8.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

8.1 Background

The Federal Environmental Impact Statement (EIS) Guidelines (see Appendix B) require that IAMGOLD consider how local conditions and natural hazards such as severe and/or extreme weather conditions (e.g., extreme floods, ice jams) and external events (e.g., natural fires, earthquakes, landslides, avalanches) could adversely affect the Project and how these in turn could result in effects to the environment as a result of malfunctions and/or accidental events.

A number of potential effects that the environment could have on the Project have been identified for assessment based on guidance provided from regulatory agencies and experience with other mine environmental assessments:

- water supply availability;
- natural hazards; and
- climate change.

The proposed Project is being planned and designed, and will be constructed and operated, with due consideration of the local environmental conditions in and around the Project site.

8.2 Water Supply Availability

There are two potential water supply scenarios to be considered from the perspective of potential effects of the environment on the Project: 1) insufficient water and 2) excess water. The Project site is located within the Upper Mattagami River Watershed and is surrounded by numerous lakes and rivers which flow to the Mollie River and to Mesomikenda Lake prior to discharging to Minisinakwa Lake and ultimately to the Mattagami River. The average annual precipitation over the Project site is approximately 856.3 mm but annual precipitation levels can be highly variable from year to year, as described in the Hydrology TSD (see Appendix I).

The primary water management structures for the Project include:

- watercourse realignments and dams;
- the mine water pond;
- the freshwater uptake pipeline from Mesomikenda Lake to the mine water pond;
- the reclaim water pipeline from the Tailings Management Facility (TMF) reclaim pond to the ore processing plant;
- the Mine Rock Area (MRA) and TMF seepage collection ponds for surface runoff and seepage collection;
- the polishing pond; and
- the discharge pipeline from the polishing pond to Bagsverd Creek, north of the TMF.

To alleviate the potential for situations where there is too much or too little water supply, the Project water management system has been designed to provide a large reservoir capacity that will accommodate year to year variations in runoff. The site water management system is also highly flexible in its ability to treat and release water to Bagsverd Creek in order to manage any excess water brought into the system (see Chapter 5 and Appendix I).

Mesomikenda Lake is also expected to provide a potential source of make-up water for use in the ore processing plant, as needed. This uptake would not exceed 20% of the daily flow and would occur seasonally when sufficient flow is available in the lake.

The primary water reservoir to support the ore processing plant start-up and operations will be the mine water pond with a volume of approximately 0.59 Mm^3. For the initial start-up, water will likely be taken from the draining of Côté Lake and from Mesomikenda Lake. Approximately 60% to 100% of the operations process water will likely be derived from recycled and treated water collected from runoff and seepage at the MRA, low-grade ore stockpile, open pit dewatering and local runoff collection facilities, the TMF reclaim pond and the polishing pond. This high rate of recycling will decrease the need for additional freshwater intake and for discharge to the environment during operations. Enough water will be stored in the system to supply the ore processing plant with water during the winter months or during potential prolonged summer/fall drought conditions.

Mine water will derive from the open pit mining operations and its removal from the open pit will be required continuously for the life of the Project in order to maintain a dry working environment. The proposed open pit will intercept groundwater and runoff from adjacent areas, as well as direct precipitation. Preliminary analysis indicates that when fully developed, and at a steady state, the open pit will intercept up to an estimated 2,210 m^3/d of groundwater from the bedrock, per year, over the Project life (see Appendix H). Potential inflows from overburden seepage are anticipated to be intercepted at the surface by collection ditches before entering the open pit.

Mine water will be collected in a series of drains and sumps at the base of the open pit, which will be progressively relocated as the open pit develops over time. Mine water from the open pit and overburden seepage from the pit perimeter drainage will be pumped to the mine water pond and to the ore processing plant for use as process water. Well field pumping and/or collection ditches may be considered, to supplement mine water collection. No special handling or treatment of snow is considered as accumulated snow in the open pit will be removed with the excavated mined materials (overburden, mine rock or ore) or will melt and drain towards the installed sumps. Portions of precipitation volume during wet annual condition and probable maximum precipitation (PMP) events would be stored in the open pit and pumped out in the days following a storm event. If necessary, a secondary pond system could be installed to increase stormwater management capacity.

8.2.1 Potential for Insufficient Water Supply

Insufficient water supply could:

- cause a temporary shutdown or scaling back of the ore process plant operations, if there is insufficient water for process water demands; and
- alter discharge timing from the TMF polishing pond if effluent doesn't meet applicable water quality criteria.

