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February 11, 2010
File: 121510031

Transportation and Infrastructure Renewal
1672 Granville St PO Box 186
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Attention: Mr. Cross

Dear Mr. Cross:

Reference: Revised Report on the Environmental Review of Highway 104 West River Bridge Options

1.0 INTRODUCTION

At the request of Nova Scotia Transportation and Infrastructure Renewal (NSTIR), Stantec Consulting Ltd. (Stantec) has prepared the following letter report to present a comparative analysis of crossing scenarios for the West River. Primarily, the report compares the potential environmental impacts of the originally approved 241 metre (m) four span bridge configuration with those anticipated for a 140 m, two span bridge configuration incorporating bridge approach fills. For discussion purposes, the areas of potential disturbance associated with these scenarios are compared with the existing condition or reference scenario of no bridge and the previous proposal (October 2009). It is noted that areas of potential disturbance identified in the October 2009 report are consistent with those associated with the 140 m, two span bridge configuration incorporating bridge approach fills.

The three scenarios considered in preparing this report included the baseline condition (no bridge) (Figure 1) the original design (241 m bridge) (Figure 2) and the 140 m bridge and approach fill scenario (Figure 3). Areas of habitat disturbance were calculated from footprints within the proposed RoW width associated with access roads and work areas, piers and abutments and bridge approach fill areas. Bridge spans were not considered in footprint calculations. The comparison of aquatic impacts was based on scour potential predicted for the bridge scenarios.

2.0 BACKGROUND

In the summer of 2009, Nova Scotia Transportation and Infrastructure Renewal (NSTIR) requested a consulting team comprised of Stantec Consulting Ltd. (Stantec) and RV Anderson Associates Limited (RV Anderson) to undertake environmental and hydrotechnical studies with respect to potential design changes for the proposed bridges at the West River, in Antigonish NS, associated with the planned development of the Highway 104. These studies required investigation of the potential effects of an alternate bridge design on the hydrological, hydraulic and fluvial dynamics at the West River. The initial design proposed was for a 241 m four span bridge that entirely spanned the West River and its floodplain. The alternate design considered potential variations on spanning the river and floodplain such as a 30% span and 70% approach fill or 50% span and 50% approach fill. In general, the addition of bridge approach fills as a design element is expected to significantly reduce capital costs compared with a completely free- spanning structure. While the study focussed on the hydrodynamics of the river, consideration was also given to the potential environmental effects on aquatic and terrestrial environments associated with the alternate design.

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The study requested by NSTIR in the summer of 2009 had two components: the hydrotechnical review and modeling exercise and the environmental review. This report represents an update to the 2009 *Environmental Review of Highway 104 West River Bridge Options* and is a companion document to be read in conjunction with the updated *Hydrotechnical Review of Highway 104 Antigonish West River Bridge Options* (RV Anderson 2010). For the purposes of the 2009 environmental field study and report, evaluation of the alternate design considered the extent of the area within the proposed Right of Way (RoW) that could be infilled for bridge approaches with minimal disturbance to the intervale habitat and rare plants present rather than specific percentages of span and approach fill. That is, an attempt was made to balance the amount of causeway that could be used against potential adverse environmental effects associated with infilling. This updated report includes the original assessment from the October 2009 report with relevant updates requested from NSTIR as described below.

Following completion of field work in August of 2009 and submission of the report in October 2009, NSTIR circulated the hydrotechnical and environmental reports to relevant provincial and federal government departments and the Highway 104 at Antigonish Community Liaison Committee (CLC) for their consideration and comment. In response to comments received on these reports from the Nova Scotia Department of Natural Resources (NSDNR), the Department of Fisheries and Oceans (DFO), and the CLC, NSTIR has requested that the reports be revised to address comments received. A summary of the comments and responses are provided in a response table in Attachment A.

In response to the CLC comments, NSTIR has requested that the following scenarios be considered to provide a comparison of potential impacts on the habitat at the West River Crossing:

- Scenario 1 Baseline condition - No new bridge;
- Scenario 2 - Original 241 m, four span bridge design; and
- Scenario 3 - 140 m, two span bridge configuration with approach fills.

The environmental study considered potential effects on sensitive species and ecologically sensitive areas through a combination of desktop and field studies. The information prepared from the environmental and hydrotechnical studies provided input to NSTIR and other government officials on the capacity of the sensitive species and areas to tolerate potential changes and to assist with the evaluation of the various bridge configuration options.

In addition to the updates to the 2009 hydrotechnical and environmental *Review of West River Bridge Options* reports, NSTIR has requested that a visual rendering be undertaken to show the anticipated limits of flooding in the vicinity of the existing and proposed bridge for the original 241 m four span bridge design and a 140 m, two span bridge configuration with bridge approach fills.

Scope of Work and Deliverables

The scope of work for the environmental study included the following:

- Desktop studies that include collection, compilation and review of existing data for the area;
- Preparation of field maps;
- Completion of a field visit to verify existing aquatic and terrestrial conditions and vegetation types and transition areas as well as collection of GPS points in areas requiring particular consideration; and

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- Preparation of a report and mapping to present findings of the desktop study and field work and to propose recommendations to minimize potential impacts.
- Preparation of a response to comments received from regulators and the CLC and updates to the environmental report.
- Preparation of a summary table and accompanying figures presenting habitat impact comparisons for four options.
- Preparation of rendered images showing the existing Highway 104 bridge as well as the original 241 m, four span bridge and a140 m, two span bridge with approach fill configurations.

Work Plan and Schedule

Work on this study was initiated the week of August 17, 2009 with a review of background information and preparation of field mapping preceding the August 20th field visit and meeting with NSTIR, Department of Fisheries and Oceans (DFO), Nova Scotia Environment (NSE) and RV Anderson. The draft report was submitted to NSTIR for review in September 2009 with a final report incorporating review comments produced for NSTIR in October 2009 for distribution to other stakeholders such as the CLC and regulators for their consideration and comment.

The work plan included a review and compilation of previously recorded site conditions gathered from the original terrestrial and aquatic site visits conducted in support of the provincial Highway 104 at Antigonish Environmental Assessment (Jacques Whitford Ltd. 2005) as well as the 2009 field visit. This information was consulted to determine the key areas of concern for review in the field. Additional site information available for review included notes and photos taken during an early summer 2009 site visit with Stantec, NSTIR and DFO to review recommended protective strategies for the original 241 m four span bridge design (*i.e.,* spanning river and floodplain) to retain and enhance aquatic habitat on site in the vicinity of the crossing.

The August 2009 site visit and preceding meeting were conducted to review and confirm environmental conditions at the site and to gather specialist input on the potential effects of the proposed changes from RV Anderson, NSE and DFO based on their expertise and knowledge of the area.

Following review of the desktop and site specific information, a report was prepared for NSTIR to present the findings of the study and to propose recommendations for potential causeway limits that may reduce potential impacts to sensitive species and habitat in the vicinity of the crossing.

The October 2009 reports were circulated to regulators and the CLC in November 2009 for review and comment, and the comments were provided to the consulting team for response at that time. In January 2010 NSTIR requested that the 2009 reports be formally revised to address these comments. In addition to addressing comments, this document also updates the assessment of terrestrial and aquatic impacts to include comparison of the three scenarios for consideration by NSTIR. The scenarios, with the exception of Scenario 1 (no new bridge), consider the footprint associated with bridge construction within the proposed RoW width (see Figures 1-3)

Methodology

Desktop studies included a data review from the 2005 Highway 104 Antigonish EA (Jacques Whitford 2005) and the 2008 Canadian Environmental Assessment Act (CEAA) Environmental Assessment Screening Report for Highway 104 Antigonish (Jacques Whtitford 2009) documents to identify issues of concern in the

area as well as confirmation of the current status of sensitive species. Data reviewed included but was not limited to the aquatic and terrestrial survey information from the EA, soils data from the borehole program and EA report, NSDNR wet areas mapping and habitat database, air photos and topographic maps *etc.*

Field mapping was prepared for use on the NOMAD unit using the above noted data and data provided by NSTIR (highway alignment information) to allow for input of relevant GPS points in the field.

