March 29, 2017

MARINE ENVIRONMENTAL MANAGEMENT PLAN (MEMP)

Appendix D

Submitted to:
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REPORT

Report Number: Doc 613-1671431
Distribution:

1 copy - Agnico Eagle Mines Limited
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Golder Associates

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ATTACHMENTS

Acronyms

Agnico Eagle	Agnico Eagle Mines Limited
BTEX/VPH	benzene, toluene, ethylbenzene, o-xylene, m-xylene, p-xylene/Volatile Petroleum Hydrocarbons
CCG	Canadian Coast Guard
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
ECSAS	Eastern Canada Seabirds at Sea
ECCC	Environment and Climate Change Canada
ERT	Emergency Response Team
EPH	Extractable Petroleum Hydrocarbon
IQ	Inuit Qaujimajatuqangit
JNCC	Joint Nature Conservation Committee
MEMP	Marine Environmental Management Plan
MMSO	Marine Mammal and Seabird Observer
PAHs (parent)	Polyaromatic Hydrocarbons
QEP	Qualified Environmental Professional
RSA	Regional Study Area
SOPEP	Shipboard Oil Pollution Emergency Plan
TOC	Total Organic Carbon
TK	Traditional Knowledge
UTM	Universal Transverse Mercator
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

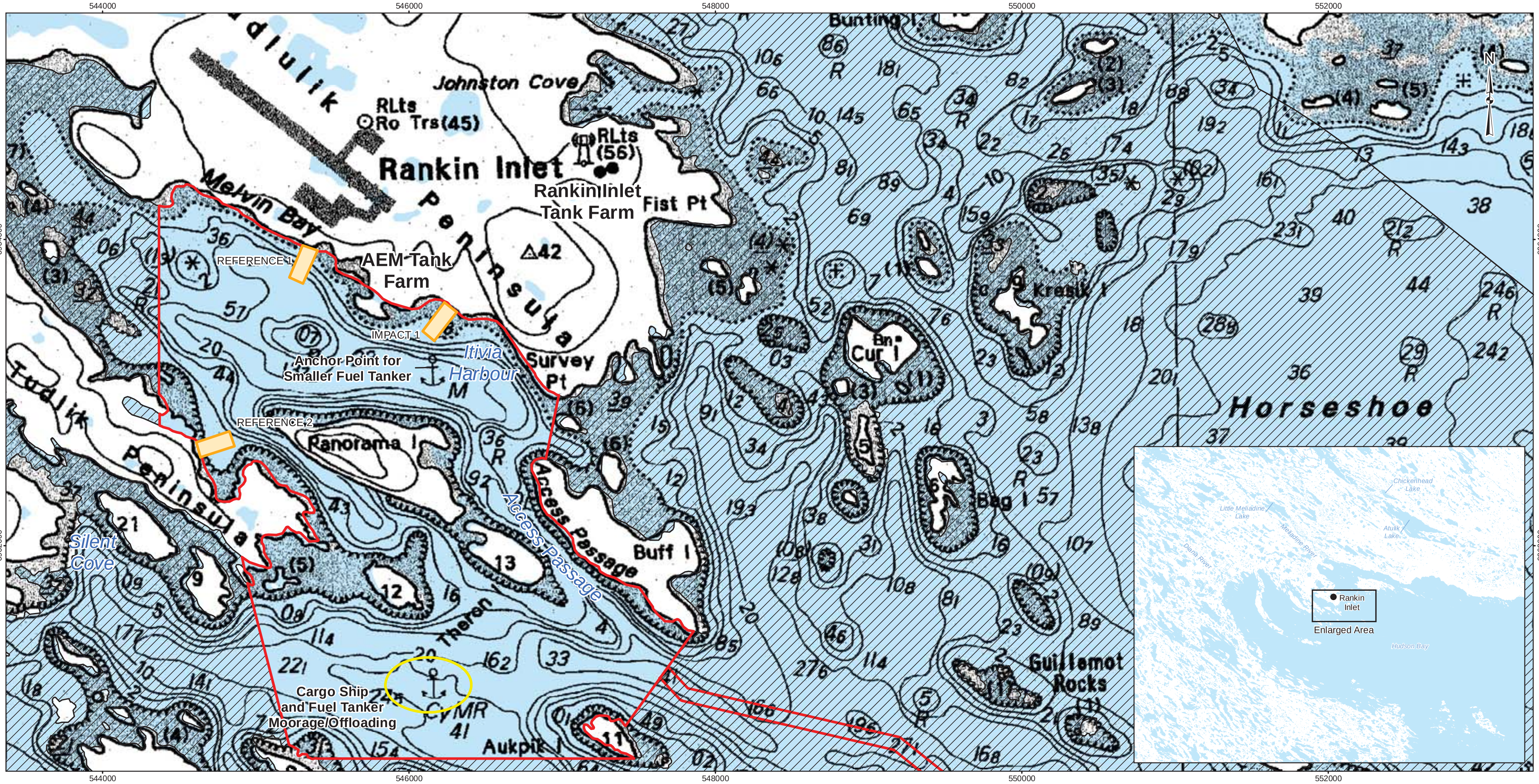
Agnico Eagle Mines Limited (Agnico Eagle) plans to ship approximately 40,000 tonnes of dry cargo (equipment and supplies) and 122 million litres of diesel fuel annually for the operations of the Meliadine Gold Mine in Rankin Inlet, Nunavut (the Mine). To meet these needs, approximately 8 ships per year will be needed to deliver dry cargo and up to 4 additional ships per year to deliver fuel. All shipping will be carried out during the open water season (typically from early July to late October) and will follow recommended shipping routes that are presently in use for the annual sea lift to Rankin Inlet and other communities (Figure D-1 and Figure D-2). The Mine will not involve any ice breaking to extend the shipping season. This Marine Environmental Management Plan (MEMP) has been developed for the Mine to meet the Terms and Conditions of the Project Certificate related to shipping activities and potential marine spills. It should be considered a living document that can be updated throughout the Mine lifecycle in order to implement adaptive management techniques. Updates shall be made in consultation with the relevant regulatory agencies (e.g., DFO, CWS, and the Government of Nunavut) as appropriate.

The MEMP has been designed to provide protocols for conducting a vessel-based Marine Mammal and Seabird Observer (MMSO) program during all routine shipping activities in the Local and Regional Study Area (LSA and RSA) and for conducting monitoring of marine wildlife and their habitats (wildlife defined as mammals, fish, and birds - including upland birds, migratory birds, waterbirds, raptors, and seabirds) in the event of any Mine-related fuel spill in the RSA.

During routine shipping operations, Mine-specific mitigation measures designed to minimize Mine impacts on marine mammals and seabirds will be initiated by vessel-based MMSOs and implemented by the ship's crew. In the event of a spill, the shipping contractor will be responsible for retaining a qualified environmental professional (QEP)[1] to implement the wildlife monitoring framework described below. The MMSO will work with the QEP to provide on-site information as required.

Data collected by the MMSOs will provide information to the Government of Nunavut and other applicable regulators (e.g., Canadian Wildlife Service) regarding the location, behaviour, abundance, and species observed as well as any interactions with Mine vessels during shipping activities in the RSA.

[1] An applied scientist or technologist who is registered and in good standing with an appropriate professional organization constituted under an Act. The QEP must be acting under that association's code of ethics, and subject to the organization's disciplinary action. The QEP should have experience in the area of interested. In this case the area of interest includes marine spill response monitoring for marine mammals, birds fish and their habitats.



LEGEND

- BASELINE SAMPLING AREA
- MOORAGE AND OFFLOADING
- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- BATHYMETRIC DEPTH CONTOUR
- WATERBODY

REFERENCE

BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED (AEM). BASELINE SAMPLING OBTAINED FROM NUNAMI STANTEC ON BEHALF OF AGNICO EAGLE MINES LIMITED (AEM). ATLAS OF CANADA DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. COUNTRY BACKGROUND DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: UTM ZONE 15

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
MARINE LOCAL STUDY AREA

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	25 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	MH	15 Mar. 2018		
CHECK	PR	18 Jan. 2013	FIGURE D-1	
REVIEW	DW	18 Jan. 2013		

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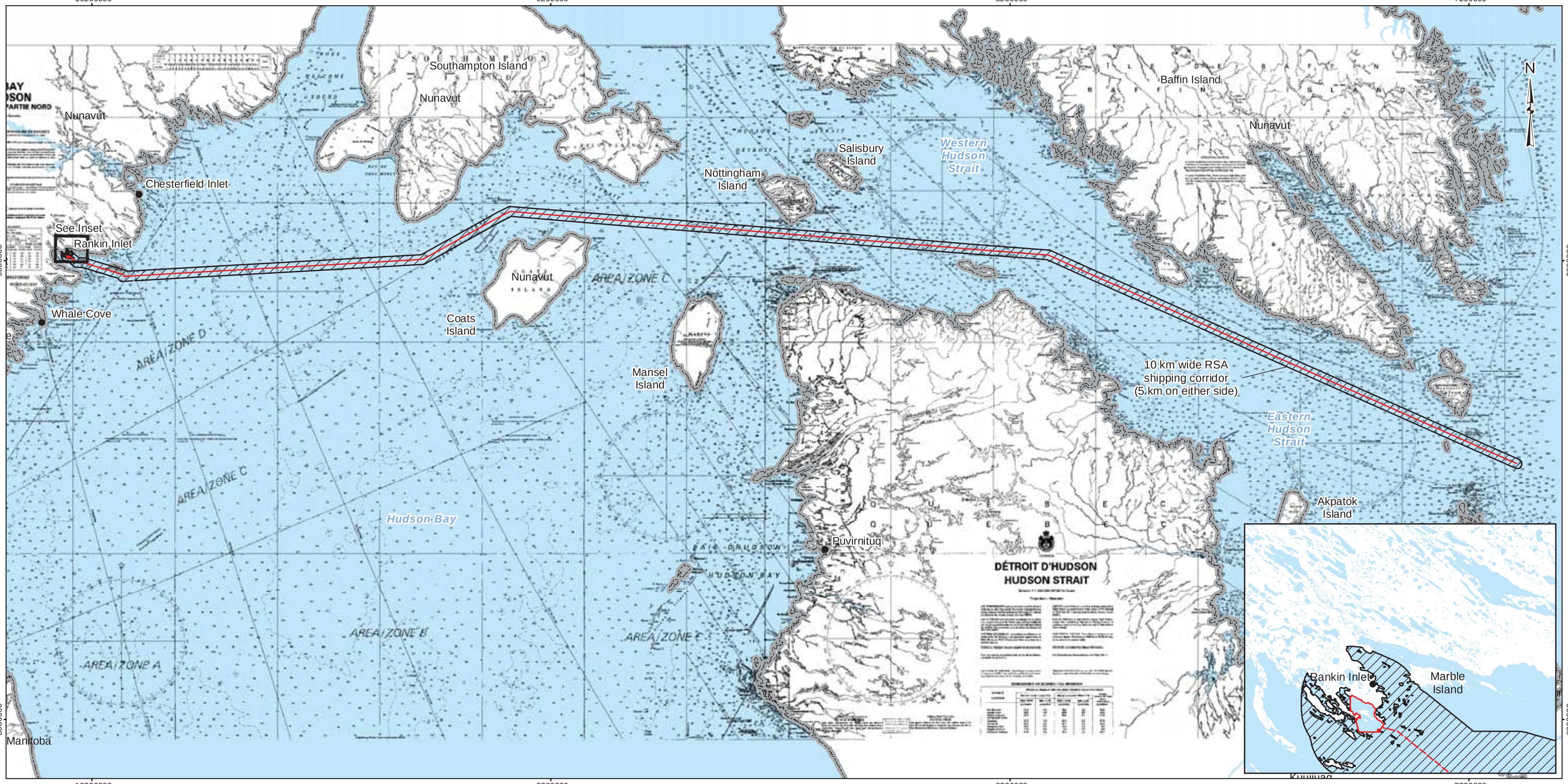

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA) (SEE INSET)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- ● COMMUNITY
- WATERBODY

REFERENCE

BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED (AEM).

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: WGS 84 PROJECTION: WORLD MERCATOR

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
MARINE REGIONAL STUDY AREA

Golder Associates

PROJECT NO.		1535029	FILE No.	
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GIS	DSC	18 Jul. 2012		
CHECK	PR	18 Jan. 2013	FIGURE D-2	
REVIEW	DW	18 Jan. 2013		

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2.0 MARINE MAMMAL AND SEABIRD OBSERVER PROGRAM

2.1 Routine Shipping Operations

This section outlines the protocol for undertaking a vessel-based Marine Mammal and Seabird Observer (MMSO) program involving full-time marine wildlife monitoring during all routine shipping activities in the LSA and RSA (Figure D-1 and Figure D-2) in accordance with Project Certificate Condition 82, which states the following:

"The Proponent shall require all contracted shipping companies to provide full-time marine wildlife monitoring using trained observers and established data collection and recording protocols. Monitoring plans should include provisions for all Species at Risk Act (SARA) and for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed species (birds and mammals)."

The seabird survey protocols were revised in February 2017 to include specific survey protocols for seabirds as laid out in Section 4.0 of the Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms.

A review of relevant marine mammal survey protocols was also undertaken and the marine mammal survey protocols were revised based on the following guidance documents:

- Guidelines for Minimising the Risk of Disturbance and Injury to Marine Mammals from Seismic Surveys (JNCC 2010).
- Recommended seabird and marine mammal observational protocols for Atlantic Canada (Moulton and Mactavish 2004)

The MMSOs will record marine mammal and seabird observations based on the protocols presented below through the LSA and RSA (Figure D-1 and Figure D-2). Datasheets outlined in Attachment A and Attachment B and daily reports outlined in Attachment C will be completed throughout the transit, copied for backup purposes and provided to Agnico Eagle upon arrival in Rankin Inlet or, when transiting from Rankin Inlet, will be provided as online communications allows, once the vessel has exited the RSA. Additional reporting requirements in the event of a spill are outlined in Section 2.2.1.5.

2.1.1 Observer Qualifications and Training

Appropriately qualified MMSOs should be selected based on their knowledge and experience with the MMSOs protocols laid out below. Previous wildlife observation field experience will be considered an asset during the MMSO selection process. Depending on the level of experience of the selected MMSO, a MMSO training session(s) will be considered and will be completed by qualified/certified marine wildlife observers with previous arctic wildlife monitoring experience. The training, if required, will review the monitoring protocols outlined below and provide instruction on how to spot and identify marine mammal and seabird species.

Primary objectives of the training will could include the following, dependent on the expertise of the MMSOs:

- Role and responsibilities of MMSOs;
- Review of the MEMP including mitigation measures;
- Health, Safety, and Environment;

- Review of marine mammal and seabird species identification (including upland birds (including migratory birds), waterbirds, raptors, as well as seabirds) observation, identification, and distance estimation methods;
- Review of operation of MMSO equipment (reticle binoculars, GPS system);
- Distances estimation techniques for various scenarios (reticle binoculars, no horizon);
- Review of, and classroom practice with, data recording and data entry; and
- Reporting templates and requirements.

2.1.2 Program Protocol

Mitigation measures outlined in Section 4.2 of the Shipping Management Plan will be implemented during all Mine shipping activities by the shipping contractor(s). MMSOs will not be directly responsible for implementing mitigation measures. The role of the MMSO is to record and report on marine mammals and seabird sightings during shipping activities, and to advise the contractor (i.e., captain and ship crew) on the location of observed marine mammals and if any action is recommended based on mitigation measures outlined in the Shipping Management Plan.

The following protocol will be implemented during the MMSO program:

- A minimum of one trained MMSO will be present on-board the Mine shipping vessels during all transits within the RSA;
- The MMSO will conduct marine mammal and seabirds observations in the RSA from the bridge during daylight hours as described in Section 2.1;
- The MMSO will observe and record sightings of marine mammals and birds during vessel movements in the RSA (including upland birds, migratory birds, waterbirds, raptors, and seabirds) as well as environmental conditions as described in Section 2.1;
- A communication plan will be established between the MMSO(s) and the ship's crew in order to provide information regarding marine mammal and seabird sightings;
- The shipping contractor will initiate mitigation measures designed to minimize Mine impacts on marine mammals and seabirds, as identified in the Shipping Management Plan; and
- MMSOs will assist in observing for marine mammals and seabirds in the event of a spill (see Section 2.2).

The MMSO program will allow for the opportunity of adaptive management techniques to be implemented if monitoring identifies potential for adverse effects on marine wildlife along the shipping route. This may include modification of mitigation measures in response to new information arising from the monitoring carried out by the MMSO and vessel crew. Adaptive management will be conducted in consultation with the Kivalliq Inuit Association, the Hunters and Trappers Organizations of the Kivalliq communities, and the relevant regulators.

2.1.3 Marine Mammal Observing Protocols

Dedicated marine mammal observations will be conducted in the RSA. The protocol outlined in this section are best conducted along a transect line, therefore, it is best to start a marine mammal observation period when the vessel is and will be moving in a straight line for an extended period of time. Note the time and location (GPS) of the start and end of each observation period as well as the vessel speed (in knots). If vessel speed or direction changes significantly during the observation period, record the time and location and the change.

Observer Position

Observations will be done from a high location on the vessel and ideally outdoors if possible and will be conducted at the same location each time. For marine mammal observations with a single observer, the MMSO will position themselves in the middle of the ship at the front (bow) to observe marine mammal on both the starboard and the port side (Figure D-3).

Observation Period

MMSO observation periods (marine mammal and seabird observations) should not last longer than 2 hours to mitigate observer fatigue and eye strain, and a MMSO observation day should not exceed 12 hours. Based on these requirements, dedicated marine mammal observations will be conducted over a 1.5 hours period following a seabird survey (approximately 30 minutes). A suggested MMSO schedule for moving and stationary ships is provided below in Table D-1 and Table D-2.

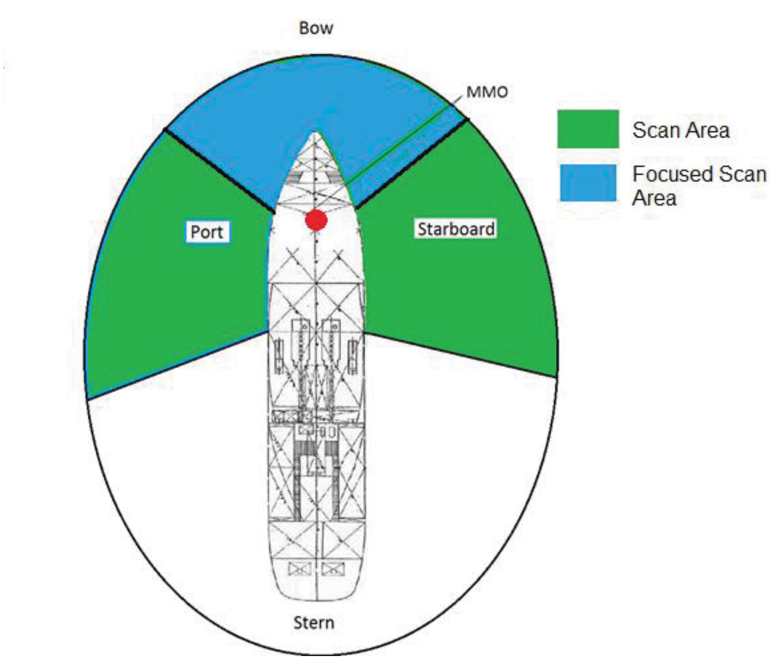

Figure D-3: MMSO position and respective observation field on a hypothetical ship

2.1.3.1 Scan Routine

The following scan routine should be conducted throughout the marine mammal observation period. Scan the water with the naked eye and use binoculars only to focus on possible sightings. Perform S and U scans of the observation field about every 20 seconds (Figure D-4). The most important aspect of marine mammal observing is to constantly scanning the observation field to capture animals that could be located in the peripheral view for brief moments (e.g., surfacing). Scans should be made from the middle of the vessel (for one MMSO) and cover the scan area shown in Figure D-3 with a focus on the water ahead and to the side to the moving vessel (e.g., focused scan area in Figure D-3). If the vessel is stationary (e.g., anchored) scans should be conducted over the entire scan area (e.g., blue and green in Figure D-3) in a uniform fashion. When the vessel is stationary, less priority can be attributed to marine mammal observations and the MMSO can switch to an observation schedule similar to that shown in Table D-2.

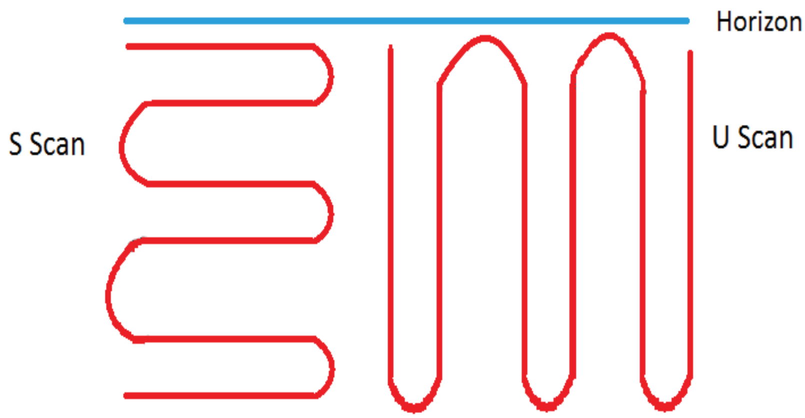

Figure D-4: S and U scanning techniques

All marine mammals observed during the dedicated marine mammal observational periods as well as incidental sightings will be recorded including GPS location, distance to animal, angle to animal, number of individuals, species, behaviour etc. (see Section 2.1.5.2 below). If a species is unknown or if a blow is the only detection of the animal observed, then mark the sighting as unknown. Marine mammals in large groups that are close together should be marked as a single sighting. When possible, photographs of marine mammal sightings will be taken and recorded alongside sightings records.

Angle to a marine mammal or group of marine mammal can be calculated using a Pelorus or by estimating the angle with an angle board. Figure D-5 shows how an angle to a marine mammal from the vessel should be estimated.

On-effort sightings should be recorded by the MMSO only, with no assistance permitted by other crew members. If additional sightings are made by other crew members or if sightings are made outside the designated marine mammal observation period (see Table D-1) then these sighting should be marked as incidental sightings on the marine mammal sighting record (Attachment A). Sightings of pinnipeds hauled-out on land will be recorded as off-effort sightings. Bow-riding dolphins or porpoises are also not recorded as on-effort sightings unless they are observed prior to their initial approach to the vessel (as it was assumed that the sighting of a bow-riding cetacean was not random but rather influenced by the presence of the vessel). Bow-riding dolphins or porpoises are recorded as incidental (off-effort) sightings.

All efforts will be made to avoid double counting individuals or groups of individuals. If a marine mammal is counted twice in the sightings record, then a note of a re-sighting should be marked. Additional information to be collected for marine mammals is outlined in Section 2.1.5.2 below.

Table D-1: Example of Daily MMSO Schedule – Moving Ship

Time of Day (24 hour Clock, UTM)	Shift Type
7:00	Seabird
7:30	Marine Mammal
8:00	Marine Mammal
8:30	Marine Mammal
9:00	Break
9:30	Break
10:00	Seabird
10:30	Marine Mammal
11:00	Marine Mammal
11:30	Marine Mammal
12:00	Break
12:30	Break
13:00	Seabird
13:30	Marine Mammal
14:00	Marine Mammal
14:30	Marine Mammal
15:00	Break
15:30	Seabird
16:00	Marine Mammal
16:30	Marine Mammal
17:00	Marine Mammal
17:30	Break
18:00	Daily Reporting
18:30	Daily Reporting

Table D-2: Example of Daily MMSO Schedule – Stationary Ship

Time of Day (24 hour Clock, UTM)	Shift Type
7:00	Seabird
7:30	Marine Mammal
8:00	Seabird
8:30	Marine Mammal
9:00	Break
9:30	Break
10:00	Seabird
10:30	Marine Mammal
11:00	Seabird
11:30	Marine Mammal
12:00	Break
12:30	Break
13:00	Seabird
13:30	Marine Mammal
14:00	Seabird
14:30	Marine Mammal
15:00	Break
15:30	Seabird
16:00	Marine Mammal
16:30	Seabird
17:00	Marine Mammal
17:30	Break
18:00	Daily Reporting
18:30	Daily Reporting

Notes: The full 30 minutes may or may not be used for seabird surveys depending on the survey method implemented. Further details are described in Section 2.1.4 below.

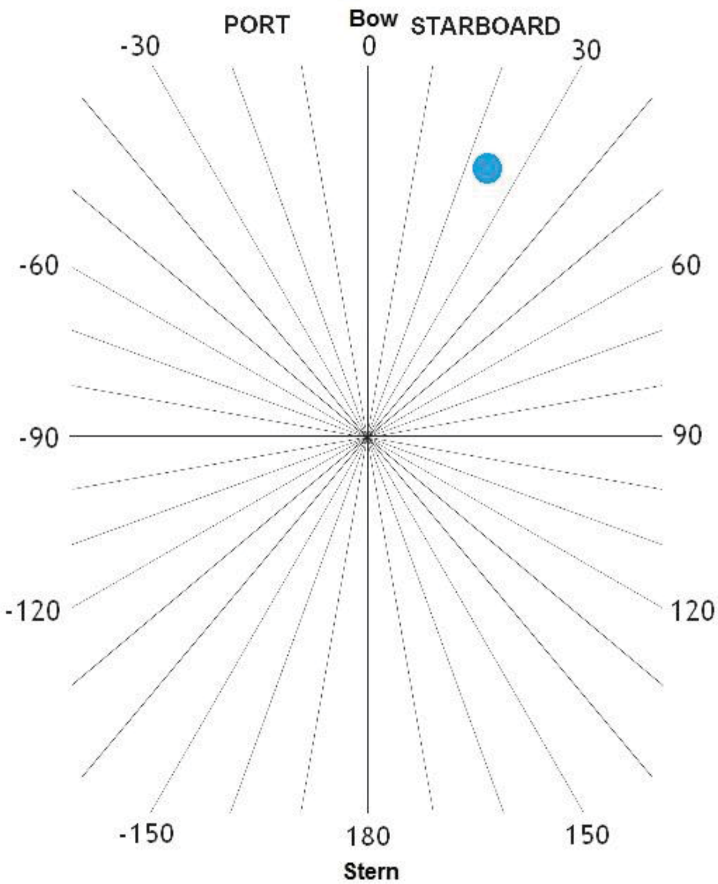

Figure D-5: Angle to Marine Mammal (blue dot) is approximately 22°

2.1.3.2 Estimating Distance

Observers should practice estimating the distance bands prior to beginning surveys. This can be accomplished by using reticle binoculars as described below or with a distance gauge made from a transparent plastic ruler (see Attachment B).

Record the distance to each marine mammal or group of marine mammal (to the centre of the group). For all marine mammals, estimate the angular distance between the marine mammal(s) and the observer.

Using Reticle binoculars

Reticle binoculars have a built in scale called a reticle (Attachment B). Estimating distances to marine mammals using reticles is based upon the distance to the horizon which is dependent on:

- the height of the observer eye above sea level in meters; and
- radians per reticle mark for the type of binoculars.

The height of the eye includes the height of the platform above the surface of the water. The number of radians (usually milliradians[2]) will depend on the type of reticles binoculars that are used. The number of radians per reticle mark can be used to produce a distance table based on an equation provided by the binocular manufacture. An example of an equation provided by Fujinon 2006 is:

Distance = (eye height + height above sea level in meters) x 1000 / # of milliradians

Reticle binoculars cannot be used to estimate distance if the horizon is obscured (by fog or land), or if they are used from a different height above sea level. Their use becomes minimal in nearshore waters.

2.1.4 Seabird Survey Protocols

Seabird survey will be conducted in the RSA. The protocols laid out bellow were extracted and adapted from the Canadian Wildlife Service (CWS) standardized protocol for pelagic seabird surveys from moving and stationary platforms (Gjerdrum et al. 2012).

Observer Position

Observations should be done from a high location on the vessel, when possible, at a location as close to the edge of the platform as possible to increase the detection of seabirds, especially for individuals that use the waters at the base of the vessel. All surveys should be conducted at the same location each time.

2.1.4.1 Survey Protocol – Moving Vessel

Transect Methods

Moving vessel seabird surveys should be conducted along a transect line when the vessel is and will be moving along a straight line for an extended period of time. Note the time and location (GPS) of the start and end of each survey period (described below) as well as the vessel speed (in knots) as laid out in the seabird survey sighting form (Attachment B).

During transect surveys, the observer is to look forward from the vessel, scanning at a 90° angle from either the port (left) or starboard (right) side depending where he or she is located. The transect width within seabirds are recorded is 300 m from the side of the vessel (see Figure D-6). Scan ahead regularly (e.g., every minute) to spot birds that may dive as the vessel approaches.

All birds observed within this 300 m transect, whether flying or on the water, are recorded and are considered in-transect sightings. The methods for recording birds on the water verses birds in flight are outlined below. All five minute surveys should begin with a snapshot survey to capture flying birds. The perpendicular distance from the line to the seabirds detected on the water or in flight is estimated for each sighting. Birds observed outside the 300 m transect are also recorded if this does not affect observations within the 300 m transect. Distance categories "E" and "T" in Figure D-6 are both considered not in transect. Binoculars and spotting scopes can be used to confirm species identification and other details as necessary. Information that will be collected during each sighting is outlined in Section 2.1.5.4.

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[2] unit of angular measurement

Moving platform transect survey are best conducted when travelling at a minimum of 4 knots (7.4 km/h) and a maximum of 19 knots (35.2 km/h). These surveys can be done when the ship is travelling less than 4 knots, but birds are often attracted to slow moving or stationary ship. If birds are clearly gathering around the ship and settling on the water when the ship is moving at decreased speeds cease the surveys until the ship resumes a higher speed. If the ship is no longer moving (e.g., anchored or on standby) switch to the stationary platform survey methods described below.

Observation Period

Each seabird survey period will be conducted during six consecutive five-minute periods which is repeated three times a day to capture morning, afternoon and evening periods (see Table D-1). These five minute surveys should be dedicated to surveying for seabirds only. These surveys should be completed regardless if birds are present or not. If the vessel is not moving (stationary), use the method for stationary vessel described in Section 2.1.4.2 below.

Short breaks should be taken at the end of each five minute period to record the vessel's position and any conditions that may have changed since the last five minute survey period. If ship speed or direction changes significantly the survey period, record the time and location (GPS), cease the current survey and begin a new five minute survey period.

The frequency of the seabird surveys outlined in Table D-1 has been selected to provide time for the MMSO to:

- have dedicated seabird and marine mammal observation periods (as described above);
- take necessary breaks to avoid observer fatigue; and
- conduct daily reporting.

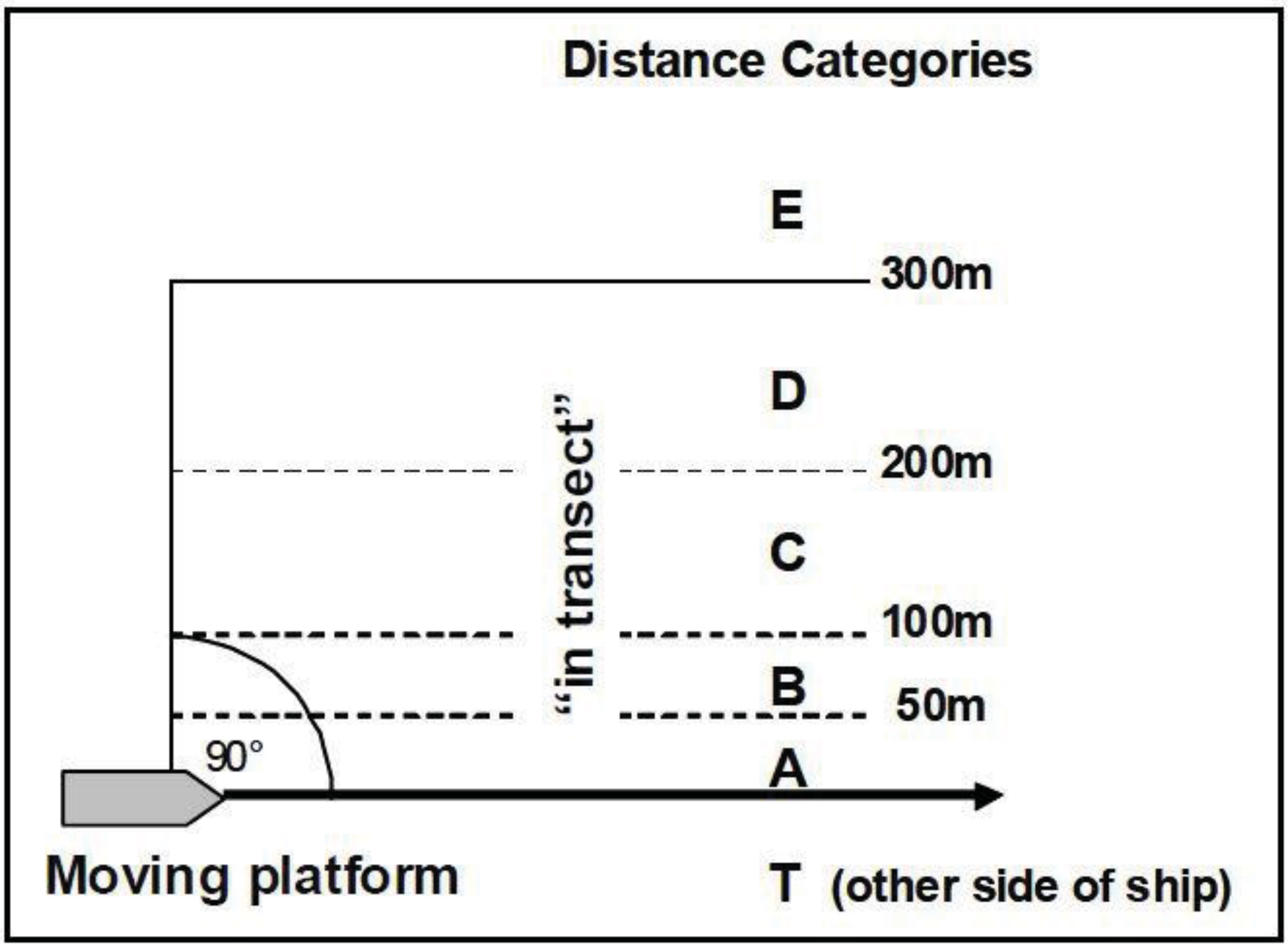

Figure D-6: Illustration of a survey using a 90° scan, covering a 300 m transect from a moving platform (extracted from Gjerdrum et al. 2012)

Birds on the Water

All birds observed on the water are continuously recorded throughout the five minute survey period. If birds in the transect fly off the surface of the water as the vessel approaches, use binoculars to help count them, and record these birds as being on the water as outlined in the seabird survey sighting form (Attachment B). These birds are not subsequently counted as a flying bird during a snapshot survey (described below for flying bird).

Birds on the water may be observed up ahead of the platform, perhaps as far as 400 m or 500 m, but still within the 300 m transect (Figure D-6). Because these individuals may dive or fly away as a result of the approaching ship, they should be counted as in transect and their perpendicular distance recorded when they are first observed. If the five minute survey will end before the ship reaches them they should be recorded in the next five minute survey period.

Birds in Flight – Snapshot method

All five min surveys should begin with a snapshot of flying birds. Flying birds are not recorded continuously throughout the five minute survey period as with birds on the water, as this would overestimate bird density. Create a routine of snapshot counts to record flying birds during the survey period. Only use the snapshot method when there are many birds observed flying in the area. The number of snapshots done will depend on the speed of the vessel (Table D-3).

During each snapshot, record flying birds as in transect if they are flying above the 300 m transect. Record all other flying birds that are seen outside of the 300 m transect or between snapshot intervals as not in transect.

Some species may fly in long lines across the 300 m survey transect. At the time of the snapshot, the number of birds in the flock is recorded and the distance class is assigned according to the location of the centre of the flock. All the birds in the flock are recorded as in transect if the centre is within the 300 m transect. If the centre of the flock is outside the 300 m transect, all birds are recorded as not in transect.

Large Groups of Birds

When very large numbers of birds are encountered that overwhelm the observer's ability to count the number of birds and measure the distance to flocks the snapshot method can be used to count all birds in flight and on the water. If this protocol is used, note the change in protocol on the seabird survey sighting form (Attachment B). If it is not practical to estimate distance to each bird or flock of birds, the observer should at least indicate whether the birds were observed in or out of transect. If it is not practical to note which birds are on the water and which are in flight use the following guidelines:

- If the majority of the birds are in the air, they can be recorded as flying.
- If birds appear first on the water and then fly away as the vessel approached, or they continuously move between the water and air, recorded them being as on the water.

Birds that follow the Vessel

To avoid double counting birds, once a bird is recorded in-flight it is not subsequently recorded again if it follows the ship and it is not recorded on subsequent snapshots. If many birds are following the vessel and it becomes difficult to determine which individuals have already been recorded, the number of birds following the ship can be estimated and recorded at regular intervals (i.e., in between each five minute survey or as possible).

Table D-3: Intervals at Which Instantaneous or "Snapshot" Counts of Flying Birds Should be conducted during a Moving Vessel Survey

Platform Speed (knots)	Interval Between Counts (minutes)
<4.5	2.5
4.5 – 5.5	2.0
5.5 – 8.5	1.5
8.5 – 12.5	1.0
12.5 - 19	0.5

Poor Visibility

When a survey period cannot be done because of poor visibility (i.e., when the entire width of the 300 m transect is not visible), the extent of visibility should be noted on the seabird survey information form.

Observation Periods with no birds

If no birds are observed during a five minute survey period, “no seabirds observed” must be noted on the seabird survey information form.

2.1.4.2 Survey Protocol – Stationary Vessel

Scan Method

Surveys while the vessel is stationary (e.g., on standby or anchored) are done using instantaneous counts, or “snapshots” of birds within a 300 m “semi-circle” area from the vessel. These surveys are conducted by scanning through a 180° arc, limiting observations to a semi-circle around the observer (Figure D- 7)

The area should be scanned from one side to the other, and all seabirds on water and in flight that are observed within 300 m are systematically recorded. Birds visible beyond 300 m are also, if possible. The distance to seabirds (inside and outside the 300 m area) from the observer is estimated and recorded for all birds. Birds observed outside the 300 m semi-circle are recorded as not in semi-circle on the seabird survey information form. Binoculars and spotting scopes can be used to confirm species identification and other details as necessary.

Observation Period

When the vessel is stationary, less priority can be attributed to marine mammal observations. Therefore, scans should be completed once every hour when the vessel is stationary (Table D-2). The length of each scan will depend on the number of birds present at the time of the scan (e.g., it may only last a few seconds if there are no birds present).

Poor Visibility

When an observation period cannot be done because of poor visibility (i.e., when the entire width of the 300 m transect is not visible), the extent of visibility should be noted on the seabird survey information form.

Observation Periods with no birds

If no birds are observed during a five minute survey period, “no seabirds observed” must be noted on the seabird survey information form.

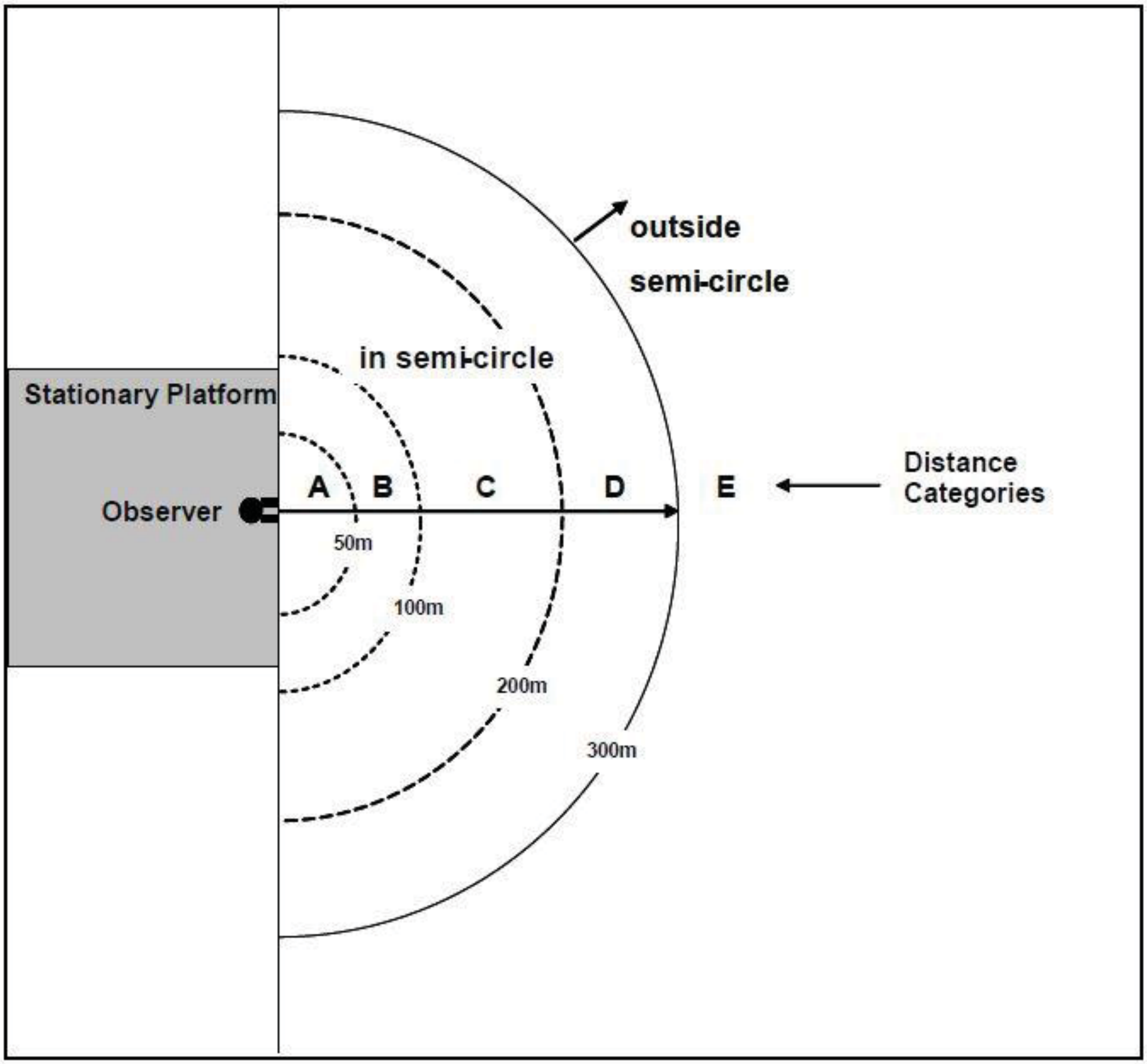

Figure D- 7: Survey using an 180º scan, surveying an area 300 m from a stationary observer (Extracted from Gjerdrum et al. 2012)

2.1.4.3 Estimating Distance

Observers should practice estimating the various distance bands prior to beginning surveys. This can be accomplished by using reticle binoculars as described above in Section 2.1.3.2 or with a distance gauge made from a transparent plastic ruler (see Attachment B).

Record the distance to each bird or flock of birds (to the centre of the flock). For all birds, estimate the perpendicular distance between the bird(s) and the observer (Figure D-6). If a group of birds is straddling the 300 m boundary with the flock centre located in D (some individuals inside and some individuals outside the transect) record the entire flock as being in D. If the flock centre is outside the transect, record the entire flock as distance class E. It is very important to record distance to birds within the 300 m strip, but if this is not possible (i.e., too busy), you may use the code 3 = within 300 m but no distance recorded. Distance T is used to indicate that the bird or flock was observed on the opposite side of the vessel.

2.1.5 Recording Observations

2.1.5.1 General Environmental Information

This information should be collected for both marine mammal and seabird observations as shown on the marine mammal and seabird sightings forms in Attachment A and Attachment B.

Ship name, agency and type: Agency is the company that has requested the survey (e.g., Agnico Eagle Mines Limited, Meliadine Division). Type may include container vessel, barge, tug, or fuel supply vessel.

Observer(s): Indicate the first and last name of the observer. Also record the name of any additional observers assisting with the survey.

Date: Date that the observation period occurred. Use format DD-MMM-YYYY (e.g. 12-Apr-2008)

Time start/Time end: Time (using 24-hour notation) at the start and end of each seabird survey or marine mammal observation. Use Universal Time (UTC) to standardize across regions.

Coordinates at start and end of observation period of track of observation period: GPS coordinates of the vessel.

Platform activity: Platform activity may influence observations and should therefore be noted. Activities could include traveling, off-loading, anchored etc.

Visibility: Estimate visibility in km from 0.3 (which is 300 m) to 20 km; estimates should also be made on foggy days.

Sea state code: Select Sea state code according to codes in Appendix II.

Swell height: Estimate the height of the swell.

Weather conditions: Record the general weather conditions at the time of the survey according to codes in Appendix II. Record the most prominent conditions within the survey area. For example, if there are distant fog patches that do not directly affect the survey conditions, the weather code will be 0 or 1. Alternatively, if there is <50% cloud cover but you are travelling through fog patches, the weather code will be 2.

Glare conditions: Light reflecting off the surface of the water can often influence detection. Record the glare conditions at the time of the survey according to codes in Appendix II.

Wind speed or force: Enter the speed of the wind in knots if instrument to measure wind is available on the bridge or use Beaufort code from Appendix III. When taking measurements from a moving platform, be sure to record the TRUE wind speed/direction.

Wind direction: Enter compass direction (**N, NE, E, SE, S, SW, W, or NW**) of the wind. See note above regarding true wind speed/direct.

Ice Type and Concentration: If ice is present during the survey, indicate the type and concentration using codes from Appendix IV. Indicate in the notes if the ice is present only beyond the transect limits.

Platform speed (knots): If speed changes during observation period, enter new speed and time that the change happened.

Platform direction: Enter compass direction (**N, NE, E, SE, S, SW, W, or NW**); if direction changes during the observation period enter new direction and time at which change happened.

Observation side: Starboard (right) or Port (left).

Height (metres): Enter height of observers' eye above water from observation point in metres.

Outdoors or Indoors: Circle **Out** when doing observations from a position outdoors and **In** for indoor observations. Remember survey should be conducted from the same location on the vessel each time.

Other Notes: Make note of disturbances or relevant activities in the area, especially if there are large vessels or fishing activities nearby, or if your vessel is sounding the fog horn.

2.1.5.2 Marine Mammal Sightings Record

Species: choose the species observed. Record all unknowns, even if they are identified only as "baleen whale" or "toothed whale".

Number of individuals: Record the number of marine mammals in each sighting. Record groups as one sighting (e.g., one line item), if they behave as a group and have the same morphological and behavioural characteristics (e.g., all adults of the same species). Record other individuals from the group that have different characteristics (e.g., different species or juveniles of the same species) in the next line but link all the sighting together to indicate they were a single sighting.

Distance: Record the distance to the marine mammal when first observed

Angle: Sighting angle to the marine mammal can be calculated using a Pelorus or an angle board

Behaviour: Chose a behaviour based on the list below

- ***Surfacing***: Marine mammals will surface in order to breathe, often exposing their backs.
- ***Breaching***: full or partial jump out of the water
- ***Fluking***: Some whales bring their tail flukes high up into the air on a deeper dive.
- ***Flipper-slapping***: Marine mammals may use their flippers to slap the surface of the water.
- ***Lob-tailing***: Whales raise their fluke high into the air in order to slap the surface of the water.
- ***Spyhopping***: Head of the marine mammal will surface out of the water as a means to get an in-air look.

- ***Porpoising***: high speed swimming is more efficiently accomplished if an animal jumps out of the water, usually observed in dolphins, porpoises, and pinnipeds.
- ***Bow- or Wake-riding***: Some species of dolphins and porpoises are attracted to ride the bow or the wake of a passing vessel.
- ***Logging***: Marine mammals resting at the surface.
- ***Feeding***: Marine mammals observed feeding on fish, krill or other marine mammals
- ***Hauled*-out**: For pinnipeds only. When they haul themselves onto land. Remember these individuals should be recorded as off-effort sightings.

Age: If possible, select whether the marine mammal is a:

- **Adult**
- **Juvenile**
- **Immature**

Sex: If possible, Male or Female

Direction of travel (N, NE, E, SE, S, SW, W, or NW): which direction the marine mammals are traveling. Not if they change the direction of travel in response to the vessel.

Note: Space is provided to record other important information, such as the presence of fishing vessels in the survey area, if the marine mammal suddenly changes behaviour etc.

2.1.5.3 Seabird Sightings Record

Observation period information: Fill in all the fields within the seabird survey form at the beginning of every five minute transect survey period (moving survey) or every scan (stationary survey).

Scan type (for stationary platforms only): Conduct a 180° scan for all stationary surveys. If part of the survey area is obstructed, indicate the scan angle used.

Scan direction (for stationary platforms only): Indicate the true (not magnetic) bearing when looking straight ahead, at centre of semi-circle.

With snapshot? Enter whether the snapshot method for birds in flight is being used by checking **Y or N.**

Species: choose the species observed. Record all unknowns, even if they are identified only as “gull” or “bird”.

Number of individuals: Record the number of birds in each sighting in the count field. Record groups of birds as one sighting, if they behave as a group and have the same morphological and behavioural characteristics (e.g., all adults of the same species in breeding plumage flying in the same direction). Record other individuals from the group that have different characteristics (e.g., different species or juveniles of the same species) in the next row but link all the sighting together to indicate they were a single sighting.

In transect or semi-circle? Y or N: Enter whether a bird observed is in (Y) or out (N) of the transect. Give priority to birds that are in transect; record birds seen outside of the observation area if this does not affect "in-transect" observations.

Behaviour (flying, on sea, and/or feeding): Record which activity a bird or group of birds is doing by selecting the activity from the drop-down menu.

Associated with platform? Y or N: Enter whether birds are following/associated with the moving platform with either a **Y** (Yes) or **N** (No).

Distance: Record the distance to each bird or flock of birds (to the centre of the flock). For all birds, estimate the perpendicular distance between the bird(s) and the observer (Figure D-6). Distance categories are as follows: A = 0 to 50 m, B = 51 to100 m, C = 101 to 200 m, D = 201 to 300 m, and E = >300 m.

Age: If possible, select whether the bird is a:

- **A** (adult plumage)
- **J** (juvenile, first coat of true feathers acquired before leaving nest)
- **I** (immature, first fall or winter plumage that replaces juvenile plumage and may continue in a series that includes first-spring plumage, but is not the complete adult plumage).

Plumage of adults: If possible, choose whether the bird has:

- **B** (breeding plumage usually in spring and summer – will apply to most birds seen during the survey)
- **NB** (non-breeding plumage, fall and winter plumage)
- **M** (moult, transitional phase between these two plumages, often with some flight feathers missing; generally not flying when molting)

Sex: (Male or Female)

Flight direction (N, NE, E, SE, S, SW, W, or NW): which direction birds in flight are heading, if not associated with platform (this info can be obtained from instruments on the bridge). If birds are flying erratically such that no one direction is appropriate, record them as ND (no direction).

Note: Space is provided to record other important information, such as the presence of fishing vessels in the survey area, if a particular bird was carrying fish, etc.

2.1.5.4 Additional Information

MMSOs will record any responsive actions undertaken by the vessel crew in response to sightings (e.g., reducing vessel speeds). This will be recorded on a daily basis as outlined in the MMSO daily reporting template provided in Attachment C and will include:

- Description of any vessel mitigation implemented (e.g., reduction in speeds, evasive maneuvers etc.); and
- Record of any vessel-animal collision (marine mammal or seabird) including the following information:
  - date, time, spatial coordinates;

- wind speed and direction, visibility, precipitation, sea state;
- number of animals found dead or injured on the deck (seabirds) and on the water (seabirds or marine mammals); and
- if search lights or vessel lighting sources were active at the time of collision.

This information will be summarized in a daily report by the MMSO. All records of vessel strikes on marine mammals and bird collisions will be provided to Fisheries and Oceans Canada (DFO) and the Canadian Wildlife Service (CWS) on a weekly basis, as vessel communications allow (i.e., as internet connections allow). Immediate reporting will be required in the event that a ship strike occurs on a marine mammal, or multiple bird collisions occur (involving more than five individuals) and the incidents appear related (i.e., similar time period, location, and weather conditions). In this instance, the regional Environment Canada (EC) Wildlife Enforcement Officer (contact information provided below) will be contacted to provide advice on the implementation of adaptive management techniques (see Merkel and Johansen 2011) to attempt to reduce the likelihood of collisions occurring in the future.

2.2 Spill Scenario

This section outlines the protocol for undertaking wildlife monitoring in the event of a major fuel spill in the LSA and RSA in accordance with Project Certificate Condition 64, which states the following:

"*The Proponent shall develop a framework for monitoring of marine bird species and their habitat in the event of a major marine fuel spill. Specific details regarding the scope of follow-up monitoring may be further refined if and when such an event were to occur.*"

There are three potential scenarios during Mine shipping operations when a fuel spill could occur:

1) During shipping activities;
2) During ship-to-ship fuel transfer; or
3) During ship-to-shore transfer of fuel.

A spill risk assessment (SD8-1: Appendix E) was conducted at 14 sites along the shipping route to better understand how a potential fuel spill would behave over time within the RSA.

In the event of a fuel spill, the following wildlife monitoring framework will be implemented. It will be the responsibility of the shipping contractor(s) to employ a qualified environmental professional (QEP) to implement this framework in the event of an incident and will be a requirement of the shipping contract. It is recommended that a QEP be retained under contract on a stand-by basis during the shipping season to be able to respond to a spill in a timely fashion.

Not all spill scenarios will require the implementation of all aspects of this framework (i.e., a small spill contained close to the vessel will not require the same level of monitoring as a larger spill). It is the responsibility of the QEP, in consultation with the relevant regulators, to determine what aspects of the framework should be implemented.

The monitoring framework outlined below is intended to be a 'living document' which provides an opportunity for adaptive management techniques to be implemented throughout an event. The objective of the framework is to provide a strategy for the coordination of marine wildlife monitoring in order to minimize potential effects as a result of an incident. The framework should be amended as new information becomes available (e.g., changes to the extent of a spill) and should ultimately address both potential acute effects to wildlife and their habitats as well as potential long term chronic effects.

There is an opportunity to involve local communities and hunters, other organizations, institutions, government departments and/or individual researchers during the initial response phase and the follow-up phase during an incident. These opportunities include, but are not limited to:

- Providing information regarding sensitive resources in the area;
- Assisting in collecting baseline sediment and water quality samples;
- Assisting with wildlife surveys;
- Collecting wildlife who have come into contact with the spill;
- Providing information regarding the extent and direction of a spill; and
- Assisting with on-going wildlife monitoring.

The involvement of these organizations in the wildlife monitoring framework should be coordinated by the QEP as well as the vessel response team (to be identified in Shipboard Oil Pollution Emergency Plan (SOPEP) or Agnico Eagle's Emergency Response Team (ERT) depending on who is taking on coordination of the clean-up efforts (See section 2.0 of the Shipping Management Plan).

Monitoring during a spill event is divided into two phases, an 'Initial Response Phase' and a 'Follow-up Phase'.

2.2.1 Initial Response Phase

The initial response phase addresses the management of anticipated acute effects of the spill on marine wildlife and their habitats. The framework for the initial response phase should be managed and updated to incorporate new information as it becomes available.

Within 24 hours of an incident, the following marine wildlife monitoring objectives should be achieved:

- Identify a QEP to coordinate the wildlife monitoring framework; and
- Set-up of a 24 hour communication line and provide contact information to the community where local community members and other interested parties can call-in to report fouled or at-risk wildlife sightings.

2.2.1.1 Surveys and Sampling

2.2.1.1.1 Marine Wildlife

During the initial phases of a spill, all wildlife observed in direct contact with the fuel spill or present in the vicinity of the spill will be recorded in a wildlife sightings record (see example in Table D-4). Encounters may be called in by local community members, other vessels, MMSO(s) onboard Mine vessel(s), or by the spill response teams themselves. If possible, the QEP or suitable designate will conduct an initial survey of the affected area to record all species occurrences as soon as possible following a spill. This may be via ground, small support vessel or by aircraft and if possible, should be continued on a daily basis until the spill is contained. Aerial surveys can assist the focus of ground surveys, depending on the extent of a spill. The purpose of these surveys is to identify wildlife resources at risk within the vicinity of the spill and develop appropriate management strategies for minimizing risk and/or impacts to these resources. Resources to be identified during the surveys include presence of pelagic birds, waterfowl, marine mammals, and sensitive fish and wildlife habitat.

In the event that a spill reaches landfall, an intertidal community structure survey should be completed in affected areas and at suitable reference locations in the region. The intertidal surveys should involve intertidal quadrat-based transect sampling and should be conducted in accordance with DFOs marine habitat assessment guidelines as outlined in Attachment E.

Table D-4: Example of a Wildlife Sightings Record in the Event of a Spill

Common Name	Number of Individuals	Date/Time	Location (GPS location if possible in UTM)	Behaviour	Condition of Animal*	Photos**
MAMMALS						
BIRDS						
FISH						

Notes: * - note if the animal has been in contact will the spill or not, if individuals have been observed moving towards the spill, or if the animal is dead.

** Photos should be attached when possible

2.2.1.1.2 Marine Habitats and Benthic Communities

Marine water, surficial sediment, and benthic invertebrate tissue samples should be collected in the affected area(s) as soon as practical to establish baseline and initial spill conditions for water, sediment and tissue quality at the time of the spill. Samples should be collected from a near field to far field direction and should start as close to the spill as possible. The sampling plan should be evaluated on an on-going basis during the initial response phase to determine if the sampling intensity is appropriate relative to the nature of the spill (e.g., additional sampling sites may be required if the trajectory of the fuel spill changes).

Standard sample collection and environmental effects monitoring methods and analytical requirements implemented during fuel spills are provided in Table D-5. Ultimately, monitoring requirements will be at the discretion of the applicable regulators (e.g., EC-CWS and DFO).

Table D-5: Example of Sampling Methods and Analytical Requirements

Parameter	Location	Collection Methods	Laboratory Analyses
Water	Sites should be distributed from a near field to far field direction. Locations as close as possible to the perimeter of the spill should be collected first.	*In situ* measurement of pH, conductivity, salinity, temperature and turbidity throughout the water column. One sample should be collected at each site with a grab sampler (e.g., a Niskin bottle or Kemmerer). *In situ* and water samples should be collected at the surface, mid-water and deep water.	• BTEX/VPH • EPH • VOCs • PAHs (parent) • Total and Dissolved Metals (including mercury) • TOC • Major ions • General parameters
Sediment	Sites should be distributed from a near field to far field direction. Locations as close as possible to the perimeter of the spill should be collected first.	Five replicates collected at each shore site where sediments are sand-sized (e.g., less than approximately 2.0 mm) or finer. For shoreline areas, samples collected with a grab sampler (e.g., Ponar) at high tide, or a stainless steel spoon and bowl at low tide, with replicates randomly distributed within the sample area. For each station, samples should be collected at high and mid to low intertidal zone. For deepwater stations, one surface sediment sample should be collected.	• BTEX/VPH • EPH • VOCs • PAHs (parent) • Metals (including mercury) • TOC • Grain size distribution
Tissue – Requires a DFO scientific fish collection permit	Sites should be distributed from a near field to far field direction. Locations as close as possible to the perimeter of the spill should be collected first.	Five replicates consisting of a composite of 20 individual bivalves collected randomly at each station where bivalves are present. Bivalves should be shucked and the soft tissues rinsed in with deionized water to remove shell pieces and other debris. Tissue samples will be handled with clean stainless steel instruments (i.e., scalpels), weighed and divided between two certified-clean, laboratory-supplied glass containers with Teflon®-lined lids, which will be then stored in a freezer. The samples will be transported on ice (frozen) to an accredited lab for analysis of parent and alkylated PAHs (following silica-gel cleanup to remove natural polar organic compounds that can cause false positives), metals, lipids and moisture content.	• PAH (parent) after silica-gel clean-up. • Metals • Moisture • Lipids

2.2.1.2 Species and Habitats of Immediate Risk

Marine species and habitats of immediate risk from the spill should be identified in order of priority (see Table D-6). This will depend on a variety of factors including the location of the spill, timing, and prevalent weather conditions. Examples of sensitive habitats of potential immediate risk include fish bearing streams, narwhal congregation areas, walrus haul-outs, coastal nesting bird sites etc. Specific locations of habitats are important to note. A revised marine baseline report (SD8-1: Appendix B of the Shipping Management Plan) provides the most current information on known sensitive marine resources in the RSA. Figure B-3 of SD8-1: Appendix B – Revised Baseline – Marine Environment outlines the various coastal habitat types in Melvin Bay in the event of a spill within the limits of the harbour.

The above information should be provided by the QEP to the spill response team and others involved in the spill clean-up (e.g., the Canadian Coast Guard) along with recommendations on what environmental resources are of greatest concern to protect. The QEP should also be involved in discussions relating to the implement of mitigation measures to avoid impacts to sensitive resources. Recommendations regarding mitigation from the QEP should be made in consultation with the relevant regulatory agencies (DFO for marine mammals and fish, CWS for marine birds and the Government of Nunavut for polar bears). The CWS provides spill response guidance on what techniques are available to be used during a spill in relation to marine birds (provided in Attachment D), this includes:

- Hazing;
- Dispersing Oil;
- Bird Collection;
- Wildlife Monitoring (as covered by this framework);
- Beached Bird Surveys (as covered by Section 3.2.1.1);
- Drift Blocks; and
- Live Oiled Bird Response (CWS 2012).

Several of these techniques require specific training and permit authorization before implementation. Therefore, prior to initiation of any of these techniques, the CWS should be contacted for input and guidance.

No similar guidance is provided by DFO for dealing with marine mammals in the event of a spill. DFOs Marine Mammal Response Program is responsible for tracking and responding to contaminated animals (DFO 2015). In the event of a major fuel spill in the RSA, DFO should be contacted immediately by the QEP to determine appropriate mitigation techniques to be utilized to limit potential adverse impacts on marine mammals.

Table D-6: Species and Habitats of Immediate Management Concern

Species and/or Habitat	Location*	Comments

Notes: * A general description of the location of the species (e.g., haul-out areas, congregating areas, fish bearing streams etc.) or specific GPS locations (in UTM) if available

2.2.1.3 Fish and Marine Wildlife Permitting

Table D-7 provides an overview of permitting requirements that may be required to implement the wildlife monitoring framework in the event of a major fuel spill. The CWS and DFO should be contacted to determine the course of action in relation to the collection of live or dead wildlife during the initial response phase.

Table D-7: Potential Permitting Requirements

Agency	Permit	Required for
CWS	Variance Order to the Migratory Bird Regulations	Required for collection, transportation, holding, treating and hazing of migratory birds (live and dead).
DFO	Fish Collection Permit	Required for the collection of marine species (live or dead).
Government of Nunavut	Scientific Research Permit	May be required for the collection of wildlife in Nunavut (live or dead).

2.2.1.4 Daily Assessment Objectives in Order of Priority

Daily assessment objectives should be reviewed each morning and updated as necessary by the QEP. An example of daily assessment objective list is provided below. These objectives will change over the course of an event as the spill is contained and cleaned up.

1) Determine maximum extent of spill area to define hazard zones to marine wildlife and their habitats. The extent of the spill will be in-flux, therefore, seek an update each morning from the spill response team.

2) From the spill origin, travel by boat along the shoreline to search for wildlife or evidence of wildlife.

3) Survey pelagic areas for birds and marine mammals.

4) Document species observations and important habitat areas that may potentially be at risk from spilled product. Bird species observations should detail species, number, behaviour, condition (oiled, not oiled), and location (UTMs). Visual and auditory indications should be used.

5) Conduct marine mammal monitoring; use binoculars to scan for the presence of marine mammals within spill area from on-shore vantage points located at a high location that have good vantage areas. The MMSO(s) can assist with this duty.

6) Update the spill response team and relevant regulators (CWS and DFO) regarding the observations of wildlife.

7) Maintain and monitor the 24 hour wildlife hotline and respond to information gathered.

8) Document impacts to wildlife and habitat, severity of impact, and potential biological implications on a daily and cumulative basis.

9) Implement and maintain wildlife deterrence strategies from oil impacted areas in consultation with the relevant regulatory agency.

2.2.1.5 Reporting

Updates to CWS and DFO regarding observations of wildlife should be a daily objective during a major fuel spill event. In addition, all wildlife sightings records (Table D-4) should be provided on a weekly basis to DFO and the CWS by the QEP.

2.2.2 Follow-up Phase

During the initial phase, all resources should be focused on limiting the effects of the spill. The follow-up phase consists of follow-up monitoring that should be executed through a long-term monitoring framework. The objective of this framework is to assess impacts to wildlife resources and their habitats as a result of the spill and any cleanup measures implemented (e.g., dispersants), as well as to measure the success of applied mitigation techniques.

The follow-up monitoring framework should be developed after the completion of the initial phase monitoring. This allows the follow-up monitoring to focus on species and habitats that have been most impacted by the spill. The framework may contain, but will not be limited to:

- Marine bird surveys;
- Coastal nest surveys;
- Marine mammal surveys;
- Fish surveys;
- Sediment quality monitoring; and
- Water quality monitoring.

The follow-up phase framework should be completed in consultation with the relevant regulatory agencies. It should also provide a mechanism to allow for local community members to be involved in monitoring, remediation and reporting efforts.

3.0 SUMMARY

This MEMP outlines the protocol for monitoring of marine mammals and seabirds during routine shipping operations of the Meliadine Gold Mine. Mine-specific mitigation measures designed to minimize Mine impacts on marine mammals and seabirds will be initiated by vessel-based MMSOs and implemented by the ship's crew. The MEMP also provides a framework to monitor for marine wildlife and their habitats in the event of a Mine-related spill. An opportunity for inclusion of local community members exists and should be considered an asset when implementing this plan. Communication and consultation with relevant regulatory agencies is essential when attempting to implement adaptive management strategies during routine operations as well as during a spill event.

This plan should be considered a living document that can be updated throughout the Mine in order to implement adaptive management techniques.

Report Signature Page

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https://golderassociates.sharepoint.com/sites/10440g/shared documents/3000 on-call regulatory support/shipping management plan/shipping management plan/appendixd_memp/app d_memp 28macrh17.docx

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ATTACHMENT A

Marine Mammal Sightings Record

Observation Period Information:				
Company/agency			Sea state code	
Platform name and type			Wave height (m)	
Observer (s)			True wind speed (knots) **OR** Beaufort code	
Date (DD/MMM/YYYY)			True wind direction	
Time at start (UTC)			Ice type code	
Time at end (UTC)			Ice concentration code	
Latitude at start / end			True platform speed (knots)	
Longitude at start / end			True platform direction	
Visibility (km)			Observation side	Starboard Port Middle
Weather code			Height of eye (m)	
Glare conditions code			Outdoors or Indoors	Out or In
Platform Activity			Notes	

Date and Time of Sighting	Vessel Travel Direction and Speed	Weather / Sea State	Re-Sighting? (Y or N)	Sighting Waypoint or Lat/Long(Garmin GPS)	Species, Number of Individuals	Distance to Animal (m or km)	Angle to Sighting	Behaviour/Travel Direction	Age/Sex	Mitigation Required?	Photo Number (if any)

Notes:

Species	How Animal Was Spotted	Certainty of ID	Animal Activity
Narwhal Whale	By Eye	Definite	Slow Swimming
Beluga Whale	Reticle Binoculars	Probable	Medium Swimming
Bowhead Whale	Big-eye Binoculars	Possible	Fast Swimming
Atlantic Walrus			Looking – Seals
Bearded Seal			Feeding
Ringed Seal			Flipper Slapping
Harbour Seal			Surfacing
Hooded Seal			Resting
Harp Seal			Diving
Polar Bear			Diving (Fluke Visible)
Killer Whale			Splashing
			Surfacing
			Fluking
			Lobtailing
			Bow Riding
			Wake Riding
			Porpoising
			Spyhopping
			Breaching
			Acrobatic
			Startle Response
			Milling
			Unknown

ATTACHMENT B

Record Sheet for a Moving Platform Survey[3]

Record Sheet for a Stationary Platform Survey[3]

Appendix I - Estimating Distance Categories Using Ruler Gauge[3]

Appendix II Through VI - Codes for General Weather Conditions and Glare, Sea State and Beaufort Wind Force, Ice Conditions, Species Codes for Eastern Seabirds, and Codes for [3]Associations and Behaviours[3]

[3] Eastern Canada Seabirds at Sea (ECSAS) Seabird Sightings Records and Background Material (Extracted from Gjerdrum et al. 2012)

Record sheet for a moving platform survey

Observation Period Information:

Company/agency			Sea state code	
Platform name and type			Wave height (m)	
Observer (s)			True wind speed (knots) **OR** Beaufort code	
Date (DD/MMM/YYYY)			True wind direction (deg)	
Time at start (UTC)			Ice type code	
Time at end (UTC)			Ice concentration code	
Latitude at start / end			True platform speed (knots)	
Longitude at start / end			True platform direction (deg)	
Platform activity			Observation side	Starboard Port
Visibility (km)			Height of eye (m)	
Weather code			Outdoors or Indoors	Out or In
Glare conditions code			Snapshot used?	Yes or No

Notes:

Bird Information: *this field <u>must</u> be completed for each record

* Species	* Count	* Fly or Water?	* In transect?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments

[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.
[2]Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction
[3]***J***(uvenile), ***I***(mmature), or ***A***(dult); [4]***B***(reeding), ***NB***(non-breeding), ***M***(oult)

Record sheet for a stationary platform survey

Scan Information:

Company/agency		Weather code	
Platform name and type		Glare conditions code	
Observer (s)		Sea state code	
Date (DD/MMM/YYYY)		Wave height (m)	
Time at start (UTC)		True wind speed (knots) **OR** Beaufort code	
Latitude		True wind direction (deg)	
Longitude		Ice type code	
Platform activity		Ice concentration code	
Scan type	180º or other (specify:)	Height of eye (m)	
Scan direction		Outdoors or Indoors	Out or In
Visibility (km)			

Notes:

Bird Information: *this field <u>must</u> be completed for each record

* Species	* Count	* Fly or Water?	* In semi-circle?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments

[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.
[2]Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction
[3]***J***(uvenile), ***I***(mmature), or ***A***(dult); [4]***B***(reeding), ***NB***(non-breeding), ***M***(oult)

APPENDIX I. Estimating distance categories

The various distance categories can be estimated using the following equation[1]:

$$d_h = 1000 \frac{(ah3838\sqrt{h}) - ahd}{h^2 + 3838d\sqrt{h}}$$

e.g. if a = 0.730 m, h = 12.5 m, and d = 300 m

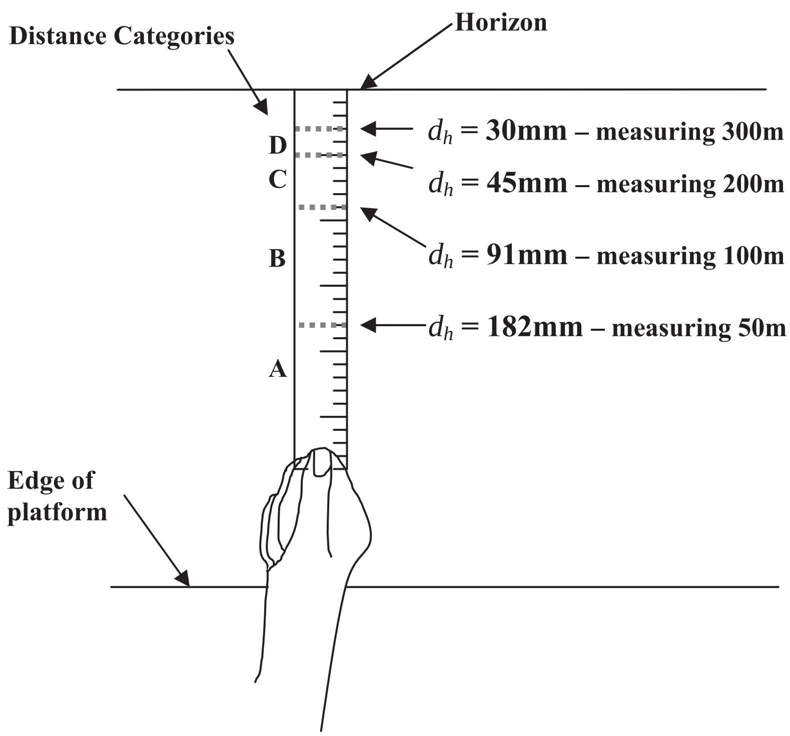
then d_h = 30.0 mm

where:

d_h = distance below horizon (mm)
a = distance between the observer's eye and the ruler when observer's arm is fully out-stretched (m)
h = height of the observer's eye above the water at the observation point (m)
d = distance to be estimated (m; a separate calculation is required for each of 50, 100, 200, 300)

Distances are easily estimated using a gauge made from a transparent plastic ruler. A different ruler will be required for each combination of observer arm length (a) and platform height (h). Calculate d_h for the boundary of each distance class (A, B, C, D) and mark them on the ruler (dashed lines in figure). To use the gauge, extend the arm fully and keep the top end of the ruler aligned with the horizon. The dashed lines now demark the distance class boundaries on the ocean surface. Keep the gauge nearby during surveys to quickly verify bird distances.

Measurements for an observer with a = 73 cm and h = 12.5 m:



[1] Formula derived by J. Chardine, based on Heinemann 1981. A spreadsheet is available from the corresponding author to perform this calculation.

