Flin Flon Soils Study-Integrated Risk Management Plan
Annual Report – March 2013

Prepared for: Hudson Bay Mining and Smelting Co., Limited

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1.0 BACKGROUND

As part of the Integrated Risk Management Plan (RMP) prepared on behalf of Hudson Bay Mining and Smelting Co., Limited (Hudbay) as a follow-up to the Flin Flon Soils Study Human Health Risk Assessment (HHRA) and Exposure Evaluation Study, Hudbay committed to providing the Governments of Manitoba and Saskatchewan annual reports by March 31 of the following year. As directed by Manitoba Conservation and the Saskatchewan Ministry of the Environment, the annual reports were to include the following information: summary of activities undertaken to date under the plan, associated results or findings, any suggested changes or modifications to the plan from these findings, and an updated plan for the following year.

This report constitutes the March 2013 Annual Report. The format of this report was intended to follow the format utilized in the final RMP submitted to the Governments in November 2011 and March 2012. With the conclusion of the Flin Flon Soils Study in 2013, future RMP annual reports will be prepared under the governance of the Joint Regulatory Group (JRG).

2.0 EXPOSURE REDUCTION STRATEGY AND ACTIONS

2.1 Reduction in Emissions and Resuspension of Dust

Hudbay has committed to the continued program of progressive remediation and re-vegetation of the area in and around the Flin Flon Metallurgical Complex. This program should result in further improvements to ambient air quality already experienced through recent dust mitigation measures and the closure of the copper smelter in June 2010. Furthermore, Hudbay will continue with operating practices and procedures aimed at minimizing any dust emissions from the Flin Flon Metallurgical Complex in areas such as the metallurgical operations and tailings facility. Hudbay will also continue with other environmental improvements within its operations such as the paving of in-plant roads and material handling upgrades which will help further improve ambient air quality.

2.1.1 Dust Control

Hudbay has been working to improve site conditions in regard to dust generated from on-site vehicles. One aspect has been the improvement of site roads in regard to dust generation. Over the past five years Hudbay has paved approximately 50% of the main in-plant roads. Paving allows the road to be cleaned and the debris to be collected to minimize dust generation due to vehicular traffic.

As some dust generation can be tied to the movement of ore on site, Hudbay has taken initial steps to shorten the on-site ore haulage routes. Several possibilities are being investigated but site preparation completed to date will be advantageous to all the possibilities being reviewed. In 2012, the logistics and exploration parking lot was paved, which aided in minimizing vehicle-generated dust next to Manitoba PTH #10 in that area.

The plan going forward is to continue with site preparations and paving of Hudbay's metallurgical plant roads. In 2013, the concentrator handling courtyard and roads are

scheduled for paving. Once paving is completed in these areas, washing of the roadways can further reduce debris on vehicle corridors and reduce the generation of air-borne dust. Several dust control measures are in place on the Flin Flon Tailings Impoundment System (FFTIS). Further details of dust control activities are documented and compiled and a year-end report is produced. Refer to Attachment A for excerpts of the 2011 FFTIS Annual Report. The 2012 FFTIS Annual report is not yet complete and will be submitted upon completion.

2.1.2 Remediation (studies/projects)

Remediation studies and projects, such as the Green Project and University of Saskatchewan research in the Flin Flon area, are on-going and continue to be funded by Hudbay. It is envisaged that these programs will continue in future years pending budgetary approvals. Information gathered from University research, combined with the significant efforts contributed by volunteers at the Green Project, is likely to provide the most effective methods for the restoration of communities of plants and soil organisms in the impacted Flin Flon area.

In partnership with Hudbay, faculty and students at the University of Saskatchewan are conducting a research project to develop cost-effective eco-restoration and revegetation strategies to be applied to Flin Flon as well as other similarly affected areas. The primary objectives of this research are to:

- Identify significant soil and environmental factors that limit the success of eco-restoration;
- Enhance the ability to identify areas where eco-restoration will be successful; and,
- Identify soil treatments that encourage eco-restoration.

Since much of the impacted Flin Flon area is remote and has limited access, many traditional restoration techniques are not feasible options. Therefore, alternative methodologies are being considered. A series of interrelated subprojects are being conducted to identify effective eco-restoration technologies for the Flin Flon area using a combination of surveys, map development, and field and laboratory experiments.

In 2012, field research focused on the identification of ‘problem’ soils that require special attention, the refinement of amendment strategies, and the evaluation of potential amendment carrier mixes under field conditions. Researchers are in the process of developing a ‘problem’ soil map that will identify soils that are not anticipated to respond favourably to liming and will likely require a biochlor/glauconite amendment strategy. A large laboratory study is focused on developing an understanding the poor recovery of the nitrogen cycle in metal impacted soils.

The refinement of amendment strategies will include recommendations for plant mixes and approaches. A field trial was performed to identify the optimal carrier of soil amendments under field conditions. A pilot test of the final optimized carrier and plant mixes is planned for the summer of 2013.

A brief description of the subprojects associated with this research is provided below.

Greenhouse Assessments of Amendments

The objective of this study was to identify the amendment(s) that effectively promote the growth of understory and climax species in smelter-affected soils. The goal is to assess the microbial community structure and relate it to soil quality, plant-available metal concentrations, and ease of revegetation. A series of growth chamber experiments were conducted using soils collected from the Flin Flon area to test a number of potential amendments.

Field Assessment of Amendments

This study assessed the benefits of soil amendments on the *in situ* growth and survival of two tree (Jack pine and trembling aspen) and two understory (American vetch and tufted hairgrass) species in smelter-affected soils in Flin Flon. Twelve sites were selected to represent a range of conditions in the impacted area. The four amendments tested were meat and bonemeal biochar, willow biochar, municipal compost, and an ecto- and endo myochorrhizal inoculant.

Evaluation of Climate Effects on Amendment Success

The focus of this study was to assess the impact of soil moisture availability on amendment success. This study was conducted through a growth chamber trial using two tree (Jack pine and trembling aspen) and two understory (American vetch and tufted hairgrass) species grown in smelter-affected soils collected from Flin Flon under two different watering regimes. Measurements on success include root, shoot and understory biomass, metal content and soil pH. These results are currently being analysed.

Metal Characterization and Speciation

The objective of this study was to determine the speciation of zinc in smelter-affected soils. Zinc speciation was conducted for three primary purposes: 1) to link the soil mapping and metal surveys with molecular scale speciation, 2) to characterize the effect of long and short term Dolostone application (liming) on zinc speciation, and 3) to evaluate the effects of soil amendments on zinc speciation. The results of this study are currently being synthesized into scientific journal articles and a zinc speciation map. Results have been presented at national and international conferences.

Soil Ecology and Ecosystem Sustainability

This study involved establishing test plots throughout Flin Flon to test potential soil treatments in soils with varying organic matter content and zinc concentrations. Plot establishment and seeding was completed in July 2012. Germination rates were monitored in August, and in September growth measurements were taken and biomass samples were collected.