On August 20, 2009, site specific conditions in the area of the crossing were reviewed on site following a meeting with the Oceans and Habitat Area Chief for DFO, Charles MacInnis, the District Manager of NSE, Paul Keats, and RV Anderson hydrologists Hans Arisz and Peter Wedge to review crossing conditions and plans for the crossing. The field visit was conducted to review site conditions and reassess the distribution of sensitive plant species in the vicinity of the proposed bridges and to identify and assess the distribution of suitable habitat types for these species. The original rare plant surveys were conducted in 2002. The August 20, 2009 survey was conducted to determine if the sensitive plant species were still present or had changed their distribution or abundance. At the time of the original survey, the accuracy of handheld GPS units was relatively poor. The 2009 survey was therefore also used to provide more accurate information regarding the distribution of the sensitive species *i.e.,* species “Yellow”- listed by NSDNR. The field visit and meeting allowed the environmental specialist to review conditions in the project area and to review with the hydrologist and DFO potential effects of changes in hydrology, flooding, ice jams, *etc.* on sensitive species and habitats. The habitats in which these sensitive species were found were described and the distribution of these habitats relative to the proposed bridge options were determined. The habitats and footprints associated with the various scenarios are shown on Figure 1 (Scenario 1) for baseline conditions, on Figure 2 (Scenario 2) for the four span bridge and on Figure 3 (Scenario 3) for the two span bridge, in Attachment B.

3.0 FINDINGS

Existing Conditions

The findings below represent a summary of the results of the 2002 and 2009 field surveys as well as the desktop information reviewed to characterize the existing environment at the crossing site and to identify potential effects of implementation of design options that include the originally proposed 241 m bridge design (Option 2) as well as the shorter bridge spans and causeway (Options 3 and 4). Option 1 which considers the habitat footprints in absence of a new bridge is considered the reference condition for this exercise.

Aquatic Habitat

The provincial and federal environmental assessments (EA) conducted for NSTIR (Jacques Whitford 2005, 2008) reported that West River has the highest juvenile Atlantic salmon (*Salmo salar*) densities per unit area of any watershed in the Maritimes and has benefitted from habitat restoration work undertaken by DFO. The proposed crossing site is noted to be a critical Atlantic salmon migration route and holding area. West River aquatic habitat supports recreational and traditional fisheries. The Mi’ kmaw Knowledge Study Highway 104 Twinning Project New Glasgow to Aulds Cove completed in 2004 by Mi ‘kmaq Environmental Services for the Confederacy of Mainland Mi’ kmaq (CMM) (CMM 2004) identified West River as a place of current Mi’ kmaq land use and resources and notes that the river supports a productive fishery. In June of 2009 representatives of the Paqtnkek First Nations confirmed the continued use of West River for fishing.

During the electrofishing conducted for the EA, eleven Atlantic salmon were caught at Stream Crossing No. 8 (West River). These fish ranged from a total length of 3.6 cm to 13.0 cm. Five white suckers (*Catostomus*

commersoni), four banded killifish (*Fundulus diaphanus*), four northern redbelly dace (*Chrosomus eos*), three three-spine stickleback (*Gasterosteus aculeatus*), one nine-spine stickleback (*Pungitius pungitius*) and six creek chub (*Semotilus atromaculatus*) were caught in the West River. The white suckers, creek chub and banded killifish were abundant in a still-water connected to the West River. The electrofishing was confined to the RoW and the results did not show the presence of either brown or brook trout (*Salmo trutta* or *Salvelinus fontinalis*). This could possibly be explained because of the dominance Atlantic salmon parr at the RoW. Both brown and brook trout do however have strong populations in the river (D. Goff, pers. comm. 2002).

Brook trout are ranked by NSDNR as a Yellow listed species in Nova Scotia, indicating that they are sensitive to human activities or natural events. Atlantic salmon are Red listed by NSDNR, indicating that they are known or thought to be at risk. It is noted that the salmon in this river are not Inner Bay of Fundy Salmon which are considered to be endangered under the federal *Species at Risk Act*. The rest of the species listed above are green listed.

The patterns of riffles, runs and pools in the vicinity of the crossing were mapped during the EA process. The crossing was noted to be located in an area of pool and riffle sequence as shown on Figure 4. The channel width was estimated at 29 m with an approximate average depth of 30 cm. Substrate was described as boulder (15%), cobble (75%) and gravel (10%) and bank stability was recorded as 50-75% with 20% undercutting noted on the west bank. Overall erosion sensitivity at the crossing was rated moderate to high based on particle size and slope class within 50 m of the river.

Soils and Groundwater Wells

The West River geotechnical investigation conducted for NSTIR by ADI (ADI Ltd. 2009) adjacent to West River generally found that there were two distinct soils stratigraphies in the vicinity of West River; one in the river valley and the other above the river valley. In the river valley, below the immediate surface of topsoil, rootmat and fill, soils were generally found to be alluvial deposits underlain by sedimentary bedrock (*i.e.,* mudstone, siltstone and anhydrite), while above the river valley was generally characterized as a surface layer of vegetation, rootmat and fill underlain by glacial till and stratified sedimentary bedrock (*i.e.,* siltstone or mudstone and anhydrite) (ADI 2009). There is groundwater wells located on the west side of the crossing location associated with homes in the vicinity of the proposed alignment. Five dugs wells in the vicinity of the West River crossing were identified in the EA, two of which would be passed over directly by the RoW.

Sensitive Terrestrial Species and Habitat

There is agricultural land in the vicinity of the crossing including pastures used for grazing on the eastern side of the West River. Periods of extended flooding tend to be associated with melt waters in the spring which would not be expected to affect grazing.

The rich intervale habitat on the floodplain of the West River was one of two uncommon habitat types identified along the proposed Highway 104 alignment. Despite disturbance to this habitat (*e.g.,* clearing for pasture), it supports a number of sensitive plant species.

Twelve rare and uncommon plant species were found along the route during the 2002 field survey. Sensitive plant species identified in rich intervale habitat at the West River crossing in 2002 and confirmed in 2009 include the coffee-tinker's weed (*Triosteum aurantiacum*), wood nettle (*Laportea canadensis*), redhead pondweed (*Potamogeton richardsonii*), Pennsylvania smartweed (*Polygonum pensylvanicum*), Canada lily (*Lilium canadense*), bloodroot (*Sanguinaria canadensis*) and hornwort (*Ceratophyllum demersum*). While the

hornwort, bloodroot and Pennsylvania smartweed are Green listed by NSDNR indicating that they are not believed to be sensitive, they are ranked by the Atlantic Canada Conservation Data Centre (ACCDC) as S3 (indicating that they may be uncommon or restricted in range) or S4 (apparently secure but of longer term concern). The coffee-tinker's weed, wood nettle, and Canada lily are Yellow listed by NSDNR indicating that they are considered to be sensitive to anthropogenic activities or natural events. These species are ranked as S3 or S2 (rare or vulnerable) by ACCDC. Redhead pondweed is listed as status undetermined by NSDNR indicating that there is insufficient information available to assess its population status in Nova Scotia. This is attributable to several factors including the difficulty in collecting this aquatic plant and the fact that members of the genus Potamogeton are difficult to identify. ACCDC lists redhead pondweed as S3? indicating that it is believed to be uncommon but there is uncertainty regarding its rank.

The rich intervale at the West River crossing site has been substantially degraded by past land use practices. It appears that the intervale was cleared and used as pasture. It was later abandoned and was colonized by tree and shrub species. The intervale thicket is characterized by: a relatively dense cover of hawthorn (*Crataegus* sp.), choke cherry (*Prunus virginiana*), speckled alder (*Alnus incana*) and white ash (*Fraxinus americana*). The ground vegetation understory is now composed mainly of dame's rocket (*Hesperis matronalis*), Canada goldenrod (*Solidago canadensis*) and wood goldenrod (*Solidago flexicaulis*). Dame's rocket is an introduced ornamental species that appears to be able to persist under the dense shrub canopy. This species may exclude native plant species from the site. The banks of the river, which in undisturbed intervales provide habitat for a variety of rare native species have, in the case of the West River intervale, been heavily colonized by a variety of introduced weed species including dames's rocket, nipplewort (*Lapsana communis*), common burdock (*Arctium minus*), couch grass (*Elymus repens*), wild cucumber (*Echynocystis lobata*), and live-forever (*Sedum telephinum*).

