KEEYASK
Hydropower Limited Partnership

0 5 10 15 Kilometres
0 2 4 6 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Nelson River Shoreline modelled by Manitoba Hydro.
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Keeyask Generating Station to Long Spruce Generating Station

Fish Community Monitoring

5.2.2.1.3 Parameters

Fish will be collected, enumerated by species, and sampled for length and weight. In addition, sex, state of maturity, and external condition (deformities, erosion, lesions, and tumours [DELTs]) will be recorded from the collected fish. Ageing structures will be collected from a subsample of the catch. The data will be analyzed to generate CPUE values and frequency of occurrence histograms. Condition factor and length-at-age will also be calculated by species.

5.2.2.1.4 Sampling Sites

Sampling in Split and Stephens lakes will generally occur at sites established during baseline studies. Sampling sites within the reservoir will be identified based on major habitat types, which is consistent with site selection method used for baseline studies.. In the tributaries (Two Goose Creek, Portage Creek, Trickle Creek, Hidden Creek; Map 11), two to four sections between 50 and 100 m in length will be sampled, depending on the length of the tributary. Once sampling locations have been established, they will be used consistently in future years.

5.2.2.1.5 Sampling Frequency and Schedule

Core monitoring will be conducted annually during the first three years after the FSL is reached and then at least every three years until ten years post-impoundment. Monitoring may continue at a reduced frequency up to 30 years post-impoundment, depending on results.

5.2.2.1.6 Methods

Monitoring will include standard index and small mesh gillnet sampling of the Keeyask reservoir, Stephens Lake, and Split Lake, and backpack electrofishing in reservoir tributaries to determine whether fish species composition and CPUE have changed substantially. Data will be compared to pre-Project data to determine changes in the fish community.

A total of 10–15 sets in each waterbody will be used to define the distribution of CPUE during the monitoring period. All sites will be sampled with bottom sets and deep areas will be sampled with both surface and bottom sets. At every third set location, a small-bodied fish gillnet gang will be attached to the large-bodied fish gang. This should provide a sufficient number of samples from which to compare CPUE values. No *a priori* power analysis is available for nonparametric tests; *post hoc* assessment of the reliability of the nonparametric tests can be achieved through iteration.

5.2.2.2 Fish Movements

Fish movements during station operation will be monitored through the continuation of the acoustic telemetry program initiated during the construction phase, and a mark and recapture program aimed at describing movements and habitat use of fish in the Keeyask reservoir. As described in Section 5.1.2, 80 acoustic transmitters will be applied at 3 year intervals to assess habitat use and movements of northern pike, walleye and lake whitefish throughout the Nelson River between Clark Lake and the Long Spruce GS. This methodology will be expanded during operation to assess the frequency and mode (i.e., turbines or spillway) of downstream fish movements through the GS. Acoustic telemetry will also be used to assess the movements of fish transported upstream over the GS during the experimental catch and transport study described in Section 5.2.3.5. Additional data on the movements of fish in the Keeyask reservoir, including downstream fish movements through the Keeyask GS and upstream fish movements into Split Lake, will be collected by marking fish with Floy®-tags in the Keeyask reservoir and determining the proportion of tags recaptured from different locations.

Data from the fish movements study will also provide additional information on the general use of habitat in the Keeyask reservoir (i.e., use of areas in the lower, middle and upper portions of the reservoir) and supplement the data collection in Section 5.2.2.1.

5.2.2.2.1 Monitoring Area

The area monitored by the acoustic telemetry system includes the Nelson River between the outlet of Clark Lake and the Long Spruce GS (Map 9). Fish marked with Floy®-tags may be recaptured upstream of the acoustic telemetry monitoring area in Split Lake, or downstream of the Long Spruce GS perhaps even as far downstream as the estuary.

5.2.2.2.2 Sampling Design

Movements of acoustically tagged fish will be monitored by manual acoustic tracking and stationary acoustic receivers as described in Section 5.1.2. However, additional stationary receivers will be deployed following filling of the reservoir to monitor the frequency and mode (spillway or turbines) of downstream fish passage through the GS, and to provide a determination of survival following passage. Acoustically tagged fish moving downstream through the GS will be detected by stationary receivers on the upstream side of the GS, and, if the fish survives passage, will be relocated by receivers on the downstream side of the GS. Tagged fish detected by the stationary receivers on the upstream side of the GS, which are not subsequently detected by the downstream stationary receivers, will be assumed to have suffered mortality. Presently, it is unknown if acoustic telemetry will be capable of discerning whether a fish moved downstream through the GS via the turbines or spillway, but given the distance between the intakes of the two structures, it is likely that receivers can be positioned to make this distinction with reasonable confidence.

Additional data on fish movements and habitat use will be collected by marking fish in the Keeyask reservoir with Floy®-tags. Northern pike, walleye and lake whitefish larger than 250 mm FL will be marked. The intent of applying Floy®-tags to these three species in the reservoir is to provide additional information on the frequency of fish movements out of the reservoir, either downstream through the Keeyask GS, or upstream into Split Lake. Marked fish will be recaptured by local fishermen, commercial fishermen and/or during biological studies such as index gillnetting conducted in Split, Gull, Stephens and Assean lakes, lake sturgeon gillnetting conducted in the Upper Split Lake Area, the Keeyask reservoir and in Stephens Lake as well as other studies described as part of this AEMP.

5.2.2.2.3 Parameters

The main parameters that will be used to monitor fish movements during GS operation is the number and proportion of walleye, northern pike, and lake whitefish implanted with transmitters or marked with Floy®-tags that:

- Remain in the Keeyask reservoir;

- Move between sections of the Keeyask reservoir (i.e., lower, middle or upper sections), and occupy various sections of the Keeyask reservoir or river kilometres in the study area (i.e., proportional distribution);
- Move downstream through the Keeyask GS into Stephens Lake or beyond;
- Move downstream through the Keeyask GS via powerhouse or spillway; and
- Move upstream into the Split Lake Area or beyond.

To the extent possible, movement data will be interpreted by fish species, size, age and state of maturity. These information may identify spawning areas, foraging areas and/or overwintering areas. Seasonal movement information such as distance moved, and proportional distribution, will be calculated for each acoustically tagged fish.

5.2.2.2.4 Sampling Sites

As previously discussed in Section 5.1.2, 80northern pike, 80 walleye and 80 lake whitefish will be tagged with acoustic transmitters, half in the Keeyask reservoir and half in Stephens Lake at three-year intervals. Fish will be tagged in each of the three sections (upper, middle and lower) of the Keeyask reservoir to provide adequate spatial representation of the tagged fish by location and species. Stationary acoustic receivers will be deployed throughout the Nelson River between Clark Lake and the Long Spruce GS as part of fish movement monitoring described in Section 5.1.2. Once the reservoir has been filled, additional receivers will be deployed immediately upstream of the GS near both the spillway and powerhouse. Acoustic receivers will be deployed throughout the year in the Long Spruce reservoir, Stephens Lake, the Keeyask reservoir and Clark Lake. Stationary receivers will be pulled out during winter in the riverine sections of the Keeyask reservoir. Manual acoustic tracking will be conducted on a bi-weekly basis from May to October in the Nelson River between Clark Lake and the Kettle GS.

To apply Floy®-tags to fish in the Keeyask reservoir, boat electrofishing will be conducted in the upper, middle and lower sections of the Keeyask reservoir. Sampling will be conducted to provide adequate spatial representation of Floy®-tagged fish within each reservoir section.

Recapture of Floy®-tagged fish will occur during sampling conducted as part of the CAMPP project in Split, Assean, Gull and Stephens lakes, lake sturgeon gillnetting in the Upper Split Lake Area, Keeyask reservoir and Stephens Lake and/or other biological monitoring studies described in this AEMP.

5.2.2.2.5 Sampling Frequency and Schedule

Because the lifespan of the acoustic transmitters that are of appropriate size for the fish species of interest is three years, transmitters will be applied to fish at three years intervals. During operation monitoring, new transmitters will be applied twice, thus providing six years of monitoring data. The need for continued movement monitoring will be assessed following the expiry of all transmitters (with the exception of those applied to lake sturgeon).

To capture fish for Floy®-tagging, boat electrofishing will be conducted for 14 day periods, during spring and fall, annually, over a 3 year period following the start of operation monitoring. The need for applying additional tags would be reassessed during the 4-year review.

5.2.2.2.6 Methods

Fish selected for acoustic tagging will be collected, anaesthetized, tagged, and released as per methods described in Section 5.1.2.6. Manual acoustic tracking and stationary receivers, also described in Section 5.1.2.6, will monitor transmitters. Monitoring is intended to continue through construction and into the operation phase to provide a continuous dataset on the movements of fish in response to the Project.

Boat electrofishing will be conducted to collect fish for Floy®-tagging. Electrofishing gear will be comprised of a Smith-Root GPP 5.0 electrofisher with dual boom 0.91 m diameter Smith-Root UAA-6 Umbrella anodes mounted approximately 2.0 m apart. The electrofisher will be set at 15 pulses per second/3.5 amps/500 volts, proven to be effective in the Nelson River. The electrofishing crew will consist of one boat driver and two netters at the bow of the boat, one each on the port and starboard sides. Floy®-tags will be applied to each fish species between the basal pterygiophores of the dorsal fin using a Dennison Mark II tagging gun.

