

# Pointe du Bois

## Spillway Replacement Project

### *SEDIMENT MANAGEMENT PLAN*

*DRAFT*



 Manitoba  
Hydro

October 2012

# POINTE DU BOIS SPILLWAY REPLACEMENT PROJECT

## *Sediment Management Plan*

DRAFT

Report Prepared for



October 2012

**KGS**  
**GROUP**  
**CONSULTING**  
**ENGINEERS**

## PREFACE

### **Manitoba Hydro's Commitment to Environmental Protection**

Manitoba Hydro supports the need to protect natural environments and heritage resources affected by its projects and facilities. This goal can only be achieved with the full commitment of Manitoba Hydro employees and consultants at all stages of projects from planning and design through implementation and the full commitment of contractors during the implementation phase.

Manitoba Hydro is committed to protecting the environment.

In full recognition of the fact that corporate facilities and activities affect the environment, Manitoba Hydro integrates environmentally responsible practices into its business, thereby:

- preventing or minimizing any adverse impacts, including pollution, on the environment and enhancing positive impacts;
- continually improving our Environmental Management System;
- meeting or surpassing regulatory requirements and other commitments;
- considering the interests and utilizing the knowledge of our customers, employees, communities, and stakeholders who may be affected by our actions;
- reviewing our environment objectives and targets annually to ensure improvement in our environmental performance; and
- documenting and reporting our activities and environmental performance.

Manitoba Hydro's environmental management policy has been incorporated in the plans for the construction and operation of the Pointe du Bois Spillway Replacement Project. The use of environmental protection plans and programs is a practical and direct implementation of Manitoba Hydro's commitment to responsible environmental stewardship.

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**GLOSSARY OF ABBREVIATIONS**

|        |   |
|--------|---|
| CCME   | Canadian Council of Ministers of the Environment            |
| DFO    | Department of Fisheries and Oceans                          |
| EGD    | East Gravity Dam  |
| EIS    | Environmental Impact Statement                              |
| GS     | Generating Station  |
| km     | kilometers  |
| m      | meter   |
| mg/L   | milligrams per liter  |
| MWQSOG | Manitoba Water Quality Standards, Objectives and Guidelines |
| NTU    | Nephelometric Turbidity Units                               |
| SMP    | Sediment Management Plan                                    |
| TSS    | Total Suspended Solids                                      |
| Tu     | Turbidity   |
| WGD    | West Gravity Dam  |

# **1 INTRODUCTION**

## **1.1 PURPOSE**

This report describes the sediment management plan (SMP) for construction of the Pointe du Bois Spillway Replacement Project (the Project). This SMP has been developed to minimize the impacts of in-stream construction activities in the Winnipeg River. It outlines the monitoring and management of Total Suspended Solids (TSS) inputs into the waterway that may occur as a result of in-stream construction, river management and the commissioning of the new spillway. The introduction of excessive amounts of sediment load could change the water quality and be harmful to fish and fish habitat. The SMP is a fundamental component of the Projects overall Environmental Protection Program.

This SMP describes the works that may cause TSS increases and the method that Manitoba Hydro will use to oversee the General Civil Contractor's (GCC) in-stream construction activities. Appendix A provides an overview of the mitigation measures that may be used by the contractor, during in-stream works. The GCC Environmental Protection Plan (EnvPP) will include mitigation measures to reduce sediment inputs during in-stream construction and to control erosion and runoff from land based activities. Fulfilling the environmental protection plan and meeting the targets outlined in Section 4.1 are contractual obligation of the contractor.

Manitoba Hydro's Project Manager will be accountable for environmental protection compliance. The Project Manager, together with the Resident Engineer and Environmental Officer, will verify that the actual work carried out complies with the regulatory requirements, approval conditions, the EnvPP, and this document.

## **1.2 PROJECT DESCRIPTION**

The Pointe du Bois Generating Station (GS) is located on the Winnipeg River approximately 170 km by road north-east of Winnipeg and 43 km east of Lac du Bonnet (Figure 1). The site is located entirely within Whiteshell Provincial Park at Section 36, Township 15, Range 14E1.

The existing Pointe du Bois GS and associated water control structures consists of the West Gravity Dam (WGD), powerhouse, East Gravity Dam (EGD), a number of spillways (bays 1 to 35, 36 to 44, 45 to 65, 101 to 114 and 121 to 133), a five-bay sluiceway and a rockfill dam.