The average annual precipitation over the Project site is approximately 856.3 mm, (see Appendix I) and in a 1:25-year annual dry precipitation condition, the Project site is projected to receive approximately 734 mm in total annual precipitation (approximately 122 mm, or 15%, less than the average annual precipitation; see Appendix I). The principal concern for consistent water supply availability is the potential for two dry years to occur in succession, resulting in a reliance on uptake from Mesomikenda Lake that is greater than expected. The concern for too little water is most acute for the ore process plant start-up and initial operations, when a sufficient inventory of water will be needed to guarantee an uninterrupted ore processing plant water source, especially through the first winter of ore processing plant operations. As a result, it will be necessary to build an initial water inventory in the mine water pond, principally from water taken during the draining of Côté Lake, local site catchments and from Mesomikenda Lake when necessary.

As discussed above, approximately 60% to 100% of the process water may be derived from the open pit, runoff and seepage collection system, and the TMF reclaim pond. Enough water will be stored in both the mine water pond and the TMF reclaim pond to supply the ore processing plant with water during the winter months or during potential prolonged summer/fall drought conditions. The mine water pond will be designed to have a storage capacity of 0.59 Mm^3; designed to store enough water to supply the ore processing plant for up to seven days during operations. With an abundance of water available from Mesomikenda Lake, insufficient water supply is not expected, and therefore, a need for temporary shutdown or alteration in discharge timing is not anticipated.

Once the ore processing plant is in full operation, there is an opportunity to build a greater water inventory and the risk to processing operations due to insufficient water supply greatly diminishes. If for any reason water inventory conditions were insufficient to support the ore processing plant start-up and operation through the first winter period, the available options would be to:

- collect or obtain additional water from another source, such as Mesomikenda Lake;
- delay the start of ore processing until such time as a sufficient water inventory could be developed; or
- temporarily scale back ore processing, particularly in the late winter.

It should be noted that delaying the ore processing plant start-up date or temporarily scaling back the ore processing plant operations would have negative financial consequences for the Project.

The other aspect of low water conditions is related to TMF effluent and the receiving water's natural assimilative capacity and potential environmental effects. Once the effluent meets applicable water quality criteria, water will be discharged (as necessary) from the polishing pond through a constructed pipeline to Bagsverd Creek, north of the TMF. To optimize final effluent quality, it is planned that in-plant effluent treatment for cyanide destruction and heavy metal precipitation would be followed by extended effluent aging internal to the TMF (primarily within the TMF reclaim pond). Minewater will also contain residual ammonia from explosives used in the open pit that, requiring extended aging prior to release to the environment.

The fact that the 1:25-year annual dry precipitation condition for the Project site is projected to be only 122 mm, or 15%, less than the average annual precipitation of 856 mm, coupled with the Project's water management system, (including an abundance of water available from Mesomikenda Lake, even during dry years) it is unlikely that the above scenario would occur.

Any effluent discharged from the Project site will be protective of aquatic life. In the circumstance where high runoff conditions were encountered, leading up to a dry Fall, the excess accumulated runoff would help to improve overall effluent quality. At the same time, the Project design capacity is such that it would also be possible to hold process water until an appropriate discharge period. Limited receiver assimilative capacity is therefore a readily manageable condition.

8.2.2 Potential for Excess Water Supply

During years of increased precipitation, there would be much more runoff entering the system from local catchments, which would lead to a need for increased water storage capacity and increased discharges of treated water to the environment (to Bagsverd Creek). In a 1:50 year wet annual climate condition, the Project site is projected to receive up to approximately 1,008 mm in total annual precipitation (approximately 152 mm, or 18%, more than the average annual precipitation of 856 mm). In a 1:25 wet annual condition, total annual precipitation is projected to be approximately 990 mm, and in a 1:10 wet annual condition up to approximately 959 mm. The PMP over 24 hours would be up to approximately 506 mm over a 25 km^2 drainage area (see Appendices H and I).

Excess accumulated water at the Project site during wet years can be managed two ways:

- by providing increased storage within the TMF reclaim pond or the mine water pond inventory; and/or
- by managing the effluent discharge so as not to accumulate a large system water inventory.