5.2.3 Specific Effects Monitoring

5.2.3.1 Monitoring of Fish Gas Bubble Trauma

Gas-bubble trauma (GBT) in fish is a physically induced condition caused by gas supersaturation in water (Bouck 1980). Such supersaturated conditions frequently exist in areas downstream of generating stations, when air bubbles in water falling from the upstream side of the GS are forced into solution when the water plunges into the deeper water on the downstream side of the GS, e.g. at spillway plunge pools (Abernethy et al. 2001; Arntzen et al. 2009). As this water moves closer to the surface, the gases are supersaturated relative to the local atmospheric pressure. Similarly, in fish acclimated to the air-enriched water at depth, air bubbles will form in blood and/or tissues as the fish experiences a drop in pressure (i.e., move up in the water column). Air bubbles may form in the blood of fish that encounter gas supersaturated water. These bubbles can block respiratory water flow and blood vessels, tear tissues, rupture the swim bladder, and may result in death (Bouck 1980; CCME 1999; updated to 2012).

5.2.3.1.1 Monitoring Area

Monitoring for evidence of GBT will be conducted in the Keeyask reservoir, downstream of the GS and the spillway, and downstream of the confluence of powerhouse flow and spillway flow.

5.2.3.1.2 Sampling Design

Fish will be collected from a site(s) downstream of the GS where TDGS may occur and compared to samples collected from upstream of the GS.

Studies will focus on walleye, supplemented by lake whitefish to the extent that the latter species can be captured. Walleye were chosen because they are one of the most abundant species in the study area and lake whitefish because they are anticipated to be the most sensitive.

5.2.3.1.3 Parameters

Fish will be visually examined for signs of GBT; typical symptoms of GBT in fish include over-inflation of the swimbladder, subdermal emphysema, and bubble formation in the gut, buccal cavity, and blood vessels, potentially leading to death. Supporting variables that will be measured as part of the water quality monitoring program include TSS, turbidity, and DO. Monitoring of total dissolved gas pressure will be conducted as part of PEMP. In addition, length, weight, sex, state of maturity, and external condition (DELTs), including the condition of the gills, will be recorded from the collected fish. Ageing structures will also be collected and archived.

5.2.3.1.4 Sampling Sites

Fish from areas downstream of the GS where TDGS may occur will be sampled for GBT, and reference samples will be collected from upstream of the GS. Sampling in the reservoir will be conducted approximately 200 m upstream of the powerhouse or spillway where crew safety is not compromised. Downstream of the GS, fish will be sampled as close to a structure as possible and over several hundred to thousands of metres below the powerhouse, spillway and confluence of the powerhouse and spillway flows. The exact extent of downstream sampling will be determined by TDG levels measured as part of the PEMP and safety considerations.

5.2.3.1.5 Sampling Frequency and Schedule

The timing of GBT monitoring will be largely determined by Nelson River flow conditions and the operation of the Keeyask GS, particularly relating to periods of spill and the distribution of flows through the spillway gate openings. GBT monitoring will be conducted in the summer after all the turbines are in operation at least once each during periods of no spill at low and intermediate river flows, and during low, intermediate, and high spill flows. Because of the ramping and frequent variability of spill flows and the time dependency of the dissolution of air, each GBT monitoring event will be conducted over 3-4 days.

5.2.3.1.6 Methods

In conjunction with TDG monitoring (included in the PEMP), areas near sampling sites will be visually surveyed for the presence of floating fish or fish showing other abnormal behaviour. Observed fish will be captured and inspected externally and internally for signs of GBT. Where conditions permit, standard gang gill nets will be surface-set near locations with confirmed TDGS and checked hourly. Alternative methods of capture could include boat electrofishing or dipnetting. Captured fish will be identified to species, measured for length, and inspected externally and internally for signs of GBT. Gillnetting will be used to collect a reference sample from the reservoir.

If the above two methods do not yield evidence for GBT, the potential for its occurrence downstream of the Keeyask reservoir could be evaluated using cage bioassays. For this, fish captured in gill nets downstream of the powerhouse or spillway will be placed in a shallow (~1 m) mesh cage anchored in an area of known high TDGS. Approximately 20 fish will be exposed to high TDGS for up to four days, during which time five fish will be checked daily for GBT symptoms. The data from the field surveys will be analyzed to calculate mean TDG concentrations, generate maps indicating the spatial extent and depth distribution of TDG concentrations, calculate the percentage of fish by species and length classes showing signs of GBT, and calculate various ratios regarding the mass loading of gases into the river.

5.2.3.2 Use of Existing and Created Spawning Habitat

5.2.3.2.1 Monitoring Area

Monitoring of spawning will occur at major rapids and created spawning habitats in the reach from the outlet of Clark Lake to the channel below the Keeyask GS, including areas where the haul roads were removed.

5.2.3.2.2 Sampling Design

Gillnetting and driftnetting/neuston tows (where conditions are suitable) will be conducted at existing and newly created spawning habitat to determine use by walleye and lake whitefish. Information on the use of these structures by other species will also be collected.

5.2.3.2.3 Parameters

Material collected in drift nets will be sorted and all larval fish and/or eggs will be enumerated by species, where possible. Catches will be expressed in number of larvae and/or eggs captured per drift net per 24-hour sampling period. Fish captured in gill nets will be enumerated by species measured for length and weight and, where possible, examined for sex and maturity. Catches will be expressed as a proportion of fish in spawning condition.

5.2.3.2.4 Sampling Sites

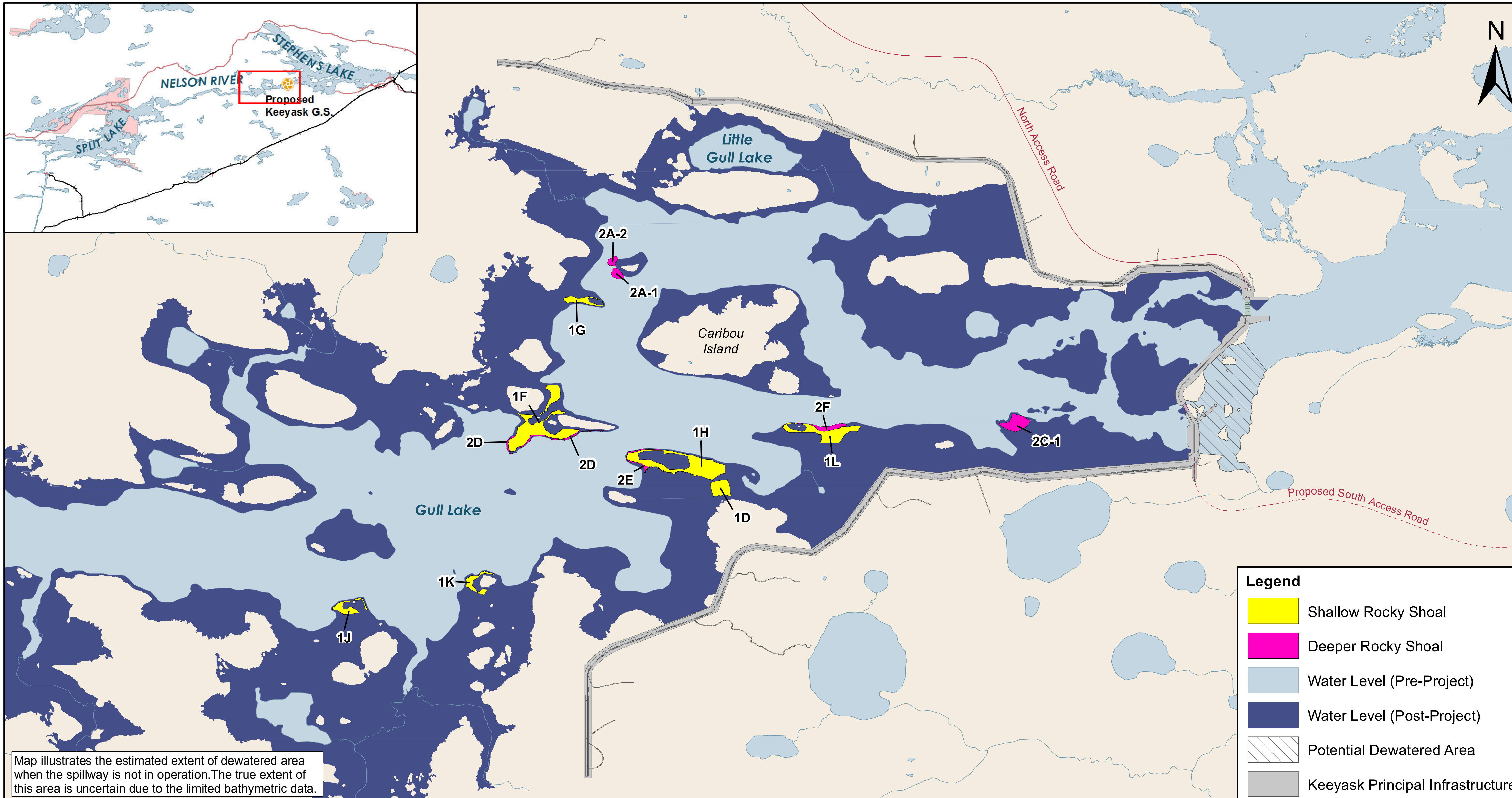
Monitoring will occur at Long Rapids, Birthday Rapids, spawning shoals in the Keeyask reservoir, the tailrace spawning structure, and the spawning shoal in Stephens Lake (maps 13, 14 and 15).

5.2.3.2.5 Sampling Frequency and Schedule

Sampling will occur annually during the first three years after the FSL is reached for the first time, and at least once every three years until ten years post-impoundment. Monitoring may continue at a reduced frequency until thirty years post-impoundment, depending on results. Gillnetting studies will be conducted in May and June for walleye and in September and October for lake whitefish, when water temperatures are within the preferred range of spawning for each species. Drift nets and/or neuston samplers will be used during spring to determine if successful spawning occurred at the aforementioned locations. The use of egg mats during fall to confirm lake whitefish egg deposition will also be considered where conditions are suitable.

5.2.3.2.6 Methods

Gill nets will be set in the vicinity of spawning locations for short durations to minimize injury or mortality. A standardized set of gill nets will be used to determine CPUE during both spring and fall; however, the length of net and size(s) of mesh that will be used cannot be determined until the Project is constructed due to uncertainties associated with areas suitable for setting gill nets near constructed habitats.