APPENDIX II. Codes for general weather conditions and glare

Code	Description	Explanation
Weather conditions		
0		< 50% cloud cover (with no fog, rain, or snow)
1		> 50% cloud cover (with no fog, rain, or snow)
2		patchy fog
3		solid fog
4		mist/light rain
5		medium to heavy rain
6		fog and rain
7		snow
Glare conditions		
0		none
1		slight/grey
2		bright on the observer's side of vessel
3		bright and forward of vessel

APPENDIX III. Codes for sea state and Beaufort wind force

Wind Speed (knots)	Sea state code and description	Beaufort wind force and description
0	**0** Calm, mirror-like	**0** calm
01 – 03	**0** Ripples with appearance of scales but crests do not foam	**1** light air
04 – 06	**1** Small wavelets, short but pronounced; crests do not break	**2** light breeze
07 – 10	**2** Large wavelets, crests begin to break; foam of glassy appearance; perhaps scattered white caps	**3** gentle breeze
11 – 16	**3** Small waves, becoming longer; fairly frequent white caps	**4** moderate breeze
17 – 21	**4** Moderate waves with more pronounced form; many white caps; chance of some spray	**5** fresh breeze
22 – 27	**5** Large waves formed; white foam crests more extensive; probably some spray	**6** strong breeze
28 – 33	**6** Sea heaps up; white foam from breaking waves blows in streaks in direction of wind	**7** near gale
34 – 40	**6** Moderately high long waves; edge crests break into spindrift; foam blown in well-marked streaks in direction of wind	**8** gale
41 – 47	**6** High waves; dense streaks of foam in direction of wind; crests of waves topple and roll over; spray may affect visibility	**9** strong gale
48 – 55	**7** Very high waves with long overhanging crests; dense foam streaks blown in direction of wind; surface of sea has a white appearance; tumbling of sea is heavy; visibility affected	**10** storm
56 - 63	**8** Exceptionally high waves; sea is completely covered with white patches of foam blown in direction of wind; edges blown into froth; visibility affected	**11** violent storm
64 +	**9** Air filled with foam and spray; sea completely white with driving spray; visibility seriously affected	**12** hurricane

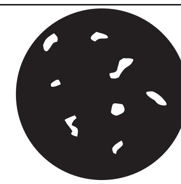
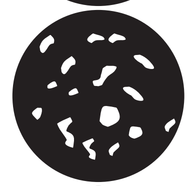
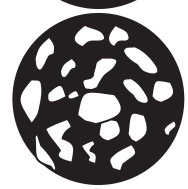
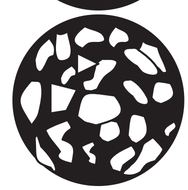
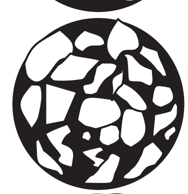
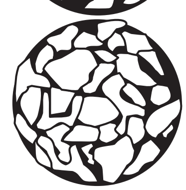
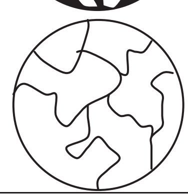
APPENDIX IV. Codes for ice conditions

Adapted from NOAA: Observers Guide to Sea Ice

Sea Ice Forms

Code	Name	Description
0	New	small, thin, newly formed, dinner plate-sized pieces
1	Pancake	rounded floes 30 cm - 3 m across with ridged rims
2	Brash	broken pieces < 2 m across
3	Ice Cake	level piece 2 - 20 m across
4	Small Floe	level piece 20 - 100 m across
5	Medium Floe	level piece 100 -500 m across
6	Big Floe	level, continuous piece 500 m - 2 km across
7	Vast Floe	level, continuous piece 2 - 10 km across
8	Giant Floe	level, continuous piece > 10 km across
9	Strip	a linear accumulation of sea ice < 1 km wide
10	Belt	a linear accumulation of sea ice from 1 km to over 100 km wide
11	Beach Ice or Stamakhas	irregular, sediment-laden blocks that are grounded on tidelands, repeatedly submerged, and floated free by spring tides
12	Fast Ice	ice formed and remaining attached to shore

Sea Ice Concentration

Code	Concentration	Description	
0	< one tenth	"open water"	
1	two-three tenths	"very open drift"	
2	four tenths	"open drift"	
3	five tenths	"open drift"	
4	six tenths	"open drift"	
5	seven to eight tenths	"close pack"	
6	nine tenths	"very close pack"	
7	ten tenths	"compact"	

APPENDIX V. Species codes for birds seen in Eastern Canada

Common name	Species code	Latin name
COMMON, REGULAR OR FREQUENTLY SEEN SPECIES		
Northern Fulmar	NOFU	*Fulmarus glacialis*
Great Shearwater	GRSH	*Puffinus gravis*
Manx Shearwater	MASH	*Puffinus puffinus*
Sooty Shearwater	SOSH	*Puffinus griseus*
Wilson's Storm-Petrel	WISP	*Oceanites oceanicus*
Leach's Storm-Petrel	LESP	*Oceanodroma leucorhoa*
Northern Gannet	NOGA	*Morus bassanus*
Red Phalarope	REPH	*Phalaropus fulicaria*
Red-necked Phalarope	RNPH	*Phalaropus lobatus*
Long-tailed Jaeger	LTJA	*Stercorarius longicaudus*
Parasitic Jaeger	PAJA	*Stercorarius parasiticus*
Pomarine Jaeger	POJA	*Stercorarius pomarinus*
Great Skua	GRSK	*Stercorarius skua*
Herring Gull	HERG	*Larus argentatus*
Iceland Gull	ICGU	*Larus glaucoides*
Glaucous Gull	GLGU	*Larus hyperboreus*
Great Black-backed Gull	GBBG	*Larus marinus*
Black-legged Kittiwake	BLKI	*Rissa tridactyla*
Common Murre	COMU	*Uria aalge*
Thick-billed Murre	TBMU	*Uria lomvia*
Razorbill	RAZO	*Alca torda*
Dovekie	DOVE	*Alle alle*
Atlantic Puffin	ATPU	*Fratercula arctica*
SPECIES MORE COMMONLY SEEN INSHORE		
Common Loon	COLO	*Gavia immer*
Red-throated Loon	RTLO	*Gavia stellata*
Red-necked Grebe	RNGR	*Podiceps grisegena*
Horned Grebe	HOGR	*Podiceps auritus*
Great Cormorant	GRCO	*Phalacrocorax carbo*
Double-crested Cormorant	DCCO	*Phalacrocorax auritus*
Greater Scaup	GRSC	*Aytha marila*
Common Eider	COEI	*Somateria mollissima*
Harlequin Duck	HARD	*Histrionicus histrionicus*
Long-tailed Duck	LTDU	*Clangula hyemalis*
Surf Scoter	SUSC	*Melanitta perspicillata*
Black Scoter	BLSC	*Melanitta nigra*
White-winged Scoter	WWSC	*Melanitta fusca*
Red-breasted Merganser	RBME	*Mergus serrator*
Black Guillemot	BLGU	*Cepphus grylle*

Common name	Species code	Latin name
INFREQUENTLY OR RARELY SEEN SPECIES		
Cory’s Shearwater	COSH	*Calonectris diomedea*
Audubon’s Shearwater	AUSH	*Puffinus lherminieri*
Lesser Scaup	LESC	*Aythya affinis*
King Eider	KIEI	*Somateria spectabilis*
South Polar Skua	SPSK	*Stercorarius maccormicki*
Bonaparte's Gull	BOGU	*Larus philadelphia*
Ivory Gull	IVGU	*Pagophila eburnea*
Black-headed Gull	BHGU	*Larus ridibundus*
Laughing Gull	LAGU	*Larus articilla*
Ring-billed Gull	RBGU	*Larus delawarensis*
Lesser Black-backed Gull	LBBG	*Larus fuscus*
Sabine’s Gull	SAGU	*Xema sabini*
Common Tern	COTE	*Sterna hirundo*
Arctic Tern	ARTE	*Sterna paradisaea*
Roseate Tern	ROTE	*Sterna dougallii*
CODES FOR BIRDS IDENTIFIED TO FAMILY OR GENUS		
Unknown Bird	UNKN	
Unknown Shearwater	UNSH	*Puffinus* or *Calonectris*
Unknown Storm-Petrel	UNSP	Hydrobatidae
Unknown Duck	UNDU	Anatidae
Unknown Eider	UNEI	*Somateria*
Unknown Phalarope	UNPH	*Phalaropus*
Unknown Jaeger	UNJA	*Stercorarius*
Unknown Skua	UNSK	*Stercorarius*
Unknown Gull	UNGU	Laridae
Unknown Tern	UNTE	*Sternidae*
Unknown Alcid	ALCI	Alcidae
Unknown Murre or Razorbill	MURA	*Uria* or *Alca*
Unknown Murre	UNMU	*Uria*

APPENDIX VI. Codes for associations and behaviours

From Camphuysen and Garthe (2004). Choose one or more as applicable.

Code	Description
Association	
10	Associated with fish shoal
11	Associated with cetaceans
13	Associated with front (often indicated by distinct lines separating two water masses or concentrations of flotsam)
14	Sitting on or near floating wood
15	Associated with floating litter (includes plastic bags, balloons, or any garbage from human source)
16	Associated with oil slick
17	Associated with sea weed
18	Associated with observation platform
19	Sitting on observation platform
20	Approaching observation platform
21	Associated with other vessel (excluding fishing vessel; see code 26)
22	Associated with or on a buoy
23	Associated with offshore platform
24	Sitting on offshore platform
26	Associated with fishing vessel
27	Associated with or on sea ice
28	Associated with land (e.g., colony)
50	Associated with other species feeding in same location

Code	Description	Explanation
Foraging behaviour		
30	Holding or carrying fish	carrying fish towards colony
32	Feeding young at sea	adult presenting prey to attended chicks (e.g., auks) or juveniles (e.g., terns)
33	Feeding	method unspecified (see behaviour codes 39,40,41,45)
36	Aerial pursuit	kleptoparisitizing in the air
39	Pattering	low flight over the water, tapping the surface with feet while still airborne (e.g., storm-petrels)
40	Scavenging	swimming at the surface, handling carrion
41	Scavenging at fishing vessel	foraging at fishing vessel, deploying any method to obtain discarded fish and offal; storm-petrels in the wake of trawlers picking up small morsels should be excluded
44	Surface pecking	swimming birds pecking at small prey (e.g., fulmar, phalaropes, skuas, gulls)
45	Deep plunging	aerial seabirds diving under water (e.g., gannets, terns, shearwaters)
49	Actively searching	persistently circling aerial seairds (usually peering down), or swimming birds frequently peering (and undisturbed by observation platform) underwater for prey
General behaviour		
60	Resting or apparently sleeping	reserved for sleeping seabirds at sea
64	Carrying nest material	flying with seaweed or other material; not to be confused with entangled birds
65	Guarding chick	reserved for auks attending recently fledged chicks at sea
66	Preening or bathing	birds actively preening feathers or bathing
Distress or mortality		
71	Escape from ship (by flying)	escaping from approaching observation platform
90	Under attack by kleptoparasite	bird under attack by kleptoparasite in an aerial pursuit, or when handling prey at the surface
93	Escape from ship (by diving)	escaping from approaching observation platform
95	Injured	birds with clear injuries such as broken wings or bleeding wounds
96	Entangled in fishing gear or rope	birds entangled with rope, line, netting or other material (even if still able to fly or swim)
97	Oiled	birds contaminated with oil
98	Sick/unwell	weakened individuals not behaving as normal, healthy birds, but without obvious injuries
99	Dead	bird is dead

ATTACHMENT C

MMSO Daily Reporting Template

1.0 MARINE MAMMALS AND SEABIRD OBSERVING (MMSO) DAILY REPORT

Project Information

Client: **Date:**

Project Name: **Location:**

Ship Contractor Information

Ship Contractor Name: **Site Supervisor or Captain:**

Ship Name/Type:

MMSO name:	
General weather conditions (throughout the day)	**Cloud cover:** **Precipitation:** **Wind (knots):** **Sea state:** **Swell height:** **Air temperature:** **Ice presence:** **Notes:**
Time start/Time end MMSO duties (UTC):	

2.0 MITIGATION LOG

Mitigation Implemented	Time (UTC)	GPS Location	Rational for Implementation

Under Activity note the following: Description of any vessel mitigation implemented (e.g., reduction in speeds, evasive maneuvers etc.)

3.0 RECORD OF VESSEL-ANIMAL COLLISIONS/INTERACTIONS

Species	Number of Individuals	Time (UTC)	GPS Coordinates	Visibility/Sea State	Comments

In the comments note the following: Animals observed on the deck (seabirds) or in the water (seabirds or marine mammals), if search lights or vessel lighting sources were active at the time of collision, and any other relevant notes.

4.0 MMSO CHECKLIST

Item or Location to Check	Yes	No	Comments - Discussed (D) with relevant Ship personnel - Observed (O) - Not Applicable (NA) - Action required (as/if applicable)
General			
Copy of SMP and appendices posted on-site			
Orientation to mitigation measures outlined in Section 4.2 of the SMP			
Overview of MMSO duties and protocols (e.g., ship crews should be made aware that the MMSO is the only individual that can mark sightings during the dedicated surveys/observation periods)			
Add additional items as necessary and depending on the role of the MMSO			

General Notes:

5.0 SUMMARY OF ISSUES AND RECOMMENDATIONS / ACTIONS

Date Noted	Issue	Recommendation/Action	Completed (Date Resolved)	Comments

ATTACHMENT D

Birds and Oil - CWS Response Plan Guidance

Birds and Oil - CWS Response Plan Guidance

In all circumstances where a polluter is identified the burden of cleanup and response lies with the polluter. However, responsibility for government overview of a response to an oil spill depends on the source of the spill. The identified **lead agency** has responsibility to monitor an oil spill response and to take control if an appropriate response is not undertaken by a polluter or their agent.

Lead agency responsibilities lie with:

- **Environment Canada**
  - For spills and incidents on federal lands and from federal vessels
  - Potentially for land-based incidents in waters frequented by fish
  - May take lead if environment is not being protected by other leads, Cabinet Directive 1973
- **Canadian Coast Guard**
  - For spills from ships
  - All spills of unknown sources in marine environment
- **Provincial Department of Environment**
  - For spills from land-based sources
- **Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) and Canada-Nova Scotia Offshore Petroleum Board (C-NSOPB)**
  - For spills related to offshore oil and gas exploration and production
- **Transport Canada**
  - To investigate ship source and mystery spills in the marine environment

The Canadian Wildlife Service has the responsibility for licensing activities which involve the handling or disturbance of birds, and of providing advice and often direction to other agencies, responders and the polluter during oil spill incidents.

1. Hazing[1]

Purpose: Prevent birds from coming in contact with oil

Options:

- Hazing by helicopter
- Hazing by FRC or other watercraft
- Release of scare devices (e.g. Breco Buoys, Phoenix Wailer)
- Use of hazing sound makers: propane cannons, whizzers, bangers, pyrotechnic devices etc.

Scare devices have a limited range of influence and likely are not a viable option with a large slick. Use of Breco Buoys and Phoenix Wailers can be used but we consider them to be largely ineffective in the situation of a large slick. Logistically, helicopter hazing would be difficult unless it was possible for a helicopter to remain on a platform offshore overnight. Hazing by FRC or other vessels would be ideal.

[1] There are several scare techniques which may be effective and do not require a permit, however a permit under the Migratory Bird Regulations **is required** for the use of aircraft or firearms (defined as capable of emitting at projectile at more than 495 feet per second). Propane cannons, blank pistols or pyrotechnical pistols firing crackers shells with **less than 495fps are legal without a permit**. Most scare tactics are relatively short lived in terms of effectiveness as birds acclimatize to the disturbance so scare techniques should be alternated to be effective.

Short-term focused hazing by the most expedient means should be attempted to move the birds away from the slick, if logistical conditions permit. Vessels at the site should have the ability to use sound makers (propane canons, pyrotechnic devices) to disperse birds in local areas. Such equipment should be deployed immediately to these ships with trained personnel to operate them. The vessels on site should be tasked to actively search and monitor for congregations of birds which could be vulnerable to oiling. If such groups are found then attempts should be made to disperse the birds away from the oil.

2. Disperse oil

Purpose: Prevent birds from contacting oil by getting oil off the surface of the water as soon as possible.

Options:

- Dispersants
- Mechanical dispersal with FRCs or other vessels
- Natural dispersal by environmental conditions

For small spills, mechanical dispersal would be the preferred method.

3. Bird Collection[2]

Purpose: Implement a humane response to oiled birds as required by Environment Canada's National Policy on Oiled Birds and Oiled Species At Risk (http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=A4DD63E4-1)

Options:

- The only option would be a ship-based effort to detect and collect dead and live oiled birds, both within the slick and adjacent to it.

All vessels in or near the slick should understand the need to collect birds. All vessels should have dip-nets, large plastic collecting bags to hold dead birds, and cloth bags or cardboard boxes in which to hold live oiled birds. Efforts should be made to retrieve live oiled birds to ensure they are dealt with humanely.

4. Wildlife monitoring

Purpose: Determine potential impact of spill

Options:

- Ship-based surveys for oiled and unoiled wildlife
- Aerial surveys for oiled and unoiled wildlife. Will require structured surveys (e.g. strip or transect surveys of spill area)
- Placement of CWS staff on vessels and aircraft

[2] Only those individuals authorized to do so (nominee on an existing federal salvage permit) can be involved with the collection of migratory birds.

Dedicated ship-based bird surveys should be initiated immediately. Ideally arrangements should be made to have a CWS observer on vessels or flights. In addition trained seabird observers need to be placed on all vessels monitoring a slick. This should continue until the slick is dispersed.

5. Beached Bird Surveys

Purpose: Determine impact of spill on wildlife and retrieve any live oiled wildlife on beaches.

Options:

- Conduct daily beached bird surveys during the incident and until one week after slick has been removed or dissipated.

CWS or other government officials (CCG, Enforcement Officers) will oversee the collection of dead and live oiled birds[3] as instructed in CWS' protocol for collecting birds during an oil spill response. This would only be required in circumstances where a large number of birds are potentially oiled or if the spill occurs in a sensitive area.

6. Drift Blocks

Purpose: Drift blocks may be deployed in slick to provide an estimate of bird mortality.

Options:

- Release from vessel
- Release from aircraft

The deployment of drift blocks would only be expected if there was a large spill and blocks should be released as soon as possible after a spill (CWS should be consulted to determine protocol for drift block deployment and tracking). The polluter or their agent would be expected to ensure drift blocks are tracked and collected as appropriate.

7. Live oiled bird response

Purpose: Implement a humane response to oiled birds as required by Environment Canada's National Policy On Oiled Birds And Oiled Species At Risk

Options:

- Rehabilitation
- Euthanization

CWS will be consulted to determine the appropriate response and treatment strategies which may include cleaning and rehabilitation or euthanization. CWS policy specifically requires that species at risk or other species of concern be rehabilitated.

[3] Only those individuals authorized to do so (nominee on an existing federal salvage permit) can be involved with the collection of migratory birds.

ATTACHMENT E

DFO's Marine Foreshore Environmental Assessment Procedure

MARINE FORESHORE ENVIRONMENTAL ASSESSMENT PROCEDURE

Marine development projects have the potential to effect fish[1] and fish habitat[2]. Fisheries and Oceans Canada (DFO) is responsible for the protection and management of fish habitats under the authority of the *Fisheries Act* and may request plans, specifications and environmental assessments specific to marine projects where more detailed information is required. Assessments may be necessary for all types of projects, including, but not limited to aquaculture, log handling, industrial port development, marinas, private moorage facilities, marine repair facilities, pipeline or outfall installations, vessel launches or barge ramps, dredging projects and shoreline protection projects (breakwaters and seawalls). Presented below are standardized, transect-based assessment procedures intended to provide DFO with the basic information required to determine the potential effects of a development project on fish habitat.

Assessment Area

For comparative purposes, the assessment area should include both the foreshore site proposed for development as well as the adjacent foreshore. This will provide a context for the project and may provide data about cumulative effects if similar developments already occur on-site. A large scale site plan, preferably an enlargement of the hydrographic chart, with a small scale insert of the general geographic location will serve as a base map of the study area.

Tidal Height and Water Depth Measurements

The lowest normal tide (0.0 m), or chart datum, will be used as the reference point for the measurement of tidal height and water depth. Tidal height is recorded as positive relative to chart datum, while water depth below chart datum will be recorded as a negative value. For example, if the assessment is made when the tide is at 2 m, and observations are taken at a water depth of 6 m, then the depth will be recorded as -4 m. Tidal height will be corrected using the closest secondary port to the reference port found in the Canadian Tide and Current Tables, with further correction made for daylight savings time as required.

Transect Layout

Transects should be established perpendicular to the shoreline at regular intervals both within and adjacent to the proposed or active development area so as to sample representative fish habitat conditions. A preliminary low water reconnaissance or dive survey may be advisable to establish

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[1] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

[2] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

appropriate boundaries for the assessment. Transects should begin at the highest high water mark (HHWM: distance referenced as Station 0.0 m) and, at a minimum, extend to a depth of -20 m (–30 m if the development has the potential to effect deeper benthic habitats). Though small-scale intertidal projects may only require intertidal transects, care must be taken to ensure that a representative sample is collected across the proposed development area. Procedural manuals are available from DFO if sampling of intertidal clam or benthic invertebrates is required. To ensure complete assessment of marine plants and animals in the photic zone, deeper transects may be necessary, especially to determine the effects of sunken debris or woodwaste accumulations resulting from existing developments. Transects should be spaced approximately 25 m apart, although this interval may vary depending on the width of the site. The number of transects required will depend on the nature of the foreshore development proposed, anticipated effects of the development, and local site conditions (tides and currents, geography, fetch, geology, etc.). Transects should be individually numbered and indicated on the site plan, and their commencement point referenced to benchmarks, where possible.

Recording Observations

Habitat inventories should be conducted during the more productive spring and summer months. At that time, algae and saltmarsh species are more readily identifiable, enabling a better assessment of the productive capacity of the site.

Observations should be recorded every 5 m along the transect or at significant changes in habitat type. Observations should include substrate type and composition, presence and relative abundance of marine animals and plants, and any other notable features (e.g., debris accumulations) using the following format:

Substrate

Substrate types are to be subdivided into the following size class categories:

- Bedrock
- Boulder (>256 mm diameter)
- Cobble (64-256 mm diameter)
- Gravel (2-64 mm diameter)
- Sand (0.0625-2 mm diameter)
- Silt/Mud/Clay (<0.0625 mm diameter)

Substrate types are recorded cumulatively as percentages out of a total of 100% (e.g., Boulder 5%; Cobble 15%; Gravel 60%, Sand 20%)

Marine Plants

Marine plants include rooted vascular vegetation (e.g., eelgrass, saltmarsh vegetation, etc.) and marine algae (e.g., rockweed, kelp, etc.). Marine plant observations are recorded as percent areal coverage estimated per 5 m × 1 m transect segment. Observations can be recorded as percentages (5%, 10%, 15%, etc.) or by utilizing the following areal coverage classes:

+	<5%
1	5-25%
2	>25-50%
3	>50-75%
4	>75-100%

Sessile Animals

Many marine animals permanently attached to substrates function as important fish habitat (e.g., barnacles, bay mussels, etc.). Sessile animals are recorded as percent areal coverage along the transect line using either estimated percentages or by areal coverage classes, as presented above.

Motile Animals

Motile animals include fish and marine invertebrates such as crabs and snails. These can be individually counted along the transect or, where too numerous, their estimated numbers can be recorded. Population estimates will most likely be applied to species such as herring or mysid shrimp that naturally occur in large numbers.

Other Features

Accumulations of wood bark and debris, sunken logs or other waste materials arising from onsite or nearby development activities should also be recorded. For wood bark and related small size debris, observations are recorded as percent areal coverage estimates per 5 m × 1 m transect segment and estimated deposition depth (e.g., 15% / 10 cm). For larger materials (sunken logs, wood chunks, etc.), observations can be recorded by individual piece count or by estimate of percent areal coverage.

Observations should be correlated to the transect distance from the HHWM and (corrected) tidal height or water depth (e.g., Sta. 0+80 m / +4.5 m), with information compiled in tabular form, by transect. Common names of observed animals and plants are acceptable for the data table; a species list with scientific names should, however, be appended to the report.

General marine plant categories (e.g., rockweed, eelgrass, bull kelp, saltmarsh, etc.) and any other notable features should be sketched to scale directly on a copy of the site plan, drawings or photographs of the site. A site profile should be prepared for each transect showing the slope of the foreshore and the location of indicator marine plants or invertebrates. A sketch of the proposed marine development should be superimposed over the site plan so that any potential effect of the project on fish habitat is clear. Compensatory habitat proposed for offsetting altered habitat should also be sketched on site maps and profiles to enable review of the positioning of replacement habitat relative to the project.

Photographic Documentation

It is essential to produce a photographic record along the intertidal and subtidal transects. A videographic record of subtidal transects is also recommended. Photos and videos provide a real-time record of characteristic fish habitat at the proposed site and can be invaluable to future post-development site monitoring. Photographic records also facilitate comparison of the productivity of natural habitats with any compensatory habitat constructed to offset habitat losses. As visibility may be a problem, careful attention should be given to appropriate tidal levels, and midday lighting conditions are recommended. Aerial photos, taken at low tide, are often useful to put the site into context with the surrounding area and to verify information provided from other sources.

Assessment reports should include photographs of representative fish habitat types. Depending upon the scope of the proposed foreshore development, an unedited, labelled copy of the assessment video may also be required for the report submission. The video footage should be referenced with pertinent information (e.g., time, date, depth, heading, etc.), and a written or recorded interpretation should accompany the video.

Summary of information to be submitted

1. Basemap showing tenure area boundaries, surrounding area, transect locations and sampling stations
2. Shoreline video/photographs of intertidal zone
3. Underwater video/photographs of transects
4. Tabular data for each transect describing substrate type and composition, marine plants, sessile and motile marine animals, and other notable features
5. Habitat map showing location of different substrate types, plants, animals and operational infrastructure
6. Profile diagrams of each transect showing slope, sediment types and the major marine plants or animals observed
7. Photographs of site and aerial photographs if available.

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APPENDIX E • SPILL RISK ASSESSMENT

March 10, 2016

SPILL RISK ASSESSMENT

Appendix E

Submitted to:
Agnico Ealge Mines Limited
10200, Route de Preissac
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REPORT

Report Number: Doc 552-1535029-R-RevA

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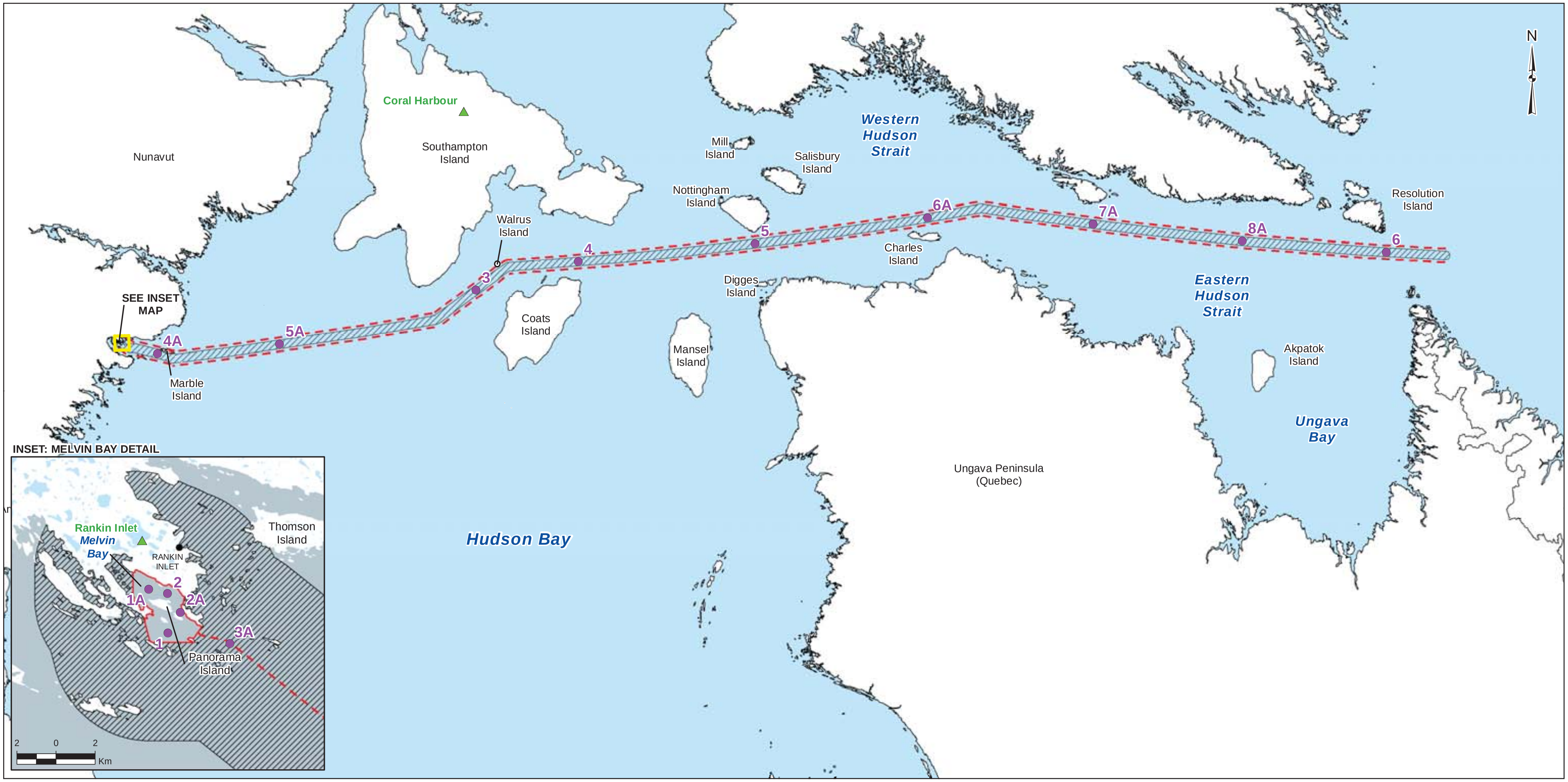
ATTACHMENT A

ADIOS2 Hypothetical Spill Modelling Inputs and Outputs

1.0 INTRODUCTION

This report presents a desktop level assessment of potential diesel fuel spill risk in the marine environment related to the Meliadine Gold Project (Project). The effects of fuel spills on sensitive biological receptors such as marine mammals and marine birds are discussed in Section 8.3.6.5 of the Final Environmental Impact Statement (FEIS) for the Meliadine Project. Golder Associates Inc. (Golder) has applied a modified version of the risk assessment strategy presented in ITOPF-TIP16 Contingency Planning for Marine Oil Spills (ITOPF 2011) based on existing Project information and available biophysical data in the Project area. This report includes an overview of oil spills in Canadian waters and potential open-water P50 diesel spills near Melvin Bay (ship-to-shore and ship-to-ship fuel transfer areas near Rankin Inlet) and along the primary deep-draught shipping route used by Project vessels during Project construction and operations phases (Figure E-1). The behavior of a diesel fuel spill in the marine environment was assessed at 14 different hypothetical spill locations in the Project area, considering aspects of evaporation, dispersion, spreading and potential distance traveled from the spill location. Five locations near Melvin Bay were considered in the assessment as these corresponded with ship-to-shore and ship-to-ship fuel transfer areas where a higher potential for fuel spills would occur (Figure E-1). Nine locations along the shipping route were also considered in the assessment as these corresponded with navigation zones in close proximity to islands or known sensitive/important coastal areas for marine mammals and/or marine birds; including Walrus Island, Coats Island, Ungava Peninsula, and Eastern Hudson Strait (Figure E-1). This assessment considered a low-probability, large spill scenario of 2 Million Litres (ML) (2,000 cubic metres [m^3]) of P50 diesel and a worst case spill scenario of 20 ML (20,000 m^3) of P50 diesel released at sites in Melvin Bay and along the shipping route. An additional spill scenario of a 100,000 litres (L) (100 metres m^3) spill was also considered at the ship-to-ship and ship-to-shore fuel transfer sites near Melvin Bay, representing smaller spills that could occur during fuel transfer activities.

The Project is primarily land-based with operations in the marine environment limited to six fuel tanker transits to Rankin Inlet from eastern North America during the open-water season (approximately August to October), and subsequent transfer of this fuel to shore using established fuel transfer locations near Melvin Bay. There were no Project-specific meteorological or oceanographic data collected as part of the baseline assessment for the Project; therefore, this assessment is based solely on information from existing literature and available third party data. Because of the limited marine operations planned for the Project, resulting in an overall low probability of a spill, this analysis was conducted with a simple fuel weathering model that does not include detailed hydrodynamic modelling.



LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- HYPOTHETICAL FUEL SPILL RELEASE LOCATION

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
SPILL RISK ASSESSMENT FOR FOURTEEN LOCATIONS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK				
REVIEW				

FIGURE E-1

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2.0 OIL SPILLS IN CANADIAN WATERS

No information is available in the public domain/published literature related to existing fuel spill rates (e.g., frequency of spills) in the Hudson Bay region, although broader-scale information is available. The Arctic Monitoring and Assessment Programme (AMAP 2010) conducted an assessment of the effects of oil and gas activities in the Canadian Arctic to quantify the potential impacts from oil spills to the Arctic ecosystem and human health. Spills in the Arctic are considered rare and are typically associated with tanker traffic, with the most common location of spills occurring near ports (ITOPF 2011). From 1972 to 2003, a total of 1,226 oil spills were reported in the Canadian Arctic region; equivalent to a total volume of 3.3 ML (3,300 m^3) and a spill frequency of 2.5 spills per year. Of this total, 75 spills consisted of diesel fuel, equivalent to 334,000 L (334 m^3) and a frequency of one spill every 0.4 years (AMAP 2010).

Transport Canada commissioned WSP (formerly GENIVAR) to prepare a risk assessment for marine ship-based spills in Canadian waters north of the 60° North parallel (WSP 2014a). The study found the probability of oil spills in the Canadian Arctic is significantly lower than in the rest of Canada primarily due to the lower vessel traffic and volumes of oil transported. For the years 2002 to 2011, the volume of refined cargo products transported in the Arctic represented 0.18% of total volumes in Canada. The risk assessment found there to be a very low risk across the Canadian Arctic for a ship-source oil spill, however, the risk is slightly higher for the Hudson Strait and the coast of Labrador, mostly due to higher volumes of oil transported and traffic in these areas. Estimates of fuel spill frequency rates in the Arctic ranged from a return period of 285 years (i.e., one spill approximately every 285 years) for small spills (10 to 99.9 m^3) to 920 years for medium spills (100 to 999.9 m^3) and 92,000 years for large spills (1,000 to 9999.9 m^3) (WSP 2014a). According to the study, the frequency estimate for spills larger than 10,000 m^3 (10 ML) is zero for fuel oil and refined cargo products due to the lack of historical spills in this size range.

The trends of spill frequency have decreased over time due to improved technology, navigation, construction of vessels, and more stringent regulations (AMAP 2010; Anderson et al. 2012; WSP 2014b). Marine transportation in the Arctic is limited due to seasonal presence of ice. The lower frequency of ship transits in the Arctic region will downward bias spill rates calculated from Arctic data when compared to global statistics of spill frequency. However, as climate change causes a decrease in ice cover and the potential for transportation and other industrial activities in the Arctic increases, potential for spills may increase as well.

A study titled “Probability of Oil Spills from Tankers in Canadian Waters” by SL Ross Environmental Research Ltd. (SL Ross) predicts the frequency of oil spills from tankers in various areas of Canada (SL Ross 1999). The expected spill rate per year is calculated by multiplying the tonnage of oil loaded and unloaded at Canadian ports by spill frequencies derived from historical statistics. The expected spill rates for large (> 159,000 L) medium (8,000 to 159,000 L), and small (< 8,000 L) spills of product oil is 2.5, 12.3, and 36 spills per 10^8 ML loaded or unloaded per year, respectively.

3.0 MARINE TRANSPORT OF DIESEL FUEL FOR THE MELIADINE PROJECT

The FEIS for the Meliadine Project states that approximately 122 ML (122,000 m^3) of P50 diesel fuel will be delivered annually during operations. P50 is an Arctic diesel fuel with a lower temperature pour point than other diesel fuels. Based on the total volume of diesel fuel that will be transported throughout the life of the Project and spill rates reported by SL Ross (1999), the overall likelihood of a fuel spill for the Project is once every 36 years for small spills and once every 526 years for large spills. The approximate Project life that includes construction, operations, and closure is 18 years.

During construction and operations, approximately six large tankers will arrive to deliver P50 diesel fuel throughout the open-water shipping season. Each vessel trip will deliver approximately 20 ML (20,000 m^3) of P50 diesel fuel. The large tankers will anchor in deeper waters outside of Melvin Bay upon arrival in Rankin Inlet (Figure E-1). Large tanker to small tanker transfer of diesel fuel will occur at the large freighter anchor location. The carrying capacity of the small tanker will be either 7,300 m^3 or 10,500 m^3, depending on which vessel is used. Therefore, each of the six large tanker deliveries will take two to three trips to offload all of the fuel. The small tankers will anchor opposite Itivia and a floating pipeline of some 300 to 500 metres (m) will connect to a shore-based pipeline for transfer of fuel to the Project tank farm located near Itivia in Rankin Inlet. Fuel will be transferred through the pipeline at approximately 400 cubic metres per hour (m^3/h) for about 18 to 26 hours (h), depending on the carrying capacity of the small tanker. Agnico Eagle Mines Limited (AEM) has prepared an Oil Pollution Emergency Plan (SD 8-2) that details necessary actions to be implemented to reduce or minimize the loss of diesel fuel. Communication between the small tanker and the shore will be maintained throughout the transfer to safeguard the transfer of the diesel and to avoid overfilling of the tanks.

4.0 WEATHERING PROCESSES OF OIL SPILLS

The fate, toxic effect and weathering of an oil spill depends on the specific gravity, pour point, viscosity, chemical composition of refined and non-refined components, volume released, area of spreading, and the environmental conditions involved (ITOPF 2002). Environmental conditions include wind speed and direction, water depth, wave energy, solar radiation, current speed and direction, water temperature and distance to land. The weathering processes include dispersion, evaporation, spreading, adsorption to sediments, biodegradation, dissolution, emulsification, and photo oxidation (Figure E-2). Dispersion, evaporation, and spreading are the primary processes for determining fate and transport of diesel fuel, which is the primary fuel type being used for the Project. Oil dispersion is largely dependent upon the type of oil and the sea state, dispersing most rapidly with low viscosity oils, in the presence of breaking waves (ITOPF 2002). The rate of evaporation depends on ambient temperatures, wind speeds, and type of fuel. Spreading of the slick depends to a great extent on the viscosity of oil, the volume and the wind stress on the slick and surface water (Lehr et al 2002).

Diesel fuel has a low viscosity and will weather rapidly when spilled into the marine environment (NOAA 2006). With a lower density than water, diesel fuel will tend to stay on the water surface and be readily dispersed by wave action. Over 90% of a small spill of diesel in the marine environment is either evaporated or naturally dispersed over a time scale of several hours to days (NOAA 2006).

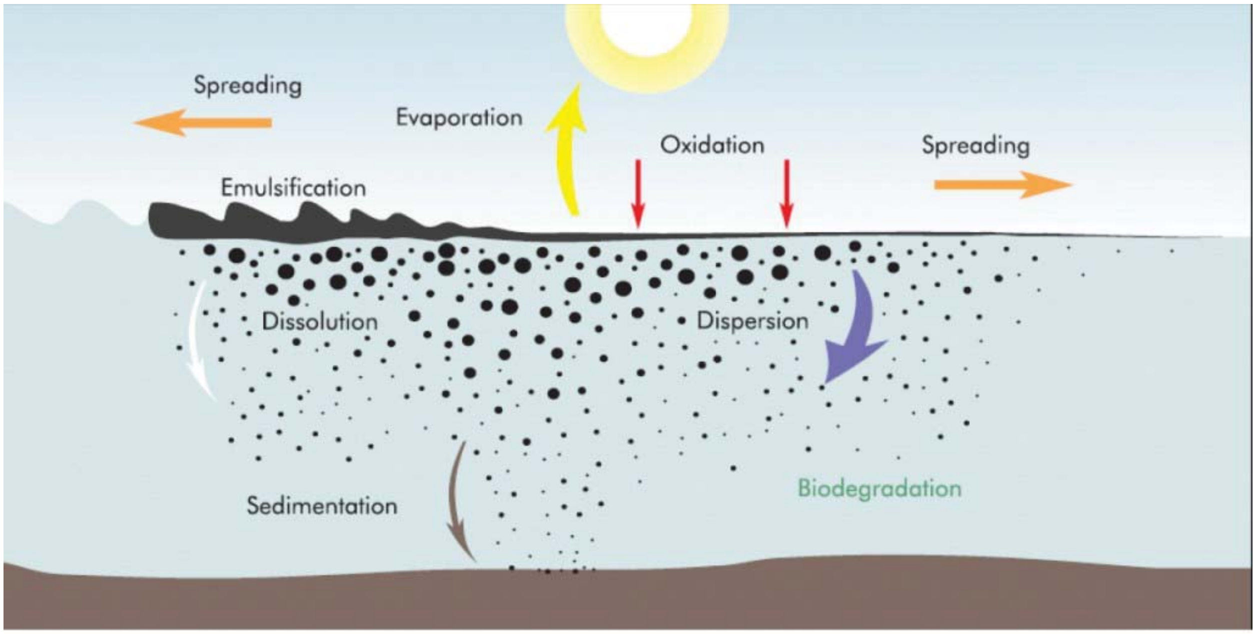


Figure E-2: Weathering Processes Action on Spilled Oil. Source: ITOPF 2002

5.0 OIL SPILL INTERACTION WITH SEA ICE

This section provides a summary of the potential ice conditions along the transportation route during the months of August to October and addresses potential effects of oil and fuel interactions and dispersion on ice covered waters in the event of a spill. The ADIOS model does not incorporate oil-ice interaction in its algorithms. Other models like the Oil Weathering Model (OWM) and Sea Ice-Ocean-Oilspill Modelling System (SIOMS) do, but they are still under development. The limited marine operation for the Project and the lack of data along the route limits the necessity and applicability of ice process-based models to this Project.

5.1 Sea Ice along the Transit Corridor

Hudson Bay is usually completely covered by ice by December or January and typically free of ice from August to October (Gagnon and Gough 2005). Sea ice in southwestern Hudson Bay typically does not breakup until well into the summer because winds and ocean currents tend to push large accumulations of ice into this region (Etkin 1991). The presence of sea ice into summer keeps waters of Hudson Bay at lower temperatures in comparison with other regions situated at similar latitudes. Hudson Bay is an enclosed bay sheltered by land with limited narrow access channels to larger ocean basins. Therefore, Hudson Bay water temperature, sea ice flows, and circulation are not strongly influenced by ice flows from other ocean basins. Instead, Hudson Bay dynamics are primarily controlled by local meteorological and micro-climate influences such as local wind and air temperature variations (Saucier and Dionne 1998; Gagnon and Gough 2005).

Ice melt starts in May and June, as an open water area develops along the northwestern shore, and a narrow coastal lead (i.e., space between ice floes, refer to Figure E-6) develops around the rest of the Bay. Open water starts to appear and expand around the shorelines in June and July. By the end of July, large patches of ice are limited to only the southern reaches of the Bay (CIS 2011). Figure E-3 shows that along the transportation route, the average ice break-up dates occur on July 2 for most of the route and on June 18 on the west side of Hudson Bay near Rankin Inlet.

Normal clearing of the pack ice progresses southward from the Chesterfield Inlet - Southampton Island area and westward from Eastern Hudson Bay. The melting of sea ice is a slow process which accelerates in July as air and water temperatures begin to warm with increased summer solar radiation. The ice pack in Hudson Bay typically breaks up into several large patches of ice prior to finally clearing in August (CIS 2011).

Sea ice typically begins to form along the northwestern shores of Hudson Bay in late October. Ice flows from Foxe Basin may also start to move into northeastern Hudson Bay in late fall. In November, the sea ice begins to accumulate and thicken as prevailing winds push it east and southeast toward the margins of the Bay. Finally, by December, Hudson Bay becomes covered with first-year ice, which continues to thicken into the winter months (CIS 2011).

In Hudson Strait, freeze-up starts as early as mid-October and as late as the first week of December as shown in Figure E-4, while complete clearing has occurred as early as late as July and as early as September. Sea ice in Hudson Strait and Ungava Bay is mostly formed locally but winds and currents can carry floes from Foxe Basin or Davis Strait into these areas. Freeze-up typically starts in western Hudson Strait and ice formation progresses eastward over the late fall months and cover the entire Hudson Strait by December (CIS 2011).

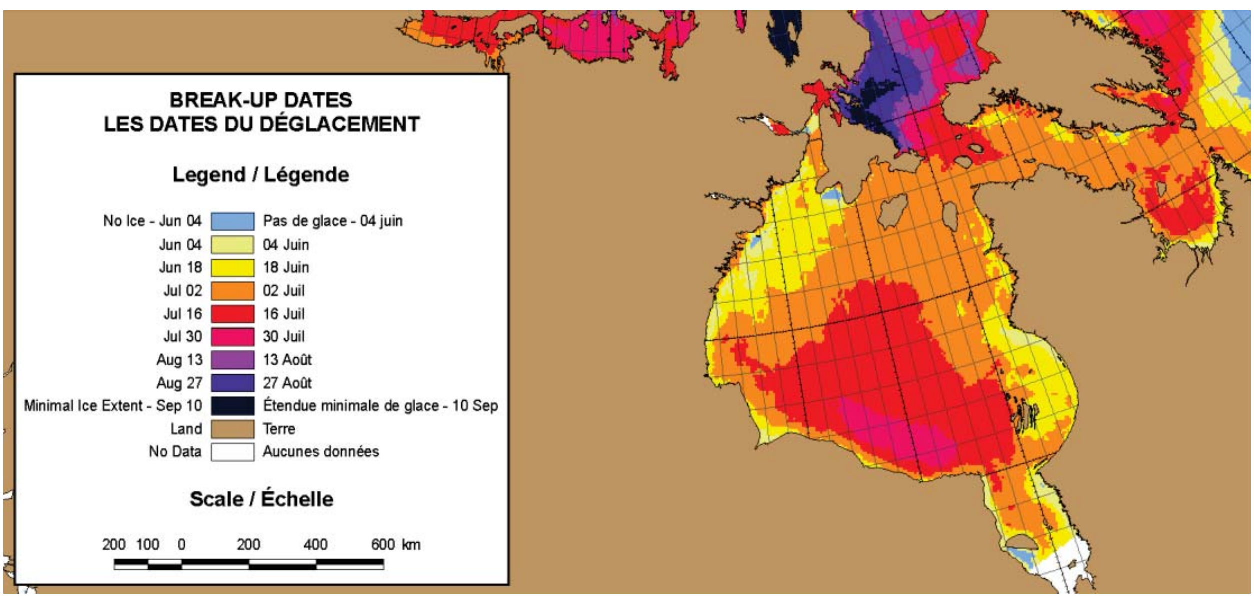


Figure E-3: Ice break-up and dates at Hudson Bay and Hudson Strait, source: CIS (2011)

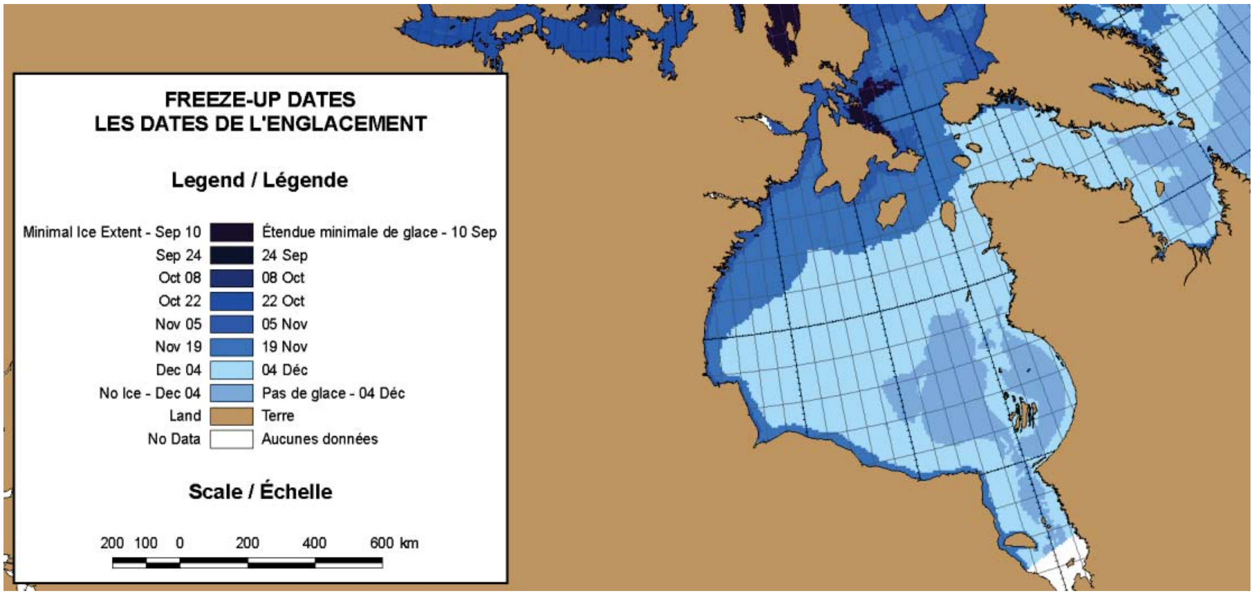


Figure E-4: Ice freeze-up dates at Hudson Bay and Hudson Strait, source: CIS (2011)

Ice-break up along the transportation route break-up occurs on June 18 in northwestern Hudson Bay in northeastern Hudson Bay as shown in Figure E-3. Therefore, early June and July are the months of greatest relevance in terms of potential oil spill interaction with sea ice.

The dates of ice freeze-up and break-up are derived from sea ice concentration data, which refers to the proportional surface area, covered by ice and is categorized over a range presented as fractional tenths (0 to 10/10). The ice break-up date represents the earliest day of the year when ice concentration reaches 5/10 or less. The ice freeze-up date represents the earliest day of the year when ice concentration reaches 5/10 or more (Gagnon and Gough 2005).

Figure E-5 presents ice concentration maps of Hudson Bay from July to November taken from the Sea Ice Climatic Atlas prepared by CIS (2011). The following observations are made from Figure E-5:

- In July (Figure E-5a), the median concentration of ice along the eastern portion of the transportation route is around 3-4/10 (open drift ice) and close pack fast ice (8-9/10) is expected on the northwest shoreline;
- The area within the route is considered ice-free for the months of August (Figure 8.2-B-4a), September (Figure E-5b) and October (Figure E-5c); and
- During November, freeze-up is expected on the northwest shoreline (4-9/10) and south shoreline of Southampton Island.

According to Dickins (2011), 1-5/10 drift ice conditions represent the greatest challenge in terms of spill containment and recovery. For ice concentrations of 6/10 and greater, spilled oil will tend to move at similar drift rates as sea ice. The intrusion of drift ice from Foxe Basin could interfere with Project vessels along the navigation route during the open water season from August to October.

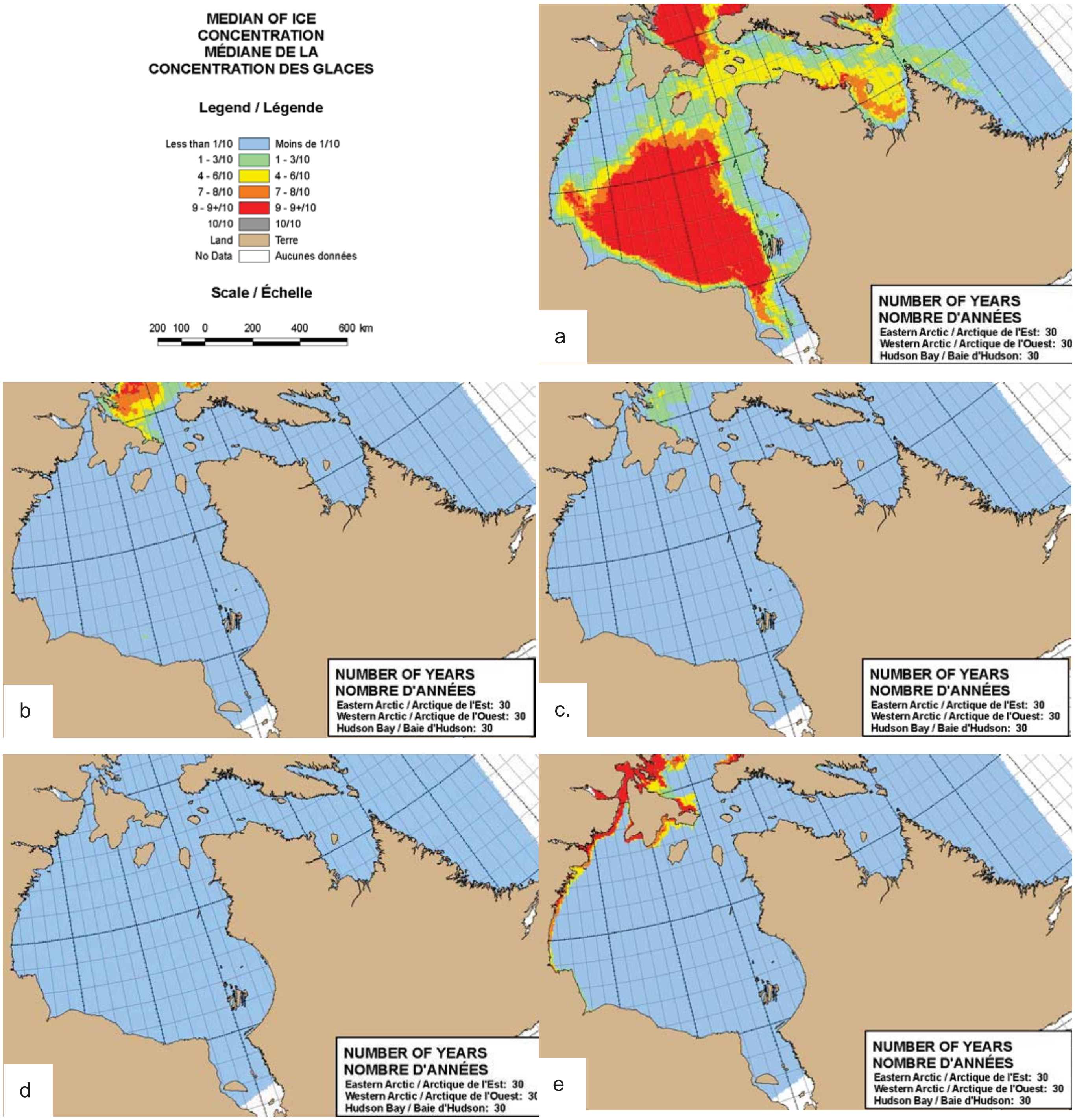


Figure E-5: Median of ice concentration in Hudson Bay and Hudson Strait during a) July, b) August, c) September, d) October and e) November, source: CIS (2011)

5.2 Ice Dispersion of a Potential Oil Spill

The behaviour of a spill in ice-covered waters is determined by the sea ice conditions at the time of the spill. Sea ice can be present in the seawater in multiple forms. A thorough understanding of the ice condition, ice coverage, energy conditions and the type of the spill and oil properties may help inform the study to determine the potential spill behaviour and fate and, consequently, improve the effectiveness for human response strategies to different spill events.

Several experiments described in Dickins (2011) have been designed to evaluate the response of the spill in different ice conditions: on and under drift and closed pack and fast ice, on surface melt pools, on snow and ice, in slush between floes, and under ice floes. Figure E-6 presents a schematic showing a range of ice and oil interactions resulting from oil spills in ice-covered waters.

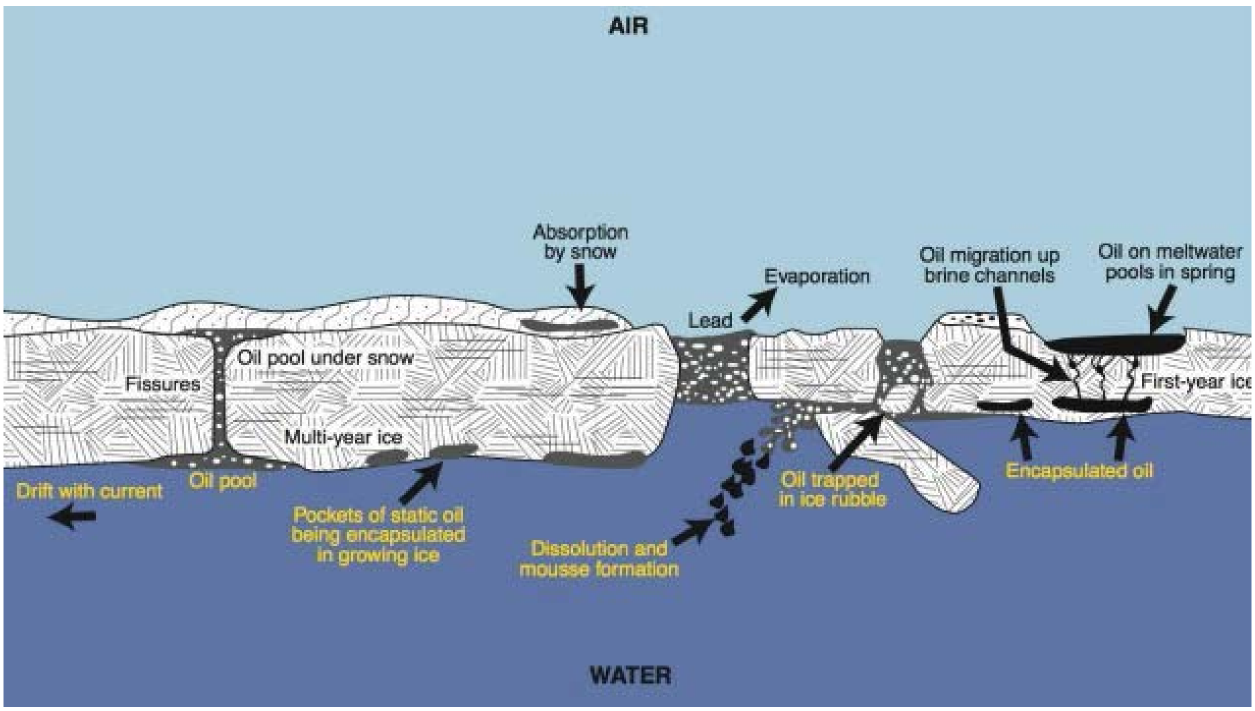


Figure E-6: Schematic showing ice and oil interactions (source: Dickins, 2011; derived from original sketch by A. Allen)

For the purposes of this study, the oil type P50 diesel fuel is examined. Some characteristics of P50 diesel are listed below:

- Most crude oils and light products such as diesel and gasoline experience significant evaporation (Potter et al. 2012);
- Small diesel spills usually evaporate and disperse naturally within a day for spills of 500 to 5,000 gallons, even in cold water (NOAA 2016);
- Diesel oil spreads very quickly to a thin film of rainbow and silver sheens (NOAA 2016);

- Diesel has a very low viscosity and is readily dispersed into the water column when winds reach 5-7 knots or with breaking waves (NOAA 2016);
- Since diesel is much lighter than seawater it is not possible to sink and accumulated on the seafloor (NOAA 2016);
- Wave action can disperse diesel to form droplets that are small enough to be kept in suspension and moved by the currents (NOAA 2016);
- Moderately volatile; will leave residue (up to one-third of spill amount) after few days (OSHA 2013);
- Moderate concentrations of toxic (soluble) compounds (OSHA 2013);
- Will “oil” intertidal resources resulting in potential for long-term contamination (OSHA 2013); and
- Cleanup can be very effective (OSHA 2013).

Table E-1 outlines different oil spill response methods for oil releases in cold and icy conditions, including a description of advantages and disadvantages for each method, as described by Lampala (2011).

Table E-1: Response Methods Used on Oil Spill Events

Method	Description
Mechanical recovery	From the environmental point of view, the mechanical recovery is usually considered as the most favorable oil spill combating method. Several skimmer types and techniques exist, but, because of variations in circumstances and climate conditions, ice coverage varies case-specifically and conditions may change even during response to a single incident, necessitating a toolbox of several response tools.
In-situ burning	*In situ* burning is particularly suitable for use in icy conditions, sometimes offering the best option for removal of surface oil. *In situ* burning of thick, fresh oil slicks can often be initiated very quickly through ignition of the oil with simple devices such as an oil-soaked sorbent pad. Oil from the water's surface can be removed efficiently and well via *in situ* burning: It is reported that the removal efficiency for thick slicks can exceed 90%. Oil removal rates of 2,000 m^3/hr can be achieved with a fire area of about 10,000 m^2.
Chemical Recovery	Dispersant chemicals work by enhancing the natural dispersion of the oil into the water column. A dispersant consists of a mixture of surfactants (surface-active agents) in a solvent. When applied to an oil slick, the surfactants will be positioned at the oil–water interface and contribute to formation of small oil droplets that will readily be mixed into the water column and be rapidly diluted and later biodegraded.
Bioremediation	Bioremediation is natural biodegrading of spilled oil, which to a certain extent can be accelerated through the addition of nutrients, oil-degrading bacteria, or both. Nutrient and bacteria addition has been tested, and some positive effects have been observed. It had been assumed that biodegrading does not occur in cold and icy conditions or is at least very slow; however, lab and field tests have shown that a low water temperature and even the presence of ice do not hamper the biodegrading of oil as much as expected. Nonetheless, it should be noted that bioremediation is a slow process that very seldom, if ever, can be considered as the primary countermeasure. The most beneficial use of bioremediation is as a secondary combating method that completes the recovery result after application of some other cleanup method.
Others	■ Use of vacuum pumps to suck oil between and under ice blocks. ■ Use of air bubbles to separate the oil and ice, with an air-induced current directing the oil into free water between ice blocks. ■ Use of propeller flow to direct oil under ice in the desired direction. ■ Creation of an ice boom to prevent drifting of oil in an undesired direction. ■ Use of specialized saw to cut slots in ice where oil can be removed.

Note:
The information in this table was derived from Lampala (2011).

In general, interactions between Project vessels and sea ice along the navigation route are predicted to be rare during the open- water season. However, changes in climate and larger scale weather patterns can result in variation to the typical break-up and/or freeze-up dates. Also, occasional incursions of drift ice from Foxe Basin and Davis Strait can be expected along the navigation route, particularly in Hudson Strait and Ungava Bay.

6.0 DIESEL FUEL SPILL SCENARIOS

For this analysis, we considered a worst case spill scenario of 20 ML (20,000 m^3) assuming all (100%) of the P50 diesel fuel carried on the ship was spilled. A second spill scenario was considered for 2 ML (2,000 m^3) based on the conservative assumption of 10% of the total P50 diesel fuel (20 ML) being carried on a single ship for the Project. Previous research indicates that spill volumes are best expressed as being equivalent to 5% to 10% of the total fuel being transported (McKenna and McClintock 2005; Coastal Ocean Resources 2013).Therefore, the 100% diesel spill assumed in the worst case scenario is extremely conservative and unlikely.

The Automated Data Inquiry for Oil Spills (ADIOS2), an oil weathering model (NOAA 2014), was used to provide estimates of the expected characteristics and behavior of fuel spilled in the marine environment. We analyzed a 20 ML and a 2 ML fuel spill at four locations in Melvin Bay and ten locations along the shipping route (Table E-2). Additional scenarios of 100,000 L (100 m^3) spills were analyzed at the four fuel transfer locations in Melvin Bay – as these represent smaller-scale spills that could occur during transfer of fuel from ship-to-ship or ship-to-shore. One of the main causes of fuel spills is related to navigational error where a tanker deviates from its planned track along the shipping route. The modelled scenarios assumed that the fuel spill would occur near the center of the main shipping lane and that ships would not deviate from this route (Figure E-1).

Table E-2: Hypothetical Fuel Spill Locations

Location Number	Location Name	UTM Zone	Easting (metres)	Northing (metres)
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546,173	6,961,117
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546,143	6,963,142
3	Shipping route south of Walrus Island	16	641,869	6,988,220
4	Shipping route north of Coats Island	17	456,430	7,000,031
5	Shipping route north of Ungava Peninsula	18	351,235	6,986,598
6	Shipping route in Eastern Hudson Strait	20	399,876	6,775,840
1A	West Melvin Bay	15	545,185	6,963,365
2A	East Melvin Bay	15	546,798	6,962,172
3A	Entrance to Melvin Bay	15	549,334	6,960,588
4A	West Hudson Bay	15	585,757	6,949,020
5A	Hudson Bay crossing	16	416,455	6,950,265
6A	Western Hudson Strait	18	546,017	6,967,899
7A	Mid-Hudson Strait	19	415,679	6,911,718
8A	Eastern Hudson Strait	19	570,404	6,842,009

6.1 Model Parameters

6.1.1 Extremal Analysis for Rankin Inlet and Coral Harbour Winds

Historical hourly wind records were obtained for Rankin Inlet (station ID: 71083) and Coral Harbour (station ID: 71915). The Rankin Inlet station is located at 62.82° N, 92.12° W at an elevation of 32.3 metres (m) above mean sea level (msl) and the Coral Harbour station is located at 64.78° N, 83.92° W at an elevation of 62.2 m above msl. Figure E-7 shows wind roses for the hourly record at Rankin Inlet from 1981 through 2012 for all wind measurements over the duration of the record (Figure E-7a) and for a filtered subset of only wind measurements made during the open water seasons (August to October) over the duration of the record (Figure E-7b). Figure E-8 shows wind roses for the hourly record at Coral Harbour for the same time period for all wind measurements over the duration of the record (Figure E-8a) and for a filtered subset of only wind measurements made during the open water seasons (August to October) over the duration of the record (Figure E-8b). In general, the prevailing wind direction at both sites is from the north-northwest (prevailing winds from 343° at both stations). The wind distribution observed between the full record and the record limited to open water seasons only are nearly identical at both stations. This indicates that there is no seasonal bias during the open water season that is not observed during the full annual distribution. Wind speed statistics were calculated for both stations and the results are shown in Table E-3 and Table E-4. Data were filtered for “0” values.

Wind speeds recorded at Rankin Inlet and Coral Harbour between 1981 and 2012 were used to determine probability distributions of wind speeds and their associated return periods. A peaks-over-threshold (POT) analysis was used to calculate the peak wind speeds of the largest storms during the 31-year record at each site. Extreme wind speeds were determined by filtering the record for peak wind speeds during storms with speeds greater than the 95 percentile value (Table E-3) sustained for at least 4 hours.

An extremal analysis following Leenknecht et al. (1992) was applied to the station record of extremes in order to determine the 5, 10, 25, 50 and 100-year wind speeds at the site. A time series of 77 maximum wind speeds measured during discrete storms between 1981 and 2012 were input to the extremal analysis. The analysis included the application of Fisher Tippett Type 1 (FT-1) and Weibull distributions to the peak water level time series. Results of the analysis for Rankin Inlet are summarized in Table E-5 and a plot of the Weibull distribution with shape parameter (k) = 1.15 is shown in Figure E-9. Results of the analysis for Coral Harbour are summarized in Table E-6 and a plot of the Weibull distribution with k = 2.00 shown in Figure E-10. The wind analysis indicates that the prevailing winds are from the north-northwest (343°) at both Rankin Inlet and Coral Harbour, while the extreme storm winds are from the north-northwest (343°) at Rankin Inlet and from the northeast (40°) at Coral Harbour. Therefore, wind direction for the 50-year storm should be applied as 343° for oil spill model points near Melvin Bay (represented by Rankin Inlet winds) and as 40° for oil spill model points along Hudson Strait (represented by Coral Harbour winds).

Table E-3: Wind Statistics for Rankin Inlet and Coral Harbour (1981-2012) in Metres/Second

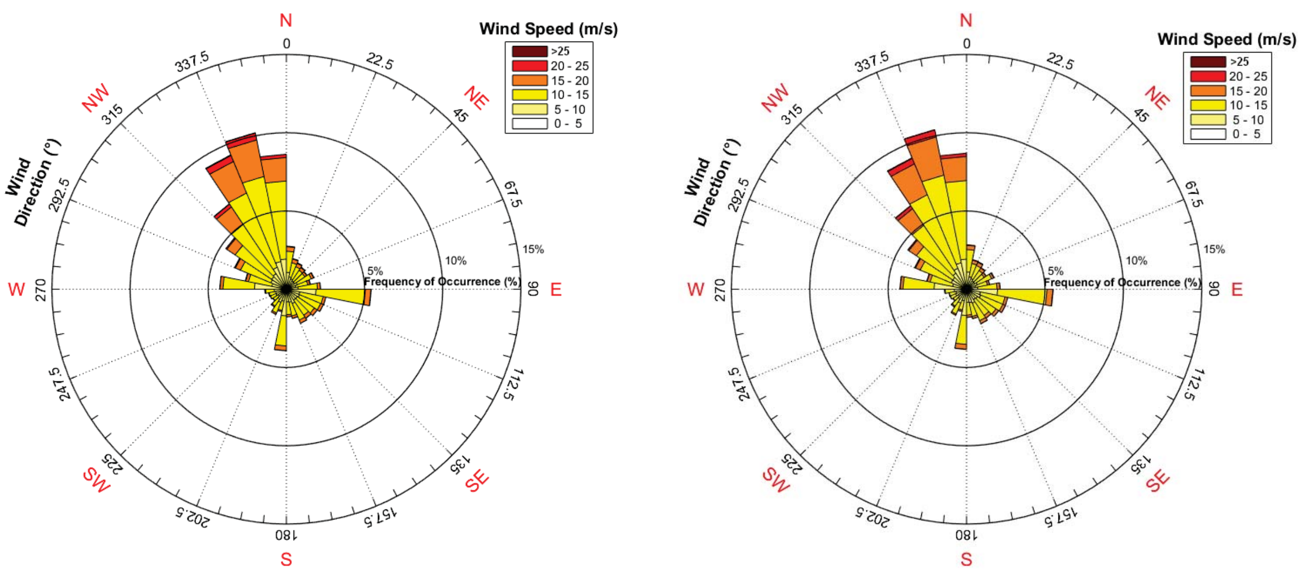
	Min	1%	5%	25%	Median	Mean	75%	95%	99%	Max	Std
Rankin Inlet	0.6	1.1	1.9	4.2	6.1	6.6	8.3	12.8	15.8	28.3	3.3
Coral Harbour	0.6	1.1	1.7	3.1	5.3	5.4	7.2	11.4	15.0	28.3	3.1

Minimum (Min), Maximum (Max), Standard Deviation (Std)

Table E-4: Wind Statistics for Rankin Inlet and Coral Harbour (1981-2012)

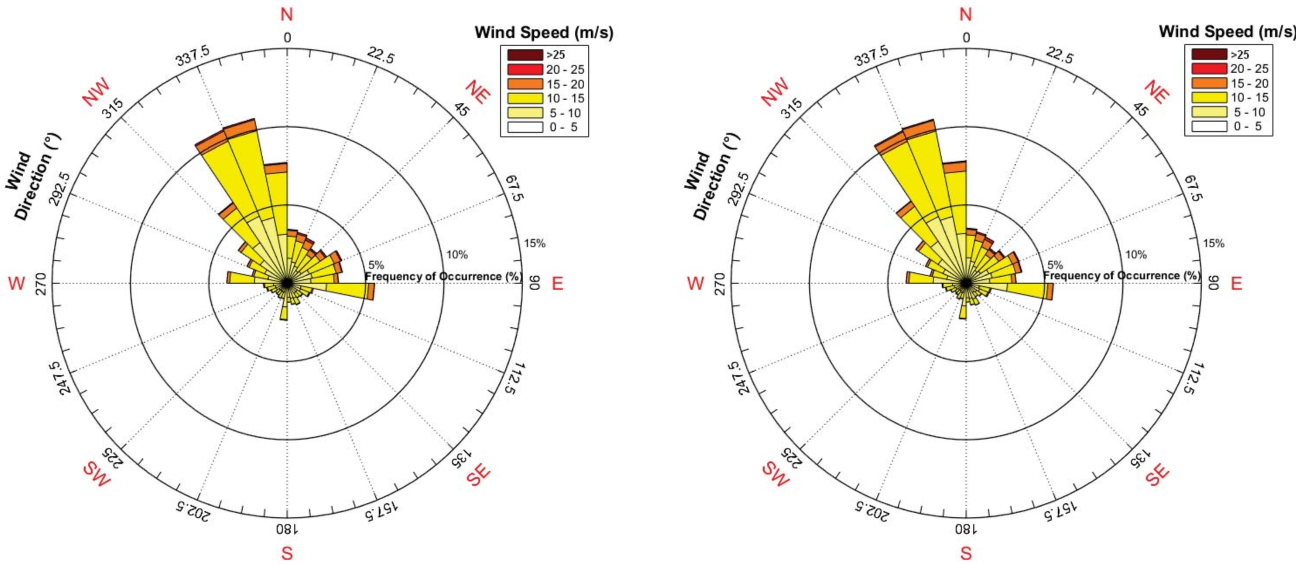
	Record Length	Missing	Number Invalid	% Invalid
Rankin Inlet	281,088	0	8,474	3%
Coral Harbour	280,608	480	23,285	8%

Invalid = “0” value



a. b.