The Project involves replacing the existing spillways and sluiceway a new 7-bay spillway, at the east shore of the Winnipeg River, and two earthfill dams. Earthfill dams will be constructed downstream of the existing spillways, sluiceways and rockfill dam to as follows:

- Main dam – to be constructed along the lower spillway shelf connecting the spillway to the bedrock outcrop east of the intake channel (center island) and transition into the south dam; and
- South dam – to be constructed adjacent to the existing east gravity dam on the downstream side. It will tie into the powerhouse by a new concrete transition structure. The alignment coming off the center island changes slightly from the Original Arrangement to line up with the new axis of the main dam.

The dams will be zoned earthfill embankments, each consisting of an impervious core with granular and crushed rock filters and outer rockfill shells. The general arrangement of the proposed Project is shown in Figure 2.

Two cofferdams will be constructed in the Winnipeg River to divert the flow away from the in-stream construction area, to allow construction activities for the Project to take place in-the-dry.

## **2 POTENTIAL SOURCES OF SEDIMENT AND MANAGEMENT STRATEGIES**

### **2.1 GENERAL**

Various alternatives have been considered in the planning, scheduling of work, design and proposed construction methods for the Project with the objective of reducing the amount of suspended sediment added to the river. The final design and construction methods that will be used at Pointe du Bois will consist of best management practices, and all in-stream work will be conducted to meet the requirements of this sediment management plan. The in-stream works that may cause increases in TSS and the mitigation strategies are outline in this section.

### **2.2 SPILLWAY REPLACEMENT - IN-STREAM CONSTRUCTION ACTIVITIES**

The plan is to construct the Project over a period of approximately 3 years. Figure 3 demonstrates the construction sequencing and the river management activities required to complete the project.

In general, the structures on the east side of the river (spillway and associated works) will be built under Stage I river management with continued operation of the existing powerhouse, spillways and sluiceway. This will be followed by construction of the west side structures (permanent dams and transition structures) under Stage II, with flow directed through the new spillway and the existing powerhouse.

This two-stage River Management approach will be used to allow construction in-the-dry for much of the Project. There are, however, several project components that require in-stream construction activities that may result in sediment increases in the Winnipeg River by disturbing fine river bottom sediments or introduction of fine sediment from placement and removal of construction materials in the river. In-stream work will not take place between April 1 and June 30 of any year for to minimize the potential of sediment increases effecting fish spawning. Potential in-stream work and incidental activities that could potentially increase TSS levels include the following (for more detail on these items refer to the Point du Bois Spillway Replacement Project Environmental Impact Statement);

- Water intake installation and removal on east and/or west side (concrete batch plant water supply)
- Lower spillway shelf road construction and removal,
- Rockfill stabilization of the east gravity dam,

- Dewatering of cofferdams and spillway approach and discharge channels,
- Managing seepage through the Main dam,
- Rockfill mattress construction (spillway approach channel),
- Spillway approach channel drilling, blasting and excavation,
- Powerhouse tie-in wall cofferdam,
- Spillway (commissioning and operation during Stage II river management), and
- Existing spillways and sluiceway decommissioning (demolition of concrete)

### **2.3 PREDICTED SEDIMENT LOAD FROM IN-STREAM ACTIVITIES**

The in-stream activities were modeled for sediment input and transport potential. Based on the model results, no construction activity was predicted to increase TSS above the guidelines outlined in Section 3.3.

Based on the model, the maximum increase in TSS is predicted to occur while opening the first gate of the spillway and would occur for a short duration (approximately 1 hour). It is predicted that the additional sediment introduced into the river during this activity, could potentially elevate the instantaneous TSS concentrations by up to 180 mg/L immediately downstream of the spillway rapids, which is site SMP-2 shown on Figure 4. The instantaneous TSS concentrations are predicted to increase by up to 65 mg/L in the fully mixed zone approximately 3 kilometres downstream (site SMP-3 shown on Figure 4). During the time when the first gate is opened, the daily average TSS is predicted to increase by 2 to 3 mg/L at the SMP-3 site. This is within the MWQSOG guidelines for the protection of aquatic life for both the 1-day average duration (i.e., 25 mg/L increase) and the 30-day average during (i.e., 5 mg/L increase).