KEEYASK
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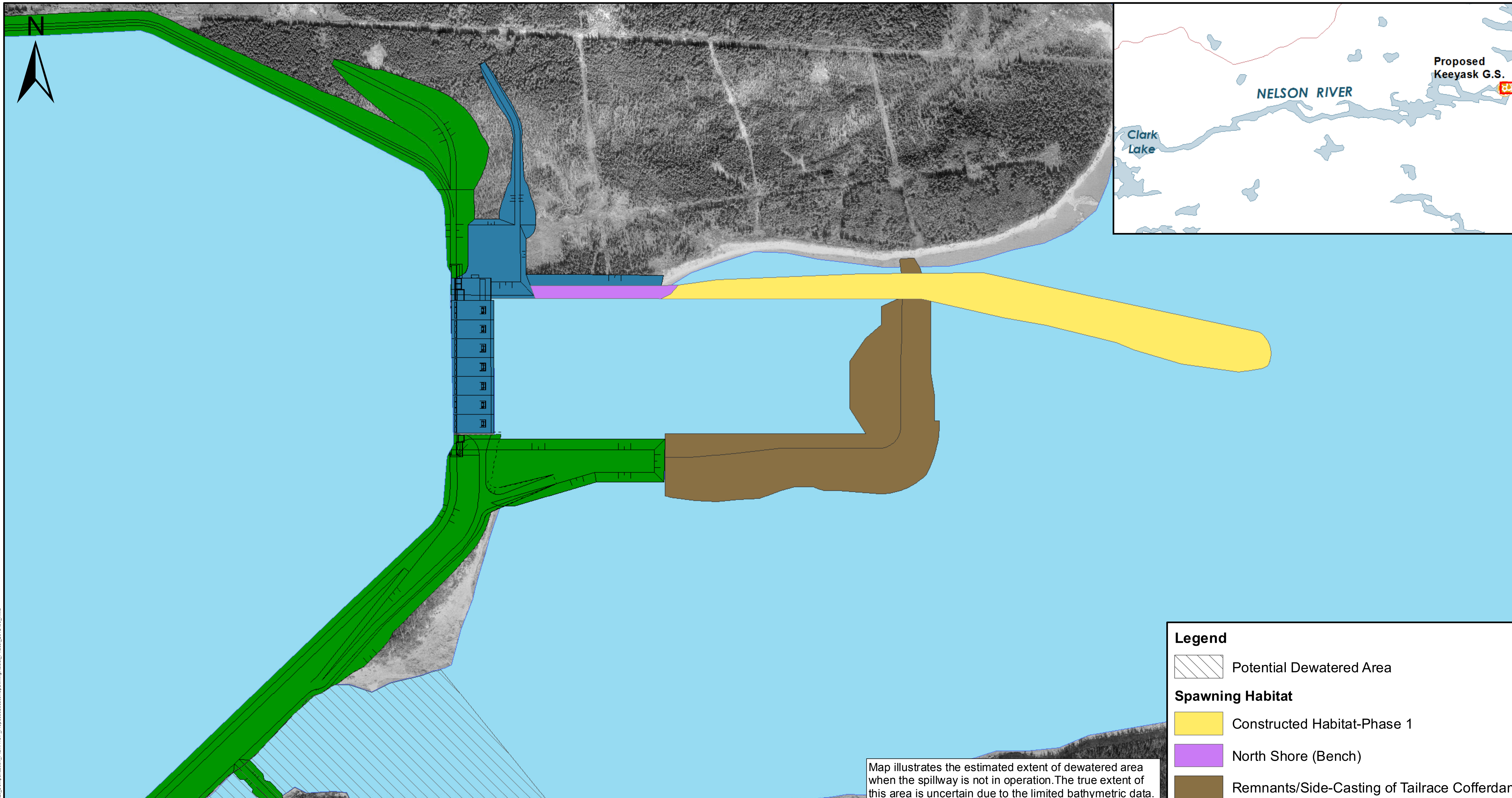
Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Preferred Habitat Development Locations in the Keeyask Reservoir



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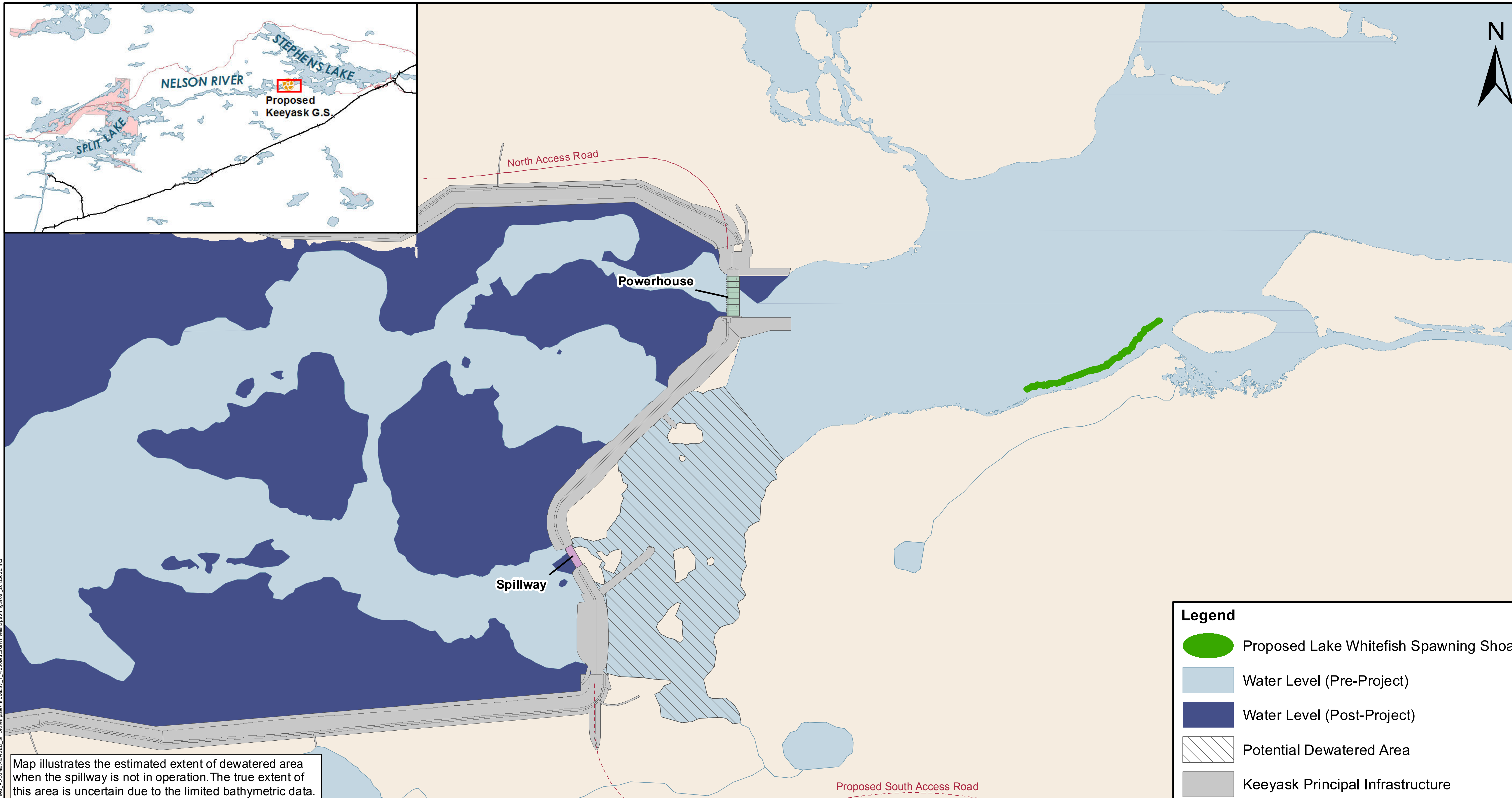
0 100 200 300 400 Metres
0 250 500 750 1,000 Feet

Projection: UTM Zone 15, NAD 83
Data Source: Memorandum GN-9.8.18 Rev. 0, Figure 26
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Proposed Location of Spawning Habitat
Phase 1



KEEYASK Hydropower Limited Partnership

0 0.5 1 1.5 Kilometres

0 0.5 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewaterd area are estimated based on the existing environment 95th percentile flow.

Proposed Lake Whitefish Spawning Shoal

Drifting eggs and larvae will be sampled during spring using bottom-set drift nets (opening of 43 x 85 cm, with an attached 300 cm long, 950 µm Nitex® screen bag, tapered to a 9 cm diameter removable ABS pipe 'cod-end'), where feasible. Drift nets will be set for approximately 24 hours.

A modified neuston sampler (Mason and Phillips 1986, Mota et al. 2000) would be used to sample for larval lake white fish if conditions are suitable. Sampling would be initiated at the onset of spring break-up.

Data collected during the spawning studies would be compared to predicted spawning locations in the AE SV.

5.2.3.3 Turbine and Spillway Mortality Study

Turbines at the Keeyask GS have been designed to incorporate features to minimize rates of fish injury and mortality. Although low rates of injury and mortality are expected, a study to assess the effects on walleye, northern pike, and, if possible, lake whitefish passing through the turbines or over the spillway will be conducted.

5.2.3.3.1 Monitoring Area

Monitoring of effects to fish passing through turbines and over the spillway would be conducted at the Keeyask GS.

5.2.3.3.2 Sampling Design

Based on currently available information, this aspect of monitoring will be modelled after studies conducted at the Kelsey GS in 2006 and 2008 (North/South Consultants Inc. [NSC] and Normandeau Associates Inc. 2007, 2009). While the approach outlined in the sections below is based on the Kelsey GS studies, alternate approaches to estimating turbine and spillway mortality at the Keeyask GS will be evaluated in consultation with MCWS and DFO before such a study is conducted, and the most effective approach will be selected.