The Côté Gold Project water inventory storage capacity will evolve over time, especially during preparation for the ore processing plant start-up and during early phase operations, and eventually both strategies may be used to manage the system water inventory within acceptable limits. Once the ore processing plant operations commence, water inventory holding capacity will be available within the TMF reclaim pond and the mine water pond. Water within the system will be managed, with any excess treated water discharged to Bagsverd Creek.

Mine water results from the combined inputs of direct precipitation, surface runoff and groundwater inflow to the open pit. Mine water will be discharged to the mine water pond for use in processing, or to the polishing pond if there is excess water beyond that which can be used immediately for processing. Mine water directed to the polishing pond will be stored as part of the system water inventory for subsequent use in processing, with any excess water being aged for eventual seasonal release to the environment through a constructed pipeline to the Bagsverd Creek.

If groundwater flow into the open pit were to be substantively greater than that anticipated by the groundwater modelling, then there may or may not be a greater excess of system water inventory requiring discharge to the environment in any given year, depending on runoff conditions. A sensitivity analysis was carried out as part of groundwater modelling to determine the potential upper limit range of groundwater inflows into the open pit (see Appendix H). The results of this sensitivity analysis showed that the maximum annual groundwater inflow to the open pit could potentially range from 1,100 m^3/d (during Year 1 of operations) to 2,210 m^3/d (during Years 17 – 20 of operations). Additional pumping systems would be installed if needed to maintain a safe working environment, and no effect on pit wall stability is anticipated. Mine water will be discharged to the mine water pond for use in processing.

The current water management plan provides for seasonal effluent discharge to the environment. Increased minewater production would potentially increase the rate and/or period of seasonal excess effluent release but not by a large amount and not beyond the design capacity of the system. There is a high degree of confidence in the groundwater model prediction and it is extremely unlikely that groundwater production numbers will appreciably exceed the conservative upper limit sensitivity analysis results.

Therefore, the condition of excess runoff and increased mine water production in extreme wet years can be effectively managed by the proposed water management system without posing a safety hazard, and without causing a malfunction or additional environmental effects.

8.3 Potential Natural Hazards

Natural hazards that could potentially affect the Côté Gold Project given its geographic location include: extreme floods, ice jams, natural fires and earthquakes (see Section 8.3), as well as climate change (see Section 8.4). Other items identified in the EIS Guidelines as potential events (landslides and avalanches) are not likely to occur due to the relatively flat topography in the region (the region is characterized by flat clay plains, interspersed with rock knobs, ridges and eskers). The proposed Project has been planned and designed, and will be constructed and operated, with due consideration of the local environmental conditions and the potential for extreme natural hazards.

8.3.1 Extreme Floods

Extreme floods have the potential to not only flood site facilities (principally the open pit) and infrastructure but also to cause structural failure of dams. Accidents and malfunctions relating to flooding and the Project are presented in Chapter 13.

Mine water will be collected in a series of drains and sumps at the base of the open pit, which will be progressively relocated as the pit develops over time. When the pit is fully developed, mine water from the open pit and overburden seepage from the pit perimeter drainage will be pumped to the mine water pond and eventually to the ore processing plant for use as process water, at a rate of up to 2,210 m^3/d. Well field pumping and/or collection ditches may be considered to supplement mine water collection. No special handling or treatment of snow is considered, as accumulated snow in the pit will be removed with the excavated mined materials (overburden, mine rock or ore), or will melt and drain towards the installed sumps. Portions of precipitation volume during wet annual condition and probable maximum precipitation events would be stored in the open pit and pumped out in the days following a storm event. During any such period the ore processing plant feed would derive from the low grade ore stockpile so as not to disrupt ore processing. There is also the potential that mining could continue to occur above the flooded pit level. If necessary, a secondary pond system could be installed to increase stormwater management capacity.

The Côté Gold Project will have retention dams located at the TMF, Chester Lake, Clam Lake, Bagsverd Lake and Three Duck Lakes. One of these dams (located at the northern tip of Little Clam Lake) will be constructed to ensure that elevated water levels during storm events do not pose a threat to the plant site. To protect the retention dams against the risk of extreme floods, they have been designed to contain an environmental flood and the spillways will be designed to pass the probable maximum flood. The probable maximum flood is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area.

The dams are designed to include dam spillways to pass extreme floods without affecting dam stability. The spillways also have the potential to become activated for short periods of time depending on the timing of the precipitation event and dam raises. If the spillways were to become activated under extreme flood conditions, there would be no perceived effect on the connected water bodies or nearby buildings and infrastructure, as the water bodies would be capable of providing maximum assimilative capacity (following the completion of retention dams and watercourse realignments construction, the water levels of Little Clam Lake, East Clam Lake, and Clam Lake are expected to decrease, thus providing more capacity to withstand any extreme flood events).