### **2.4 PRIMARY MITIGATION STRATEGIES**

Primary mitigation strategies were reviewed and incorporated into the preliminary design, and these will be utilized to reduce potential sediment releases during in-stream construction. They have been determined based on project site characteristics and the construction activities taking place and include the following:

- managing the river to direct flows away from in-stream construction works, where possible;

- constructing cofferdam with cross-sections that have the least potential for erosion;
- incorporating measures, such as deflector groins, to reduce flow velocities across the face of cofferdams;
- carefully controlling in-stream work to minimize streambank and bed disturbance; and
- working in the dry, where possible.

A summary of the preliminary mitigation strategies for in-stream construction activities associated with the Project components are presented in Appendix A.

## **2.5 SECONDARY MITIGATION STRATEGIES**

Sedimentation estimates are based on engineering judgment, numerical modeling results, and best construction practices and are considered as the worst-case scenarios. Understandably, some uncertainty exists about the amount of riverbed sediment that may be re-suspended, and the amount of fine material that may be washed away from the impervious fill, granular transition fill, and rockfill during cofferdam construction and removal in-the-wet. While there have been investigations and modeling completed to minimize and manage the uncertainties, they are typical for this type of work and are not practical to completely eliminate. Due to these uncertainties, secondary mitigation strategies may need to be implemented to reduce sediment releases into the watercourse from in-stream construction activities, should the need arise.

Secondary mitigation measures will be employed if target levels described in Section 4.1 are exceeded. The selection of the most practical secondary mitigation strategy will depend on the type and duration of the construction activity, when and where it is occurring, and the local water conditions in the work area. They include:

- installing a turbidity curtain, and or
- slowing down or temporarily stopping construction activities to reduce the sediment concentrations.

### 3 SEDIMENT REAL-TIME MONITORING PROGRAM

The Manitoba Hydro construction management team will implement an in-stream real-time TSS monitoring program throughout the construction and commissioning phases of the new spillway to monitor the magnitude, spatial, and temporal changes in TSS increases in the Winnipeg River. The monitoring program design was based on numerical modeling results related to the sedimentation regime in the river, expert knowledge of the study area, and recent experience by Manitoba Hydro on other hydroelectric construction projects. Overall, the design is based on an upstream downstream approach, with sufficient coverage of the river to define effects in the initial mixing zone as well as effects downstream.

The construction management team will include an Environmental Officer position whose role includes ensuring environmental compliance, as well as overseeing the sediment monitoring program. The Environmental Officer will also be integral in implementing the *Adaptive Action Plan* and the *Spillway Commissioning Management Plan*, described later in this document, should the TSS exceed the water quality target levels given in section 4.1 of this document.

#### 3.1 OBJECTIVE

The sediment monitoring program is intended to document the spatial and temporal characteristics of TSS and the magnitude of the increases in the Winnipeg River during in-stream construction. In addition, the program has been designed to facilitate responses to pre-determined action levels in order to meet the provincial and federal guidelines described in Section 3.3.

#### 3.2 MONITORING PROGRAM

The main parameter being monitored is TSS; however, because TSS cannot be measured in real-time, turbidity (Tu) measurements will be used as a surrogate. A relationship between TSS and Tu has been developed to facilitate the use of turbidity as the monitoring surrogate. Currently the developed relationship is;

$$\text{TSS (mg/L)} = 1.06 * \text{Tu (NTU)}.$$

During in-stream work, samples of water at the monitoring stations will be periodically collected and analyzed for TSS to confirm or adjust this relationship, as required.

### 3.2.1 TSS-TURBIDITY RELATIONSHIP DEVELOPMENT

Preliminary assessment of TSS concentration and Turbidity data at Pointe du Bois showed poor correlations between these two parameters due to the distribution of the TSS and Tu data and very low sediment concentration in existing environment [Ref. 1]. Even if a relationship could have been developed in existing environment, its effectiveness in representing changes in TSS as a result of construction material could be questionable. Therefore, a TSS-Tu relationship was developed based on laboratory experiments using both naturally present and construction materials found at the project site [Ref. 2].