Figure E-7: Wind Roses for Rankin Inlet from 01 October 1981 to 01 October 2012 for (a) all wind measurements and (b) wind measurements during the open water seasons only



a. *b.*

Figure E-8: Wind Roses for Coral Harbour from 01 October 1981 to 01 October 2012 for (a) all wind measurements and (b) wind measurements during the open water seasons only

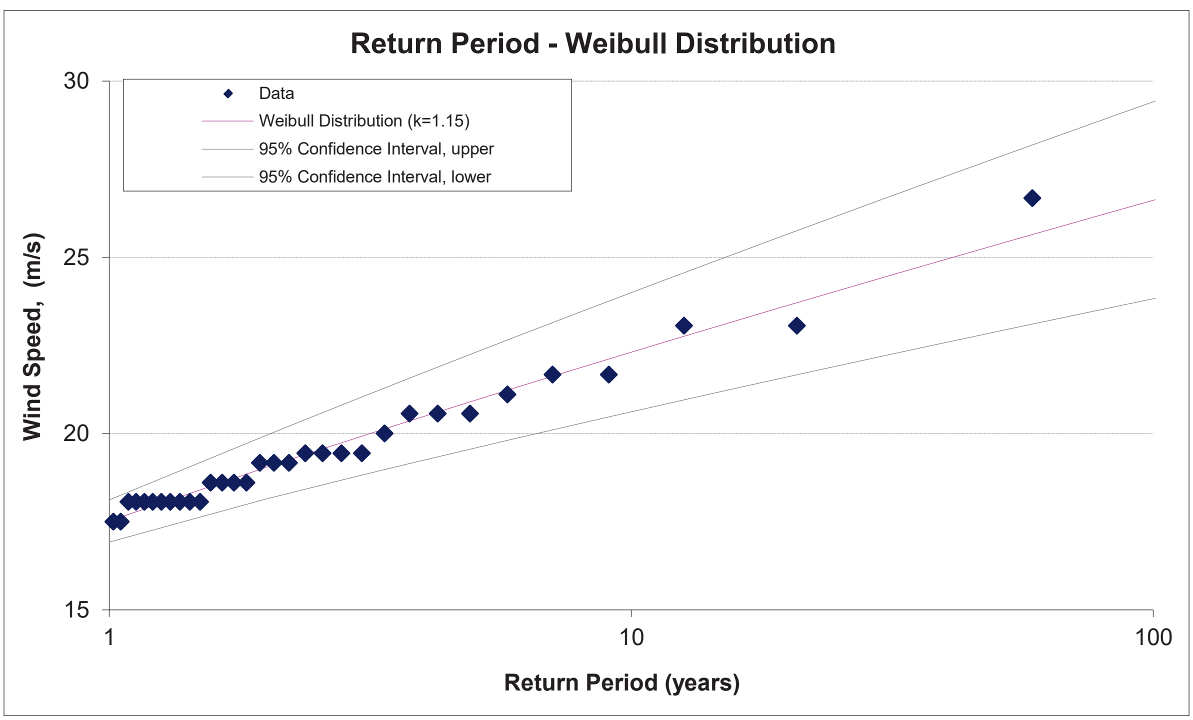


Figure E-9: Wind speed as a function of return period for a Weibull (k=1.15) distribution for Rankin Inlet wind record

Table E-5: Extreme Wind Speeds (m/s) and Associated Return Periods for Rankin Inlet

N= 77	Nu= 1.00					
NT= 77	K= 32	FT-I	Weibull	Weibull	Weibull	Weibull
Lambda=2.41			k= 0.75	k= 1.15	k= 1.49	k= 2.00
Correlation Coefficient		0.9880	0.9711	0.9918	0.9860	0.9708
Sum Square of Residuals		8.23	19.72	5.65	9.64	19.89
Return Period (yr)		m/s	m/s	m/s	m/s	m/s
	2	19.2	18.52	19.05	19.23	19.33
	5	20.8	20.59	20.94	20.92	20.80
	10	22.0	22.34	22.31	22.07	21.73
	25	23.6	24.85	24.06	23.46	22.82
	50	24.7	26.88	25.35	24.44	23.56
	100	25.9	28.20	26.62	25.03	24.00
Confidence Interval	Return Period (yr)	m/s	m/s	m/s	m/s	m/s
95 % C.I.	5	19.7 - 21.9	18.4 - 22.7	19.6 - 22.3	19.8 - 22.0	19.9 - 21.7
95 % C.I.	10	20.7 - 23.3	19.4 - 25.3	20.6 - 24.0	20.7 - 23.4	20.7 - 22.8
95 % C.I.	25	21.9 - 25.2	20.7 - 29.0	21.9 - 26.2	21.9 - 25.0	21.6 - 24.0
95 % C.I.	50	22.8 - 26.6	21.8 - 31.9	22.9 - 27.8	22.7 - 26.2	22.2 - 24.9
95 % C.I.	100	23.7 - 28.1	22.5 - 33.9	23.8 - 29.4	23.1 - 26.9	22.6 - 25.4

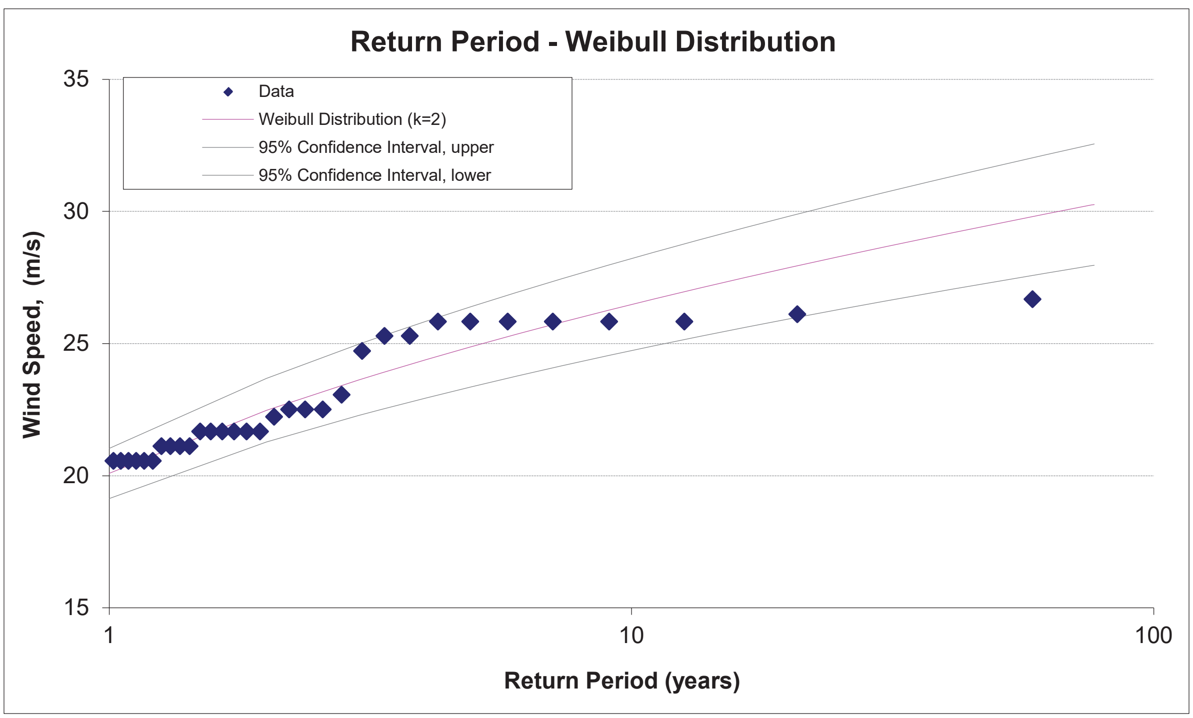


Figure E-10: Wind speed as a function of return period for a Weibull (k=2.00) distribution for Coral Harbour wind record

Table E-6: Extreme Wind Speeds (m/s) and Associated Return Periods for Coral Harbour

N= 77	Nu= 1.00					
NT= 77	K= 32	FT-I	Weibull	Weibull	Weibull	Weibull
Lambda=2.41			k= 0.75	k= 1.15	k= 1.49	k= 2.00
Correlation Coefficient		0.9580	0.8222	0.9195	0.9535	0.9757
Sum Square of Residuals		78.25	308.39	147.11	86.46	45.71
Return Period (yr)		m/s	m/s	m/s	m/s	m/s
	2	22.1	20.90	21.83	22.21	22.48
	5	24.8	23.80	24.74	24.92	24.92
	10	26.7	26.26	26.84	26.76	26.48
	25	29.2	29.79	29.54	28.99	28.29
	50	31.1	32.64	31.52	30.57	29.53
	100	32.9	34.49	33.47	31.52	30.26
Confidence Interval	Return Period (yr)	m/s	m/s	m/s	m/s	m/s
95 % C.I.	5	23.0 - 26.5	20.2 - 27.4	22.5 - 27.0	23.1 - 26.8	23.4 - 26.4
95 % C.I.	10	24.5 - 28.9	21.3 - 31.2	24.0 - 29.6	24.6 - 29.0	24.7 - 28.2
95 % C.I.	25	26.4 - 31.9	23.0 - 36.6	26.0 - 33.1	26.4 - 31.6	26.3 - 30.3
95 % C.I.	50	27.9 - 34.2	24.2 - 41.0	27.4 - 35.6	27.6 - 33.5	27.3 - 31.7
95 % C.I.	100	29.3 - 36.5	25.1 - 43.9	28.8 - 38.1	28.4 - 34.7	28.0 - 32.6

6.1.2 Spill Scenarios and Input Parameters

ADIOS2 predicts changes over time in the density, viscosity, and water content of diesel fuel, including evaporation and dispersion rates. The following assumptions were made for model set-up:

- ADIOS 2 diesel fuel oil (Canada), equivalent to P50;
- Spill of 100,000 L (100 m^3) and 2 ML (2,000 m^3) for near-shore spills;
- Spill of 2 ML (2,000 m^3) for shipping route spills;
- Spill of 20 ML (20,000 m^3) for shipping route spills;
- Sea salinity of 32 parts per thousand (ppt);
- Surface water and diesel fuel temperature of 5° Celsius (C);
- Sediment load of 5 milligrams per litre (mg/L);
- Spill occurs near the center of the proposed shipping lane; and
- Spill scenarios assume no mitigation.

Winds and waves are generally the driving physical forces used to determine the oil drift slick speed and distance travelled (DNV 2011). Golder analyzed winds from Rankin Inlet and Coral Harbour and performed an extremal analysis for 31-years of hourly data (Section 6.1.1). For modeling simulations, Golder used mean, 2-year, and 50-year wind conditions. For the 31-year record, the majority of the winds from both stations originated from 343° (North-Northwest). The extreme winds at Rankin Inlet also originate from North-Northwest (typically 343°), but the extreme winds at Coral Harbour originate from the northeast (typically 40°). For all scenarios except the 50-year extreme wind scenario, the fetch was measured along the axis of prevailing wind direction from 343° to 163°. The 50-year extreme wind scenario was measured along the axis of the dominant wind direction. In Rankin Inlet, extreme winds typically blow from 343° to 163° and this wind alignment would be applicable for points in Melvin Bay and Hudson Bay (points 1, 1A, 2, 2A, 3A, 4A, and 5A). At Coral Harbour, extreme winds blow from 40° to 220° and this wind alignment would be applicable for points along Hudson Strait (points 3, 4, 5, 6A, 7A, 8A and 6). Wind-related model parameters (i.e., fetch, distance to shore, and wind speeds) for the hypothetical fuel spill locations are provided in Table E-7. Summary tables and figures from the ADIOS2 model simulations inputs and outputs are provided in Attachment A.

Table E-7: Wind Related Model Parameters for Spill Scenarios along Shipping Route

Location (Number)	Fetch (km)			Distance to Shore (km)			Wind Speed (m/s)		
	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Ship-to-ship fuel transfer (1)	0.5	Mean[1]	Mean[1]	0.9	Mean[1]	Mean[1]	6.6	19.0	25.4
Ship-to-shore fuel transfer (2)	0.4	Mean[1]	Mean[1]	0.4	Mean[1]	Mean[1]	6.6	19.0	25.4
West Melvin Bay (1A)	0.9	Mean[1]	Mean[1]	0.6	Mean[1]	Mean[1]	6.6	19.0	25.4
East Melvin Bay (2A)	1.3	Mean[1]	Mean[1]	0.3	Mean[1]	Mean[1]	6.6	19.0	25.4
Walrus Island (3)	43	Mean[1]	134	55	Mean[1]	760	5.4	22.5	29.5
Coats Island (4)	58	Mean[1]	50	23	Mean[1]	22	5.4	22.5	29.5
Ungava Peninsula (5)	16	Mean[1]	24	46	Mean[1]	106	5.4	22.5	29.5
Eastern Hudson Strait (6)	26	Mean[1]	775	46	Mean[1]	325	5.4	22.5	29.5

Location (Number)	Fetch (km)			Distance to Shore (km)			Wind Speed (m/s)		
	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Entrance to Melvin Bay (3A)	2	Mean[1]	Mean[1]	12	Mean[1]	Mean[1]	6.6	19	25.4
West Hudson Bay (4A)	14	Mean[1]	Mean[1]	700	Mean[1]	Mean[1]	6.6	19	25.4
Hudson Bay crossing (5A)	148	Mean[1]	Mean[1]	857	Mean[1]	Mean[1]	6.6	19	25.4
Western Hudson Strait, Charles Island (6A)	183	Mean[1]	115	20	Mean[1]	21	5.4	22.5	29.5
Mid-Hudson Strait (7A)	45	Mean[1]	29	160	Mean[1]	93	5.4	22.5	29.5
Eastern Hudson Strait, north Ungava Bay (8A)	47	Mean[1]	48	305	Mean[1]	164	5.4	22.5	29.5

Notes:
1. Cells listed as "Mean" indicates that cell values are equivalent to the mean wind case values.

The 2 ML and 20 ML spill scenarios were each modelled with and without the influence of currents on the slick trajectory. A summary of the predominant current velocities at each location is presented in the results table in Section 6.3, Table E-9 through Table E-11. A background literature review was conducted to provide the oceanographic conditions along the shipping route with particular attention to the surface currents along the route. Current velocity along the western portion of the shipping route (Rankin Inlet to Coats Island) is predominantly forced by tides running along the axis of the route, but the eastern portion of the route through Hudson Strait east of Coats Island is dominated by the cyclonic circulation forcing a current to the east-southeast (Drinkwater 1986; Drinkwater 1988; Saucier et al 2004). South of the proposed shipping route in Hudson Bay, currents have been modelled to predict the seasonal cycle of water masses and sea ice by Saucier et al. (2004) and Wang et al. (1994). Currents from the Arctic Ocean flow around both sides of Southampton Island from the north (Ingraham and Prisenburg 1998). Coastal currents flow counter-clockwise along the southwestern portion of Hudson Bay towards James Bay, north along the eastern coast of Hudson Bay and through the southern Hudson Strait into the Labrador Sea. The surface eddy current is strongest during ice-free periods and reaches 15 to 20 centimetres per second (cm/s) (Saucier et al. 2004) in northeastern Hudson Bay. Current enters into Hudson Strait from the Atlantic along the southern shore of Baffin Island and exits along the northern shore of Quebec (Drinkwater 1986; Drinkwater 1988; Ingraham and Prisenburg 1998; Straneo and Saucier 2008). In the center of Hudson Strait there is a cyclonic pattern which brings the current across the channel from the north to south. Figure E-11 provides an overview of circulation patterns for the region, adapted from Straneo and Saucier (2008) and Drinkwater (1986).

Current data are available at several mooring locations in Hudson Strait and west of Southampton Island from the MERICA (*etudes des MERs Interieures du Canada*) 2003 to 2007 oceanographic data collection program (DFO 2015). Surface current data from representative sites were used to supplement or verify the literature review.

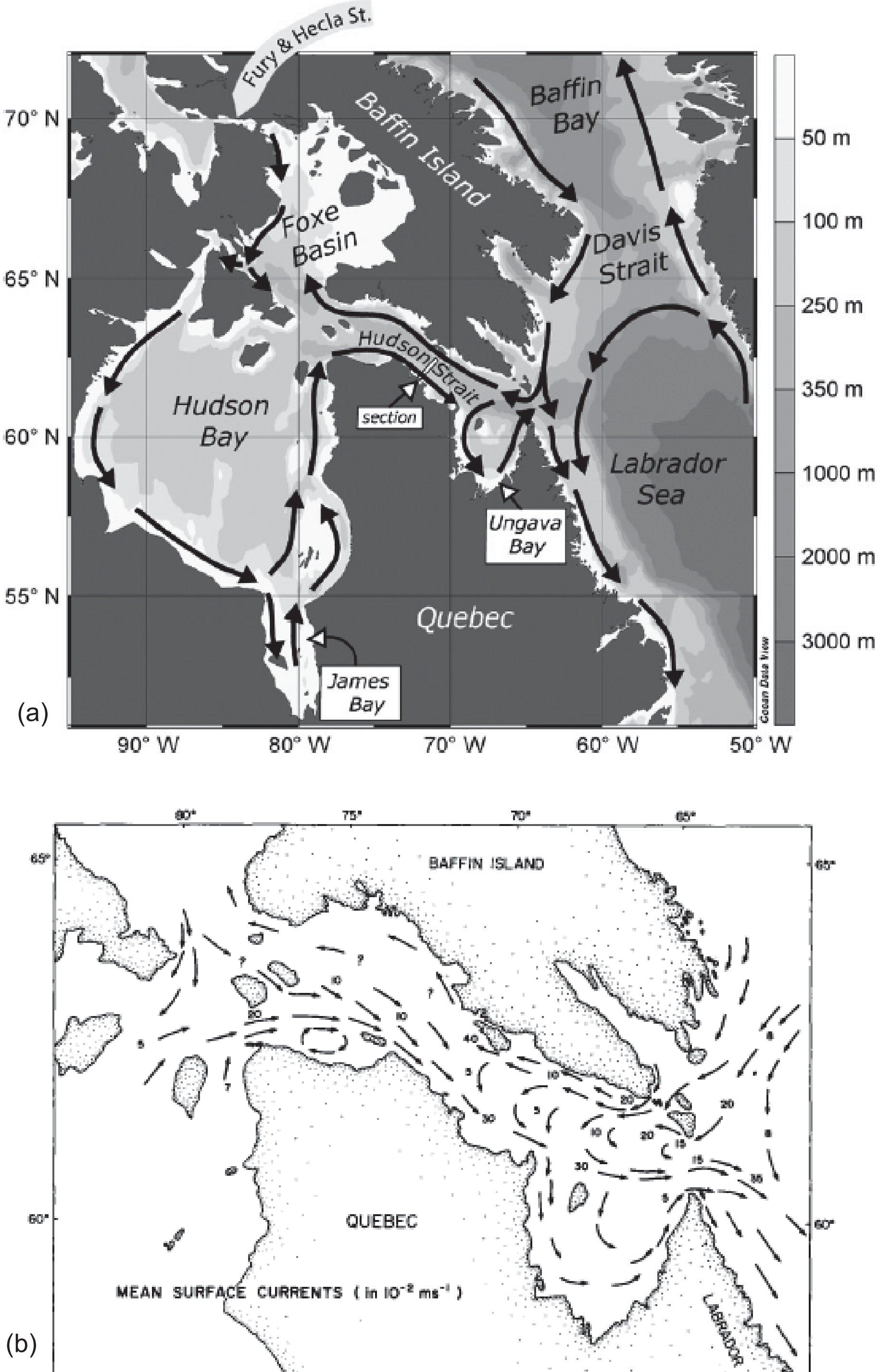


Figure E-11: (a) Hudson Bay system bathymetry and schematic circulation. Source: Straneo and Saucier 2008 and (b) Surface circulation in Hudson Strait and Ungava Bay. Source: Drinkwater 1986

Mean surface currents were considered at the locations along the shipping route when available. No information on currents in Melvin Bay near Rankin Inlet were available, therefore, no currents were applied to locations 1, 2, 1A, 2A, or 3A in the calculations. For the purpose of this analysis, predominant current direction and velocity at each location were used based on the availability of data, influence of currents on dispersion, and periodicity of the tides. Peak tidal currents were not considered because the tides are semi-diurnal and would switch direction multiple times during the course of a potential oil spill which could continue weathering for 12 hours or longer.

Currents were not input into the ADIOS2 model because these scenarios were considered instantaneous releases of fuel and each part of the slick would therefore experience the same net displacement (Lehr et al. 2002). The input of currents into the ADIOS2 model is generally used for modeling a spill from a fixed point such as an offshore platform. Mean surface currents were used for calculation of the slick velocity as a vector sum in combination with drift resulting from wind velocity.

6.1.3 Modelling Methodology

The ADIOS2 model output provided weathering half-life, and equations presented by the Australian Maritime Safety Authority were used to calculate the time for a spill to reach shore and the quantity of fuel from a spill that would be deposited on shore (DNV 2011). The quantity and proportion of fuel deposited on shore was determined after calculating the quantity of fuel remaining in the slick at the shore. The time between the occurrence of the spill and the slick initially reaching the shore (T_{shore}) depends primarily on the distance to shore (D_{zone}), wind velocity in the direction of the shore (V_{wind}), and the slick's velocity represented as a fraction (3%) of the wind velocity (RV_{drift}) (DNV 2011):

$$T_{shore} = \frac{D_{zone}}{V_{wind} RV_{drift}}$$

The quantity remaining in the slick (Q_s) relates to the original spill quantity (Q), weathering half-life to the quantity of fuel remaining (H), and time to shore (T_{shore}) (DNV 2011).

$$Q_s = Q * 2^{-T_{shore}/H}$$

For the scenarios where the mean surface current was considered, the slick velocity was calculated as a vector combination of the wind velocity and the current velocity:

$$V_{slick} = V_{wind} RV_{drift} + V_{current} RV_{drift}$$

Studies have found that slick transport due to surface currents is typically 60% (RV_{drift}) of the ambient current speed (Blaikley et al 1977): A new distance to shore was calculated based on the trajectory of the slick (V_{slick}) and used to determine the quantity deposited on shore.

6.2 Spills near Melvin Bay

The spill scenarios in Melvin Bay were completed for three different spill volumes: 100,000 L, 2 ML, and 20 ML, representing an average spill scenario, a large but low-probability spill scenario (10% spilled from a large tanker), and a worst case spill scenario (100% spilled from a large tanker), respectively. The weathering half-life (time required for removal of 50% of the diesel fuel from the sea surface) was determined using the ADIOS2 model. The amount of time it would take for a fuel spill to reach the shoreline given anticipated wind effects was then determined (originating from approximately 343º from the spill location) (Table E-8) along with the proportion of fuel estimated to be deposited on shore under the different spill scenarios.

Weathering characteristics for a 2 ML fuel spill are shown in Figure E-12. This figure illustrates the amount of fuel that would evaporate and disperse over time following the initial spill. For all spill scenarios considered at the fuel transfer locations near Melvin Bay, the weathering half-life was determined to be < 35 h. The time required for the spill to reach shore varied from approximately 6 minutes (min) (0.1 h) to 1 h 20 min. For all sites in Melvin Bay, it was determined that between 89% and 100% of the total volume of spilled diesel fuel would reach shore assuming no responsive mitigation occurred.

Table E-8: Distance to Shore, Weathering Half-Life, Time to Shore, and Estimated Percent of Spill Deposited on Shore for 100,000 L, 2 ML, and 20 ML Diesel Fuel Spill Scenarios in Melvin Bay

Location	Spill Amount (L)	Distance to Shore (km)	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Ship-to-ship fuel transfer (1)	100,000	0.9	7.8	3.4	2.7	1.3	0.4	0.3	89%	91%	92%
Ship-to-ship fuel transfer (1)	2,000,000	0.9	18.5	9.2	6.9	1.3	0.4	0.3	95%	97%	97%
Ship-to-ship fuel transfer (1)	20,000,000	0.9	34.8	16.1	14.8	1.3	0.4	0.3	98%	98%	98%
Ship-to-shore fuel transfer (2)	100,000	0.4	7.8	3.4	2.7	0.6	0.2	0.1	95%	96%	96%
Ship-to-shore fuel transfer (2)	2,000,000	0.4	18.5	9.2	6.9	0.6	0.2	0.1	98%	99%	99%
Ship-to-shore fuel transfer (2)	20,000,000	0.4	34.8	16.1	14.8	0.6	0.2	0.1	99%	99%	99%
West Melvin Bay (1A)	100,000	0.6	8	3.5	2.7	0.8	0.3	0.2	93%	94%	95%
West Melvin Bay (1A)	2,000,000	0.6	18.5	8.7	6.9	0.8	0.3	0.2	97%	98%	98%
West Melvin Bay (1A)	20,000,000	0.6	33.7	16.5	17.4	0.8	0.3	0.2	98%	99%	99%
East Melvin Bay (2A)	100,000	0.3	8	3.5	2.7	0.4	0.1	0.1	97%	97%	97%

Location	Spill Amount (L)	Distance to Shore (km)	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
East Melvin Bay (2A)	2,000,000	0.3	18.5	8.7	6.9	0.4	0.1	0.1	99%	99%	99%
East Melvin Bay (2A)	20,000,000	0.3	33.7	16.5	17.4	0.4	0.1	0.1	99%	99%	100%

km (kilometre); yr (year); h(hour); L (liter)

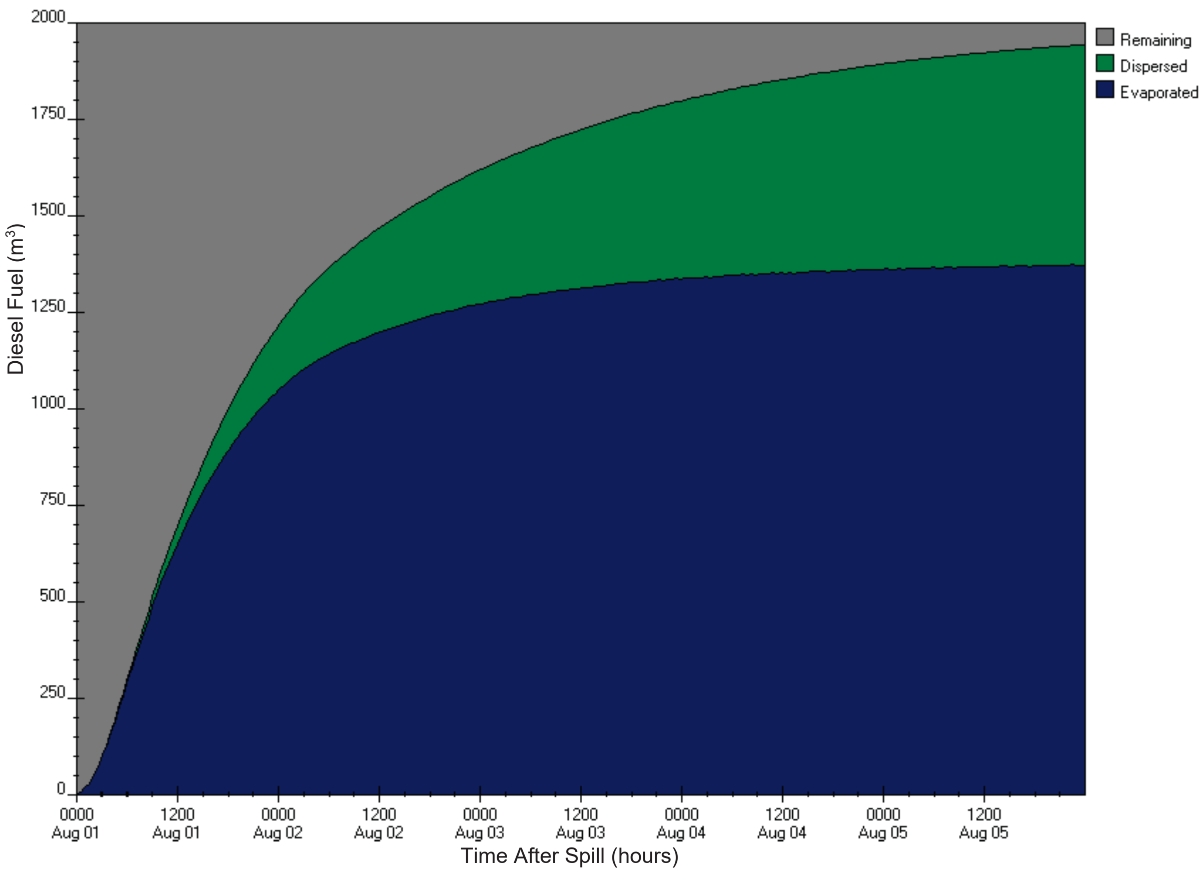
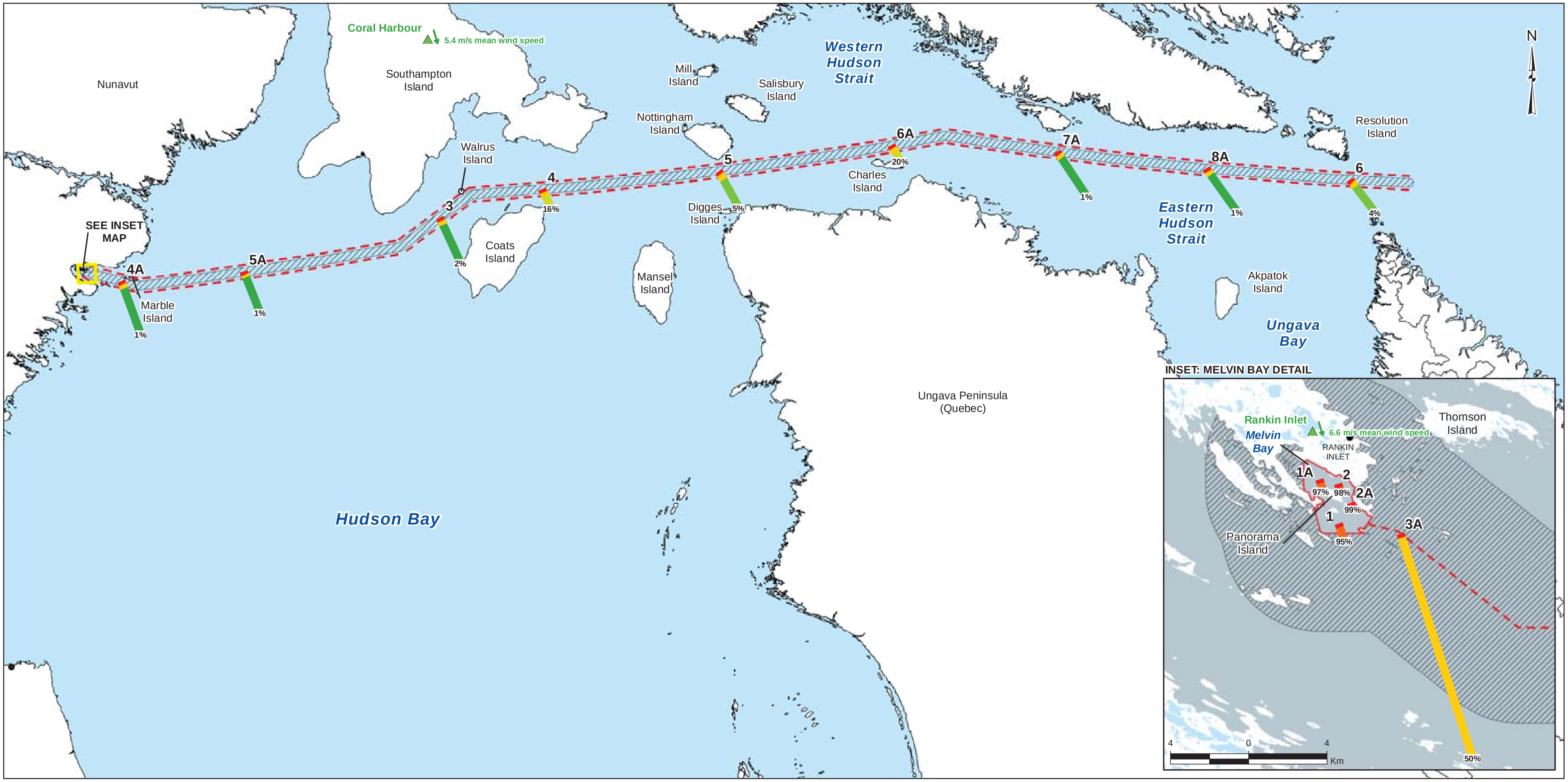


Figure E-12: Weathering Characteristics of a 2 ML Diesel Fuel Spill in Melvin Bay under Mean Wind and Wave Conditions



LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, MEAN WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-13	
REVIEW	LY	06 Jan. 2016		

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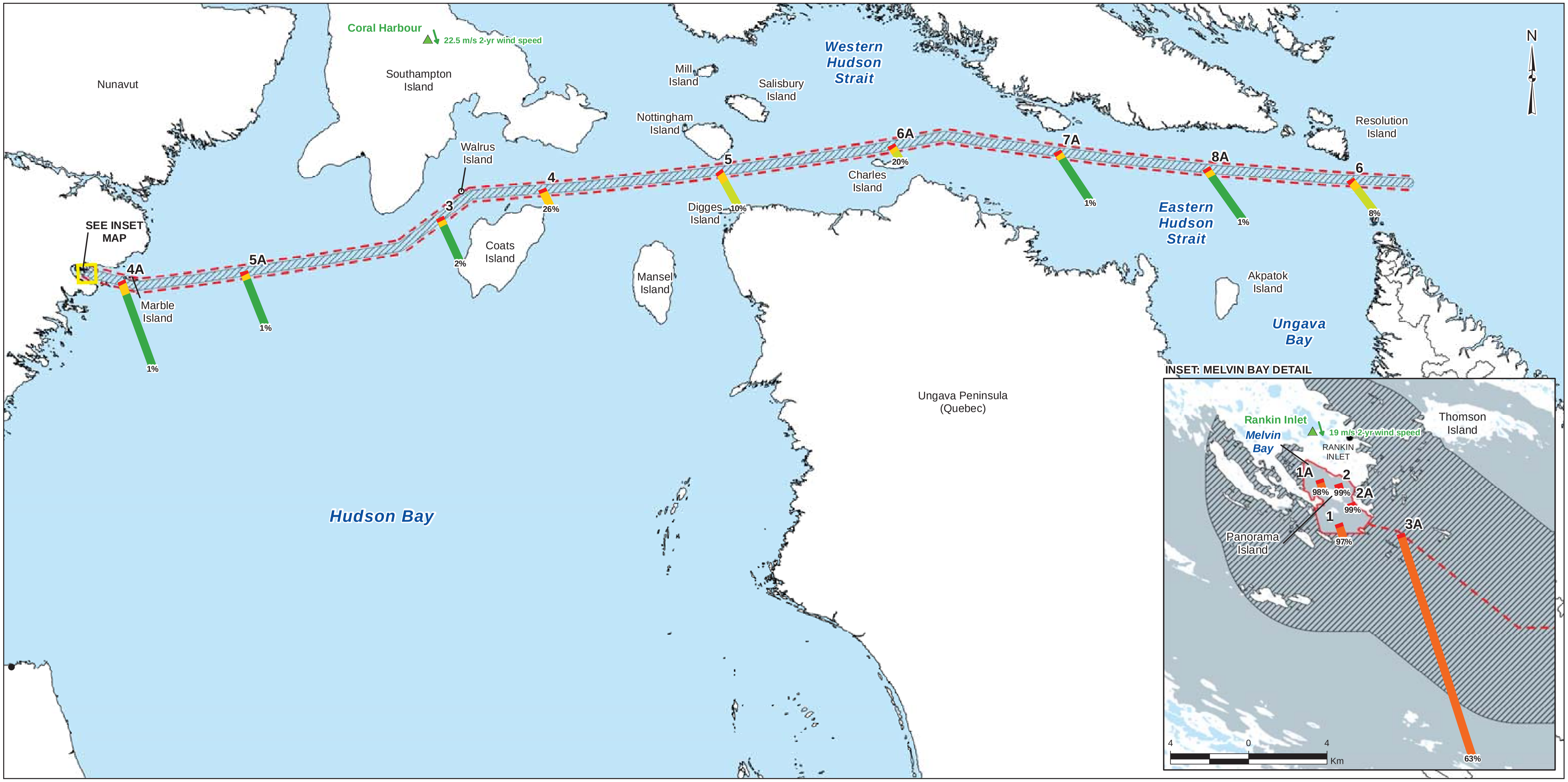

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 2-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-14	
REVIEW	LY	06 Jan. 2016		

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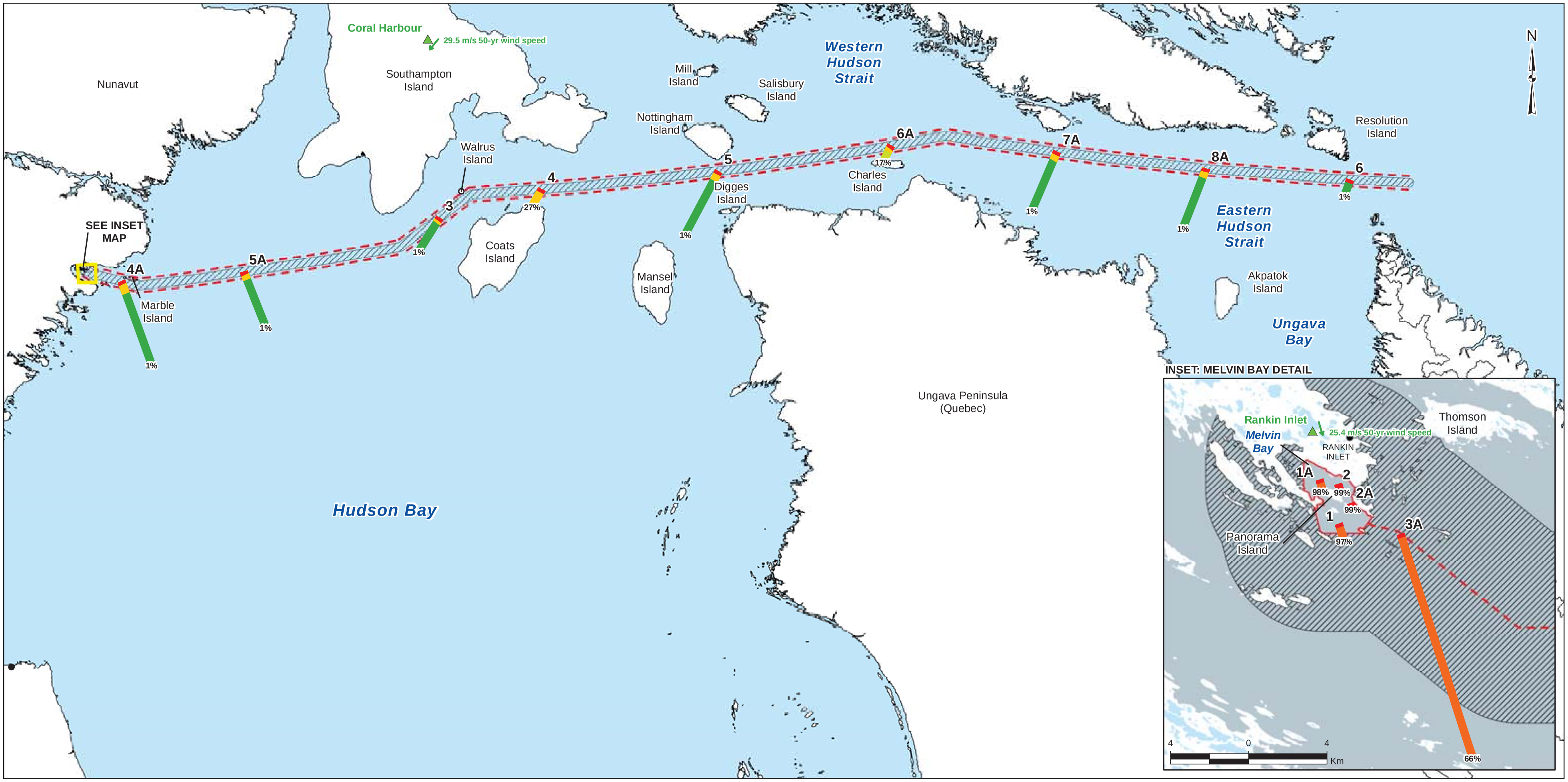

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 50-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.	1535029		FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-15	
REVIEW	LY	06 Jan. 2016		

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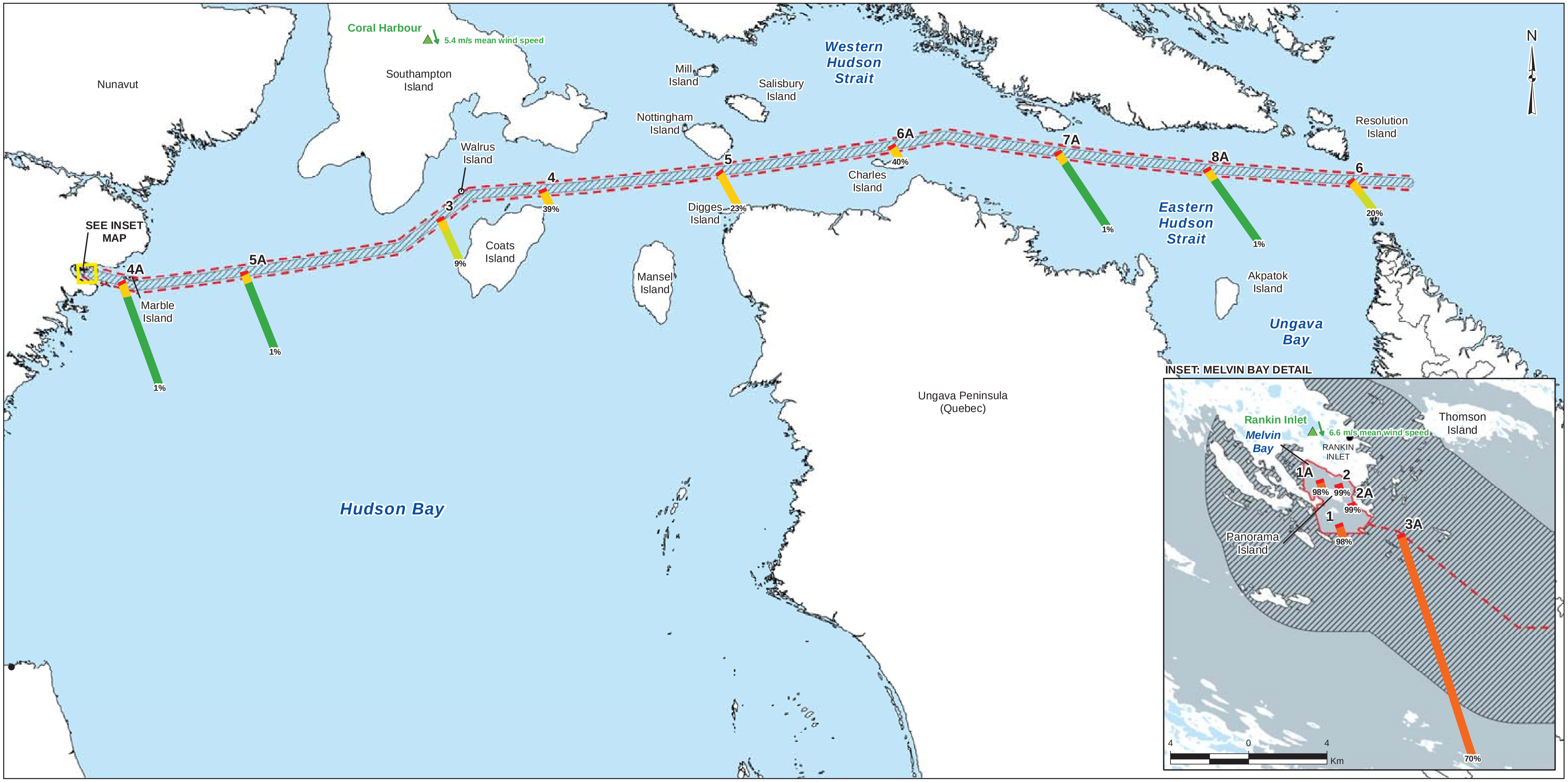

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, MEAN WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN REV. A
GIS	CDB	06 Jan. 2016	
CHECK	JC	06 Jan. 2016	FIGURE E-16
REVIEW	LY	06 Jan. 2016	

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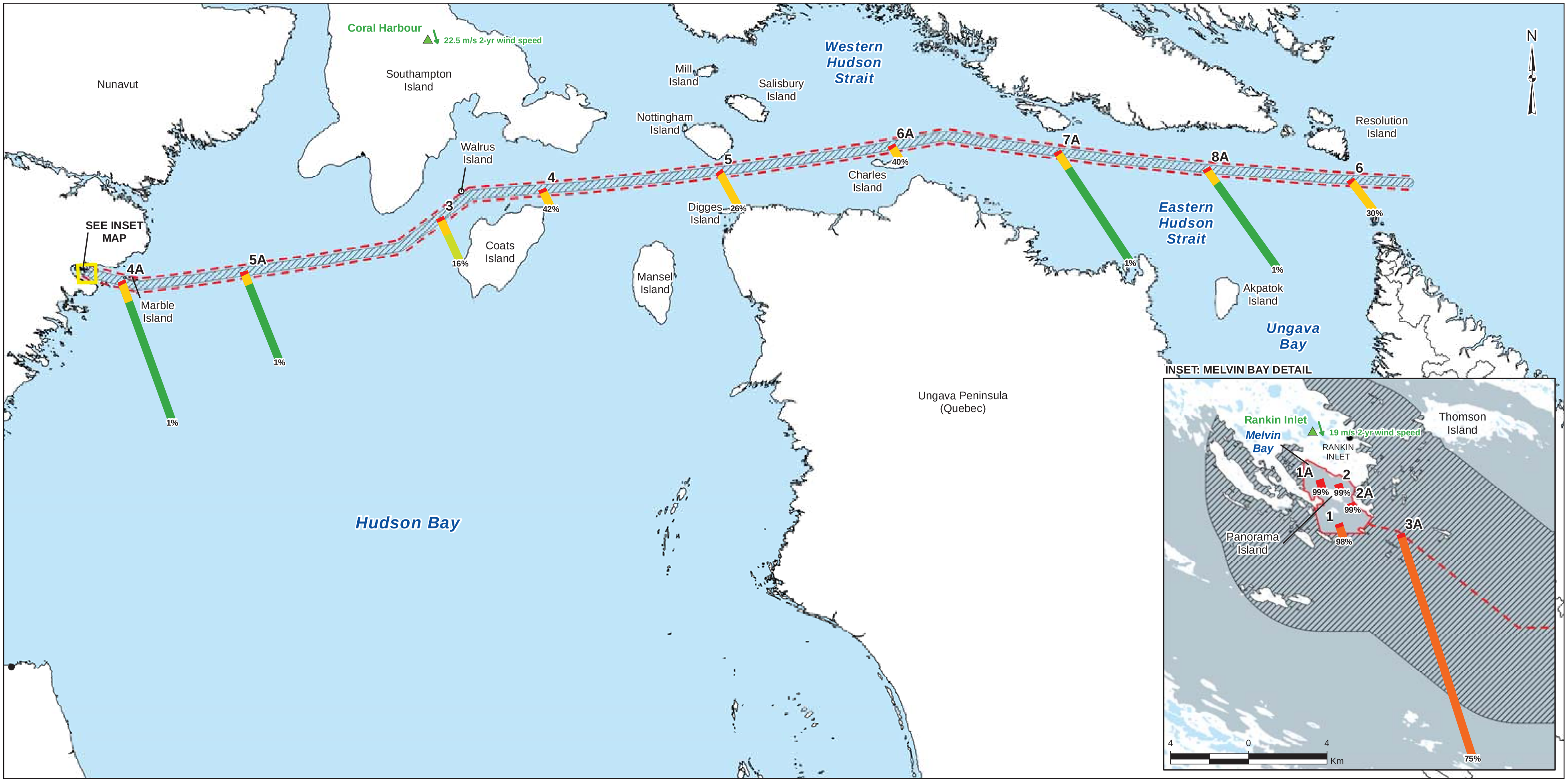

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 2-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-17	
REVIEW	LY	06 Jan. 2016		

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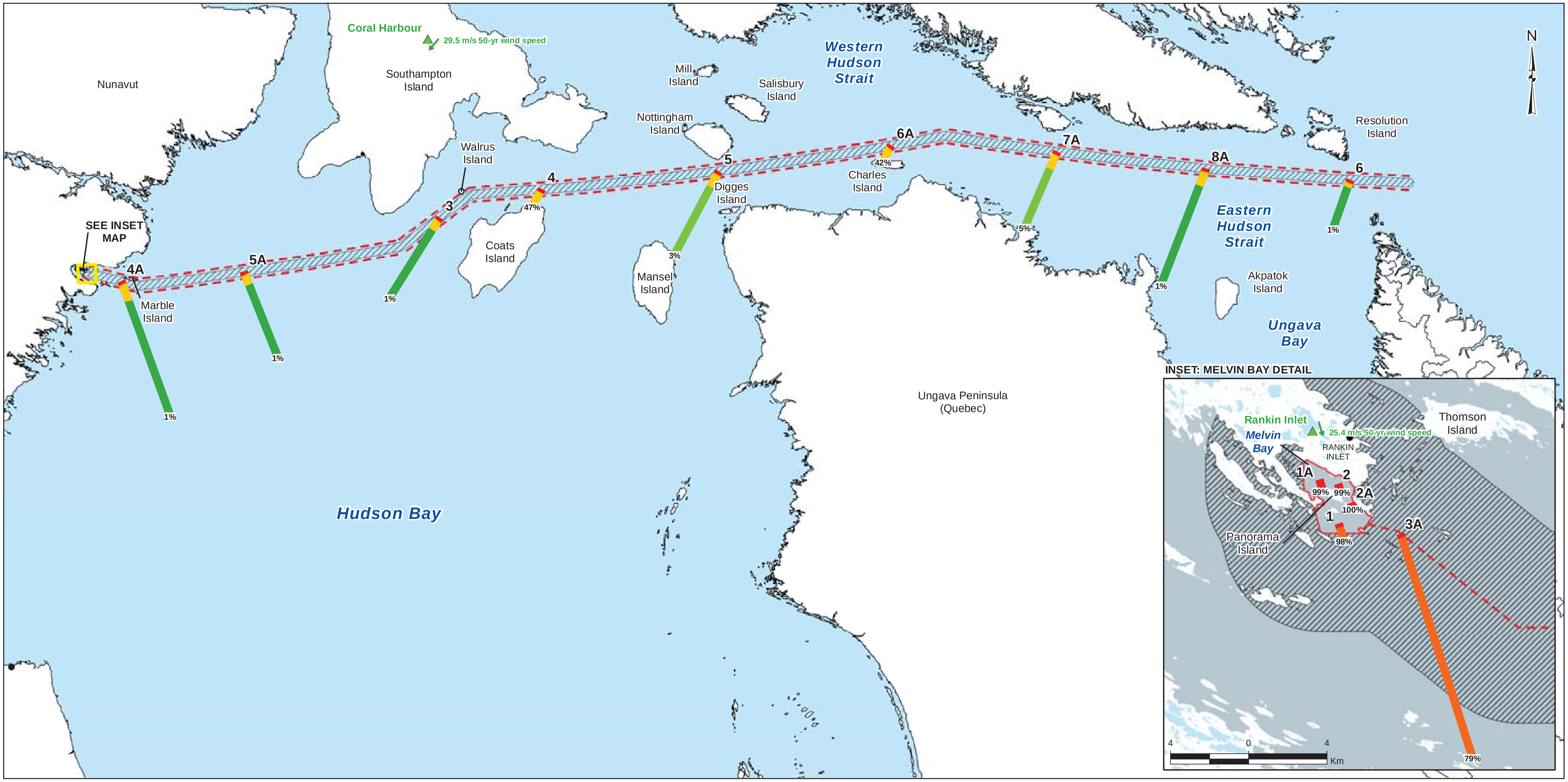

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

• LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
• WIDTH OF LINE IS NOT TO SCALE
• ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 50-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016	FIGURE E-18	
CHECK	JC	06 Jan. 2016		
REVIEW	LY	06 Jan. 2016		

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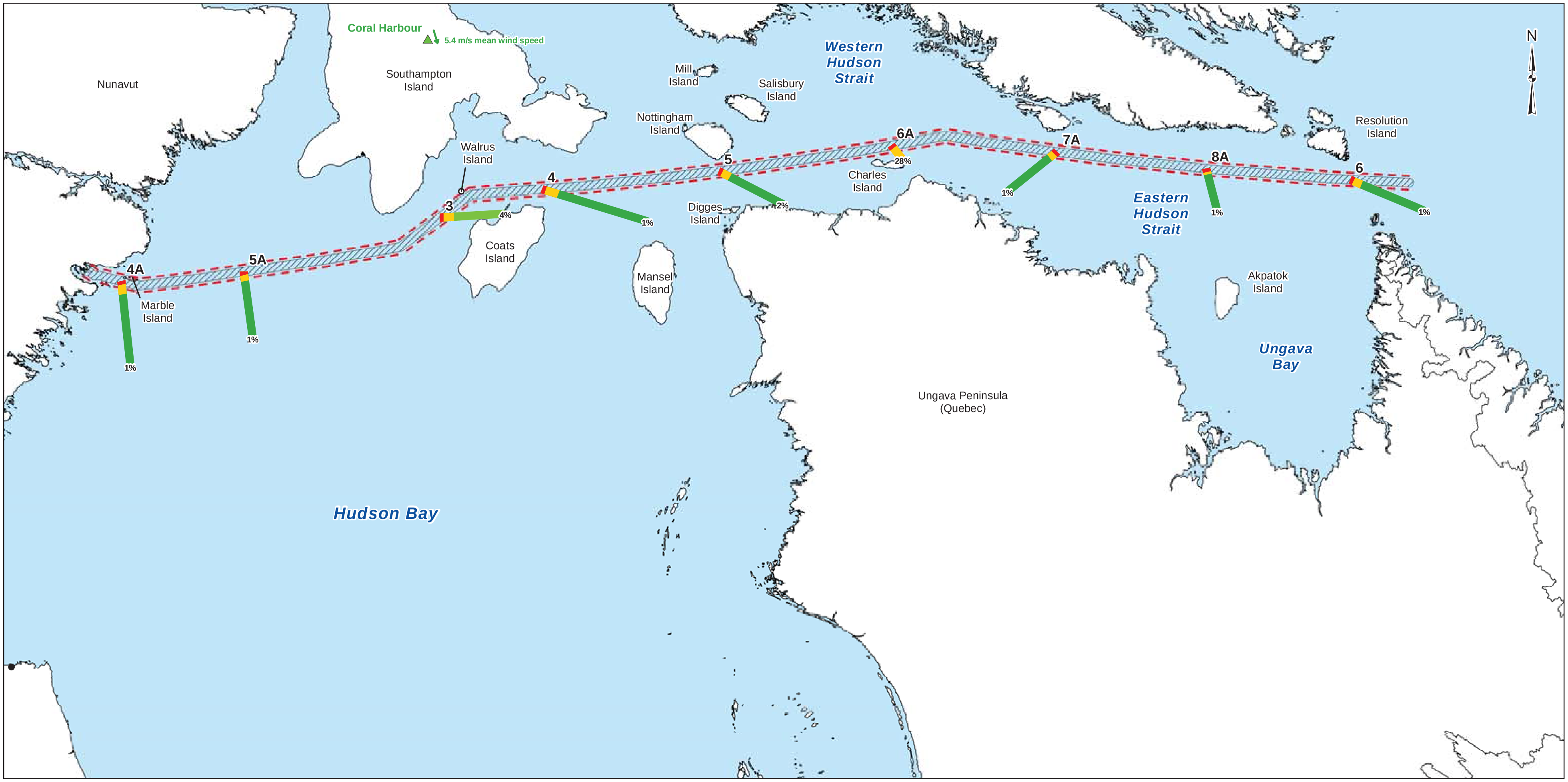

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, MEAN WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-19	
REVIEW	LY	06 Jan. 2016		

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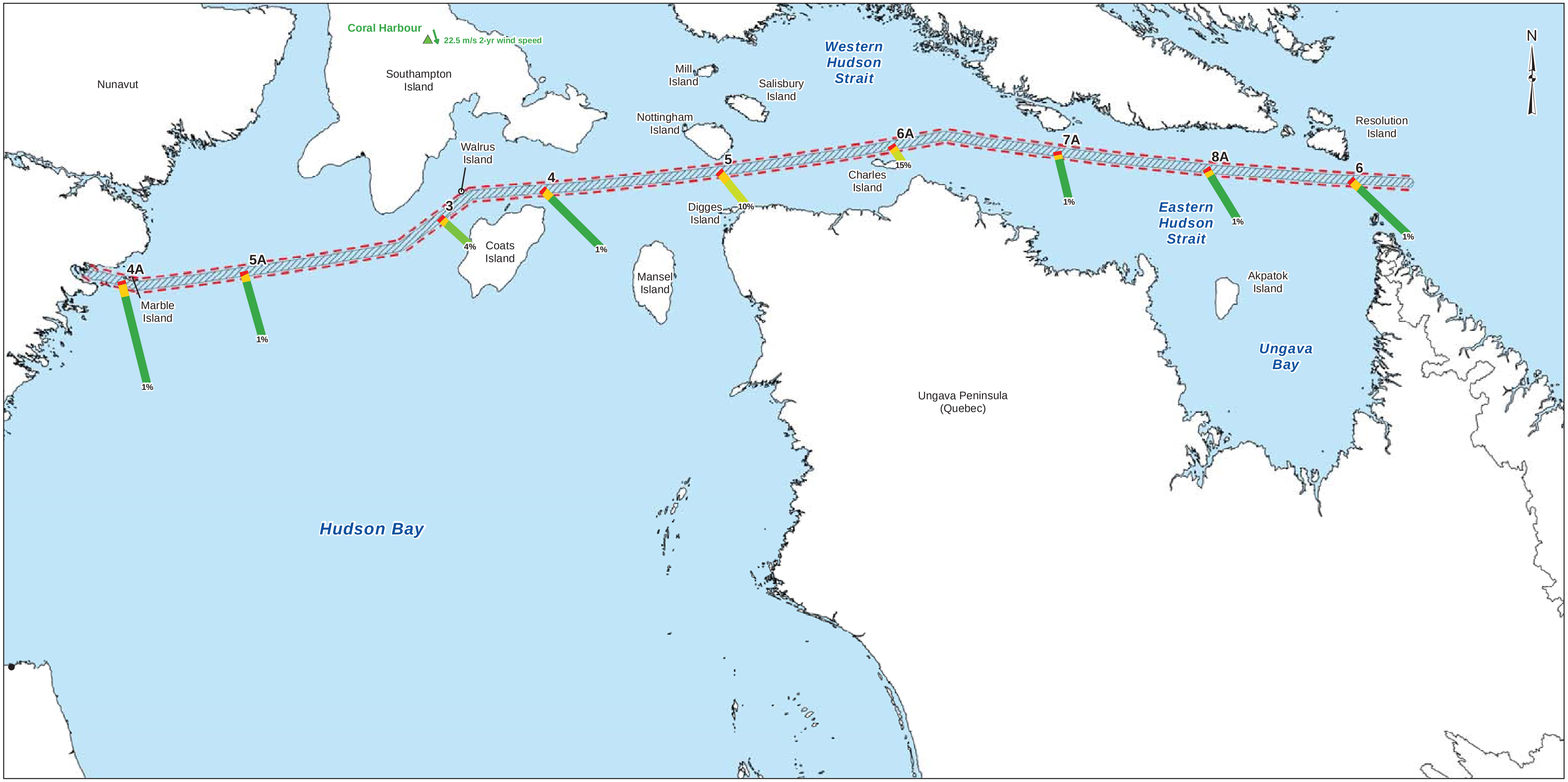

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 2-YR WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-20	
REVIEW	LY	06 Jan. 2016		

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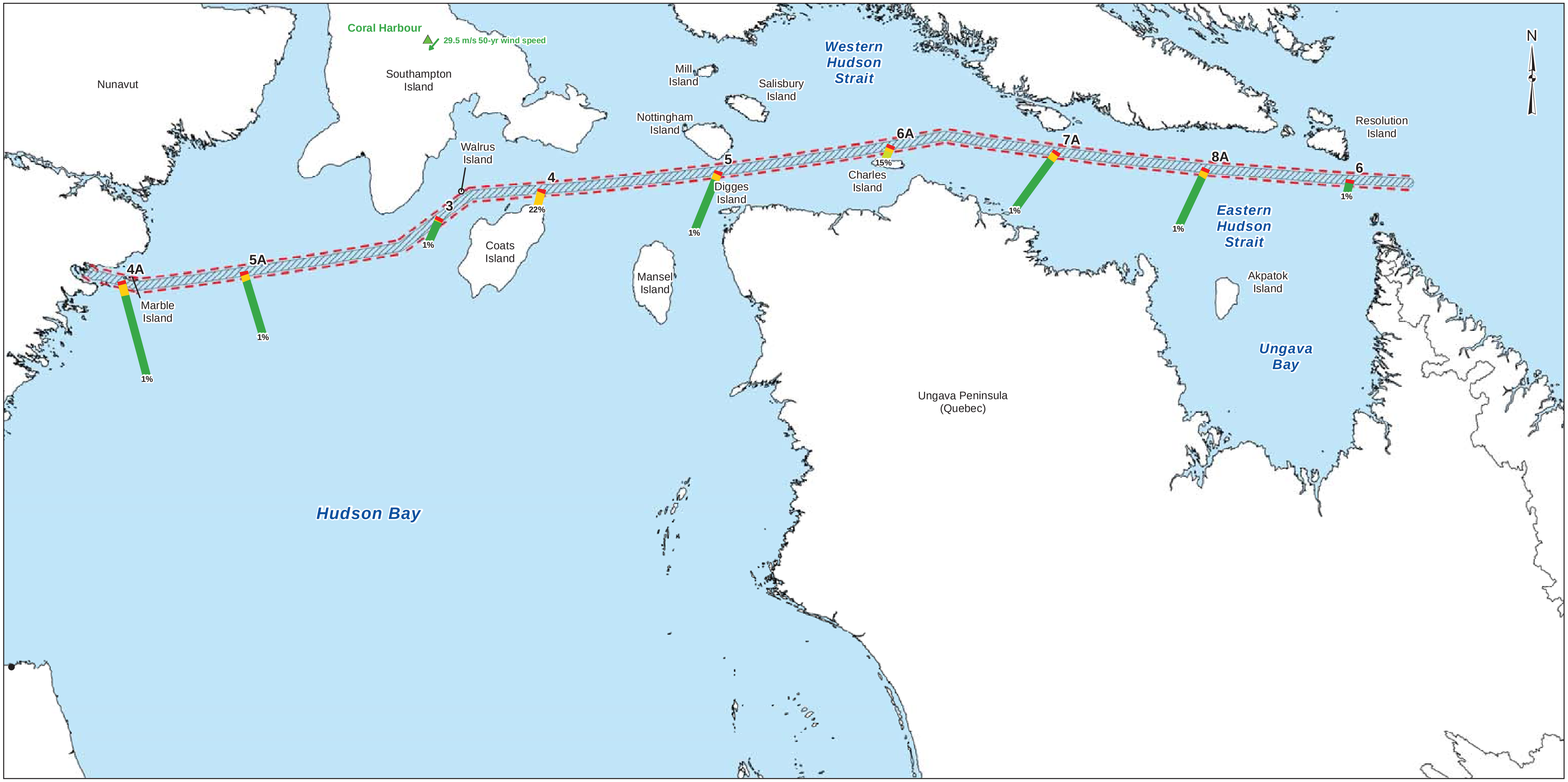

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 50-YR WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016		
REVIEW	LY	06 Jan. 2016		

FIGURE E-21

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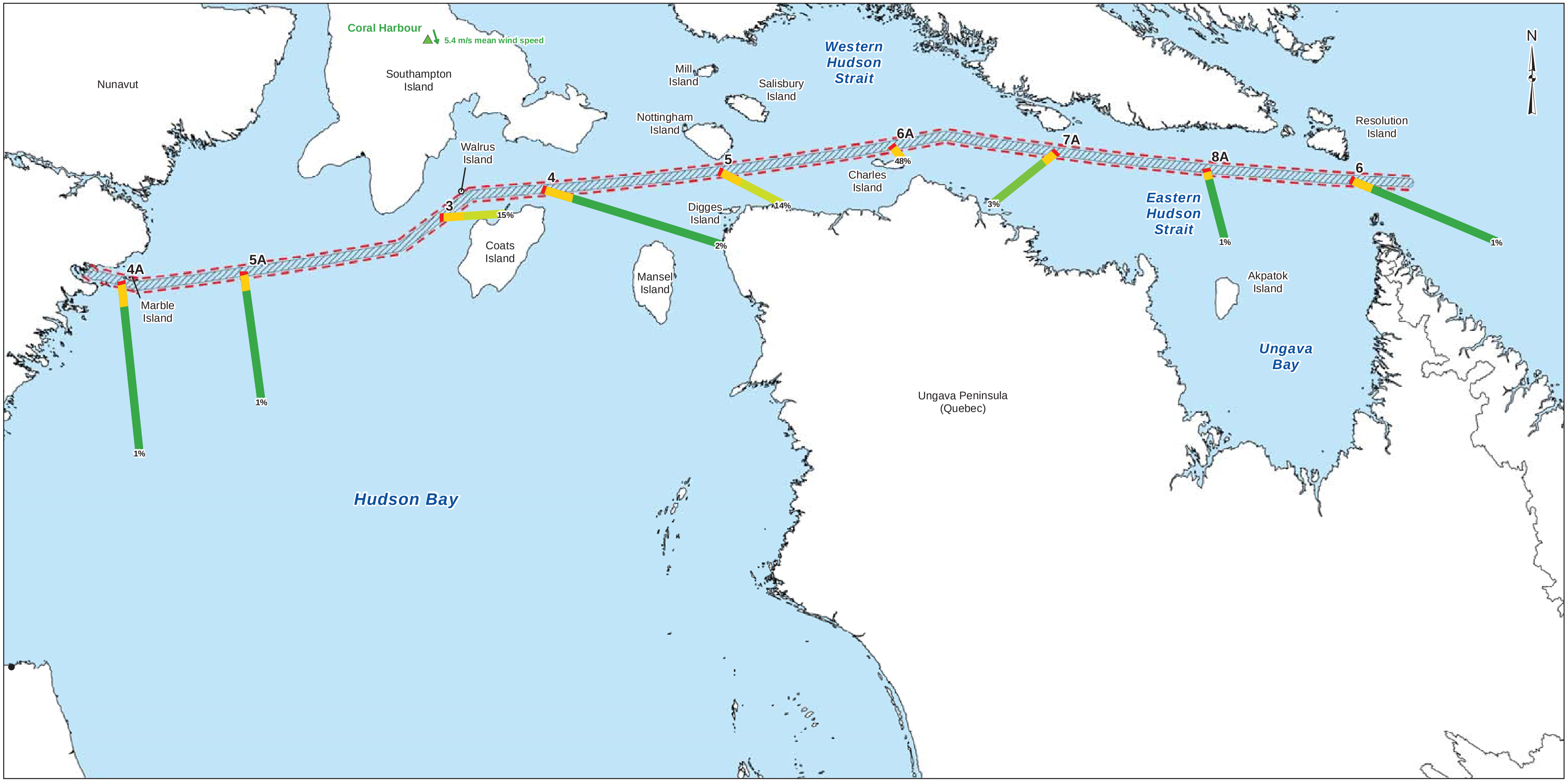

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

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NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

OIL SPILL SCENARIO: 20,000,000 L SPILL, MEAN WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-22	
REVIEW	LY	06 Jan. 2016		

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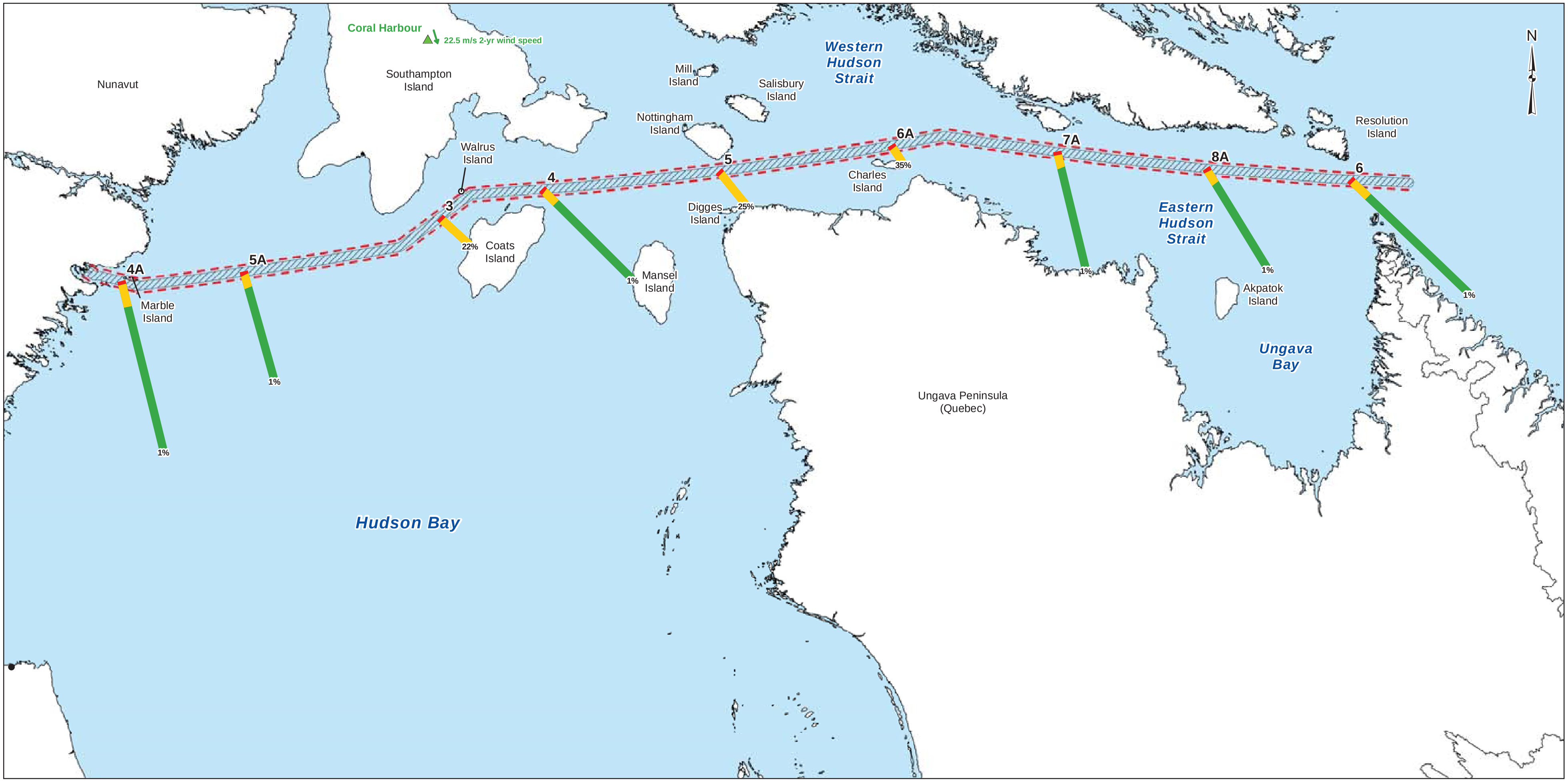

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
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7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 2-YR WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016	FIGURE E-23	
CHECK	JC	06 Jan. 2016		
REVIEW	LY	06 Jan. 2016		

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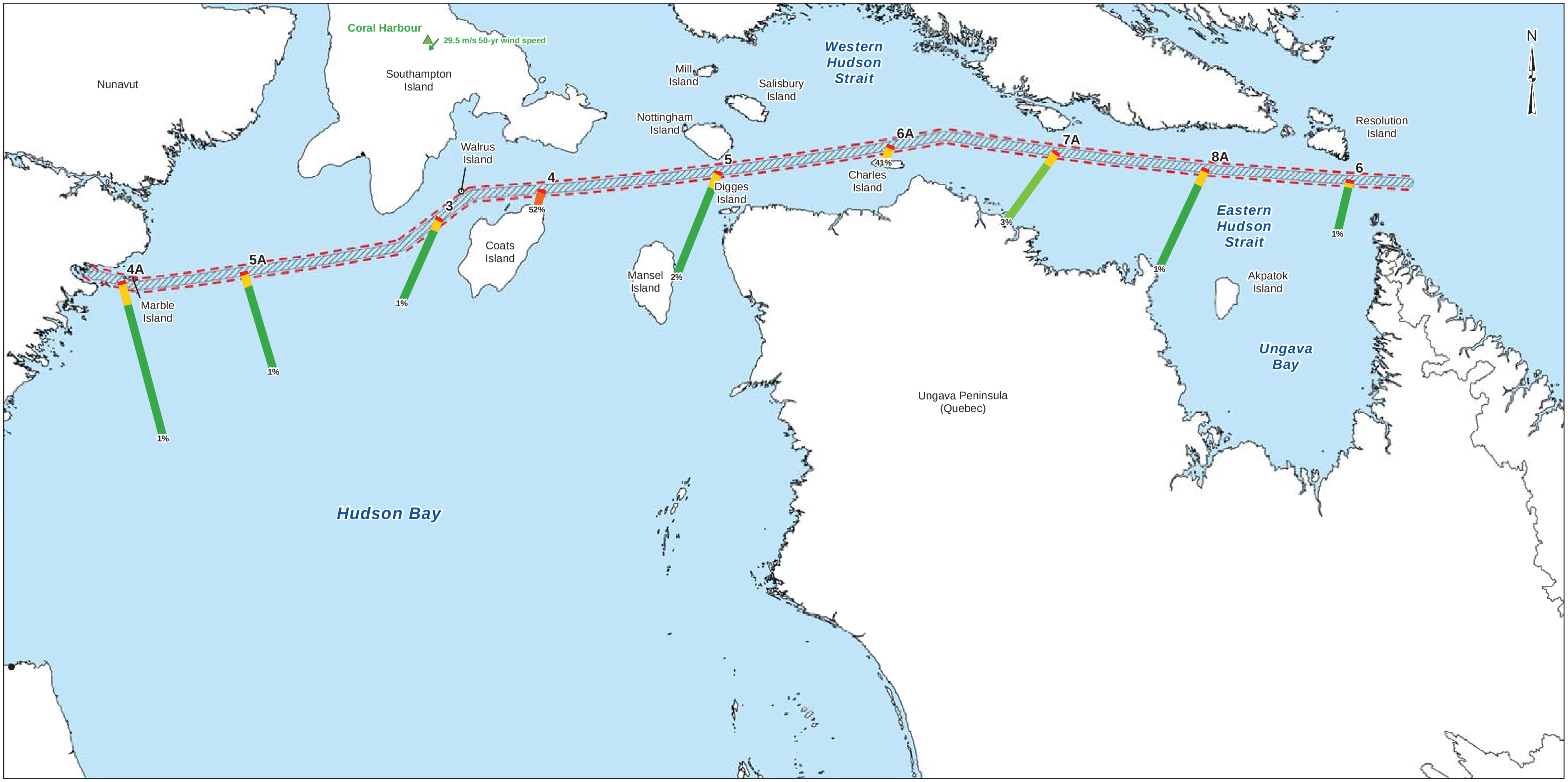

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
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6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 50-YR WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016		
REVIEW	LY	06 Jan. 2016		

FIGURE E-24

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6.3 Spills along Shipping Route

Diesel fuel spills have the potential to occur anywhere along the shipping route. For the purpose of the ADIOS2 analysis, ten (10) sites were chosen along the shipping route that correspond with either areas of the route that are in close proximity to land (e.g., pinch points) or established sensitive habitat areas for marine mammals and/or marine birds. These sites include Walrus Island, Coats Island, Ungava Peninsula and Eastern Hudson Strait (sites numbered 3 to 6); and entrance to Melvin Bay, western Hudson Bay, Hudson Bay crossing, western Hudson Strait near Charles Island, mid-point Hudson Strait, and eastern Hudson Strait north of Ungava Bay (sites numbered 3A to 8A). Tables E-4 and E-5 include the weathering half-life, time to shore, and proportion of spill deposited on shore for the 2 ML and 20 ML spill scenarios, respectively, (for mean, 2-yr, and 50-yr wind speeds). The weathering half-life was predicted to be less than 19 h for all the 2 ML scenarios and less than 34 h for all the 20 ML scenarios. Depending on the distance to shore and wind scenario, the time to shore would vary from about 4 h to 50 days for the 2 ML scenario and the amount of fuel predicted to be deposited on shore would vary from 0% to 66%. For the 20 ML scenario, the amount of fuel predicted to be deposited on shore would vary from 0% to 79%. The trajectory of the slick drift is a primary factor in the amount, if any, of fuel deposited on shore. For example, at site 3 (Walrus Island), 16% of the spill is deposited on shore for the 20 ML, 2-yr wind spill scenario because the direction of the slick drift is 163°, directly towards Coats Island. For the 50-yr wind scenario, the direction of the slick drift is 220°, towards the open water of Hudson Bay.