Extreme flood events are not expected to affect the Côté Gold Project except as discussed above, and no resulting environmental effects are expected. This would be similarly true of floods of higher probability, such as the 5-year or 10-year floods which represent less extreme events.

8.3.2 Ice Jams

An ice jam (or ice dam) occurs when the upper portion of a river thaws and ice is carried downstream to a section of the river that is still frozen. The floating ice becomes blocked, forming a dam that can flood areas upstream. Once the ice jam breaks apart, areas downstream are often flooded by the sudden surge of water that breaks through the jam. Ice jams typically form in spring but can also occur in early winter when the downstream part of a river freezes first. Smaller ice jams can be artificially cleared using dynamite or other mechanical means.

Although there have been instances of flooding in the region due to heavy regional precipitation, no previous ice jams have been reported near or at the Project site. Currently, the only river that could pose a potential threat to Project components or infrastructure by way of a catastrophic ice jam is the Mollie River system that includes Clam Creek. As part of the proposed development of the open pit, Mollie River and Clam Creek will be realigned around the open pit (from Chester Lake, through Clam Lake, to Bagsverd Lake). As a result no substantial river systems are located within 200 m of any Project component, and therefore, the potential for catastrophic ice jams at the Côté Gold Project is low.

Portions of Three Duck Lakes, Chester Lake, Clam Lake will be dammed and will also require realignment to allow for the safe development and operation of the open pit. These retention dams will be designed to withstand the pressure of ice build up, and the realignment channels between Little Clam Lake and West Beaver Pond, Clam Lake and Little Clam Lake, Bagsverd Lake’s southern arm to the Weeduck Lake and Weeduck Lake to Upper Three Duck Lake, will be too narrow to pose any major ice jam threat. The watercourse realignment channels between Chester Lake and Clam Lake, and between Bagsverd Lake and Unnamed Lake #2 are wider than other Project realignment channels but are not located close enough to any Project components or infrastructure to pose a threat.

The TMF will not be subject to ice jam effects as it will have insufficient wind fetch to generate an ice jam either during operations or at closure.

8.3.3 Natural Fires

Forest fires are part of the natural regeneration cycle of the region where the Côté Gold Project is situated (Ecoregions 3E - Lake Abitibi and 4E – Lake Tamagami); with stand-replacing fire cycles ranging between 30 and 210 years (Van Sleeuwen, 2006; Crins et al., 2009). The Project site lies within a heavily forested area dominated by upland deciduous - mixedwood forest, upland coniferous forest and coniferous swamp communities. Therefore, all Project components are vulnerable to a natural fire. Accidents and malfunctions that could occur at the Project site due to fires (natural or human caused) are presented in Chapter 13. Fire suppression systems will be constructed to protect key buildings and help ensure the safety of personnel, and that multiple road and highway accesses would be available to evacuate people from site if needed. Should it be determined in the future that additional fire breaks are required, appropriate approvals will be obtained from the Ministry of Natural Resources and Forestry (MNRF).

The two transmission line alternatives are approximately 159 km (Shining Tree alignment) and 117 km (Cross-Country alignment) long and both pass through heavily forested areas along their entire lengths. Fire suppression systems will not exist along the chosen transmission line and with stand-replacing fire cycles ranging between 30 and 210 years in this area, the transmission line is vulnerable to a large fire. If portions of the transmission line were to be damaged by fire, those portions of the line would need to be repaired. Until such time, ore processing and associated operations would cease due to a lack of power. A small set of contingency transmission line poles may be stored at site to facilitate expeditious line repair in the event of fire damage to the line. The existing electrical distribution system at the Project site would still be available to provide limited power to support critical functions such as pumps at the site, in addition to emergency diesel generators.

While natural fires could have an effect on Côté Gold Project components such as the chosen transmission line, fires are not expected to cause Project-related malfunctions or accidents that would result in an additional environmental effect.