Laboratory simulation of suspended sediment load increases in the Winnipeg river were run using sediment samples collected from the forebay bottom immediately upstream of the existing rockfill dam (new spillway approach channel) and using construction material from the project borrow sources. The construction material tested included crushed rock (crushed into silt particles), clay and a mixture of the two. The resulting TSS values were statistically correlated with Tu and a linear regression was calculated.

This TSS-Tu relationship was developed based on the combined datasets from the in-situ sediment samples and the construction material mixed in a ratio of 70% Clay and 30% Crushed Rock. The relationship was obtained for a range of TSS concentration values from 0 to 450 mg/L, and it is statistically appropriate for use to estimate in-stream concentrations up to this level.

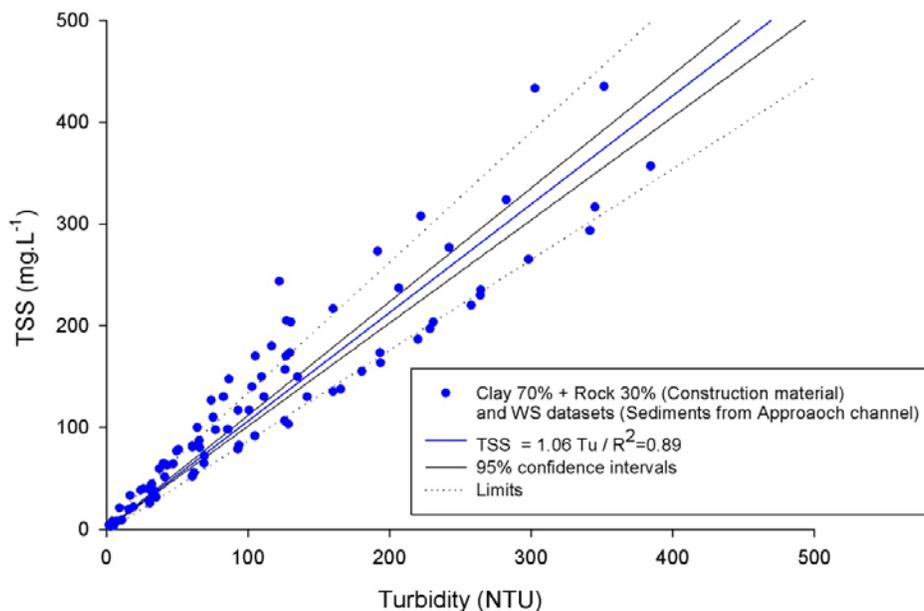


Figure 1 TSS-Tu relationship for the Winnipeg River at Point du Bois

### 3.3 GUIDELINES

In order to protect freshwater aquatic life the Canadian Council of Ministers of the Environment (CCME) and Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) have established a criterion of an allowable increase in TSS of 25 mg/L over a 24-hour period or 5 mg/L over a 30-day period for clear flow (background TSS concentrations <250 mg/L).

### 3.4 MONITORING LOCATIONS

Project activities that may affect TSS are located in the vicinity of Pointe du Bois Spillway. TSS and turbidity will be monitored through deployment of in-situ turbidity loggers near the surface and bottom of the water column at three transect locations as shown in Figure 4 and described as follows:

- SMP-1 is located upstream of construction activities to define background conditions. Loggers will be located at two sites across the forebay, one in the vicinity of the existing sluiceway (SMP-1a), and the other in the vicinity of the inner forebay (SMP-1b);
- SMP-2 is located downstream of all in-stream TSS sources, at a location within the mixing zone where flow from the powerhouse and construction area converge, approximately 750 m downstream of the construction site;
- SMP-3 is located 3 km downstream of the construction site at the end of the fully mixed zone, downstream of Eight Foot Falls.

The monitoring locations are consistent with the baseline monitoring sites that were used in the Pointe du Bois Replacement Project assessment studies. While it is intended that monitoring be undertaken at these locations, the actual locations may be adjusted in the field based on consideration of factors such as safety, accessibility and ambient conditions (i.e. high river flow or water velocity, unsafe ice).

### 3.5 MONITORING METHODOLOGY

Real-time turbidity data from the turbidity loggers installed will be remotely transmitted to a central computer at the construction site at a pre-determined interval (every 15 minutes) so monitoring results can be evaluated as soon as possible.

