10.0 CHAPTER 10 – RIVER PROTECTION WORKS INSPECTION

10.1 INTRODUCTION

Many river crossings in Alberta are located over reaches that are prone to lateral instability and changes in flow alignment. As a result, river protection works (RPW) have been designed and constructed at many sites to stabilize and align the stream in the vicinity of bridges and roadway encroachments. These protection works play an important role in maintaining the structural integrity and functionality of bridges and roadways.

RPW can consist of river engineering structures such as guidebanks and spurs, and armouring of channel banks and bridge headslopes. In most cases, these works consist of an earthen fill or slope protected by an armour layer. Although the current preference for armour material is rock riprap (see Best Practice Guideline No. 9), a variety of materials have been used in the past.

These RPW are typically designed to protect the road and bridge infrastructure during a design runoff event, although they may suffer some damage in the process. In addition, it is generally not cost effective or environmentally acceptable to protect for all possible future channel changes during the initial construction. Therefore, it is important to monitor sites that are prone to lateral mobility to assess the condition and functionality of the RPW on an ongoing basis.

The condition of some components of RPW and channels are inspected as part of the Level 1 BIM inspection. However, the condition and functionality of RPW cannot be accurately assessed without an understanding of factors such as:

- the morphological setting of the river, and ongoing river processes
- stream alignment and recent flood history
- interaction of the RPW with the bridge or roadway
- extent and purpose of all RPW structures and armouring

It is therefore beneficial to have the functionality and condition of these works periodically reviewed by personnel with experience in river engineering and familiarity with the characteristics of each site. This document describes the current approach to RPW inspection for Alberta Transportation bridges.

10.2 HISTORY

Prior to 1995, inspection of RPW was done by bridge planning staff with extensive experience in river engineering and familiarity with site characteristics and history. The inspection of sites was triggered by factors such as:

- proximity of nearby projects requiring site investigation
- observations of regional bridge engineers or BIM inspectors
- occurrence of significant floods in the area
- inspection associated with the pier scour inspection program
- results of detailed studies on river processes by the Alberta Research Council.

With changes in the delivery of bridge design services, the need for a formal program for inspection of RPW was identified. In the late 1990's, a systematic review of RPW infrastructure was undertaken to identify all sites with significant river engineering structures, and those that had a high likelihood of lateral instability. Following this review, most of this infrastructure was inspected and reviewed for functionality by personnel with river engineering expertise. In 2009, the system was re-evaluated using more objective criteria and a schedule for functionality review and condition inspection and proposed.

10.3 INSPECTION PRIORITY

As of February 2009, there are 1004 sites with major bridges over rivers or highway encroachments in the Alberta Transportation inventory system that are classified as "in service" and not under the jurisdiction of a city. In addition, there are 23 sites identified as highway encroachments (sites where RPW structures have been built adjacent to highways that are not close to crossings). In order to identify sites of interest for RPW inspection and to establish priorities for inspection, the following parameters have been considered:

- presence of RPW structures that extend beyond the bridge headslopes
- channel morphology – indicator of potential for lateral mobility
- bridge length – indicator of channel size and structure significance

Of the 1027 sites investigated, 164 have RPW structures that extend beyond the bridge headslopes. These structures are indicative of past channel stability and flow alignment issues. These sites will also require channel inspections that exceed the BIM level 1 inspections. All of these sites have been included in the BIM level 2 RPW inspection program.

Each of the 1027 sites were investigated using satellite photography and review of channel profiles to assess the potential for lateral mobility. Each site was assigned to one of the following channel stability rating categories:

Channel Stability Rating	Description	No. Sites
1	• Multiple channels, frequent in-stream bars • Sharp changes in flow alignment • Low water width << bank width • Recent channel shifts	367
2	• Few channel splits, vegetated islands • Active bend erosion - scour, point bars • Some active bank erosion - steep, un-vegetated • Some vegetated oxbows (cutoffs)	293
3	• Few channel features • Vegetated, stable banks • Incised – e.g. rock wall canyons • Lakes, canals	367

The potential for lateral mobility decreases with an increase in the channel stability rating. Sites were assessed on a reach by reach basis to ensure consistency, using the slope derived from the channel profiles in the department's Hydrotechnical Information System (HIS), as an indicator of changes in channel properties. The TIMS Webmap tool, with the satellite photography layer turned on, was used to visually assign the appropriate rating.

As all major bridges are not the same, and those over smaller channels can be more thoroughly examined in a BIM level 1 inspection, bridge length was also used to assist in assigning an inspection priority. The bridge length is used as a rough indicator of stream width and infrastructure significance for the sites that are not stream encroachments. The following criteria were used to group bridges:

Bridge Length	Number of Structures
>= 60m	318
>=40m and <60m	278
<40m	408

These three categorizations were then combined to identify sites of interest to the RPW inspection program, and to assign inspection priorities to them. This was done as follows:

Priority	RPW	Channel	Bridge Length	No. Sites
1	Y	1	All	106
2	Y	2	All	32
2	N	1	>=60m	74
3	Y	3	All	26
3	N	1	>=40m and <60m	66
4	N	2	>=40m	133
5	N	1,2	<40m	242
5	N	3	All	339

The assignment of priority will affect the frequency and extent of inspection at each site. Sites rated '1', '2', or '3' will be in the RPW inspection program. Sites rated '4' will be of marginal interest with periodic review, and sites rated '5' will not be considered as part of the RPW inspection program unless triggered by other factors. The assignment of these ratings and priorities and supporting inventory data are stored in the "RPW Inspection Management" table in the HIS database ("S:\Bridge Planning\Engg Software\HIS\HIS.mdb"). This database should be updated once per year to account for changes in infrastructure (link to BIS data) and to update priorities based on the most recent inspections.