2.1.3 Remediation (operational work)

Mouse Pond

The 3.5-hectare Mouse Pond (MP) rehabilitation site is located in the Hudbay complex in Flin Flon, Manitoba, with work occurring from May to August 2011. In 2012, the project area was extended to include the 2.5-hectare North Mouse Pond (NMP). The sites are adjacent to Manitoba PTH #10 and the 777 Mine site.

At the NMP area, a 6-inch layer of clay was placed and track packed with an excavator, providing a separating layer between the oxidized material and the topsoil. The clay was also placed in the "pockets" on the top of any rock outcrops within the area. Topsoil was hauled and stockpiled by Joey Werbicki Trucking from The Pas, Manitoba, to be used as a vegetative medium at the site. Compost from a local farm in The Pas was also stockpiled on site. The compost and topsoil were combined in equal parts and applied as the growing medium, at a minimum depth of 6 inches after track compaction. The area was fertilized using an ATV-mounted fertilizer after the black topsoil was in place.

In 2011, there were some issues at MP with Lamb's Quarters, an annual agricultural weed that arrived with the topsoil. The MP area was mowed by hand, and most of the weeds were collected, bagged and disposed in an attempt to reduce the quantity of weeds competing with the new growth. This weed-control strategy was found to be very effective, as there were few Lamb's Quarters growing on the site in the spring of 2012.

The NMP area was hydroseeded in August 2012, with the development of the same agricultural weed found at MP. However, it is unlikely that they will present a problem in the 2013 growing season, as the weeds did not have time to mature before they were eliminated by the frost.

South Main

In 2012, the final steps in the revegetation process were completed at South Main. In the fall of 2011, hydroseeding had been postponed at the site due to wet conditions. The majority of the site, an area of approximately 7 hectares, was hydroseeded in May 2012. A small area of 0.5 hectares was included with the hydroseeding in August, as it had not been covered with the topsoil growing medium until after the May hydroseeding was complete.

The planted vegetation at the site grew well over the 2012 growing season, although the presence of weeds was noticeable. A weed management strategy is tentatively planned for the 2013 growing season at South Main and other revegetated areas around the Flin Flon complex.

Acid Lake Area

As part of the FFTIS plan to handle the maximum rainfall and flooding event, a larger culvert joining the Acid Lake area to the South Drainage ditch was installed in March 2012.

There are currently no plans to revegetate the area, as it is still used as an emergency water retention area during heavy rainfall events, reducing the amount of water collecting in Lake Bottom. The material that was the main cause of contamination has been excavated from the

site, making it easy to revegetate once it is no longer required as an additional water retention area. Further site grading to improve the positive drainage from Acid Lake has tentatively been scheduled for the 2017 construction season.

Hanson Lake Highway Drainage

In order to facilitate future reclamation and remedial activities, it is necessary to complete all required work on the FFTIS as per the closure plan. The re-vegetation on the slopes of the FFTIS cannot proceed until the drainage channel improvements required post-closure are completed.

A drainage ditch along the Hanson Lake Highway was designed to accommodate future seepage water from the FFTIS as well as extreme flood conditions. The construction of this drainage channel was initiated in the fall of 2010, with work continuing in 2011 and 2012. Once complete, this drainage channel will be operated in perpetuity. Its completion will facilitate further remedial work on the FFTIS slopes.

In 2012, drainage improvements continued along the base of the South Dam, located across from the Acid Lake area. The ditch construction along the base of the South Dam included cutting ditch slopes of 3:1, placing of riprap on top of the soft tailings and the installation of a 5-foot culvert, which tied the newly constructed ditch to the existing system. The new culvert was installed beneath the access road directly to Acid Lake's rock drainage channel to promote positive drainage.

FFTIS Slope Revegetation

In October 2011, after the dam expansion project was completed, leftover clay from the construction project was spread across the remaining unvegetated half of the Hanson Lake Highway dam slopes. Black topsoil from The Pas was spread over these slopes in 2012, and the area was hydroseeded in August 2012.

A slag-covered area at the base of the dam is the next area to be revegetated in this area. Revegetation work is scheduled to continue in this area in the spring of 2013. The area will be revegetated using a similar method to the other slope areas; it was capped with a clay cover in the fall of 2012 and is scheduled to be covered with topsoil, and then seeded and fertilized during the 2013 growing season.

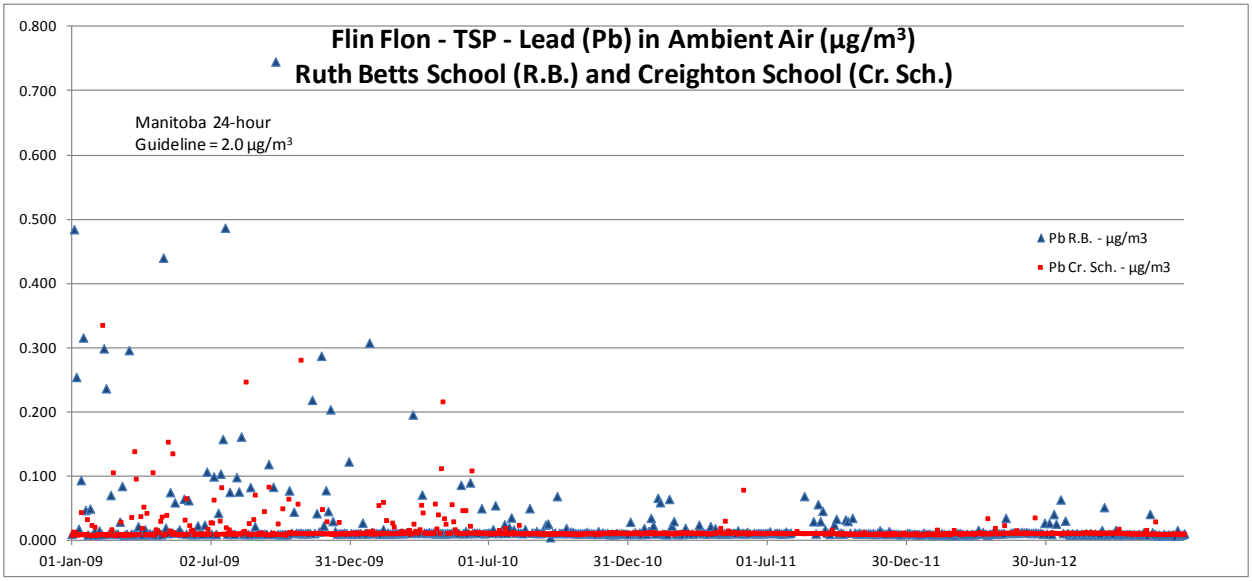
Contour work on the South Dam's slope was also initiated, which is the first step in the continued revegetation efforts of the slopes at the south end of FFTIS.