The computer program will automatically convert the turbidity reading into the TSS reading using the regression equation  $TSS \text{ (mg/L)} = 1.06 * Tu \text{ (NTU)}$ , as described above. The TSS change between SMP-1 and SMP-2 will be determined by comparing the baseline TSS calculated at SMP-1 with the calculated TSS at SMP-2. The change in TSS concentration at

SMP-3 will be calculated the same way, except it will be converted into a 24- hour rolling average. The information will be displayed graphically so it can be easily seen if the action and target levels at SMP-2 and SMP-3 are being met or exceeded.

In-situ Turbidity logger data will be supplemented through manual monitoring of turbidity using handheld loggers. At each location, water will also be collected for analysis of TSS to confirm or improve TSS-Tu relationship. Manual sampling will consist of collection of turbidity measurements at near surface, mid-depth, and near-bottom depths in the water along a river cross section in the vicinity of the turbidity loggers (SMP sites) and in the lake sturgeon habitat area. It should be noted that manual samples will be collected only if it is safe to do so and not during lake sturgeon spawning.

Visual inspections will be conducted in the immediate vicinity of the construction activities during major construction events to document activities that cause large, obvious increases in TSS in order to supplement real-time monitoring.

### **3.5.1 BIOFOULING EFFECT AND LOGGERS MAINTENANCE**

The turbidity loggers that will be used for the Project are equipped with self-cleaning optical sensors with integrated wipers to remove biofouling and maintain high data accuracy. However, the loggers will be visited every two weeks to maintain and clean the monitoring system (and free them of algae and vegetation debris) to avoid erratic spikes in data.

## 4 ADAPTIVE ACTION PLANS

### 4.1 TARGET LEVELS

Recent experience by Manitoba Hydro at another hydroelectric generating station and past discussions with DFO related to that project provided valuable experience that can be applied to this project. This included developing TSS action levels at a monitoring site located in closer proximity to the construction site (SMP-2) than the end of fully mixed zone (SMP-3). To ensure that the guidelines are met at the end of the mixing zone, management of TSS will incorporate two action levels measured in the mixing zone at SMP-2:

- (i) four consecutive 15-minute averaged measurements over 25 mg/L above background TSS at monitoring site SMP-1, and
- (ii) a 200 mg/L increase of above background TSS at monitoring site SMP-1.

Both proposed action levels (i.e., 25 mg/L and 200 mg/L above background) are below acutely lethal thresholds of suspended sediment for freshwater fish, which range from the hundreds to hundreds of thousands [Ref. 3]. Exceedence of these action levels will initiate an action plan to identify the source of the TSS and initiate secondary mitigation strategies for unanticipated events and/ or a modification to spillway gate commissioning procedure.

### 4.2 ADAPTIVE ACTION PLAN FOR UNANTICIPATED EVENTS

The *Adaptive Action Plan* for responding to TSS levels will be implemented as soon as possible in response to these results as follows:

- When the displayed output is less than 25 mg/L above background at SMP-2 and SMP-3 results will continue to be monitored and no action will be taken.
- When the TSS at SMP-2 is equal to or greater than 25 mg/L above background for four consecutive, 15 minute readings, but less than 200 mg/L, the Resident Engineer and Environmental Officer will:
  - a. Ensure the results are accurate (i.e. rule out logger malfunction);
  - b. If possible, take a handheld turbidity reading to confirm the result;
  - c. **Take Action**, which includes investigating to try and identify the activity resulting in the recorded TSS increase and if it is still underway, implement mitigation, if possible. Mitigation may include advising the contractor of the need to modify work activities, such as (but not limited to);

- Temporary suspension of work activity,
    - Modifying the rate of material placement or removal,
    - Modifying the sequence of material placement or removal,
    - Installing additional erosion and sediment control measures,
    - Verifying the quality of the material being used is appropriate, and
    - Temporarily moving to a new work area
  - d. Record the event in the daily report.
- 
- When the TSS at SMP-2 is equal to or greater than 200 mg/L above background (one reading), the Resident Engineer and Environmental Officer will:
    - a. Ensure the results are accurate (i.e. rule out logger malfunction);
    - b. If possible, take a handheld turbidity reading to confirm the result;
    - c. Discuss exceedence with the Project Manager;
    - d. **Take Action**, which in this case should be carried out by the Project Manager after he/she evaluates whether the construction activity that resulted in high TSS is still underway. If so, the following measures may be required of the contractor;
      - Temporary work stoppage,
      - Installation of sediment containment, and
      - Other modifications to construction practices
    - e. Notify Fisheries and Oceans Canada (DFO); and
    - f. Record the event in the daily report.
  