To estimate the rates of injury and mortality of fish during passage through the Keeyask GS, walleye, northern pike, and lake whitefish (if adequate numbers can be captured) will be experimentally passed through one turbine and the spillway in sufficient numbers to make statistically valid predictions of 48-hour survival. Control fish will be released immediately downstream of the GS and the spillway. All study fish will be captured in the area of the Keeyask GS, marked with HI-Z (balloon) and radio tags, and released into the turbine intake or spillway. Fish will be recaptured downstream of the GS, injuries assessed, and survival calculated after a 48-hour holding period.

5.2.3.3.3 Parameters

Parameters to be examined include injury rates and types, and 48-hour survival rates by species and a range of size-classes, after turbine or spillway passage.

5.2.3.3.4 Sampling Sites

Monitoring will be conducted at the Keeyask GS and fish used in the study will be captured downstream and, to a lesser extent, upstream of the GS.

5.2.3.3.5 Sampling Frequency and Schedule

The turbine passage study will be conducted in June or July of the first year that all turbine units are operational.

5.2.3.3.6 Methods

Walleye, northern pike, and lake whitefish will be captured in the area of the Keeyask GS, using a variety of non-lethal methods, and held in holding pools for 24 hours. Only fish in excellent condition following 24 hours of holding will be considered as treatment or control fish. Treatment fish will be intentionally passed through the turbine or down the spillway using a proven guidance and release device. Fish passed into the turbine will be released at three depths (shallow, mid, and deep). Control fish (i.e., fish not passed through the turbine or down the spillway, but otherwise treated identical to experimental fish) will be released directly into the tailrace downstream of the GS through a flexible plastic tube. Approximately 200 fish of each species will be tested (30 fish at each of three separate turbine release points, 60 fish released into the spillway, and 50 control fish).

Prior to release, fish will be measured for fork length, and marked with HI-Z (balloon) tags and external radio tags. These tags allow for the retrieval and assessment of the condition of the fish within minutes of their release. Upon retrieval, fish are assessed for condition as either clean, injured, or a mortality. Injuries are further classified by type and severity of injury. Mortalities are assessed for probable cause of mortality. Live fish are then transferred to holding pools for up to 48 hours. Fish are further assessed for injury and mortality at 24 hours and again at 48 hours, after which the live fish are released.

5.2.3.4 Fish Stranding Following Spill Events

Spillway operation and fluctuating water levels in Stephens Lake have the potential to create isolated pools downstream of the spillway that do not connect to Stephens Lake. Fish can become stranded in these isolated pools resulting in mortality. Spillway pools will be monitored following spill events, or periods of water level fluctuation in Stephens Lake, to determine where fish are stranded, the number and size of the isolated spillway pools, the number and size fish stranded, and periods of the year that fish may be more susceptible to stranding.

5.2.3.4.1 Monitoring Area

Monitoring will be conducted between the base of the Keeyask GS spillway and Stephens Lake.

5.2.3.4.2 Sampling Design

Sampling will be conducted following a variety of different water level and spillway flow scenarios (i.e., spill volume, duration, number of spillway gates opened, as well Stephens Lake water levels) to gain a better understanding of the factors affecting fish stranding. Sampling will aim to determine where, when and what types of fish, by size class, and sex and maturity status are being stranded, as well as the location, number and size of isolated pools.

5.2.3.4.3 Parameters

Parameters to be examined will include the number, species, and sizes of fish stranded in the spillway pools. Additional information associated with each spill event, including the amount of flow that passed through the spillway, the duration of the spill, the tailrace water level, and the time of year, will be used to provide context for the stranding results.

5.2.3.4.4 Sampling Sites

Monitoring will be conducted in spillway pools between the Keeyask GS spillway and Stephens Lake.

5.2.3.4.5 Sampling Frequency and Schedule

Sampling will be conducted following spill events and periods of water level fluctuation in Stephens Lake during the first year(s) of operation. The sampling frequency and schedule will be determined on an annual basis and will be dependent upon the frequency of spillway use and Stephens Lake water level fluctuation. The duration of the program will depend on range of spill events that occur and results.

5.2.3.4.6 Methods

Upon termination of a spill event or water level fluctuation event in Stephens Lake that results in isolating pools in the spillway, sampling will be conducted in the isolated pools using a variety of non-lethal fish capture methods (i.e., short set gill nets, electrofishing, dipnetting). Any fish that are captured will be enumerated by species, measured for fork length (mm), and released into the Nelson River downstream of the GS.

5.2.3.5 Experimental Catch and Transport Monitoring

Upstream fish passage at the GS will be provided by an experimental catch and transport program during the initial years of station operation. The intent of this program is to develop a better understanding of fish movements after construction of the GS to assist in the development of a long term approach to fish passage. The monitoring program is designed to:

- Identify locations immediately downstream of the Keeyask GS where fish congregate during open-water periods; and
- Assess fish behaviour/movement following transport (catch and transport) upstream over the Keeyask GS.

Monitoring downstream movements of fish through the GS and the success of passage via the spillway and turbines is addressed in sections 5.2.2.2 and 5.2.3.3, respectively.

5.2.3.5.1 Monitoring Area

Site specific monitoring will be conducted during spring, summer and fall immediately downstream of the Keeyask GS to identify fish congregating in this area (i.e., exhibiting a behaviour suggesting intent on moving upstream). A sub-sample of these fish will be tagged with acoustic transmitters, transported upstream over the GS, and released at various locations/habitats in the upper, middle and lower sections of the reservoir. Acoustically-tagged fish will be monitored by manual acoustic tracking and an array of acoustic receivers deployed in the Nelson River between Clark Lake and the Long Spruce GS as described in Section 5.2.2.2.

5.2.3.5.2 Sampling Design

The initial phase of upstream fish passage monitoring is composed of two components: 1) identification of fish species and size/age classes exhibiting an intent to move upstream during spring, summer and fall; and, 2) tagging a sub-sample of the fish exhibiting behaviour that is consistent with an intent to move upstream with acoustic transmitters, transporting them over the Keeyask GS, releasing them in various habitats/locations, and monitoring their movements/behaviour. A proposed approach is described below; it is anticipated that the proposed approach and on-going conduct of the work will be modified based on consultation with DFO and MCWS and interpretation of data collected during the initial phase of monitoring.

The intent of the experimental transport program is to transport fish that would have been capable of moving upstream over Gull Rapids prior to construction of the GS. Fish that will be targeted for upstream transport are those exhibiting behaviour consistent with an intent to move upstream. For example, fish aggregating in off-current areas immediately downstream of the GS will be considered as fish exhibiting behaviour consistent with an intent to move upstream, as they have already moved upstream through high velocity habitat. However, it is recognized that these fish may simply be aggregating in this area to fulfill a specific life history requirement (e.g., spawning). Selection of fish to transport upstream would be based on discussions with DFO and MCWS and would include consideration of: avoiding detrimental effects to the Stephens Lake fish population; whether or not the fish were in spawning condition at time of capture; and, the number and size range of fish that are sufficient to provide scientifically defensible information on fish behaviour following upstream transport.

Release locations upstream of the GS will be selected based on discussions with DFO and MCWS and would aim to assess the response of fish to release in different habitats (e.g., lower section of the reservoir, riverine section of reservoir, Birthday Rapids, Long Rapids). It is important to note that adult lake sturgeon would not be transported if the number of spawning fish is limiting reproduction within Stephens Lake.

5.2.3.5.3 Parameters

Parameters to be examined include the number, size/age and sex of fish congregating downstream of the GS during spring, summer and fall. The main parameters that will be used to monitor fish movements following active transport upstream of the GS include the proportion of fish implanted with transmitters that: remain upstream of the Keeyask GS; utilize habitat in the lower, middle or upper sections of the reservoir; move downstream through the Keeyask GS into Stephens Lake or beyond; and/or move upstream into the Split Lake Area or beyond. Further, distance moved and proportional distribution will be calculated for each tagged fish by season.

5.2.3.5.4 Sampling Sites

Sampling will occur immediately downstream of the Keeyask GS although the specific site/sites that will be sampled will be determined following GS construction. Monitoring of acoustically-tagged fish will occur in the Nelson River between Clark Lake and the Long Spruce GS as described in Section 5.2.2.2.

5.2.3.5.5 Sampling Frequency and Schedule

This study will begin after the river is impounded to full supply level and will be conducted initially for three years. During this period, operation of the GS will change as all turbine units are installed. Depending on results, the duration of this study would be adjusted to recognize periods of rapid change in the environment. For example, during the initial 10 years of impoundment, habitat in the reservoir will change considerably, and how fish respond to translocation within various parts of the reservoir may also change as habitat in the reservoir evolves. Acoustic transmitters applied to fish will have a battery-life of three years. It is proposed that all tags for this study are applied during the first year of study.

Sampling for fish congregating immediately downstream of the GS will occur for 14-day periods during each of spring, summer and fall and include both day and night sampling, if feasible. In the first year, acoustic tagging will occur during the same 14 day period during each season. During the second and third year of the study, acoustic tags would not be applied but fish would be captured downstream of the GS to determine the species composition and sizes of fish congregating at this location.

5.2.3.5.6 Methods

To identify location, timing, species, condition and size of fish exhibiting intent to move upstream of the GS, a combination of observation, DIDSON camera use, acoustic telemetry and fish capture by either hoop net, gill net, dip net, boat electrofishing and/or angling, will be used depending on feasibility and effectiveness of each method downstream of the GS. The method of fish capture would be designed in consideration of human safety and would minimize the risk of injury and stress to fish.