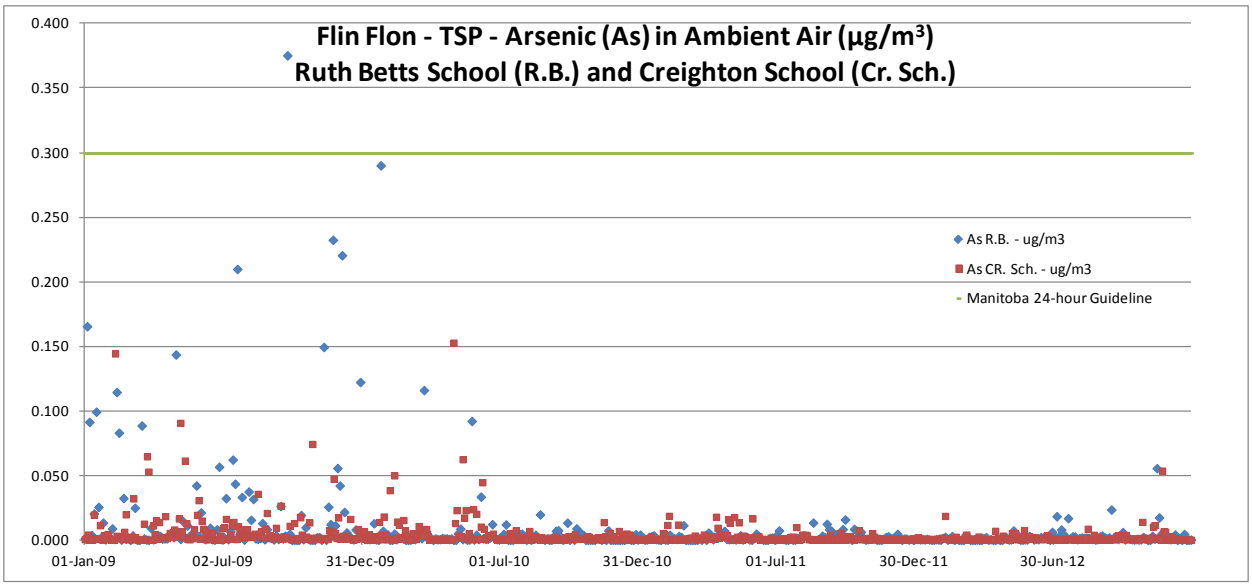
2.2 Continued Environmental Monitoring Activities

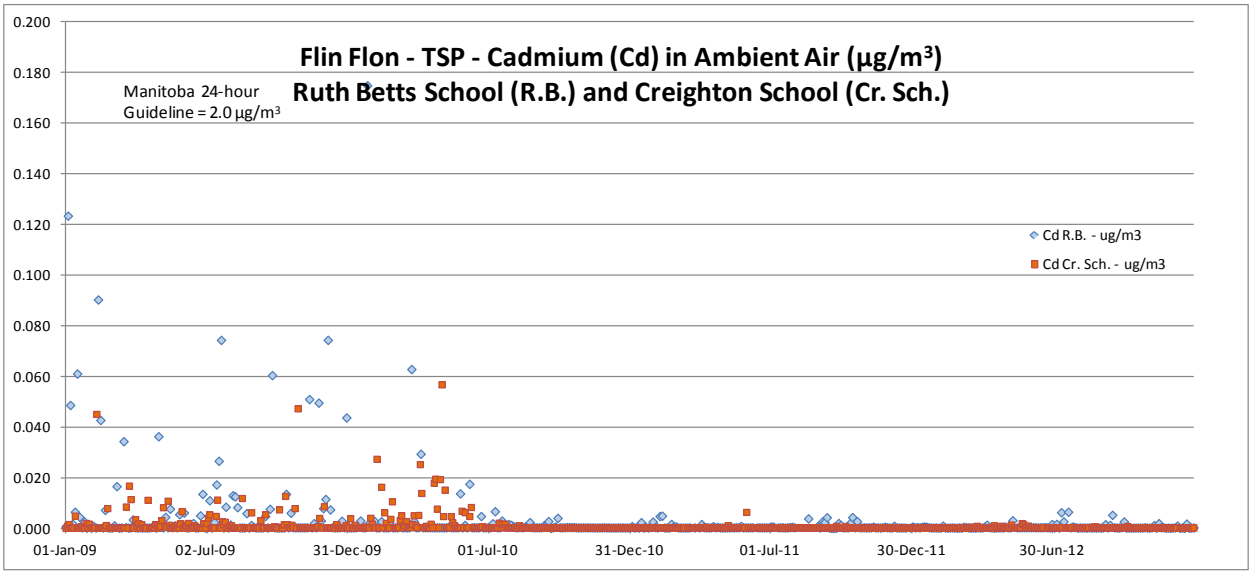
Air Quality Monitoring

Hudbay is committed to the continuation of its ambient air quality monitoring program to confirm that the anticipated ambient air quality improvements have been achieved. Hudbay, in conjunction with the Manitoba Government, will also ensure that such information continues to be publicly available. Although an annual Air Quality Update presentation is typically included as part of the Healthy Flin Flon meetings, this meeting was not held in 2012.

The following graphs provide air quality data for lead, arsenic and cadmium from 2009 through December 2012 from air samplers operated by Hudbay on Ruth Betts School in Flin Flon and Creighton School in Creighton. Of note, recent airborne concentrations of the three metals appear significantly reduced at both monitoring locations relative to historical levels. The reduction in airborne concentrations coincides with the smelter closure in June 2010 and the implementation of the Integrated Risk Management Plan.







Snow Sampling

Snow surveys have been undertaken in recent years in the vicinity of the Hudbay facility as a means of measuring deposition of facility-related contaminants. Samples collected pre- and post-smelter closure provide a comparison between operating and non-operating conditions and the effect on snow contaminant levels. Similar to the recent air quality results, snow sampling results from previous years indicate a significant reduction in deposition at all monitoring locations. The reduction in snow concentrations coincides with the smelter closure and implementation of the Integrated Risk Management Plan.

Due to the warm weather in the winter of 2012, there were very poor slushy ice conditions on the lakes in February 2012. As such, the snow survey was postponed until the winter of 2013. The 2013 snow survey was completed on February 26 and 27, 2013 by North South Consultants, with the assistance of Environmental Control personnel. The results of this survey were not available to be incorporated into the current report.

2.3 Public Outreach and Education

Education outreach activities led by AECOM have been ongoing in Flin Flon and Creighton since the spring of 2011. The outreach initiatives focus on general lead awareness and raising the profile of two major public health issues in Canada that reduce lead exposure:

- The presence of lead-based paint in older homes
- Proper hand washing, particularly among young children

The following has taken place in 2012 as part of the education outreach campaign:

General Lead Awareness

Fact Sheets
Fact sheets on lead and lead exposure, lead-based paint, and hand washing have been available online, at community events, and for pick-up at various public buildings in Flin Flon since the spring of 2011.