10.4 INSPECTION REQUIREMENTS

There are two aspects to the RPW Inspection program – functionality review and condition inspection. The functionality review will be based on a desktop bank tracking review using temporal airphotos in a GIS tool while the condition inspection will be a visual site inspection.

There are many sources for the airphotos used in the desktop review. Historic hardcopy airphotos dating back as far as 1920 have already been procured and scanned for many sites. Many recent airphotos have been collected by the department in digital format and are available through the TIMS Webmap tool dating back to 1997. The department has also purchased complete coverage of the province in georeferenced satellite imagery, with multiple coverages available between 2005 and 2008, and future purchases planned. Some additional georeferenced block airphotos have been collected for certain areas of the province. Airphotos may also be purchased from the Alberta Environment library as required to provide good temporal coverage for all sites of interest. Sites that are due for a functionality review update can be added to the annual flying list coordinated by AT's GIS Department.

Using Global Mapper, or an equivalent GIS tool, multiple years of airphoto coverage can be georeferenced and river banks can be traced with vectors. Multiple vector layers can then be shown on top of the most recent photography, allowing for observation of historic changes in bank location and flow alignment. The location, magnitude, and rate of change in channel features can be readily identified. This facilitates assessment of the overall functionality provided by existing RPW and the identification of possible future enhancements. It also identifies areas of interest for the next visual condition inspection. It is envisioned that Global Mapper files will be prepared and maintained by TSB staff for all sites rated '1', '2', or '3', with updates based on the approximate schedule shown in the next section.

Prior to undertaking a visual site inspection, output from the latest bank tracking analysis and existing design drawings should be procured and reviewed. All RPW elements should be identified

and a plan for the path of inspection developed. These drawings can be used to map and collect inspection observations on site. Specific items of interest during the inspection are as follows:

Category	Description
Typical channel dimensions	• Identify portions of channel that appear typical of the reach • Estimate bed width, top width, and bank height
Hydraulic influences	• Natural - rock ledges, changes in cross section and slope, beaver dams, recent cutoffs • Other structures - weirs, lakes, bridges
Highwater data	• Note type, location, approx. elevation of any highwater/ice marks e.g. drift and grass deposits, siltation, marks on piers and girders, ice scars… • Note any backwater impacts e.g. farmlands, buildings…
Flow alignment	• Sketch channel features on hardcopy map/photo • Note bends, splits, skew, points of attack, zones of high velocity, bars, islands, drift accumulations • Visualize flow alignment at flood stage • Confirm channel stability classification
Bed and banks	• Map and assess bank stability – note slope, height, vegetation, material, erosion, slumps, rock outcrops, springs • Describe bed material – gravel, sand, silt, D_{50}, armour size
RPW	• RPW structures – under direct attack or out of flow, adjacent scour holes, slumps, loss of fill, signs of overtopping or outflanking • Ends of protection tied into bank or exposed • Apron – signs of launching, covered by deposits • Rock armour - lost rock, confirm rock size and angularity, signs of disintegration • Concrete armour – cracks, displacement, missing sections • Other armour – describe, compare to design
Drift potential	• trees in basin, active bank erosion, beaver activity • drift accumulations – at bridge/RPW, on banks, on bars

It is recommended that photos and videos be taken of any condition related issues, as well as general site coverage which should include a pan of the upstream and downstream channel from the bridge deck, and a wide angle or pan of the upstream and downstream faces of the bridge. Some rough vertical measurements may be of assistance to future assessment work, so it is advisable to take some tools along for the inspection, such as a handheld laser rangefinder or level, and a weighted tape. A handheld GPS unit may also be of benefit to mark the position or extent of features of interest.

In addition to the photos and video, a brief report summarizing key observations and measurements should be prepared for each site. This report should also summarize conclusions based on an evaluation of these results, as discussed in section 10.6. These reports should be stored in a directory used by TSB for tracking the BIM Level 2 RPW Inspection program.

10.5 SCHEDULE

For public safety, accountability, and optimal structure management reasons, it is desirable to inspect all sites in the RPW inspection program on a somewhat regular cycle. This cycle should be related to the inspection priority for the site, subject to flood events, observations, and construction activities. A minimum cycle of 5 years and a maximum cycle of 10 years has been selected. Updates to the functionality reviews should be done prior to visual site inspections. Based on the priorities established for the sites in the RPW inspection program, the following inspection cycle for functionality reviews and visual site inspections is proposed:

Priority	No. Sites	Functionality Review Cycle	Visual Site Inspection Cycle
1	106	5	5
2	106	5	10
3	92	10	-
4	133	-	-

Sites rated ‘4’ would receive periodic checks of recent information (satellite photos, BIM level 1 inspection, post-flood observations) to identify any issues that may affect the priorities for these sites.

This schedule will result in approximately 50 functionality review updates and 35 visual site inspections per year. The functionality reviews will mostly be done by TSB staff, and once the base files have been established, preparation of updates should be an efficient process. The visual site inspections may be done by a combination of TSB and regional bridge staff, with appropriate coordination. The site inspections may be bundled with pier scour survey and other bridge engineering trips.

10.6 EVALUATION

The functionality reviews and visual site inspections can be used to modify inspection priorities, identify sites that may require assessment for construction work, provide useful information for future design activities, and provide summary data to assist in reporting the status of the bridge system. The results of the RPW inspection program will also be of use in assessing results from the pier scour survey program, as pier scour is often a function of changes in flow alignment. Assessments that are triggered by the RPW inspection program may consider restoration or enhancement of the works, as well as possible impacts on bridge replacement.