One Yellow listed bird species, Bobolink (ACCDC rank S3) and one uncommon bird species, Black-billed Cuckoo (ACCDC rank S3, NSDNR rank Green) were recorded in the vicinity of the West River crossing site. A Bobolink was heard singing in a hay field located west of the RoW, while a Black-billed Cuckoo was heard singing in shrub thickets adjacent to the West River. Breeding habitat for the Bobolink (hay field) is present near the crossing in the farmer's fields. Much of the tall shrub habitat on the west side of West River will be affected by bridge construction. Dead elms along the intervale are used as perching sites by Bald Eagles and Osprey that feed on various fish species which utilize the West River as a migration route.

Wood turtles have also been recorded on the West River. The wood turtle is Yellow listed by NSDNR in Nova Scotia and listed by ACCDC as S3. The wood turtle is listed as a species of special concern under the federal *Species at Risk Act* (SARA) and vulnerable under the provincial *Endangered Species Act*. West River habitat is supportive of wood turtles which have been previously reported upstream and downstream of the crossing location. The habitat at the area of the crossing is described as relatively shallow and swift flowing with localized side pools. The substrate is described as boulder with cobble and gravel. Generally, the river is broad with areas of good hibernation potential (>1 m depth and areas of more moderate flows) scattered along the survey area. Several slough like inflows and indents off the river provide small pool and marshy habitats.

Potential Environmental Effects

Replacement of open bridge spans by causeway could have a number of adverse effects on aquatic and terrestrial species depending on how much of the open bridge span is replaced by fill. Potential effects considered include increased flooding due to constriction of the West River floodplain as well as potential for scouring of the river bottom (with potential changes to aquatic habitat) and the floodplain in the vicinity of the

causeway with associated loss of habitat supporting sensitive plants. Replacement of open bridge spans by fill can also have direct effects on terrestrial habitat through direct disturbance associated with infilling.

Aquatic Habitat

The proposed crossing site is a critical migration route and holding area for salmonids. Site specific concerns DFO had with the crossing of West River were: ice jamming at the proposed bridge location with associated bank and bottom substrate scouring; sedimentation from sub-grade; and interference with existing fisheries.

In the experience of the local DFO Area Chief, 1:5 year storms fill little ponds and gullies in the area surrounding the crossing, while the entire floodplain is filled during 1:100 year storms (pers. comm. C. MacInnis, 2009). Based on preliminary modeling results of a bridge design with some causeway development, it appears that while changes to the flooding, ice jamming and sediment transport regimes may not be an issue, some scouring is anticipated at the crossing site. Model indications from RV Anderson are that scour may occur due to the contraction of flood flows, potentially resulting in a scour depth following a 1:100 year event of approximately 0.3 m for the 241 m bridge (Scenario 2) and approximately 0.5 m for Scenario 3. Some natural scour would be anticipated over time for Scenario 1 (no bridge).

During an early summer field visit with DFO to review the footprint of the original 241 m four span bridge plan (Scenario 2), it was noted that steep banks and vegetation maintenance approximately 150 m to 200 m downstream of the crossing have resulted in scour and erosion along the banks of the West River, leading to widening of the river which has been managed by DFO through installation of a kicker and tree plantings along the embankment over the past several years. These efforts have narrowed the streambed by as much as 2.5 m.

Scour results when the forces of water movement exceed the forces resisting particle motion, typically during periods of peak discharge such as storm events; these forces can mobilize streambed resulting in a loss of salmonid eggs and alevin by entrainment (Schuett-Hames *et al.* 1996) or can result in a loss of gravels used by salmonids for spawning. The introduction of fine particles into the water can harm fish by abrading gills or scales resulting in excessive mucous production and reduced capacity to absorb oxygen and can also settle into interstitial spaces in gravel beds where eggs are laid and larvae feed ultimately smothering the eggs and larvae; increased turbidity can also affect the ability of salmonids to feed since they rely on site to locate prey (New Brunswick Department of the Environment (NBDOE) 2009). It is not expected that scour resulting from the construction of the crossing would generate excessive fines given that the scour would occur within the main channel streambed which comprises predominantly coarse materials and is subject to constant movement of water.

Another potential impact of a shorter bridge and approach fills at the crossing (Scenario 3) is a modification of the pool-riffle sequence of the river. The scour at the crossing is expected to take out the riffle near the crossing and result in a semi-permanent pool at the crossing and a readjustment of the pool-riffle sequences downstream that would be anticipated to stabilize in a few years (RV Anderson, 2009). It is noted that this is a natural phenomenon; however anthropogenic influences such as construction of watercourse crossing can expedite changes in stream morphology. Primary flow in the river is affected by the channel and bedform which can modify flow velocity, and can interact with secondary currents and obstructions to modify pool-riffle sequences (Schuett-Hames *et al.* 1996).

The models completed for this study in 2009 and 2010 indicate that significant impacts on the sediment transport regime were not anticipated. Potential impacts of sedimentation associated with sub-grade

construction would be managed through the site specific erosion and sediment control plans (ESCP) with input from DFO at the time of construction when these plans are implemented in proximity to the river. In consideration of the implementation of mitigation measures, the continual movement of the river and the coarse nature of the streambed materials in the main channel, effects of sedimentation are not expected to be an issue of concern.

Soils and Groundwater

Soil loss through erosion could be incurred if appropriate erosion and sediment control practices are not employed. In addition, soils may be affected by prolonged periods of inundation. The risk of soil loss from crossing construction is anticipated to be minimal and effects on site soils are not anticipated provided appropriate controls and best practices are employed. Periods of inundation from flooding are not expected to vary given that significant changes to the flooding regime are not anticipated (RV Anderson 2010).

Groundwater wells in the vicinity of the crossing could be affected by the introduction of sediment laden water resulting from erosion and sedimentation or alternatively by dewatering. It is noted however, that wells located within the RoW on Cunningham Road are on property that has been acquired by NSTIR to accommodate construction and will be decommissioned. In addition, soils in the vicinity of the wells are glacial till rather than sandy or loamy soils which are more permeable and more susceptible to effects of sedimentation. Dewatering as a result of excavation or blasting for the crossing is not anticipated. Effects on groundwater wells are not anticipated for any of the proposed scenarios.

Sensitive Terrestrial Species and Habitat

Five habitat types are present within the footprint of the bridges. These include the scour zone of the floodplain, the floodplain, seasonal drainage courses on the floodplain, forested upland habitat and agricultural land. Two of these five habitat types have the capacity to support the resident sensitive species.

The scour zone is affected by water and ice scour during flood events. The vegetation is characterized by a dense sward of grasses and forbs with a patchy cover of low and tall shrubs. Trees are uncommon and typically bear ice scour scars on their trunks. Tree cover consists largely of American elm (*Ulmus americana*). Shrub cover consists largely of speckled alder (*Alnus incana*) and willow (*Salix eriocephala*). The dominant species of the ground vegetation layer are blue-joint reedgrass (*Calamagrostis canadensis*), clematis (*Clematis virginiana*), Canada goldenrod, and reed canary-grass (*Phalaris arundinacea*). The scour zone habitat typically forms a fringe along the river bank extending an average of 5 m landward from the river bank (Figures 1-3). Sensitive plant species associated with this habitat include wood nettle, Canada lily and coffee-tinker's weed.

The flood zone habitat is characterized by moderately dense tree canopy composed largely of apple (*Pyrus malus*), English hawthorn (*Crataegus monogyna*) and American white ash (*Fraxinus americana*). As noted above, clumps of vegetation may be imported into this zone during flood events. The shrub layer consists of scattered patches of choke cherry (*Prunus virginiana*) and hawthorn (*Crataegus* sp.). The dominant species of the ground vegetation layer include dame's rocket, Canada goldenrod and wood goldenrod. The floodplain is exposed to flooding each spring and during extended periods of heavy rainfall but is not exposed to heavy ice scour. This habitat occupies a band approximately 70 m wide on the eastern bank of the river and approximately 20 m on the western side of the river. This habitat type is dominated by non-native plant species including dame's rocket, apple and English hawthorn. One sensitive plant species, coffee-tinker's weed, is associated with this habitat type.