During the first year of the study, a representative sub-sample of the fish (walleye, northern pike, lake whitefish and possibly lake sturgeon) captured immediately downstream of the Keeyask GS, during each season, will be tagged with acoustic transmitters, transported upstream over the GS, and released at varying distances upstream of the GS. In total, 90 fish will be tagged, 30 during each of spring, summer and fall. The proportion of transmitters applied by species and fish size/sex will be determined in the field following an assessment of the species and size composition of the catch and discussions with DFO and MCWS.

5.2.3.6 Fish Winterkill in Area of Little Gull Lake

As described in the AE SV, there is a potential for fish to become trapped during winter in the area of the Keeyask reservoir that is currently the site of Little Gull Lake. Channels to connect this area to the remainder of the reservoir will be constructed as a mitigation measure. To determine whether this measure is effective in preventing winter kill, surveys will be conducted in spring after ice off.

5.2.3.6.1 Monitoring Area

Monitoring will be conducted of the north shoreline in the area that was Little Gull Lake prior to impoundment.

5.2.3.6.2 Sampling Design

Boat-based surveys will be conducted after ice-off.

5.2.3.6.3 Parameters

The number and species of dead fish observed will be recorded.

5.2.3.6.4 Sampling Sites

Monitoring will be conducted along the length of the north shoreline in the area occupied by Little Gull Lake.

5.2.3.6.5 Sampling Frequency and Schedule

Sampling will be conducted immediately after ice-off during the first year(s) of operation.

5.2.3.6.6 Methods

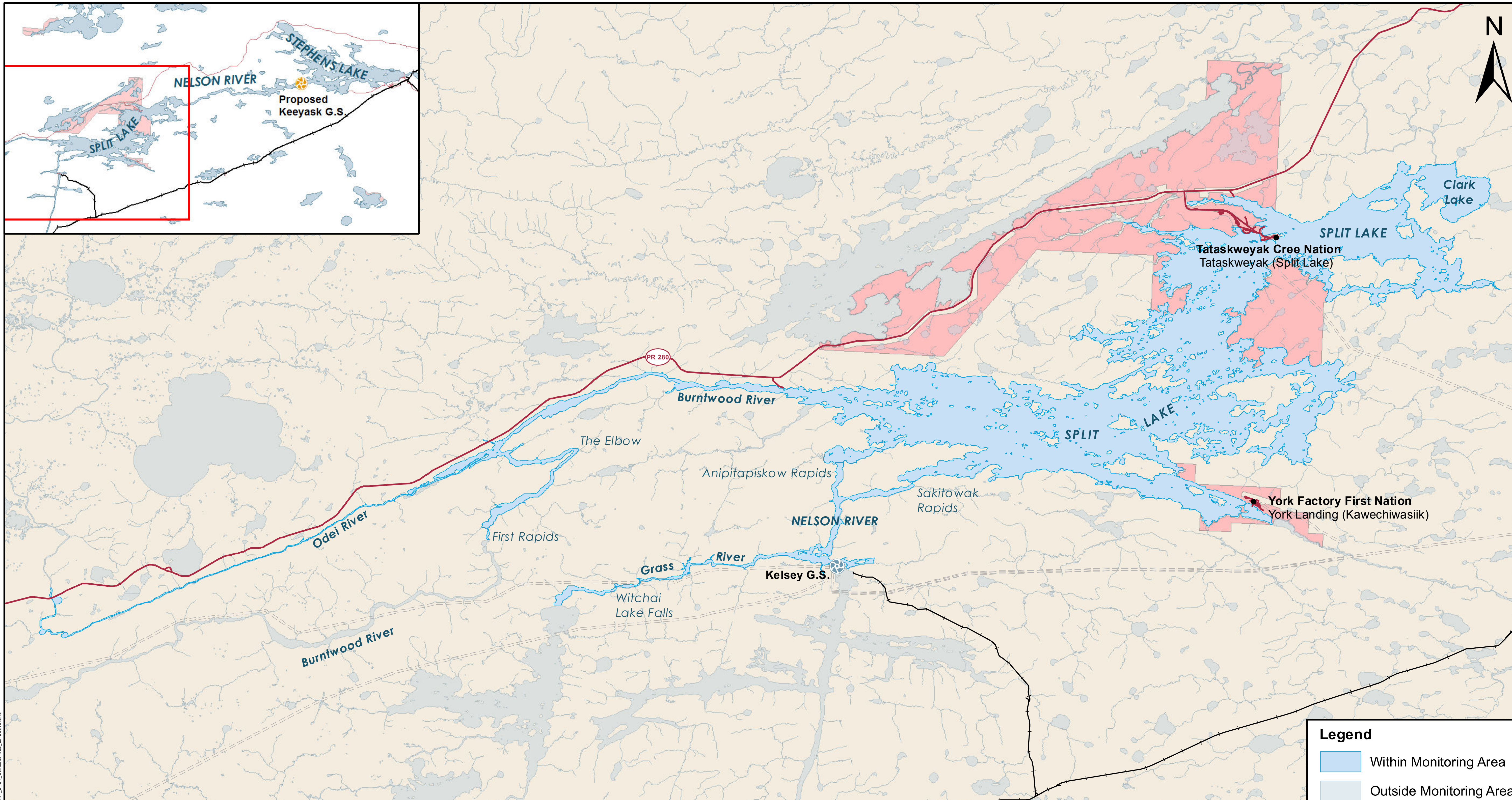
All dead fish observed will be identified and counted.

6.0 LAKE STURGEON

Monitoring of Project-related impacts and the effectiveness of mitigation measures on lake sturgeon during the construction (Section 6.1) and operation (Section 6.2) phases of the Project are described below. Lake sturgeon monitoring will be conducted in three general areas: 1) Upper Split Lake (including the Nelson River between the Kelsey GS and Split Lake, the Grass River between Witchai Lake Falls and the Nelson River, the Burntwood River from First Rapids to Split Lake, and the Odei River between First Falls and its confluence with the Burntwood River); 2) the Nelson River between the outlet of Clark Lake and the Keeyask GS; and 3) the Nelson River downstream of the Keeyask GS to the Kettle GS (i.e., Stephens Lake) (maps 16, 17 and 18). To quantify possible downstream movement through the Kettle GS, the monitoring of lake sturgeon movements will also include the reach of the Nelson River between the Kettle GS and the Long Spruce GS.

The lake sturgeon monitoring programs will continue in conjunction with mitigation programs until self-sustaining populations have been established.

This draft of the AEMP does not provide details on monitoring micro-scale movements of lake sturgeon near the Project site. It is expected that, following discussions with MCWS and DFO, future AEMP drafts will include this information. Similarly, this draft of the AEMP does not include details of a lake sturgeon conservation and awareness program, as discussions with the KCNs and regulators are required to determine how increased access to lake sturgeon populations near the GS will be managed.



KEEYASK
Hydropower Limited Partnership

0 5 10 15 20 Kilometres
0 2.5 5 7.5 10 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000

Split Lake Area
Lake Sturgeon Monitoring

KEEYASK
Hydropower Limited Partnership

0 2.5 5 7.5 10 Kilometres

0 1.25 2.5 3.75 5 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Nelson River Shoreline modelled by Manitoba Hydro.
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Outlet of Clark Lake to Keeyask Generating Station

Lake Sturgeon Monitoring

KEEYASK
Hydropower Limited Partnership

0 5 10 15 Kilometres
0 2 4 6 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Nelson River Shoreline modelled by Manitoba Hydro.
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Keeyask Generating Station to Long Spruce Generating Station

Lake Sturgeon Monitoring

6.1 MONITORING DURING CONSTRUCTION

Lake sturgeon monitoring during the construction phase consists of a core monitoring program that examines changes in lake sturgeon abundance, biological metrics, habitat use/movements, and recruitment.

6.1.1 Pathways of Effect and Key Questions

Construction-related activities will result in the direct loss and alteration of lake sturgeon spawning and foraging habitat in Gull Rapids. Instream construction activities, such as cofferdam construction, are expected to result in disturbances (i.e., noise), temporary increases in TSS, and increased sediment deposition in Stephens Lake. These impacts may affect the condition and growth of lake sturgeon of all life stages, and affect lake sturgeon behaviour (alteration of habitat use and macro-scale movements). For example, an increase in the frequency of long distance movements away (emigration) from the construction site may occur. Similarly, increases in TSS and sedimentation may affect adult use of the river channel immediately downstream of the construction site and/or sub-adult use of a sand lens located approximately 4–5 km downstream of the construction site.

Cofferdam construction and associated changes to water velocity patterns downstream of the construction site will affect lake sturgeon spawning habitat in Gull Rapids. Habitat alterations will occur over the period that the GS is being constructed and result in the complete loss of habitat in Gull Rapids. These habitat alterations will alter sturgeon spawning site selection, hatch success, and the spatial extent of larval drift, all of which directly contribute to annual recruitment/cohort strength of the lake sturgeon population in Stephens Lake. To mitigate impacts on lake sturgeon recruitment, a lake sturgeon stocking program, initiated prior to construction of the Project, will continue throughout the construction phase.

The key questions that will be addressed by the lake sturgeon core monitoring studies during construction are:

- Will the abundance of adult lake sturgeon in the Upper Split Lake area, and in the Nelson River between Clark Lake and the Kettle GS, change during the construction phase of the Project?
- Will condition and growth of sub-adult and adult lake sturgeon in Gull and Stephens lakes change during construction?
- Will disturbances associated with construction alter lake sturgeon habitat use and macro-scale movements upstream and/or downstream of the construction site?
- Will the frequency of long-distance movements (emigration) of sub-adult and adult lake sturgeon increase during construction?
- Will recruitment of wild lake sturgeon be successful upstream and/or downstream of the GS during construction?
- What is the proportion of hatchery-reared to wild recruits within a cohort (i.e., how successful is the lake sturgeon stocking program)?