Websites and Social Media
A general campaign website, www.communityhealthproject.ca was launched in the spring of 2011 and continues to be the online hub for all program information, updates and resources. Program information and updates are also shared through various social media channels: Facebook, Twitter and a blog on Tumblr.

Hand Washing Program

Community Events and School Visits
AECOM continued to work with members of the community, the school boards and health authorities to guide hand washing education outreach efforts directed at young children (age 6 and under) in Flin Flon and Creighton. Hand washing resources were distributed to children at various community events such as the Trout Festival and the Trade and Leisure Show throughout the spring and summer of 2012. The hand washing “super hero”, Mighty Bubble, built a name for himself by appearing at these events and his character was incorporated into a hand washing “toolkit” that was distributed to kindergarten to grade 2 students in Flin Flon/Creighton in the fall of 2012.

The hand washing toolkit contained various resources for parents and caregivers to share with their children to encourage hand washing at home. Fran Labarre of Primary Health delivered the fall school program in 2012.

www.MightyBubble.com
Mighty Bubble's own hand washing website was launched in the spring of 2011 to provide an additional avenue for distributing resources to the people of Flin Flon and Creighton. As new hand washing resources are developed and made available to the community, they are posted to the website and available for download. The website also connects users to the program's social media feeds (Facebook, Twitter *etc.*)

Lead-Based Paint Program

Lead Test Kits
Lead-based paint test kits certified by the Environmental Protection Agency (in the United States of America) have been available at no charge to the community since the spring of 2011. Test kits are available for pick-up at McMunn & Yates, a home renovation and lumber store located in downtown Flin Flon. The availability of these kits were publicized through advertisements in the local paper and on the radio in 2012.

CFAR 590 Trade and Leisure Show 2012
Building on the success from previous years at the Leisure show, representatives from AECOM and Intrinsik attended the 2012 CFAR 590 Trade and Leisure show in April. At the show, AECOM and Intrinsik distributed resources (fact sheets, paint test kits *etc.*) and spoke to community members about ongoing activities such as the Follow-up Exposure Study to be completed in fall 2012.

Door Knocking
A second round of door-knocking occured in west Flin Flon in May 2012. The goal of door knocking was to speak to residents once again about the hazards of lead-based paint prior to the spring/summer renovation season. As an incentive to pick-up a paint test kit at McMunn & Yates, a coupon for discounts at the store were distributed. A contest for those who pick-up a test kit was also run at McMunn & Yates over the summer months, and a Winnipeg Jets jersey was given to the winner.

HEPA Vacuum Rental Program
A HEPA-filter equipped vacuum was purchased by Hudbay in the fall of 2011 and is available for rent at no charge by any member of the community in Flin Flon/Creighton. The vacuum can also be rented by contractors. Information on the program has been added to the website (www.communityhealthproject.ca).

What's Next…

Fall School Program
It is anticipated that the fall school program will consist of a classroom visit by Mighty Bubble and a NOR-MAN RHA community health developer and will take place in October 2013. Activity packages will be left with all teachers and each child will receive a mini toolkit of hand washing resources to take home.

All kindergarten to grade 2 classrooms in Flin Flon and Creighton will be visited as well as all public daycare centres. Hand washing resources will also be made available to the community-based health and wellness programs in Flin Flon and Creighton, including Kids First North and Head Start. Responsibility for the ongoing hand washing campaign and overall health

messaging will be transferred from AECOM to local resources. Fran Labarre of Primary Health delivered the fall school program in 2012.

2.4 Follow-up Evaluation of Lead Exposure in Children in the Flin Flon Area

Based on the findings from the human health risk assessment (HHRA) and the Evaluation of Exposure study completed in 2009, recommendations were made in 2010 to undertake efforts to reduce children's exposure to lead. The main efforts undertaken included a public health awareness campaign that targeted parents and children to improve the frequency and quality of handwashing among children. Other efforts included continuation of a Hudbay program of progressive remediation and re-vegetation of the area in and around the Flin Flon Metallurgical Complex, as well as a sustained effort by Hudbay to continue with operating practices and procedures aimed at minimizing dust emissions in areas such as the metallurgical operations and tailings facility. In addition, there have been some operational changes in the three years since the original exposure study including the closing of the Copper Smelter in 2010. The follow-up blood lead monitoring program was intended to determine the extent to which the community blood lead levels (BLLs) of children living in the Flin Flon Area have changed since the original exposure study.

The 2012 study followed a nearly identical approach to that employed in the 2009 study. The one additional component was the collection of environmental samples (*i.e.*, household dust, yard soil, tap water, and paint assessment) for households in which children providing blood samples lived. The study consisted of four main components which included the collection of blood samples from children under 7 years of age, collection of environmental samples (household dust, tap water, yard soil, lead paint), household surveys and observation for household features that may contain lead (*e.g.* old pipes, old paint, *etc.*). Throughout each phase of the study, there was a heavy emphasis on community consultations and communications.

Flin Flon Area children's internal exposure to lead was measured using capillary blood samples. Based on the 118 samples collected from children under 7 years old, the geometric mean was found to be 1.41 µg/dL. Children's BLLs were statistically significantly lower in 2012 than in 2009. The geometric mean dropped from 2.73 µg/dL in 2009 to 1.41 µg/dL in 2012. This constitutes a drop in mean levels of 1.32 µg/dL. This finding is consistent across all sub-groups according to age, gender and region. The proportion of children in the upper-levels of the distribution was also considerably smaller. In 2009, 13% of samples were at or above 5.0 µg/dL compared with 2% of samples in 2012.

The study indicated that there were very few factors associated with children's lead exposure in 2012. The only factor that was found to be significant was age of housing. Children living in older housing were more likely to have higher BLLs. The study also indicated that environmental media concentrations are poor indicators of BLLs and that additional factors likely represent a greater influence on BLLs in children in the Flin Flon Area.

Consideration of the results of the 2012 study and the available regulatory and scientific information regarding lead intervention levels and strategies leads to the conclusion that operational changes to the Hudbay facility has resulted in a significant decrease in the levels of lead exposure for children in the Flin Flon Area. Current levels are within the normative range

and are consistent with or lower than levels found in other communities in Canada. The conclusion of the study was that further intervention strategies are not warranted and not likely to further influence BLLs in the Flin Flon Area.