  - When the TSS at SMP-3 is equal to or greater than 25 mg/L above background (measured as a 24 hour rolling average), the Resident Engineer and Environmental Officer will:
    - a. Ensure the results are accurate (i.e. rule out logger malfunction);
    - b. Discuss exceedence with the Project Manager;
    - c. **Take Action**, which includes investigating to try and identify the activity resulting in the recorded TSS increase and if it is still underway, mitigation may need to be implemented. This may include advising the contractor of the need to modify work activities, such as (but not limited to);

- Temporary suspension of work activity,
  - Modifying the rate of material placement or removal,
  - Modifying the sequence of material placement or removal,
  - Installing additional erosion and sediment control measures,
  - Verifying the quality of the material being used is appropriate, and
  - Temporarily moving to a new work area
- d. Record the event in the daily report;
- If the exceedance at SMP-3 continues for 3 days in a row, the Project Manager and Environmental Officer will:
    - a. Take further action which in this case should be carried out by the Project Manager. The following measures may be required of the contractor;
      - Temporary work stoppage,
      - Installation of sediment containment
    - b. Notify DFO.

### **4.3 SPILLWAY COMMISSIONING MANAGEMENT PLAN**

Commissioning of the spillway is the activity that could cause excess sediment to be transported downstream. When water first passes through the spillway approach and discharge channels, it will flow over residual materials that may be left behind on the river bottom after the rock mattress and cofferdams are removed. Although every effort will be taken to remove residual material, inevitably some will be left behind and gets flushed out when water first passes through these structures. In order to allow a gradual flush of this material, the following steps will be taken:

- When the spillway gates are first used near the end of Stage I river management, the gates will be opened slowly, one at a time, in small increments to prevent a large concentration of sediment from being washed downstream;
- Gate opening activities will be closely monitored using the real-time sediment monitoring information to prevent exceedences of target levels;
- Systematic opening and closing of the gates will be undertaken to prevent exceedence of target levels; and
- The staged approach to gate opening will continue until real-time output clearly illustrates there is no excess sediment being generated.

## 5 REPORTING

For each day there is in-water construction activity, a daily report on the monitoring results will be prepared and submitted to DFO one to two days after the Sediment Monitoring Program results are collected and analyzed. The report will contain the following type of information:

- A brief statement of major construction activities taking place that day;
- Any construction issues that arose that may have impacted TSS in the river;
- Any exceedence of target levels;
- A brief description of the incident that led to the exceedence (if known);
- Adaptive management carried out to correct the exceedence (if known); and
- Data for the 24-hour result period and time stamped photographs of the day of construction activities, any incidents and corrective action taken.

An annual summary report of the SMP activities will also be prepared for submission to both DFO and Manitoba Conservation and Water Stewardship.

## 6 REFERENCES

- 1) KGS Acres 2011. Pointe du Bois Spillway Replacement, Physical Environment- Erosion and Sedimentation Baseline Data Summary Report 2007-2010. Deliverable No: P-1.2.2.2.1.0204.1, Rev 0, Manitoba Hydro File 00102-11120-0001\_00.
- 2) Environnement Illimité Inc. 2012. Establishing a Total Suspended Solids – Turbidity Relationship for the Winnipeg River in the Pointe du Bois Spillway Replacement Project Area.
- 3) Department of Fisheries and Oceans Canada. 2000. Effects of Sediment on Fish and Their Habitat. DFO Pacific Region Habitat Status Report 2000/01.

## **Appendix A**

Summary of Construction Activities, Their Potential Effects and Associated Mitigation