Seasonal drainage courses are found throughout the floodplain (Figures 1-3). These drainage courses conduct flood waters vegetation, sediment and seeds through the floodplain. They remain wet for the early portion of the growing season and do not provide suitable habitat for trees or shrubs. This habitat type typically supports a dense growth of spotted jewelweed (*Impatiens capensis*) with scattered patches of dame's rocket and wild cucumber (*Echinocystis lobata*). No sensitive plant species are associated with this habitat type.

Upland forested habitat is found at elevations high enough that they are not flooded during high water periods (Figures 1-3). This habitat type typically supports a moderately dense forest composed largely of American white ash, white spruce (*Picea glauca*) and apple. The shrub layer is moderately dense and composed mainly of choke cherry and shadbush (*Amelanchier* sp.). The dominant species of the ground vegetation are typically wood goldenrod and lady fern (*Athyrium felix-femina*). No sensitive plant species were associated with this habitat type.

Agricultural land occupies both the riparian and upland areas (Figures 1-3). At the West River bridge site, agricultural land consists of pasture and hay fields. Agricultural land was not accessible during the August 20, 2009 field visit so plant community descriptions are not available. None of the sensitive plant species found at the West River crossing site are expected to be found in the agricultural land shown on Figures 1-3.

Three scenarios have been considered in Table 1 below to compare the potential impacts at the West River crossing site. These include the reference condition of no bridge (Scenario 1), the original bridge design, a 241 m, four span bridge (Scenario 2), and the 140 m two span bridge with approach fills (Scenario 3). Potential environmental effects associated with bridge construction can be expected to vary depending on what bridge configuration is selected. Table 1 presents a comparison of the areas of disturbance or loss for each of the five habitat types present at the West River crossing for the various scenarios.

Habitat Type	Area of Disturbance/Loss Scenario 1 (ha)	Area of Disturbance/Loss Scenario 2 (ha)	Area of Disturbance/Loss Scenario 3 (ha)
Agricultural Land	0	0.18	0.53
Flood Zone	0	0.16	0.20
River	0	0	0
Scour Zone	0	0	0
Upland Forest	0	0.23	0.55
Total Area	**0**	**0.57**	**1.28**

Table 1 indicates that in comparison to the original four span bridge design (Scenario 2), Scenario 3 will result in an increase (0.71 ha) in the total area of habitat lost. Most of this habitat loss is attributable to loss of agricultural land and upland forest, neither of which provide habitat for rare or sensitive plant species. The hydrological modeling results in the *Hydrotechnical Review of Highway 104 West River Bridge Options* (RV Anderson 2010) suggest that the flood zone habitat will not be adversely affected as a result of replacement of open bridge spans (Scenario 2) by one composed of a combination of open spans and approach fills (Scenario 3). As such, no hydrologically related adverse effects on sensitive plant species found on the flood zone habitat are expected. These species would include coffee-tinker's weed, and bloodroot. However, these species can be adversely affected by approach fills as a result of direct disturbance of plants or loss of potentially suitable habitat. One existing patch of coffee-tinker's weed will be lost to bridge construction. This patch contains 11 shoots and is located at a bridge pier location on the southern bridge (Figure 2 and

Figure 3). Both bridge scenarios have a pier at this location and will therefore have the same effect on this species.

Table 1 indicates that the 140 m bridge configuration for Scenario 3 will result in a small increase in the amount of flood zone habitat lost (0.04 ha) in comparison to the original 241 m bridge design (Scenario 2). This would represent habitat that does not currently support rare or sensitive species but could potentially support them. Almost all of this flood zone habitat loss would occur on the western bank of the West River where no rare or sensitive plants have been recorded in the flood zone habitat.

Table 1 indicates that there would be no direct loss of scour zone habitat associated with any of the bridge configurations. However, the 2010 hydrotechnical report prepared by RV Anderson report indicates that for Scenario 3, there is potential for a 1:100 year storm event to result in scouring to a final depth of approximately 0.5 m at the crossing location. The final depth of scouring anticipated for Scenario 2 for such a storm event would be approximately 0.3 m. Further information from RV Anderson indicates that while scour is expected to be primarily aquatic, it may result in localized scouring of the river bank in the crossing area that could extend to approximately 5 m to 10 m downstream of the structures (Arisz. pers. comm. 2009). It is therefore recognized that there is potential for loss of some of the sensitive plants located in the scour zone habitat near the river's edge; in particular the coffee-tinker's weed, wood nettle, Canada lily and redhead pondweed. Given that these plants are located within the scour zone, it is expected that the habitat would remain favourable for these species once the area stabilizes following a scour event. It is noted that scour zone habitat would be expected to be replaced by similar habitat but that it may take a few years for the habitat to stabilize following construction.

Scouring of a pool at the bridge site may result in the displacement of redhead pondweed in that area. This species is scattered along the river in areas of moderate to slow flow both inside and outside the area crossed by the bridges. The pool created by river bed scouring can be expected to be re-colonized by redhead pondweed once the area stabilizes.

Hornwort was found in a quiet side channel upstream of the bridge crossing site. Alteration of the river bed by scouring is unlikely to affect this species. Pennsylvania smartweed grows on disturbed sites such as exposed river banks. The course of the river is not expected to change as a result of river bed scouring so the areas where this species is found are not expected to change substantially. It is noted that this species is adapted to survive in disturbed areas.

Proposed changes to the crossing that may affect the wood turtle include modification of the intervale habitat, particularly the loss of flood zone and scour zone habitat close to the river bank that would be used as foraging areas and travel routes for wood turtles. These changes are expected to be minor if the footprint of the crossing in the intervale immediately adjacent to the river is minimized and the intervale will remain in place alongside of the river in areas outside of the crossing location. Sufficient terrestrial corridor will be required on either side of the river to accommodate passage of the wood turtle and other wildlife. A review of Figures 1 to 3 indicates that the two span bridge configuration with approach fills (Scenario 3) has essentially the same effects on wood turtles as the original bridge design (Scenario 2). Both scenarios maintain travel and foraging habitat along the banks of the West River.

Some loss of Bobolink habitat (hay fields) may be incurred as a result of infilling for the bridge approaches for Scenario 3, and for the construction of the access roads for Scenarios 2 and 3. In consideration of the amount of pastureland that will remain in place, the loss would likely be minor. All of the bridge scenarios would have similar effects on Bobolink.

4.0 RECOMMENDATIONS

The 2005 and 2008 EA documents identified a variety of measures to be implemented to avoid significant residual environmental effects from highway construction and operation. The recommendations below are intended specifically to address potential effects of implementation of a causeway at the West River crossing and are meant to supplement existing applicable mitigation from the EA. No specific additional recommendations are considered necessary to address effects of a design change on soils and groundwater, or wood turtles; however some recommendations are suggested to reduce potential impacts of the proposed changes on the aquatic and terrestrial habitat at the West River crossing.

Aquatic Habitat

It is recommended that where abutments or piers approach the river and cutting of large trees is required, large rocks be keyed into the banks prior to cutting to minimize potential for streambed movement. DFO should be consulted on any proposed design changes to determine requirements for rock stabilization around piers and along river banks or other site specific mitigation that may reduce potential impacts on fish habitat. Rock fill or armouring should be considered to stabilize areas to be infillled for bridge approach construction to reduce potential for erosion and sedimentation during periods of inundation. Furthermore, gravel borrow and rock fill will be used to construct access roads and work areas to minimize this potential.

Scour and the resulting change in aquatic habitat sequences (*e.g.,* pool-riffle) were recognized as the primary effects of the proposed change in design. DFO has expressed concerns with changes to existing habitat. Habitat should be monitored following construction to determine whether the pool-riffle sequence will be modified. NSTIR should consult with DFO to determine potential requirements for monitoring of aquatic habitat sequences (*i.e.,* riffle-pool) at the crossing and immediately downstream. If required, a HADD application would be completed and compensation undertaken to ensure no net loss of habitat.

Sensitive Terrestrial Species and Uncommon Habitat

Scenarios 2 and 3 minimize the loss of habitats that support rare or sensitive species (scour zone and flood zone habitats). Minor scour is anticipated for all bridge configurations and may result in localized losses of sensitive plants in the scour zone habitat and river bed. It is recommended that as part of the mitigation proposed in the EA, that these plants and their habitat be monitored after construction to determine whether they are at risk from scouring of the river bed and banks. If the plants are at risk, a plant propagation program or translocation should be undertaken to move the plants to nearby suitable habitat unaffected by scouring.