2.5 Public Consultation & Communication

Hudbay has committed to the continuation of the public consultation and communication programs through 2013 and beyond. With the conclusion of the Flin Flon Soils Study in 2013, future RMP annual reports and public communication programs will be managed under the JRG. The following activities are anticipated for 2013 and beyond:

- Hudbay will continue to maintain the Flin Flon Soils Study website (www.flinflonsoilsstudv.com) and telephone helpline (204-687-2020 or 204-687-2700) to ensure that the study results, and potential future developments, remain fully accessible to the public and that queries can be addressed, for as long as is required. No public queries were made in 2012.
- A public open house is tentatively scheduled for May 14, 2013 to present the results of the Follow-up Evaluation of Lead Exposure in Children. The results of this study will be documented within a technical report to be made available to the public on the Flin Flon Soils Study website.
- It is expected that the TAC and CAC will disband shortly following the public open house in May 2013.
- Healthy Flin Flon Meetings will resume in 2013 with presentations by Hudbay and Manitoba Conservation.

Summary of Activity - Flin Flon Soils Study Technical and Community Advisory committees Fiscal Year 2012 – 2013

Technical Advisory Committee Conference Calls

- **April 27, 2012 –** Review of Risk Management Plan and planning for the Follow-up Evaluation of Lead Exposure in Children in 2012
- **August 1, 2012 -** Update on the status of the planning for the Follow-up Evaluation of Lead Exposure in Children
- **February 4, 2013 –** Summary of results of the Follow-up Exposure Study
- **March 5, 2013 –** Comments on the Draft Report detailing the results of the Follow-up Exposure Study. Preliminary planning for a spring open house.

- Expected activity in upcoming fiscal year – conference call in mid- to late April to review the final report detailing the results of the Follow-up Exposure Study and to plan the public open house tentatively scheduled for May 14 in Flin Flon.

TAC Health Subcommittee (Manitoba Health and Healthy Living, Saskatchewan Health, Health Canada, study team members)

- **February 13, 2012 –** Conference call with biomonitoring sub-committee to discuss planning for the Follow-up Evaluation of Lead Exposure in Children in 2012
- **March 12, 2012 –** Conference call with biomonitoring sub-committee to discuss planning for the Follow-up Evaluation of Lead Exposure in Children in 2012

Community Advisory Committee Meetings

- **September 20, 2012, Mtg. 19 –** Meeting was held in Flin Flin to discuss ongoing risk management and the progress of the Follow-up Evaluation of Lead Exposure in Children.
- **February 25, 2013, Mtg. 20 –** Meeting was held in Flin Flon to provide the CAC with a summary of results of the Follow-up Exposure Study and to discuss community awareness of the study. Feedback from the CAC was sought regarding methods for the communication of the results to the public, including a public open house.

- Expected activity in upcoming fiscal year – it is not anticipated that there will be any additional CAC meetings in the upcoming fiscal year.

Communications Working Group

- Expected activity in upcoming fiscal year – it is anticipated that there will be a series of conference calls with the communications working group associated with preparation for the public open house in May 2013.

2.6 Current and Evolving Science & Regulatory Policy Regarding Lead

In light of an increasing body of scientific research demonstrating a broad spectrum of health outcomes associated with lead exposure, most notably neurological effects among children at low blood lead levels (*i.e.*, less than 10 µg/dL), various regulatory agencies have, or are in the midst of, updating their respective health-based policies and guidelines concerning lead.

Of the authoritative resources available, most agree that BLLs < 10 µg/dL in children and adults are associated with a broad range of health-related outcomes including cardiovascular effects; renal effects; developmental/reproductive effects; nervous system effects; and immune system related effects. There is general agreement that a wide spectrum of neurological effects (*e.g.*, decreased cognitive function, behavior effects, impulsivity, inattention, and memory effects, *etc.*) in children occur at BLLs < 10 µg/dL and in some cases < 2 µg/dL. Many of the agencies (US EPA, 2006; ATSDR, 2007; Health Canada, 2013a,b; US EPA, 2012) make reference to the pooled analysis conducted by Lanphear *et al*. (2005) as some of the most compelling evidence to support the nonlinear nature of the dose-response relationship between low BLLs and cognitive function and thus the lack of an effects-based threshold.

Health Canada published a report in February of 2013, entitled “Final Human Health State of the Science Report on Lead” (Health Canada, 2013a) in response to this increasing body of scientific evidence demonstrating health effects occurring below the current Canadian blood lead intervention level (10 µg/dL). The State of the Science Report (Health Canada, 2013a) is

not a comprehensive or critical review of all available scientific data but rather a summary of information used to form the basis of the evaluation. The health effects assessment presented by Health Canada (2013a) focused on chronic health effects in humans where sufficient evidence was present that either developmental neurotoxic, neurodegenerative, cardiovascular, renal, or reproductive effects are occurring below the current Canadian intervention level of 10 µg/dL. Health Canada (2013a) provided an overarching discussion of the key scientific studies and summarized (in tabular form) the effects observed and their corresponding BLL for each study under the five (5) endpoints mentioned above.

Health Canada (2013a) concluded that there is evidence of health effects occurring below 10 µg/dL, in fact, Health Canada (2013a) states that there is sufficient evidence that BLLs below 5 µg/dL are associated with adverse health effects and that developmental neurotoxicity (the endpoint associated with the lowest BLL in both observational studies and *in vivo* experiments) can occur at BLLs as low as 1 to 2 µg/dL. Developmental neurotoxic effects have been demonstrated to persist in humans into the late teen-age years while in animals, these effects have been shown to persist after exposure has ended and lead concentrations in both blood and brain have returned to control levels. According to Health Canada (2013a), the majority of data collected from observational studies does not point to a population-based threshold (below which developmental neurotoxicity is not expected to occur) within the range of current environmental exposures.

Health Canada (2013a) indicated that the relationship between IQ score (in children) and BLLs is the strongest line of evidence of adverse effects in humans below a BLL of 10 µg/dL and that neurodevelopmental effects among infants and children is the primary health effect of concern, with IQ score being the most sensitive of all neurological related endpoints. Health Canada (2013a) considers the meta analysis conducted by Lanphear *et al*. (2005) as the most comprehensive analysis concerning developmental neurotoxicity and is of the mind that selecting children as the most susceptible subpopulation and neurodevelopmental effects as the most critical endpoint is protective of other adverse effects of lead exposure (*i.e*., cardiovascular, renal, and reproductive effects) across the entire population.