| Potential Sediment Problem  | Mitigation Techniques   |
|---|---|
| <b>Installation of sheet pile in cofferdam</b>  |   |
| Potential re-suspension of fine river bottom sediments during installation of sheet pile.   | Sheet piles will be contained within rockfill on a prepared bedrock therefore sediment should not be disturbed  |
| <b>Placement of concrete</b>  |   |
| Potential source of sediment that may enter the river is washing of fine grain size material from the concrete when placed in the wet for the below water section of the sluiceway tie-in wall  | <p>Use of tremie concrete (i.e. Concrete placed underwater by way of pumping through a tremie pipe) to minimize the amount of material that comes in contact with the surrounding water and containing an anti-washout admixture that decreases the percentage of fines and cement paste that are washed out prior to setting.</p> <p>If monitoring identifies a sediment concern then in certain locations the tremie concrete could be pumped directly into grout bags designed to prevent the washout of cement paste and fines from the concrete mixture as it is being placed.</p>   |
| <b>Placement of rockfill and riprap</b>   |   |
| <p>Potential source of sediment that may enter the river is the washing of fine grain size material due to flow through and along the face of the rockfill used for the East Gravity Dam stabilization, barge landings and cofferdams as well as the rockfill mattress and lower spillway.</p> <p>Potential re-suspension of fine river bottom sediments when placing rockfill used for the cofferdams as well as the rockfill mattress and shelf road.</p> | <p>The rockfill (Class C: 64 to 750 mm) and riprap zone (Class D: &gt;300 mm) will consist of rock fragments of sufficient size to resist being carried downstream by the current.</p> <p>If monitoring identifies a sediment concern the following mitigation could be applied:</p> <ul style="list-style-type: none"> <li>• rock will be screened to lower fines content.</li> <li>• larger Class D fill will be placed on the flow side and advanced ahead of the Class C fill to provide protection from flow.</li> </ul> <p>Installation of a turbidity curtain for rockfill mattress, where flow conditions permit, to isolate the construction area and control the release of sediment.</p> |

| <b>Placement of granular fill</b>   |   |
|---|---|
| <p>Potential source of sediment that may enter the river is the washing of the finer grain size material by water seeping through the rockfill to reach the granular fill if it is required for the cofferdams and lower spillway shelf road access.</p> <p>Initially, a small portion of even the coarse grained material may be washed through the rockfill, with the size of the particles being washed gradually reducing until essentially no washing occurs.</p> <p>Potential re-suspension of fine river bottom sediments when placing granular fill in the area between the rockfill groins of the cofferdams.</p>              | <p>The granular transition fill (Class B), if required, will consist of low silt content gravelly sand or gravel.</p> <p>Placement of granular fill will be sheltered with flow impeded due to the prior cofferdam rockfill advancement minimizing mobilization of sediments.</p> <p>If monitoring identifies a sediment concern then the following additional mitigation could be applied:</p> <ul style="list-style-type: none"> <li>• granular fill will be end-dumped on top of the granular fill that has already been placed and pushed into the water so that it will enter the water as a sliding mass.</li> <li>• the granular fill zone will be constructed to a level that is slightly above the water level as it is advanced and subsequently be raised to final elevations in the dry.</li> </ul>   |
| <b>Placement of impervious fill</b>   |   |
| <p>Potential source of sediment that may enter the river is the washing of fine grain size material by water seeping through the cofferdam and from velocities along the surface of impervious fill used for the cofferdams.</p> <p>Initially, a small portion of the impervious fill may be washed through the rockfill if a granular transition fill has not been used; with the size of the particles being washed gradually reducing until essentially no washing occurs.</p> <p>Potential re-suspension of fine river bottom sediments when placing impervious fill in the area between the rockfill groins of the cofferdams.</p> | <p>The impervious fill (Class A) will consist of high plasticity, low permeability silty clay material that will form a homogeneous impervious mass.</p> <p>Placement of impervious fill will be sheltered with flow impeded due to the prior advancement of the rockfill (and transition zones if required) of the cofferdam minimizing mobilization of sediments.</p> <p>If monitoring identifies a sediment concern then the following additional mitigation could be applied:</p> <ul style="list-style-type: none"> <li>• impervious fill will be end-dumped on top of the impervious fill that has already been placed and pushed into the water so that it will enter the water as a sliding mass.</li> <li>• the impervious fill zone will be constructed to a level that is slightly above the water level as it is advanced and subsequently be raised to final elevations in the dry.</li> </ul> |