The influence of currents on the trajectory of the slick drift was considered using the mean currents at each site when data was available. Table E-9 provides the mean current velocity at each site, resultant wind and current vector speed and direction, distance to shore in the direction of the resultant vector, time to shore, and proportion of spill deposited on shore for the different 2 ML and 20 ML spill scenarios.

The predominant current patterns enhance the rate at which the fuel would spread across the water surface, particularly along narrower portions of the route where current speeds can be enhanced and slicks spread in the direction of the current. This typically results in the slick trajectory being altered to more parallel to the shipping route and in most cases less fuel deposited on the shore. However, in some cases, the change in trajectory results in a shorter distance to shore and a higher proportion of fuel deposited onshore.

Table E-9: Distance to Shore, Weathering Half-Life, Time to Shore, and Estimated Percent of Spill Deposited on Shore for 2 ML Diesel Fuel Spill Scenarios along Shipping Route

Location (Number)	Distance to Shore (km)	Distance to Shore (km); 50-yr wind	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Walrus Island (3)	55	760	15.6	4.1	2.1	94.3	22.6	239	2%	2%	0%
Coats Island (4)	23	22	14.7	4.9	3.7	39.4	9.5	6.9	16%	26%	27%
Ungava Peninsula (5)	46	106	18.5	5.8	3.8	78.9	18.9	33.3	5%	10%	0%
Eastern Hudson Strait (6)	46	325	17.0	5.3	0.9	78.9	18.9	102	4%	8%	0%
Entrance to Melvin Bay (3A)	12	N/A	17.5	8.7	7.4	16.8	5.8	4.4	51%	63%	66%
West Hudson Bay (4A)	700	N/A	13.3	7.6	5.5	982	341	255	0%	0%	0%
Hudson Bay crossing (5A)	857	N/A	10.4	4.9	3.7	1202	417	312	0%	0%	0%
Western Hudson Strait, Charles Island (6A)	20	21	14.8	3.5	2.6	34.3	8.2	6.6	20%	20%	17%
Mid-Hudson Strait (7A)	160	93	15.6	4.2	3.4	274	65.8	29.2	0%	0%	0%
Eastern Hudson Strait, north Ungava Bay (8A)	305	164	15.6	4.5	3.4	523	126	51.5	0%	0%	0%

Notes:
km (kilometre); yr (year); h(hour); L (liter)

Table E-10: Distance to Shore, Weathering Half-Life, Time to Shore, and Estimated Percent of Spill Deposited on Shore for 20 ML Diesel Fuel Spill Scenarios along Shipping Route

Location (Number)	Distance to Shore (km)	Distance to Shore (km); 50-yr wind	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Walrus Island (3)	55	760	26.8	8.7	5	94.3	22.6	239	9%	16%	0%
Coats Island (4)	23	22	28.7	7.6	6.4	39.4	9.5	6.9	39%	42%	47%
Ungava Peninsula (5)	46	106	37	9.7	6.4	78.9	18.9	33.3	23%	26%	3%
Eastern Hudson Strait (6)	46	325	33.7	10.9	2.8	78.9	18.9	102	20%	30%	0%
Entrance to Melvin Bay (3A)	12	N/A	32.8	14.4	12.7	16.8	5.8	4.4	70%	75%	79%
West Hudson Bay (4A)	700	N/A	26.8	12.4	8.9	982	341	255	0%	0%	0%
Hudson Bay crossing (5A)	857	N/A	20.3	8	5.7	1202	417	312	0%	0%	0%
Western Hudson Strait, Charles Island (6A)	20	21	26	6.2	5.3	34.3	8.2	6.6	40%	40%	42%
Mid-Hudson Strait (7A)	160	93	26.8	9.3	6.7	274	65.8	29.2	0%	1%	5%
Eastern Hudson Strait, north Ungava Bay (8A)	305	164	26.8	8.7	6.7	523	126	51.5	0%	0%	0%

Notes:
km (kilometre); yr (year); h(hour); L (liter)

Table E-11: Weathering Half Life and Time to Shore for 2 ML and 20 ML Diesel Fuel Spill Scenarios along Shipping Route with Currents

Location (Number)	Mean Current		Vector Sum Speed (Direction), m/s and deg			Distance to Shore (km)			Time to Shore (h)			% Deposited on Shore 2 ML			% Deposited on Shore 20 ML		
	Speed (m/s)	Dir (deg)	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Walrus Island (3)	0.45[a]	60	0.3(94)	0.7 (140)	0.6 (212)	74	46	732	73.1	19.0	316	4%	4%	0%	15%	22%	0%
Coats Island (4)	0.45[a]	90	0.4 (116)	0.8(144)	0.7 (204)	211	144	22	167	49.9	8.2	0%	0%	22%	2%	1%	52%
Ungava Peninsula (5)	0.2[b]	80	0.2 (129)	0.7 (153)	0.8 (214)	81	49	127	106	19.3	44.0	2%	10%	0%	14%	25%	2%
Eastern Hudson Strait (6)	0.2[b]	90	0.2 (133)	0.7 (154)	0.8 (214)	1000	354	33	1227	136	113	0%	0%	0%	0%	0%	0%
West Hudson Bay (4A)	0.2[c]	200	0.3 (177)	0.7 (169)	0.9 (168)	600	650	652	547	270	210	0%	0%	0%	0%	0%	0%
Hudson Bay crossing (5A)	0.2[c]	200	0.3 (177)	0.7 (169)	0.9 (168)	684	784	789	623	325	255	0%	0%	0%	0%	0%	0%
Western Hudson Strait, Charles Island (6A)	0.2[b]	135	0.2 (155)	0.7 (161)	0.9 (216)	21	25	23	27.2	9.5	6.8	28%	15%	15%	48%	35%	41%
Mid-Hudson Strait (7A)	0.4[b]	290	0.2 (248)	0.6 (183)	1.0 (233)	92	138	97	133	67.4	27.0	0%	0%	0%	3%	1%	3%
Eastern Hudson Strait, north Ungava Bay (8A)	0.1[b]	290	0.1 (184)	0.6 (167)	0.9 (224)	134	319	125	280	137	38.1	0%	0%	0%	0%	0%	1%

Notes:
km (kilometre); yr (year); dir (direction); ML(million litres); m/s (metres per second); N/A (not available)
[a] DFO (2015); mooring H9
[b] Drinkwater (1986)
[c] DFO (2015); mooring H7

6.4 Discussion of Mapped Results

Maps representing the results of the hypothetical spill scenarios are presented in Figure E-13 through Figure E-24. The maps are provided for the 2 ML and 20 ML spill scenarios, three (mean, 2-yr, and 50-yr) wind scenarios, and with and without currents. Each map shows the estimated trajectory of the spill at the fourteen locations based on the wind and current for the given scenario and the spill volume remaining (percentage) at a given distance based on the weathering results from the ADIOS2 model. The percentage of the spill volume remaining is shown by the color ramp gradation from red (more remaining) to green (less remaining). The extent of the slick drift is shown at the start of the spill (100% volume), at one half-life (50% spill volume remaining), and when the slick reaches shore or is weathered to 1% of the spill volume remaining (whichever occurs first). If the slick is estimated to reach shore, the percentage of the spill volume remaining is labeled at this location. In some cases, particularly in Melvin Bay, the spill reaches shore quickly and only two colored lines are shown on the map. Wind vectors are also provided for each scenario to illustrate the wind direction and speed used for a given map scenario.

There is a slight apparent difference in spill trajectory angles between the westernmost points when compared to the easternmost points despite scenarios that use the same wind direction. This slight apparent difference in spill trajectory angles is a function of the map projection extending over a large area and over multiple UTM zones and is therefore a projection distortion rather than a measureable difference in trajectory.

It is important to consider these maps as a depiction of the potential fuel spill trajectory and percent remaining at a coarse scale under a very specific set of climate conditions. As noted on the maps, the length of the fuel spill path represents the estimated travel distance and the angle represents the calculated spill trajectory given the specific wind, current, and spill volume conditions bracketed by each spill scenario. The actual distance travelled and the angle of the spill trajectory will be highly dependent on the site-specific ambient conditions and the nature and location of the spill at the time of a potential spill. In general, the width of a fuel spill at land fall and the length of shoreline that could potentially be affected by a given fuel spill is difficult to estimate due to the high degree of uncertainty related to the spreading of a slick (DNV 2011).

A summary of the mapped scenarios follows:

- The dominant slick drift trajectory for the modelled scenarios is towards the south-southeast (163°) for all scenarios without currents except for the 50-yr wind scenario at sites east of site 5A, where it is towards the southwest (220°). The south-southeast trajectory results in a slick trajectory headed towards open water at sites 4A, 5A, 7A, and 8A. At sites in Melvin Bay (1, 2, 1A, and 2A) the fuel slick reach shore within a few hours. Trajectory at these sites is less important as they are almost entirely bounded by land, resulting in a majority of the spill reaching land in any direction. At sites 3A, 3, 4, 5, 6A, and 6, the slick is estimated to reach shore with 50% or less of the spill volume remaining.
- The 50-yr wind scenario at sites 3 and sites further east results in a slick trajectory to the southwest (220°). Under this scenario a slick at site 3 would head towards open water and sites 5 and 6 would have a longer distance to travel to shore than for the other wind scenarios. Differences in the direction to shore for slicks originating at sites 4, 6A, 7A, and 8A are minimal between wind scenarios.
- The percentage of the fuel deposited on shore increases for the 20 ML spill scenario versus the 2 ML spill scenario because of the increase in the weathering half-life.

- The addition of mean currents in the modelling typically results in altering the slick trajectory to a more parallel orientation to the shipping route and in most cases less fuel deposited on the shore. However in some cases the trajectory results in a shorter distance to shore and more fuel deposited on the shore. For example, at site 6 the trajectory of the spill drift is altered when an eastward current is considered such that the slick heads towards open water rather than south-southeast towards land in close proximity. Conversely, for site 3, 9% of a 20 ML spill volume is estimated to reach shore for the mean wind and no surface current scenario, but due to the orientation of the shipping route with respect to Coats Island, 15% of the spill volume is estimated to reach shore when the surface current is considered. Similarly, site 6A increases from 20% to 28%, and site 7A increases from 1% to 3% with the addition of the current forcing.

7.0 CONCLUSIONS

Although diesel spills have a low likelihood of occurrence, it is important to understand where the spill will travel and the best way to mitigate impacts. Based on the total amount of diesel fuel transported and predicted spill rates reported by SL Ross (1999), the overall likelihood of a fuel spill ranges from a return period of 285 years (i.e., one spill approximately every 285 years) for small spills (10 to 99.9 m^3) to 920 years for medium spills (100 to 999.9 m^3) and 92,000 years for large spills (1,000 to 9999.9 m^3) (WSP 2014a). If a spill was to occur near Melvin Bay, it is predicted that for all spills, a majority of the fuel would reach the nearby shoreline within several hours without mitigation efforts. If a spill was to occur along the shipping route, the amount of weathered fuel, the trajectory of the slick, and amount deposited on shore varies by site and wind and current scenario. The different spill scenarios are provided in summary tables in Sections 6.2 and 6.3 and presented in oil spill projection maps in Appendix C. Proximity of land in the direction of the slick drift is a primary consideration for the potential for fuel to be deposited on shore. The inclusion of mean currents in the modelling typically results in reorienting the slick trajectory along an alignment that is more parallel to the shipping route and in most cases this results in less fuel deposited on the shore, with the exception of sites 3, 6A, and 7 where there is an increase in percentage (of about 2% to 8%) of remaining fuel that reaches the shore.

An important consideration when interpreting the hypothetical fuel spill scenarios is the relative response times. Without mitigation, a spill in Melvin Bay is estimated to reach shore relatively quickly and with a higher proportion of the spill reaching shore before being naturally dispersed, however, there is potential for a more rapid spill response in this area. Open water spills along the shipping route are predicted to be less severe in most cases, but the potential response time is slower due to the distance offshore. As part of the Oil Pollution Emergency Plan (SD 8-2), AEM has committed to pre-emptive and responsive mitigation actions to reduce or minimize the loss of diesel fuel during ship-to-ship and ship-to-shore transfers near Melvin Bay.

This analysis has been conducted to assess the potential for impacts associated with a diesel fuel spill in the marine environment. The ADIOS2 model was used with the input of local wind speed to approximate wave conditions and then predict the weathering half-life of the fuel. This is a one-dimensional analysis and does not account for other site-specific effects such as modifications to the wave height, period and direction due to local bathymetry. Therefore it is an approximation of the travel time and percent diesel fuel remaining to be used for planning and decision making purposes.

8.0 CLOSURE

We trust that this report meets your immediate requirements. If you have any questions regarding the content of this report, please do not hesitate to contact this office.

GOLDER ASSOCIATES LTD.

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https://capws.golder.com/sites/capws2/1114280011meliadine/type a water license/5_post-submission/project certificate conditions/shipping management plan/appendix e - spill risk assessment/552-1535029-r-reva-sd8-1-appespill risk assmt.docx

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ATTACHMENT A

ADIOS2 Hypothetical Spill Modelling Inputs and Outputs

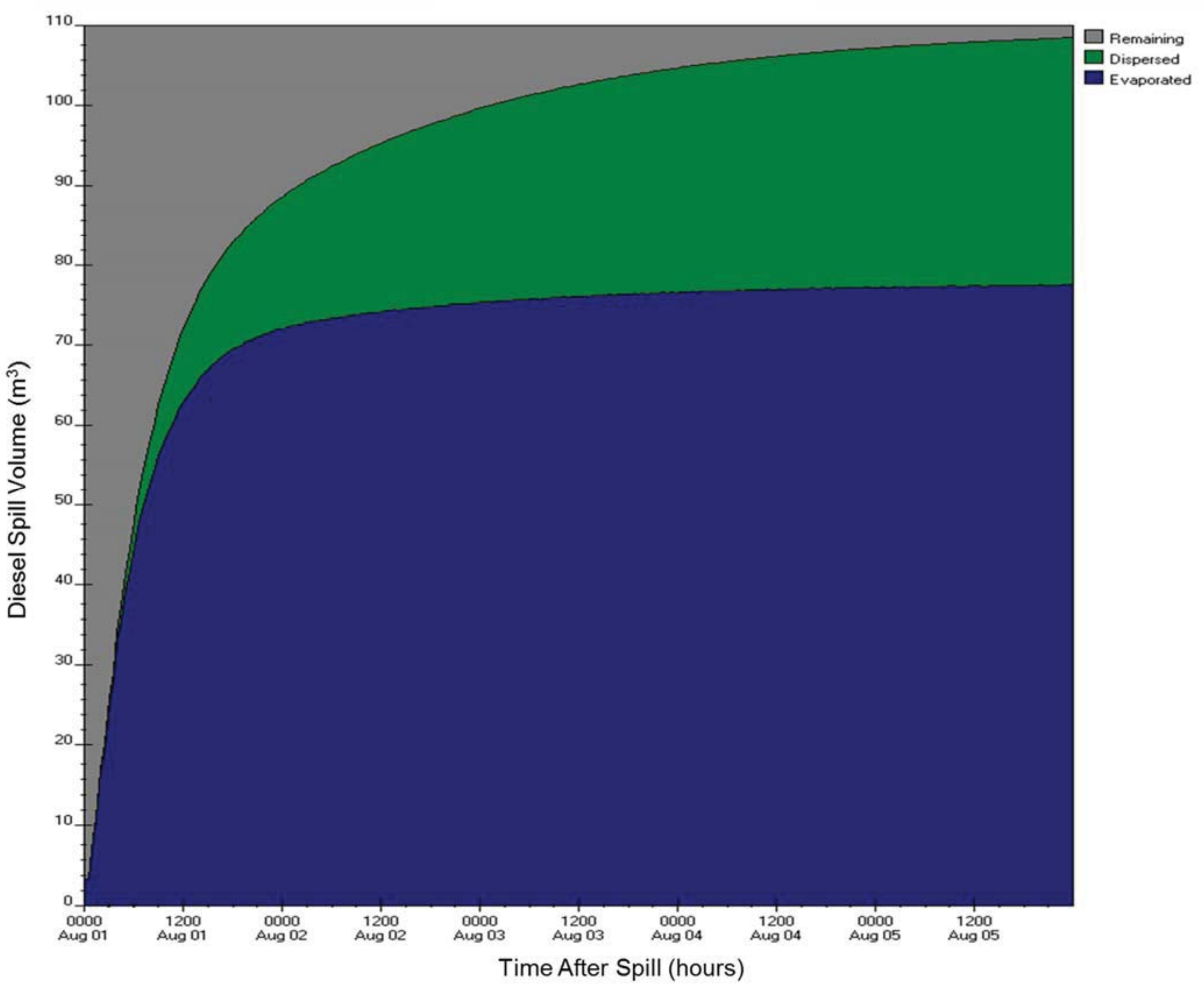

Figure E-A1: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 100 m^3, mean wind speed scenario

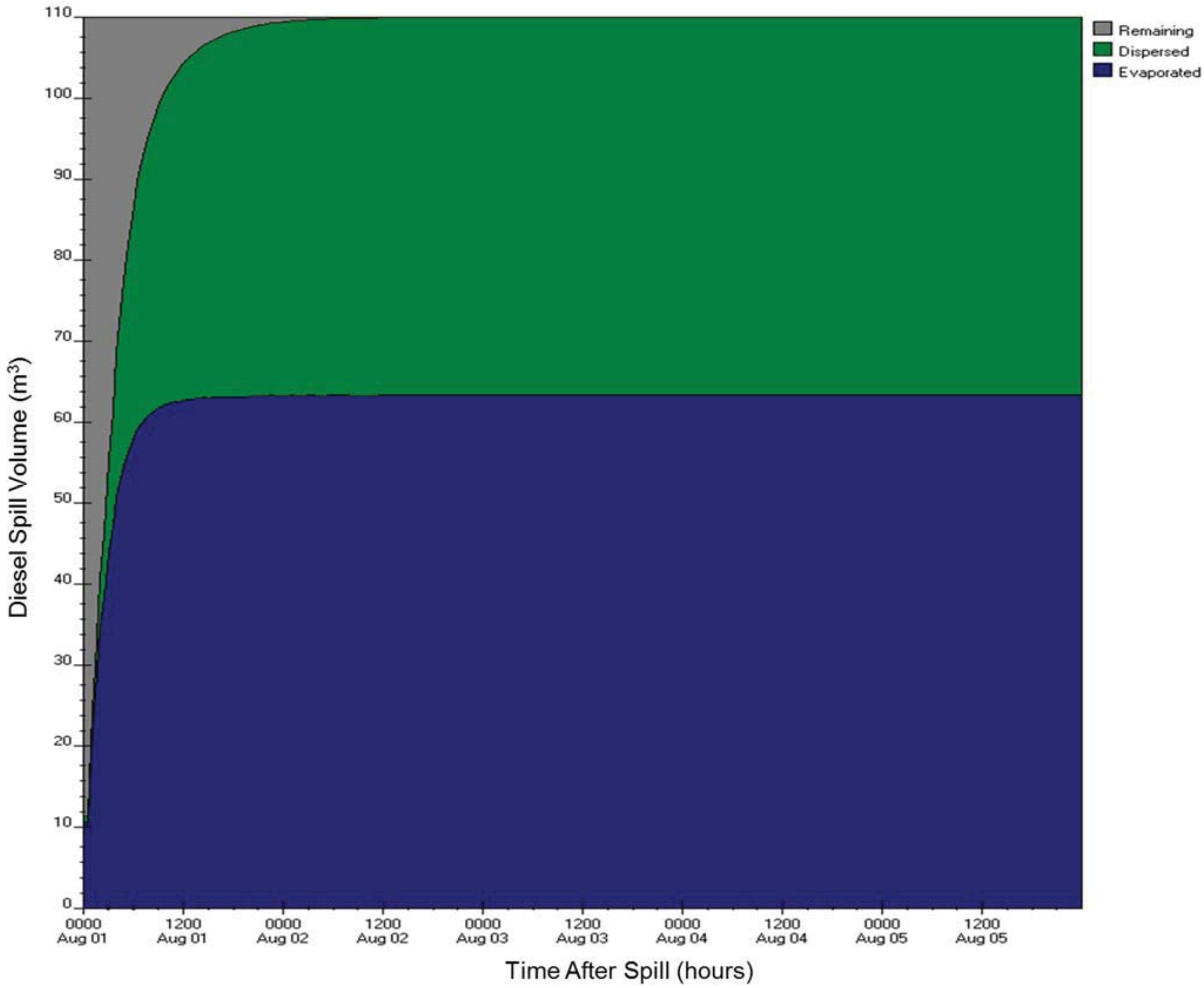

Figure E-A2: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 100 m^3, 2-yr wind speed scenario

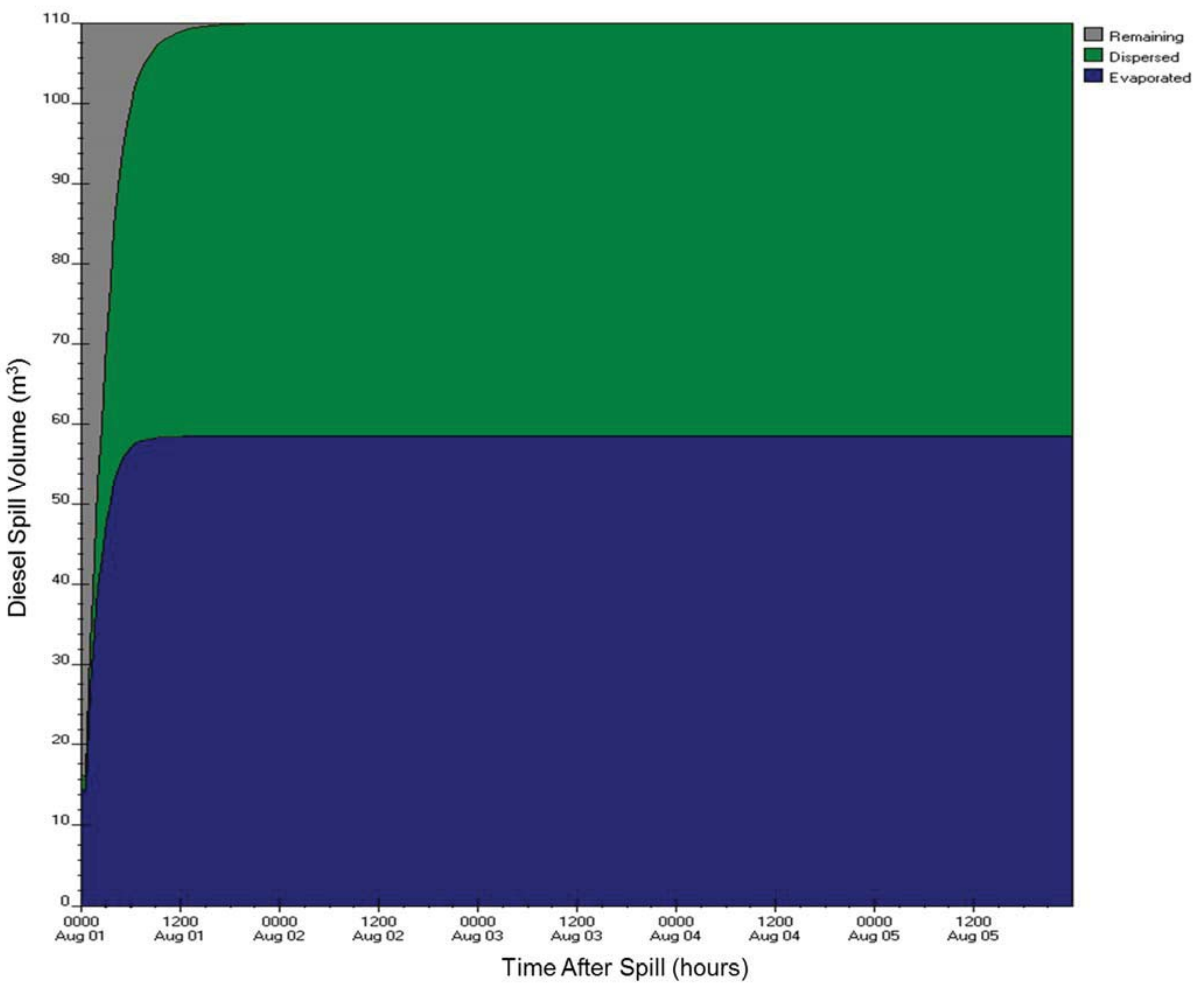

Figure E-A3: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 100 m^3, 50-yr wind speed scenario

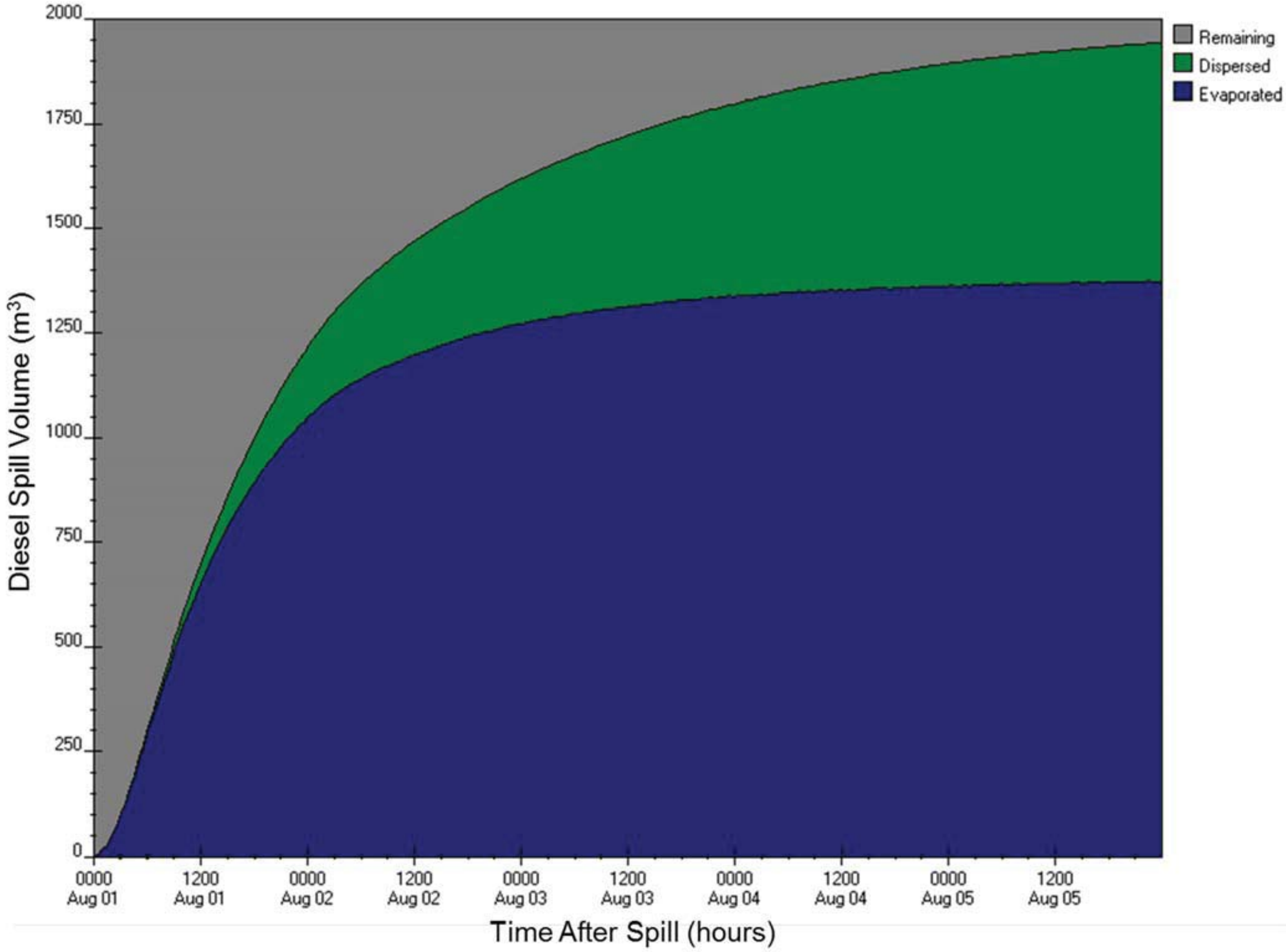

Figure E-A4: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 2,000 m^3 spill, mean wind speed scenario

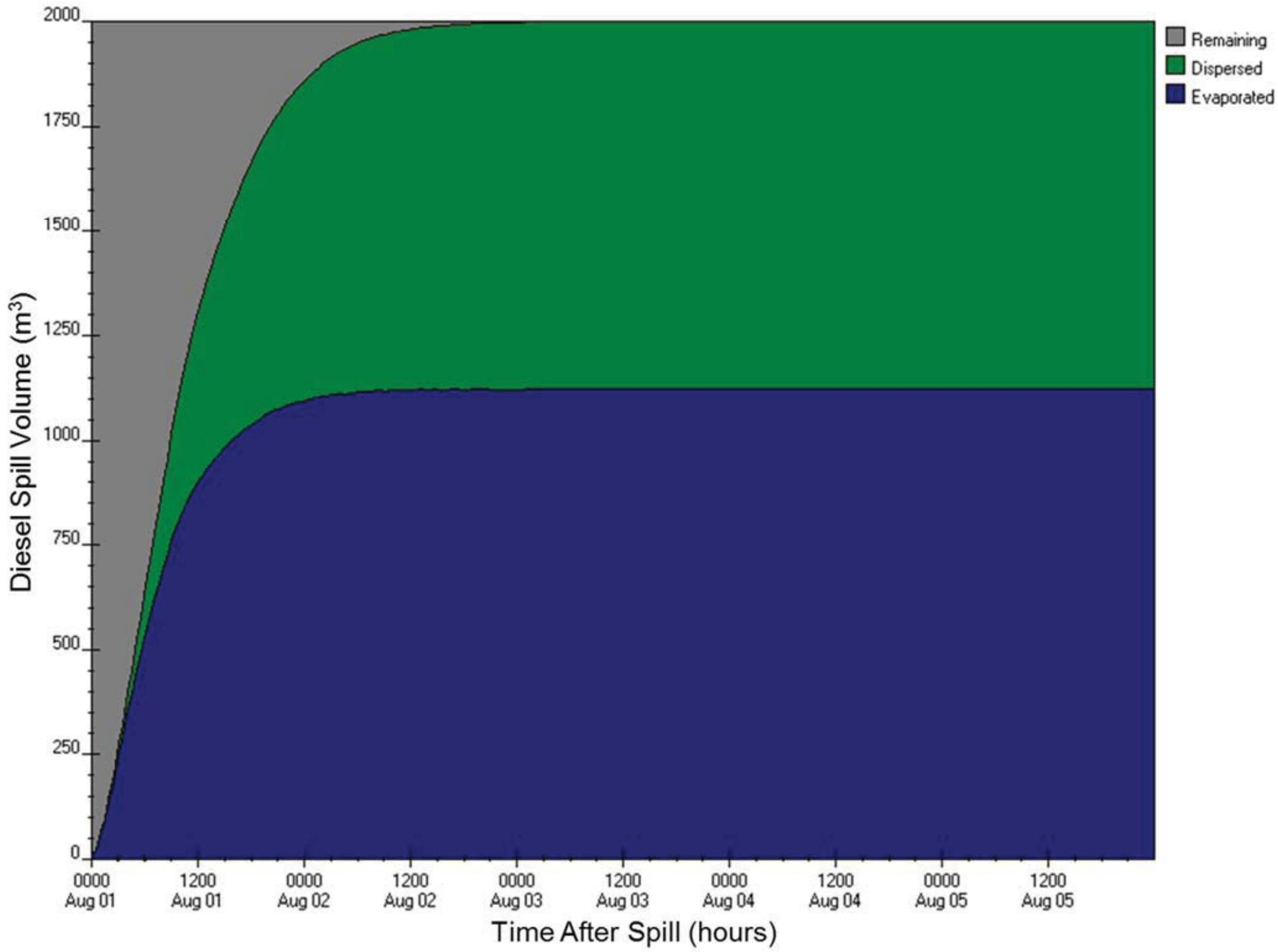

Figure E-A5: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 2,000 m^3, 2-yr wind speed scenario

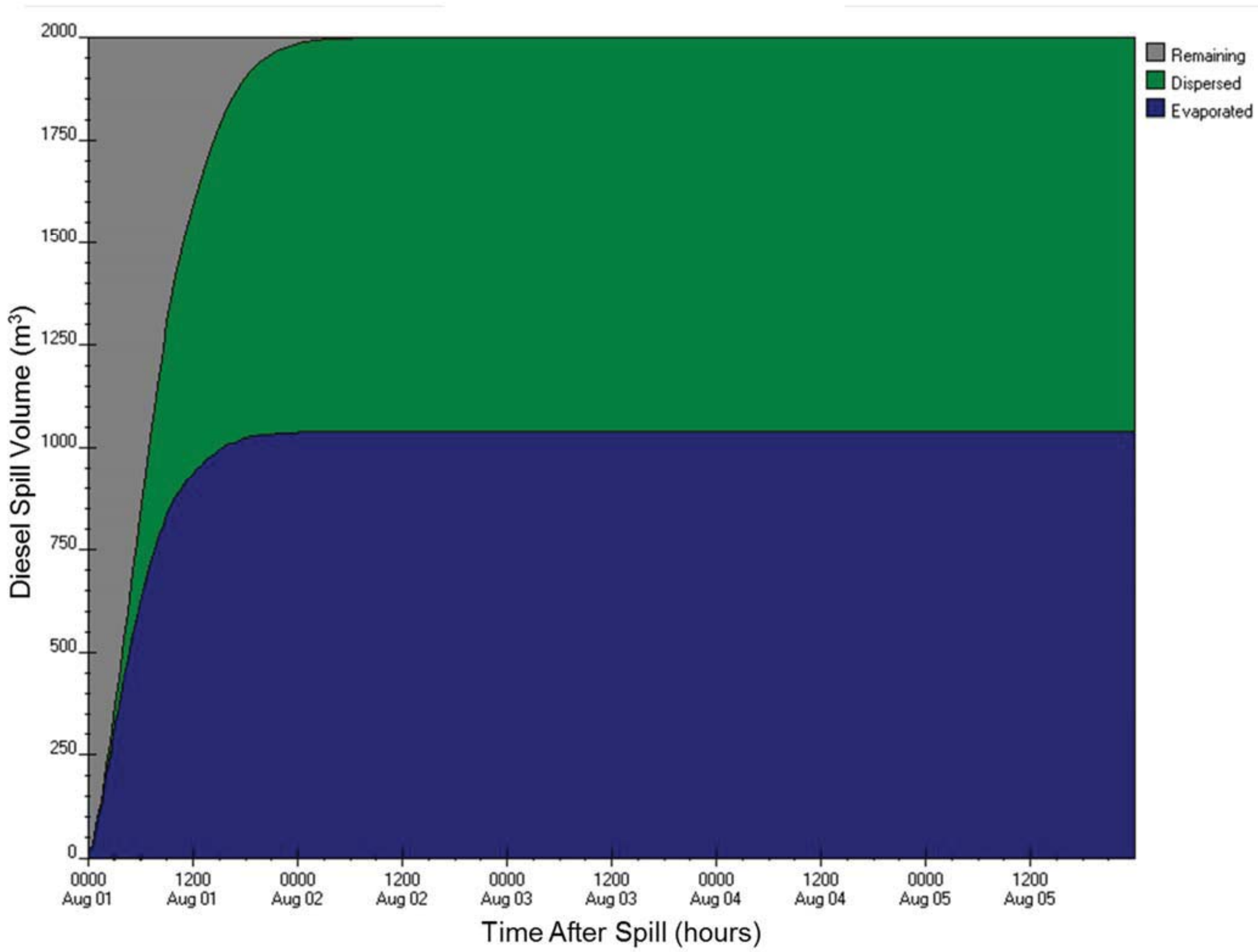

Figure E-A6: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 2,000 m^3, 50-yr wind speed scenario

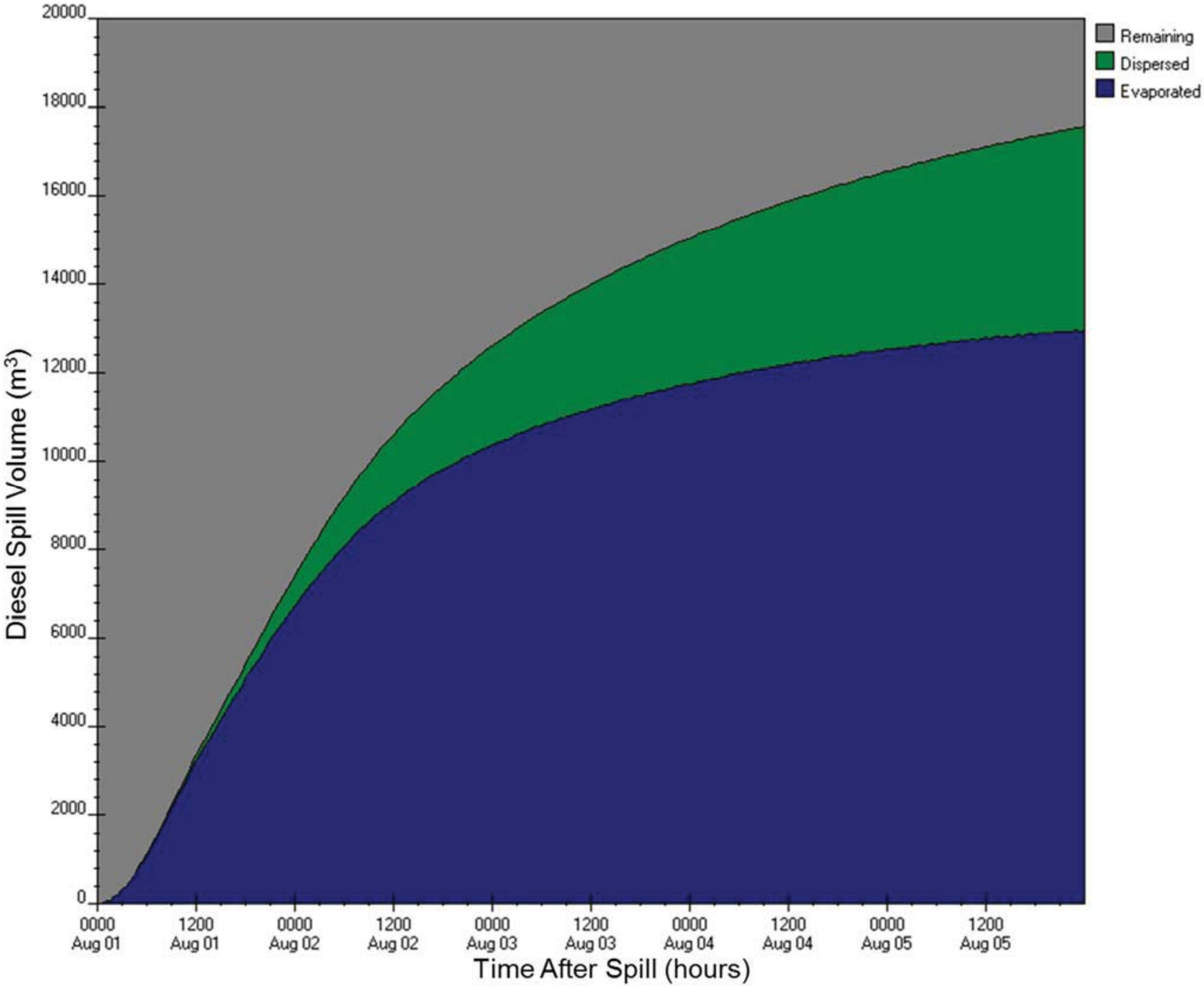

Figure E-A7: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 20,000 m³ spill, mean wind speed scenario

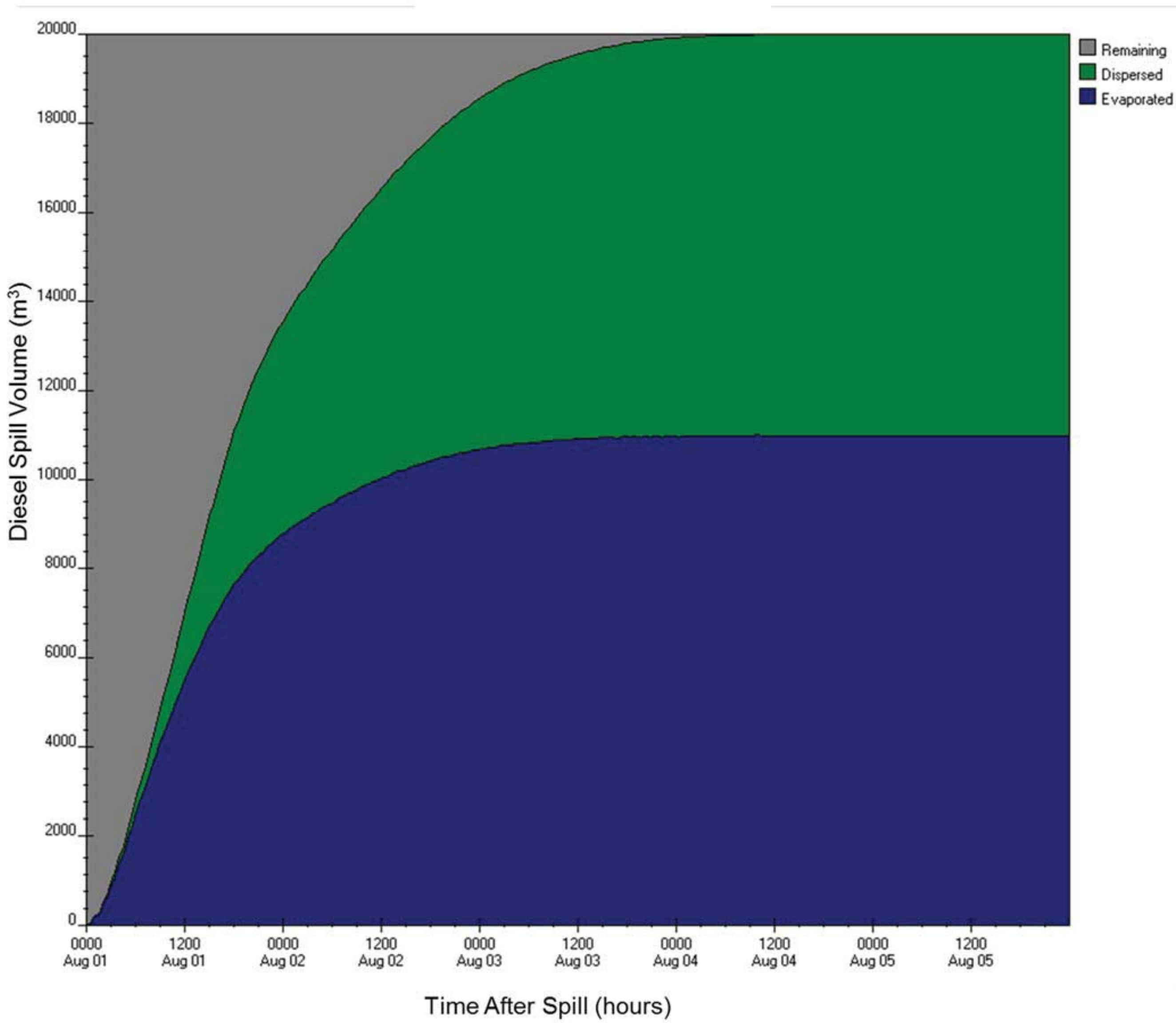

Figure E-A8: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 20,000 m^3, 2-yr wind speed scenario

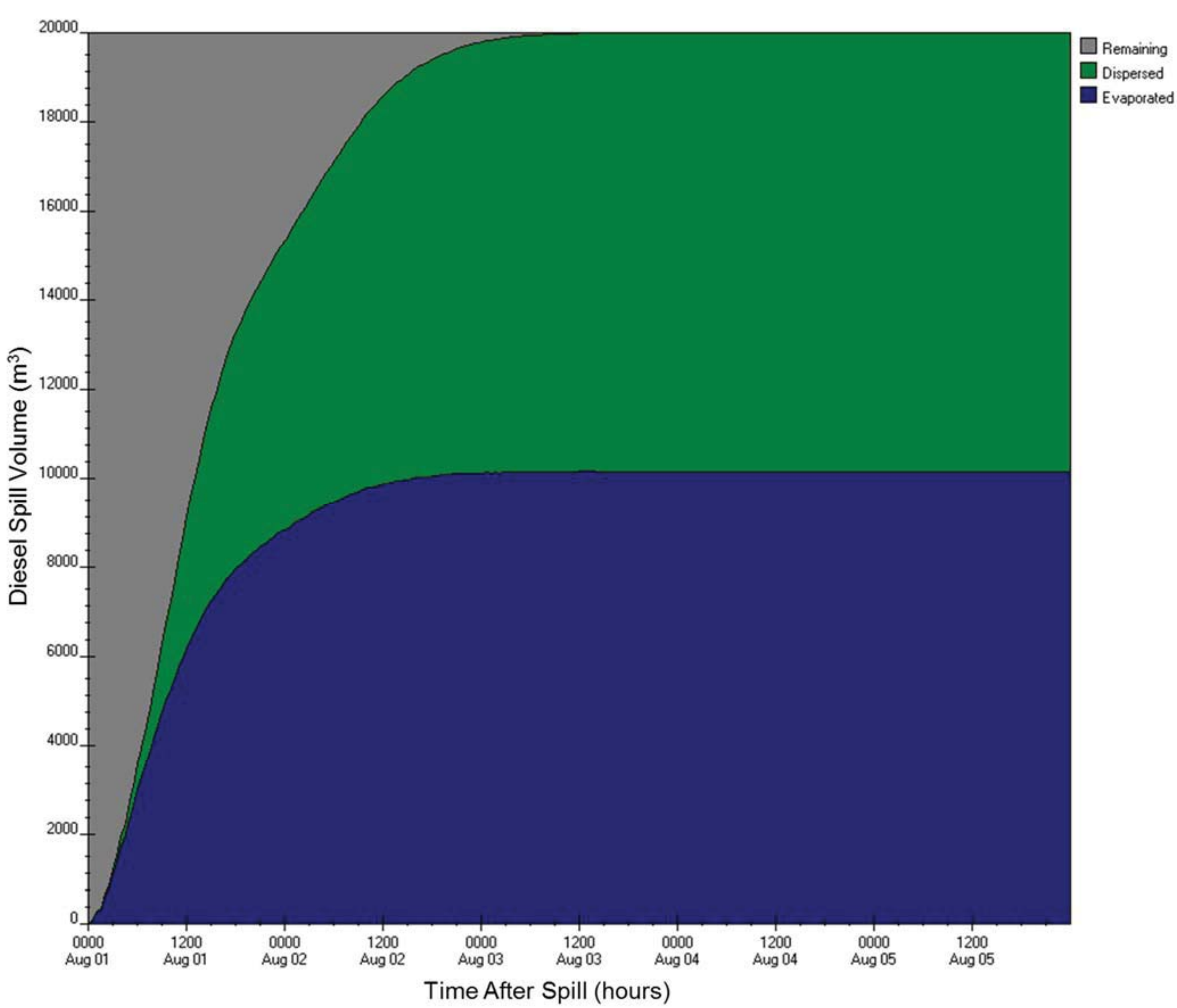

Figure E-A9: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 20,000 m^3, 50-yr wind speed scenario

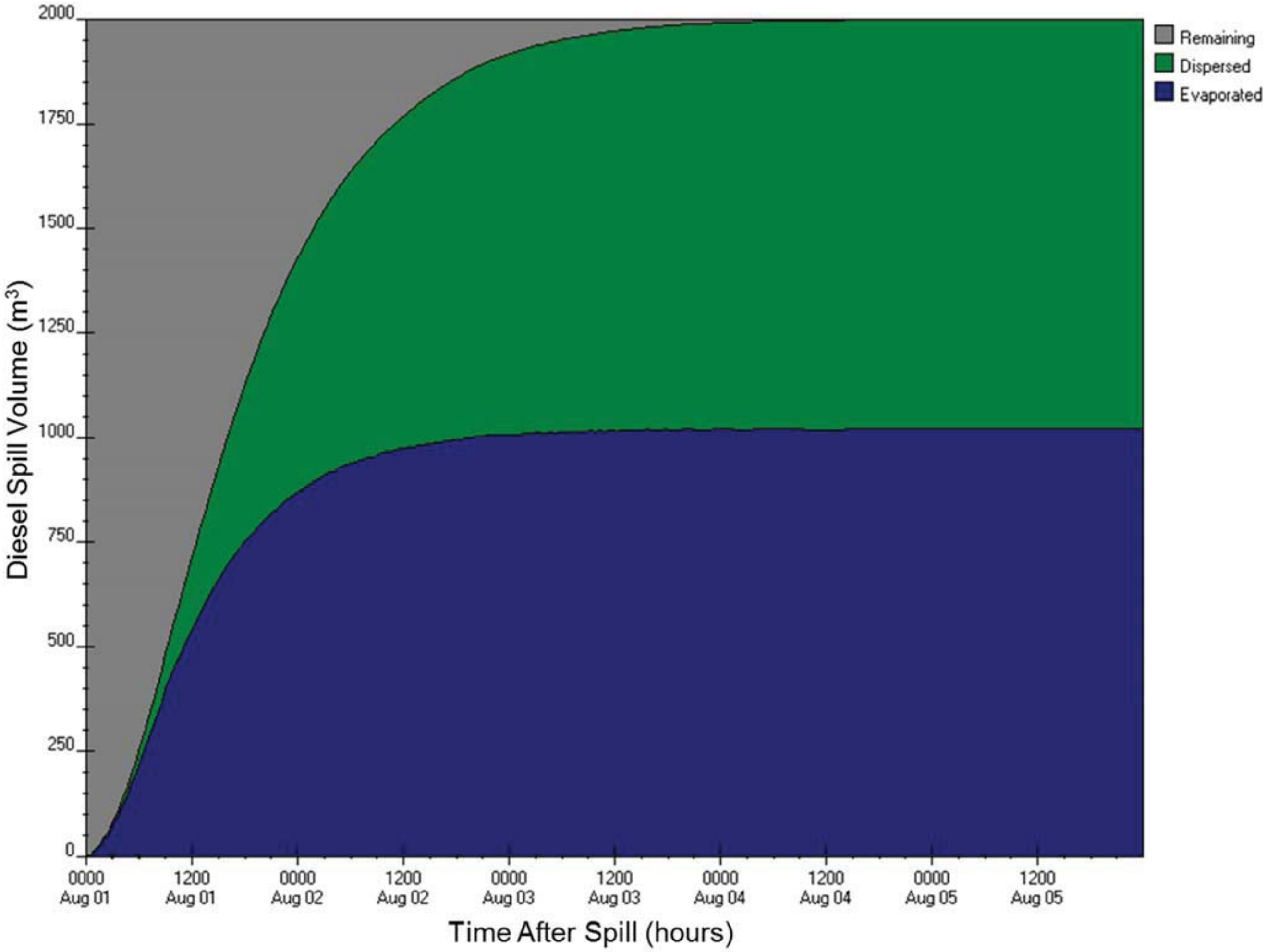

Figure 8E-A10: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 2,000 m^3, mean wind speed scenario

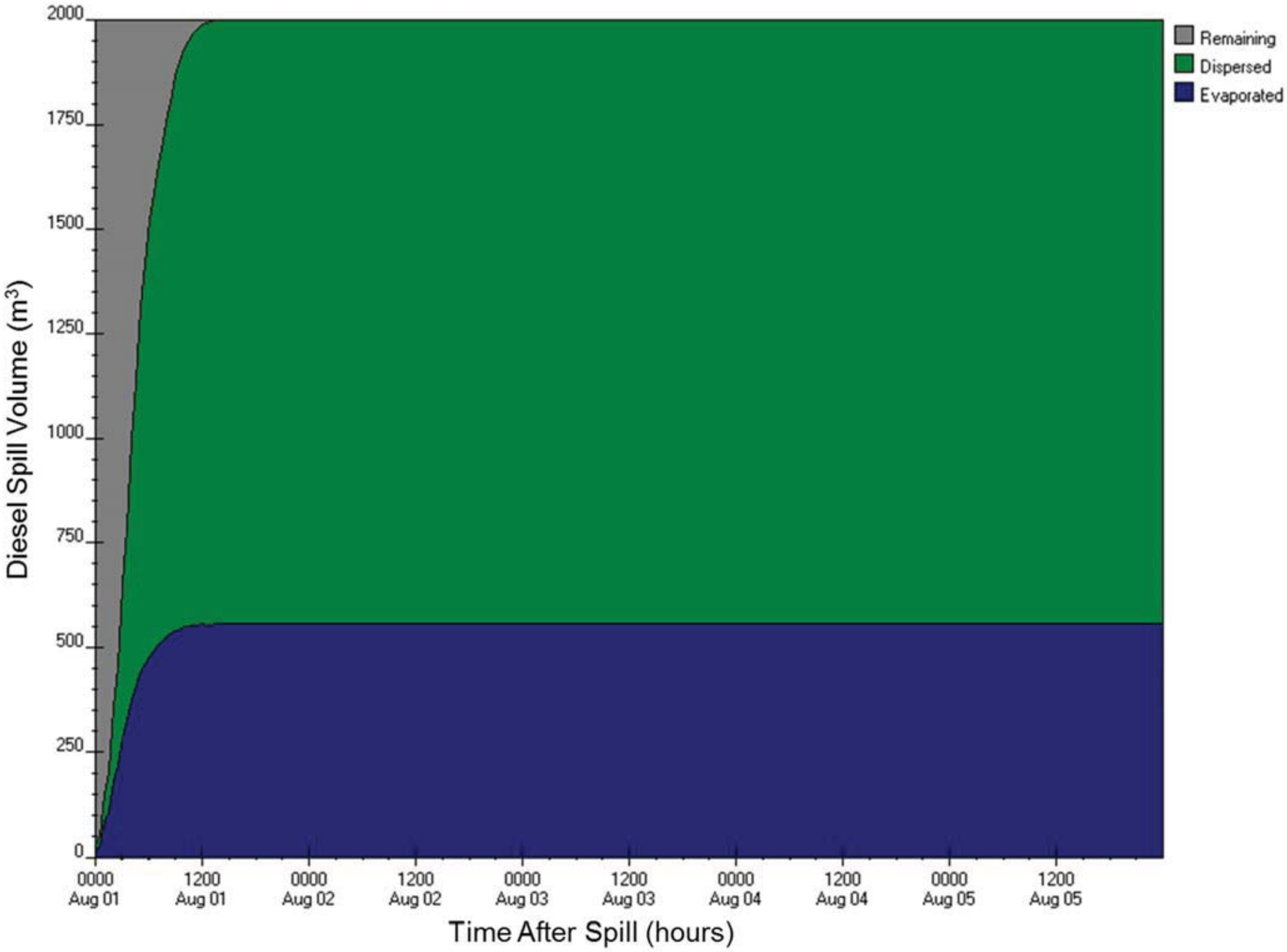

Figure E-A11: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 2,000 m^3, 2-yr wind speed scenario

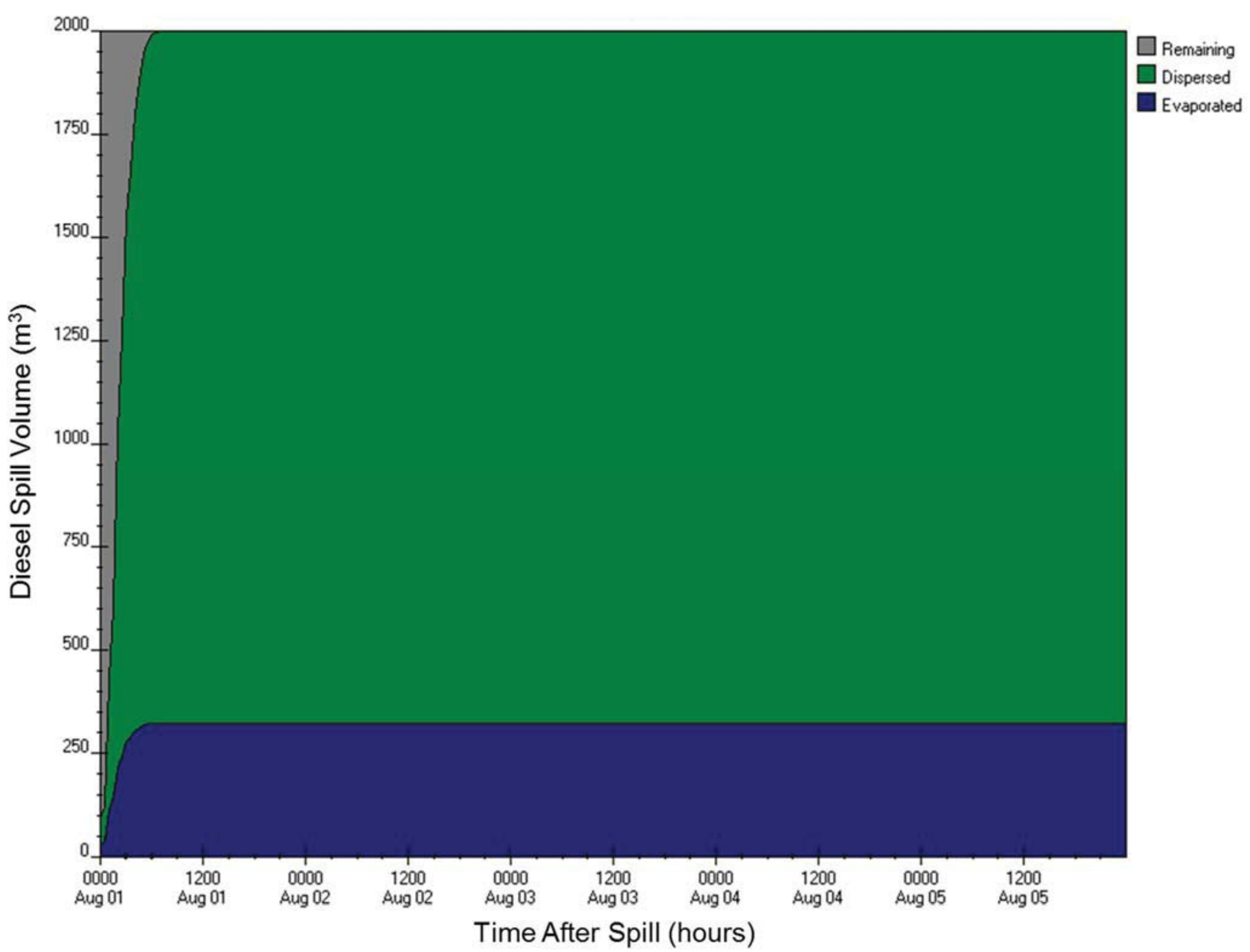

Figure E-A12: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 2,000 m^3, 50-yr wind speed scenario

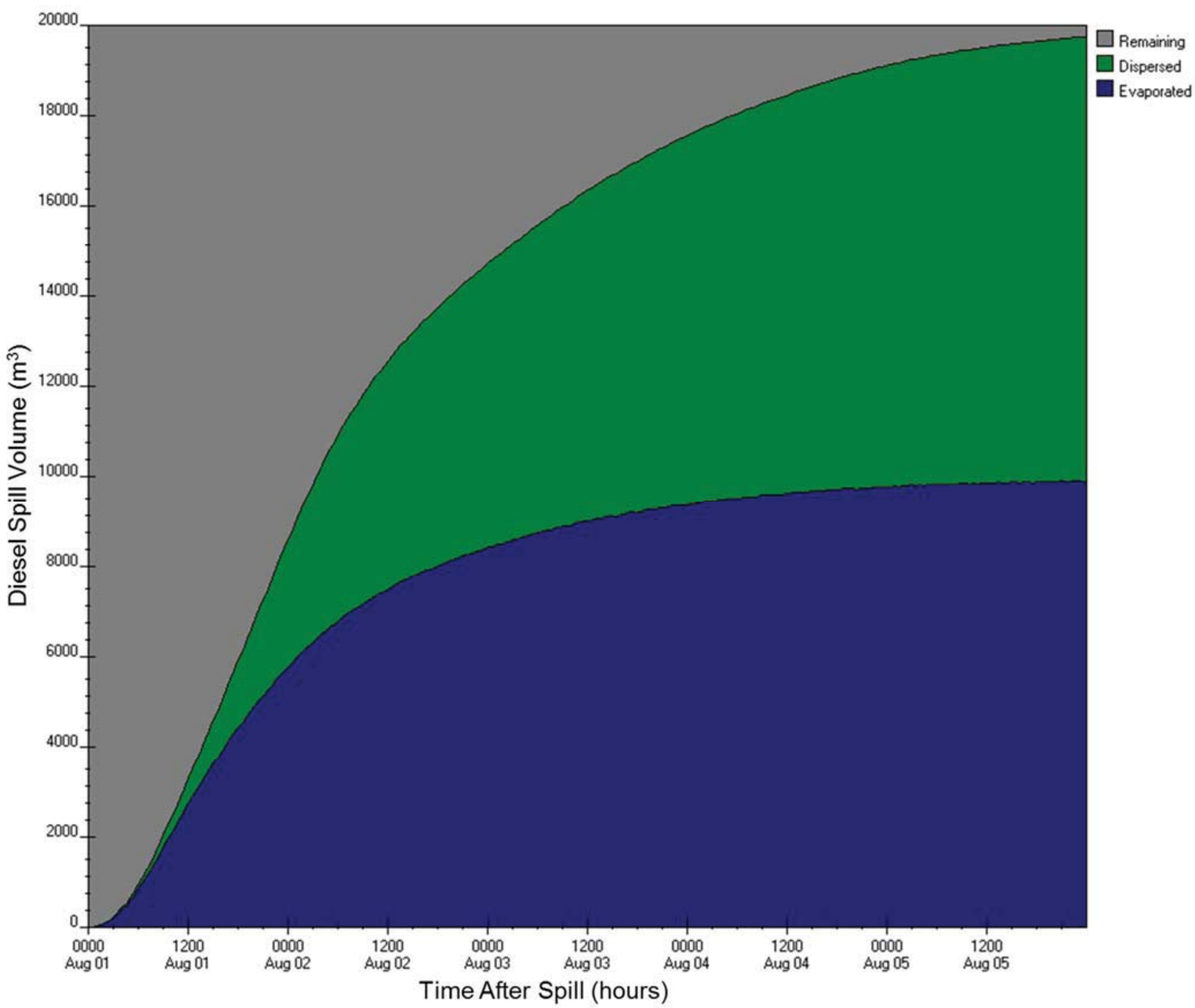

Figure E-A13: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 20,000 m^3, mean wind speed scenario

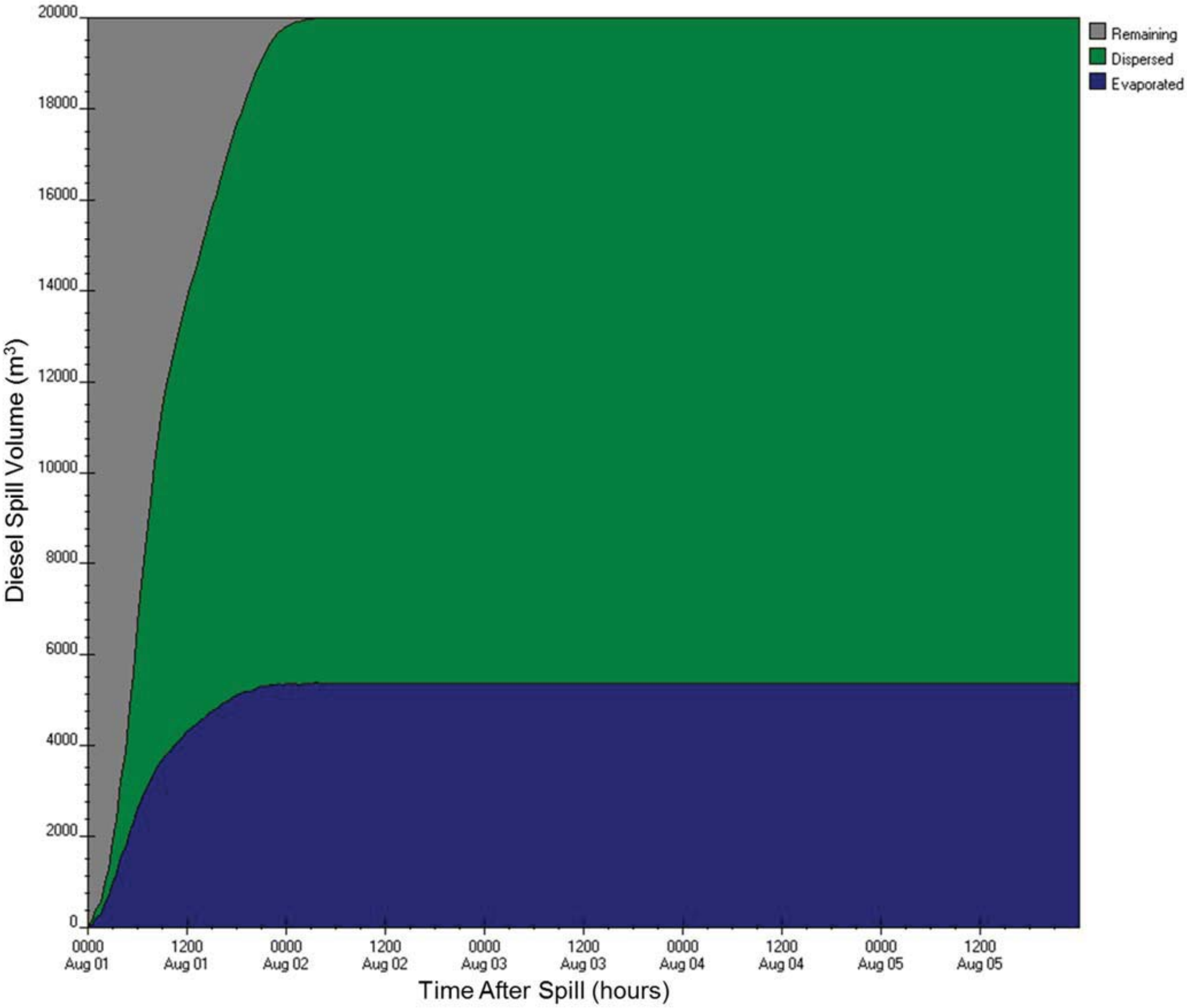

Figure E-A14: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 20,000 m^3, 2-yr wind speed scenario

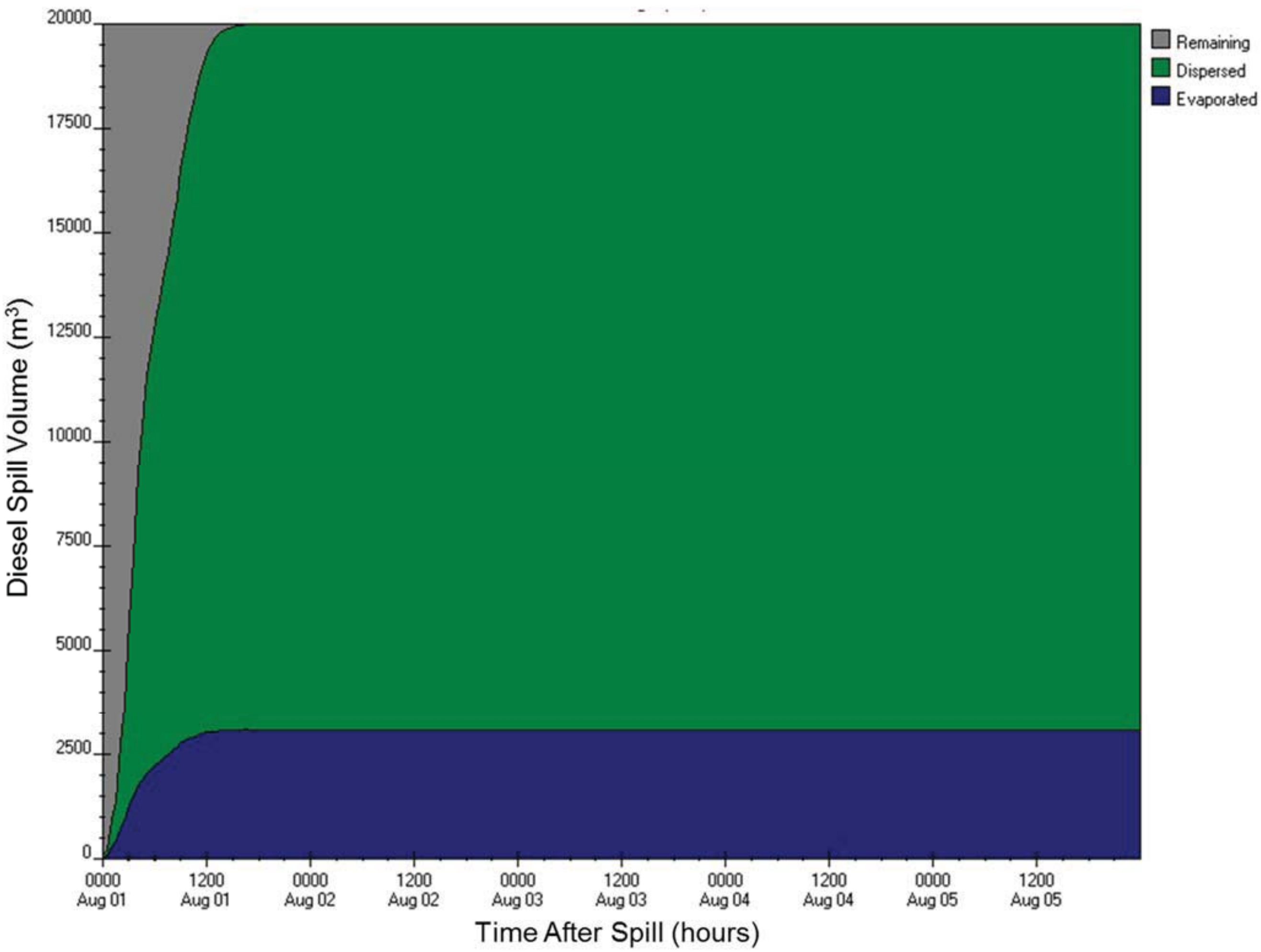

Figure E-A-15: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 20,000 m^3, 50-yr wind speed scenario

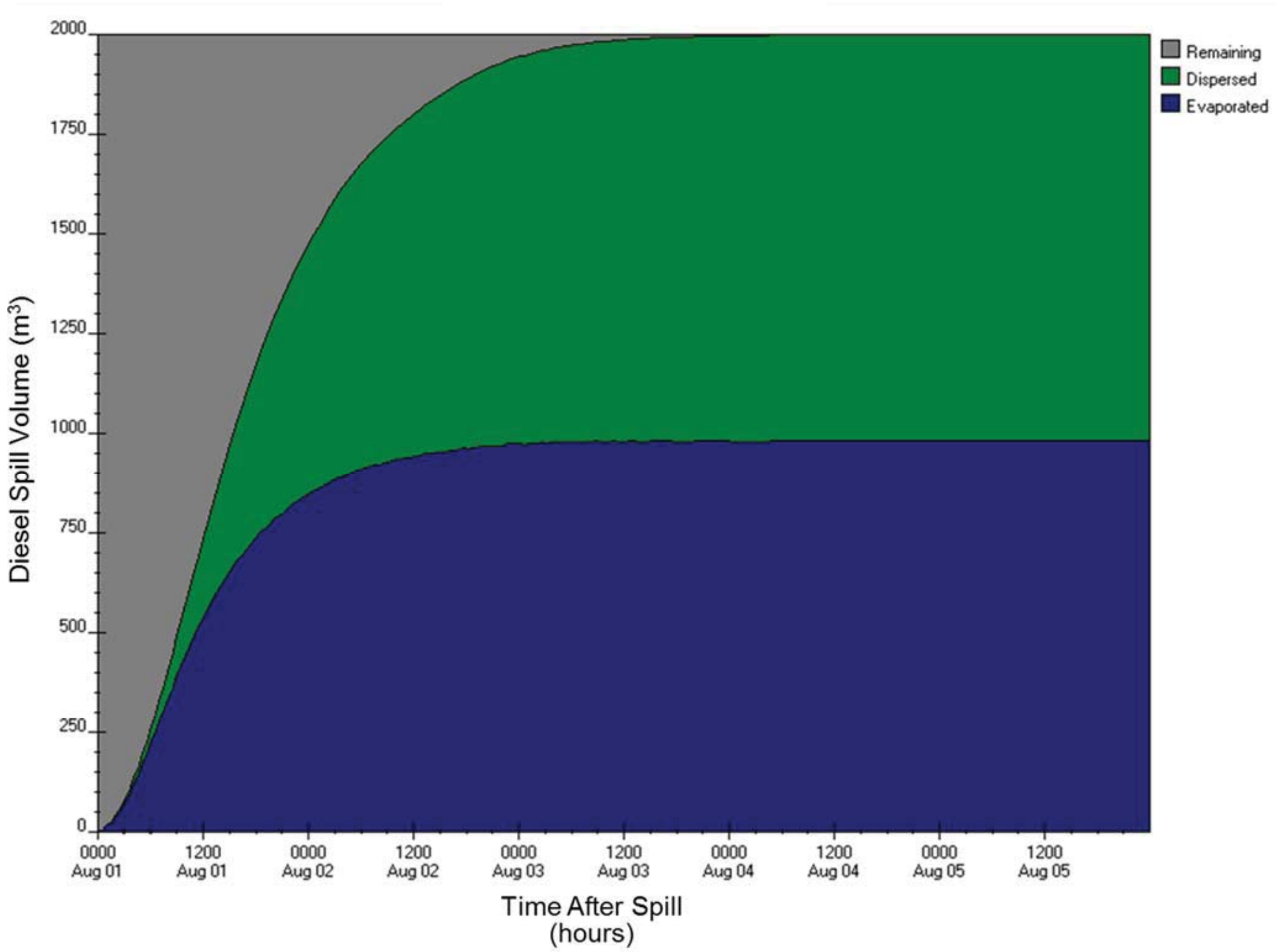

Figure E-A16: ADIOS2 diesel fuel budget output for Coats Island station (4) for 2,000 m^3, mean wind speed scenario