The outcome of this State of the Science report is consistent with conclusions from other regulatory reviews. The 10 µg/dL intervention level for lead is no longer considered to be health protective, as there is no evidence of a threshold for critical lead-induced health effect. It is considered appropriate to apply a conservative approach when characterizing risk; accordingly, additional measures to further reduce exposures of lead to Canadians are warranted. Health Canada has also published a second report in February of 2013, entitled “Risk Management Strategy for Lead” (Health Canada, 2013b). The objective of the Proposed Lead Risk Management Strategy was to provide continued support of the existing programs (under the Canadian federal risk management strategy for lead) and to pursue additional actions to further reduce lead exposure to the greatest extent practical (Health Canada, 2013b). Blood lead levels of Canadians have declined significantly over the past 30 years. That said, in response to the evidence that health effects are occurring at levels below 10 µg/dL, and in consideration that it is appropriate to apply a conservative approach when characterizing risk, it was concluded that additional measures to further reduce exposures of Canadians to lead, with a particular focus on vulnerable populations, are warranted. Accordingly, the proposed risk management objective for lead is to pursue additional management measures to reduce exposure to lead, and hence associated risks, to the greatest extent practicable. The overall Government of Canada risk management objective is to reduce exposure to lead to the greatest

extent practicable by strengthening current efforts in priority areas where the government can have the greatest impact upon exposure of Canadians.
In developing a new Canadian Soil Quality Guideline (SQG) value for lead, CCME (2012a,b) has established a reference value for lead based on the most studied neurodevelopmental toxicity endpoint, for which there is also the greatest weight of evidence, related to the adverse consequences of chronic early-life lead exposure on intelligence tests (IQ) among school-aged children. The level of protection associated with the draft SQG values relate to soil concentrations resulting in no more than a one (1) IQ point decrease on a population level, as measured by full-scale Wechsler IQ. The current literature also suggests that neonates and infants are the most sensitive receptors with respect to lead exposure and as such the selection of neonates and infants as a susceptible subpopulation and neurodevelopmental effects as the critical health effect was considered protective for other adverse effects of lead across the entire population (CCME, 2012b).

For adults, cardiovascular toxicity was identified as the most sensitive endpoint for lead toxicity. The current epidemiological literature supports a “relatively mild, but statistically significant” association between whole BLLs and increases in blood pressure, particularly systolic blood pressure (SBP). CCME (2012b) notes that based on a number of published studies, each doubling of BLLs is associated with an increase in SBP of approximately 1 mm Hg. It also notes that epidemiological evidence is suggestive, but not entirely consistent, of an association between environmental lead exposure and SBP or risk of hypertension among subjects with average BLLs less than 10 µg/dL (CCME, 2012b).

The Toxicological Reference Value (TRV) used by CCME (2012b) to derive SQGs for lead was calculated using a benchmark concentration approach. The TRV for lead is referred to as a Bench Mark Concentration Lower (bound) (or BMCL) and is typically derived using studies that express observed adverse effects (among adults and children) as a function of BLLs. A BMCL typically represents the upper bound estimate of the slope of the dose response relationship. The CCME (2012b) employed the use of a loss in IQ (for children) or increase in SBP (for adults) of 1% (on a population basis) as an adverse effect level for the purposes of deriving a provisional TRV. It is noted that the provisional TRV derived by CCME (2012b) does not represent a daily exposure rate for which a given population can experience without an unacceptable risk of adverse health effects (*i.e.*, it does not represent a threshold).

The Office of Environmental Health Hazard Assessment (CalOEHHA, 2007) among other regulatory agencies, conducted dose-response analyses using the Lanphear *et al*. (2005) dataset. The CalOHHEA (2007) analysis indicated that an incremental increase of 1 µg/dL blood lead was associated with a 1% decrease in IQ score on a population basis. The CCME (2012b) employed the results of CalOEHHA (2007) analyses to represent their provisional lead TRV for infants, toddlers, children and adolescents (*i.e.*, an incremental increase of 1 µg/dL blood lead was associated with a 1% decrease in IQ score in a population basis). For adults, SBP was selected as the critical endpoint and data generated by Vupputuri *et al*. (2003) was used to evaluate a dose-response relationship. An incremental increase of 1.4 µg/dL blood lead (among Canadian adult females) was associated with a 1% increase in SPB on a population basis. This relationship was used by CCME (2012b) to derive SQG protective of the adult population.

One of the largest uncertainties is the ability to quantify health effects based on an IQ drop of 1 point. IQ tests are generally considered blunt measures of neurologic status, and the ability to

accurately identify such a minute drop as correlated to neurological impacts is questionable (CCME, 2012b). For example, as noted by CCME (2012b), the World Health Organization (WHO, 2001) has indicated that IQ estimates computed from the Wechsler scales or other measures have not, in general, been demonstrated to be particularly sensitive to neurotoxic exposure. It has also been widely documented that there are a large number of confounders that must be considered when measuring an effect on children's intelligence, including socio-economic status (SES), parental IQ, and the quality of the home environment.

The CCME (2012b) indicated that pooled analysis by Lanphear *et al*. (2005), the dataset used to derive the lead TRV, included a large number of diverse subjects with a sufficient number of pre-school and school-age children with BLLs ≤10 µg/dL to provide it sufficient statistical power to describe the relationship between BLLs and cognitive function. However, there is uncertainty regarding the extrapolation of the dose-response curve to levels currently found in Canadians as the lowest BLL in the Lanphear *et al*. (2005) study was 2.4 µg/dL.

Regardless, CCME (2012b) indicates that the level of confidence in the scientific literature reporting the association between lead exposure and neurodevelopmental toxicity in humans is high. They note that numerous human observational studies that assess multiple organs or systems are available, and the critical health effects identified are based on well-established endpoints and are supported by mechanistic data as well as studies conducted in laboratory animals.

The issue of what magnitude of lead exposure, as measured by a blood lead concentration, should trigger intervention remains outstanding. Often, this is a matter of weighing the effectiveness of intervention against the potential health effects of exposure. Historically blood lead intervention levels have been based on health risks. The absence of an identified threshold for the adverse effects of lead makes it difficult to set a blood lead intervention value that is without health risks. As a result, recent guidance recommends a "normative" approach to establishing blood lead action levels (ACCLPP, 2012). Under the normative approach, decision-making on the requirement for intervention is based on the following questions:

- Is the individual or community blood lead concentration atypical (*i.e.*, higher than normal)?
- If so, what can be done to effectively reduce the atypical exposure?

The Advisory Committee for Childhood Lead Poisoning Prevention (ACCLPP) was established by United States Centers for Disease Control and Prevention's (CDC) to provide advice and guidance to the CDC concerning recent technical and scientific advances (and their associated implications) in the area of childhood lead poisoning prevention efforts. In January of 2012, the ACCLPP presented a report to the CDC entitled 'Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention'. The report (ACCLPP, 2012) made thirteen (13) specific recommendations. Rather than the use of a static population-based 'level of concern', the ACCLLP (2012) recommended the use of a childhood BLL reference value, representing the 97.5th percentile of BLL among children (1 – 5 years of age). It was recommended that the 97.5th percentile should be derived using the two (2) most recent cycles of the U.S., NHANES data and be re-evaluated (by the CDC) every four (4) years to ensure any changes in this sub-population (1 – 5 years of age) are correctly represented. The childhood BLL reference value is to be used to identify individual children with increased lead exposure and to help set public health goals. The current childhood BLL reference value should be set at 5 µg/dL. The

ACCLLP (2012) report has placed an emphasis on primary prevention strategies (*i.e.*, strategies to prevent exposures to lead) rather than responses to specific BLLs. Many of the recommendations put forth by the ACCLLP (2012) revolve around mechanisms to facilitate on-going primary prevention and reporting strategies. In a document entitled 'CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention' (U.S. CDC, 2012), the CDC either agreed or agreed in principle (*i.e.*, the CDC agreed with the recommendation but lacked the funding at this time to implement any changes) with each of the thirteen (13) recommendations put forward by the ACCLLP (2012).