6.1.2 Core Monitoring

The core monitoring program consists of three components: abundance and biological metric monitoring (Section 6.1.2.1); macro-scale movement/habitat use monitoring (6.1.2.2); and recruitment/year-class strength monitoring (Section 6.1.2.3).

6.1.2.1 Abundance and Biological Metric Monitoring

The data collected during lake sturgeon abundance and biological metric monitoring will be used to monitor change during Project construction.

6.1.2.1.1 Monitoring Area

Abundance and biological metric monitoring will be conducted in the Upper Split Lake area and in the Nelson River between Clark Lake and the Kettle GS.

6.1.2.1.2 Sampling Design

Field programs to estimate the abundance of lake sturgeon in the Upper Split Lake area and in the Nelson River between Clark Lake and Gull Rapids have been conducted since 2005. These studies will continue to be conducted using mark and recapture methodologies established during the Keeyask environmental studies. Presently, due to the low number of sturgeon in Stephens Lake, an insufficient number have been captured in Stephens Lake to calculate a population estimate. Attempts to capture sufficient numbers of sturgeon to generate an estimate will continue during construction monitoring.

Population estimation studies utilize gill nets of various mesh sizes to capture lake sturgeon. Similar amounts of gillnetting effort will be used with each mesh size during both mark and recapture phases of the study. Program MARK (White and Burnham 1999) will be used to generate population estimates based on individual capture and recapture histories.

6.1.2.1.3 Parameters

Individual capture and recapture histories will be used to calculate survival, recruitment, and abundance of lake sturgeon. Biological metrics such as length, weight and age will be collected from each lake sturgeon captured, enabling calculations of condition factor and length-at-age, and creation of size/age frequency histograms. Ageing structures will not be collected from sturgeon greater than than 834 mm fork length due to ageing inaccuracies associated with ageing larger, older fish.

6.1.2.1.4 Sampling Sites

Similar to previous lake sturgeon population estimation studies conducted in the study area since 2005, sampling sites will be comprised of both spawning areas and areas distant from spawning areas. The number of gillnetting sites, location of gillnetting sites and amount of gillnetting effort will be comparable to previous studies to enable the comparison of results among years.

6.1.2.1.5 Sampling Frequency and Schedule

Sampling will be conducted during spring over a three-week marking phase and a three-week recapture phase. Monitoring of adult lake sturgeon abundance during Project construction will be conducted on a biannual basis and in rotation (e.g., Upper Split Lake during odd numbered years and the Keeyask reservoir and Stephens Lake during even years).

6.1.2.1.6 Methods

Large mesh gill nets (8, 9, 10, and 12 inch) will be used to capture lake sturgeon. Each lake sturgeon captured in gill nets will be measured, weighed, aged (if less than 834 mm fork length), examined for previously applied Floy®-tags, and marked with a Floy®-tag if previously unmarked. In addition, samples suitable for genetic analysis will be collected from all fish captured and archived, in the event that further genetic analysis is required in the future. Length-at-age and condition factor data will be calculated and compared to data collected prior to Project construction from similar locations, using appropriate statistical tests, to determine if physical changes to lake sturgeon have occurred during Project construction.

Encounter histories will be developed for all lake sturgeon captured. Population analyses will be run using the industry standard Program MARK using classic Jolly-Seber and Pradel Models (Pradel 1996), and age-structured models to assess the annual survival, recruitment, and abundance of lake sturgeon. Given the substantial baseline data set that has been established, together with the continued collection of these data during monitoring, long-term population trends will be observed.

6.1.2.2 Macro-scale Movement / Habitat Use Monitoring

Movements of sub-adult and adult lake sturgeon will be monitored upstream and downstream of the construction site to determine if changes to habitat use and movements occur during construction. Information from these studies will assist in identifying key habitats (i.e., spawning, rearing and foraging areas) that lake sturgeon are utilizing during construction and in quantifying fish movements both away from (emigration) and within the study area.

6.1.2.2.1 Monitoring Area

During construction, the movements and habitat use of sub-adult and adult lake sturgeon in the Upper Split Lake area and in the Nelson River between Clark Lake and the Kettle GS will be monitored using Floy®-tags (Section 6.1.2.1), with additional monitoring to be conducted in the Nelson River between Clark Lake and the Long Spruce GS using acoustic telemetry.

6.1.2.2.2 Sampling Design

Movement information will be collected from each previously Floy®-tagged lake sturgeon recaptured during abundance estimation and biological metric monitoring (Section 6.1.2.1). Mark and recapture histories from these recaptured fish will be compared to pre-Project movement information to determine if the frequency and extent of movements have changed during construction.

Adult lake sturgeon movements will also be monitored using acoustic telemetry. In 2011 and 2012, 60 adult lake sturgeon were tagged with acoustic transmitters (31 upstream and 29 downstream of Gull

Rapids) that have a 10-year battery life. This will allow the movements and habitat use of these fish to be monitored throughout the construction phase and into the operation phase of the Project. Data collected from these transmitters during construction will be compared to movements of the same fish prior to construction, as well as to an acoustic telemetry data set collected from 20 adult lake sturgeon tagged in 2001 and monitored until 2004.

In order to monitor the movements and habitat use of sub-adult lake sturgeon, 40 sub-adult lake sturgeon (20 tagged upstream of the construction site and 20 tagged downstream of the construction site) will be tagged with acoustic transmitters just prior to the start of construction. Acoustic transmitters implanted into sub-adult lake sturgeon will have a 2-3 year battery life. Acoustic transmitters will be applied to an additional 40 sub-adult lake sturgeon in the last year of construction just prior to the operation phase. Further details on monitoring sturgeon movements (using these transmitters) during the operation phase are provided in Section 6.2.2.2.

As discussed in Section 5.1.2, stationary acoustic receivers (VEMCO model VR2W) and manual tracking with a VR100 (VEMCO) will be (and are currently being) used to continuously monitor tagged adult and sub-adult lake sturgeon. An array of approximately 60 acoustic receivers will be deployed in the Nelson River between the outlet of Clark Lake and the Long Spruce GS during the open-water period, and a portion of the receivers will remain be deployed throughout the winter (see Section 5.1.2). Manual tracking will occur during the open-water period to provide additional movement information.

6.1.2.2.3 Parameters

Distance(s) between the initial capture and recapture location(s) will be calculated for each lake sturgeon that is marked with a Floy®-tag and subsequently recaptured.

For each acoustic-tagged lake sturgeon, total distance moved, extent of distance moved (range in river km), proportional distribution (days/river kilometer (rkm) or zone), monthly movement range, and seasonal movement range will be determined. The movements of lake sturgeon implanted with transmitters will also provide information that can be used to estimate the number and proportion of the lake sturgeon population that:

- Remain in the reservoir;
- Use habitat in the immediate vicinity of construction activities (e.g., spawning in Gull Rapids);
- Move downstream over Gull Rapids into Stephens Lake or beyond;
- Moves upstream through Gull Rapids; and
- Move upstream into the Split Lake area or beyond.

Appropriate statistical tests will be used to compare these metrics to data collected prior to construction to determine if lake sturgeon movements and habitat use have changed during the construction phase. Tags that are never detected are considered defective and excluded from movement and habitat use analyses, as are tags that consistently omit a signal but do not move for an extended period of time (indicative of tag loss/mortality). Tagged lake sturgeon may also be harvested, which will reduce the sample size of tagged fish in the area. If the number of tagged lake sturgeon becomes too low to support meaningful interpretation of the data, tagging additional fish will be considered.

6.1.2.2.4 Sampling Sites

Sampling for Floy®-tagged lake sturgeon will occur at gillnetting sites selected during abundance and biological metric monitoring (Section 6.1.2.1).

Acoustic receivers will be located at the same sites as those established in 2011 (Map 9). In general, acoustic receivers were set in low velocity areas between Clark Lake and the Long Spruce GS to maximize spatial coverage and the detection range of each acoustic receiver; additional receivers may be placed in the vicinity of construction activities (see Section 5.1.2.2).

6.1.2.2.5 Sampling Frequency and Schedule

Acoustic receivers will continuously monitor for transmitters within their detection range for as long as the transmitters are active (see Section 6.1.2.2.2). Due to the battery-life of the transmitters applied to lake sturgeon, movement monitoring will occur throughout the construction phase, into the operation phase. Manual tracking will occur at bi-weekly intervals throughout the open-water period.

6.1.2.2.6 Methods

Methods used to monitor movements of Floy®-tagged sturgeon are described in Section 6.1.2.1.6. Methods used to monitor movements of acoustically tagged lake sturgeon are described in Section 5.1.2.

6.1.2.3 Recruitment/Year-class Strength Monitoring

Recruitment/year-class strength monitoring and determining the relative contribution of wild and hatchery-reared fish to each cohort are important components of the AEMP for lake sturgeon. These data will be used to evaluate the success of the lake sturgeon stocking program.

6.1.2.3.1 Monitoring Area

Monitoring will be conducted in the Nelson River between Clark Lake and the Kettle GS, and in the Upper Split Lake area.

6.1.2.3.2 Sampling Design

A multi-mesh gillnetting study will be conducted to target YOY and sub-adult lake sturgeon in each monitoring area. Gillnets of various mesh sizes will be used to capture a representative sample of the size and age classes of lake sturgeon in each area. Gillnetting sites will be selected to provide spatial representation and account for potential differences in the distribution and abundance of lake sturgeon size and age classes.

6.1.2.3.3 Parameters

Captured fish will be measured, weighed, aged, and marked with an individually numbered Floy®-tag. Condition factor and length-at-age will be calculated for individual fish from each area. Catch data will provide an estimate of relative cohort strength. In addition, mark and recapture data will be used to assess cohort survival.