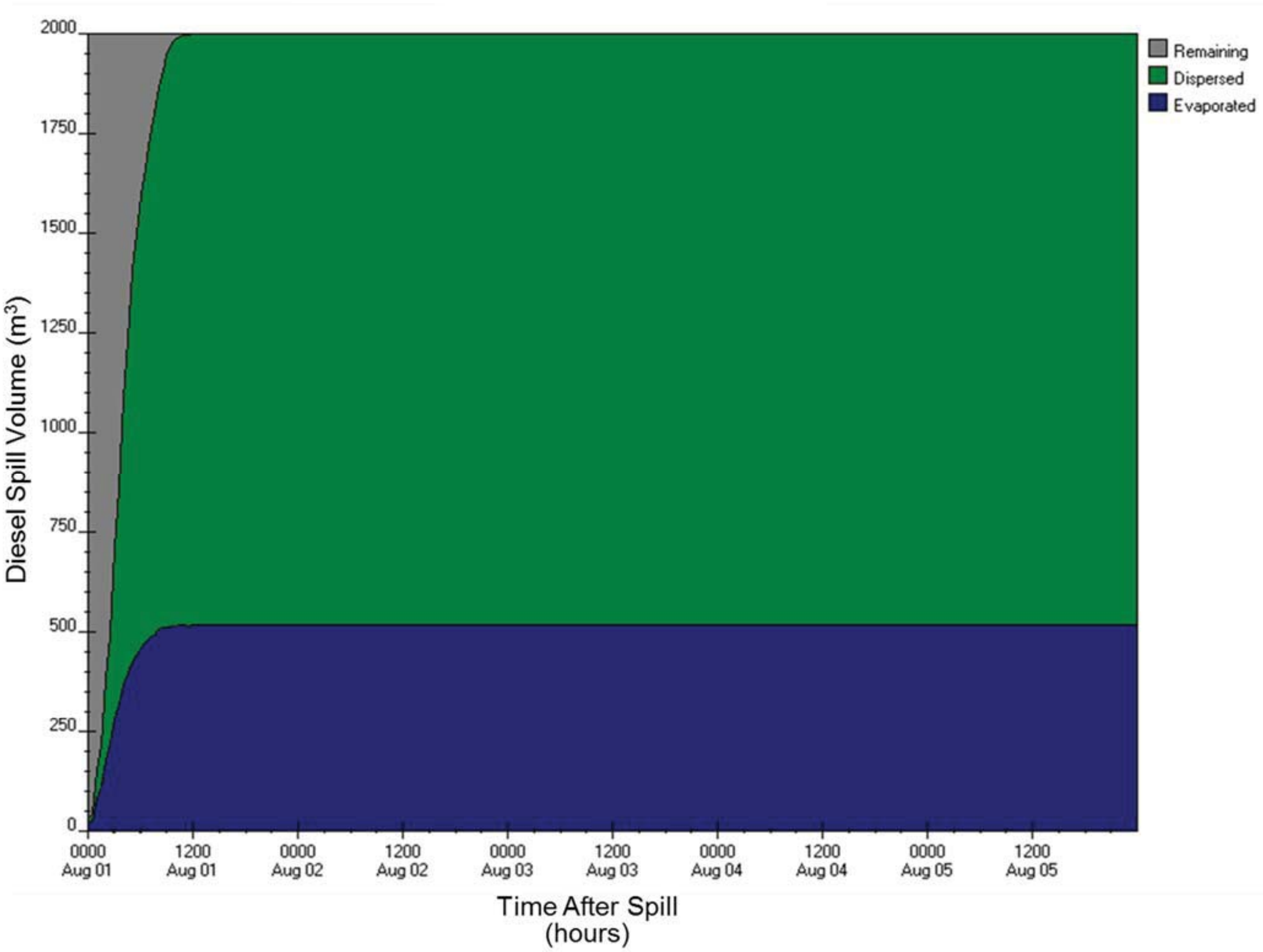

Figure E-A17: ADIOS2 diesel fuel budget output for Coats Island station (4) for 2,000 m^3, 2-yr wind speed scenario

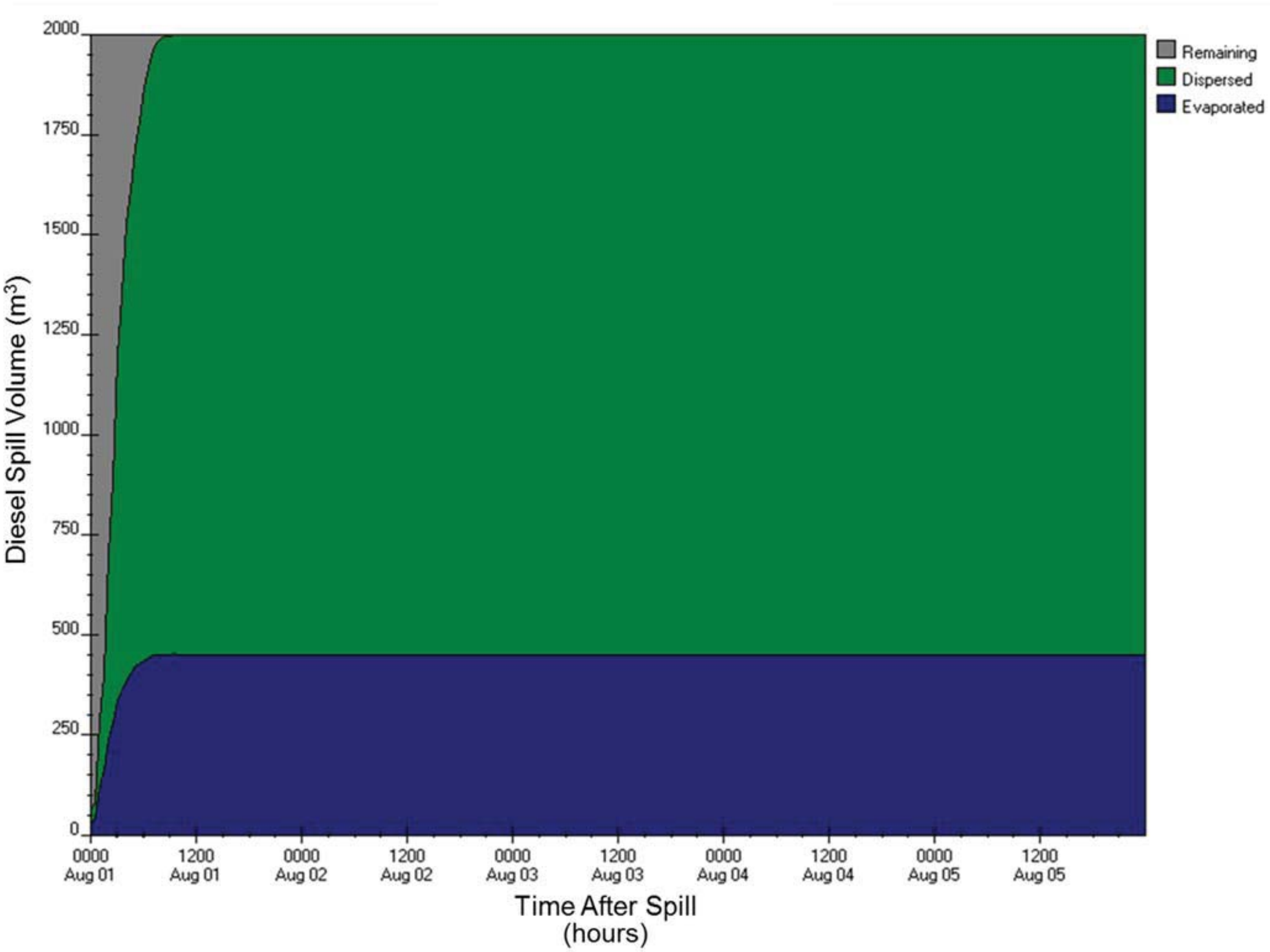

Figure E-A18: ADIOS2 diesel fuel budget output for Coats Island station (4) for 2,000 m^3, 50-yr wind speed scenario

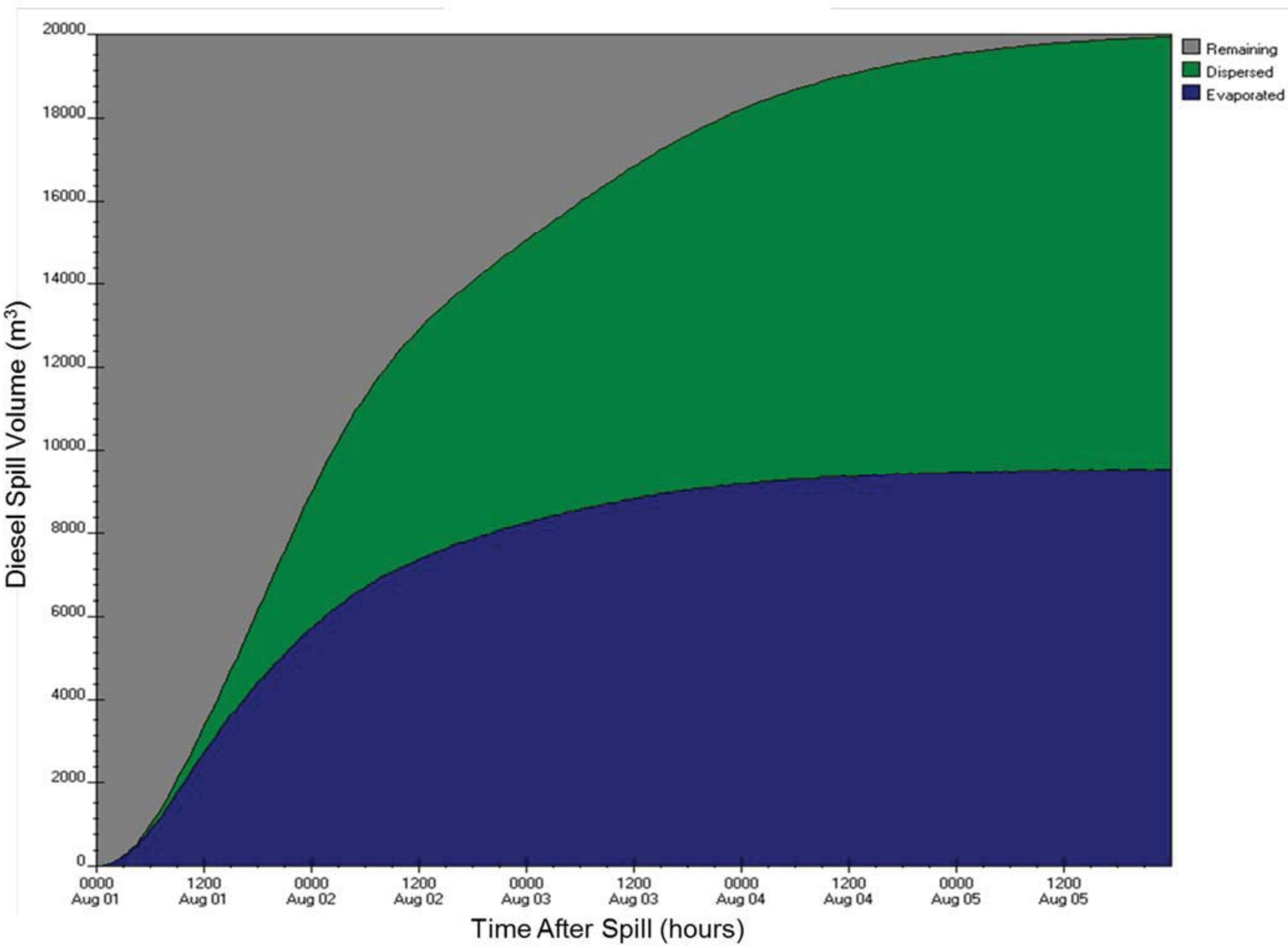

Figure E-A19: ADIOS2 diesel fuel budget output for Coats Island station (4) for 20,000 m^3, mean wind speed scenario

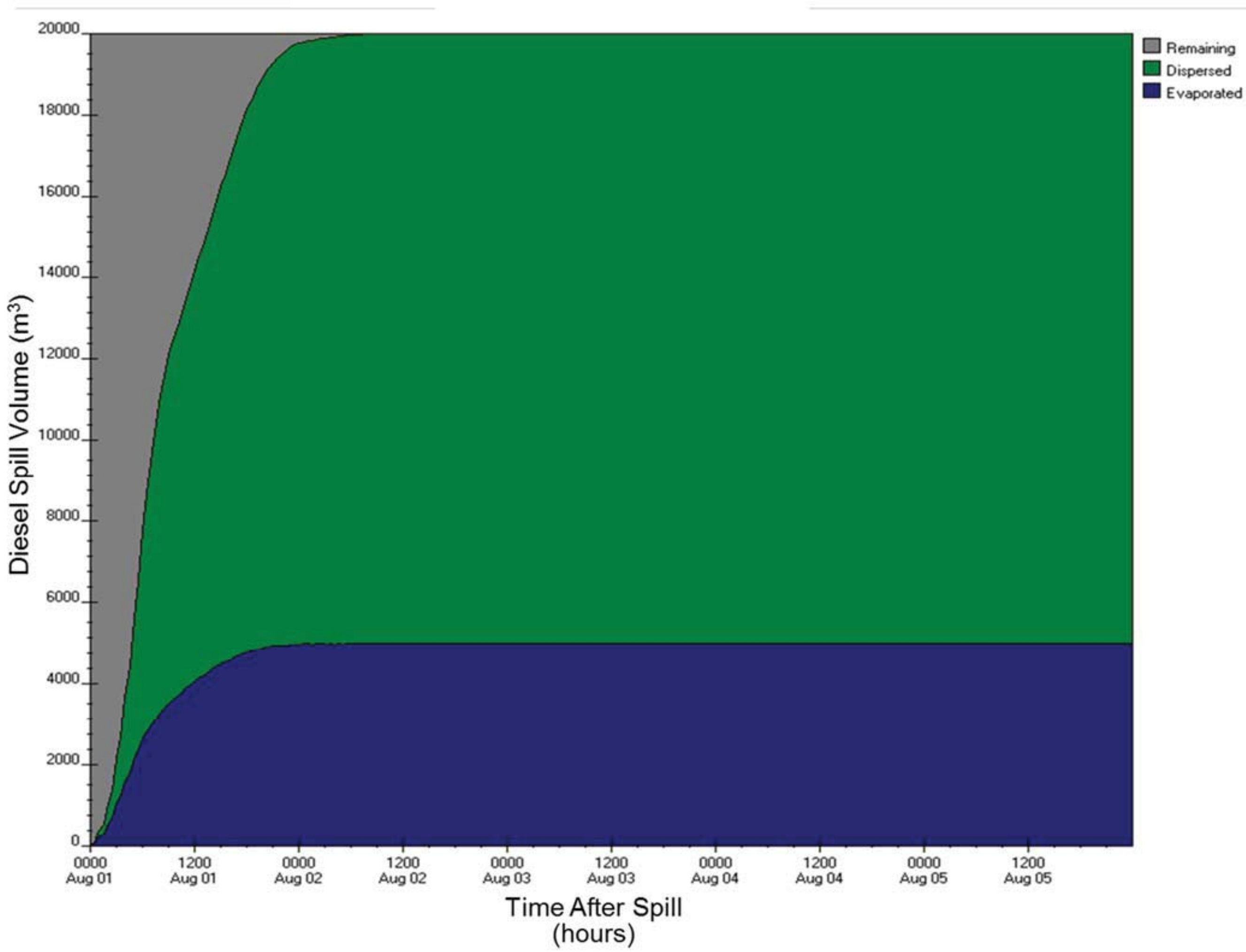

Figure E-A20: ADIOS2 diesel fuel budget output for Coats Island station (4) for 20,000 m^3, 2-yr wind speed scenario

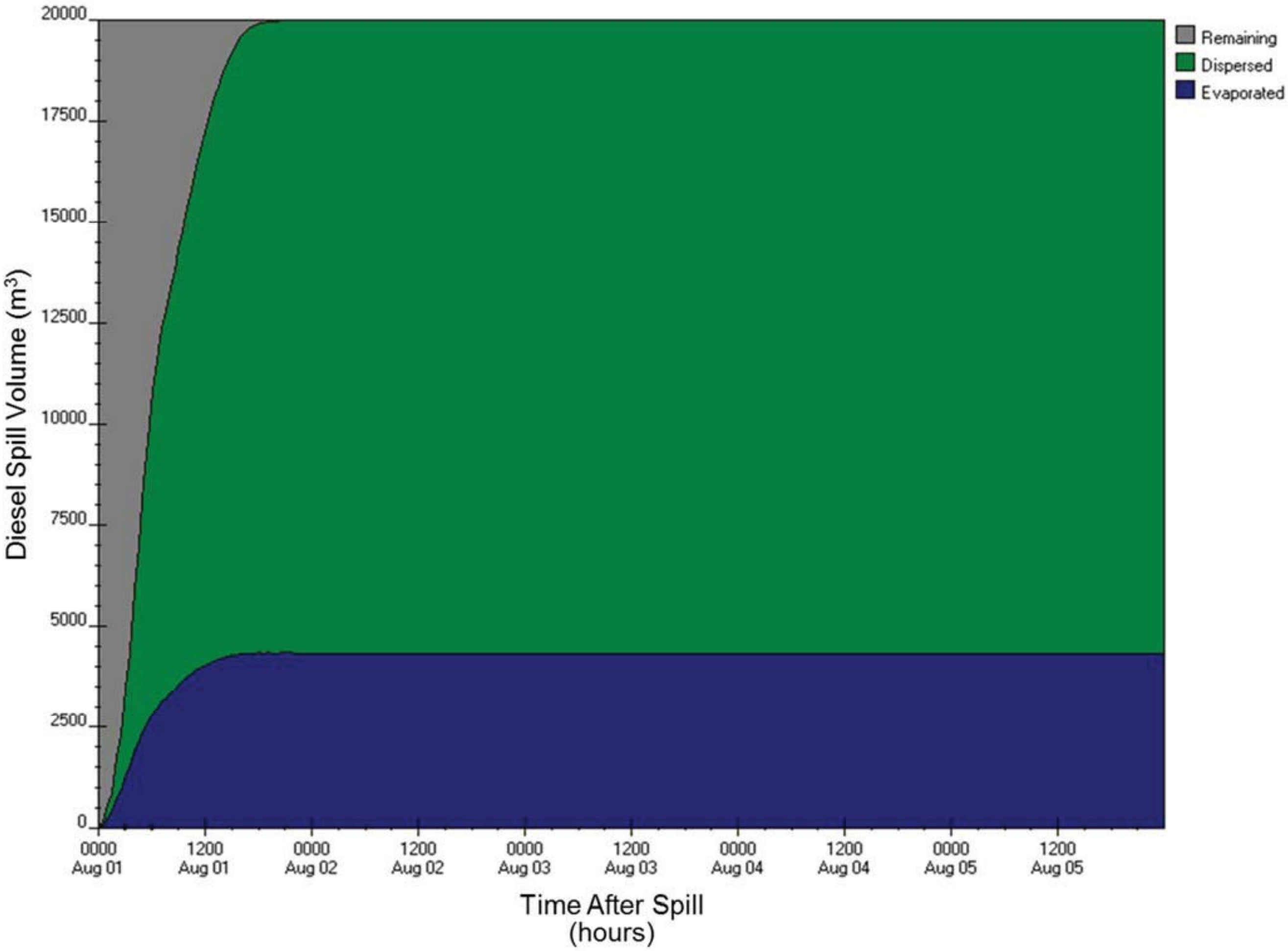

Figure E-A21:ADIOS2 diesel fuel budget output for Coats Island station (4) for 20,000 m^3, 50-yr wind speed scenario

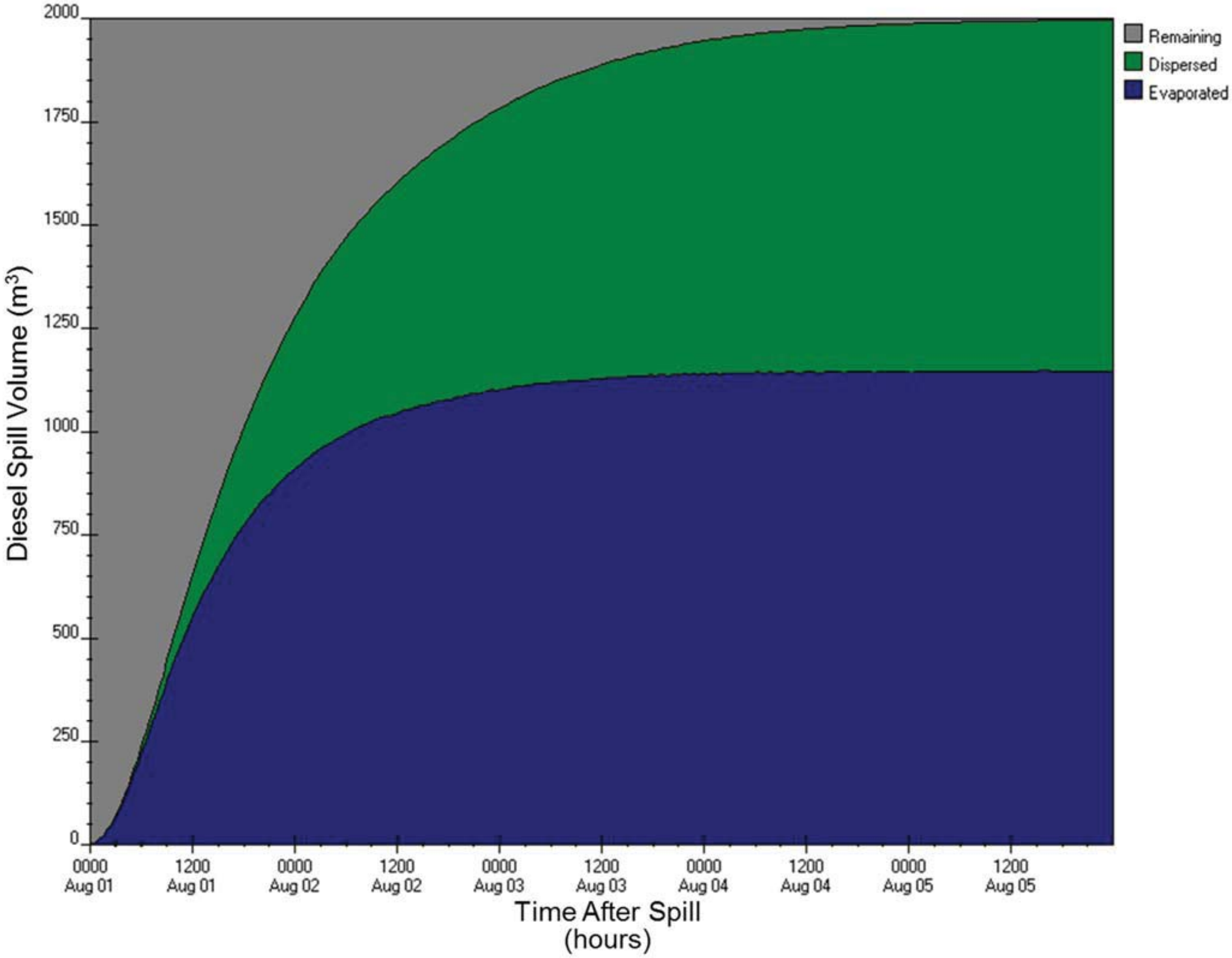

Figure E-A22:ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 2,000 m^3, mean wind speed scenario

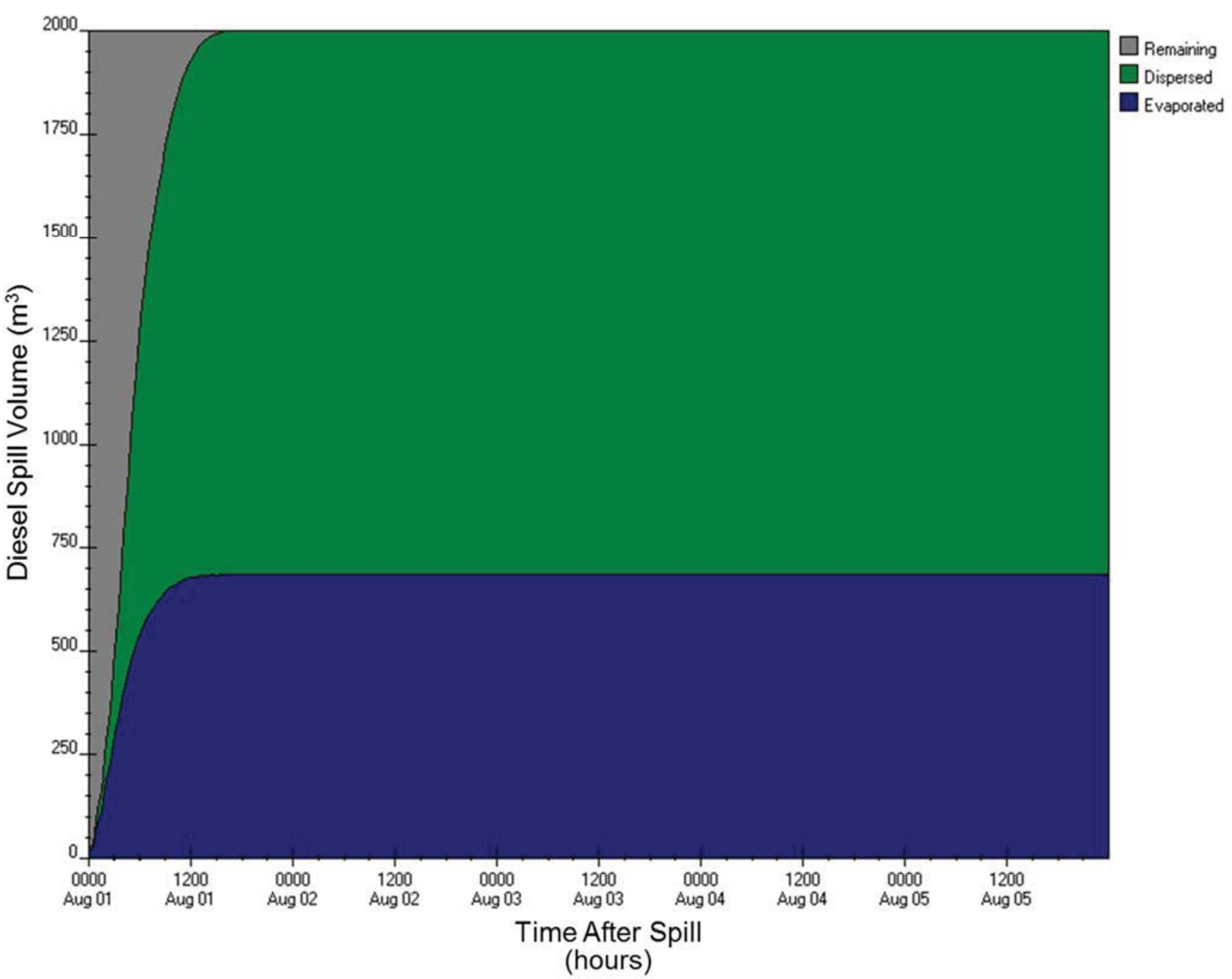

Figure E-A23: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 2,000 m^3, 2-yr wind speed scenario

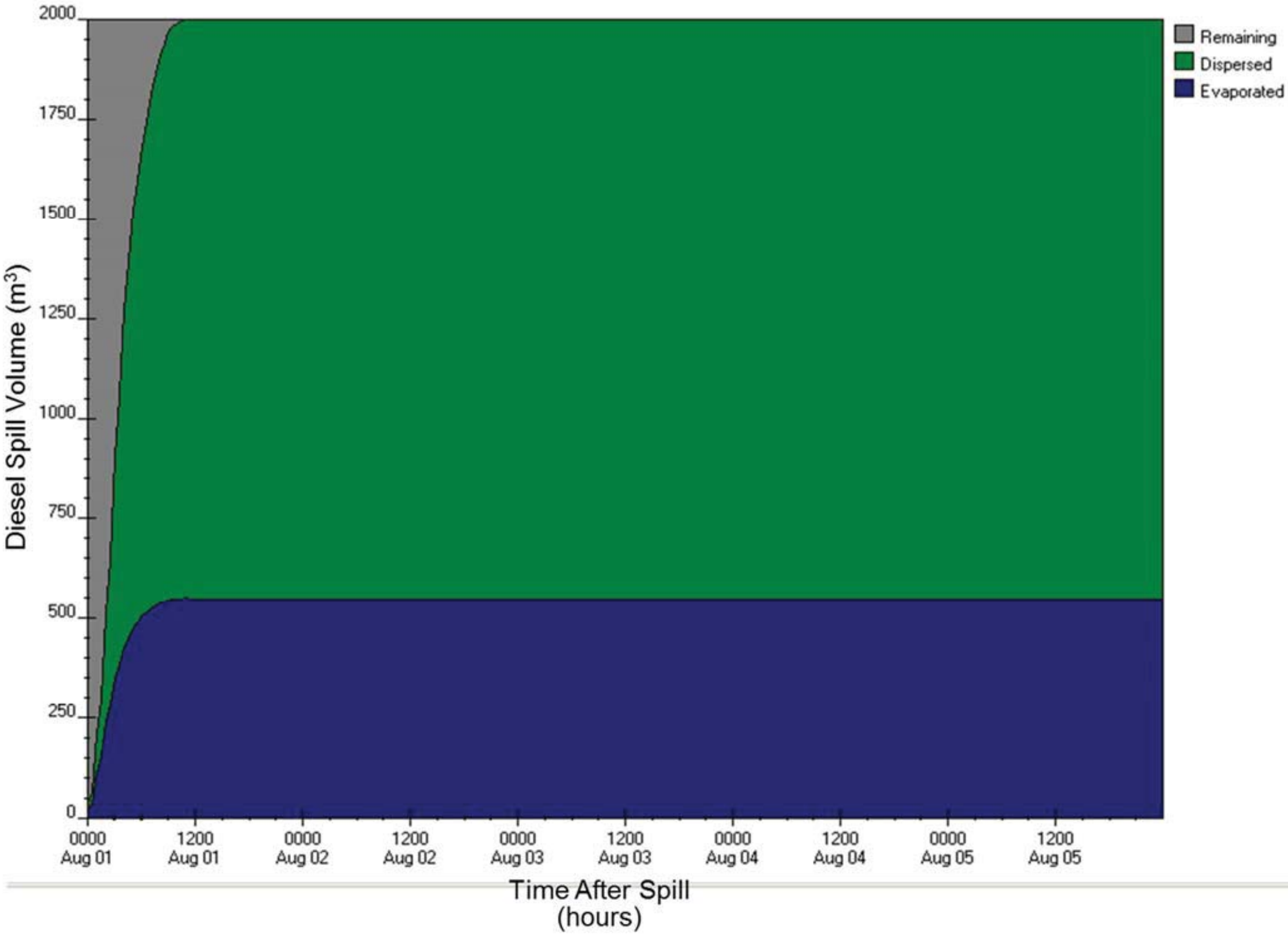

Figure E-A24: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 2,000 m^3, 50-yr wind speed scenario

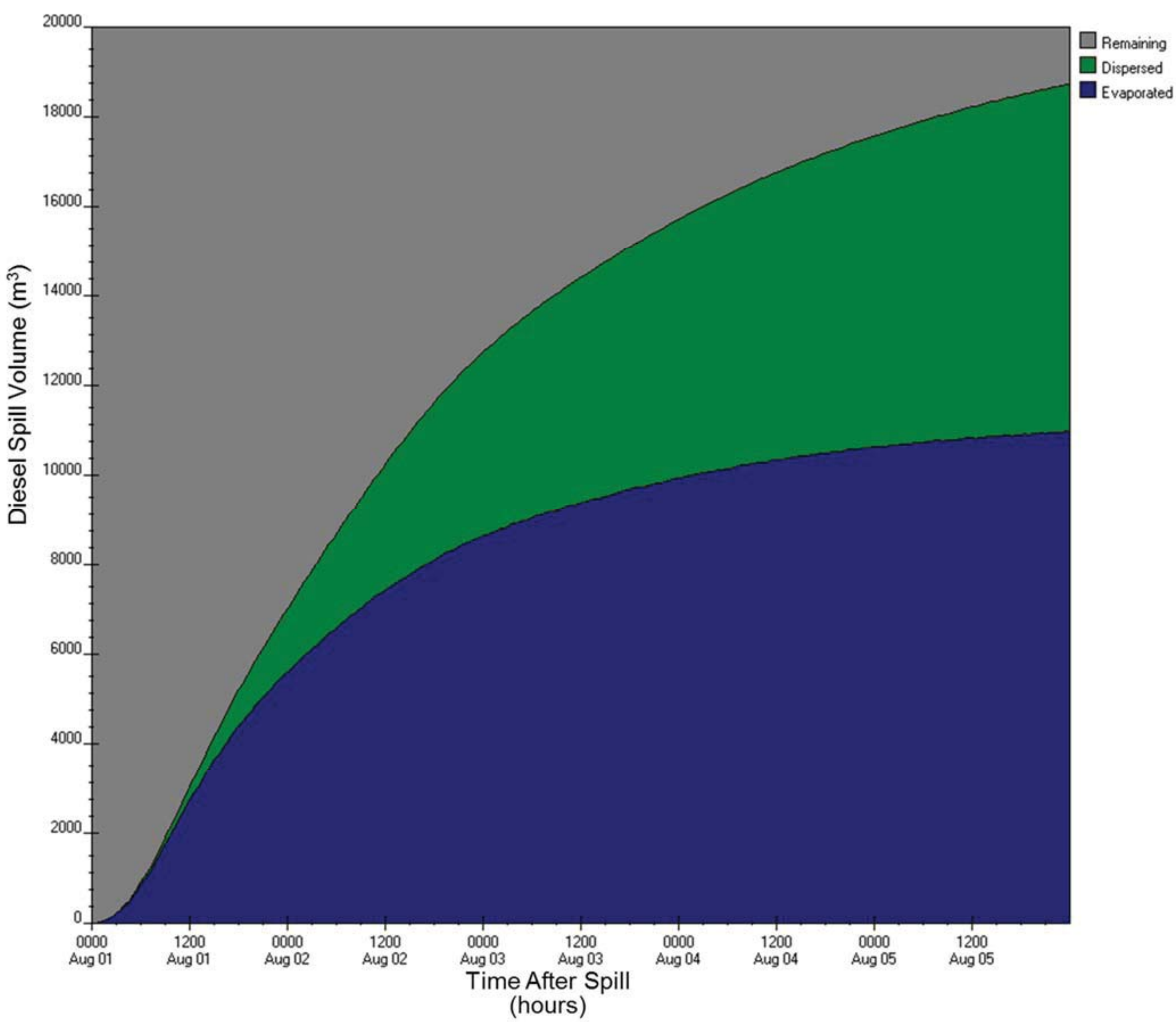

Figure E-A25: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 20,000 m^3, mean wind speed scenario

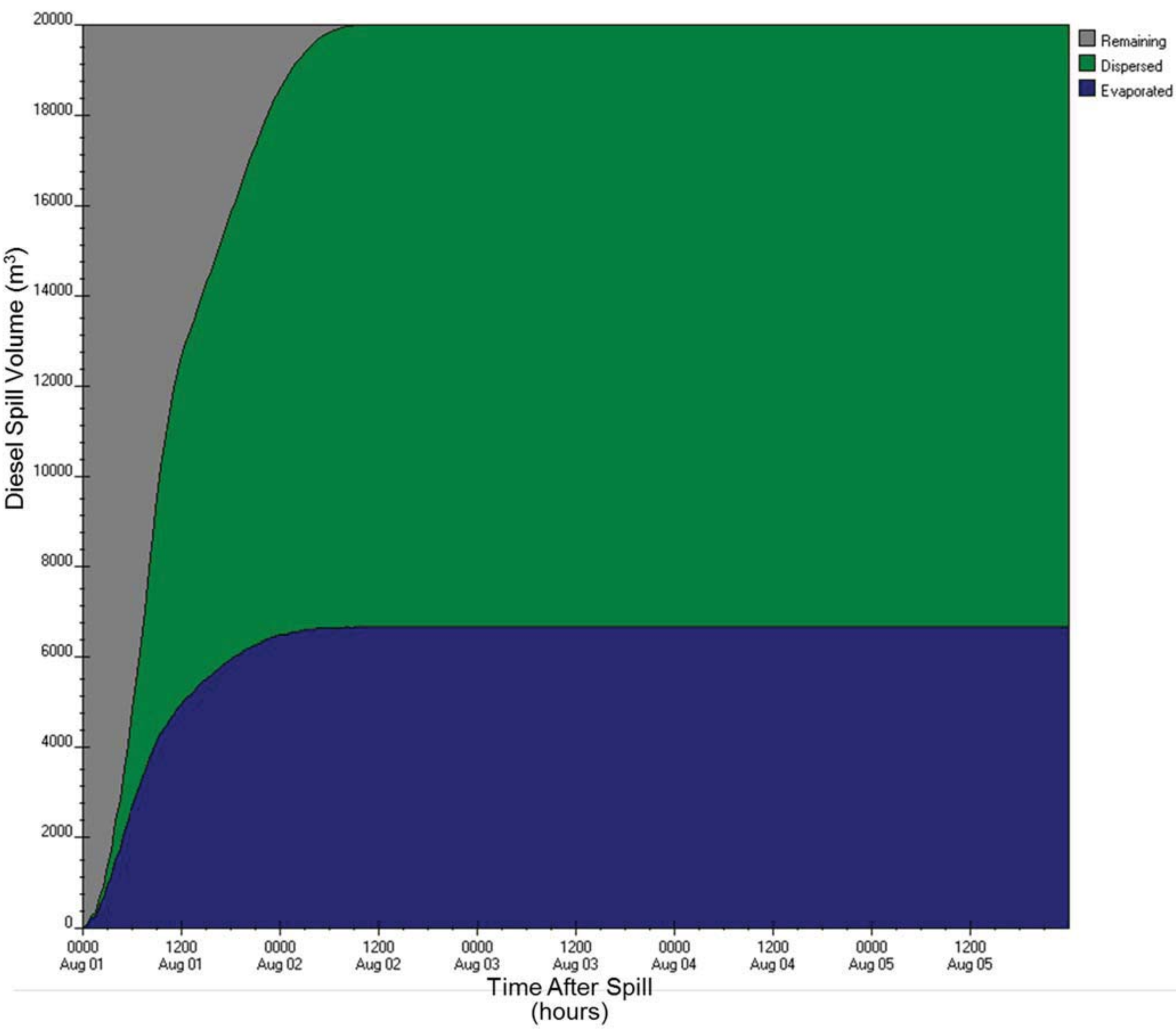

Figure E-A26: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 20,000 m^3, 2-yr wind speed scenario

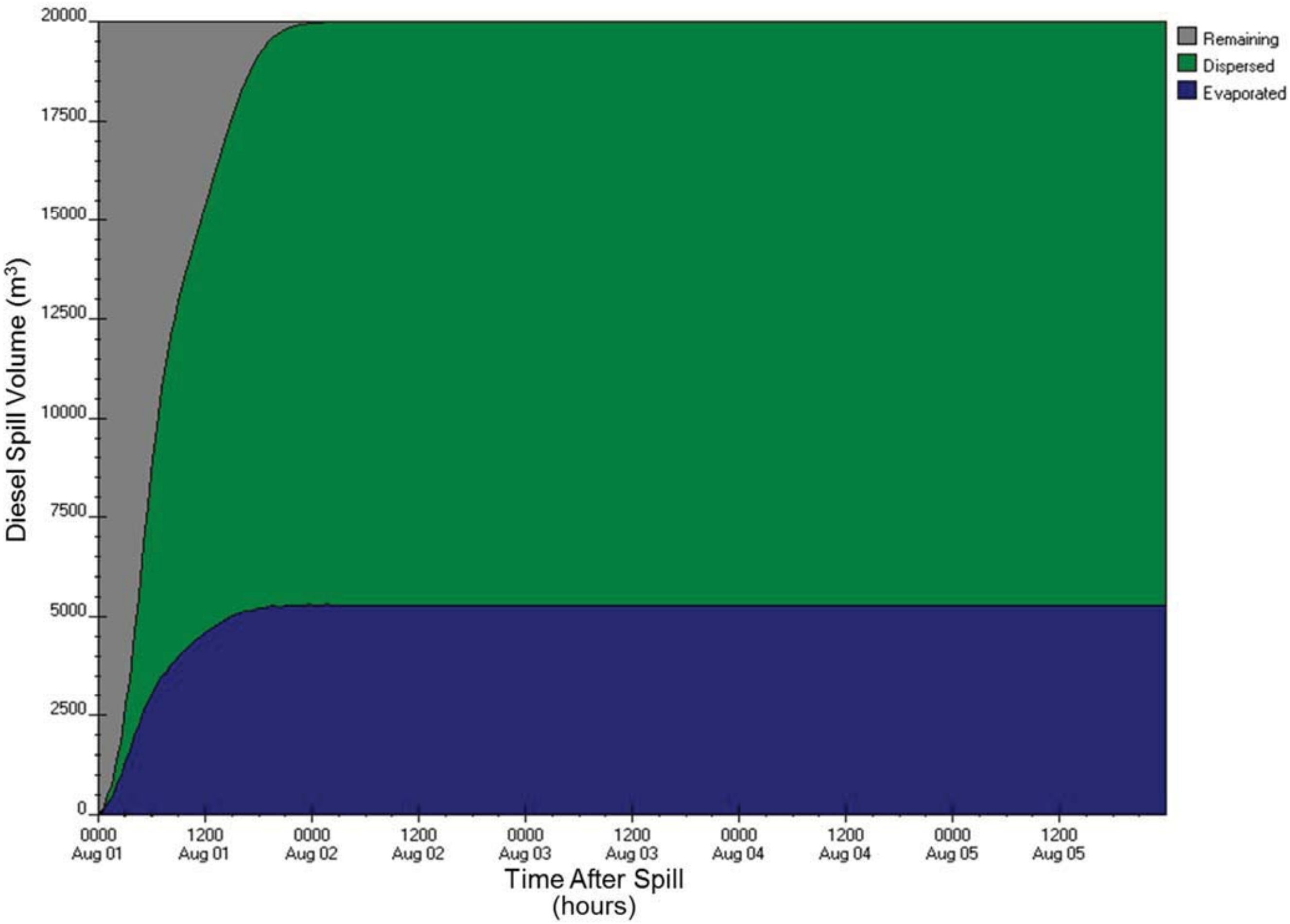

Figure E-A27: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 20,000 m^3, 50-yr wind speed scenario

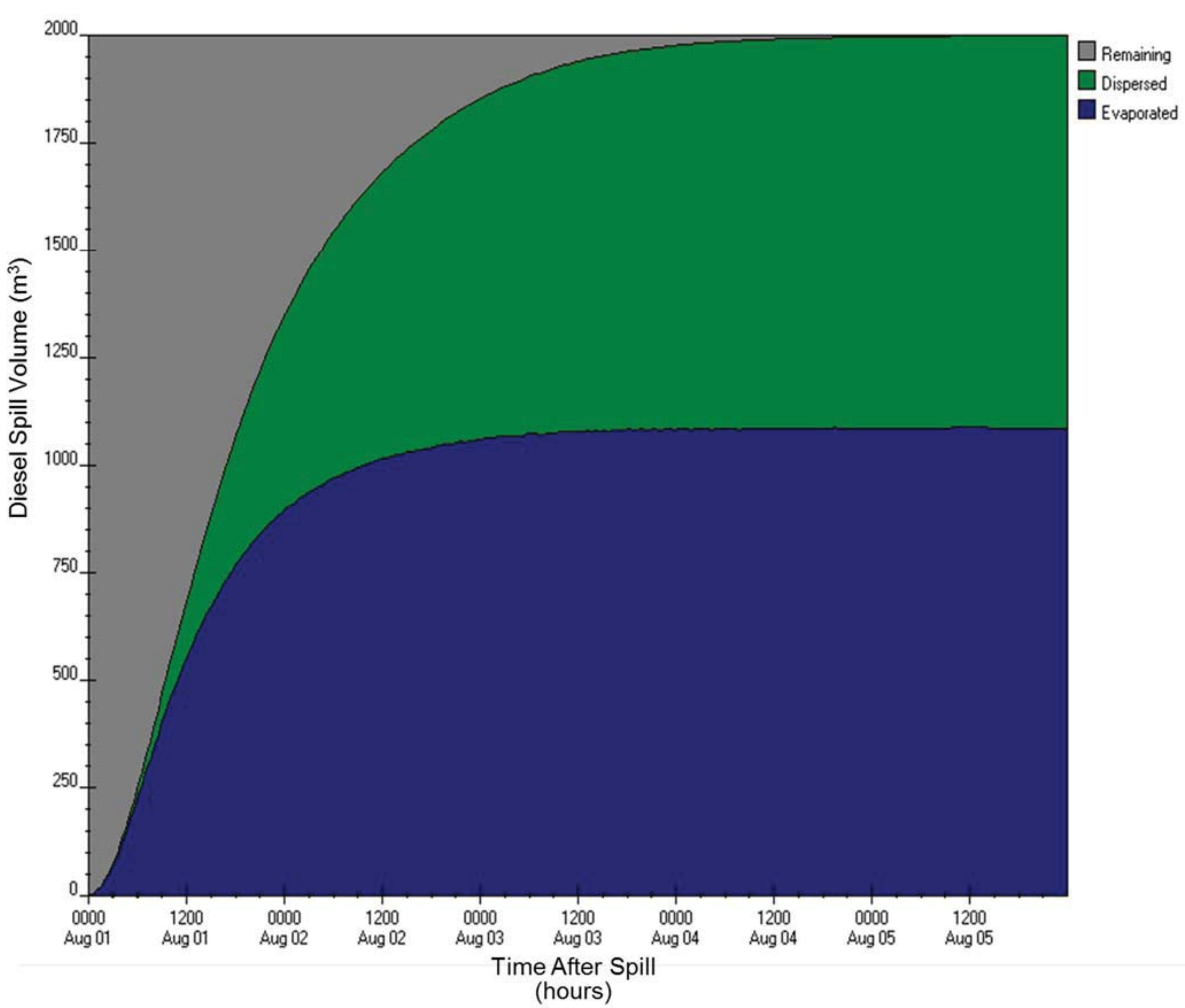

Figure E-A28: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 2,000 m^3, mean wind speed scenario

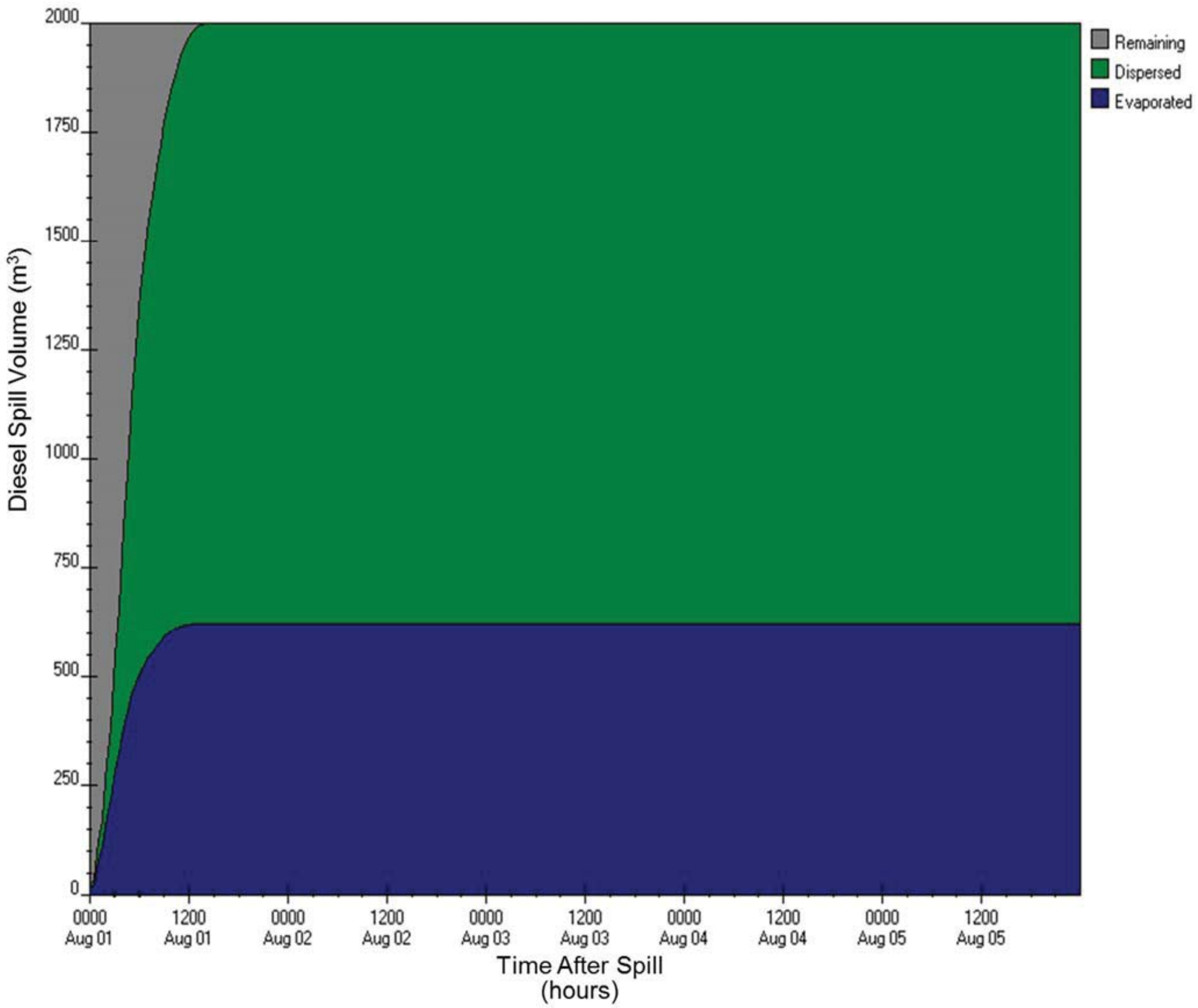

Figure E-A29: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 2,000 m^3, 2-yr wind speed scenario

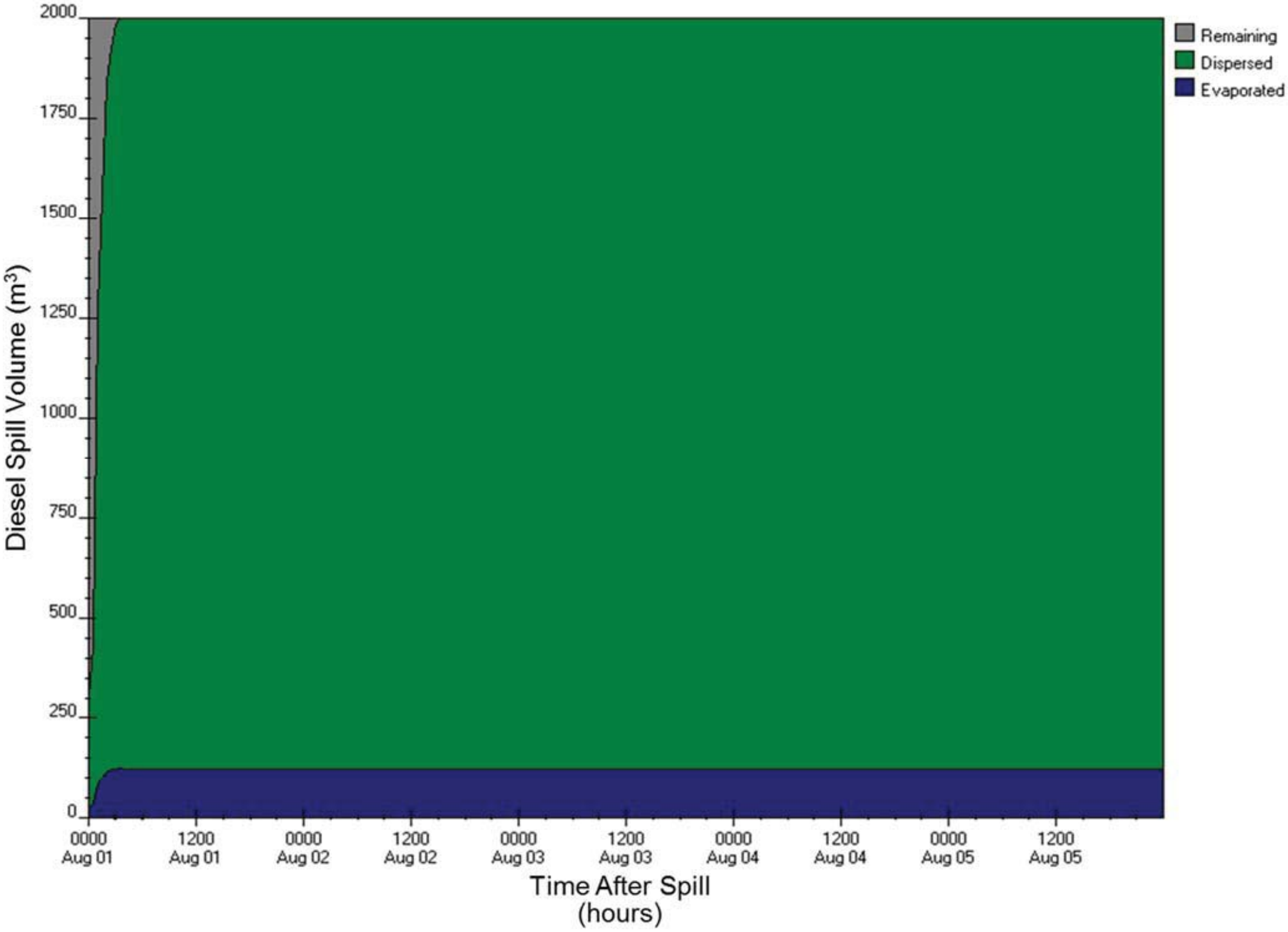

Figure E-A30: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 2,000 m³, 50-yr wind speed scenario

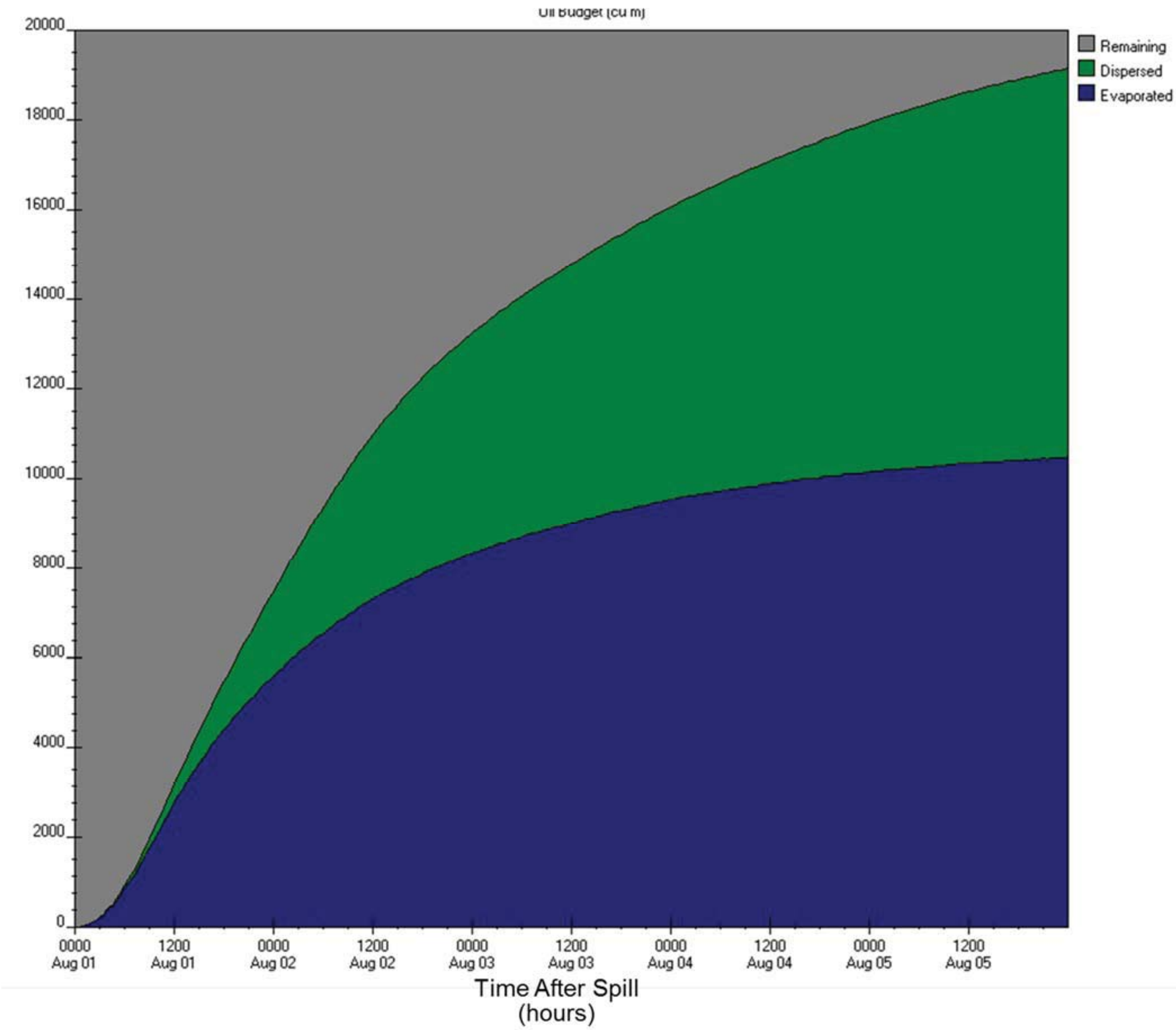

Figure E-A31: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 20,000 m^3, mean wind speed scenario

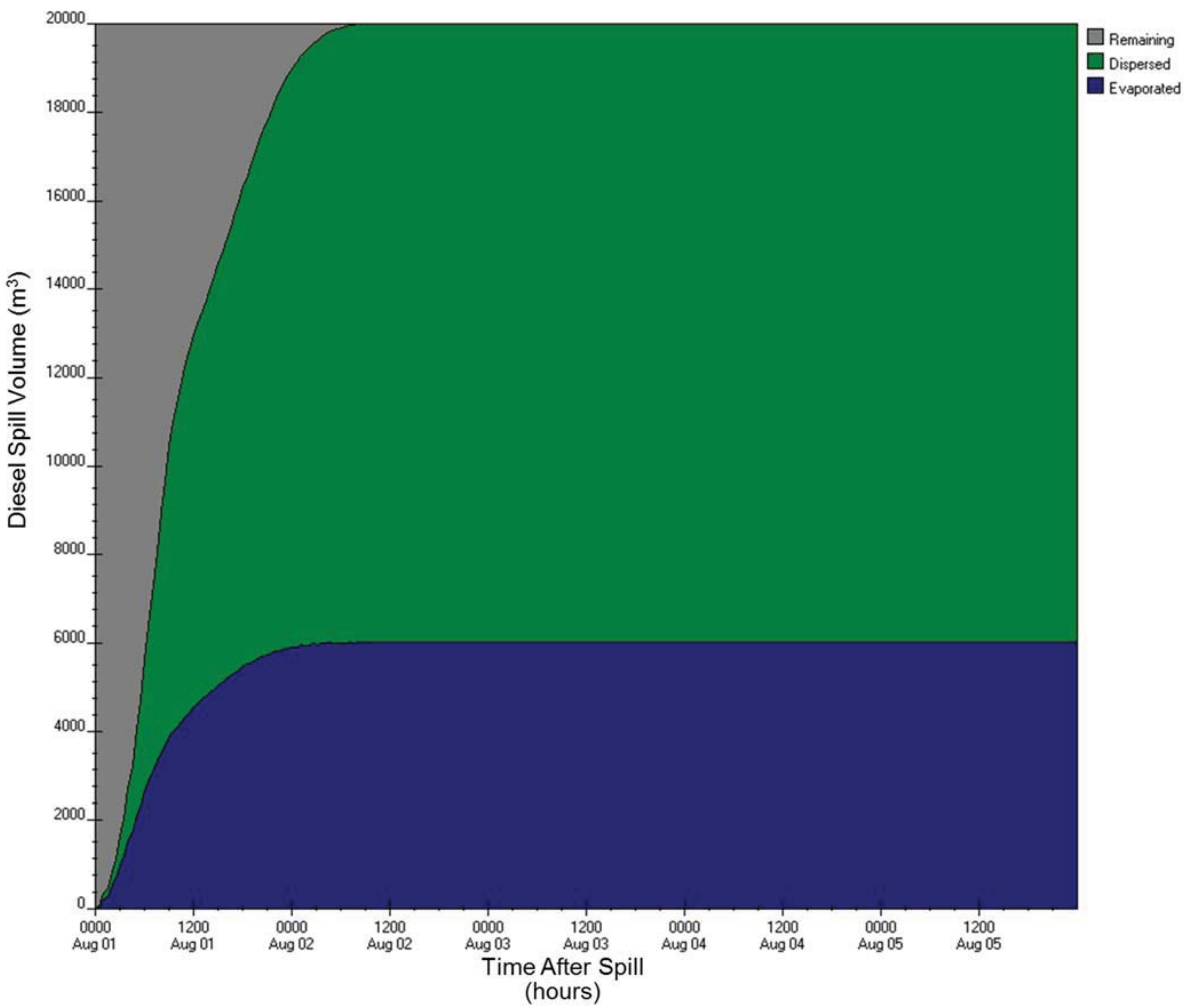

Figure E-A32: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 20,000 m^3, 2-yr wind speed scenario

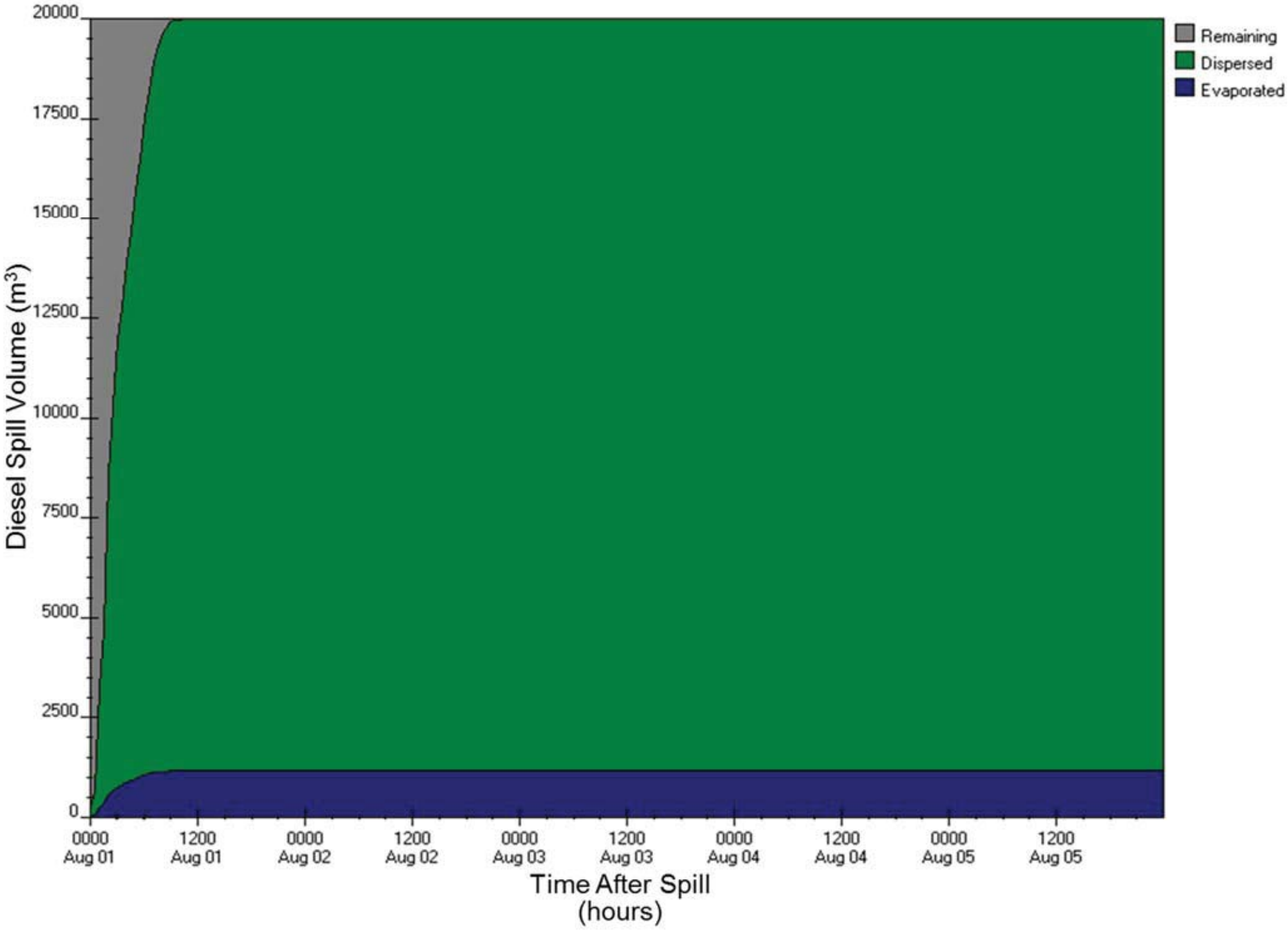

Figure E-A33: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 20,000 m^3, 50-yr wind speed scenario

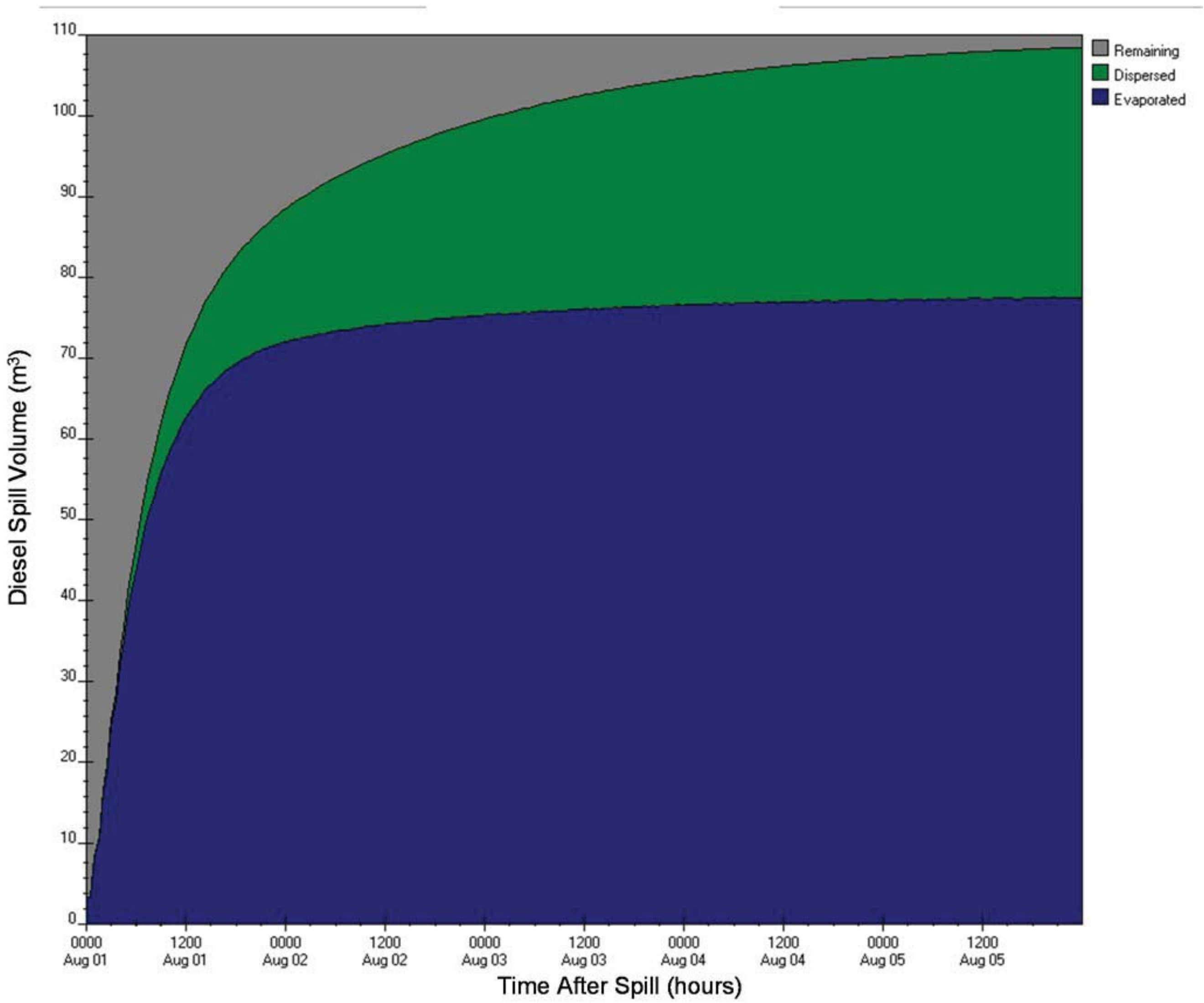

Figure E-A34: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 100 m^3, mean wind speed scenario

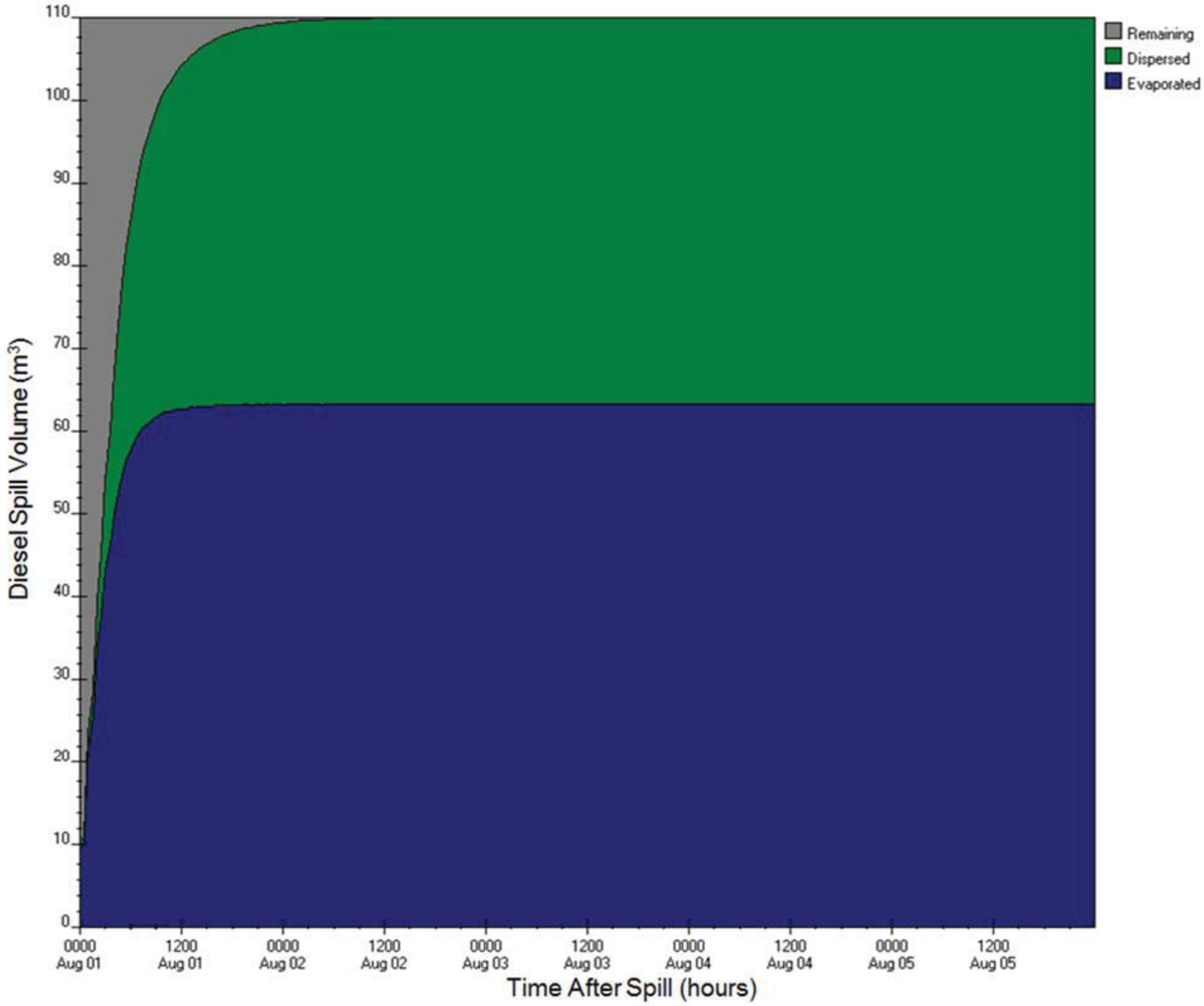

Figure E-A35: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 100 m^3, 2-yr wind speed scenario