One existing patch of coffee-tinker's weed will be lost to bridge construction for both bridge scenarios since it is located in the pier footprint. Lengthening the span or shifting the pier location to the east approximately 20 m would avoid these plants and provide a buffer. It is possible however, that such a shift could result in other impacts related to fill encroachment on the river channel. Suitable habitat is present and supporting coffee-tinker's weed in the adjacent areas of floodplain habitat near the bridge, so it may be possible to move this patch to another nearby location. It is important to ensure that if it is necessary to relocate plants, that they be moved to an area of suitable habitat.

5.0 CONCLUSIONS

Based on the results of the hydrotechnical model and a review of desktop information and existing conditions, there is potential for localized effects on sensitive aquatic and terrestrial habitat to result from the inclusion of a causeway in the design for the West River crossing. Causeway-related effects on groundwater and soils are not anticipated.

While changes to the flooding, ice and sediment transport regimes are not anticipated, there is potential in a 1:100 year storm for scour at the crossing site of approximately 0.3 m for Scenario 2 (241 m four span bridge) and approximately 0.5 for Scenario 3 (140 m two span bridge). This scour is anticipated to result in a change to the pool-riffle sequence in the river. Appropriate mitigation should be developed in consultation with DFO and monitoring undertaken if required. Specific plantings and the use of rock to stabilize areas around the abutments and piers, access road and work areas, and to armour the approach fills are expected to minimize potential for erosion and sedimentation.

The proposed spanning of the West River and its broad floodplain was recommended in the 2005 and 2008 EAs to prevent scour and reduce the project footprint in the area of the crossing. Some plants in the scour zone habitat may be at risk during a 1:100 year storm for bridge Options 2, 3 and 4 as a result of scour. It is noted however, that scour is a natural process and therefore plants in this type of habitat are perpetually exposed to some level of risk due to their location.

The patch of coffee-tinker's weed located in the pier area on the east side of the river (Figures 1-3) that will be lost to bridge construction should be translocated to one of the nearby locations supporting other plants of this species if the pier location cannot be shifted.

Monitoring of plants and habitat to be undertaken under the EA mitigation should include assessment of the potential risk to these plants, an early propagation program prior to construction if the plants are at risk and if required, translocation to nearby suitable habitat. Propagated or translocated plants will be monitored for survival.

In summary, combining causeway and free spanning elements to the crossing design for West River is not expected to result in significant adverse residual effects (*i.e.,* after recommended mitigation is applied). The effects can be managed through standard mitigation measures, mitigation reviewed and approved for the 2005 and 2008 environmental assessments, the above noted site specific measures and through habitat compensation if required.

6.0 CLOSING

This report has been prepared for the sole benefit of the Nova Scotia Transportation and Infrastructure Renewal. The report may not be used by any other person or entity without the express written consent of Stantec Ltd. and NSTIR.

Any use that a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Jacques Whitford Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made, or actions taken, based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices

current at the time the work was performed. Conclusions and recommendations presented in this report should not be construed as legal advice.

The conclusions presented in this report represent the best technical judgment of Stantec Ltd. based on the data obtained from the work. The conclusions are based on the site conditions observed by Stantec Ltd. at the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations.

This report was prepared by Mike Crowell, M.Sc. and Shannan Murphy B.Sc. Senior review was conducted by Robert Federico, MPA.

We trust that the above report addresses the intended scope of work and your project needs. If you have any question regarding the contents of the report, or require further information, please contact the undersigned

Sincerely,

STANTEC CONSULTING LTD

ORIGINAL SIGNED BY

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Project Manager
Tel: (902) 468-7777
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6.0 REFERENCES

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Arisz, Hans. 2009. RV Anderson Associates Limited. Personal Communication. October 22, 2009.

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Attachment A

Attachment A
Response Table to Comments on the Environmental Review of Highway 104 West River Bridge Options

Attachment A

PREFACE

This response table has been prepared by Stantec Consulting Ltd. for Nova Scotia Transportation and Infrastructure Renewal (NSTIR) to address comments arising from the review by regulators at the Department of Fisheries and Oceans, Nova Scotia Natural Resources and the Highway 104 at Antigonish Community Liaison Committee of the October 2009 *Environmental Review of Highway 104 West River Bridge Options.* Comments related to the hydrotechnical evaluation will be addressed under separate cover by RV Anderson.

Comments and responses are provided below with comments listed by originator abbreviation (*e.g.,* Department of Fisheries and Oceans - DFO) and comment number (01), for example DFO-01. Originator designations are as follows:

- NSDNR – Nova Scotia Department of Natural Resources
- Department of Fisheries and Oceans
- Highway 104 at Antigonish Community Liaison Committee – CLC

Attachment A

Comment:

DFO- 01	Charles MacInnis Oceans and Habitat Area Chief Antigonish, NS	One concern I have noticed is comments attributed to me on page 9 paragraph 5 in it mitigation I discussed with your consultants on site have been taken out of context. Those comments were made prior to any indications from your department that you wished to build a causeway across the floodplain. It should be clear that these comments were not made in conjunction with this particular study. I would go further and say those comments are not valid as an infill across the causeway changes completely my perspective on this project, and I never discussed rock armoring as a mitigation measure for this causeway.

Response:

Text has been revised to clarify this and to reflect that DFO should be consulted on any proposed design changes to determine requirements for rock stabilization around piers and along the river banks or other site specific mitigation that may reduce potential impacts on fish habitat. Recommendations for rock armouring of the causeway originated from Stantec and remain applicable. NSTIR will continue to engage DFO throughout the remainder of the West River crossing design process, as applicable to ensure that aquatic mitigation is appropriate.

Attachment A

Comment:

NSDNR- 01	Randy Milton Manager Habitat Programs Kentville, NS	The report and recommendations by Stantec are based in-part upon the predicted hydrological results. We are in agreement with Stantec's recommendation (Section 3.0) on how to minimize impacts to sensitive terrestrial species and uncommon habitats with the proposed changes to the design of the crossing. However we are tempering our support with the caveat that hydrological responses to climate change, such as predicted sea level rise, increased frequency and height of storm surges, and changes in precipitation patterns, will not affect flood levels, scour potential, or ice regime or their impacts to sensitive species and uncommon habitats in the vicinity of the crossing. We recommend that TIR consider these impacts before making their decision.

Response:

NSDNR comments are noted. Hydrological responses to design changes (including with respect to climate change predictions) are addressed in the RV Anderson report *Hydrotechnical Review of Highway 104 West River Bridge Options*.

Attachment A

Comment:

CLC- 01	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	The cost analysis and anticipated savings calculated from shortening the bridge must reflect all tangible and intangible costs associated with the design change. The CLC believes these types of costs need to be included in any costs/savings assessment, as their inclusion may reveal that the anticipated savings do not truly outweigh the costs. Examples of the types of costs that are not currently under consideration include those involved with: • Undertaking a new EA process on the proposed design changes; • An extended highway construction time due to a six month to two year EA process; • Money spent on the first EA conducted to approve the current design; • Environmental remediation from flood damage on land in the area of anticipated increased flooding; and • Current and future ecological service costs from loss of wetlands due to causeway construction.

Response:

TIR has completed additional financial analysis, which included additional factors as suggested. These will be discussed with the CLC.

Initial findings of the hydrotechnical study indicate that there will not be significant effects on the flood regime; therefore additional costs associated with flooding would not be anticipated.

No wetlands were identified in the crossing area; therefore no losses (including ecological service costs) are anticipated from causeway construction.

Attachment A

Comment:

CLC- 02	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	Some members of the CLC note that they have a difficult time assessing the environmental, social and other impacts of the new bridge design against the economic savings - it is like comparing apples to oranges. These members are concerned that NSTIR staff will face a similar challenge, and as a result the economic savings may be unfairly regarded as more important than the negative impacts.

Response:

NSTIR has considered the environmental effects of the West River crossing options associated with the detailed design process (see Section 2.0) and will be meeting with regulators and the CLC in February to communicate these findings. As noted in response to CLC-01, the environmental effects associated with these different scenarios are not significant although the cost implications for taxpayers may be considerable.