|   |   |
|---|---|
| <b>Laying/anchoring pipe for water intake</b>   |   |
| Potential re-suspension of fine river bottom sediments when laying the water intake pipe and anchoring the intake screen.   | The pipe and intake will extend less than 10 m from the shoreline and only four anchor points per intake to minimize the disturbance to the river bottom. (intake screen requirements are discussed in the aquatic effects monitoring program)  |
| <b>Dewatering cofferdams</b>  |   |
| Water trapped within the cofferdam areas may have elevated sediment levels from the introduction of fine materials and/or re-suspension of fine river bottom sediments during cofferdam construction.   | Any water trapped within the cofferdam during construction which becomes contaminated with sediment beyond that as stipulated in the regulatory requirements will either be collected and pumped out to a settling pond/tank for treatment prior to discharge to the river or it will be allowed to settle in-situ until it meets requirements and can be pumped to the river. If not contaminated, it will be discharged directly back to the river.   |
| <b>Managing seepage through cofferdams</b>  |   |
| Water that seeps through the cofferdams during construction activities may have elevated sediment levels when it comes in contact with fine materials from the work areas.  | Seepage water will be kept separate from the work areas through use of collection sumps and diversion berms and discharged directly back to the river.<br><br>Any seepage water that is not contained within these diversion berms which becomes contaminated with sediment beyond that as stipulated in the regulatory requirements will either be collected and pumped out to a settling pond/tank for treatment prior to discharge to the river or it will be allowed to settle in-situ until it meets requirements and can be pumped to the river. If not contaminated, it will be discharged directly back to the river. |
| <b>Underwater blasting</b>  |   |
| Potential source of sediment is the generation of finer grain size material as the rock is shattered during the drilling and blasting activities for the spillway approach channel. Additionally, fine river bottom sediments will be re-suspended while drilling and from the force of the blasting. | The rockfill mattress will contain any sediments generated or re-suspended and therefore control the release of sediment.   |

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| <b>Rock excavation and removal of rockfill</b>   |  |
| <p>Potential source of sediment that may enter the river is the washing of the finer grain size material during excavation and removal of the blasted spillway approach and discharge channel rock and removal of rockfill used for the East Gravity Dam stabilization, barge landings and cofferdams as well as the rockfill mattress and lower spillway shelf road.</p> <p>The finer grain material in the rock will consist of material that washed from the granular or impervious fill into the rockfill during construction or re-suspended fine river bottom sediments.</p> | <p>The inner rockfill groin of cofferdams will be removed as much as possible using the outer groin for protection from the bulk of the flow minimizing mobilization of sediments.</p> <p>Installation of a turbidity curtain, where flow conditions permit, to isolate the construction area and control the release of sediment.</p> <p>Adaptive management of spillway operation to decrease the flows in the vicinity of the work or allow working in the dry.</p>   |
| <b>Removal of granular and impervious fill</b>   |  |
| <p>Potential source of sediment that may enter the river is the washing of the finer grain size material being removed or re-suspended fine river bottom sediments disturbed during removal of the granular and impervious fill used for the cofferdams and lower spillway shelf road access.</p>  | <p>The granular and/or impervious fill used in cofferdams will be removed as much as possible using the outer groin for protection from the bulk of the flow minimizing mobilization of sediments.</p> <p>Installation of a turbidity curtain for excavation of rockfill mattress, where flow conditions permit, to isolate the construction area and control the release of sediment.</p> <p>Adaptive management of spillway operation to decrease the flows in the vicinity of the work or allow working in the dry.</p> |
| <b>Commissioning spillway</b>  |  |
| <p>Sediment generated within the approach and discharge channels during construction, as well as fine river bottom sediment accumulated upstream of the approach channel will be mobilized and transported downstream during commissioning of the spillway.</p>  | <p>Construction areas with work completed in the dry, such as the discharge channel, will be cleaned as much as practical prior to commissioning.</p> <p>Sequence the commissioning to control the timing and volume of flow released to minimize TSS increases.</p>   |

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| <b>Operating spillway (Stage II river management)</b>  |  |
| Potential source of sediment is the fine river bottom sediment accumulated within and upstream of the approach channel being mobilized and transported downstream during operation of the spillway if flows exceed those experienced during commissioning. | Measures used for commissioning as described above will have already partially cleared sediments.  |
| <b>Underwater demolition of concrete</b>   |  |
| Potential source of sediment is the generation of finer grain size material as the concrete piers or other concrete structures are decommissioned either by blasting, hoe ramming, wire saw, and/or underwater excavation.                                 | Installation of a turbidity curtain, where flow conditions permit, to isolate the construction area and control the release of sediment. |