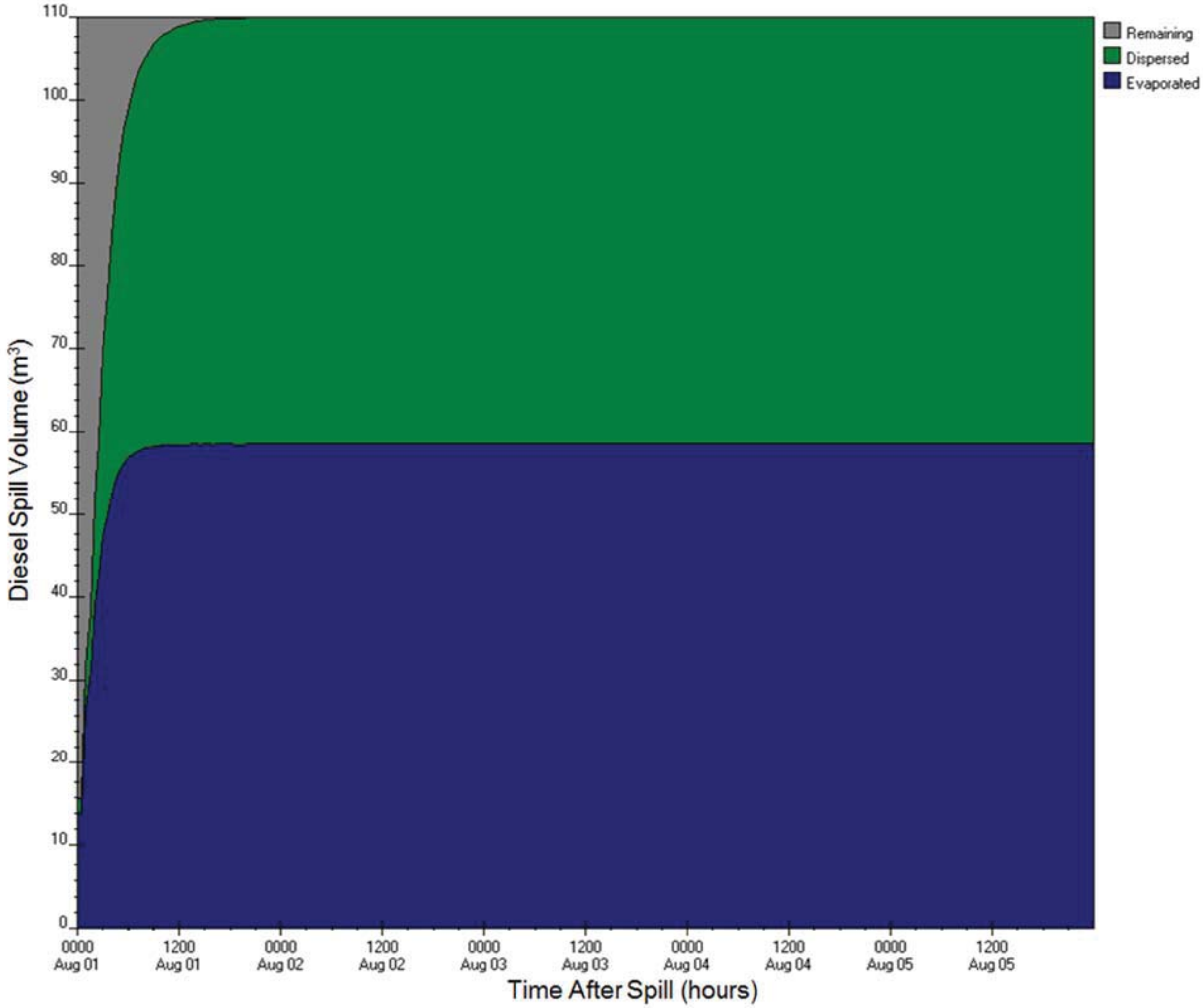

Figure E-A36: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 100 m^3, 50-yr wind speed scenario

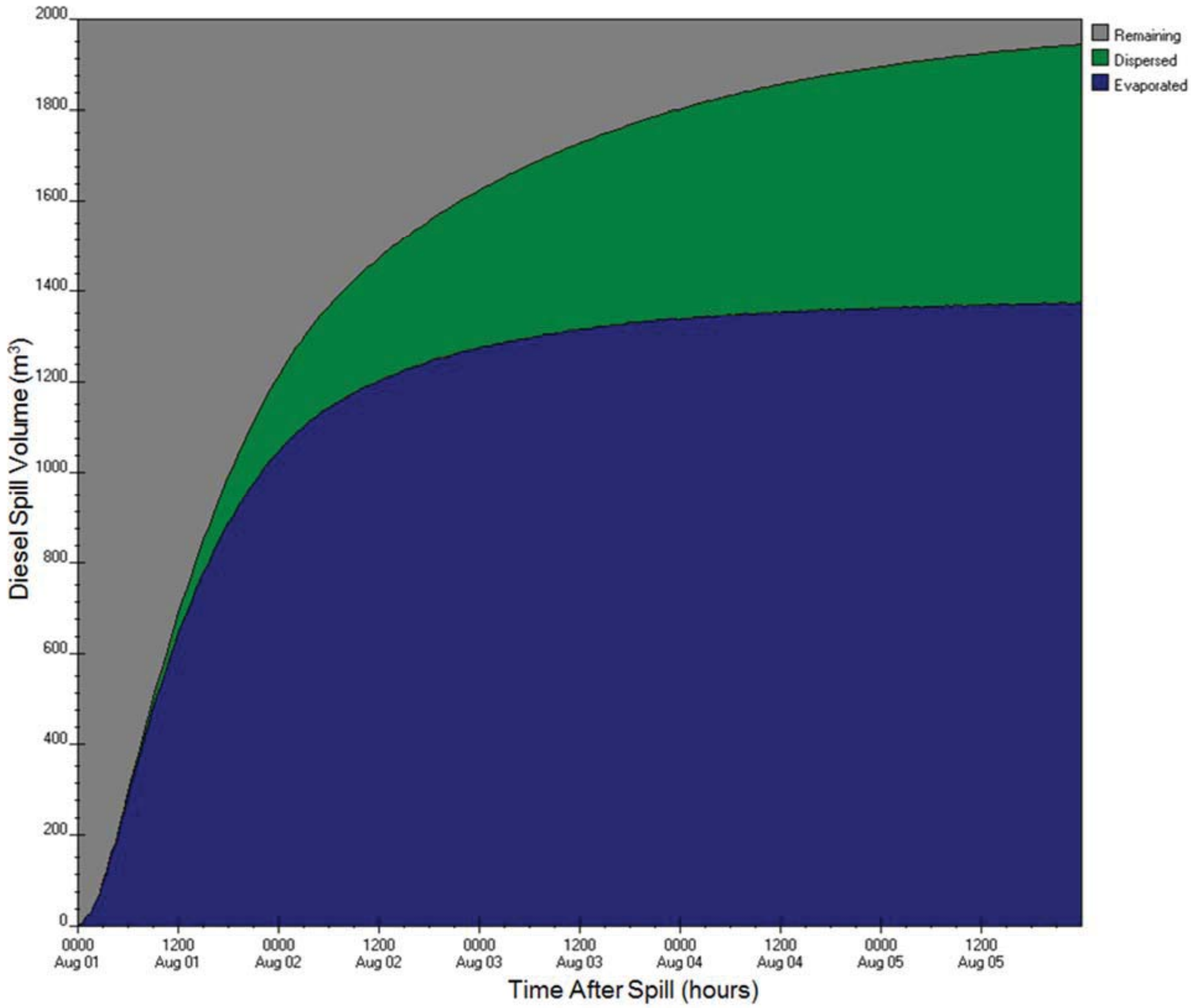

Figure E-A37: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 2,000 m^3, mean wind speed scenario

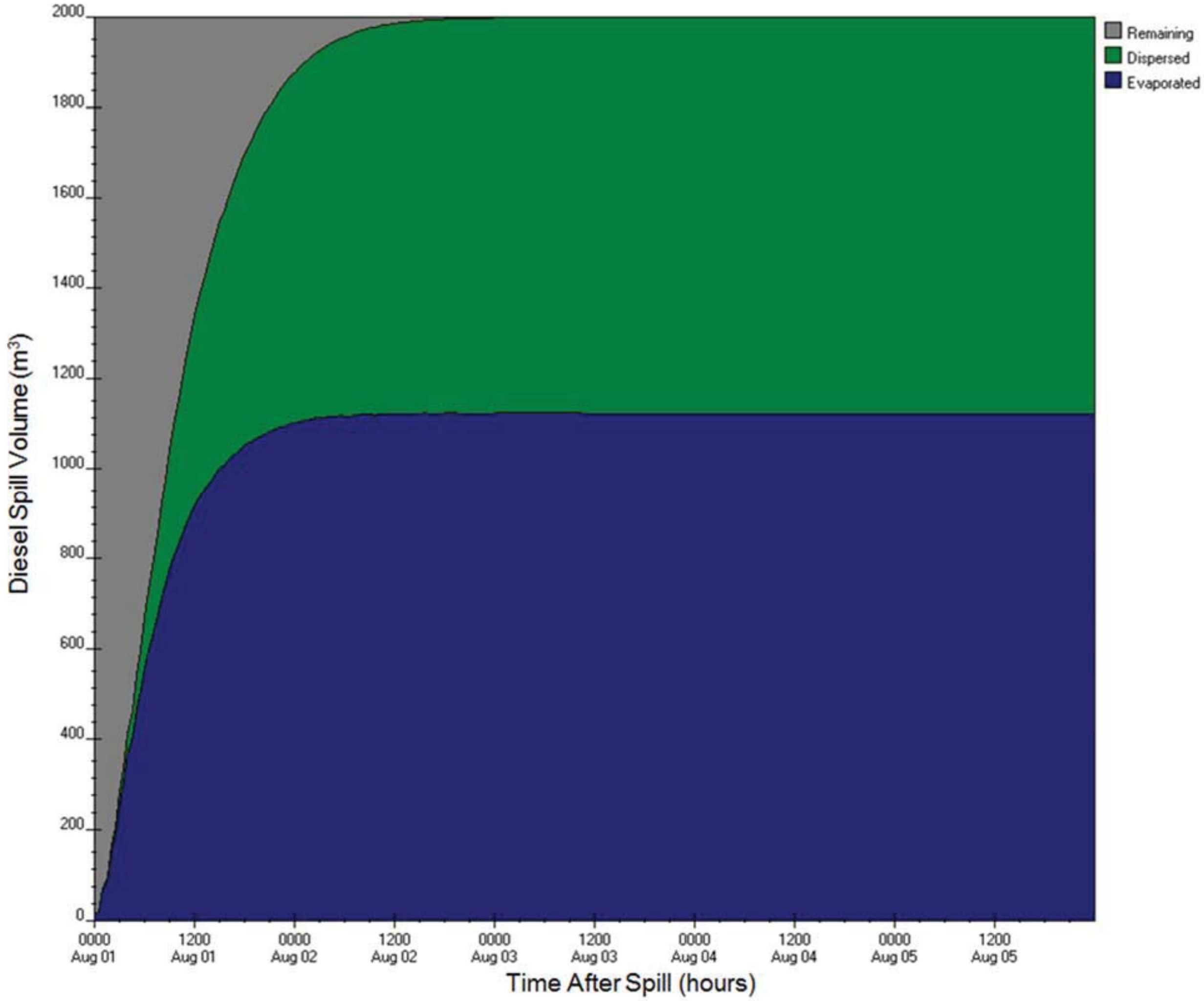

Figure E-A38: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 2,000 m^3, 2-yr wind speed scenario

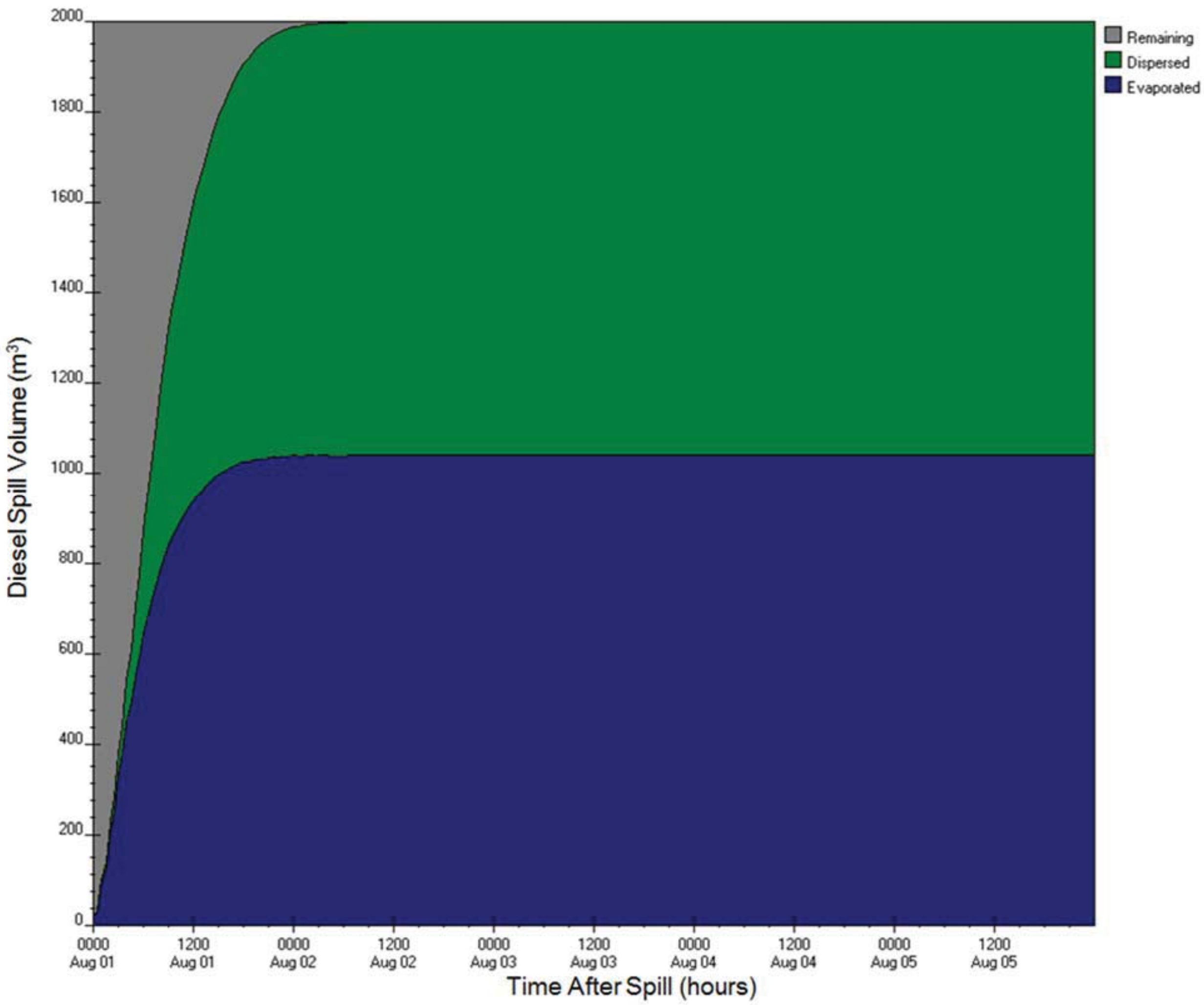

Figure E-A39: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 2,000 m^3, 50-yr wind speed scenario

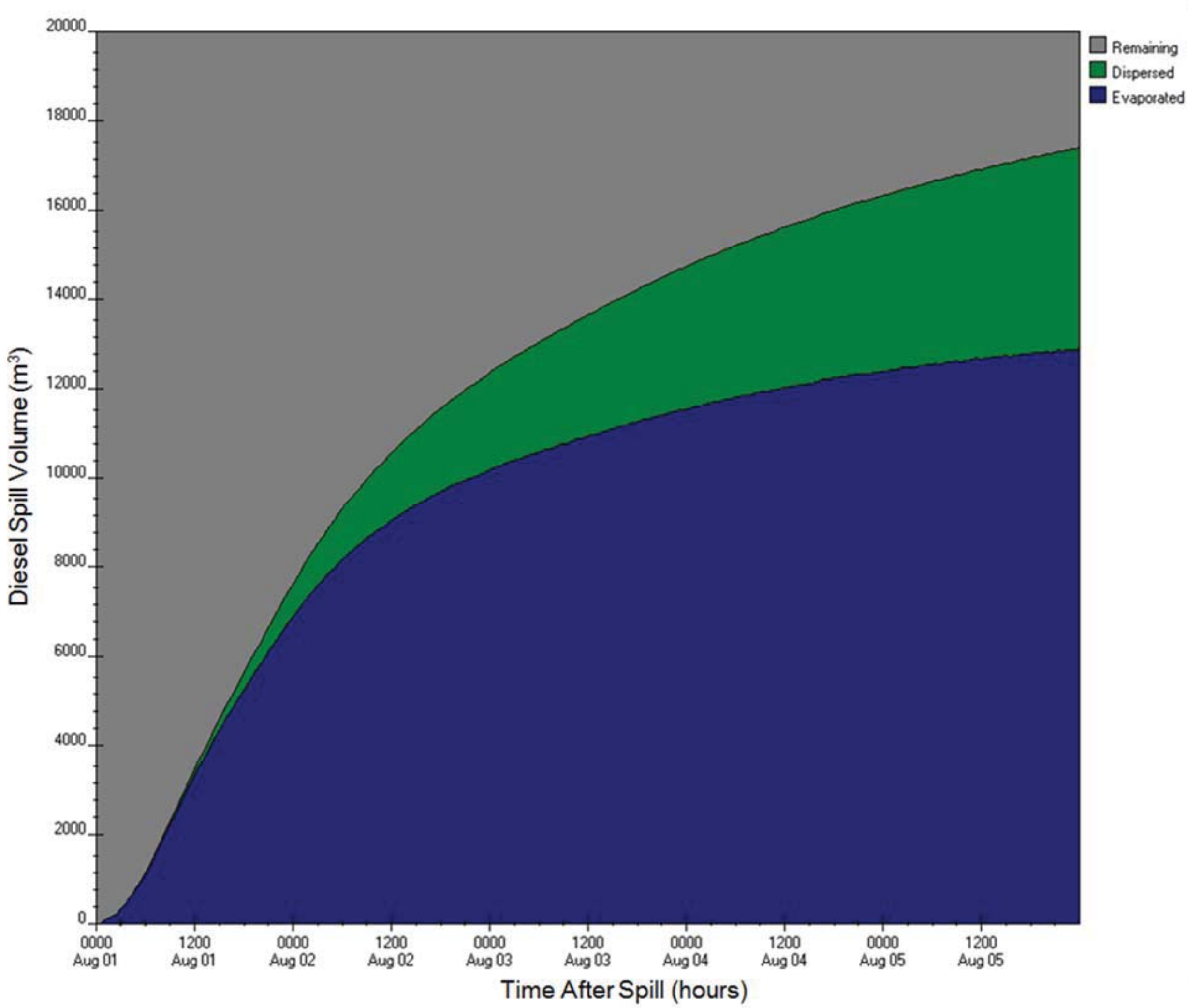

Figure E-A40: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 20,000 m^3, mean wind speed scenario

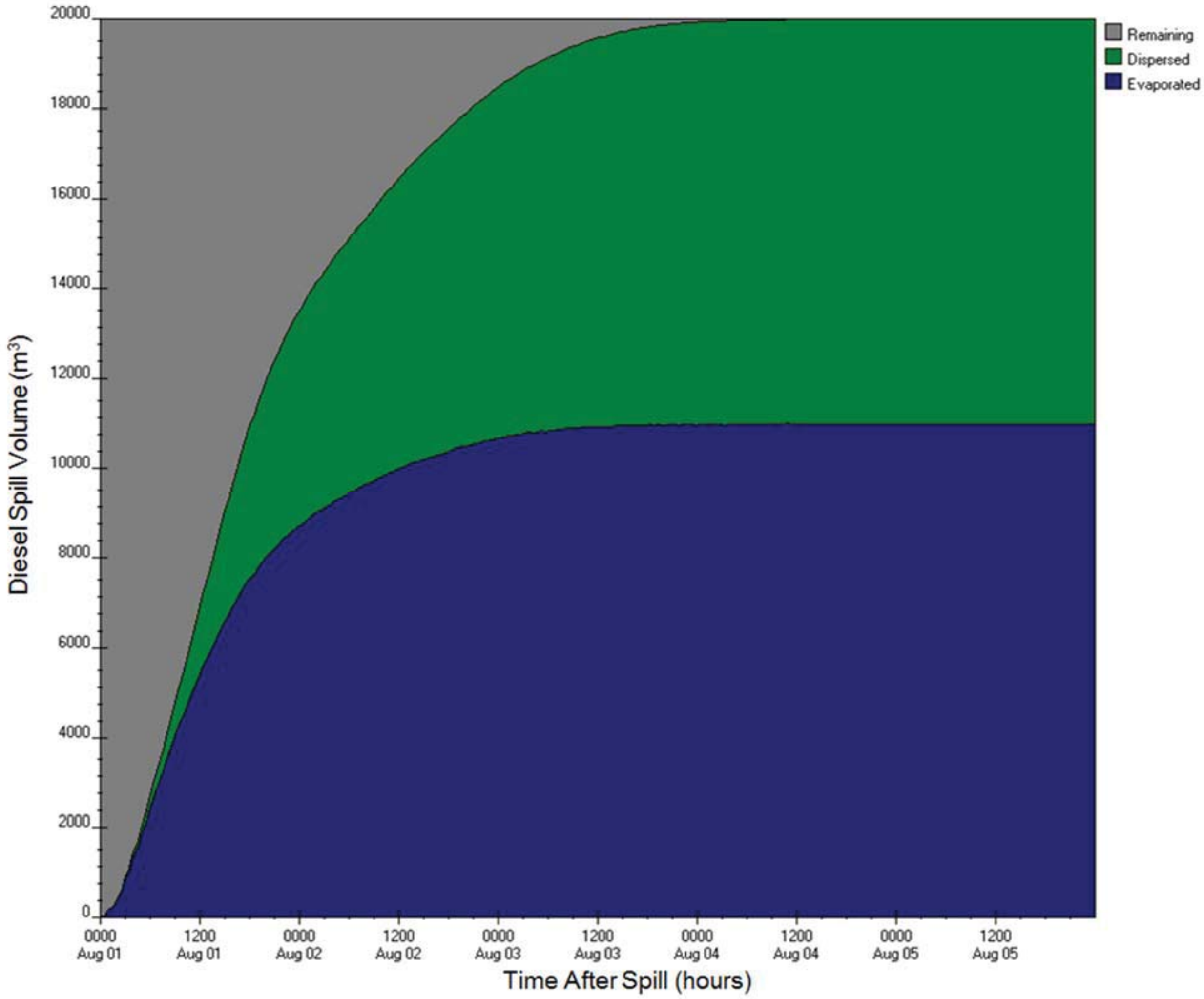

Figure E-A41: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 20,000 m^3, 2-yr wind speed scenario

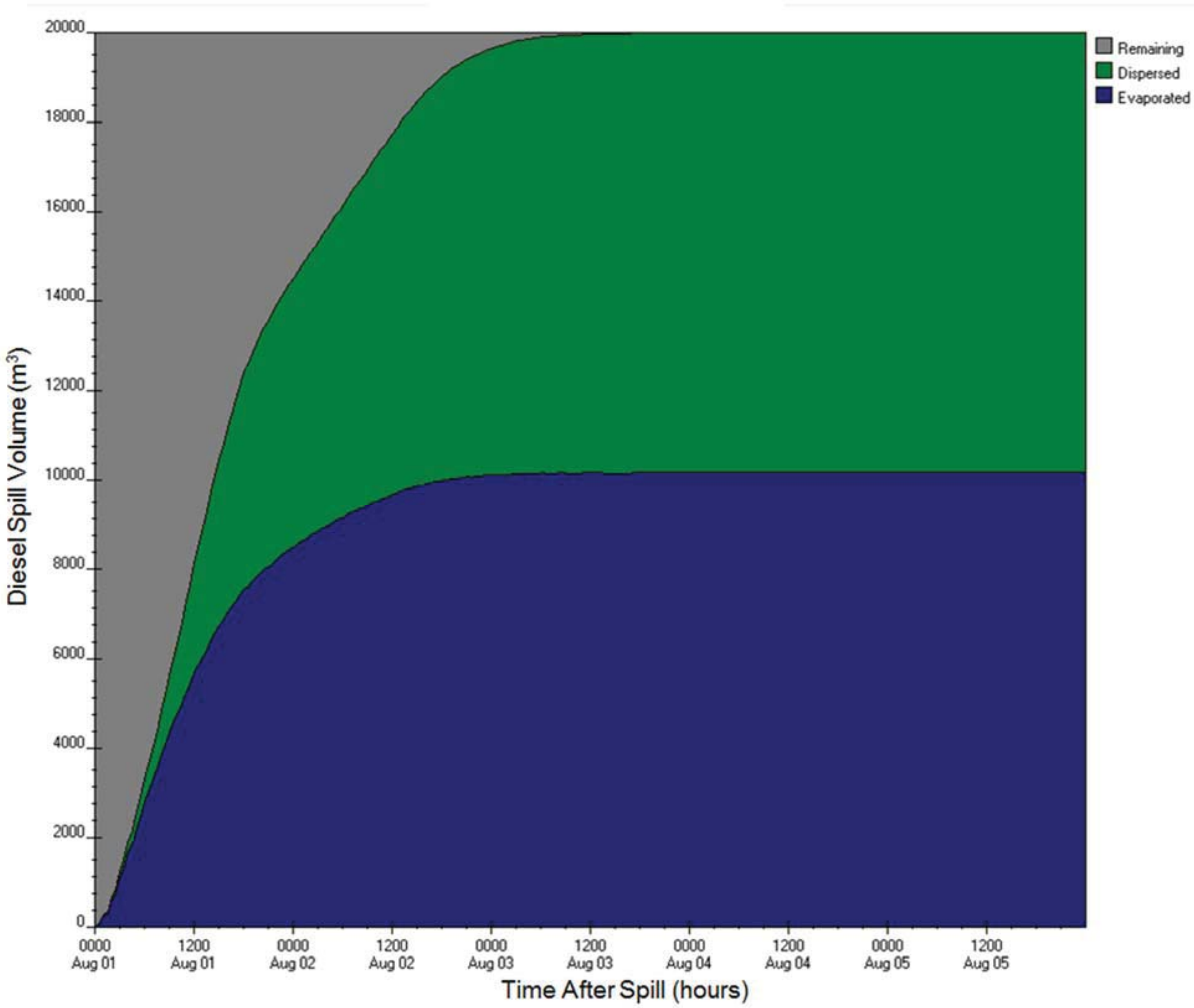

Figure E-A42: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 20,000 m^3, 50-yr wind speed scenario

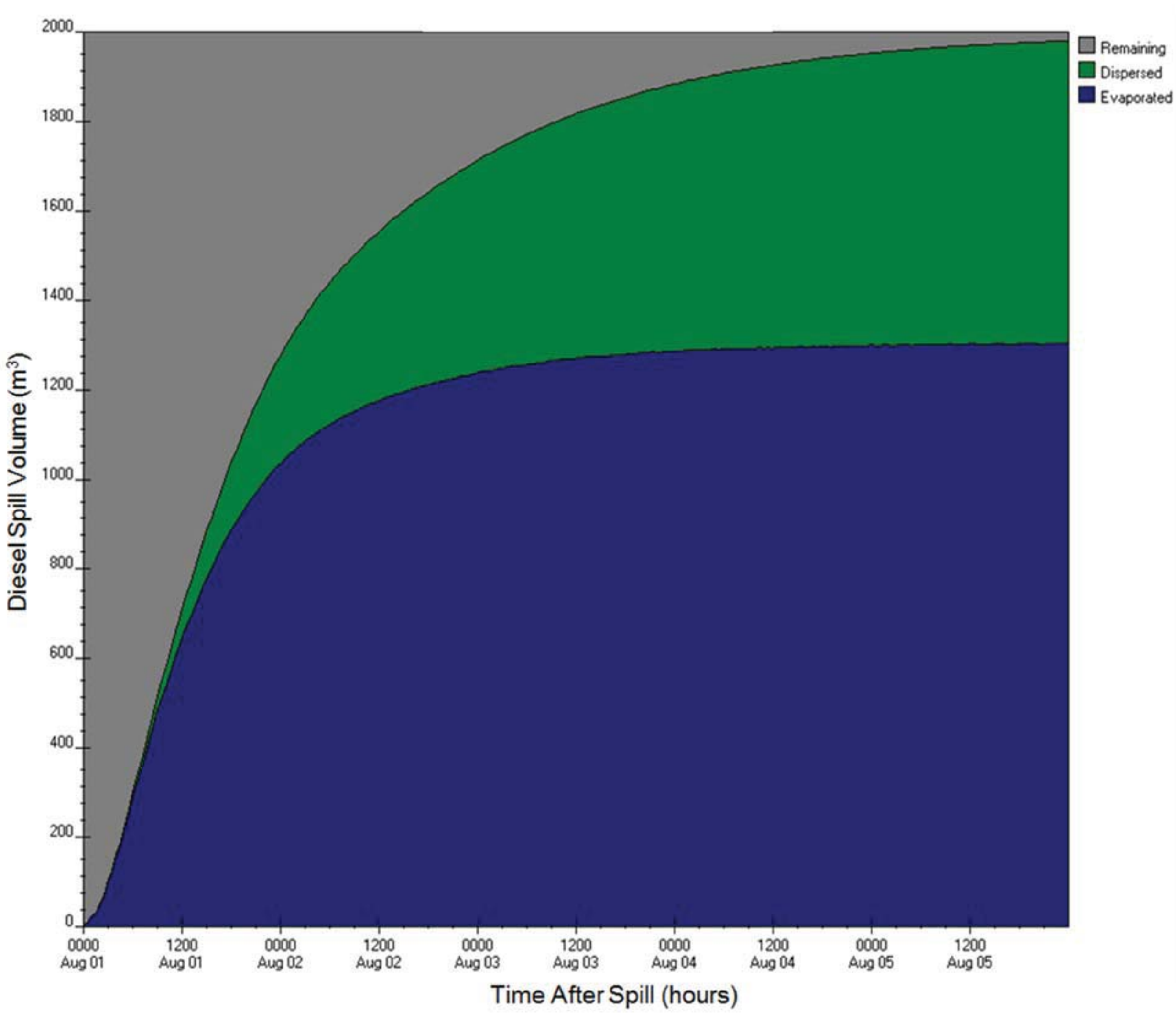

Figure E-A43: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 2,000 m^3, mean wind speed scenario

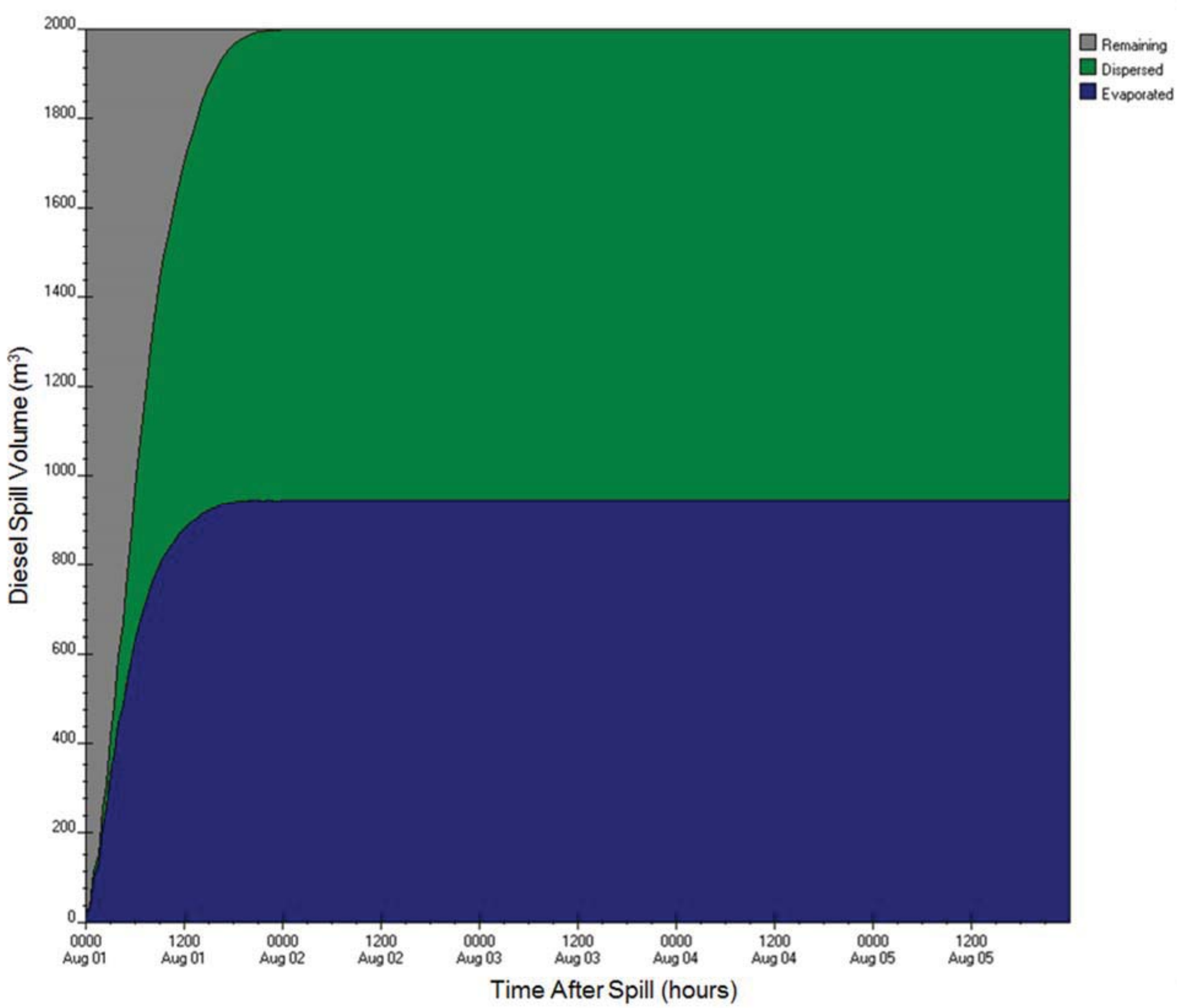

Figure E-A44: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 2,000 m^3, 2-yr wind speed scenario

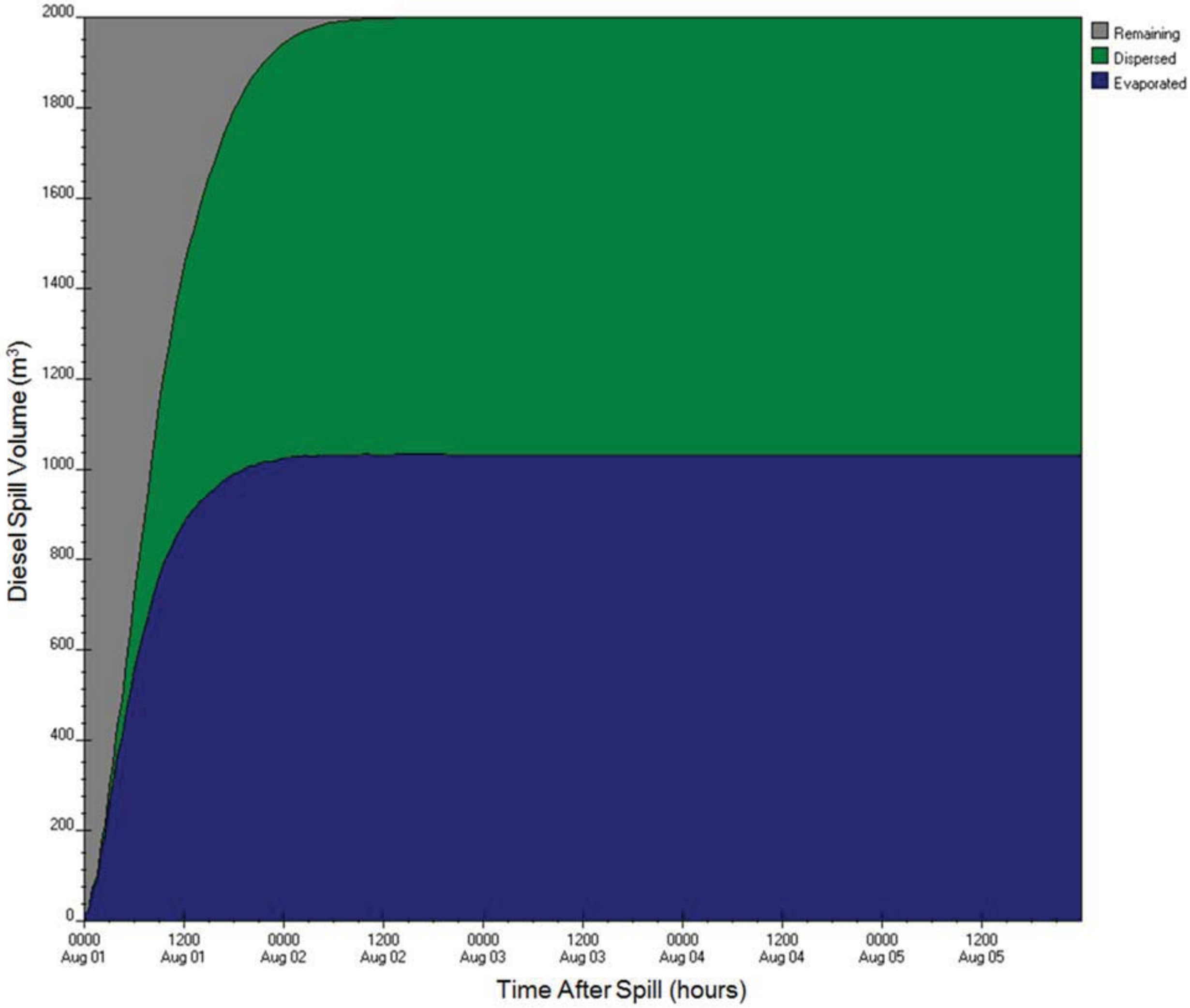

Figure E-A45: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 2,000 m^3, 50-yr wind speed scenario

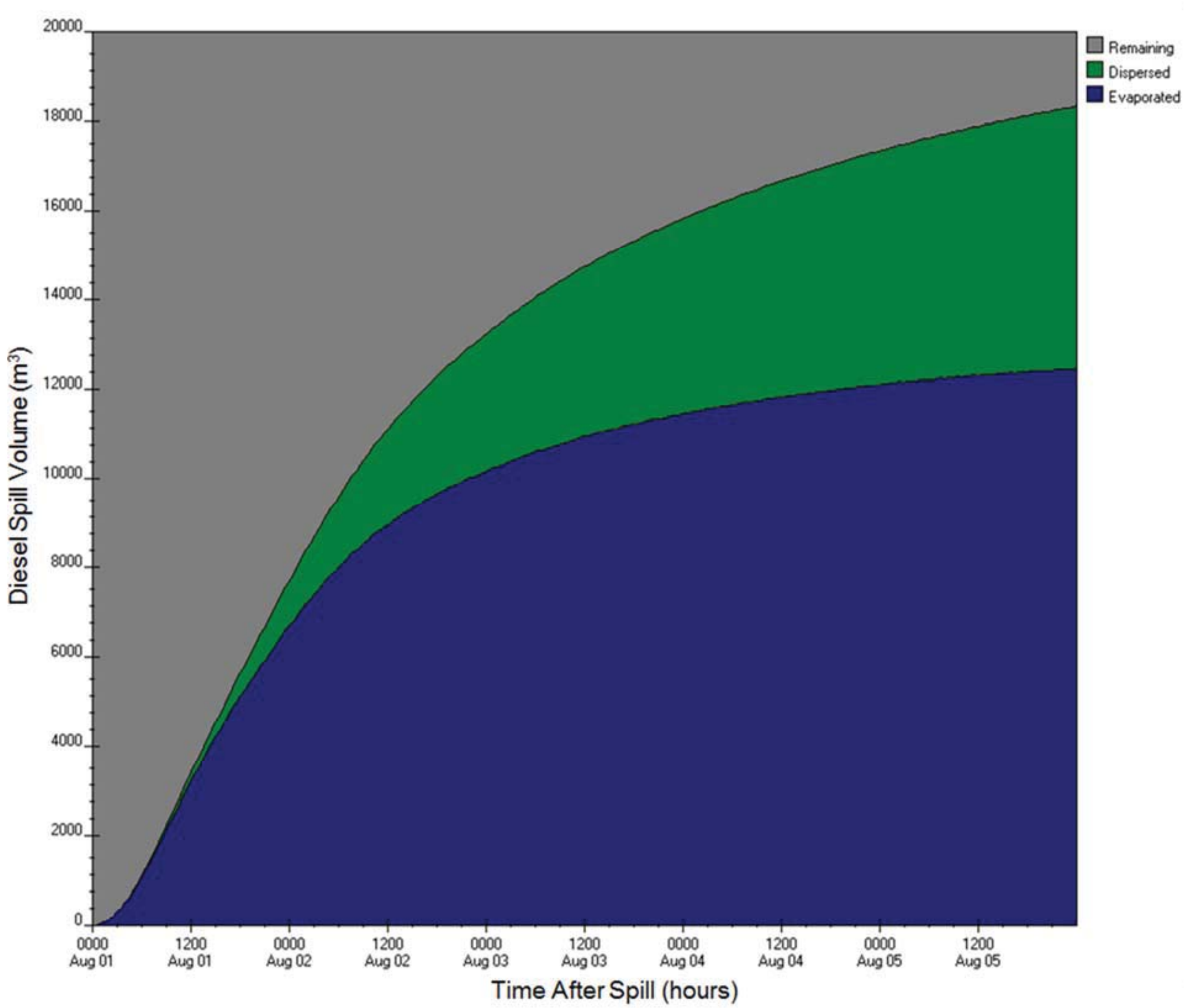

Figure E-A46: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 20,000 m^3, mean wind speed scenario

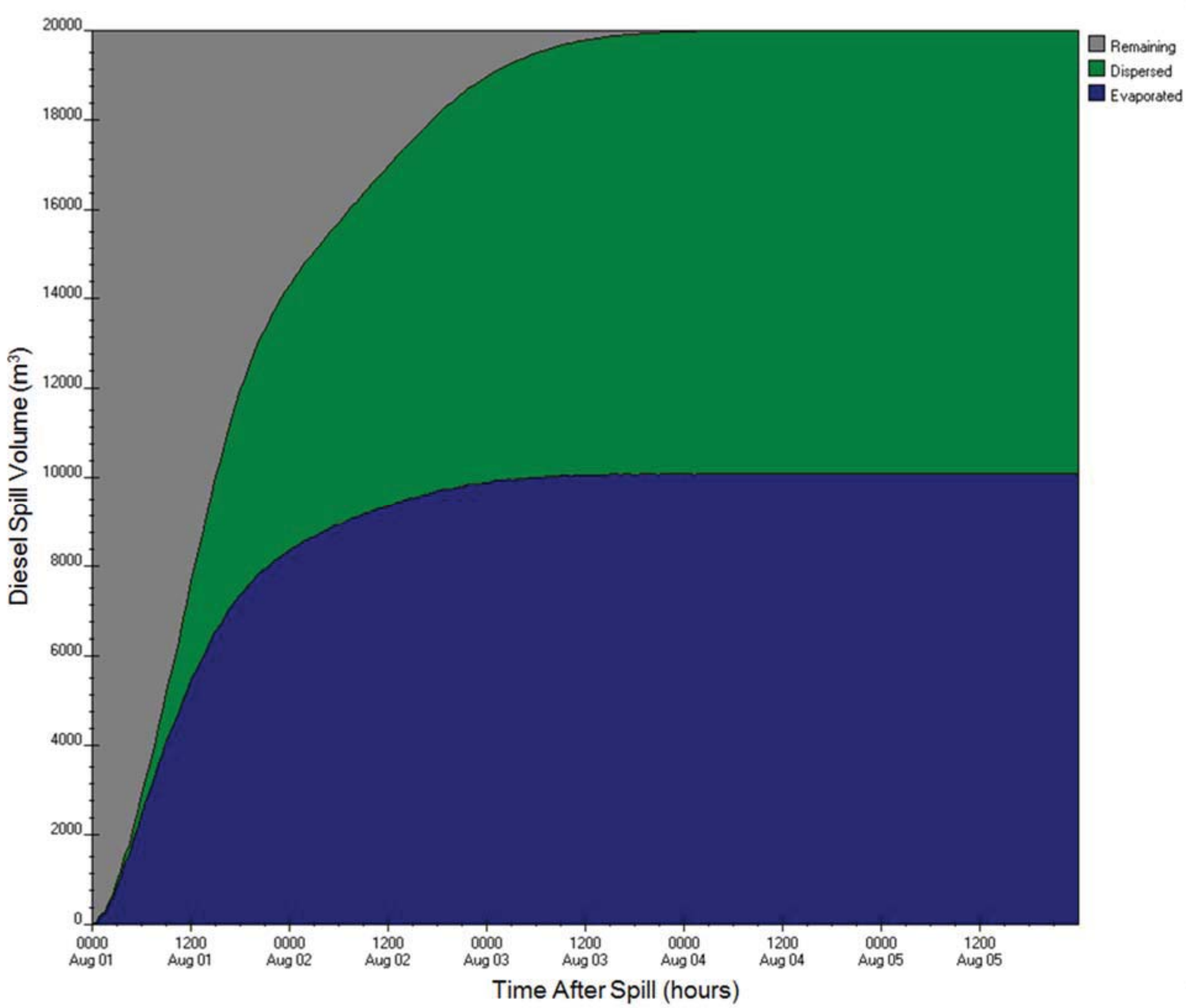

Figure E-A47: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 20,000 m^3, 2-yr wind speed scenario

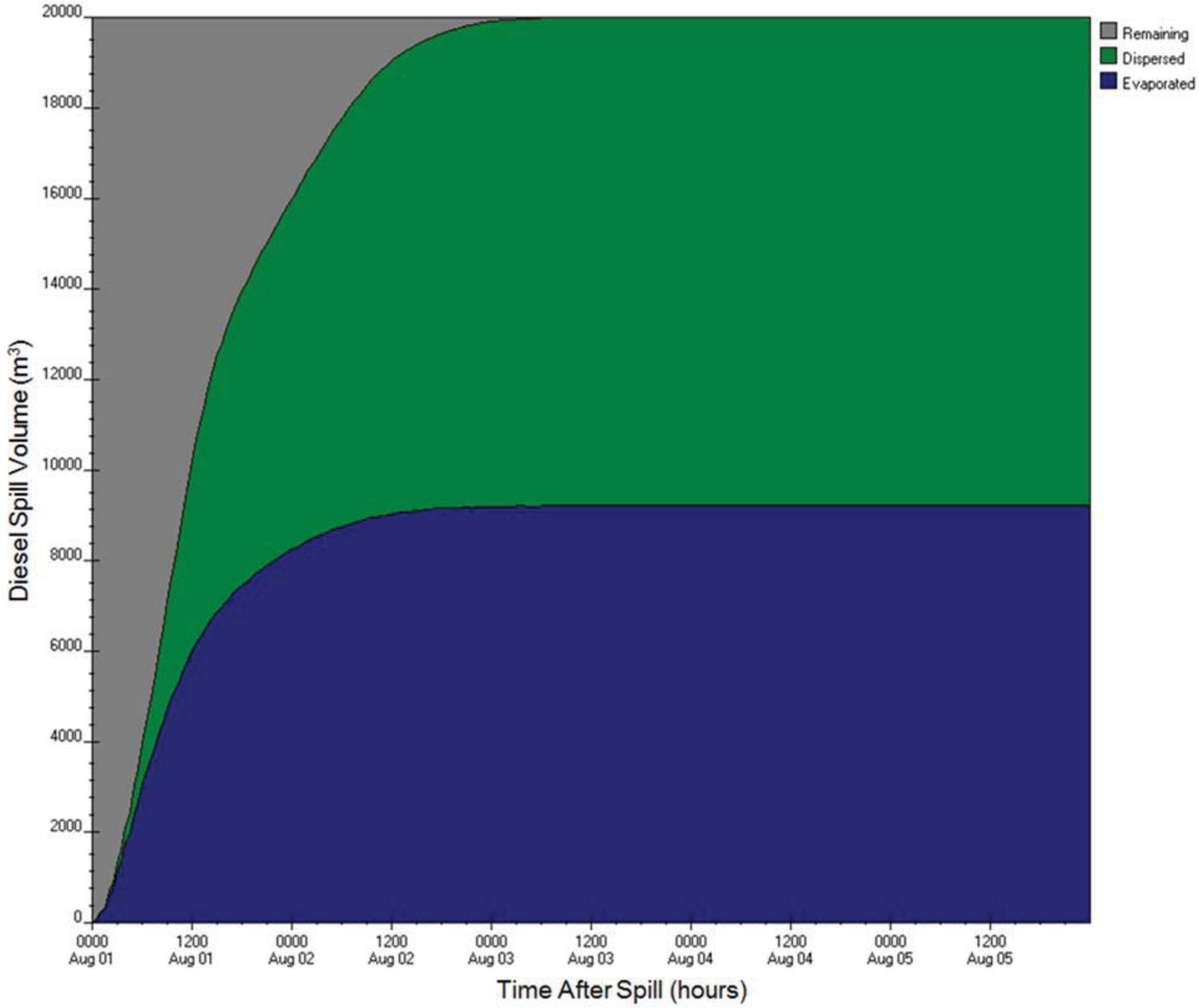

Figure E-A48: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 20,000 m^3, 50-yr wind speed scenario

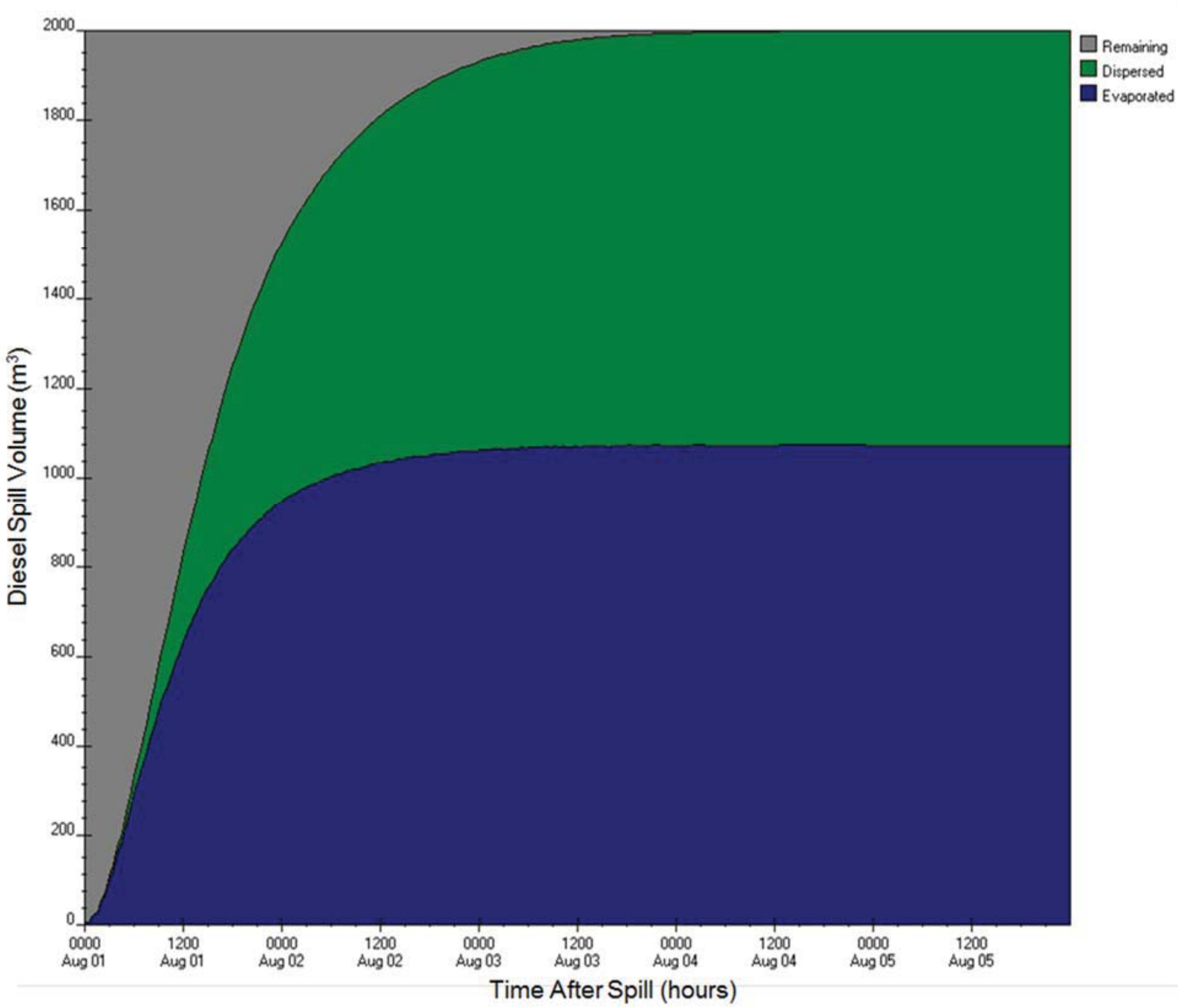

Figure E-A49: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 2,000 m^3, mean wind speed scenario

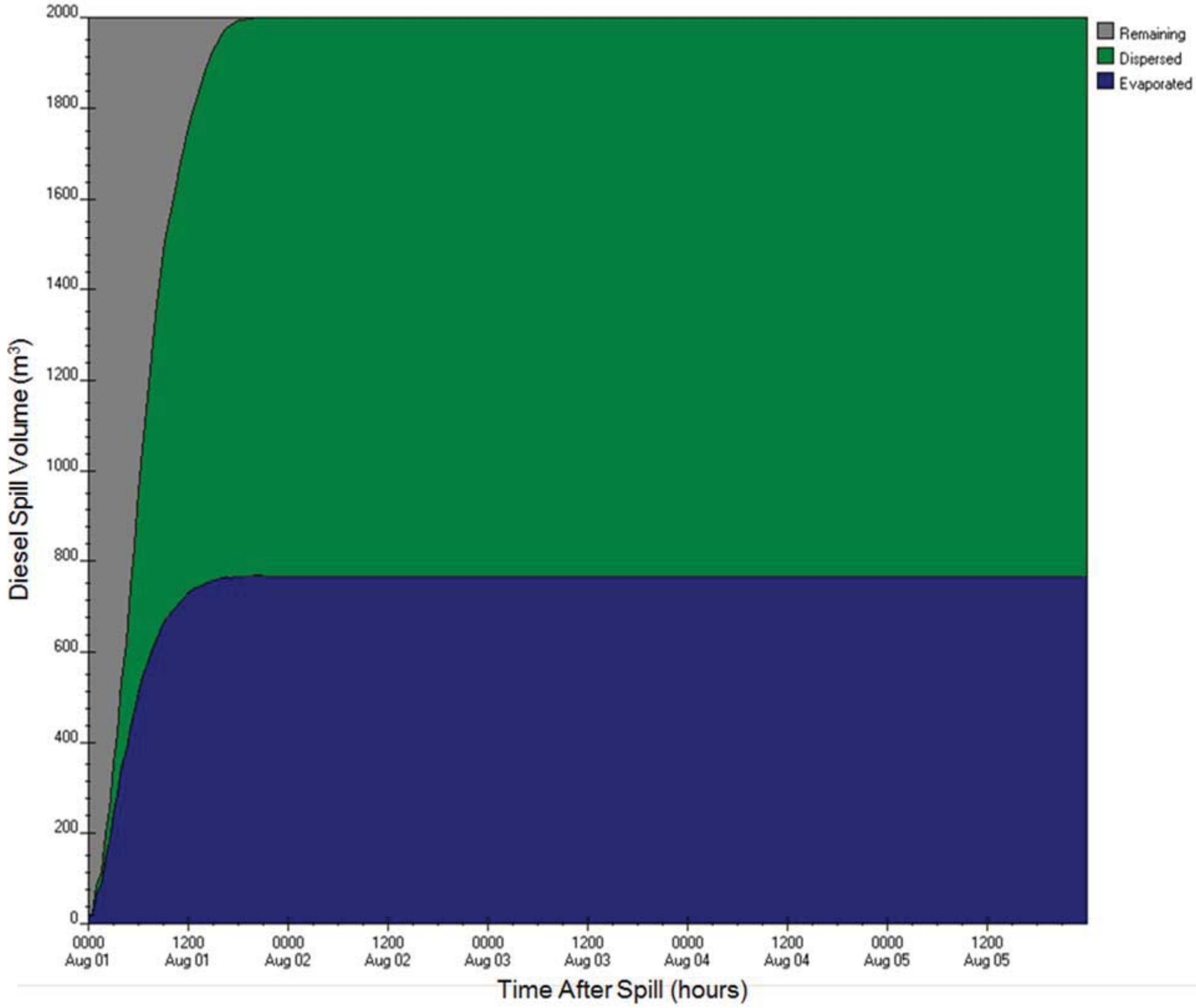

Figure E-A50: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 2,000 m^3, 2-yr wind speed scenario

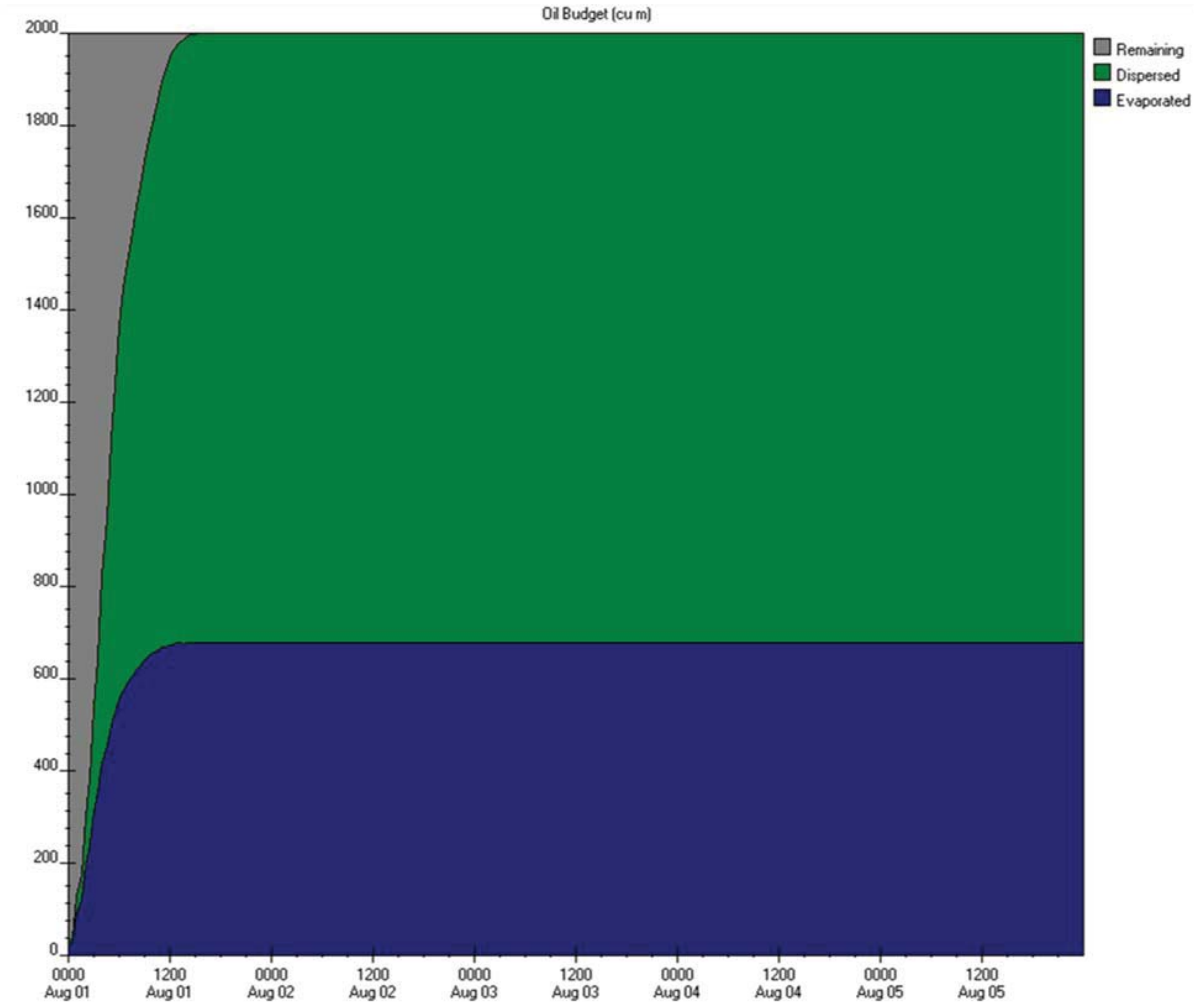

Figure E-A51: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 2,000 m^3, 50-yr wind speed scenario

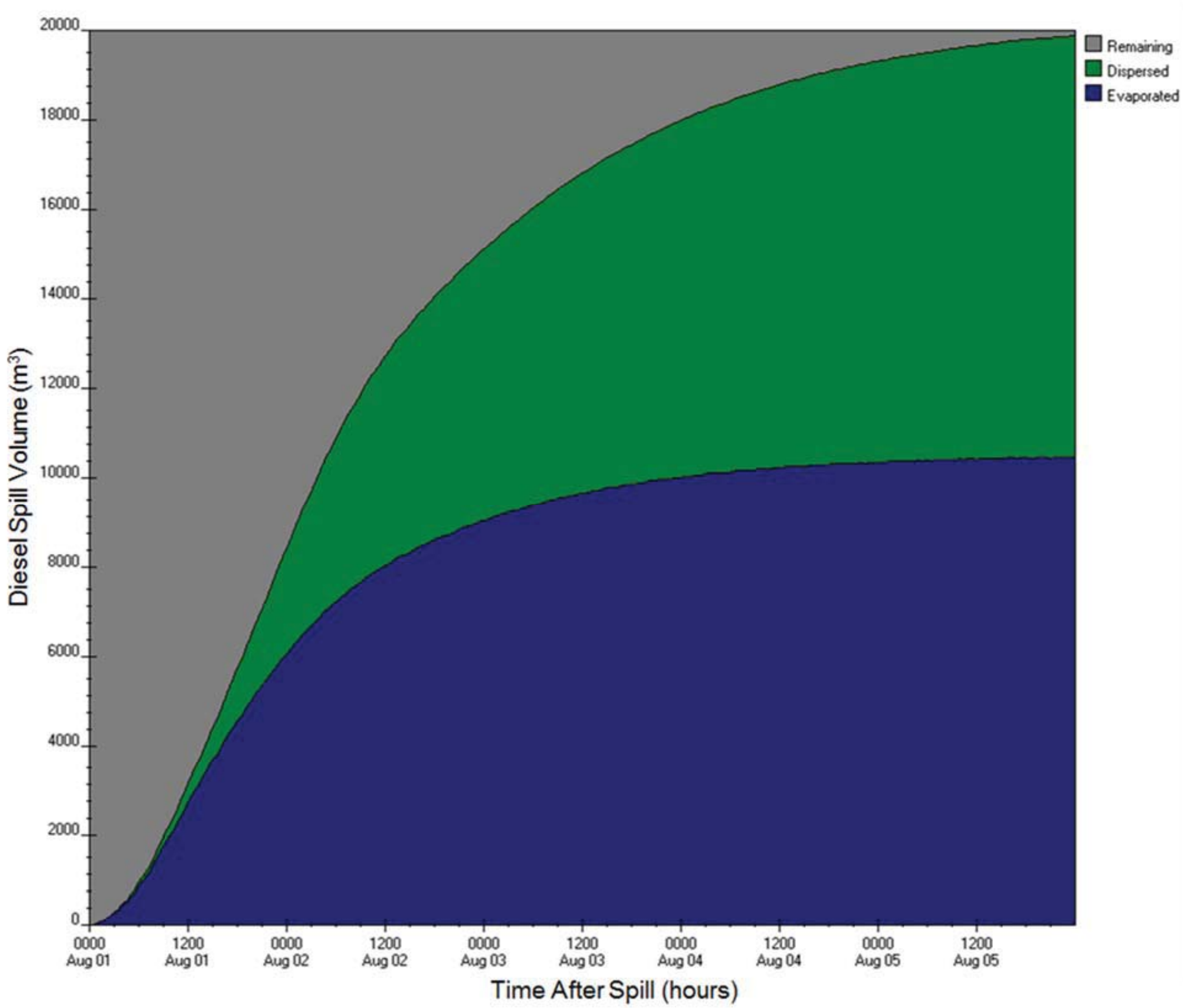

Figure E-A52: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 20,000 m^3, mean wind speed scenario

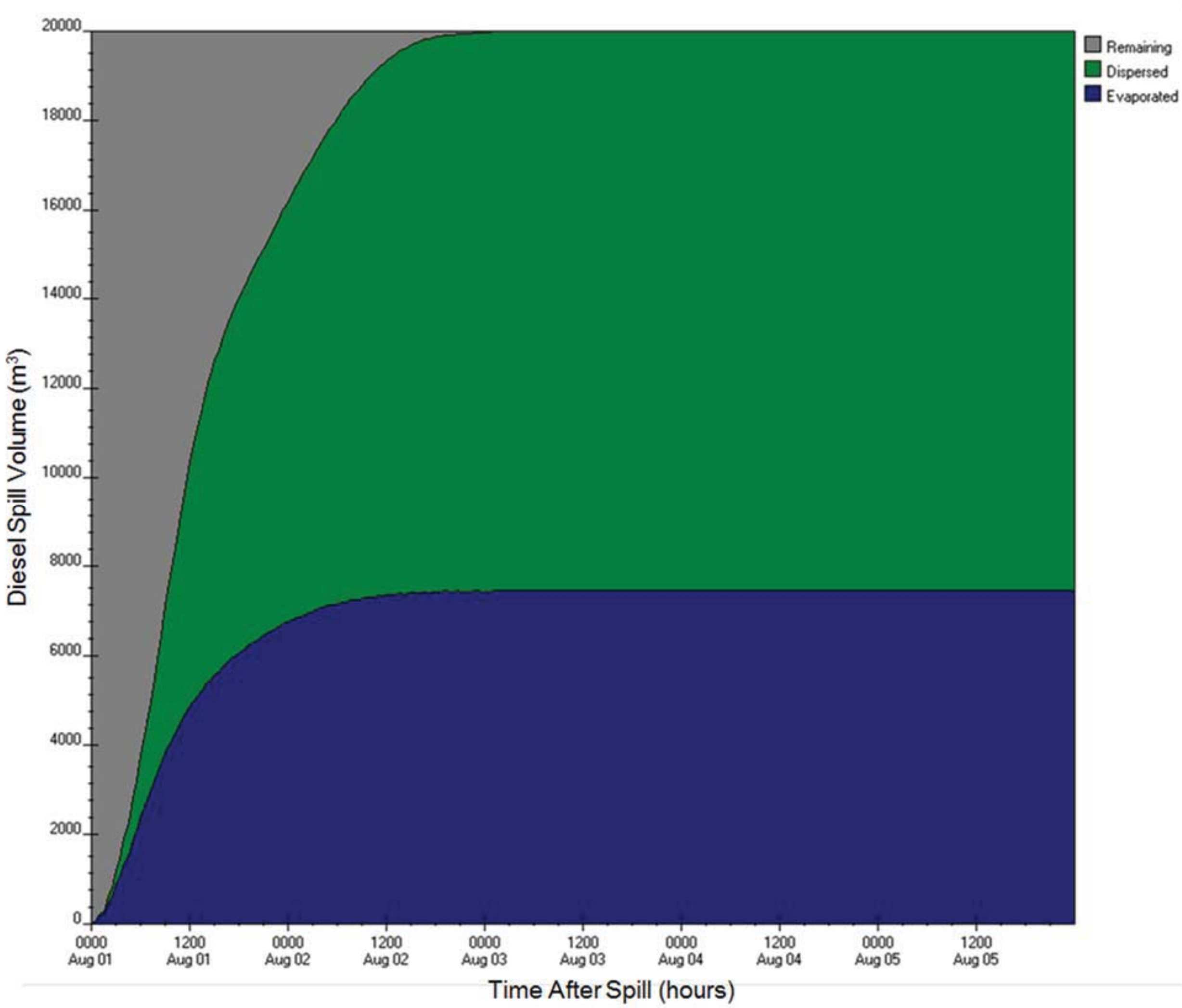

Figure E-A53: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 20,000 m^3, 2-yr wind speed scenario

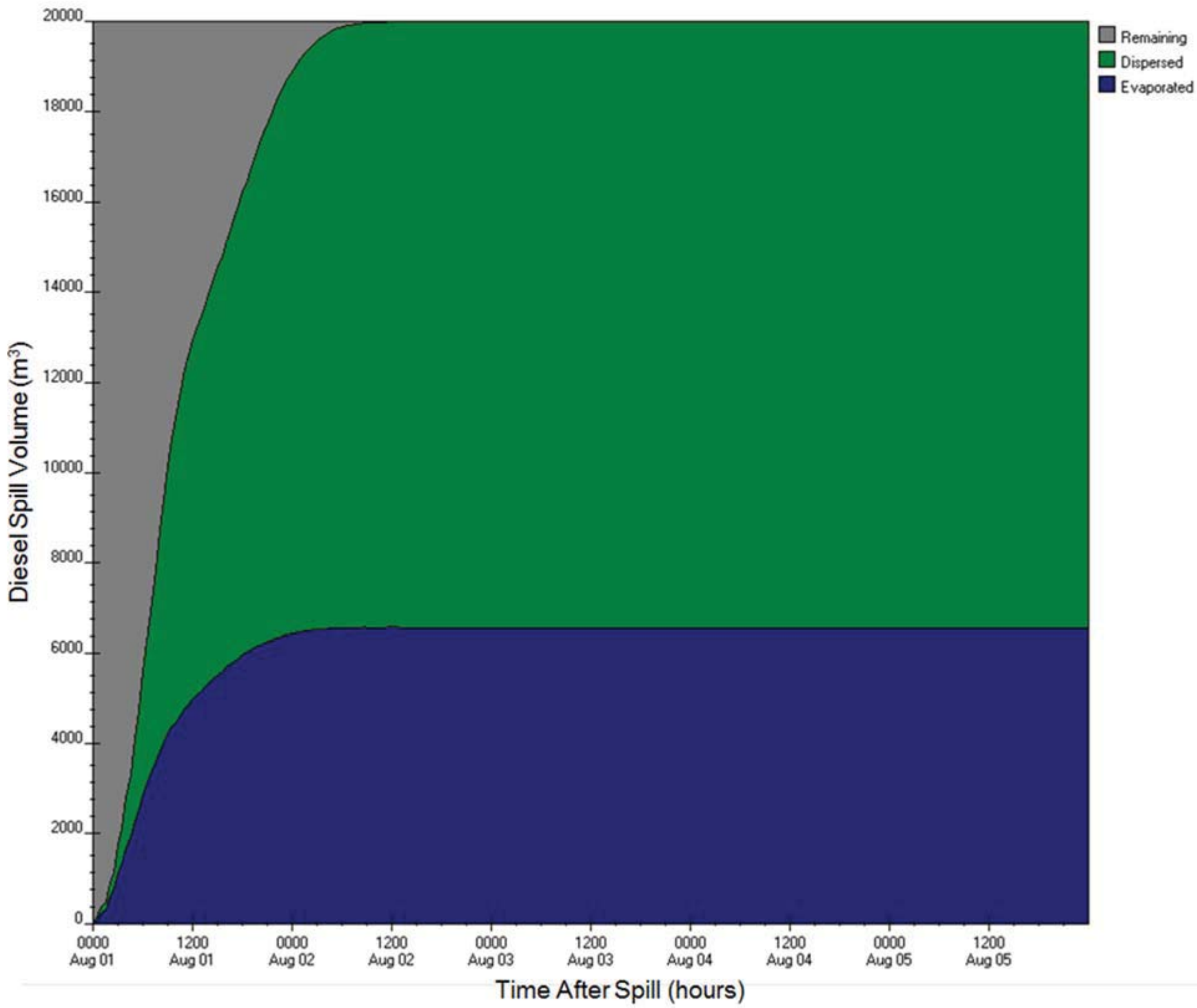

Figure E-A54: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 20,000 m^3, 50-yr wind speed scenario