A small tissue sample will be collected from each captured fish for genetic analysis, allowing for a determination of whether or not the fish is hatchery-reared or of wild origin. This will provide key information on the success of the stocking program.

6.1.2.3.4 Sampling Sites

Approximately 40 gillnet sampling sites will be selected at each location. Sampling sites will be located exclusively in the deep-water habitats, known to be preferred by YOY and sub-adult lake sturgeon in the Nelson and Burntwood rivers.

6.1.2.3.5 Sampling Frequency and Schedule

Recruitment/year-class strength monitoring will occur annually in the Nelson River between the outlet of Clark Lake and the construction site, and in Stephens Lake. Sampling will be conducted on a bi-annual basis in the Upper Split Lake area. Sampling will occur during the fall to minimize fish mortality.

6.1.2.3.6 Methods

An array of gillnet mesh sizes, including 1, 2, 3, 5 and 6 inch mesh will be used to capture YOY and sub-adult lake sturgeon. Methods will follow those employed during similar recruitment studies conducted in several Manitoba waterbodies since 2010.

6.2 MONITORING DURING OPERATION

Core monitoring of lake sturgeon abundance and biological metrics, habitat use/movements, and recruitment (as described during construction; see Section 6.1) will continue throughout the operation phase. In addition to core monitoring, lake sturgeon spawning and spawning success in the vicinity of Long Rapids, Birthday Rapids and in the tailrace and spillway of the Keeyask GS will be monitored.

6.2.1 Pathways of Effect and Key Questions

Once the FSL has been reached, habitat upstream of the Keeyask GS as far upstream as Long Rapids will be altered; areas of current along the main channel will be converted into reservoir habitat. In general, water depth in the reservoir will increase, coupled with a corresponding decrease in water velocity, which will alter sedimentation and substrate patterns. These habitat alterations may affect habitat use for all life stages of lake sturgeon. As a result, lake sturgeon habitat use and movement patterns may change. For example, in an area of Gull Lake north of Caribou Island that is currently known to support relatively high numbers of sub-adult lake sturgeon, substrate is expected to change over time from sand to silt;.it is unknown if sub-adult lake sturgeon will continue to occupy this habitat post-Project.

Backwatering will result in changes to mainstem spawning habitat (i.e., vicinity of Birthday Rapids) and GS construction will eliminate the spawning habitat at Gull Rapids. Conditions at Birthday Rapids are expected to change from the turbulent conditions that presently exist to a more laminar flow that lacks “white water”. Hydraulic conditions further upstream at Long Rapids are expected to remain unchanged. It is unknown if lake sturgeon will continue to spawn in the vicinity of Birthday Rapids or move further upstream to Long Rapids where turbulent/white water conditions remain.

Construction of the Keeyask GS will eliminate lake sturgeon movements from Stephens Lake to areas above the GS (in the absence of active or passive fish passage); however, lake sturgeon above the GS will be able to move downstream into Stephens Lake through the turbines or over the spillway.

Currently, YOY use sandy habitat north of Caribou Island; however, post-Project, it is anticipated that the reduction in water velocity may reduce the extent of larval drift, and thus, drifting larvae may no longer drift to and settle out in these areas. Recruitment monitoring will attempt to determine the post-Project distribution of YOY and sub-adult lake sturgeon. Habitat characteristics (water depth, water velocity, and substrate) will be measured in areas where YOY and sub-adult lake sturgeon are captured to determine if mitigative measures are needed to create suitable habitat in locations where larvae and YOY settle out. Downstream of the GS, although lake sturgeon spawning locations will change, it is likely that drifting larvae will settle out in the same areas as in the present day environment.

Downstream of the GS, a lake sturgeon spawning structure will be constructed in the tailrace and suitable lake sturgeon spawning habitat may also exist within and downstream of the spillway. The tailrace spawning structure will be designed to mimic natural lake sturgeon spawning habitat by providing suitable combinations of water depth, water velocity and substrate that lake sturgeon require when spawning.

In addition, the lake sturgeon stocking program will be continued both upstream and downstream of the GS during the operation phase to mitigate effects on recruitment.

The key questions that will be addressed by lake sturgeon monitoring during the operation phase are:

- Will the abundance of adult lake sturgeon in the Upper Split Lake area, and in the Nelson River between Clark Lake and the Kettle GS, change during the operation phase of the Project?
- Will condition and growth of sub-adult and adult lake sturgeon in Gull and Stephens lakes change during Project operation?
- How will reservoir creation alter lake sturgeon habitat use and macro-scale movements?
- Will recruitment of wild lake sturgeon be successful upstream and/or downstream of the GS during the operation phase of the Project?
- Where in the reservoir and in Stephens Lake will YOY rearing habitat be located, and will the distribution of YOY and sub-adult lake sturgeon change?
- Does additional YOY or sub-adult lake sturgeon habitat need to be created in the reservoir or in Stephens Lake?
- Will lake sturgeon move upstream past Birthday Rapids to spawn in Long Rapids where flows may be higher and more turbulent flows remain?
- Will lake sturgeon in Stephens Lake utilize and spawn successfully on the tailrace spawning structure or areas below the spillway?
- Will lake sturgeon deposit their eggs in the vicinity of Birthday Rapids or downstream of the Keeyask GS (on the tailrace spawning structure and in the spillway) during operation, and if so, where and under what conditions?

- Will lake sturgeon eggs hatch from altered or created spawning habitat during Project operation?
- What proportion of each lake sturgeon cohort is hatchery-reared as compared to wild recruits (i.e., how successful is the lake sturgeon stocking program)?

It should be noted that several of the specific effects studies described for the fish community will also include lake sturgeon, if determined to be appropriate in consultation with DFO and MCWS. These studies include assessment of gas bubble trauma downstream of the GS (Section 5.2.3.1), assessment of the effects of turbine and spillway passage (Section 5.2.3.3), spillway stranding (Section 5.2.3.4), and the experimental catch and transport program (Section 5.2.3.5).

6.2.2 Core Monitoring

The components of lake sturgeon core monitoring during the operation phase generally follow those described for the construction phase: abundance and biological metric monitoring (Section 6.1.2.1); macro-scale movement and habitat use monitoring (Section 6.1.2.2); and recruitment/year-class strength monitoring (Section 6.1.2.3). As previously noted, core monitoring will continue until self-sustaining populations have been established.

6.2.2.1 Abundance and Biological Metric Monitoring

Biannual population estimates and monitoring of biological metrics will continue to be conducted in the Upper Split Lake area during odd-numbered years and in the Keeyask reservoir and Stephens Lake during even-numbered years. Sampling design, parameters, sampling sites, sampling frequency and schedule, and methods are similar to those described in Section 6.1.2.1.

6.2.2.2 Macro-scale Movement/Habitat Use Monitoring

Similar to Section 6.1.2.2, adult lake sturgeon movements will be monitored upstream of the Keeyask GS to the outlet of Clark Lake, as well as downstream of the Keeyask GS to the Long Spruce GS. Mark and recapture and acoustic telemetry techniques will be employed. Monitoring of acoustic transmitters equipped with a battery life of 10 years that were applied to lake sturgeon in the Nelson River between the outlet of Clark Lake and the Kettle GS in 2011 and 2012, will continue until 2022. Once the transmitters have expired, the need for additional acoustic telemetry studies on adult lake sturgeon will be assessed.

Sub-adult lake sturgeon movements will also be monitored upstream and downstream of the Keeyask GS during the operation phase. Methods and number of tags applied will be similar to those described in Section 6.1.2.2. Transmitters with a 2–3 year battery life will be applied to sub-adult lake sturgeon just prior to the operation phase. Once these transmitters have expired, additional transmitters will be applied during the operation phase, if warranted.

Monitoring area, sampling design, parameters, sampling sites, sampling frequency and schedule and methods will follow those described for construction.

6.2.2.3 Recruitment/Year-class Strength Monitoring

Monitoring lake sturgeon recruitment/year strength during operation will follow the approach employed during the construction phase (described in Section 6.1.2.3). Additional key questions were identified in Section 6.2.1 that relate to the distribution of larval sturgeon, habitat use of YOY and sub-adults, and identify the need for YOY habitat creation upstream and downstream of the GS. Although these additional key questions will be addressed, modifications to the monitoring approach described in Section 6.1.2.3 should not be necessary. Therefore, monitoring area, sampling design, parameters, sampling sites, sampling frequency and schedule and methods will follow those described for construction in Sections 6.1.2.3.

6.2.3 Specific Effects Monitoring

6.2.3.1 Spawning Area Identification

Due to uncertainties regarding the response of spawning lake sturgeon to altered habitat conditions upstream and downstream of the Keeyask GS, monitoring will be conducted to determine where lake sturgeon spawn between the outlet of Clark Lake and the Kettle GS. Monitoring will determine whether contingency measures to create conditions suitable to attract spawning sturgeon to Birthday Rapids need to be implemented, or if a higher proportion of lake sturgeon are using the spawning habitat at Long Rapids. . The capture of several spawning fish downstream of a potential spawning area would provide a general indication that lake sturgeon are spawning in the vicinity. Should sufficient numbers of spawning lake sturgeon be captured at a potential spawning site, egg deposition (Section 6.2.3.2) and larval drift monitoring (Section 6.2.3.3) would be conducted to monitor spawning success.

6.2.3.1.1 Monitoring Area

The monitoring area will encompass the possible lake sturgeon spawning areas between Clark Lake and the Kettle GS. These include, but will not be limited to: Long Rapids, Birthday Rapids, the artificial spawning structure, and the Keeyask GS spillway when it is in operation.

6.2.3.1.2 Sampling Design

During the spring spawning period, large mesh gill nets will be used to capture spawning lake sturgeon. Captured lake sturgeon will be assessed for sex and state of maturity to determine if the fish is in spawning condition during the current year. Acoustic telemetry will also be used to provide additional information on where lake sturgeon may be spawning. Manual acoustic tracking will be conducted daily during the spawning period to locate tagged fish near spawning areas. The congregation of several lake sturgeon in spawning condition in the vicinity of a potential spawning site will suggest that lake sturgeon are spawning in that area.