Attachment A

Comment:

CLC- 03	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	Environmental impacts of the proposed new design appear more extensive than those in the existing design – especially in terms of destruction of wetland habitat, change in configuration of riffle/pool patterns, impact on fish habitat, and loss of flora and fauna. While the majority of the CLC acknowledges that a potential EA process would provide a thorough assessment of any new environmental impacts, the justification for the extra time and expense involved with a new EA is questionable given that the current bridge design has already received public approval as having a lower environmental impact.

Response:

It is noted that implementation of a causeway would create a larger footprint in the West River intervale habitat. The environmental report did not identify wetland destruction as a potential impact as no wetland habitat has been identified in the study area. A change has been identified to the pool/riffle sequence at the crossing which will require review by DFO to determine appropriate mitigation. Potential impacts identified to fish habitat include changes in bedforms due to scour and potential for the introduction of fines from grading. Change in bedform will be temporary and will stabilize as this is a natural phenomenon. Potential for erosion to result in sedimentation will be managed using best management practices and typical mitigative measures outlined in the Transportation and Infrastructure Renewal Standard Specifications (1997 and revisions) and the Environmental Protection Plan. It is noted that there will be losses of some of the rare plants identified within the RoW at least temporarily. It is understood that some of the plants within the scour zone habitat may be expected to re-establish but that some losses, such as the coffee-tinkers weed to be lost to bridge construction are expected to be permanent. There were no losses of fauna anticipated to result from the proposed change to the crossing. No environmental effects are predicted to be significant. See response to CLC-01 with respect to potential for additional EA and associated costs/delays.

Attachment A

Comment:

CLC- 04	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	Some CLC members are concerned that the environment may be receiving an unfairly low priority in comparison to economic concerns of the project. Adequate assessment of environmental impact is obscured by insufficient data used in the consultant reports including: 1) Modelling data taken from watersheds other than the specific area of West River under question; 2) Snapshot surveys of flora and fauna (e.g. one electro-fishing sample) that do not reflect daily or seasonal variations; and 3) Use of 2005 data instead of more recent and up-to-date information.

Response:

1) Modelling data concerns will be responded to by RV Anderson under separate cover.

2) Flora surveys carried out for the provincial environmental assessment included early and late seasonal surveys. The information from these surveys was confirmed in the field in August of 2009. Fauna surveys conducted in support of environmental assessments are collected over various visits (breeding bird surveys and recorded again during flora surveys and wetland surveys). In addition, a dedicated wood turtle survey was conducted in 2008. Information on flora and fauna do not come solely from the field surveys conducted for environmental assessments but are also collected through a search of the Atlantic Canada Conservation Data Centre, Nova Scotia Natural Resources habitat mapping information, from traditional knowledge studies conducted by First Nations, discussions with Department of Fisheries and Oceans among others. Electrofishing surveys are conducted under electrofishing permits and are not generally carried out on multiple occasions unless specifically requested by DFO.

3) Information about the site and natural resources was not only from 2005, but included information from a variety of sources over an extended period (including the 2009 field surveys).

Attachment A

Comment:

CLC- 05	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	Subsequent to the CLC meeting, the Atlantic Salmon Federation (ASF) submitted a letter highlighting the importance of the West River in maintaining salmon populations. Their concern is that the bridge design being considered will have a serious impact on the salmon habitat, especially given that the Northumberland Strait has been identified as the only area left in Nova Scotia with a healthy Atlantic Salmon population. As well, the CLC has received a copy of a PowerPoint presentation by DFO researchers that underscores the importance of the West River for salmon habitat.

Response:

Comment noted. NSTIR has conducted hydrotechnical studies of the West River crossing scenarios associated with detailed design (presented under separate cover). NSTIR believes that any of the potential crossing methods will not result in significant adverse effects to Atlantic salmon populations (*i.e.,* after application of mitigative measures) through alteration of feeding, spawning or migratory habitats as the channel in the vicinity of the crossing is not a salmon spawning area and there will be no effects on fish passage in any of the scenarios. As noted in response to DFO-01, NSTIR will continue to engage DFO throughout the remainder of the West River crossing design process, as applicable to ensure that aquatic mitigation (including protection of Atlantic salmon) is appropriate.

Attachment A

Comment:

CLC- 06	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	Increased flooding upstream of the bridge has potential impact on agricultural lands bordering the area that have not been considered. Specifically, increased deposits from flooding can affect soil quality, which can then potentially impact the choice of crops grown on that land. The geographical scope of the two consulting reports is not sufficiently large enough to fully assess upstream flooding impacts on agricultural land (e.g. Brierly Brook should be included). To better gauge these potential impacts, the CLC recommends that the owners of the two large agricultural properties in the area be consulted, based on their current experience with flooding.

Response:

Comment noted. The *Environmental Review of Highway 104 West River Bridge Options* considered the area of the proposed RoW. It is noted that changes to the flooding regime were not identified as a potential impact in the 2010 *Hydrotechnical of Highway 104 West River Bridge Options* report.

Comment:

CLC- 07	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	The design changes have the potential to impact fish habitat and traditional Mi'kmaq fishing grounds. The CLC would like to ensure that DFO, DNR, and other relevant agencies are sufficiently consulted about possible fish habitat impacts.

Response:

Comment noted. See also responses to previous comments.

Attachment A

Comment:

CLC- 08	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	The CLC respects the privileged role of providing feedback and input to the Highway 104 Team on behalf of members' representative agencies. However, the CLC would like to put on record the frustration and general concern with the rapid pace with which members have been requested to provide advice and feedback on this particular decision. Specifically: • Members had an especially short time frame to review the consultant reports and provide informed feedback to the final decision meeting that will occur in the next few weeks. The reports were received by CLC members on October 28th, written comments were requested by November 2nd, and discussion ensued at a meeting on November 4th; • It was difficult to provide comments when the reports could not be distributed publicly to CLC member groups for feedback and discussion; • It was difficult to assess and review the complex technical consulting reports in such a short time period when the CLC does not have the technical expertise to do so.

Response:

Comments are noted and appreciated. NSTIR is scheduled to meet with the CLC in February at which time the relevant information as well as the review process can be discussed.

Attachment A

Comment:

CLC- 07	Ken Donnelly Chair Highway 104 at Antigonish Community Liaison Committee Antigonish, NS	The CLC suggests that the following additional information would help members better understand and assess potential impacts of the proposed new bridge design: 1) Comparative tables outlining potential impacts of the current design against potential impacts of the new design; 2) Clear topographical maps providing a visual representation of potential impacts (e.g. flooding) with respect to current land use in the area; and 3) Examples of other cases where causeways have been used, and the resulting impacts.

Response:

The request for additional information has been addressed by the following:

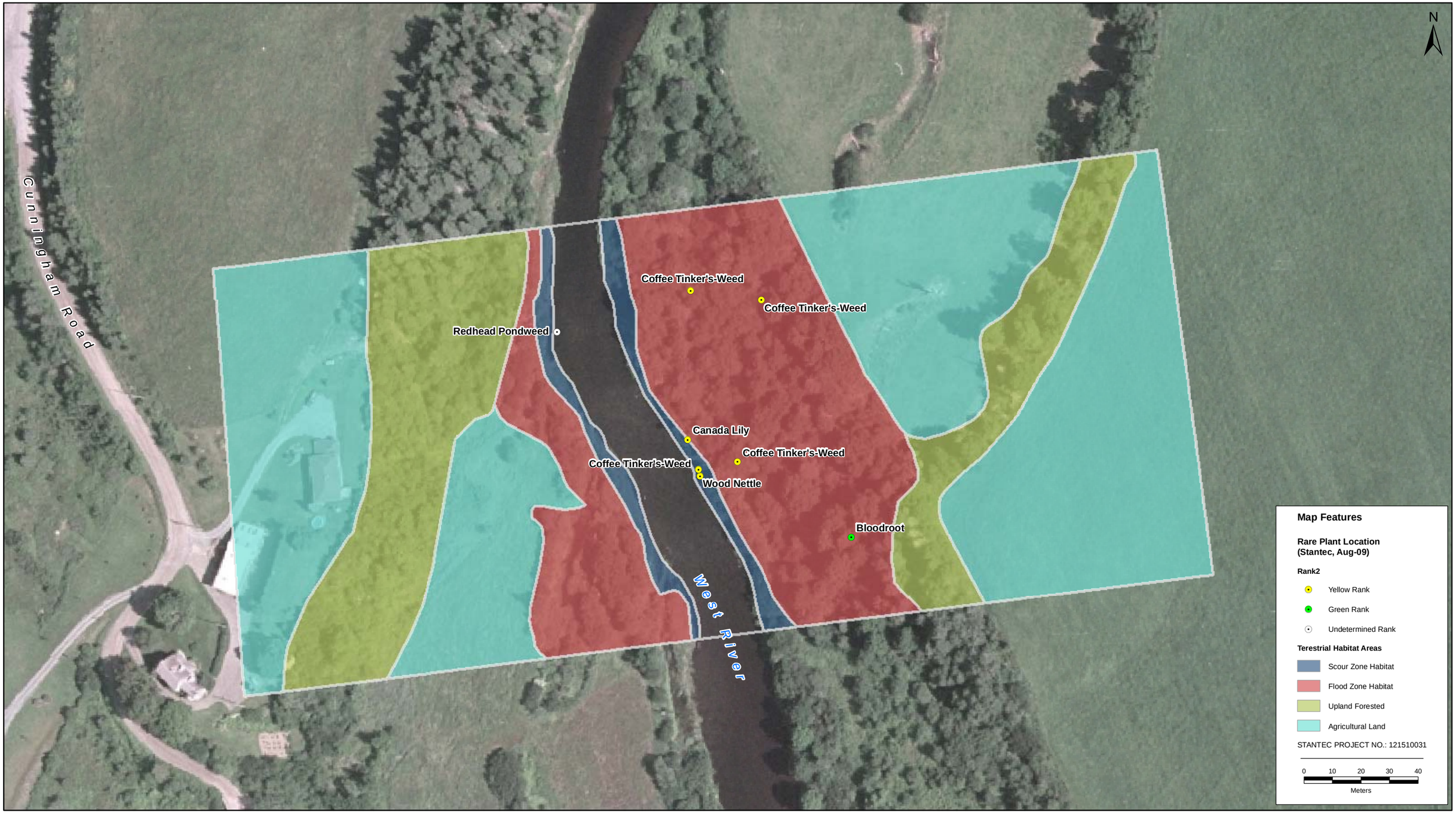
1) Tables have been produced to provide a quantitative comparison of habitat impacts.

2) Images of the proposed crossing area have been produced based on the results of the hydrotechnical review.

3) Comment noted. This request is considered outside the scope of the current evaluation. Potential environmental and hydrotechnical effects associated with the specific project at West River have been included in this analysis. The effects of flow constriction during high flow periods from bridge approach fills predicted for Scenario 3 would be quite different from the effects associated with other well known causeways such as the Canso and Windsor causeways which substantially reduce the transfer of water.

Attachment B

Attachment B
Figures



DATE: 29/01/2010

PREPARED BY: C. Shupe

NOVA SCOTIA
Transportation and Infrastructure Renewal

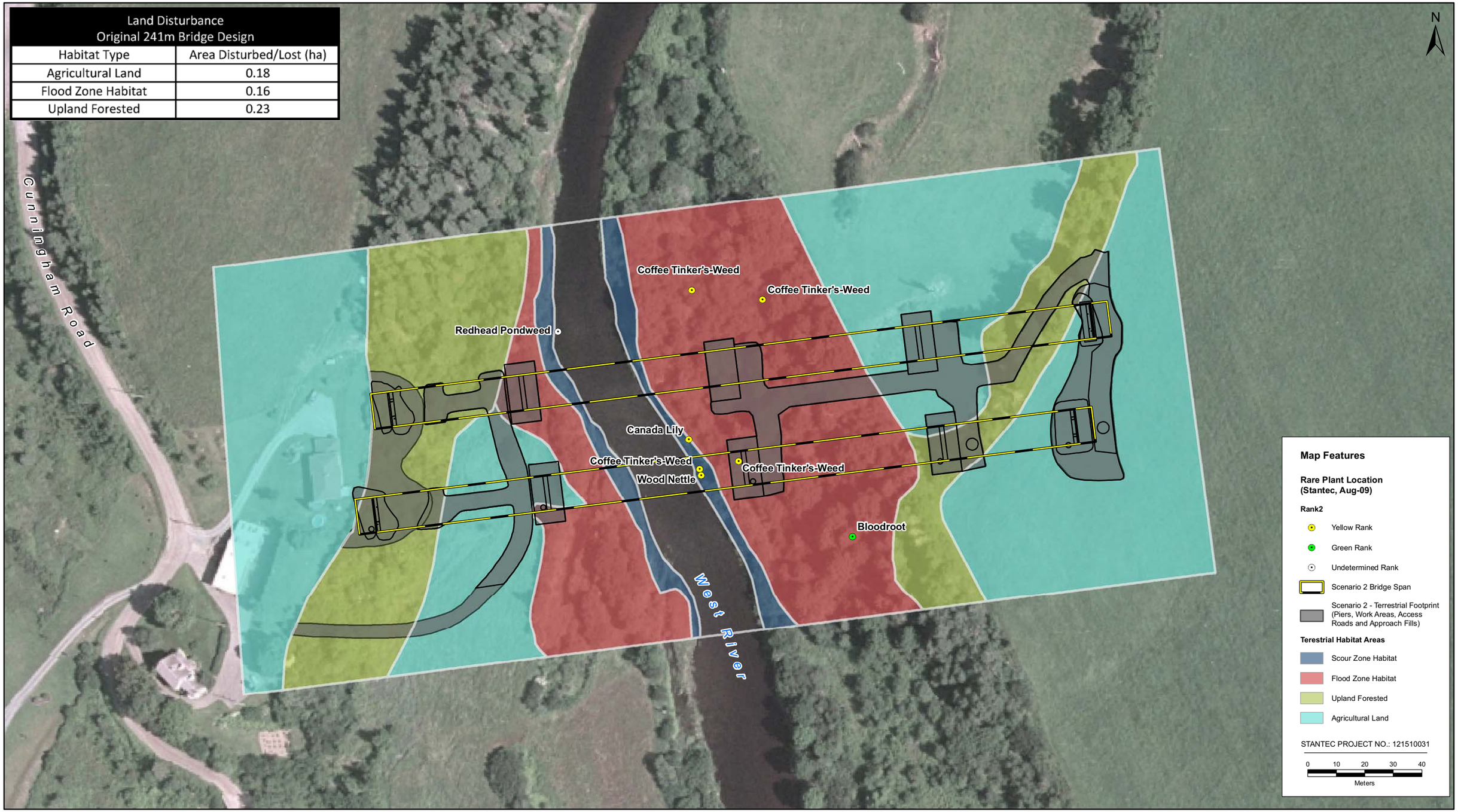
HIGHWAY 104 TWINNING - WEST RIVER - AREAS OF TERRESTRIAL IMPACT

Terrestrial Habitats (Scenario 1 - No New Bridge)

FIGURE NO.: **1**

Stantec

Land Disturbance Original 241m Bridge Design	
Habitat Type	Area Disturbed/Lost (ha)
Agricultural Land	0.18
Flood Zone Habitat	0.16
Upland Forested	0.23