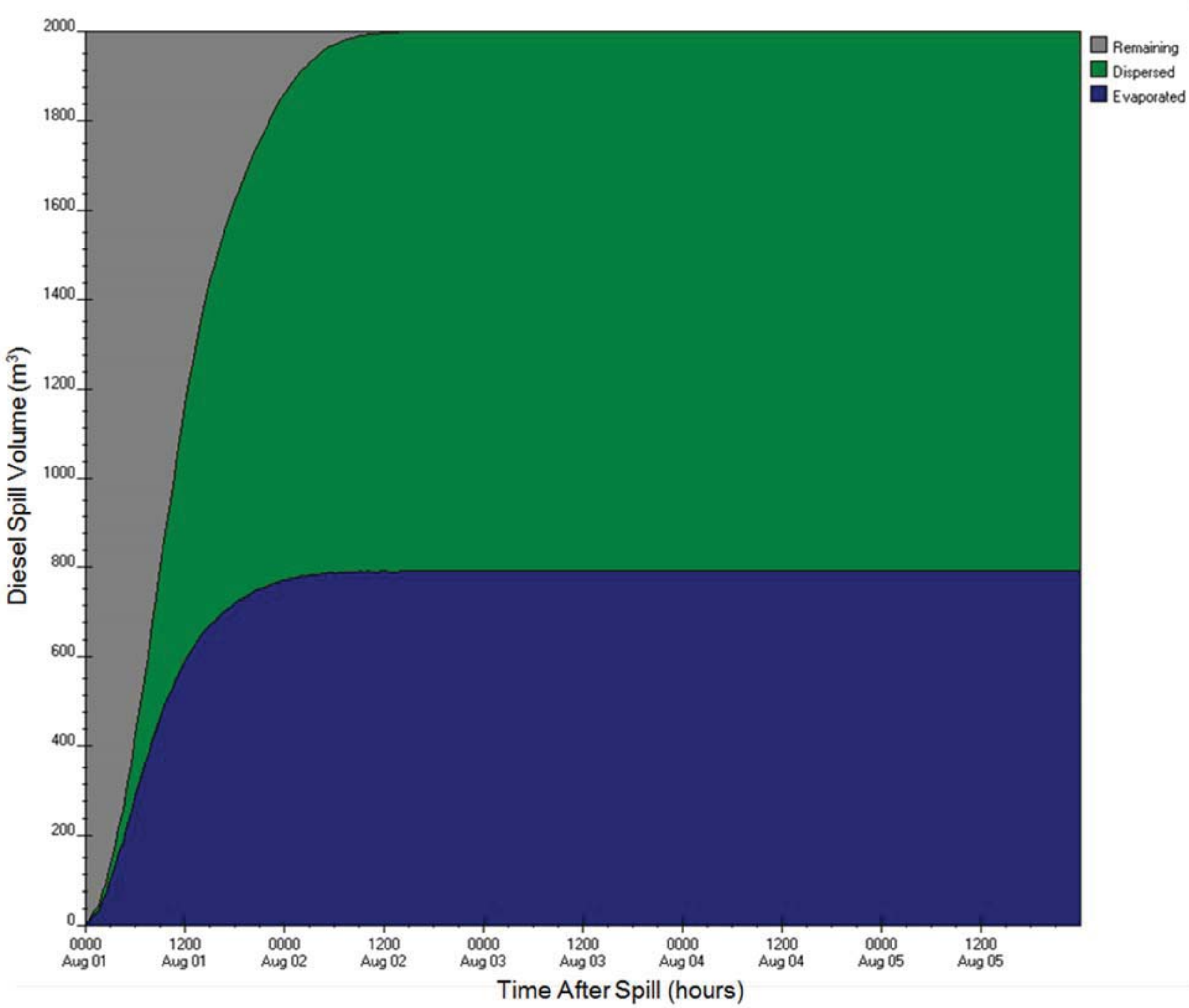

Figure E-A55: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 2,000 m^3, mean wind speed scenario

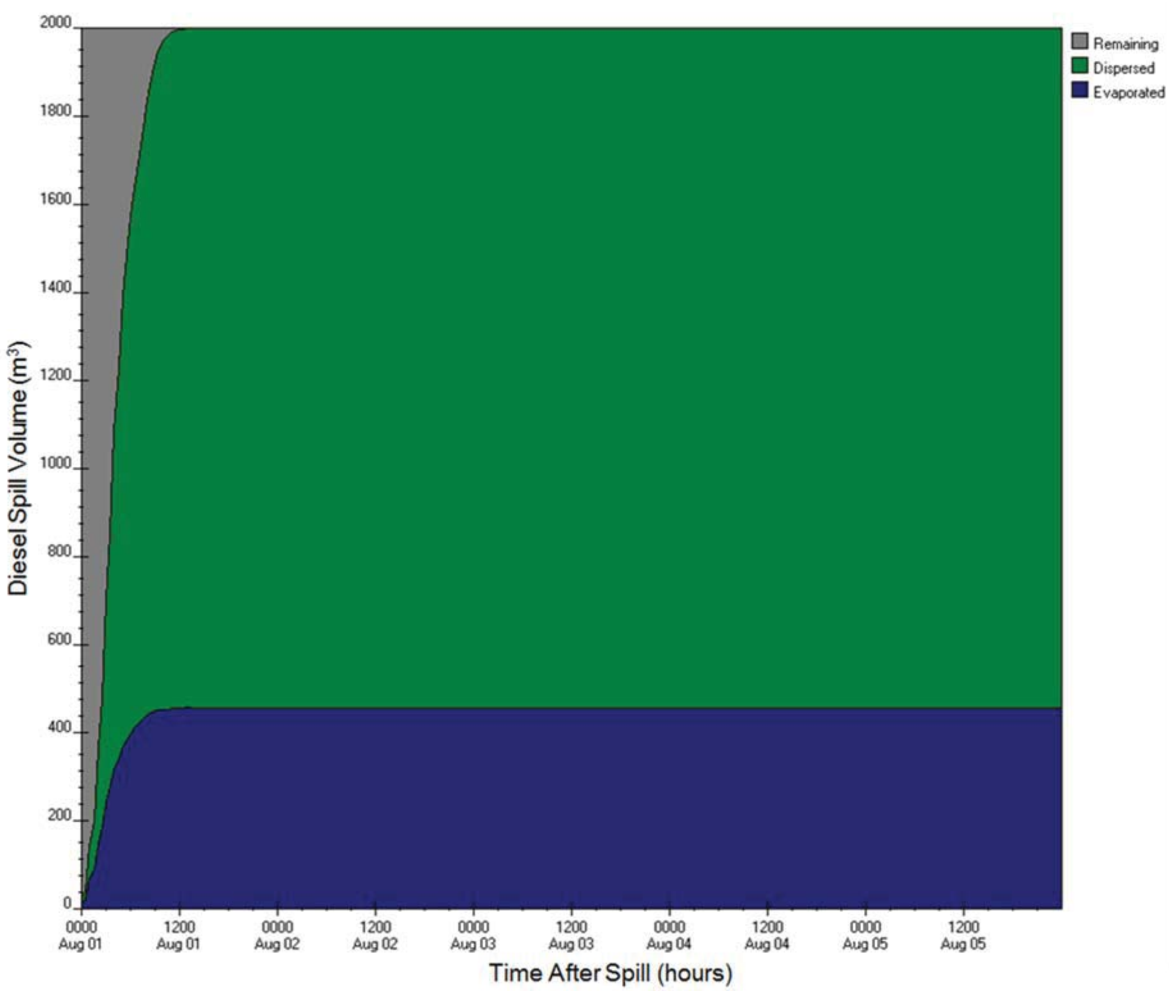

Figure E-A56: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 2,000 m^3, 2-yr wind speed scenario

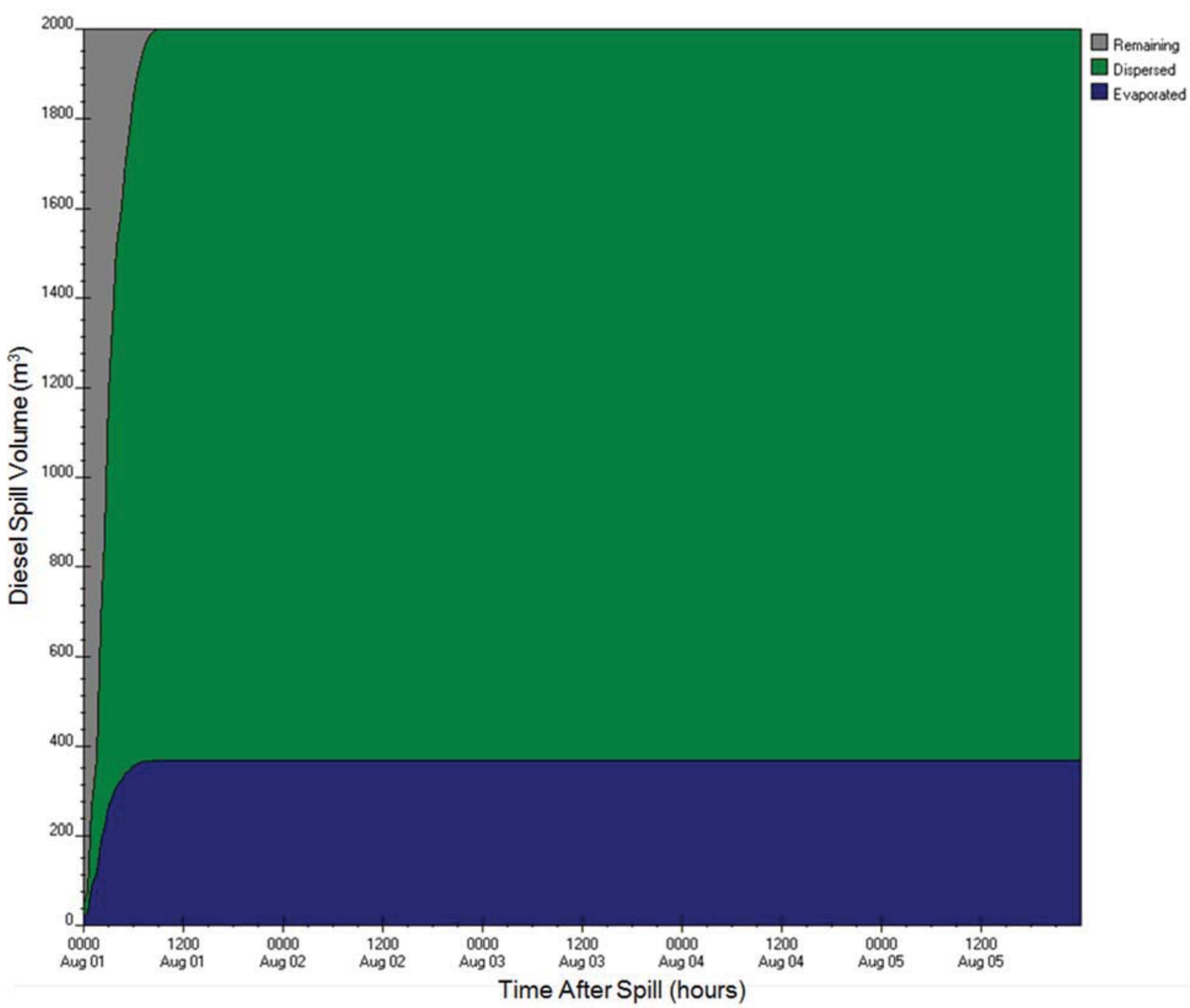

Figure E-A57: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 2,000 m^3, 50-yr wind speed scenario

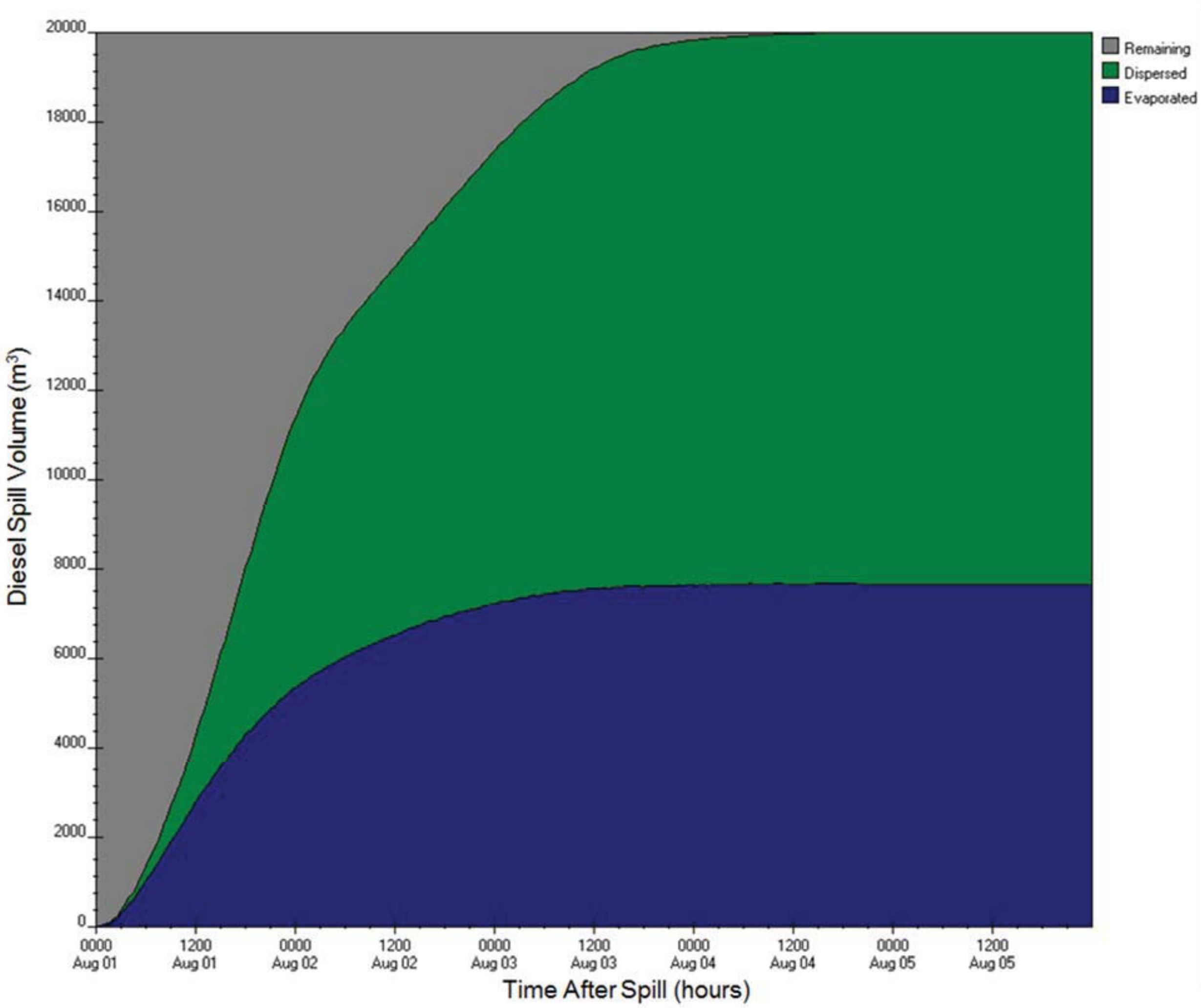

Figure E-A58: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 20,000 m^3, mean wind speed scenario

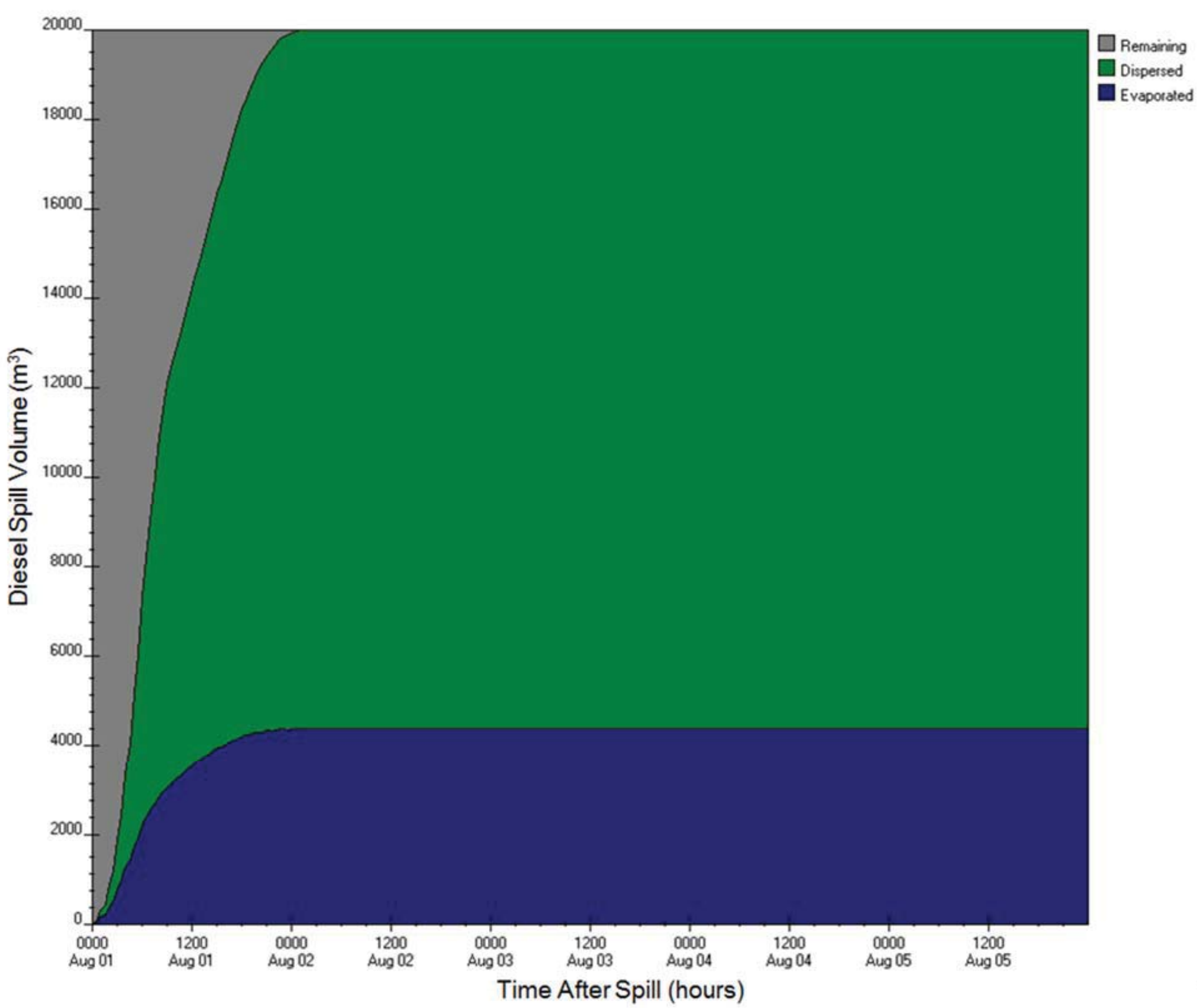

Figure E-A59: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 20,000 m³, 2-yr wind speed scenario

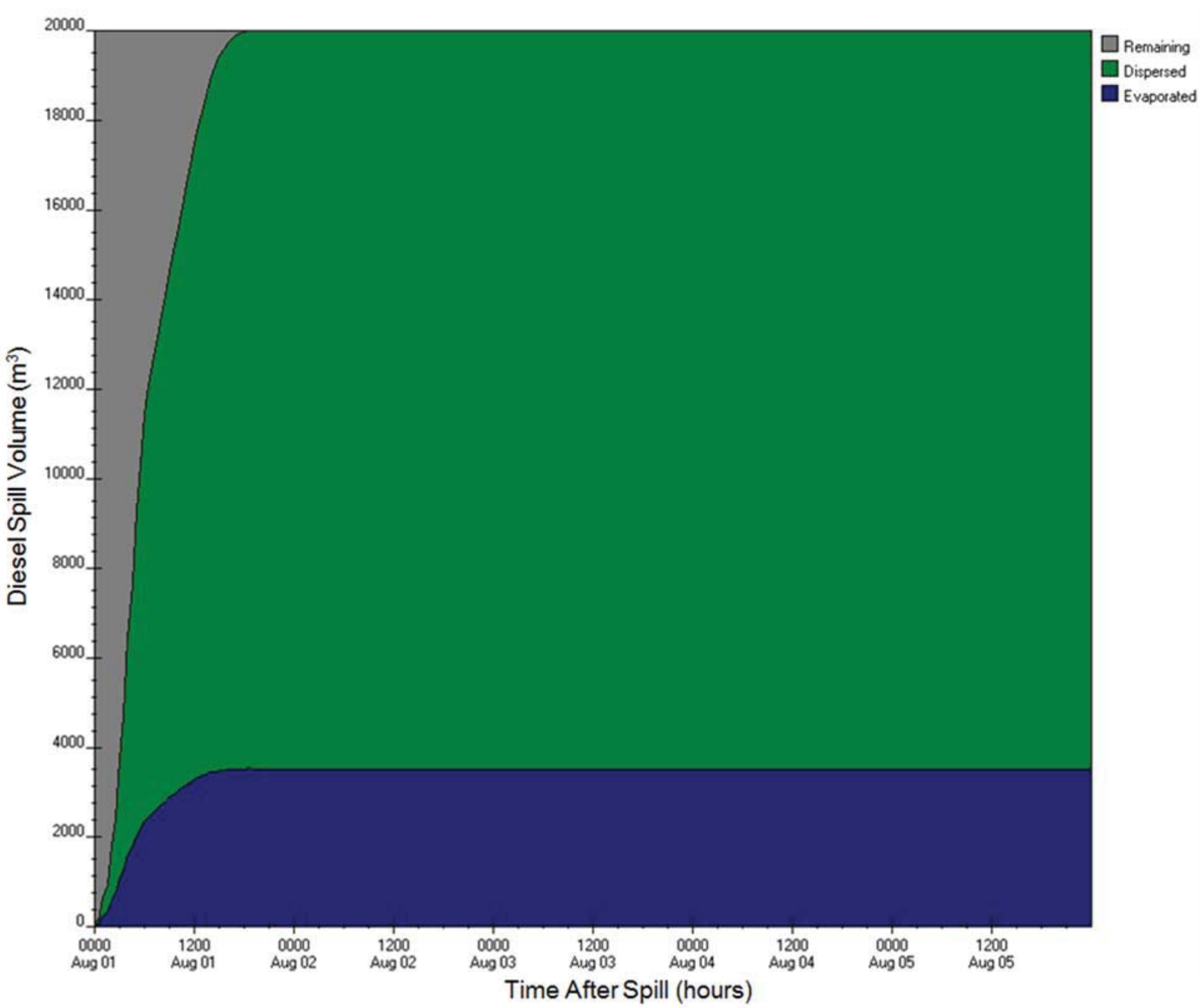

Figure E-A60: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 20,000 m^3, 50-yr wind speed scenario

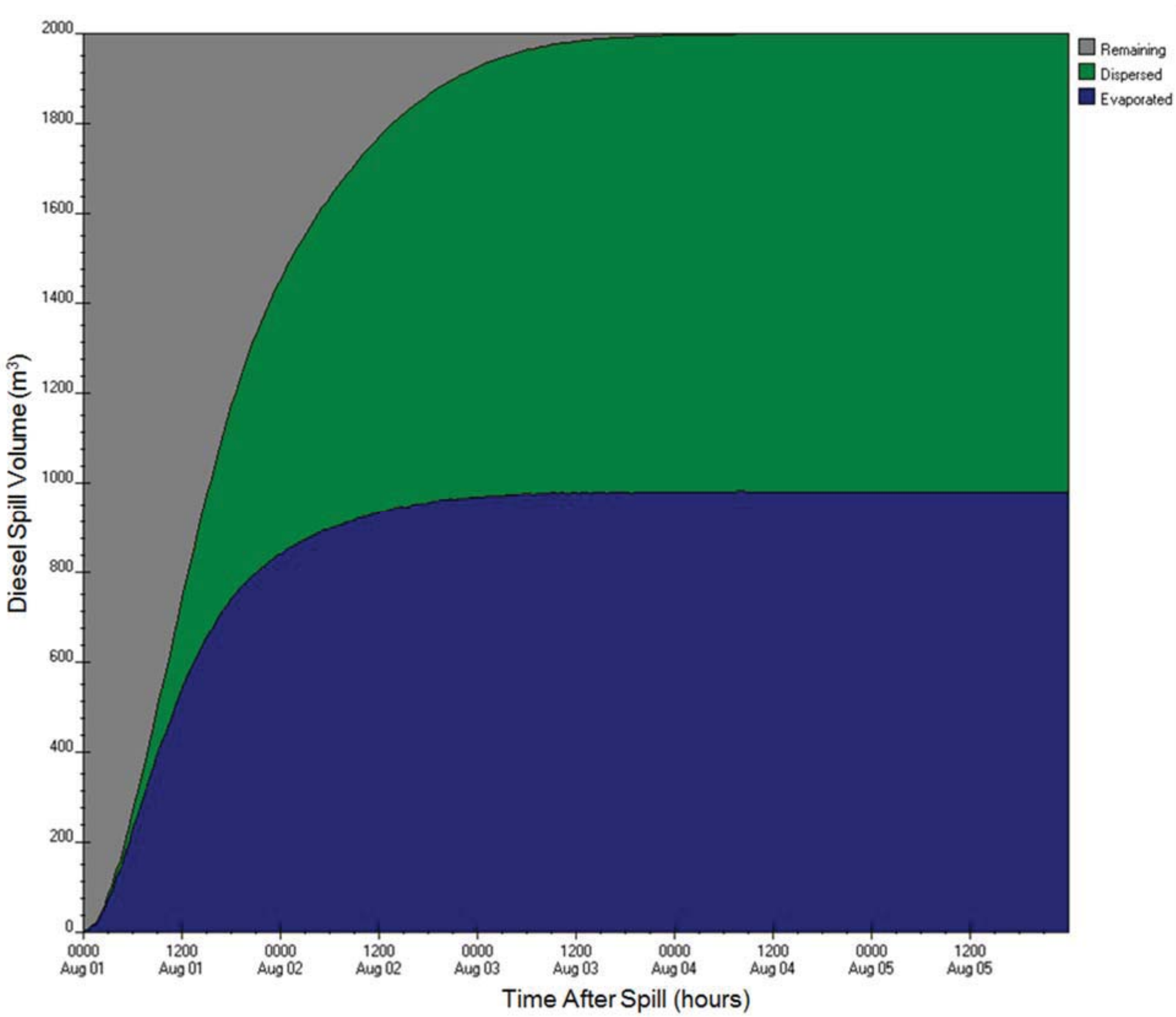

Figure E-A61: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 2,000 m^3, mean wind speed scenario

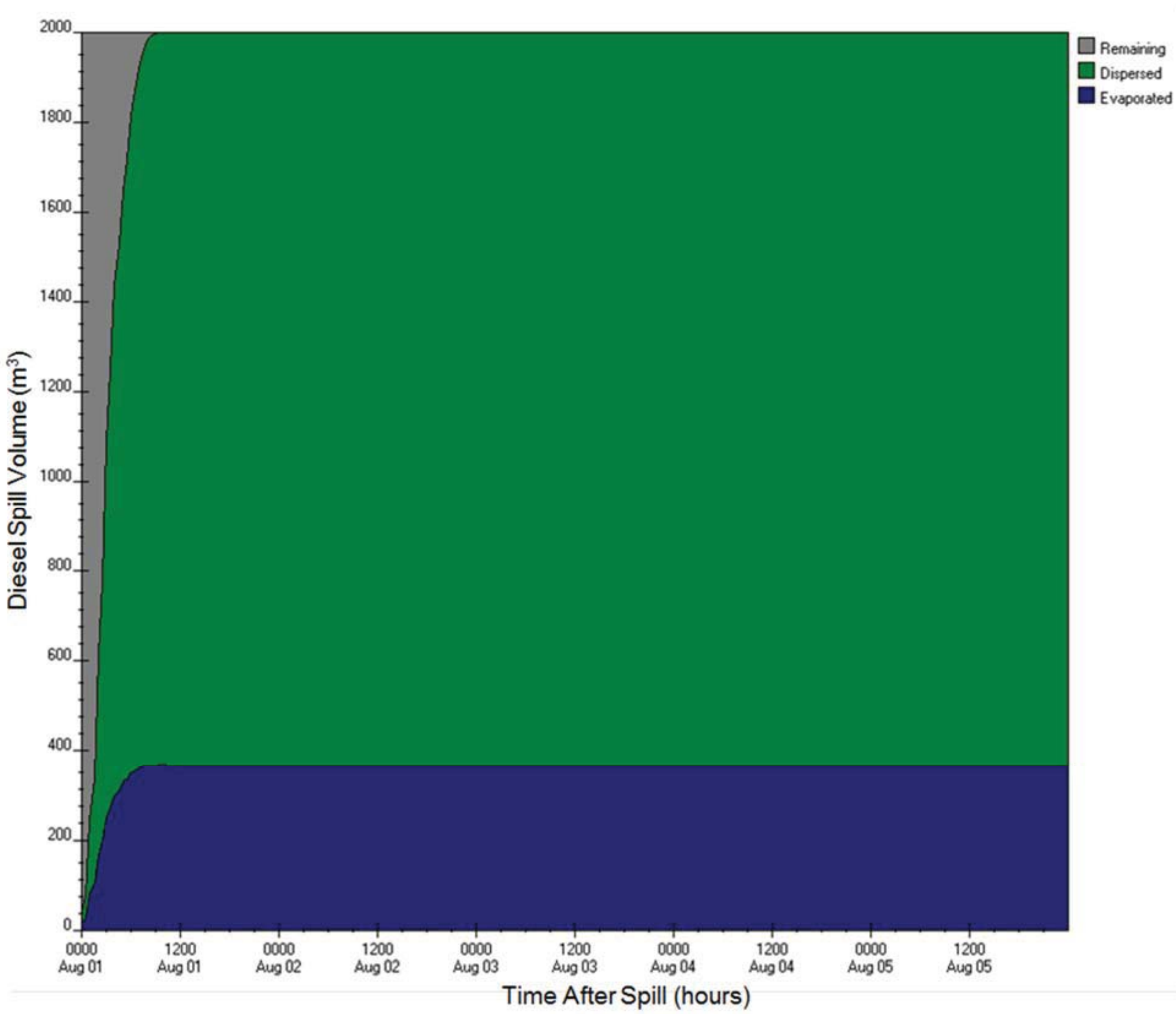

Figure E-A62: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 2,000 m^3, 2-yr wind speed scenario

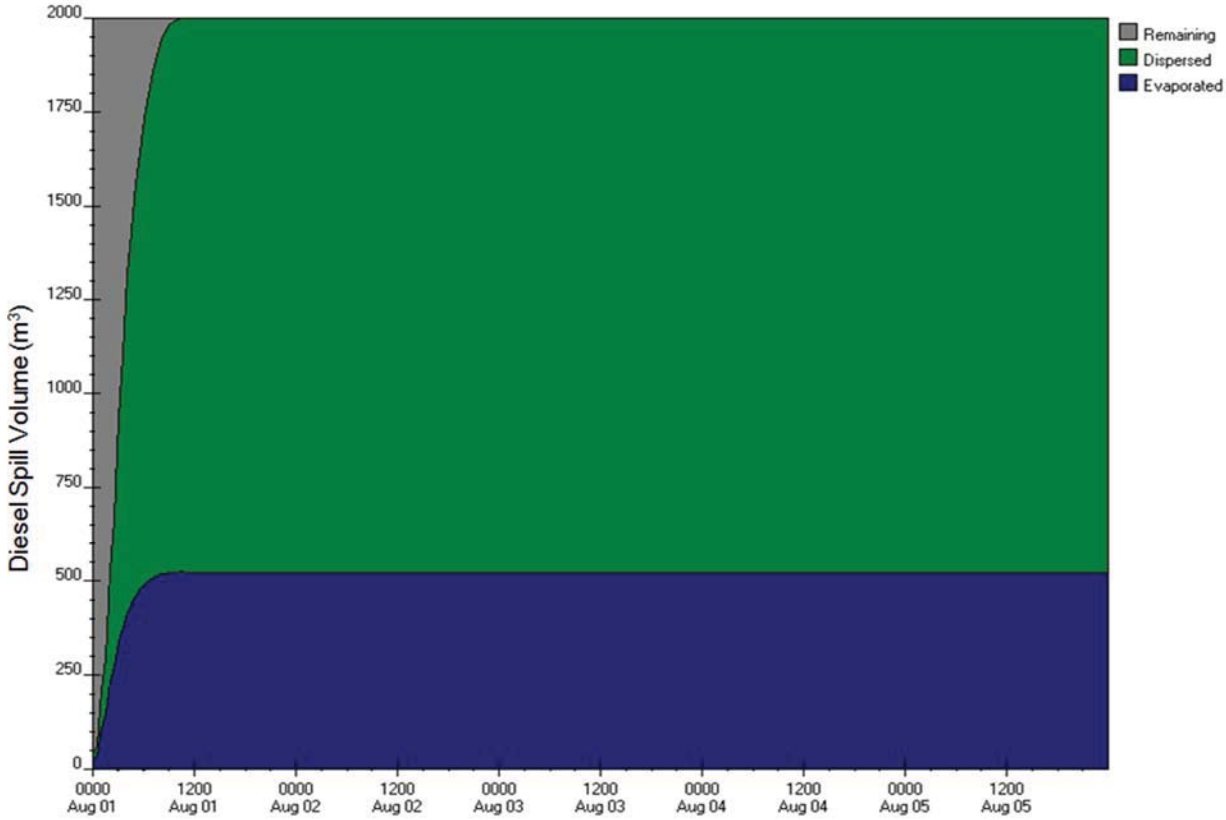

Figure E-A63: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 2,000 m^3, 50-yr wind speed scenario

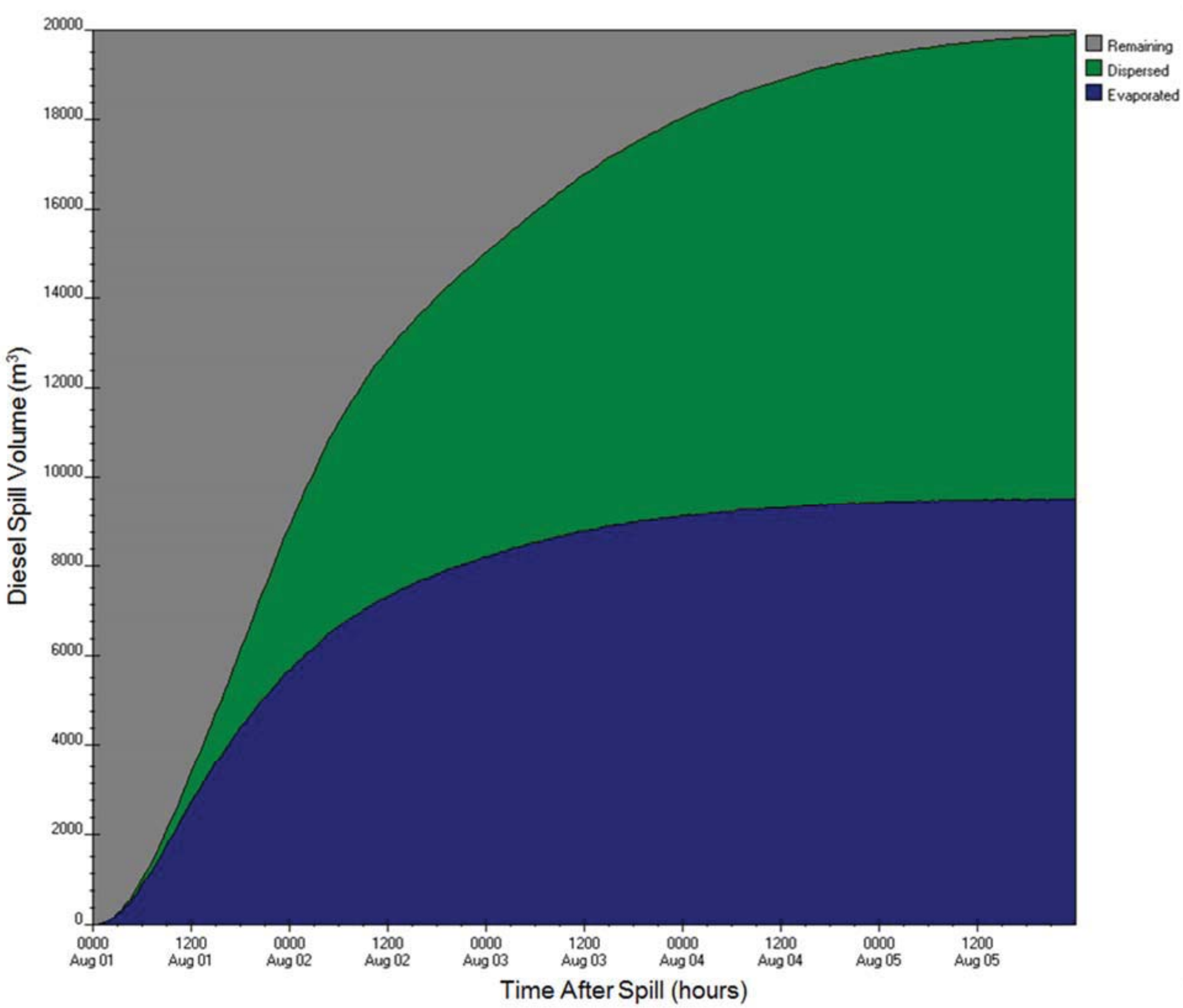

Figure E-A64: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 20,000 m^3, mean wind speed scenario

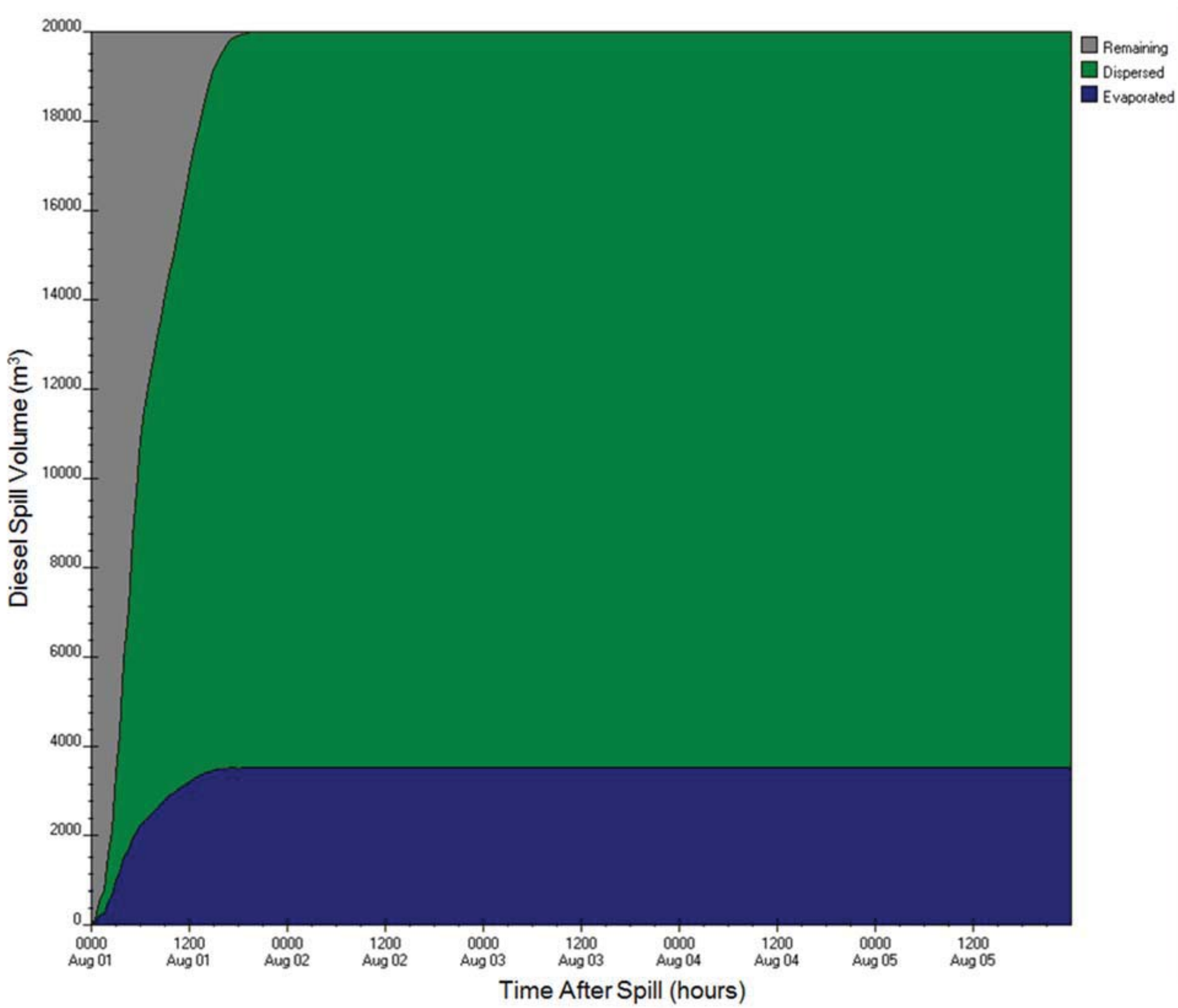

Figure E-A65: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 20,000 m^3, 2-yr wind speed scenario

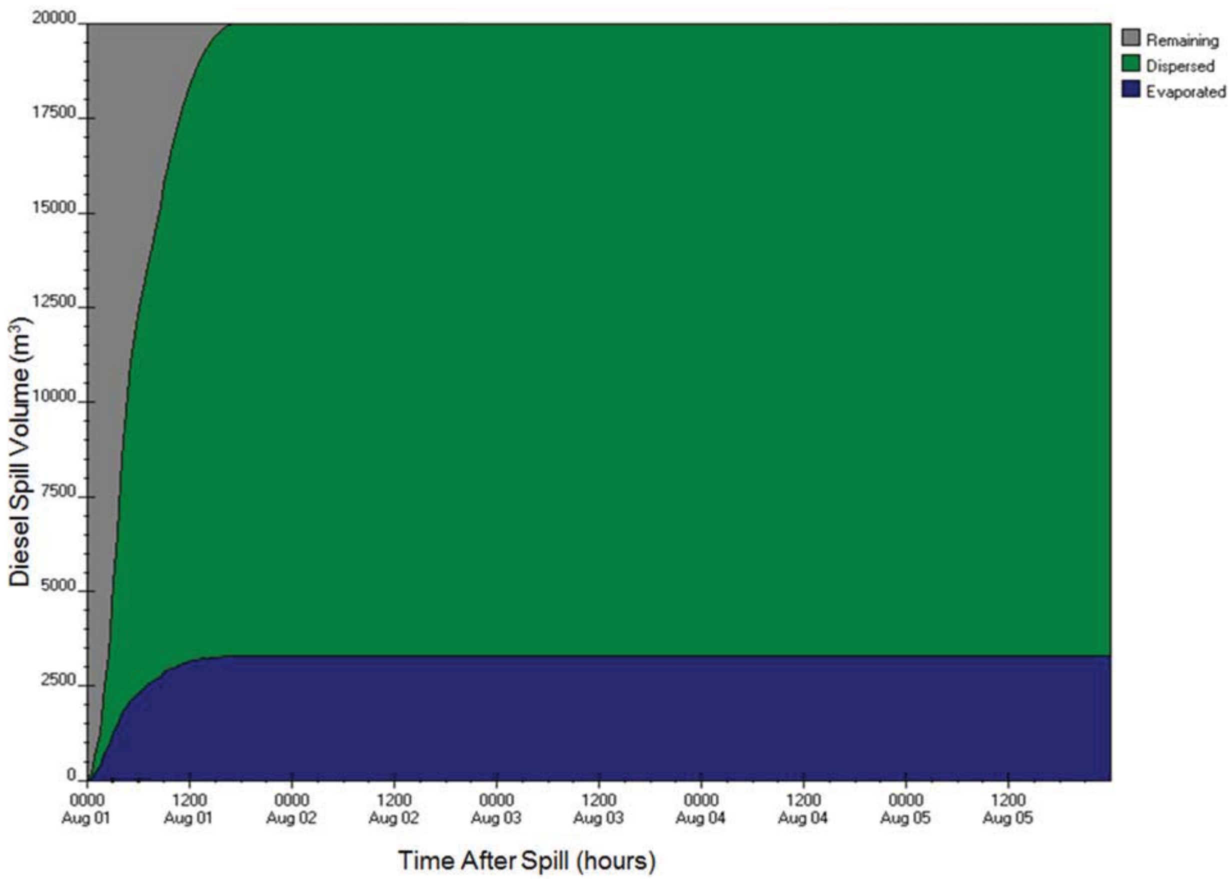

Figure E-A66: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 20,000 m^3, 50-yr wind speed scenario

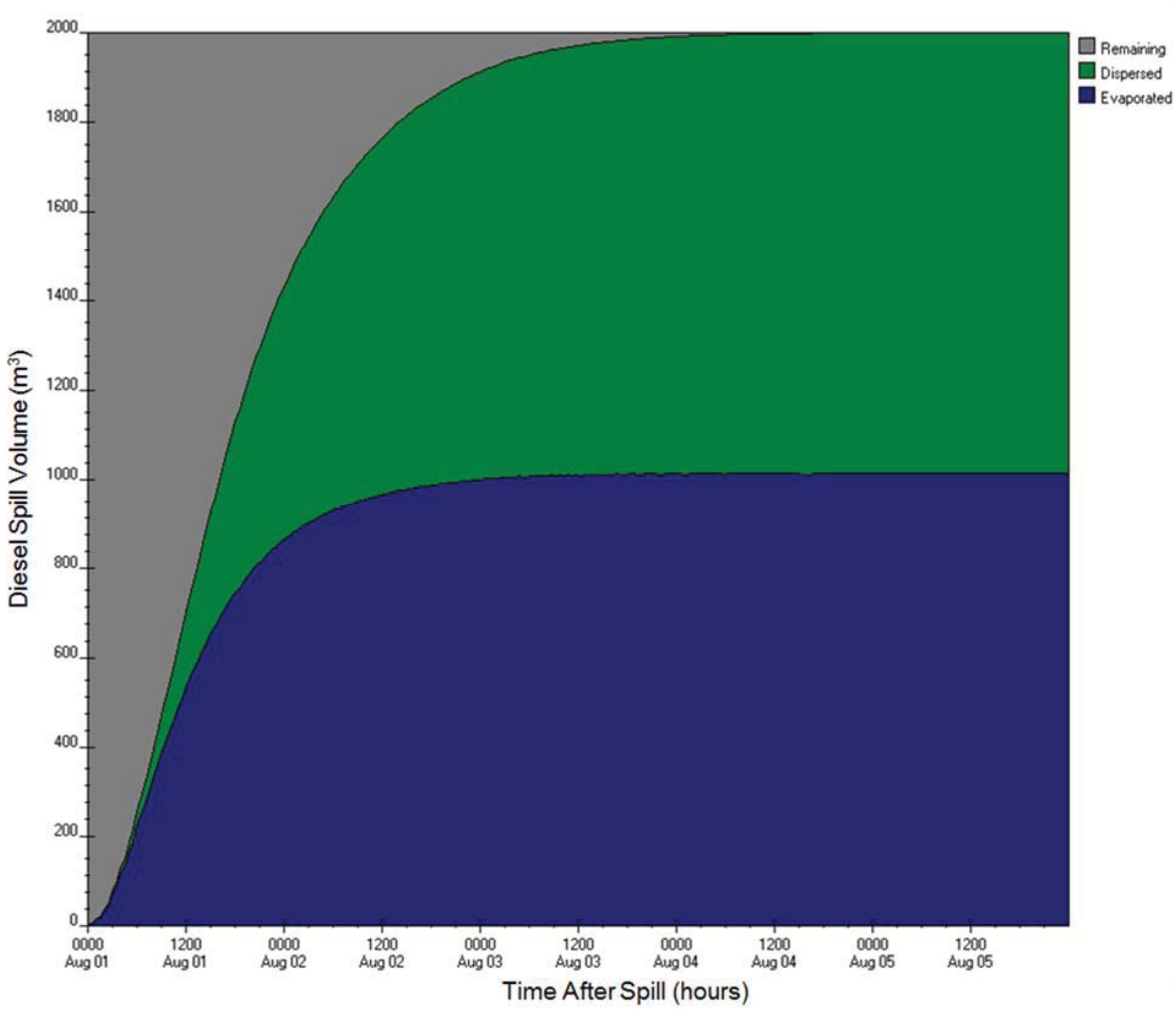

Figure E-A67: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 2,000 m^3, mean wind speed scenario

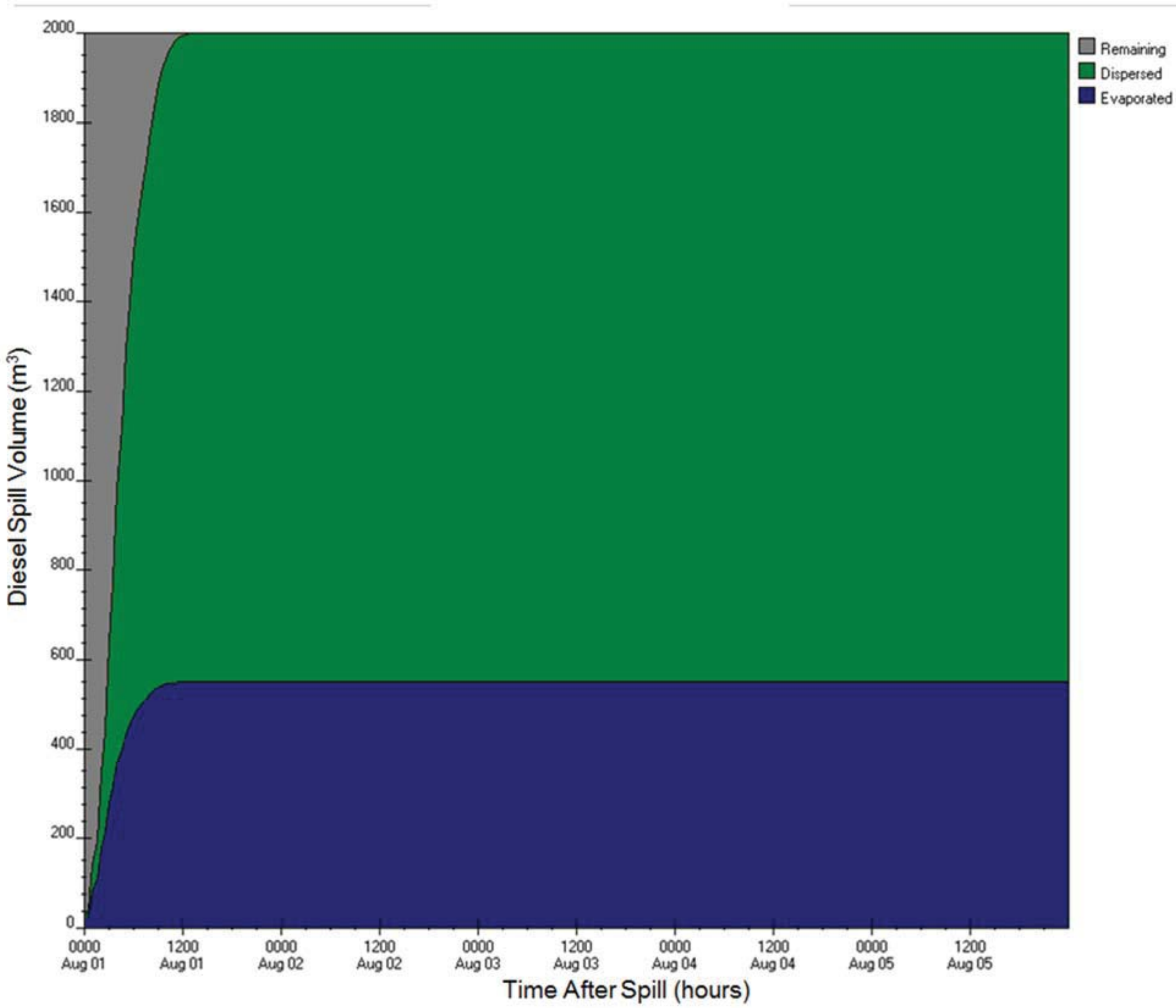

Figure E-A68: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 2,000 m^3, 2-yr wind speed scenario

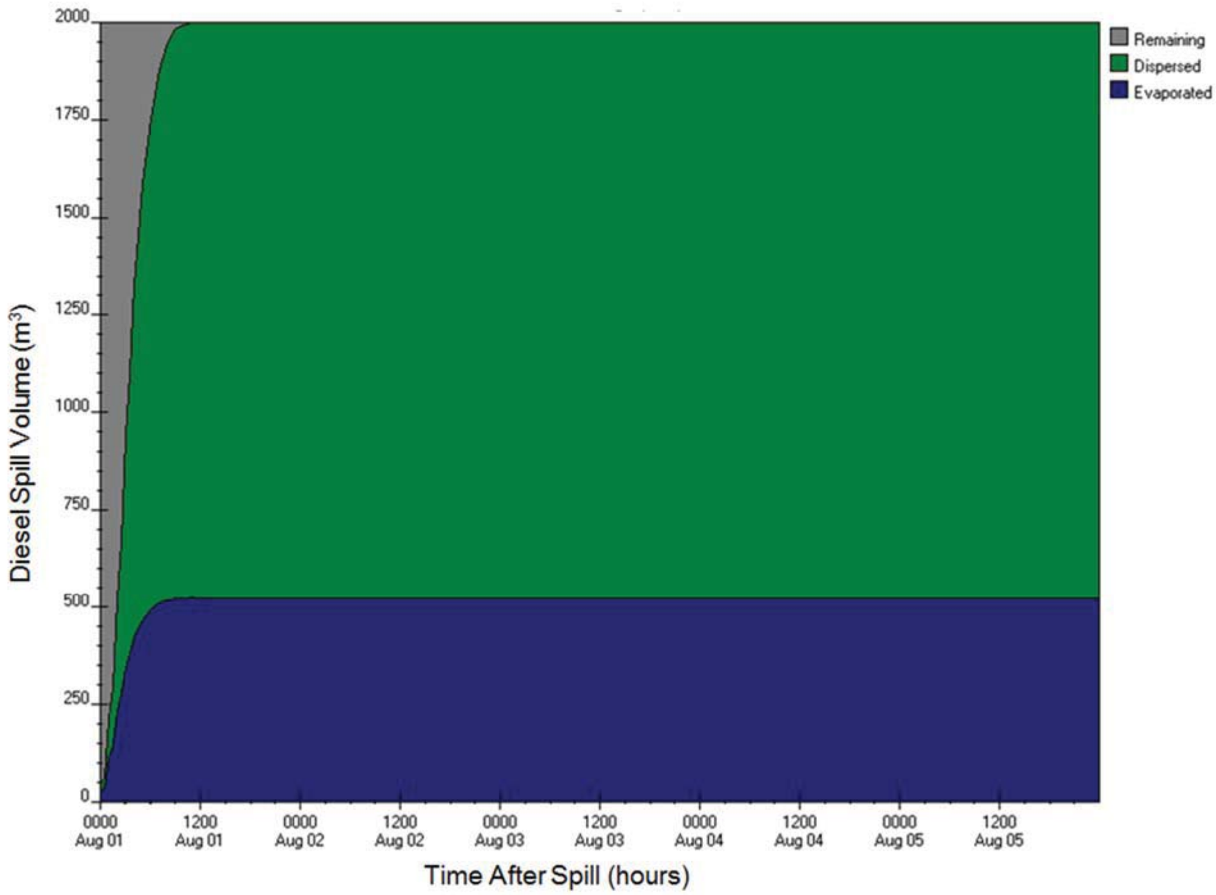

Figure E-A68: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 2,000 m^3, 50-yr wind speed scenario

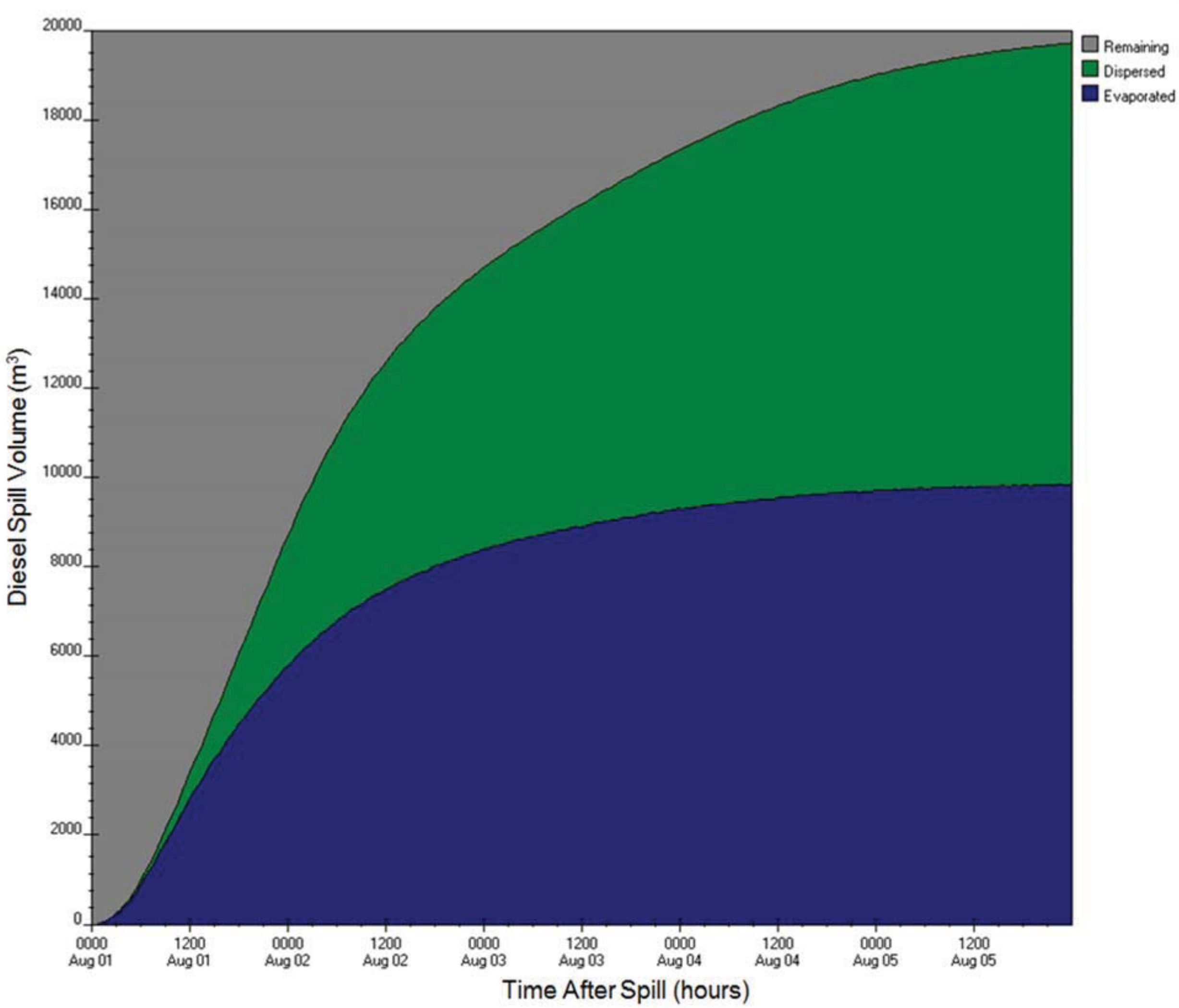

Figure E-A69: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 20,000 m^3, mean wind speed scenario

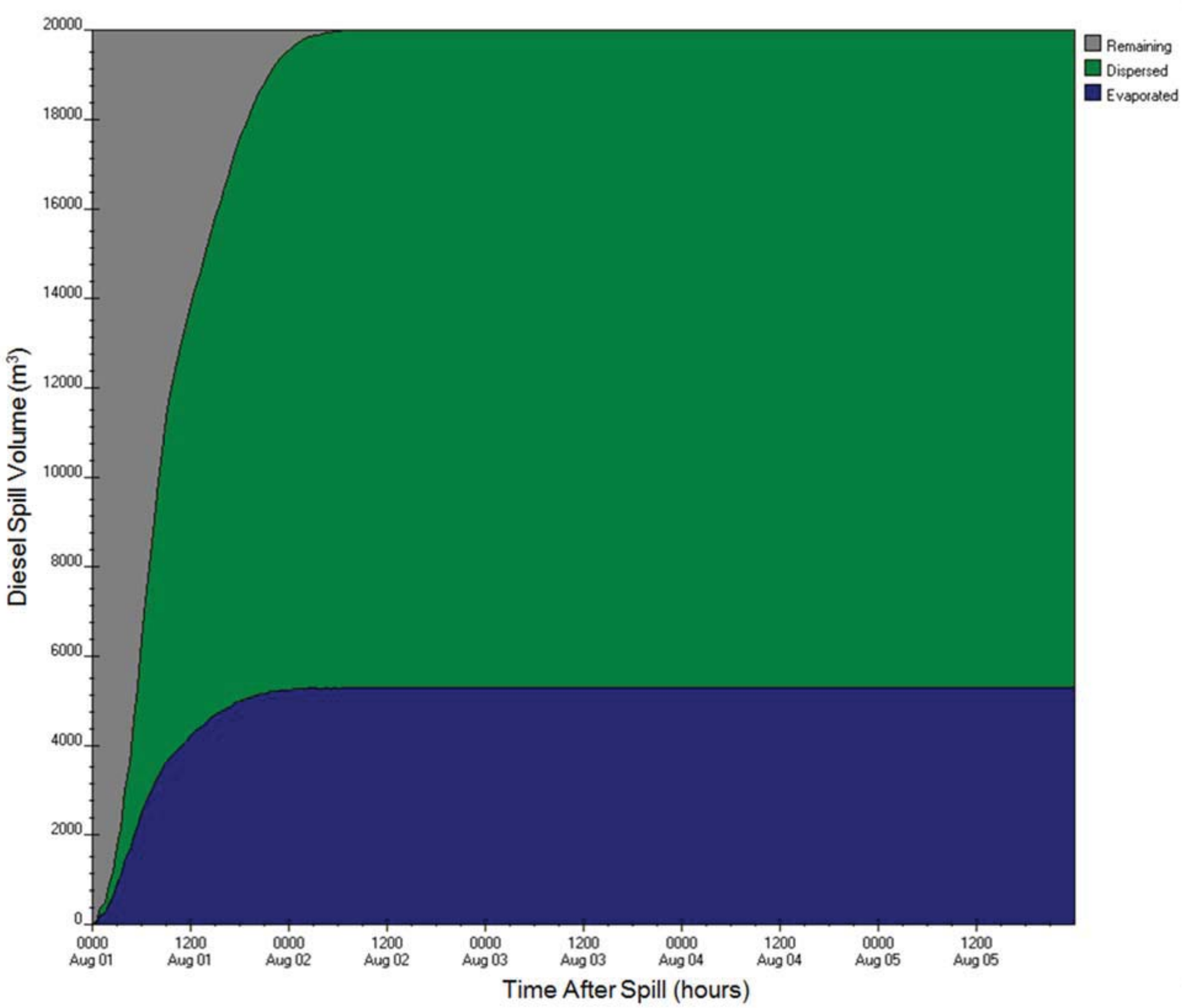

Figure E-A70: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 20,000 m^3, 2-yr wind speed scenario

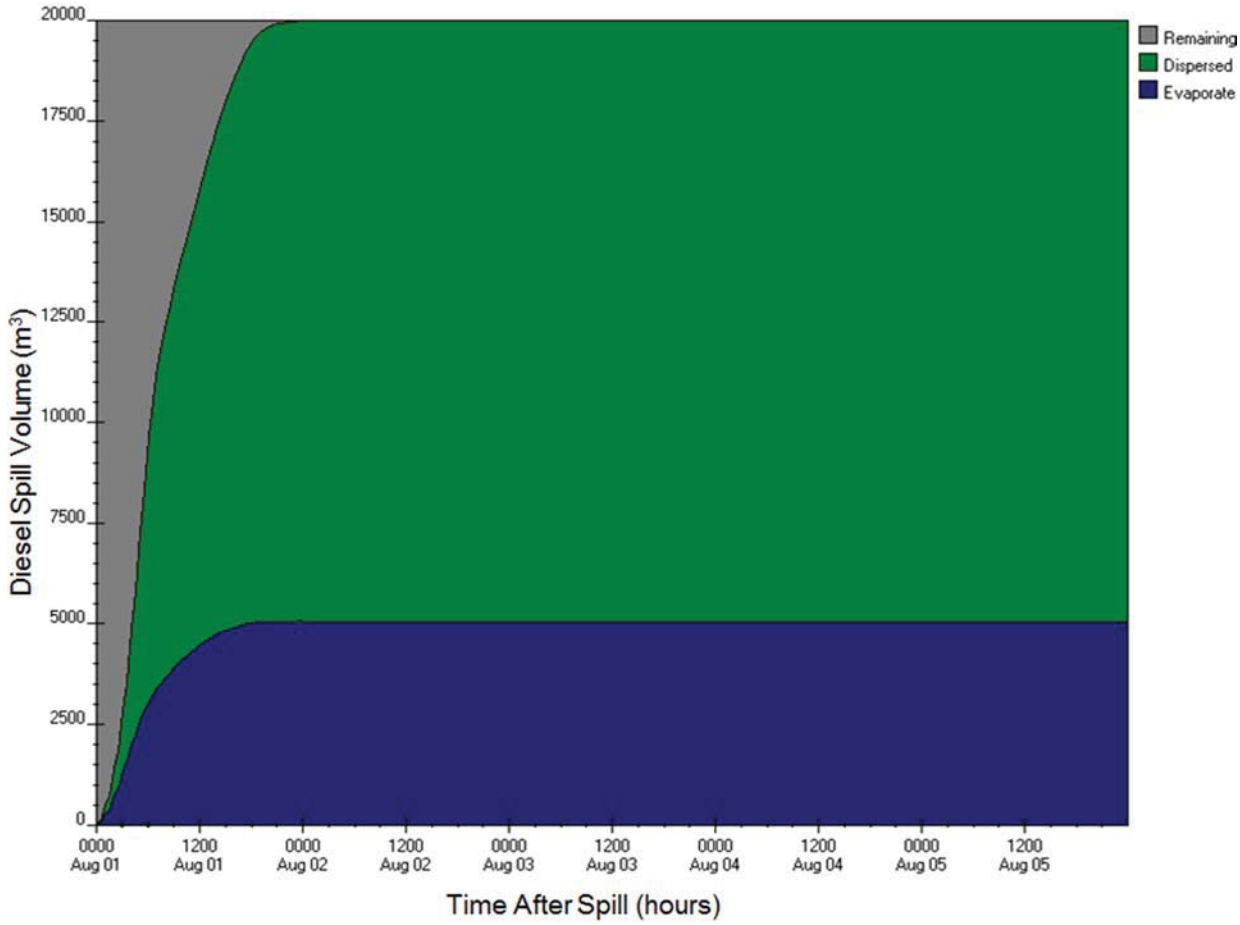

Figure E-A71: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 20,000 m^3, 50-yr wind speed scenario

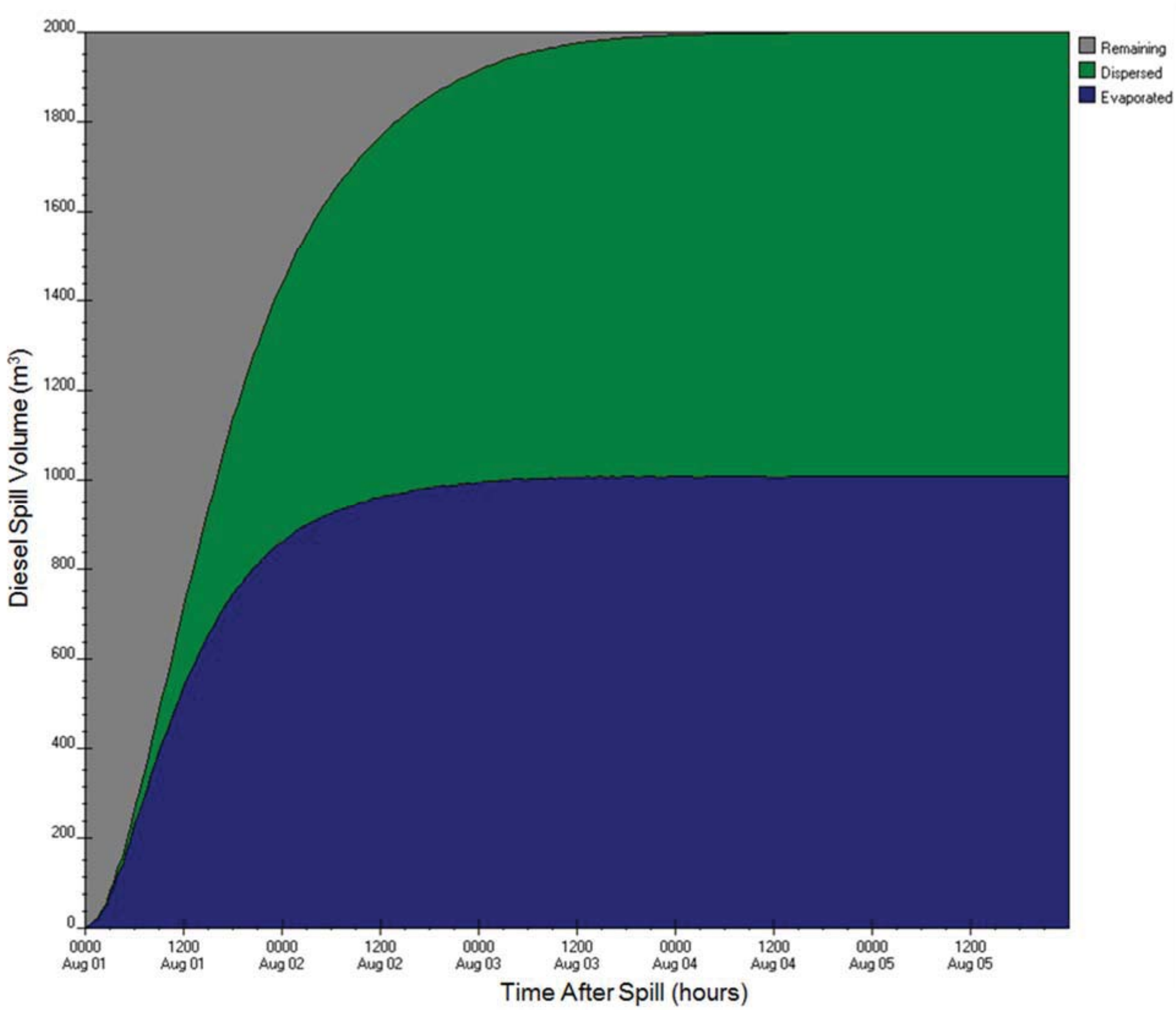

Figure E-A72: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 2,000 m^3, mean wind speed scenario

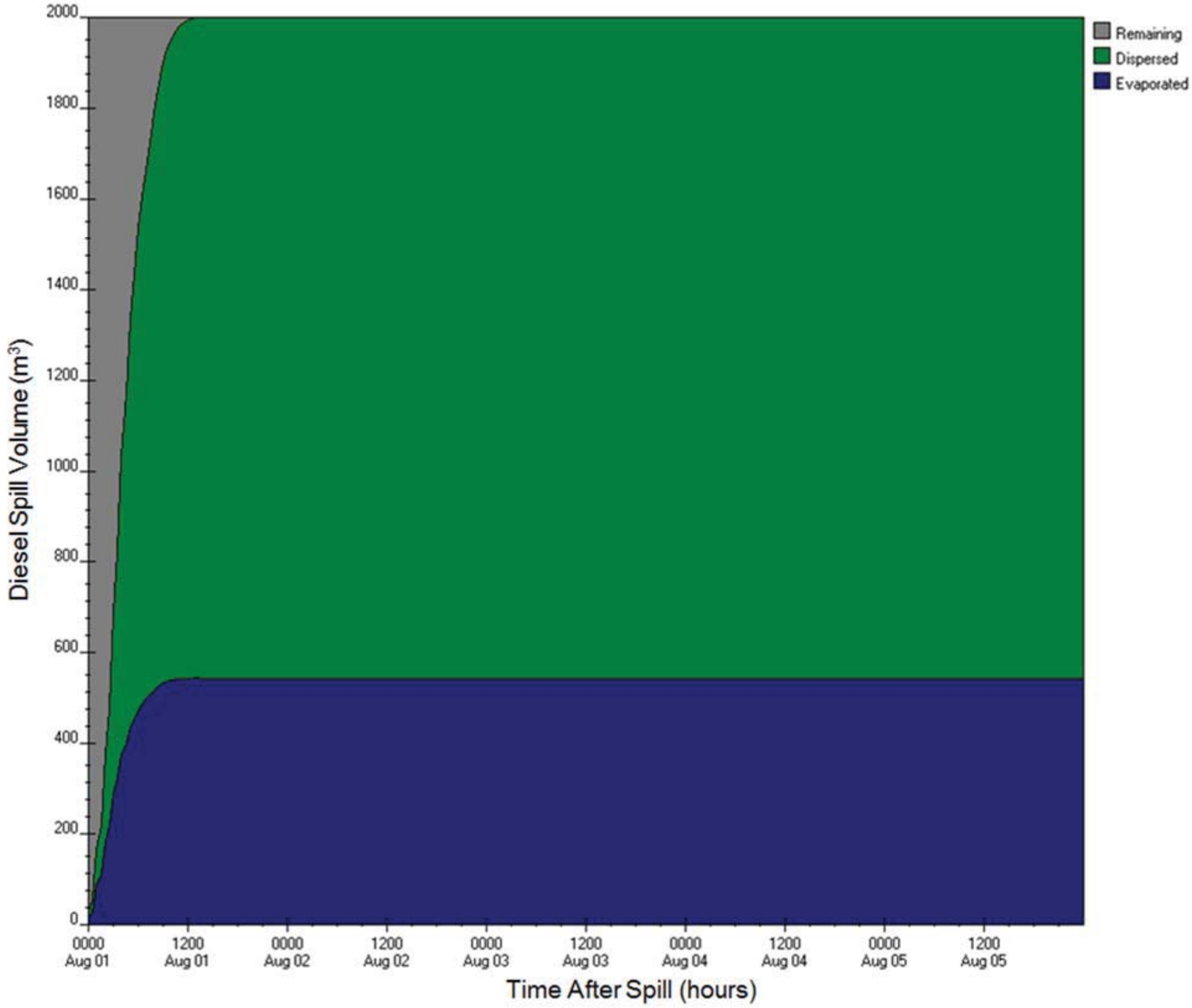

Figure E-A73: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 2,000 m^3, 2-yr wind speed scenario