6.2.3.1.3 Parameters

Catch-per-unit-effort, sex ratio, reproductive readiness, and standard biological data (lengths and weight) will be recorded. All unmarked lake sturgeon captured will be marked with a numbered Floy®-tag to allow for future identification and to supplement movement information.

6.2.3.1.4 Sampling Sites

Gill nets will be set in close proximity to suspected spawning locations. Long Rapids, the vicinity of Birthday Rapids, and downstream of the GS will be targeted. Other potential spawning sites between the outlet of Clark Lake and Gull Lake will also be assessed.

6.2.3.1.5 Sampling Frequency and Schedule

Annual sampling will be conducted for the first three years following reservoir creation, after which the need for this type of monitoring would be reassessed in consultation with DFO and MCWS. If it is determined that habitat improvements are necessary at Birthday Rapids or downstream of the Keeyask GS, monitoring will continue until suitable conditions that allow sturgeon to spawn successfully can be created, or alternative mitigation measures are implemented.

6.2.3.1.6 Methods

Large mesh gill nets (8, 9, 10, and 12 inches) will be set in close proximity to suspected spawning locations during spring, when water temperatures range from 8–15°C. Gill nets will be checked every 24 hours and all captured fish will be measured for length and weight and assessed for sex and state of maturity. Habitat characteristics (i.e., water depth, water velocity and substrate) associated with each gillnetting site will be documented.

6.2.3.2 Egg Deposition Monitoring

Lake sturgeon egg deposition monitoring will be implemented based on results obtained during the spawning area identification monitoring (described in Section 6.2.3.1). Should a potential lake sturgeon spawning location be identified, egg deposition monitoring would occur at the suspected spawning area. Lake sturgeon egg deposition has been monitored with success in the Winnipeg River downstream of the Pointe Du Bois GS but may not be as successful in the Nelson River due to the river's size and the low numbers of spawning sturgeon in the area.

6.2.3.2.1 Monitoring Area

The monitoring area will encompass possible lake sturgeon spawning areas between the outlet of Clark Lake and the Kettle GS. These include, but will not be limited to, sites at Long Rapids, Birthday Rapids, the artificial spawning structure, and the Keeyask GS spillway.

6.2.3.2.2 Sampling Design

Egg mats will be used to document the precise spawning location and physical conditions under which lake sturgeon egg deposition occurred. Possible spawning locations will be gridded with egg mats. The number of egg mats used will be largely dependent upon the size of the potential spawning area.

6.2.3.2.3 Parameters

The number of eggs collected by each mat in 24 hours will be determined. The percent of viable eggs collected by each mat will also be assessed.

6.2.3.2.4 Sampling Sites

Only potential spawning sites, as suggested by gillnetting and acoustic telemetry data, will be monitored. In general, sampling will focus on the current edges of high velocity flows. Since flow patterns may vary from year-to-year, fine-scale spawning site selection, and therefore sampling sites, may vary on a yearly basis.

6.2.3.2.5 Sampling Frequency and Schedule

Egg deposition monitoring will only proceed when a potential spawning site has been identified. Egg mats will be retrieved periodically (every 1–3 days) so as to quantify timing of egg deposition.

6.2.3.2.6 Methods

Monitoring will occur when water temperatures range from 10–14°C. Wherever possible, egg mat transects deployed parallel to the main current will be employed to aid in quantifying egg deposition locations. To better quantify the habitat conditions at spawning sites, Acoustic Doppler Current Profilers (ADCP) will be used at each egg mat/transect at the onset of study in the reservoir (where flows are steady state), and conditionally again if river inflows change notably. Below the GS, velocity sampling will target the range of conditions that will occur at each egg mat/transect due to changes in turbine operation.

6.2.3.3 Larval Hatch and Drift Monitoring

Larval drift monitoring will be conducted in conjunction with spawning site identification and egg deposition monitoring to provide a measure of larval emergence and confirmation of spawning success. Similar to egg deposition monitoring, the extent and locations of monitoring will be dependent upon the capture of spawning adults (Section 6.2.3.1).

6.2.3.3.1 Monitoring Area

The monitoring area will be the same as described in Section 6.2.3.2.1.

6.2.3.3.2 Sampling Design

Larval drift nets will be set at/downstream of any locations where lake sturgeon may have deposited their eggs.

6.2.3.3.3 Parameters

Lake sturgeon larvae will be enumerated and measured. The number of larvae captured per trap per 24 hour sampling period will be calculated.

6.2.3.3.4 Sampling Sites

Only potential spawning sites, as suggested by gillnetting, acoustic telemetry data, and egg deposition monitoring, will be sampled.

6.2.3.3.5 Sampling Frequency and Schedule

Larval hatch and drift monitoring would occur annually at suspected lake sturgeon spawning locations upstream and downstream of the Keeyask GS, if warranted. Drift nets would be deployed 10 days after the onset of spawning and continue for a three-week period. Drift nets will be checked at 24 hour intervals.

6.2.3.3.6 Methods

Sinking larval drift nets (opening 43 X 85 cm, with an attached 300 cm long, 950 µm Nitex screen bag, tapered to a 9 cm diameter removable ABS pipe cod-end) will be used.

7.0 MERCURY IN FISH FLESH

Monitoring of mercury levels in fish will be conducted during the operation phase of the Project. Mercury concentrations are expected to increase during the first years after full impoundment and reach peak levels in species such as walleye and northern pike in three to seven years.

7.1 MONITORING DURING CONSTRUCTION

Although some sampling may occur during Project construction all sampling would be conducted prior to any increase in water level. The information would be considered additional baseline data and would not be part of the construction monitoring program.

7.2 MONITORING DURING OPERATION

7.2.1 Pathways of Effect and Key Questions

Several Project-related impacts are associated with potential increases in the release of mercury to the aquatic environment, as well as increased bioaccumulation. Upstream of the GS, these impacts include: flooding; conversion of intermittently wetted to permanently wetted habitat; and disintegration and decomposition of peatlands. Downstream of the GS, mercury concentrations in fish flesh could increase due to the downstream transport of methylmercury in water and potentially in lower trophic level organisms from the Keeyask reservoir. In addition, there is the potential for fish that accumulate mercury in the Keeyask reservoir to move upstream into Split Lake and downstream into Stephens Lake. Monitoring of mercury concentrations in fish muscle during Project operation is aimed at evaluating potential increases in mercury relative to baseline conditions (i.e., looking for increases relative to pre-operation phase) and to concentrations predicted in the AE SV (Section 7.2.4.2.2).

Large-bodied fish species that will be sampled for muscle mercury are lake whitefish, northern pike, and walleye. These species were selected for historic reasons (i.e., these species were commonly sampled in historic studies), because of their economic importance (they are harvested commercially and domestically), and in the case of northern pike and walleye, because they are top predators and are, therefore, at the greatest risk for biomagnification of mercury. In addition to these large-bodied, long-lived fish, 1-year old (1+) yellow perch will be sampled for the analysis of mercury. Yellow perch are widespread and abundant prey fish for northern pike and walleye in the study area and, because they do not undertake extensive movements, are suitable indicators of "local" methylmercury production and bioaccumulation. The young perch may also provide insights regarding annual changes in the supply of mercury to the ecosystem.

Key questions that will be addressed through monitoring mercury in fish muscle during the operation phase are:

- What are the maximum mercury concentrations in the muscle of target fish species during operation of the Project in relation to reference areas and in comparison to pre-Project levels?

- When are the maxima reached?
- How long does it take for fish mercury concentrations to return to background levels or stable levels?

7.2.2 Monitoring Area

Monitoring of mercury in fish will be conducted in the Keeyask reservoir ,Stephens Lake, Split Lake, and the Aiken River (to address YFFN concerns). Sampling may also extend downstream, depending on the extent of observed increases in Stephens Lake (Map 19).

7.2.3 Sampling Design

Based on recommendations from earlier fish mercury monitoring programs (i.e., "Program for Monitoring of Mercury Concentrations in Fish in Northern Manitoba Reservoirs" [MMMR]; Jansen and Strange 2007; Strange and Bodaly 1999), 36 individuals of each large-bodied species (lake whitefish, northern pike, and walleye) will be collected from each waterbody for mercury analysis. The number and the size distribution of the whitefish, northern pike, and walleye available for mercury analysis will be constantly evaluated during fish capture to obtain a distribution representing all available size classes (see Strange and Bodaly 1999 for an example). A maximum of 25 one-year-old yellow perch will be collected. Age will be estimated based on perch size distribution, recognizing that these fish will measure between 60-100 mm at the end of their second growing season. The actual number of fish from each species to be analyzed will largely depend on their availability within the different waterbodies and it is expected that numbers will occasionally differ from the target sample size. Only northern pike and walleye will be collected from the Aiken River.

Mean mercury concentrations will be length-standardized to facilitate comparisons between samples of fish collected from the same location or between samples of fish obtained from different waterbodies over time. Standard lengths have been designated as 350, 550 and 400 mm for lake whitefish, northern pike, and walleye, respectively (see Strange and Bodaly 1999). A standard length of 100 mm will be applied to yellow perch. In addition to arithmetic means, standardized means will be calculated from unique regression equations for each species and waterbody based on the analysis of logarithmic transformations of mercury concentrations in muscle and fish fork lengths using the following relationship:

$$\mathrm{Log10[Hg]} = a + b\,(\mathrm{Log10}L)$$

Where: [Hg] = muscle mercury concentration (μg/g);

L = fork length (mm);

a = Y-intercept (constant); and

b = slope of the regression line (coefficient).