DATE: 11/02/2010

PREPARED BY: C. Shupe

NOVA SCOTIA
Transportation and Infrastructure Renewal

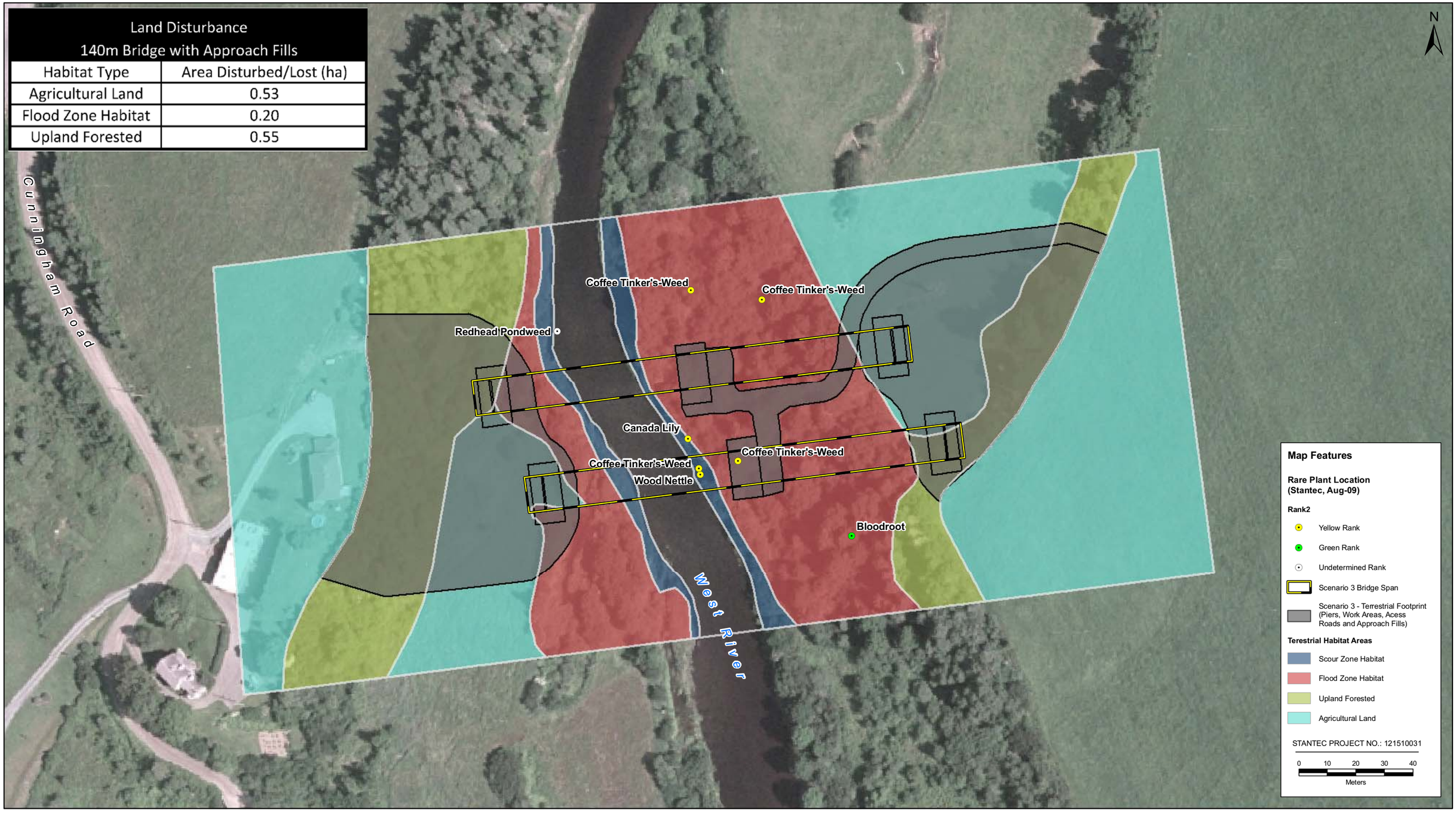
HIGHWAY 104 TWINNING - WEST RIVER - AREAS OF TERRESTRIAL IMPACT

Terrestrial Habitats (Scenario 2 - Original 241m Bridge Design)

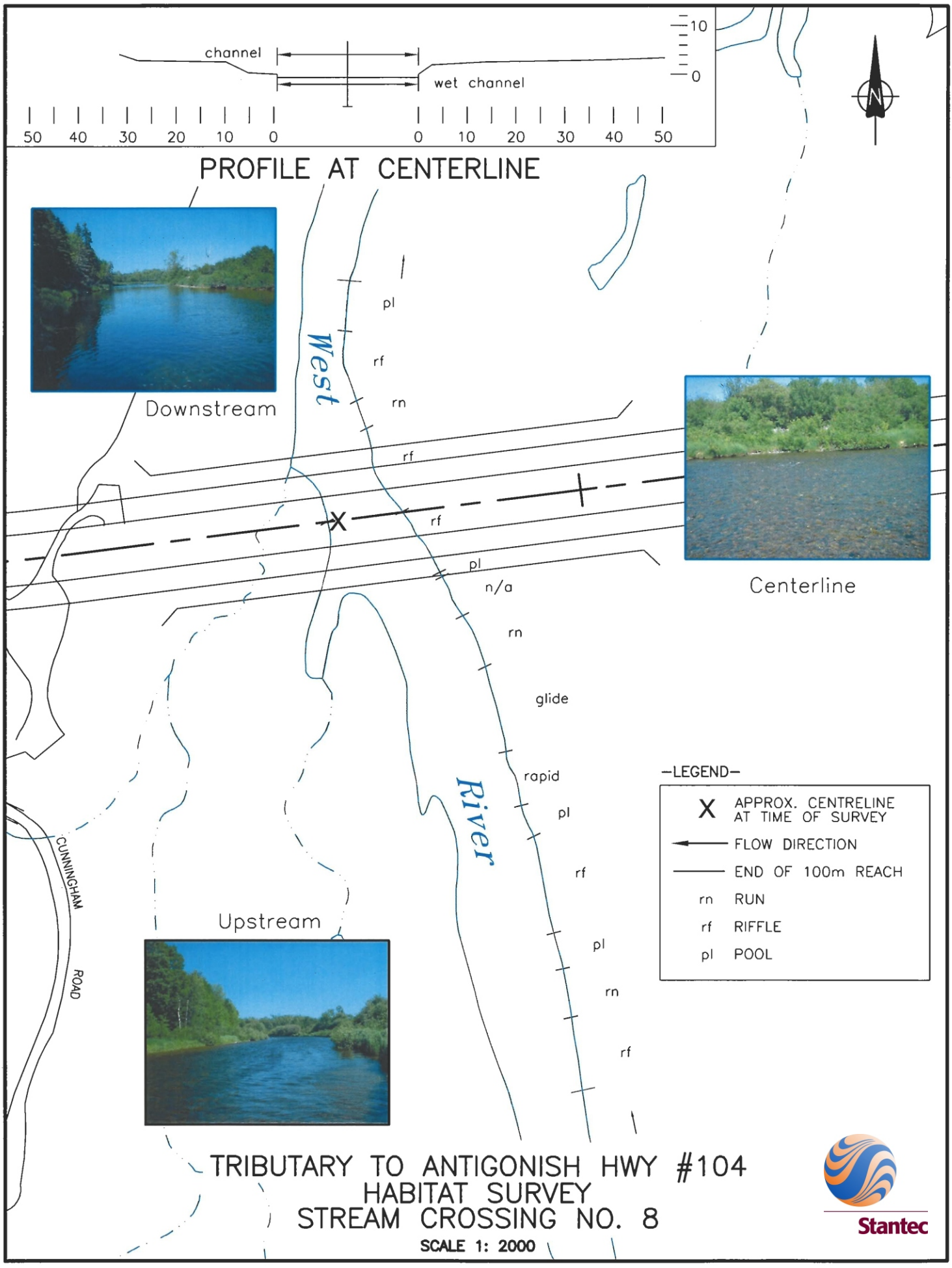
FIGURE NO.: **2**

Stantec

Land Disturbance 140m Bridge with Approach Fills	
Habitat Type	Area Disturbed/Lost (ha)
Agricultural Land	0.53
Flood Zone Habitat	0.20
Upland Forested	0.55



DATE: 11/02/2010 PREPARED BY: C. Shupe NOVA SCOTIA Transportation and Infrastructure Renewal	HIGHWAY 104 TWINNING - WEST RIVER - AREAS OF TERRESTRIAL IMPACT **Terrestrial Habitats (Scenario 3 - 140m Span with Bridge Approach Fills)**	FIGURE NO.: 3 Stantec


channel
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PROFILE AT CENTERLINE
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West
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glide
rapid
pl
rf
pl
rn
rf
River
Centerline
Upstream
CUNNINGHAM
ROAD
-LEGEND-
X APPROX. CENTRELINE AT TIME OF SURVEY
FLOW DIRECTION
END OF 100m REACH
rn RUN
rf RIFFLE
pl POOL
TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 8
SCALE 1: 2000
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Figure 4