8.3.4 Earthquakes

The Côté Gold Project is situated in a low risk seismic zone (Adams and Halchuk, 2008; Adams, 2011), and accidents and malfunctions related to earthquakes and the Project are presented in Chapter 13. Nevertheless, the TMF dams have been designed to withstand the maximum credible earthquake according to the MNRF *Lakes and Rivers Improvement Act* (MNR, 2011), which is utilized in Ontario (these Ontario requirements are essentially equivalent to the Canadian Dam Association (2007) requirements). More specifically, the TMF dams have been designed to exceed the prescribed short-term, long-term and pseudo-static minimum factor of safety (see Chapter 5).

To ensure that calculated factors of safety are maintained through the construction process, the TMF dam construction (initial construction and subsequent dam raises) are required to be, and will be, completed under the supervision of a qualified geotechnical engineer. The risk of a tailings dam failure resulting from an earthquake was taken into consideration in the dam designs, and is reflected in dam construction plans.

As a result, seismic events are not expected to cause Project-related malfunctions or accidents that would result in an additional environmental effect.

8.3.5 Tornados

The province of Ontario has experienced tornados historically, though historical climate data for the region in which the Project is situated indicates that winds are normally not considered to be strong, with a maximum gust speed of 89 km/h recorded at the Chapleau weather station, to the south-west of the Project site, between 1997 and 2008 (Environment Canada, 2013). As a result, there is no reasonable potential for tornados to occur in the area.

Project components and infrastructure are being designed as per best engineering practices to ensure safe operations. Personnel will be trained to take evasive and emergency measures as part of the emergency and spill response plan in the unlikely event of a tornado at the Project site. Many of the procedures indicated under flooding and spill response would be employed as needed, including repair and follow-up inspections.

8.4 Climate Change

Climate change over the course of the life of the Project could potentially result in shifts in weather conditions (temperature, precipitation levels) and/or the frequency of extreme weather events (droughts or floods). These changes could increase the risk of environmental effects due to malfunctions and/or accidental events, however, any such changes in the climate would be minor relative to the Côté Gold Project timelines.

Various climate change assessments have been developed for northern Ontario (Colombo et al., 2007; IEEC, 2012; Racey, 2004). Virtually all of these assessments predict an increase in temperature, stable to increasing precipitation, more episodic precipitation, and an increased risk of natural fires. The primary means by which climate change has the potential to affect the Côté Gold Project is through water balance during both operations and at closure, and to a lesser extent, through the risk of natural fires.

Colombo et. al (2007) predicted changes to Ontario winter and summer temperatures and precipitation levels based on application of the Canadian Coupled Global Circulation Model for two scenarios: an ‘extreme’ scenario (with greenhouse gas levels reaching a value of 1,320 ppm by volume by 2100) and a ‘less extreme’ scenario (with greenhouse gas levels reaching a value of 915 ppm by 2100). Under the extreme scenario, these authors predicted that by the year 2100, average summer and winter temperatures for the Côté Gold Project area would increase by about 4 to 5°C and that summer precipitation rates would remain about the same as they are currently, but that winter precipitation rates would increase by about 10%. In the nearer term (2011 to 2040) they predicted that summer precipitation rates would increase by 0 to 10% and that winter precipitation rates would remain unchanged.

The more recent study (IEESC 2012) study predicts a near-term (2020 to 2049) median (50% probability) average temperature increase for the region to be between 2.3 to 2.5°C, and a longer-term (2070 to 2099) median average temperature increase to be between 5.3 to 5.8°C.

The IEESC (2012) authors predict an average annual short and long term median precipitation increase for the region to be between 3.8 to 6.6%.

There is consequently a trade-off in the prediction of temperature and precipitation increases which would tend to balance runoff conditions; with increased temperatures leading to reduced runoff and increased rates of evaporation during summer months, and increased (and more episodic) precipitation leading to increased runoff.

Runoff data from 2007 – 2012 are available from the Mollie River Water Survey of Canada station (Station 04LA006) located near the proposed open pit. The station is regulated and has a contributing watershed area of 92 km^2. Year to year runoff rates appear to be similar over the six years recoded, showing no trend of increasing or decreasing. The Minisinakwa River station (Station 04LA005) near Gogama has been operating since 2002 and shows a similar trend (little to no annual fluctuation in water levels) over the course of 11 years.