Guidance contained within the two recent reports Health Canada released addressing lead that provide some insight into the direction of any forthcoming policy statements from Health Canada:

- Final Human Health State of the Science Report on Lead (February 2013)
- Risk Management Strategy For Lead (February 2013)

Both reports indicated the following:

- Blood lead levels in the Canadian population have declined significantly over the past 30 years.
- Health effects are occurring below the current Canadian blood lead intervention level of 10 µg/dL.
- Health effects have been associated with BLLs as low as 1–2 µg/dL.
- Additional measures to further reduce lead exposures to Canadians are warranted.

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ATTACHMENT A

EXCERPTS FROM THE 2011 FFTIS ANNUAL REPORT

Hudson Bay Mining & Smelting Co., Limited

Flin Flon Tailings Impoundment System

Saskatchewan Government Annual Report – 2011

Hudson Bay Mining & Smelting Co., Limited
Flin Flon Tailings Impoundment System

Saskatchewan Government Annual Report - 2011

1. Introduction

Hudson Bay Mining & Smelting Co., Limited (HudBay) has operated the base metal tailings management area known as the Flin Flon Tailings Impoundment System (FFTIS) for over 80 years. In 1991, the Saskatchewan Department of Environment and Public Safety, Mines Pollution Control Branch, established effluent limits for the tailings pond discharge by issuing Ministerial Approval No. MPCO-36. This license has been replaced several times since then, most recently with IO-257 which was issued by Saskatchewan Environment (SE) in March 2010.

In addition to IO-257, effluent from the FFTIS is also subject to the monitoring and reporting requirements of the federal Metal Mining Effluent Regulations (MMER).

HudBay continues to maintain the ISO-14001 certification that was achieved in 2003 and OHSAS-18001 safety certification that was achieved in 2004.

2. General Performance

Operation of the FFTIS over 2011 was in accordance with all conditions of IO-257.

2.1 Final Discharge

Compliance with the allowable levels of arsenic, copper, lead, nickel, zinc, total suspended solids, and pH at the North Weir discharge was 100% during 2011. Compliance with the allowable levels was 100% throughout the previous reporting period, 2010.

Compliance with the allowable concentration of un-ionized ammonia at the confluence of the North Weir discharge and Beaverdam Creek was 100% during 2011. Compliance with allowable levels was 100% throughout the previous reporting period, 2010.

2.2 Tailings Pond Dusting / Ambient Air Quality

In 2011, HudBay continued to be proactive in handling dusting events by implementing dust control measures as outlined in the corporate dust control plan (FFTIS Dust Control Guidelines, LAI-612). A more detailed list of actions completed in 2011 is outlined in Section 5.4.

Total Suspended Particulate (TSP), PM_{10}, and $PM_{2.5}$ levels from the Creighton School monitoring station along with details of dusting events that occurred throughout the year were forwarded to SE on a monthly basis.

3. Monitoring Programs

3.1 Effluent and Downstream Water Quality

During the reporting period, FFTIS water sampling stations were situated at Beaverdam Creek, the North Weir discharge, the confluence of the North Weir Discharge and Beaverdam Creek, Flin Flon Creek at the Perimeter Highway, and Ross Lake at Third Avenue. Analytical results of water samples were forwarded to SE on a monthly basis. A summary of monthly results for 2011 and annual historical effluent data (1996 – 2011) are contained in Appendix 1A while the following table summarizes the 2011 average annual results at each location.

IO-257 2011	North Weir	Beaverdam Creek	Flin Flon Ck. Confluence	Flin Flon Creek	Third Avenue
pH	8.36	8.25	7.93	7.64	8.02
Zn	0.0591	0.258	0.171	0.241	0.362
Cu	0.0114	0.054	0.038	0.047	0.044
Ni	0.006	0.015	0.015	0.015	0.015
Pb	0.008	0.030	0.030	0.030	0.030
As	0.0066				
TSS	1.38	1.28	1.74	2.45	2.98
NH3-UI	0.08		0.02		

All parameters are in mg/L except pH.

A comparison of the average annual 2011 zinc levels to 2010 indicates that zinc concentrations increased at the North Weir, but decreased at all other locations. The North Weir was 16% higher, Beaverdam Creek was 27% lower, the Confluence was 10% lower, Flin Flon Creek was 7% lower, and Third Avenue was 10% lower.

Of particular importance is the effect of thiosalt activity on downstream pH. The pH at Third Avenue during 2011 averaged 8.02, up significantly from 7.25 in 2010. Tailings deposition was planned to maximize retention time in the FFTIS during the critical summer months when thiosalt degradation leads to the formation of sulfuric acid and depresses the effluent pH. The downstream pH at Ross Lake was maintained above 7.0 for all samples throughout the year. A chart showing thiosalt concentrations and pH levels downstream of the FFTIS is included in Appendix 1A.

3.2 Air Quality

Air quality monitoring is conducted on a daily basis at the Creighton School. Results are reported to SE on a monthly basis. The following table summarizes the 2011 annual geometric mean concentrations in each particulate size fraction:

Parameter	Total Suspended Particulate	PM_{10}	$PM_{2.5}$
PM	18.25	16.43	9.16
Cu	0.0238	0.0209	0.0096
Zn	0.0130	0.0356	0.0135
Cd	0.0006	0.0084	0.0047
Pb	0.0118	0.1671	0.0926
As	0.0012	0.0020	0.0010
Hg	0.0001		
SO_4	0.7953		

All parameters are in $\mu g/m^3$.

Metal content of ambient particulate was reduced in 2011 when compared to previous years. This likely reflects the closure of the HudBay Copper Smelter in June, 2010 and the subsequent cessation of particulate matter and metal emissions from the HudBay Main Stack.

A summary of the annual average results since inception of the ambient particulate monitoring program at Creighton School is included in Appendix 1B. A major decrease in the metal content of total suspended particulate was observed beginning in 2003. This reflects the changes in fugitive dust management that resulted following the major dusting event that occurred on December 6, 2002. A second drop in metal content begins in 2008 as production at the HudBay Copper Smelter began ramping down in preparation for closure in 2010.

3.3 Settlement Plates

Settlement plate data and graphs from the North Weir Dam are attached in Appendix 2. New settlement plates and pins were installed in 2005. The coordinate system is UTM Nad83 datum, as opposed to the historical use of a local mine grid.

North Weir Dam settlement plates were surveyed twice in 2011, once on June 10 and again on September 3.

