusters in the backwater embayment area. Photo

Figure 9: Slinger with a pipe trunk system installing the gravel liner underneath the structure. Photo by Jewel Eng.

Detail of Gravel Liner and Boulder/Boulder Clusters



Boulder/Boulder Cluster - Typical Section



Note 1: Boulders to be derived from rough quarry stone and range in size from 512 mm to 1024 mm.

Note 2: Boulder clusters to comprise 2-3 leaning one against the other.

N.T.S.

Figure 10

Designed by LGL Limited
Environmental Consultants

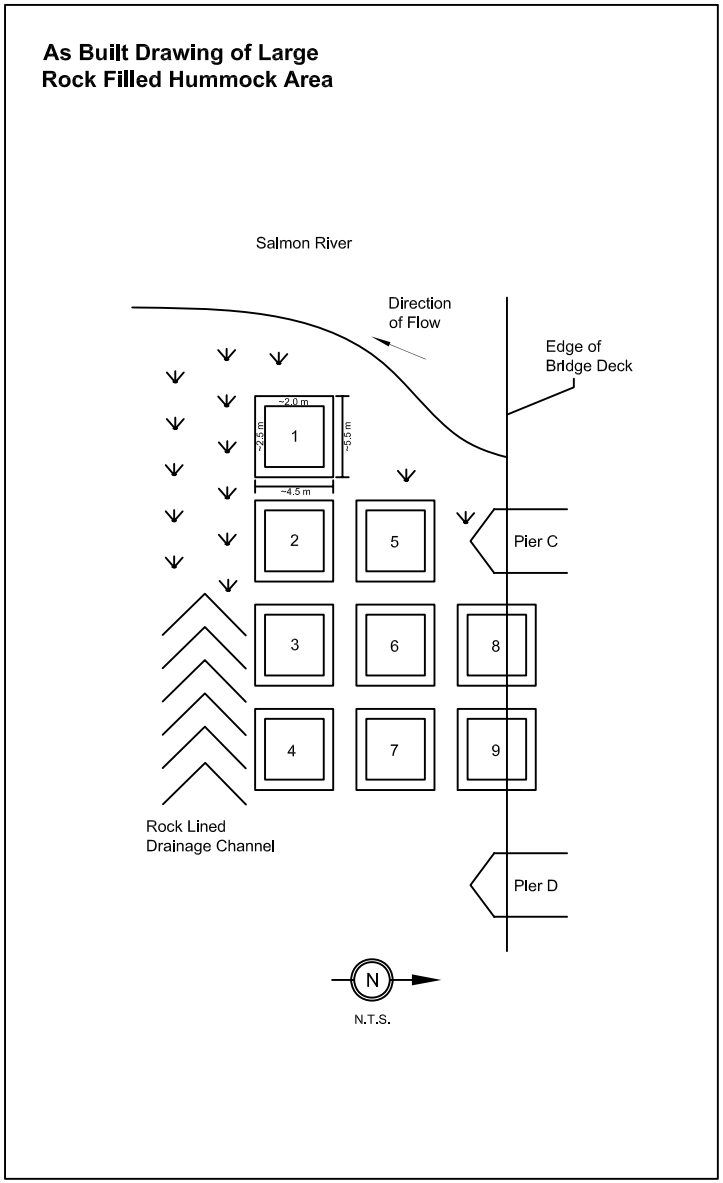
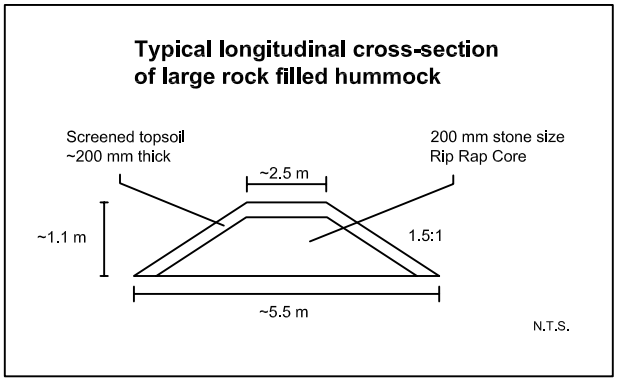