Seasonal and annual temperature and precipitation projections were collected from a number of climate change models to assess projected changes on water balance (see Appendix V). Projections were made for thirty-year average values representing the estimated future conditions in 2020, 2050 and 2080. These future years generally reflect the tri-decade periods 2005-2034 (representing 2020), 2035 to 2064 (representing 2050) and 2065 to 2094 (representing 2080). In some cases the periods 2011-2040 and 2041-2070 have also been used to represent the 2020 and 2050 period properties, respectively, depending on data availability. Estimates were developed for these three future periods and for the 5th, 25th, 50th, 75th and 95th non-exceedance percentile values across the ensemble of General Circulation Model projections of future climate (see Appendix V). These percentile values reflect the differences in projections of future climate conditions across the climate models and are a conservative means of addressing uncertainty. The model uses the extremes in the distribution of results to represent minimum bounds of possible future conditions. In this approach, the 5th and 95th percentile values would be used to characterize the lower and upper bounds of the possible changes in the annual water balance. The projected change in climate in conditions is determined for each climate projection by comparing the climate condition during the overlap period from the climate condition at some future point in time, and applying that projected change to historical conditions.

The Intergovernmental Panel on Climate Change (IPCC) recognized climate model outputs available on the Environment Canada’s Canadian Climate Change Scenario Network (CCCSN) website for the grid cell encompassing the study area. Project increases in annual precipitation for the Gogama area (CCCSN, 2009) are summarized in Table 8-1 (based on data from the weather station at Timmins Airport (#6078285; see Appendix V). Increases in seasonal precipitation are also expected for the winter and spring, with larger increases further into the future. Projected increases for the 2050 time frame are very sensitive to the base ensemble, but point to potential major increases in total precipitation over the winter and spring and decreases in total precipitation over the summer months in some cases.

Table 8-1: Summary of Total Precipitation for Gogama

Time Period/ SRES Scenario	Total Precipitation (mm)				
	Annual	Winter	Spring	Summer	Autumn
1971-2000	833.0	151.9	181.4	264.0	235.8
SR-B1 (Low)					
2020's	862.1 ± 25.7	162.0 ± 7.6	193.0 ± 9.9	265.1 ± 16.1	241.2 ± 12.0
2050's	883.6 ± 43.9	167.6 ± 8.8	201.2 ± 11.8	268.5 ± 27.3	245.2 ± 16.8
2080's	898.3 ± 29.3	173.8 ± 8.7	206.1 ± 12.5	266.7 ± 18.1	248.6 ± 13.7
SR-A1B (Medium)					
2020's	868.5 ± 29.9	162.5 ± 7.1	193.6 ± 10.1	269.0 ± 15.6	242.9 ± 16.2
2050's	897.5 ± 37.8	171.4 ± 10.6	204.6 ± 15.6	267.5 ± 23.1	252.3 ± 16.1
2080's	921.0 ± 48.7	177.9 ± 13.5	217.5 ± 19.8	265.1 ± 32.5	257.4 ± 19.5
SR-A2 (High)					
2020's	865.7 ± 26.7	159.5± 5.6	194.9 ± 12.8	268.8 ± 12.2	241.4 ± 15.0
2050's	897.7 ± 33.8	173.9 ± 9.0	205.1 ± 13.2	262.6 ± 19.3	252.2 ± 15.5
2080's	932.6 ± 62.3	187.4 ± 13.9	224.1 ± 25.7	257.1 ± 37.2	259.1 ± 23.9

Source: CCCSN website

The CCCSN has produced a summary of findings from the most recent IPCC AR4 (2007) modelling assessment for Canada. Twenty-four international modelling centres have contributed to the international dataset. The output used in this analysis is a mean ensemble from all available international modelling centres, although not all centres have produced runs for all emission scenarios. Results for the grid in which the Project is located are summarized in Table 8-2. The two sets of results are consistent in suggesting that precipitation in the summer months will not change significantly, and only will increase marginally in the fall months but will increase significantly in the winter and spring.

It should be noted that annual average rainfall and heavy rainfall (as defined for this analysis) are not the same; nonetheless, the expectation of increased seasonal rainfall in the future suggests the potential for more extreme rainfall events, particularly in the winter and spring.