Data collected since 1984 indicates that the subsoil continues to consolidate. Since 1995, surveys have indicated both minor increases and decreases in the settlement plate elevations. The 2011 settlement plate monitoring indicated an average annual decrease in elevation of 0.1 cm, as compared to an average annual elevation decrease of 1.9 cm per year since 1985 and a 0.5 cm decrease in 2010.

4. Inspections

As required in Appendix C of IO-257, inspection patrols were conducted on a daily basis. The observations from each inspection are recorded in a logbook that is available for review upon request. The logbook hardcopy is maintained for one year; all daily inspection sheets are scanned and stored permanently in electronic format.

5.4 Dust Control

There were no significant dusting occurrences during 2011. All incidents were local to the tailings facility and no fugitive dust was noted leaving the FFTIS disposal limits. Minor dusting incidents occurred on the following dates:

February 8 - Minor dusting was observed coming from the North Borrow pit exposed tailings beach. Winds were strong from the Northwest at 25 km/hr, gusting to 45 km/hr. The fall out of the dust appeared to be within the vicinity of the Lake bottom valley/North end of the Open Pit area. A local contractor began loading rock trucks with lake bottom water discharge, and dumping the water at the South end of the exposed tailings area. The area quickly developed sheets of ice, progressing towards the North, and effectively minimized the tailings dusting.

March 29 – In response to visual inspections identifying large sections of exposed tailings beaches, a local contractor began placement of salted sand between the South tailings pipeline and lake bottom discharge pipelines and also commenced sanding the North borrow pit exposed tailings beach to prevent the possibility of any dusting during the spring shoulder season.

May 17/18/19 - In response to visual inspections identifying dry crest conditions on the East perimeter Dam, North and West ZPL Dam crests, a local contractor began belly dumping salted sand on the crests of the dams to prevent the possibility of any dusting during the drier months of May and June.

June 17 – Due to increased construction traffic working at the South Perimeter Saddle dam area, and during the South Perimeter Dam crest raise, localized dusting was noted during the hot and dry weather at peak afternoon periods. A local contractor began belly dumping salted sand on the crest to minimize construction generated dust. Water trucks were also diverted to that area to maintain the road in a wet state during construction.

July 25 – Following construction of a tailings road between the West abutment of The South Causeway and the old Creighton Landfill access road, a local contractor began placement of dust control sand by belly dump truck.

July 28 – Dust control sand was placed on a lay down area storage pad constructed of tailings, located between the South Causeway's West abutment and the existing Creighton Landfill access road. HBM&S pipefitters were mobilizing to the site to conduct 18" HDPE pipe fuse welding, and asked for sand to be placed to minimize dusting in their work area, and to make moving pipe easier, which would require less cleaning prior to performing the fuse welds.

During the 2011 summer construction season, three water trucks maintained dust control in areas of tailings excavation (borrow pits), haul roads, and construction of tailings fill embankments to maintain optimum moisture content during compaction of fill. The water trucks were active from early May to late October and were effective in controlling all areas from fugitive tailings dust generated by vehicular traffic.

Following the completion of tailings fill embankment construction, all dams crests and fill slopes within the Primary and Secondary Pond structures were sanded for dust control. This was accomplished by use of a belly dump semi-truck, and in some areas, a sand truck was used. All dam crests and fill slopes on the ZPL facility were covered with screened sand following tailings fill embankment construction.

"Dust Bind Plus" chemical dust suppressant was initiated on September 28, by placing the product on the South Perimeter Dam exposed tailings beach (spigoted), and within the Northwest corner of the North tailings borrow pit area. A small spigot beach on the East Perimeter Dam was treated, North of the borrow pit.
Salted sand was placed throughout the month of October during colder mornings on the exposed tailings beach at the Southeast corner of the Secondary Pond. Additional salted sand was placed along sections of spigoted beach located along the South Perimeter Dam between the lake bottom discharge pipes, and the South tailings line support berm. The spigoted beach on the East Perimeter Dam (South Weir Dam

Section) had salted sand placed on it to reduce the potential for dusting. The sand was spread by a small Cat 902 loader.

A waste rock berm was constructed on October 26/27 between the end of the South tailings pipeline support berm and the North borrow pit berm. The berm was utilized as a method to retain lake bottom waters which created an ice cap to areas of inaccessible exposed tailings beach within the Primary Pond.

Mill process waters were retained within the excavated North Borrow pit area to cover as much exposed tailings as possible, and to allow it to freeze to create a more longer term cap cover.

The West South Causeway Spillway outflow was restricted in early October to allow the Primary Pond water level to back flood as far south as possible, to create a water cover over the exposed tailings and to allow the water to create an ice cap, while maintaining a suitable beach width of ~40 meters. The North Perimeter Dam Spillway flows were restricted by placement of 3 stop logs to back flood waters within the Secondary Pond, to create a water cover over the exposed tailings and to allow the water to create an ice cap, while maintaining a suitable beach width of ~40 meters.

5.5 North Weir Acid Plant

On April 27, 2011, the acid plant was shut down to allow a technician from Prominent Fluid Controls to overhaul the acid metering pumps and replace the diaphragms on the pumps.

5.6 Miscellaneous

Geotechnical consultants from BGC Engineering Inc. were in Flin Flon between September 26, 2011 to September 30, 2011, to conduct the annual audit of the FFTIS.

North Weir settlement plates were surveyed twice in 2011, once on June 10 and again on September 3.

5.7 Storage Capacity

As of December 31, 2011 the available storage capacity within the FFTIS with current dam heights was:

Primary Pond ..... 1,377,494 tonnes of tailings
Secondary Pond..... 6,284,131 tonnes of tailings
Clarification Pond ..... 424,000 m^3

6. Site Rehabilitation Activities

The following is a brief summary of rehabilitation projects conducted on the Flin Flon Metallurgical Complex.

6.1 South Main Site

Rehabilitation of the Callinan (South Main) site continued in 2011 and included:

- Excavation of mine rock and subsequent disposal down the mine shafts.
- Capping of the mine access shafts.
- Excavation of diesel contaminated soil and rock surrounding the former fuel storage area.
- Site contouring with clay and black dirt.

6.2 Heavy Fuel Oil Tank Demolition

Following closure of the Smelter in 2010, the heavy fuel oil (HFO) system was rendered obsolete. Removal of the final two HFO tanks was completed in the fall of 2011.

6.3 Miscellaneous

Revegetation work along the Highway #10 Perimeter area continued. Contouring and black dirt application over the area immediately north of the 777 Mine was completed in the spring. Hydro-seeding of the area occurred during the summer.

Clay was placed along the Hanson Lake Highway Dam in preparation for contouring and revegetation work scheduled for 2012.

6.4 Planned Rehabilitation Activities for 2012

Rehabilitation work planned for 2012 includes the following projects:

- Hydro-seeding of the Callinan / South Main site.
- Contouring and hydro-seeding of the remaining section of the Hanson Lake Highway Dam.