Figure 11



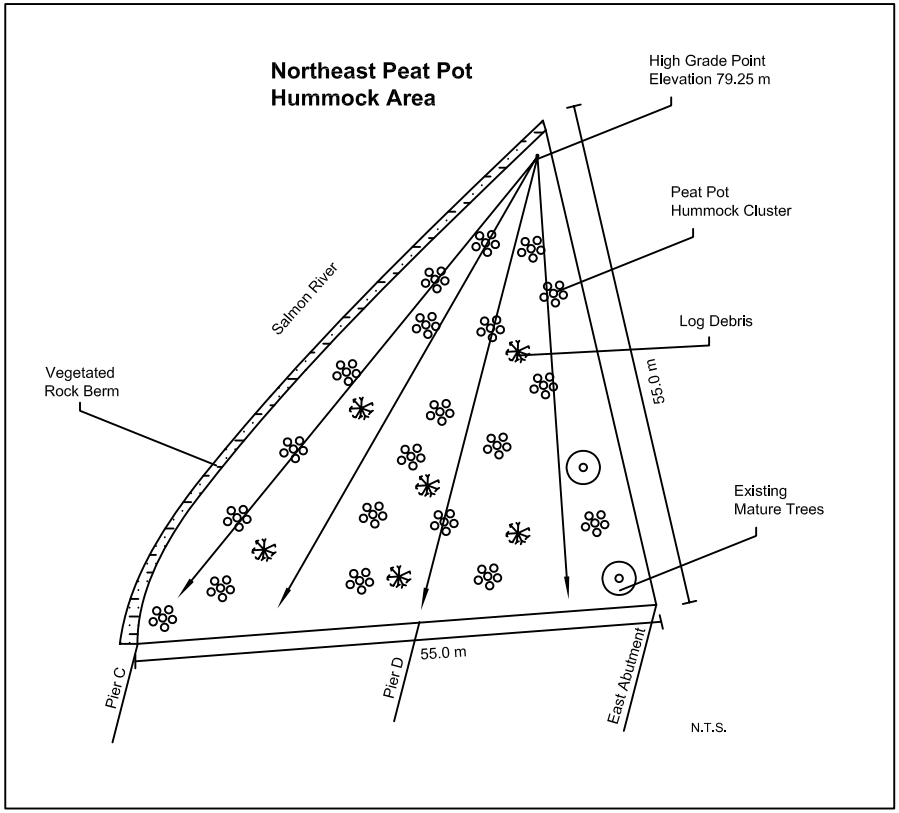


Figure 12

Designed by EcoTec
Environmental Consultants

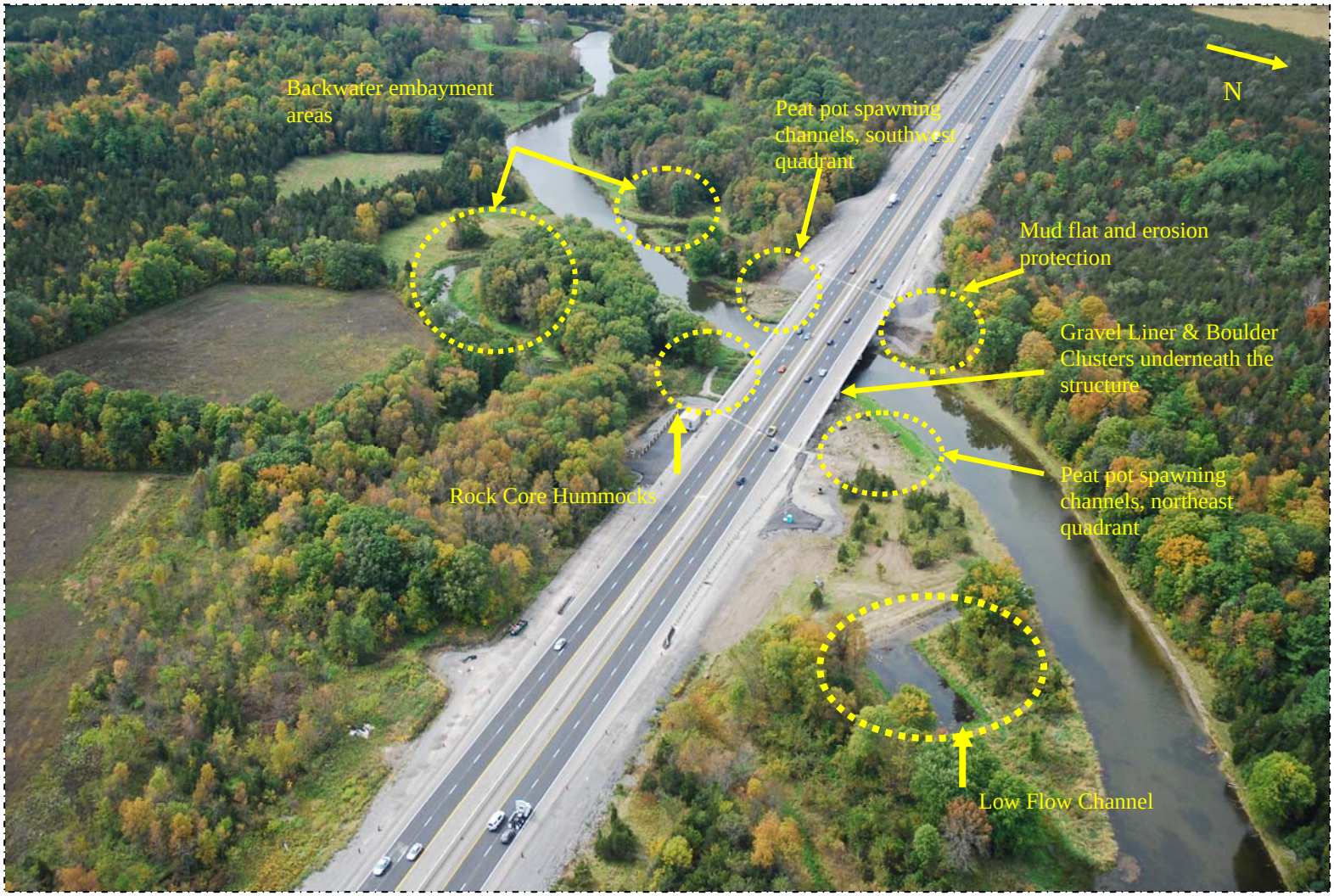


Figure 1: Indicating areas of enhancement. Photo by Aecon Construction

Figure 2: Captured channel darter during monitoring. Photo by Ecotec

Figure 3: Fresh water clams. Photo by Jewel Eng.