Table 8-2: Projected Changes in Precipitation

Time Period	Change in Total Precipitation (%)				
	Annual	Winter	Spring	Summer	Autumn
National AR4-A1B Ensemble Seasonal and Annual Precipitation Change (1971-2000 baseline)					
2020's	4.1	7.0	6.5	1.8	2.5
2050's	7.6	12.8	12.5	1.3	6.7
2080's	10.5	17.6	19.5	0.5	8.7
2050's Ensemble Seasonal and Annual Precipitation Change (1961-1990 baseline)					
Low	5.9	10.5	10.8	1.0	4.4
Medium	6.5	11.9	11.5	0.5	5.3
High	7.0	13.0	11.8	0.5	5.8
CRCM[1] High	12 to 14	25 to 30	25 to 30	10 to 15	0 to 5

Source: CCCSN website
[1] Note: CRCM – Canadian Regional Climate Model

From this assessment, it is clear that the overall effect of climate change across the complete ensemble of climate change projections on the Côté Gold Project site will be a net increase in the overall water balance of between 29 mm (by 2020) and 99 mm (by 2080). There is also the potential for a higher degree of episodic precipitation events leading to pulses of higher than usual runoff. However, based on the results of this assessment, water balance determinations which have been used in the design of the Côté Gold Project water management system and closure strategy (include flooding of the open pit) are unlikely to change during the life of the Côté Gold Project (2015 – 2034), and are also unlikely to change appreciably over the longer-term, within the accuracy of predictive models (see Appendix V).

Three different rainfall definitions are used for design purposes in Ontario as outlined below. Each supports different aspects of design and regulation and has the potential to be influenced differently under anticipated climate change.

1. Stormwater management planning in Ontario is based on Ministry of Environment and Climate Change guidelines which direct the use of 2 through 100 year intensity-duration-frequency (IDF) curve based rainfall estimates for design. An IDF curve is a tool that characterizes an area's rainfall pattern. By analyzing past rainfall events, statistics about rainfall re-occurrence can be determined for various standard return periods; for example, the size of rainfall event that statistically occurs every 10 years. For context, the current 24 hour 100 year return period design rainfall for weather stations in the vicinity to the Project; namely, Chapleau, Timmins, and Sudbury are 110.1 mm, 113.9 mm and 98.6 mm, respectively.

   It should be noted that the published IDF relationships are computed for a single station based solely on historical data and do not include any element of trend analysis or climate change projection. The last update of the IDF data for stations across Canada was completed in February 2012.

   The selected design rainfall event for stormwater management at the Project will depend on the type of feature (e.g., culvert, emergency spillway) and the guidelines and legislation associated with the installation of the feature (e.g., Lakes and Rivers Improvement Act).

2. The MNRF defines a Regulatory Storm based on a review of all extreme rainfall events in the Province for the purpose of flood plain management. The present definition of the Regulatory Storm, specific to different areas of the Province, is outlined in the Lakes and Rivers Improvement Act (LRIA) as follows:

   - Zone 1 - the peak flow resulting from the Hurricane Hazel Storm (using hydrological modelling) or the 100 year flood (based on single event hydrological modelling using the 100 year rainfall as input or a statistical analysis of recorded stream flows to determine the peak flow associated with a 100 year event);

- Zone 2 - the 100 year flood; and
- Zone 3 - the peak flow resulting from the Timmins Storm or the 100 year flood, whichever is greater.

The Project is located in Zone 3 for Regulatory Storm definition. The Hurricane Hazel Storm (October 1954) and the Timmins Storm (August 1961) are recorded events with total rainfall volumes of approximately 200 mm over 12 hours. Currently, the Regulatory Storm is not used as a design basis for infrastructure for this Project. However, the Regulatory Flood will be considered should further detailed engineering suggest that this is potentially a critical storm event.

3. The World Meteorological Organization defines PMP as "the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location, at a particular time of year, with no allowance made for long-term climatic trends" (WMO, 1986). It should be noted that the PMP represents a theoretical maximum. The current PMP estimate for Ontario (MNR, 2011), as defined in the LRIA, is in the range 405 mm (6 hour event) to 460 mm (48 hour event). The revised draft PMP estimates for Ontario (MNR, 2006) define PMP estimates at the Project ranged from about 460 mm (6 hr event) to about 505 mm (24 hr event) and about 520 mm (48 hr event). It should also be noted that, although the revised PMP estimates for Ontario have as yet to be integrated into the LRIA, it is expected that this will occur with a future revision of the LRIA.

   The design basis for stormwater management the Project uses the revised draft PMP estimates for Ontario (MNR, 2006). It is anticipated that the PMP will be used in the context of the Project development to evaluate dam safety considerations.

The potential for increased occurrence of forest fires has implications primarily for the transmission line as indicated in Section 8.3.3; but any such implications due to climate change would be minor because of the comparatively short-term duration of the Côté Gold Project relative to climate change scenarios.