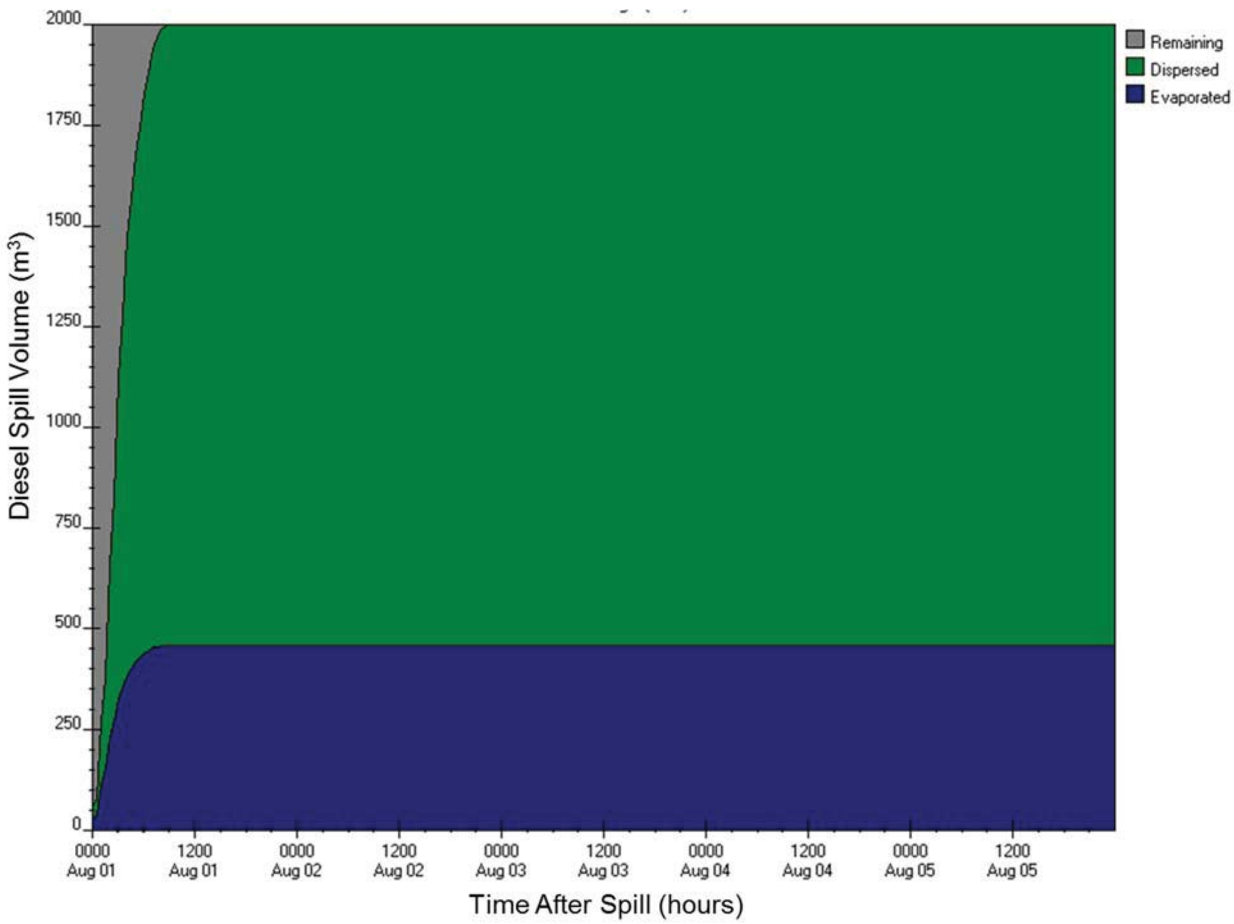

Figure E-A74: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 2,000 m^3, 50-yr wind speed scenario

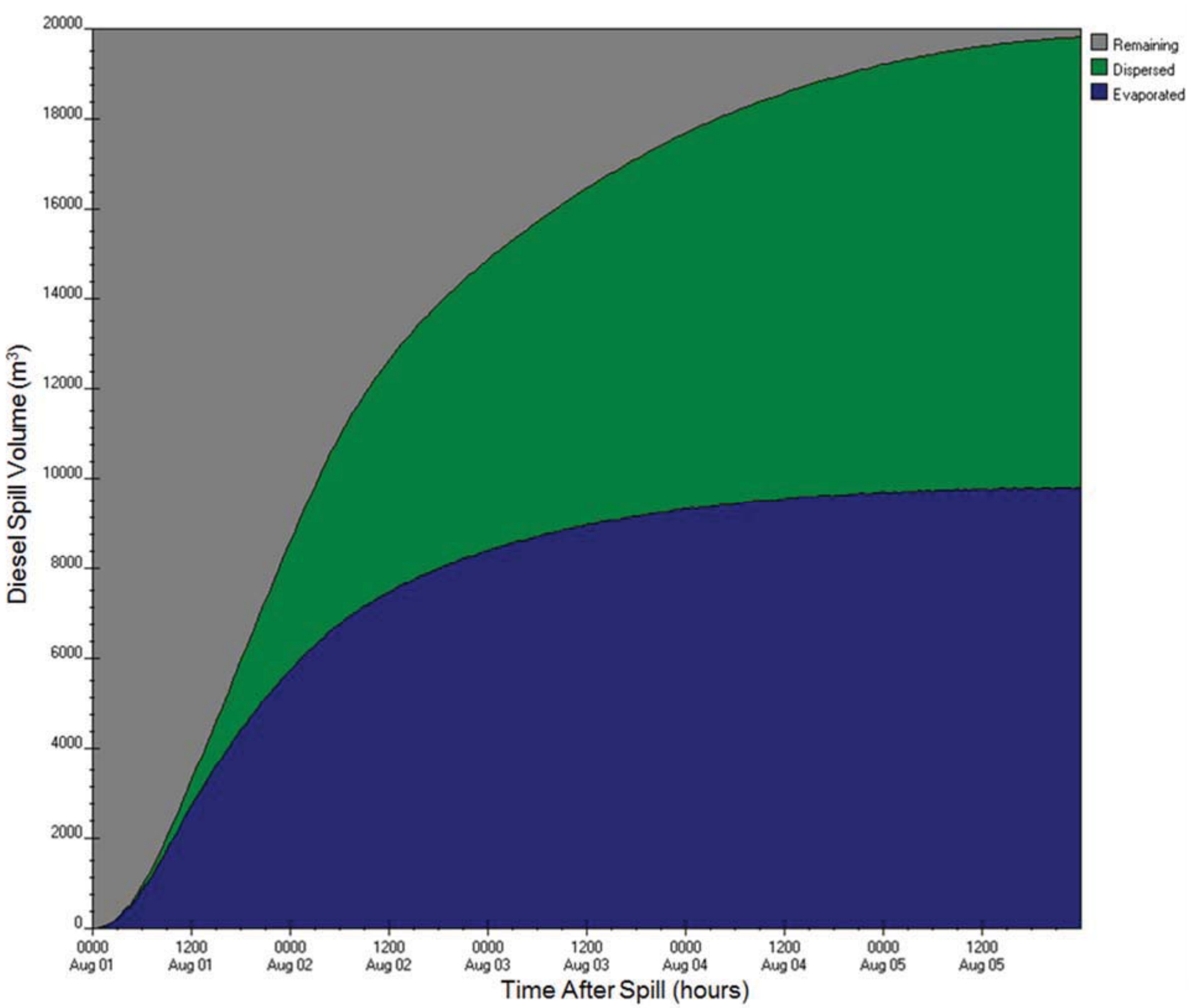

Figure E-A75: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 20,000 m^3, mean wind speed scenario

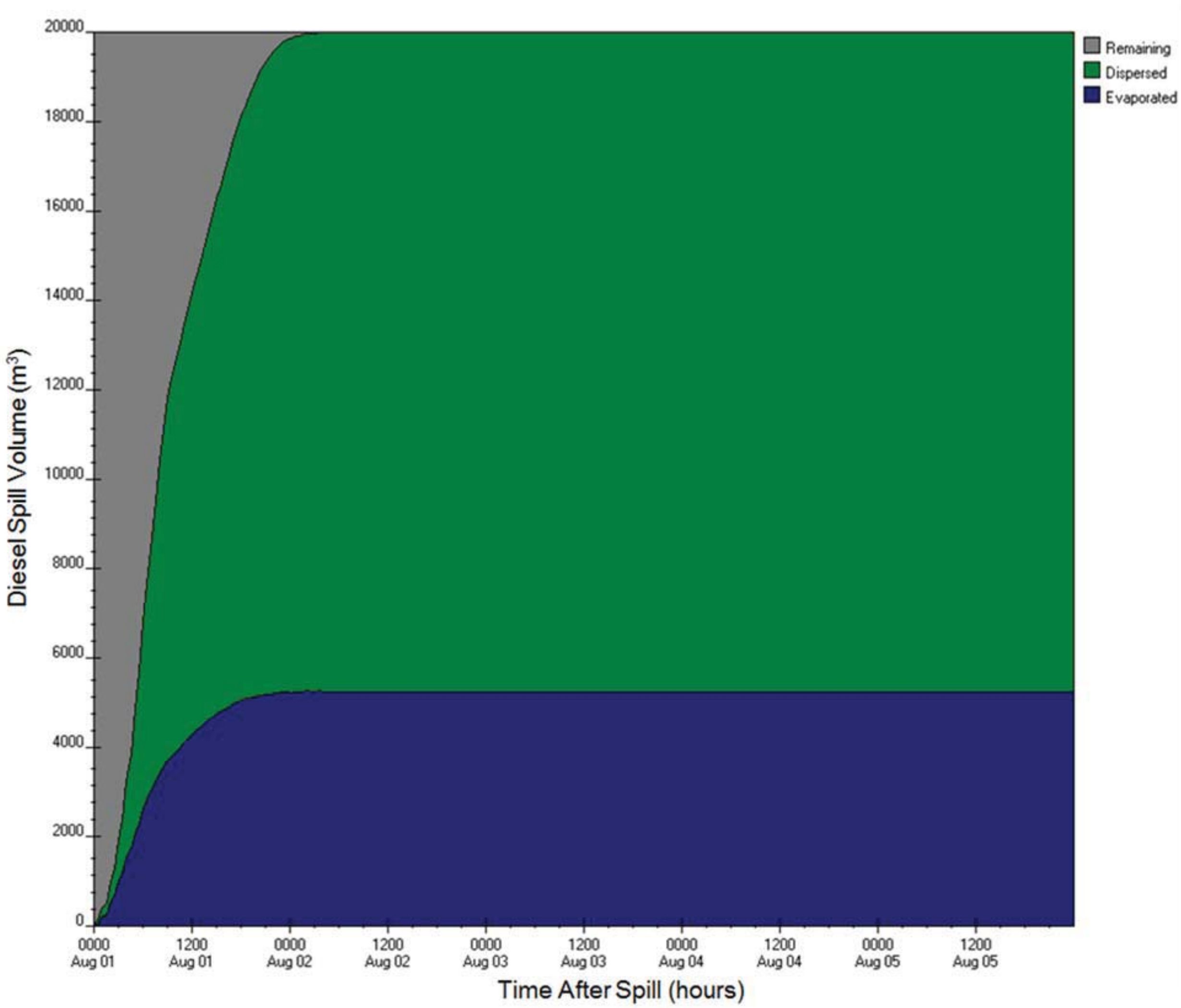

Figure 8.2-B-B-76: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 20,000 m^3, 2-yr wind speed scenario

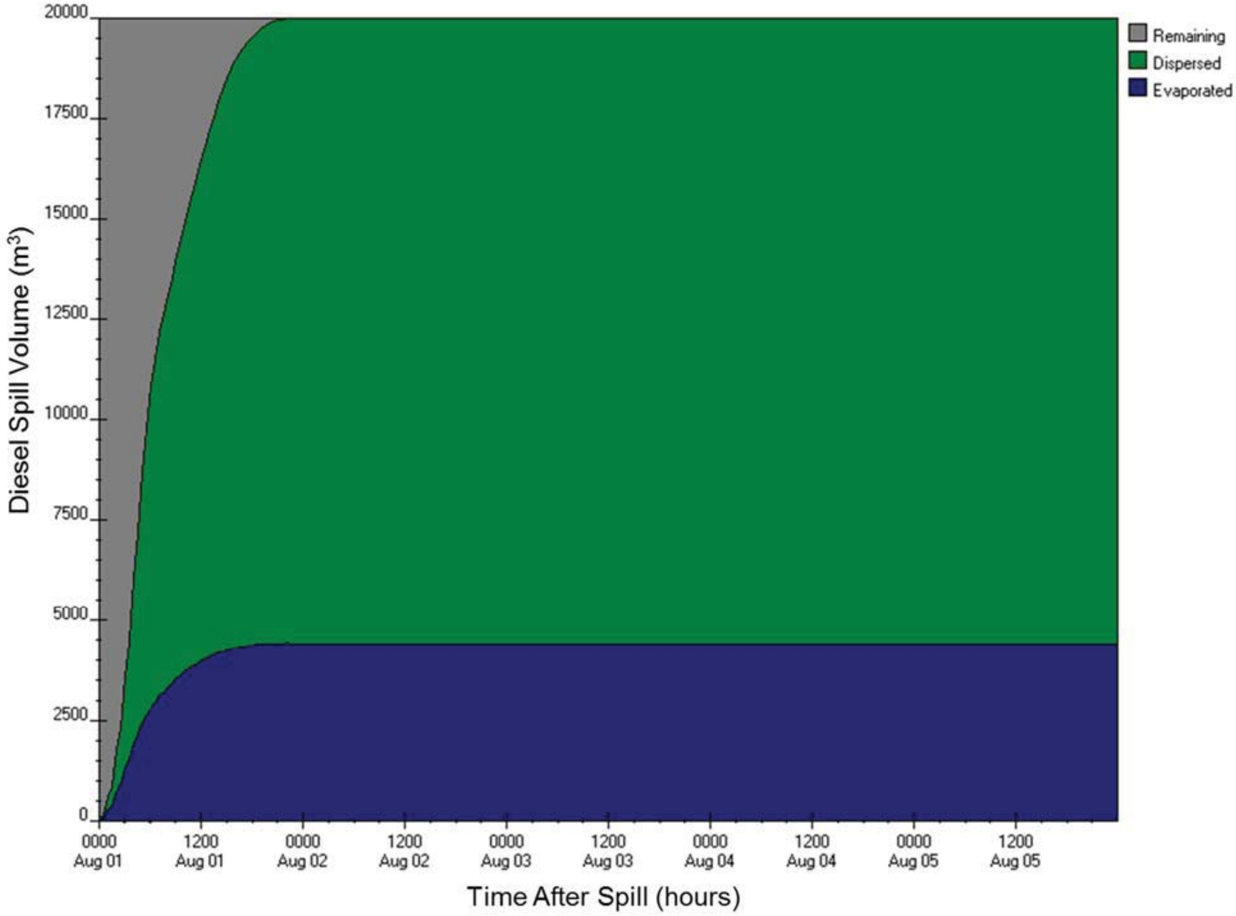

Figure E-A77: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 20,000 m^3, 50-yr wind speed scenario

AGNICO EAGLE

MELIADINE GOLD PROJECT

Landfarm Management Plan

February 2019
Version 3
6513-MPS-15

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ᐊᓖᓂᑦᑯᑦ ᑕᓯᕐᔪᐊᕐᒥᑦ ᒂᓗᒧᑦ ᐅᔭᕋᒃᑕᕆᐊᕐᒥᑦ ᐱᕙᓪᓕᐊᓂᖃᖅᑐᑦ, 25 ᑭᓛᒥᑕᓪᓗᐊᓂᒃ ᐅᐊᖕᓇᖕᒐᓂᑦ ᑲᖏᖅᓱᓂᕐᒥᑦ ᐅᖕᒐᓯᒃᑎᒋᔪᖅ, ᐊᒻᒪᓗ 80 ᑭᓛᒥᑕᓪᓗᐊᓂᒃ ᓂᒋᖅᐸᓯᐊᓂᑦ ᐱᖕᒐᖕᓇᖅᐸᓯᐅᓂᑦ ᐃᓪᓗᓕᒫᕐᔪᖕᒥᑦ ᐅᖕᒐᓯᒃᑎᒋᔪᖅ ᕿᕙᓪᓕᕐᒥᑦ ᓄᓇᕗᒻᒥᑦ. ᐅᔭᕋᒃᑕᕆᐊᕐᒧᑦ ᐸᕐᓇᐅᑎ ᓄᓇᒥᑦ ᐅᒃᑯᐃᖕᒐᓗᒍ ᐊᒻᒪᓗ ᓄᓇᐅᑉ ᐃᓗᐊᓂᑦ ᐅᔭᕋᒃᑕᕆᐊᕐᓂᐅᓂᐊᖅᑐᖅ ᐱᕙᓪᓕᐊᓗᒍ ᑎᕆᒐᓂᐊᖅ ᒂᓗᑕᓕᒃ, ᒪᕐᕉᖕᓂᒃ ᓄᓇᒥᑦ ᐅᒃᑯᐃᖕᒐᔫᓗᑎᒃ (ᑎᕆᒐᓂᐊᖅ ᓄᓇᒥᑦ ᐅᒃᑯᐃᖕᒐᔪᖅ 1 ᐊᒻᒪᓗ ᑎᕆᒐᓂᐊᖅ ᓄᓇᒥᑦ ᐅᒃᑯᐃᖕᒐᔪᖅ 2) ᐊᒻᒪᓗ ᐊᑕᐅᓯᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓂᑦ ᐅᔭᕋᒃᑕᕆᐊᕐᓂᖅ.

ᑖᒪ ᑎᑎᖅᑲᖅ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᖅ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒥᒃ ᐱᓕᕆᐊᕐᒧᑦ ᐊᒻᒪᓗ ᐋᖅᑭᒃᓯᑉᓗᓂ ᐃᓚᒋᔭᐅᔪᖅ ᑎᑎᖅᑲᓕᕆᓂᕐᒧᑦ ᐱᔭᐅᔪᖅ Type "A" ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯᒥᒃ ᑐᒃᓯᕋᐅᑎᒧᑦ. ᑖᒪ ᐸᕐᓇᐅᑎ ᐅᖃᐅᓯᖃᖅᑐᖅ ᐋᖅᑭᐅᒪᓂᕆᔭᖕᒋᓐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᓂᒃ ᐊᒃᑕᑯᖅᑕᐅᔪᑦ ᐃᓂᒋᓂᐊᖅᑕᖕᒐᓄᑦ ᓴᓇᔭᐅᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᕐᒥᑦ ᑕᐃᑯᙵᖅᑕᐅᓂᐊᕐᓗᑎᒃ ᐱᓕᕆᐊᖑᓗᑎᓪᓗ ᐅᖅᓯᐊᓗᖕᒥᑦ ᐱᔪᓂᒃ ᐱᐅᖏᑦᑐᖅᑕᖃᖅᑐᑦ.

ᐃᓂᐅᔪᒥᑦ ᑐᖅᑯᖅᓯᓂᖅ ᐊᒻᒪᓗ ᓄᑖᙳᖅᑎᕆᓃᑦ ᐊᑐᖅᑕᐅᖕᒑᕈᒪᔪᖅ ᐱᓕᕆᐊᕆᓂᐊᕐᓗᒋᑦ ᐅᖅᓯᐊᓗᖕᒥᑦ ᐱᐅᖏᑦᑐᖅᑕᖃᖅᑐᑦ ᐱᔭᐅᔪᑦ ᐅᔭᕋᒃᑕᕆᐊᕐᕕᐅᔪᒪᔪᒥᑦ. ᐊᒃᑕᑰᖅᑕᐅᔪᓄᑦ ᐃᓂᐅᔪᖅ ᐋᖅᑭᒃᓯᒪᔪᖅ ᐃᑉᔪᓂᒃ, ᐅᔭᖅᑲᓂᒃ, ᐊᐳᑎᒥᒃ, ᐊᒻᒪᓗ ᓯᑯᒥᒃ ᐱᐅᖏᑦᑐᖅᑕᖃᖅᑐᓂᒃ ᐅᖅᓯᐊᓗᖕᒥᑦ ᐱᖃᑦᑕᕐᓂᐊᕐᓗᓂ. ᐃᓚᐅᓂᐊᖅᑐᑦ ᐱᐅᖏᑦᑐᖅᑕᖄᕐᔪᒃᑐᑦ ᐅᖅᓯᐊᓗᖕᒥᑦ ᐊᒻᒪᓗ ᐅᖅᓯᕐᒥᑦ ᐱᓕᕆᐊᖑᔪᑦ ᐊᒃᑕᑯᖃᕐᕕᖕᒥᑦ.

ᐊᒃᑕᑰᕐᕕᒃ ᐃᓂᒦᑦᑐᖅ ᐱᕐᑯᑎᖅᑲᕐᕕᐅᑉ ᓯᓚᑎᐊᕐᔪᐊᓂᑦ, 200 ᒦᑕᓪᓗᐊᓂᒃ ᐅᖕᒐᓯᒃᑎᒋᔪᖅ ᑲᑎᖅᓯᐃᑉᕕᐅᔪᖅ ᑕᓯᕋᔭᒃ 1-ᒥᑦ (CP1). ᐊᒃᑕᑰᕐᕕᒃ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᖅ ᒥᑭᓛᒃᑯᖕᒐᑎᑦᑐᒪᑉᓗᒍ ᐃᓂᐅᔪᖅ ᐅᔭᕋᒃᑕᕆᐊᕐᒧᑦ ᐊᒻᒪᓗ ᐊᓪᔭᖅᑐᖅᑕᐅᔪᓂᒃ ᐅᖕᒐᓯᒃᑎᒋᓂᖕᒐᓄᑦ ᐱᐅᖏᑦᑐᖅᑕᓕᖕᓂᑦ ᑯᕕᔪᖅᑲᕋᔭᖅᐸᑦ. ᐊᒃᑕᑰᕐᕕᒃ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐱᓕᕆᐊᖅᑲᑦᑕᕐᓂᐊᕐᓂᖕᒐᓄᑦ 5,000-ᓗᐊᓂᒃ ᑭᐅᐱᒃ ᒦᑕᓂᒃ ᐱᐅᖏᑦᑐᖅᑕᓕᖕᓂᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓛᖅᑎᑦᑎᓂᕐᒥᑦ, ᐊᒻᒪᓗ ᐅᒃᑯᐊᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ, ᐊᒻᒪᓗ 500 ᑭᐅᐱᒃ ᒦᑕᓂᒃ ᐊᐳᑎᒥᒃ ᓯᑯᒥᓪᓗ ᐊᕐᕋᒍᑕᒫᖅ. ᐃᒻᒥᖅᐸᓪᓕᐊᓂᖅ ᐊᒃᑕᑰᕐᕕᖕᒥᑦ ᑯᕕᑎᑕᐅᔾᔮᖏᑦᑐᖅ ᓯᓚᒨᑐᐃᓐᓇᖅ. ᑲᑎᑕᐅᓂᐊᖅᑐᖅ CP1-ᒨᓪᓗ ᑯᕕᑎᑕᐅᓗᓂ ᐱᓕᕆᐊᖑᓂᐊᕐᓗᓂ. ᐊᒃᑕᑰᕐᕕᒃ ᐃᓗᐹᕿᑕᖅᑲᕐᓂᐊᖅᑐᖅ ᐊᒻᒪᓗ ᐊᒃᑐᖅᓯᓂᖅᑲᕐᓂᐊᕐᓂᖕᒐᓄᑦ ᓂᕆᐅᒋᔭᐅᙱᕐᓗᓂ ᓄᓇᒥᑦ ᐃᒪᕐᒥᑦ.

ᐅᓂᑉᑳᓕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐊᒃᑐᑰᕐᕕᖕᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐊᕐᕌᒍᑕᒫᒃᑯᑦ ᐊᕙᑎᓕᕆᔩᒃᑯᓐᓄᑦ, ᓇᓗᓇᐃᕐᓗᑎᒃ ᖃᓄᑎᒋᐅᓂᖕᒥᑦ ᐃᓚᔭᐅᔪᑦ ᐊᒃᑕᑰᓇᕝᕕᖕᒧᑦ, ᖃᓄᑎᒋᐅᓂᖕᒥᑦ ᐊᑐᖅᑕᐅᔪᑦ ᐲᖅᑕᐅᓂᖕᒥᑦ ᐊᒻᒪᓗ ᐊᒃᑕᑰᖅᑕᐅᓂᖕᒥᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐊᑐᖅᑕᐅᒃᑲᓐᓂᕐᓂᖕᒐᓄᑦ ᐃᓂᐅᔪᖅ, ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓗᒃᑖᑦ, ᖃᓄᑎᒋᐅᓂᖕᒥᑦ ᐊᒻᒪᓗ ᖃᓄᐃᑦᑑᓂᖕᒥᑦ ᐃᓚᔭᐅᔪᑦ, ᑕᑯᒃᓴᐅᔪᒃᑯᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ, ᐊᒻᒪᓗ ᖃᓄᑎᒋᐅᓂᖕᒥᑦ ᑯᕕᔭᐅᔪᑦ ᐃᒪᖅ ᐊᑐᖅᑕᐅᓯᒪᔪᑦ.

ᐱᐅᖏᑦᑐᖅᑕᖃᓕᖅᑐᑦ ᐅᖅᓯᐊᓗᖕᒥᑦ ᐱᔪᓂᒃ ᓇᓚᐅᑦᑖᕐᓂᖅᑲᓇᐊᖅᑲᕐᓂᐊᖅᑐᑦ ᐱᖕᒐᓯᓂᑦ ᐊᐅᔭᓗᒃᑖᕐᒧᑦ ᓄᑖᙳᖅᑎᑦᑎᐊᕐᓂᐊᕐᓗᒍ. ᓄᑖᙳᖅᑎᖅᑕᐅᒃᐸᑦ, ᐃᑉᔪᐃᑦ ᐲᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᒃᑕᑰᕐᕕᖕᒥᑦ ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᔪᖕᓇᕐᓂᐊᕐᓗᑎᒃ ᓴᓇᕙᓪᓕᐊᓂᕐᒧᑦ ᐳᕐᓗ ᐃᓚᒋᔭᐅᓗᑎᒃ ᖄᓚᑦᑎᔭᐅᓂᐊᕐᓗᓂ ᕿᒪᒃᑎᑦᑐᓂᒃ ᑐᖅᑯᖅᓯᓯᒪᕝᕕᖕᒧᑦ ᐅᕝᕙᓘᓐᓃᑦ ᑲᑎᑕᐅᓗᑎᒃ ᐊᒃᑐᖅᑕᐅᔪᓄᑦ ᐅᔭᖅᑲᓂᒃ ᑐᖅᑯᖅᓯᓯᒪᕝᕕᖕᒧᑦ.

EXECUTIVE SUMMARY

Agnico Eagle Mines Limited (Agnico Eagle) has developed the Meliadine Gold Project (Project), located approximately 25 kilometres (km) north of Rankin Inlet, and 80 km southwest of Chesterfield Inlet in the Kivalliq Region of Nunavut. The mine plan includes open pits and underground mining methods for the development of the Tiriganiaq gold deposit, which includes two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine.

This document presents the Landfarm Management Plan for the Project and forms a component of the documentation series produced for the Type A Water Licence Application. The Plan describes the design features and operational procedures for the landfarm located at the Project for the storage and treatment of petroleum hydrocarbon contaminated soils.

On-site storage and remediation has been established as the preferred method for treatment of light petroleum hydrocarbon contaminated soil that may be generated on the proposed mine site. The landfarm is designed to receive soils, rock, snow, and ice contaminated with petroleum hydrocarbons. This will include light hydrocarbons such as diesel and gasoline being treated in the landfarm.

The landfarm is located just off the industrial pad, approximately 200 metres from Collection Pond 1 (CP1) and is shown on Figure 2-1. The central location of the landfarm (Figure 2-1) was chosen to minimize the footprint of the site and the transport distance of contaminated material from potential spill locations. The landfarm is expected to effectively treat up to 5,000 cubic metres of contaminated soil over the construction, operations, and closure of the Project, and 500 cubic metres of snow and ice annually. Water accumulating in the landfarm is not discharged directly to the receiving environment. It is first sent through an oil/water separator, before being discharged to CP1 for further treatment. The landfarm has an impervious liner and no impacts on shallow groundwater are anticipated.

A report of landfarm activities is prepared annually by Environment Department, indicating the volume of material added to the facility, amount of material removed, disposal or re-use location, analysis results, volume and type of nutrient addition, visual inspection results, and volume of contact water pumped.

Soils contaminated with light end petroleum hydrocarbons are remediated in accordance with the criteria stated in The Government of Nunavut, Environment Department's Environmental Guideline for the Management of Contaminated Sites. When remediated, the soils will be removed from the facility and can be used for construction purposes, such as part of the cover of the Tailings Storage Facility, Landfill or stacked in the Waste Rock Storage Facility.

In addition Agnico Eagle continues remediation of the historical landfarm associated with the Type B Water License – 2BB-MEL1424 that was in use for the former Meliadine Exploration Camp.

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TABLES AND FIGURES

DOCUMENT CONTROL

Version	Date	Section	Page	Revision	Author
1	April 2015			First version of the Landfarm Management Plan	John Witteman, Env. Consultant, Agnico Eagle
2	February 2018	Figure 2-1	5	- "Main Infrastructure for the Meliadine Project, including the Landfarm" - figure added to figure reference	Meliadine Environment Department
		3.1	9	- Antifreeze removed from list of acceptable contaminates for landfarm disposal	
		2.1	3	-Approximate volume of material adjusted to 700 m^3	
		1.3	2	- Updated Oil Pollution Emergency Plan revision date and version	
		All	All	-General review and revision	
3	February 2019	1.1	1	-Estimated quantity of material in Type A landfarm adjusted to 1500 m^3	Sean Arruda
		2.1	3	-Estimated quantity of material in both landfarms adjusted to 3706 m^3 (1500 m^3 in Type A landfarm, 2206 m^3 in Type B landfarm) -Paragraph containing estimated annual inputs to landfarm has been removed - gasoline and light oil added -microbial activity 'slows' (changed from 'stops')	
		2.2.1	4	-'oil' changed to 'hydrocarbons'	
		Figure 2-1	5	-Site map figure updated.	
		Table 2-2	8	-Sump surface area was a typo (10,040 m^2). Changed to 144 m^2	

3.1.1	10	-'Aboriginal Affairs and Northern Development Canada' changed to 'Crown-Indigenous Relations and Northern Affairs' -Sentence added "If there is uncertainty whether or not the material contains additional, unknown contaminants, the material should be placed in totes/drums until lab results confirm that they can be placed in the landfarm."
3.3	11	-Contaminated snow is now being sent to the snow cell area

ACRONYMS

Agnico Eagle	Agnico Eagle Mines Limited
BTEX	benzene, toluene, ethylbenzene, and xylene
CP1	Collection Pond 1
GN	Government of Nunavut
NWB	Nunavut Water Board
PHC	Petroleum hydrocarbons
Project	Meliadine Gold Project
RMMS	Responsible Mining Management System
TSF	Tailings Storage Facility
WRSF	Waste Rock Storage Facility

SECTION 1 • INTRODUCTION

1.1 Project History

Agnico Eagle Mines Limited (Agnico Eagle) has developed the Meliadine Gold Project (Project), located approximately 25 kilometres (km) north of Rankin Inlet, and 80 km southwest of Chesterfield Inlet in the Kivalliq Region of Nunavut. Situated on the western shore of Hudson Bay, the proposed Project site is located on a peninsula between the east, south, and west basins of Meliadine Lake (63°1'23.8'' N, 92°13'6.42"W), on Inuit Owned Lands. The Project is located within the Meliadine Lake watershed of the Wilson Water Management Area (Nunavut Water Regulations Schedule 4).

The mine plan proposes open pit and underground mining methods for the development of the Tiriganiaq gold deposit, with two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine. The mine will produce approximately 12.1 million tonnes (Mt) of ore, 31.8 Mt of waste rock, 7.4 Mt of overburden waste, and 12.1 Mt of tailings. There are four phases to the development of Tiriganiaq: just over 4 years of construction (Q4 Year -5 to Year -1), 8 years of mine operation (Year 1 to Year 8), 3 years of closure (Year 9 to Year 11), and post-closure (Year 11 forwards).

The Landfarm Management Plan (Plan) focuses on minimizing the waste footprint on-site, and maximizing remediation potential through implementation of bioremediation experience and research carried out at the Agnico Eagle's Meadowbank Gold Mine.

During the advanced exploration phase of the Project, the Nunavut Water Board (NWB) approved amendment #6 to Water Licence 2BB-MEL1424, which allowed the operation of a light PHC soil stockpile. This approval supported using a landfarm developed inside a bermed and lined area previously used to store fuel bladders. Soil contaminated with light PHC is being deposited in this bermed and lined area for treatment. To date, there is approximately 1500 cubic metres (m^3) of contaminated soil being treated. This quantity resulted from inadvertent spills that occurred during the advanced exploration phase of the Project.

When possible, materials contaminated with heavy hydrocarbons (e.g., hydraulic fluid or grease), are to be segregated, packaged, and shipped south for treatment and/or disposal.

1.2 Objectives

On-site storage and remediation has been established as the preferred method for treatment of light PHC contaminated soil that may be generated at the proposed mine. Specifically, remediation through landfarming has been identified as the primary treatment option and, as such, is the focus of this contaminated soil management plan. A pilot project to enhance rates of bioremediation through addition of a nutrient source is being carried out at Meadowbank and will be employed at the Project should it prove successful. Alternate contingency options in the event that landfarming is not successful or as efficient as planned are also discussed.

This Plan is a component of the Responsible Mining Management System (RMMS)[1]. The objectives of this Plan are to:

- provide an overview of contaminated soil management at the Project;
- describe the physical setting, location, and design criteria of the landfarm;
- define acceptable types of contaminated soils to be placed in the landfarm and conditions for removal of treated soil;
- define operating procedures and monitoring requirements for the landfarm; and
- describe contingency options for alternate treatment/storage of PHC contaminated soil.

1.3 Related Documents

Spill prevention is the first stage in contaminated soil management at the Project. Documents containing information related to this Plan and submitted as part of the Type A Water Licence Application include:

- Spill Contingency Plan;
- Environmental Management and Protection Plan; and
- Risk Management and Emergency Response Plan.

There is also a related Oil Pollution Emergency Plan (Agnico Eagle 2018), which is specific to spills at Agnico Eagle's Itivia Oil Handling Facility located in Rankin Inlet. The Oil Handling Facility is located on the shore of Melvin Bay, which is part of Hudson Bay. The Oil Pollution Emergency Plan was prepared as a requirement of the *Canadian Shipping Act* and associated regulations. It is submitted to Transport Canada for approval prior to any shipping related to the Project.

1.4 Spill Prevention

Similar to the waste management philosophy, plans are to actively work towards minimizing spills through suitable work procedures. Plans developed from the environmental impact study address the management of spills on land, ice, water, and into the marine environment. When spills do occur, the goal is to limit the spread of the spill, and then manage contaminated material resulting from the spill. The Spill Contingency Plan describes spill prevention measures.

[1] The RMMS is described in the Environmental Management and Protection Plan.

SECTION 2 • LANDFARM DESIGN

2.1 Background

In the event of a spill, on-site storage and remediation is the most practical and efficient method in handling contaminated soil, particularly in an isolated location such as the Project. Any PHC contaminated soils generated during the construction, operation, and closure phases will be adequately managed. Soils contaminated with light PHCs, such as diesel, gasoline, and light oils will be treated on-site in a landfarm. This method involves spreading, mechanical mixing, addition of nutrients and water and placing the contaminated soil in windrows within a containment area, and promoting conditions favorable for the volatilization and aerobic microbial degradation of hydrocarbons. When possible, materials contaminated with heavy hydrocarbons (e.g., hydraulic fluid or grease), are to be segregated, packaged, and shipped south for treatment and/or disposal.

There are currently PHC contaminated soils, totalling approximately 3706 m^3, stored on-site in two landfarms resulting from spills that occurred during the exploration and construction phases (approximately 1500 m^3 in Type A Landfarm, and 2206 m^3 in Type B Landfarm).

Landfarm option analysis prepared for Agnico Eagle by Golder Associates (2007) identified factors relevant to landfarming in the north. This includes environmental factors and physical properties of the soil that affect microbial growth and rates of biodegradation, including temperature, pH, soil moisture, nutrient content, salinity, and soil particle size.

Although rates of biodegradation decline with temperature, landfarming is still a feasible technique in Arctic climates as demonstrated by the Meadowbank landfarm. Degradation in the north is typically restricted because microbial activity slows between 0 to -5 degrees Celsius (°C) restricting biodegradation to the months of June to September[2]. Nevertheless, degradation was reported at 90% over two summers on Resolution Island (Paudyn et al. 2008).

It is estimated that soils contaminated with light end PHCs would require three full summer seasons for complete remediation. When remediated, the soils will be removed from the facility and can be used for construction purposes such as part of the cover of the Tailings Storage Facility (TSF) or stacked in the Waste Rock Storage Facility (WRSF). Based on a remediation period of three seasons, it would be possible to close the landfarm facility on three years after the end of the process plant operation.

2.2 Location

The overall site plan showing the main infrastructure for the Project, including the landfarm, is shown in Figure 2-1. The area has no exposed bedrock and up to 20 metres (m) of glacial-fluvial till that has little ground ice and shows no permafrost degradation. The central location of the landfarm was chosen to minimize the footprint of the site and the transport distance of contaminated material from

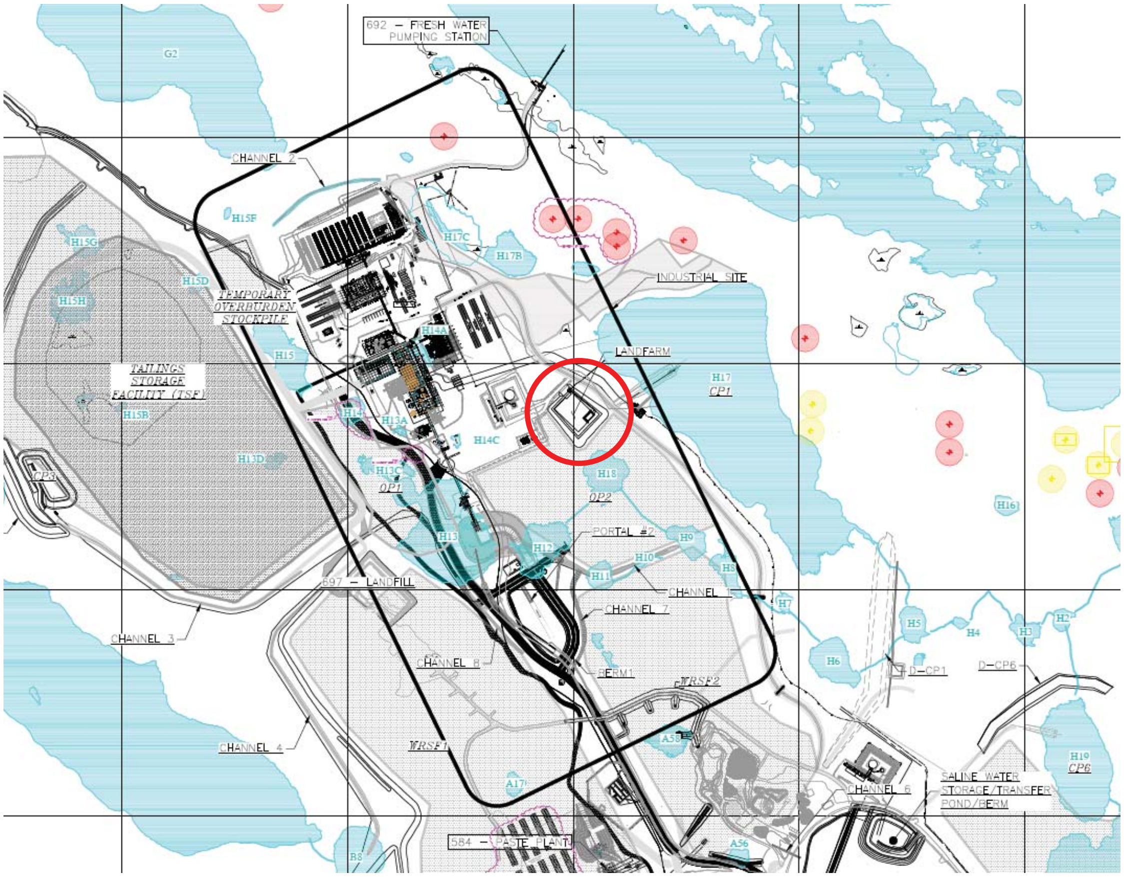
[2] Even though bioremediation ceases below -5°C, volatilization of the PHCs does continue but at a much slower rate.

potential spill locations. The management of all waste generated at the Project in the form of dry stack tailings, waste rock, incinerator, and landfill waste are located in close proximity to the main infrastructure.

2.2.1 Proximity of Surface Water

The landfarm is located adjacent to the infrastructure pad, approximately 200 m from Collection Pond 1 (CP1). The landfarm is located on land that slopes towards the southwest corner, which results in any rainwater or snowmelt draining to temporary water storage having the capacity to store a 1:100 wet year spring freshet plus 500 m^3 of water from melting of contaminated snow/ice. Drainage from the landfarm may be used as water in the turning of the windrows during the remediation process. Excess water is collected within a sump inside the landfarm and will be pumped to an oil pre-treatment plant to remove any hydrocarbons. The treated water will then be discharged into the CP1. Discharge from CP1, is controlled by a dike, which stops direct flow to Meliadine Lake. Meliadine Lake is the source of freshwater for the site and is used by Inuit for traditional pursuits. If water is to be discharged from CP1 to Meliadine Lake, it is treated to meet compliance criteria. Except for a short duration during the spring freshet or a heavy rainfall, water ponding will be eliminated in the landfarm by the end of the summer such that a sufficient storage capacity is available for the upcoming spring freshet.

Figure 2-1 Landfarm Site Location Plan



2.2.2 Proximity of Groundwater

In the Project area, the groundwater within the active layer is estimated to reach 1.5 m in October. The active layer begins to form in July when temperatures largely remain above 0°C, and deepens to a maximum in October. Shallow groundwater flow in the area of the landfarm is towards the industrial site.

To prevent movement of contaminants from the landfarm facility into groundwater and the surrounding environment, Environment Canada (SAIC 2006) recommends implementation of a barrier with 10^{-7} centimetres per second hydraulic conductivity at a thickness of 0.6 m. The Meliadine landfarm has an impervious liner and no impacts on shallow groundwater are anticipated.

2.3 Design

The landfarm is designed to receive soils, rock, snow, and ice contaminated with petroleum hydrocarbons. This will include light hydrocarbons such as diesel and gasoline. The design volume of the landfarm is based on allowances for the materials being treated at Meadowbank.

The average floor slope is 3.1% going in the designed direction of northwest to southeast, matching the natural ground slope. This slope is still adequate allowing leachate/drainage from the PHC soils and internal runoff to gradually seep through the filter berm into the sump area. The water collected in the sump will be pumped to the oil separator for oil removal before being discharge into CP1. The sump area was built as per design capacity.

The geomembrane liner crest elevation was installed at an elevation of 74.80 m, it does allow for 0.45 m of freeboard before reaching the geomembrane liner crest elevation.

2.3.1 Soil Volume Requirements

The landfarm was built with the expectation of effectively treating up to 5,000 m^3 of contaminated soil over the construction, operations, closure of the Project, and 500 m^3 of snow and ice annually. Based on the experience at Meadowbank, the volume of PHC would be approximately 350 m^3 per year during construction, operation, and closure phases. Table 2-1 outlines the estimated volumes of contaminated soils and rock, and contaminated snow and ice expected during each phase of the mine.

Table 2-1 Estimated Volume of Petroleum Hydrocarbon Contaminated Soil and Ice/Snow to be Managed

Project Phase	Volume of PHC Soil/Rock (m^3)	Annual PHC Snow/Ice (m^3)
Advanced exploration	2,209 (volume in exploration landfarm to date)[(a)]	500 per year
Predevelopment (2 years)	350 (175 per year)	
Construction (3 years)	1,050 (350 per year)	
Operations (7 years)	2,450 (350 per year)	
Closure & Reclamation (2 years)	700 (350 per year)	
Total	**4,970**	

[(a)] The contaminated soil in the advanced exploration landfarm will be transferred to the mine landfarm upon its completion and commissioning.

As described in the Landfarm Design & Management Plan (Agnico Eagle 2008), it is estimated that soils contaminated with light end PHCs would require three full summer seasons for complete remediation. When remediated, the soils will be removed from the landfarm and used on-site, placed in a WRSF or used as cover at the TSF.

2.3.2 Design Specifications

The design criteria for the landfarm is outlined in Table 2-2. Its footprint is approximately 11,000 square metres (m^2), with a perimeter berm that is approximately 2.0 m high over the landfarm surface. The geometry and characteristics of the landfarm are shown in Table 2.2.

Table 2-2 Geometry and Characteristics of the Landfarm

Item	Actual
Dimensions of Perimeter Berm Crest Exterior (avg.)	86.8 m x 68.4 m
Dimensions of Perimeter Berm Crest Interior (avg.)	74.4 m x 53.3 m
Side Slopes of Perimeter Berm (avg.)	1V:2.5H (40%)
Perimeter Berm Crest Width (avg.)	3.5 m
Perimeter Berm Height (Min. to Max.)	1.4 m to 5.2 m
Perimeter Berm Crest Elevation (avg.)	75.25 m
Dimensions of Filter Berm Crest Interior (avg.)	19.0 m x 12.0 m
Side Slopes of Filter Berm (avg.)	1V:1.5H (67%)
Filter Berm Crest Width (avg.)	1.0 m
Geomembrane Liner Crest Elevation	74.80 m
Interior Floor Slope (avg.)	-3.1% (NW to SE)
Fill Thickness Above Original Ground for Inside Base/ Sump Area (Min.)	1.52 / 1.48 m
Fill Thickness Above Liner	0.5 m
Inside Base Surface area Including Sump Area	3,794 m²
Sump Surface Area	144 m²

Table 2-3 indicates the growth and stabilization of the volume of PHC considering remediation over three years and the maximum volume of contaminated material that is anticipated to be stored over a period of 13 years.

The size of the landfarm is based on the design criteria (Table 2-2), the estimated volume of material (Table 2-3), and the requirement to turn over the surface of the piles during the summer months. The designed footprint of the landfarm is 11,000 m² with a useful landfarm surface of 3,650 m². Contaminated material is piled 1.5 m so that the material is below the crest height of the perimeter berm. At the maximum estimated capacity of the facility, three windrows having each 890 m³ of PHC will cover 1,800 m² allowing 1,850 m² for turnover and water management.

Table 2-3 Volume of Petroleum Hydrocarbon Contaminated Material in the Landfarm

Mine Year	Estimated PHC Produced (m³)	Accumulated PHC in Landfarm for Remediation (m³)	Treated PHC Removed from Landfarm (m³)	Hydrocarbon Contaminated Snow or Ice to Landfarm (m³)	Maximum Accumulated PHC in Landfarm (m³)
Before -6	420			0	0
-6 and -5	350			0	0
-4	350			0	0
-3	350	1,470		500	1,970
-2	350	1,820		500	2,320
-1	350	2,170		500	2,670
1	350	1,400	1,120	500	1,900
2	350	1,400	350	500	1,900
3	350	1,400	350	500	1,900
4	350	1,400	350	500	1,900
5	350	1,400	350	500	1,900
6	350	1,400	350	500	1,900
7	350	1,400	350	500	1,900
8	350	1,400	350	500	1,900
9	0	1,050	350	0	1,050
10	0	525	525	0	525
11	0	0	525	0	0

SECTION 3 • LANDFARM OPERATION AND MANAGEMENT

Agnico Eagle is responsible for managing and implementing the landfarm operation plan. Operation and monitoring of the landfarm as well as designation of training requirements will be the responsibility of the Environment General Supervisor, Coordinators or designate.

3.1 Acceptable Landfarm Material

3.1.1 Contaminants

The landfarm facility will only treat and/or store light PHC contaminated soils that have been generated through mine related activities at the Project and which have been transferred from the Project's advanced exploration camp landfarm upon closure. Material from the Hamlet of Rankin Inlet or other sites will not be accepted without approval from the NWB, Crown-Indigenous Relations and Northern Affairs, Water Resources Inspectors, and the Kivalliq Inuit Association.

The following products are acceptable for treatment in the landfarm if generated on-site and spilled on soil:

- diesel fuel;
- gasoline;
- hydraulic oil
- aviation fuel (Jet A);
- other light oil (e.g., engine oil, lubricating oil);

In the event that the contaminant source is unknown, soil samples will be analyzed for PHCs and possibly additional contaminants prior to placement in the landfarm. These additional parameters could include total metals, oil and grease, and volatile organic compounds. Analysis for additional compounds will be determined by the Environment Department on a case-by-case basis. If there is uncertainty whether or not the material contains additional, unknown contaminants, the material should be placed in totes/drums until lab results confirm that they can be placed in the landfarm.

Concentrations of contaminants will be compared to the site background values (for metals) and/or criteria in the Government of Nunavut (GN) *Guidelines for Contaminated Site Remediation* (GN 2009). If this analysis indicates soil contamination above background or GN guidelines for any substance not approved for landfarming (i.e., non-PHC contaminants), the spill material will not be placed in the landfarm. This is to ensure that PHC contaminated soils are not contaminated with other products.

Spills of non-PHC material (e.g., solvents) will be placed in drums and stored on-site for shipment to approved facilities during shipping season.

3.1.2 Grain Size

Bioremediation of very coarse-grained, larger soil material, is inhibited as it does not readily retain moisture. However, volatilization will occur more rapidly (SAIC 2006). It has been noted that this material likely contains lower concentrations of contaminants due to a lower volume-to-surface area ratio, and can typically be screened out prior to landfarming (SAIC 2006). As a result, soils and rock material with grain size less than 2.5 centimetres (cm) will be separated from larger-grained material, where possible. This will occur at the spill location or in the landfarm using a screen sieve, should it prove necessary. The two soil fractions will be treated separately in the landfarm.

3.2 Contaminated Soil Additions

3.2.1 Spill Excavation

Soil contaminated with the above-described petroleum hydrocarbon materials will be excavated and transported to the landfarm facility in dump trucks or other approved methods. Care will be exercised to ensure that the entire spill is excavated (verified by olfactory and visual assessment, or sampling if necessary) and that none of the contaminated material is lost during transport.

3.2.2 Placement in the Landfarm

As described above, larger coarse material (rocks) will be separated from the finer material (sand and gravel) in the landfarm and assessed visually for PHC staining and product. If the material is saturated it will be spread to allow volatilization in the designated area of the landfarm.

Materials identified as acceptable in the landfarm will be placed in windrows with dimensions about 18 m wide at base x 1.5 m high x 34 m long. Windrows may be piled wider, higher, or longer as space permits. A record will be kept by the on-site Environmental Coordinator or designate of the amount of contaminated soil placed in the landfarm and the location of each load within it.

3.2.3 Decontamination of Soil Movement Equipment

The decontamination of soil movement equipment is outlined in the Landfarm Soil Movement Procedure, included as the Appendix A to this Management Plan.

3.3 Contaminated Snow

Petroleum hydrocarbon contaminated snow and ice will be placed in a designated snow-cell area and treated as contact water after snowmelt. After snowmelt, the contaminated water will pumped through the site's oil-water separator to remove PHC residue. The treated water will be discharged to the CP1.

Snow accumulation in the Landfarm will be allowed to melt and accumulate in the Landfarm sump where it will be treated through the oil-water separator as needed upon melt or used in the bioremediation process for the contaminated soil. Any excess snow accumulation in the Landfarm will be moved to the snowcell.

3.4 Remediation

Remediation of fine grained PHC contaminated soil in the landfarms occurs naturally through volatilization and aerobic microbial degradation. Soil aeration, nutrient amendment and water addition, are recognized as methods for improving rates of remediation. Agnico Eagle commissioned the National Research Council Canada to undertake the bioremediation research study to optimize the biodegradation process. Agnico Eagle will look at increasing biodegradation rates through potential opportunities such as nutrient amendment.

3.4.1 Absorbent Materials

Coarse-grained soils are not readily bio-remediated, but concentrations of PHC contaminants may still be reduced through volatilization. Oil absorbent pads will be used to help remove visible product from coarse-grained material.

3.4.2 Aeration

To promote aerobic conditions throughout the windrows, soil will be mixed mechanically with earth-moving equipment. This turnover of soil piles will occur approximately two to four times per year, during the summer months.

3.4.3 Soil Moisture

Prior to turning, site personnel will ensure that soil is not so dry as to generate significant dust, nor overly saturated. If soil is too dry, non-contaminated water from within the landfarm containment area will be used as a moisture source and sprayed on the piles. If no accumulated water is available, water from CP1 or freshwater will be used. If the windrows are saturated, aeration will be delayed until the moisture content is reduced.

3.4.4 Nutrient Amendment

The use of sewage sludge as a nutrient amendment has precedent in the north. Sewage sludge as a nutrient source has also been proposed for the Milne Inlet Mary River Project (EBA 2010). This material not only provides the benefit of nutrients, but also adds organic matter to help retain moisture and microorganisms. Furthermore, the use of sewage sludge produced on-site helps to reduce the waste footprint of the mine by re-directing this material from disposal facilities and avoids needing to import a chemical fertilizer. The use of sewage sludge or another recommended nutrient amendment will be considered for optimization of biodegradation.

3.5 Removal of Soil From the Landfarm

3.5.1 Government of Nunavut Remediation Guidelines

The following parameters will be measured and compared with the GN industrial remediation criteria to determine whether PHC contaminated soil has been adequately remediated:

- benzene, toluene, ethylbenzene and xylene (BTEX); and
- petroleum hydrocarbon fractions 1 - 4.

The GN remediation criteria are characterized for agricultural/wildlife, residential/parkland, commercial, and industrial land uses. At the Project, remediation to agricultural/wildlife criteria is targeted; however, if these criteria cannot be met, industrial criteria will be followed.

The GN remediation criteria for coarse-grained soils will be applied. Table 3-1 presents the applicable Tier 1 criteria for coarse-grained soil, assuming agricultural/wildlife or industrial land uses.

Table 3-1 Summary of Relevant GN Tier 1 Soil Remediation Criteria for Surface Soil (mg/kg)

	Land Use Criteria (mg/kg)	
	Agricultural/Wildlife	**Industrial**
Benzene	0.03	0.03
Toluene	0.37	0.37
Ethylbenzene	0.082	0.082
Xylene	11	11
PHC Fraction 1	30	320
PHC Fraction 2	150	260
PHC Fraction 3	300	1,700
PHC Fraction 4	2,800	3,300

mg/kg = milligram per kilogram

3.5.2 Sampling and Analysis

Landfarm windrows will be sampled annually at the end of the summer season to determine if remediation objectives have been met. Representative composite samples will be taken of each windrow to estimate remaining PHC concentrations. For each 10 m of windrow length, one composite sample will be collected, each consisting of three surface sub-samples and three sub-samples at 1 m depth. Sub-samples will be taken approximately 3.3 m apart, and will be taken from both sides of the windrow. Sampling QA/QC measures will include collection of 1 duplicate per 10 samples.

After two seasons of treatment in the landfarm, degradation rates will be assessed to estimate the total remediation time required for PHC contaminated soil under these conditions. If remediation to GN guidelines is feasible within the life-of-mine timeframe, landfarm operations will continue, with aeration and possible nutrient amendments as described above. If rates of degradation are not sufficient through this method, alternate options will be further investigated as described in Section 4.2.

3.5.3 Soil Removal

Coarse-grained soils will be assessed near the end of the summer season by Environment Department technicians for PHC product and odour. Based on the experience learned at Meadowbank, Agnico

Eagle is confident that confirmatory sampling and laboratory analysis is not required prior to removing coarse-grained soil from the Landfarm. Observations show that volatilization of PHCs from coarse-grained soil occurs more rapidly than biodegradation. It has been noted that this material likely contains lower concentrations of contaminations due to a lower volume-to surface area ratio, and can typically be screened out prior to landfarming. Thus, the use of a photoionization detector (PID) is sufficient to confirm material is in a suitable state to be removed from the landfarm. When PHC odours are no longer detected, the material will be removed to waste rock storage facility or at the TSF to be used as cover material.

When sample analysis of fine-grained material at the end of a season indicates that concentrations of contaminants are below GN guidelines, a soil pile or the appropriate section of a pile will be deemed acceptable for removal from the facility. Interim monitoring may be conducted through measurements of headspace with a portable instrument (e.g., flame ionization detector), but samples will be confirmed by an accredited laboratory prior to soil removal.

When remediated, the soils will be removed from the facility and can be used for construction purpose such as normal overburden (i.e., part of the cover of the TSF) or stacked in the WRSF. Based on a remediation period of three seasons, it would be possible to close the landfarm facility three years after the end of the process plant operation.

3.6 Water Management

Since the landfarm facility is uncovered to facilitate natural weathering, water accumulating inside the bermed area may come into contact with contaminated material.

While the landfarm has an impermeable liner, visual inspections by the Environment Department will be conducted for seepage of contact water coming through the perimeter berm, or the accumulation of water within the containment berm. This will be conducted on a weekly basis starting after freshet and continuing until October when water is likely to be present. In the event of water accumulation or seepage, the ponded water will be pumped through the site's oil-water separator to remove PHC residue and will be analyzed for BTEX, lead, and oil and grease prior to discharge to CP1 or used on the windrows to increase moisture content, as required. Water accumulating in the landfarm will not be discharged directly to the receiving environment.

3.7 Winter landfarm management

Uncontaminated snow will be removed as much as possible during winter to minimize the quantity of spring melt water inside the berm. Care will be taken to ensure contaminated snow/soil is not disturbed by leaving a base layer of snow of no less than 10 cm in place. Following snowmelt, any contaminated product left from winter spill clean-up operations will be padded up. The base soil in these areas will be excavated and added to existing remediation windrows as soon as possible after snowmelt to minimize migration into the facility substrate.

3.8 Landfarm Closure and Reclamation

After removal of all remediated soil and prior to closure and reclamation of the landfarm, the berm and base will be sampled on a 10 m grid, to determine if these soils are free from PHC contamination. Results of this analysis will be compared to GN criteria set out in Table 3-1. No excavation will be necessary if agricultural/wildlife criteria are met. If industrial criteria are used, the landfarm will be covered with 2 m of waste rock or other material used for reclamation. The surrounding berm will be breached to avoid water accumulation on the landfarm.

3.9 Summary of Activities

A summary of landfarm activities including monitoring of the physical condition and potential environmental impacts of the landfarm is provided in Table 3-2. An annual report will be prepared indicating the volume of material added to the facility, amount of material removed, disposal or reuse location, all analysis results, volume and type of nutrient addition, visual inspection results, and volume of contact water pumped. This information will be appended to Agnico Eagle's NWB Annual Report.

Table 3-2 Summary of Landfarm Activities, Analyses, and Records

Activity	Analysis	Frequency of Analysis	Record
Excavation of spill and transport of contaminated material to landfarm.	If unsure of full excavation - F1-F4, BTEX If contaminant source unknown, F1-F4, BTEX, metals, oil and grease, VOCs	As needed	Date, time and location of spill and excavation; estimated volume of spill; estimated quantity of excavated soil; storage/disposal location of excavated soil, if applicable. Any evidence of remaining product
Soil aeration	NA	Two to four times over the summer	Date and time of the aeration; location; soil condition (moisture, odour, granulometrie, etc.)
Soil treatment with sewage sludge as nutrient supplement.	Visual inspection to ensure proper incorporation	At least once during summer on selected windrows	Date and time; type of treatment (aeration or nutrient amendment); location in landfarm; any odour noticed during aeration
Sampling for progress of remediation	Hydrocarbon vapour in headspace (by PID); F1-F4, BTEX (laboratory)	Vapour – as needed; Laboratory - annually	Date and time; location; odour; laboratory report
Soil removal from landfarm	Removal subject to meeting GN criteria	Once GN criteria are met	Date and time; location; quantity of soil removed; final location
Ponded contact water	BTEX, oil and grease, lead – as specified in Water Licence	Prior to any dewatering; if re-used in landfarm, no sampling necessary	Date and time, location, laboratory report, in Annual Report
Seepage	Visual inspection; BTEX, oil and grease, lead – as specified in Water License	Weekly during summer	Location, extent, approximate depth, evidence of sheen
Identification of maintenance requirements	Visual inspection of landfarm	Twice over the summer	Inspected areas; condition of berm and base; previously unidentified safety concerns

SECTION 4 • CONTINGENCY OPTIONS

This section describes the contaminated soil management plan, should a large spill event occur, and if landfarm treatment prove not successful.

4.1 Large Spill Event

A large spill event producing a quantity of soil that cannot be contained in the landfarm is unlikely because the landfarm is designed to hold nearly two times as much contaminated soil as is expected to be produced. Nevertheless, in this event, soils will be placed in a temporary storage area. A temporary stockpile area would be set up on an emergency basis, such as in the Waste Rock Storage Facility (WRSF) or the Tailings Storage Facility (TSF). As space becomes available, the soil would be added to the landfarm. Through spill prevention measures discussed earlier in this Plan, Agnico Eagle is minimizing the probability of this scenario occurring.

4.2 Alternate Treatment Options

Should landfarm treatment not perform as anticipated and it is evident that rates of degradation are not sufficient to meet GN Tier 1 criteria within the life-of-mine and the anticipated closure, the following alternative treatment options will be considered. Implementation will be after development of a more detailed protocol and approval of a revised plan by the NWB.

4.2.1 Soil Amendment

Since pH, salinity, moisture content, and microbial population density all affect rates of biodegradation by microbes, these factors may be monitored and adjusted through soil amendments if they are not found to be optimal (SAIC 2006). In addition, the height of soil windrows could be reduced to maximize air exposure if space in the landfarm allows.

4.2.2 Tier 2 – Modified-Criteria Approach

According to the GN *Environmental Guideline for Contaminated Site Remediation* (GN 2009), in cases where site conditions, land uses, receptors, or exposure pathways are different from those assumed in the development of the Tier 1 criteria, modified criteria may be permitted. This process requires the collection of site-specific information on exposure and risk estimates, and is subject to GN approval. For this Project, landfarmed soils are to be encapsulated in a WRSF rather than used in surface applications, as assumed in Tier 1, reducing the likelihood of exposure to any remaining contamination. Therefore, the Tier 2 approach could be warranted if Tier 1 criteria cannot be met. Any consideration for this approach would be based on soil sampling results and science based information.

4.2.3 Direct Placement in Waste Rock Storage Facility or on Tailings Storage Facility

Another option for management of contaminated soil if bioremediation proves not effective would be the direct placement of this material in a WRSF or on the TSF. Although the use of PHC contaminated soils in these storage areas is not optimal, the quantity generated on-site is small in comparison to the quantity of waste rock and cover on the TSF. While this method would not result in the treatment of soil, it is a viable contingency option because it would allow for the safe disposal of the contaminated material. Encapsulation and freeze-back would occur, eliminating any movement of contaminants. Over time, this material would undergo natural degradation. Consideration of this option would also include a suitable monitoring program for PHCs, which would be incorporated into the Closure and Reclamation Plan.

SECTION 5 • ASSESSMENT AND REPORTING

5.1 Feasibility

After two seasons of treatment in the landfarm, degradation rates of PHC contaminants are assessed to estimate the total remediation time required under these conditions. If remediation to GN guidelines is feasible within the life-of-mine timeframe, landfarm operations will continue, with aeration and possible nutrient amendments as described above. If rates of degradation are not sufficient through this method, alternate options will be further investigated (Section 4).

5.2 Reporting

Reporting of landfarm activities is submitted annually by the Environment Department, indicating the volume of material added to the facility, amount of material removed and disposed or the re-use location, and confirmatory analysis results. This information will be appended to Agnico Eagle's NWB Annual Report.

5.3 Plan Review and Continual Improvement

The Landfarm Management Plan is reviewed annually by the Meliadine Environmental Department, and, if necessary, updated at least every two years of operation.

REFERENCES

Agnico Eagle (Agnico Eagle Mines Limited). 2008. Landfarm Design and Management Plan In Accordance with Water License 2AM-MEA0815, Meadowbank Gold Project, 20 p. + Figures and Appendix. October 2008.

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Golder (Golder Associates Ltd). 2007. Technical Memorandum: Landfarm Option Analysis, Meadowbank Gold Project, Nunavut. Prepared for: Agnico-Eagle Mines Ltd. August 23, 2007.

Government of Nunavut, March 2009. Environmental Guideline for Contaminated Site Remediation http://env.gov.nu.ca/sites/default/files/Guideline%20Contaminated%20Site%20Remediation.pdf

Paudyn, K. et al, 2008. Remediation of hydrocarbon contaminated soils in the Canadian Arctic by landfarming. Cold Regions Science and Technology, v53, p 102-114, n 1 June 2008

SAIC (Science Applications International Corporation), 2006. Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils. Final report presented to: Contaminated Sites Division and Emergencies Engineering Technologies Office (EETO), Environmental Technology Centre, Environment Canada. SAIC Canada Project #: 11953.B.S08. CM #: 001659. March 31, 2006.

TetraTech EBA. 2014. Tailings, Waste And Water Management For Feasibility Level Study Meliadine Project, Nunavut, FILE: E14103188-01, AEM Report Number: 6509-REP-05, 145 p. + Appendix.

APPENDIX A

AGNICO EAGLE
NUNAVUT

	DOCUMENT ID: NU-E&I-PRO – Land farm soil movement
People concerned: Site services HEO, environmental department	Effective Date: 2018-03-13
This procedure corresponds to the required minimum standard. Each and everyone also have to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.	

Rev #	Date	Description	Initiator
0	2018-03-13	Draft	Guillaume Gemme

Objective:

- Safe operation of equipment during land farm soil movement

Definitions (If applicable):
This procedure is in place to ensure proper usage of heavy equipment on the land farm during the soil movement process.

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Tool/Equipment Required	PPE Required
• Heavy equipment (Backhoe/excavator/ Dozer/ Etc.) equipped with flat lip bucket to avoid membrane damage • Measuring device (Ex: Measuring tape) • Shovel and broom	• Standard PPE

Specific Training Requirements
• Appropriate Heavy equipment operator training. (Class 2 Operator or equivalent)

1. Access to the Land farm
   a. Before entering the land farm, the operator need to have the approval of the Site Services field Supervisor and be accompanied by an environmental representative.
2. Soil movement
   a. Following the environmental department direction, proceed with the requested soil movement work. (Drawing of the work to be done including exact location, dimension of the area and maximum deepness to reach need to be done by Environment department before proceeding with the work)
   b. Sampling will be completed by environment department following procedure : MEL-ENV-Permanent Land farm & Soil Sampling

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AGNICO EAGLE NUNAVUT

3. Equipment decontamination
    a. Before exiting the area, make sure to remove all contaminated soil from the heavy equipment.
    b. Using a hand shovel remove all contaminated soil on the equipment. If required use a broom to reach all potential contaminated parts of equipment
    c. Call the field supervisor to assess the equipment cleanness before exiting the land farm.

Related Documentation (If applicable):
• N/A

References (If applicable):
• Meliadine Water license type A (Land farm Management plan)

Appendix (If applicable):
• Pictures • Plans

AGNICO EAGLE

MELIADINE GOLD MINE

Water Quality and Flow Monitoring Plan

JANUARY 2019

VERSION 1

EXECUTIVE SUMMARY

The Water Quality and Flow Monitoring Plan (the Plan) has been prepared in accordance with the requirements of the Nunavut Water Board Type A water license 2AM-MEL1631. The Plan is one component of the *Aquatic Effects Management Program* (AEMP) and is closely associated with the *Water Management Plan* and the *Metal and Diamond Mining Effluent Regulations (MDMER)*.

Section 2 of this Plan includes an overview of the monitoring programs and mine development schedule. Section 3 provides specific details (including sampling locations and parameters to be measured) for the compliance monitoring program, along with general guidance for the event monitoring program. An adaptive management program is described for regulated discharge and non-regulated discharges in Section 3. Requirements of the flow monitoring program are described in Section 4, and an overview of the reporting requirements in Section 5.

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IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEL1631, Part B, Item 10, the proposed implementation schedule for this Plan is outlined below.

This Plan will be implemented immediately (December 2018) subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

Environmental Superintendent
Environmental Coordinators
Environmental Technicians

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	18/12/16	All	All	Comprehensive plan for Meliadine project. First version composed by Meliadine Environment Department.

Prepared by:

Agnico Eagle Mines Limited - Meliadine Division

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SECTION 1. INTRODUCTION

The Water Quality and Flow Monitoring Plan (the Plan) has been prepared in accordance with the requirements of the Nunavut Water Board Type A water license 2AM-MEL1631 (the License). The Plan is one component of the *Aquatic Effects Management Program* (AEMP) and is closely associated with the *Water Management Plan* and the *Metal and Diamond Mining Effluent Regulations (MDMER)*. The implementation and periodic updates to this Plan are the responsibility of the Meliadine Environment Department under the guidance of the Meliadine Environment Superintendent or designate.

The Plan summarizes the monitoring locations, sampling frequency, monitoring parameters, compliance discharge criteria and an adaptive management plan for water quality at the Meliadine Gold Project.

The purpose of this Water Quality and Flow Monitoring Plan is to establish the program that is to be implemented and followed by AEM's Meliadine environmental management team to monitor the performance of the waste and water management systems at the Meliadine Gold Project. The program includes:

- Verifying and validating the predicted water quality values with empirical measurements of the mine site water quality and flows;
- A comparison of measured water quality data to compliance requirements stipulated in the License; and
- A framework for adaptive management that allows the identification and rectification, where necessary, of unexpected trends or non-compliance in water quality and flows.

The Plan provides information on the locations of the monitoring stations at the various stages of mining. These monitoring locations are used to evaluate the performance of the mine waste and water management system.

The objectives of the monitoring program are:

1) To track the chemistry of the contact and non-contact water prior to and during discharge;

2) To assist in identifying if water treatment is required prior to discharge; and

3) To minimize the potential impacts of mining activities on the surrounding environment.

Additional locations outside the footprint of the mine (and outside the scope of this Plan) will be monitored under the *Meliadine Gold Project Aquatic Effects Management Program* (Golder 2016).

SECTION 2. OVERVIEW

2.1 OVERVIEW OF SITE WATER MANAGEMENT PLAN

Details of overall water management are discussed in the Meliadine Water Management Plan which is updated annually. A network of berms, dikes, containment ponds, channels, culverts and sumps are in place and maintained to facilitate water management (Section 3 of the *Water Management Plan*).

As specified in the *Water Management Plan*, surface contact water is intercepted, diverted and contained within various containment ponds prior to evaporation or treatment. Contact water from the Underground Mine is collected in underground sumps and recirculated for use in various underground operations. Underground contact water that is not used for operations is stored underground and any excess water that cannot be stored underground is pumped to the Saline Ponds or to the Saline Water Treatment Plant (SWTP) for treatment (See Section 3.9 of the *Water Management Plan*). Additional Saline Storage ponds will be developed on the Meliadine site (surface) in the future as groundwater inflows in the underground workings of the mine are greater than predicted. Agnico Eagle has received approval from the Nunavut Impact Review Board to discharge saline water via a diffuser to the sea in Rankin Inlet (Melvin Bay).

2.2 MONITORING PROGRAMS

This Plan has been divided into two levels of monitoring to characterize the range of impacts between the sources of contact water in the individual mine facilities and the point of discharge or release to the receiving environment. The two levels of monitoring include:

1) Compliance monitoring; and

2) Event monitoring.

2.2.1 Compliance Monitoring Program (CM)

The CM sites are those stipulated in the License; these sites vary from contact water collection ponds, structures such as ditches, culverts prior to discharge to the receiving environment and local lakes surrounding the mine site. The requirements of the License, including water quality limits, will be applied at the applicable mine discharge points identified in the CM program.

The CM program provides a mechanism to assess water quality at specified sites, and to confirm and document compliance of discharge with regulatory requirements. As part of adaptive water management, these internal monitoring stations provide protection to the receiving water environment, provide data to predict pit re-flooding water quality and ensure exceedances of predicted or regulated levels are appropriately managed or mitigated to reduce impacts.

2.2.2 Event Monitoring Program (EM)

The EM sites result from unexpected events such as spills, accidents, and malfunctions. The response programs for such events are discussed in greater detail in the following four (4) documents:

- Meliadine Spill Contingency Plan (March 2019;
- Meliadine Emergency Response Plan (May 2018);
- Meliadine Freshet Action Plan (March 2019); and
- Meliadine Water Management Plan (March 2019).

Each accidental release will require mobilization of site equipment to stabilize the release, procedures to contain, neutralize, and dispose of the discharge, and recommendations for monitoring the site following the incident.

2.3 OVERVIEW OF MINE DEVELOPMENT SCHEDULE

The Mine Plan and key mine development activities, including mine waste management are currently used concurrently with the *Water Management Plan*.

The Mine Plan proposes one underground mine (Tiriganiaq Underground Mine) and two open pits (Tiriganiaq Open Pit 1 and Tiriganiaq Open Pit 2) for the development of the Tiriganiaq gold deposit.

The Mine is estimated to produce approximately 14.9 million tonnes (Mt) of ore, 31.8 Mt of waste rock, 7.4 Mt of overburden waste, and 14.9 Mt of tailings. The following phased approach is proposed for the development of the Tiriganiaq gold deposit;

- Phase 1: 3.5 years for Mine Construction. Construction began in 2015 and is estimated to be completed in Q2 of 2019 (Q4 Year -5 to Year Q2 -1);
- Phase 2: 8.5 years for Mine Operations, beginning in 2019 (Q2 Year -1 to Year 8);
- Phase 3: 3 years Mine Closure (Year 9 to Year 11); and;
- Phase 4: Post-Closure (Year 11 forward).

Mining facilities on surface will include a plant site and accommodation buildings, three ore stockpiles, a temporary overburden stockpile, a tailings storage facility (TSF), three waste rock storage facilities (WRSFs), a water management system that includes containment ponds, water diversion channels, retention dikes/berms, and a series of water treatment plant

SECTION 3. MONITORING PROGRAM

The monitoring program is presented in three sections; requirements of the compliance monitoring program, an overview of the event monitoring program, and then details of the adaptive management program for monitoring results.

3.1 COMPLIANCE MONITORING PROGRAM

The CM program monitors the chemistry of four local lake surrounding the mine site (E3, G2, H1 and B5) as well as mine contact water collected and diverted at specified locations prior to release into the receiving water environment. The sampling is conducted in order to confirm and document compliance with regulatory requirements. The types of water and the timing of the CM program include:

- Non-contact water from local lakes;
- Mine contact water collected from drainage of different structures; and
- Monitoring points located within the containment ponds prior to release into the receiving water environment

The CM sampling program has multiple monitoring stations across the project site, with sampling at different stages of the mine life. All of the CM stations, a description of their location, parameters to be monitored and sampling frequency are listed in Table 3.1. Specific details for the monitoring parameter groups are provided in Table 3.2. In summary, Agnico Eagle follows 5 groups of parameters, as identified in Meliadine's Type A Water License Schedule I Table 1.

Figures 3.1 shows the approximate location of each of the sampling sites. The actual location of each sampling site is determined by access and safety considerations and are marked by a stake that defines the exact location of the collection point for sampling events with appropriate attached signage in English, Inuktitut and French.

GPS coordinates for all compliance monitoring stations were confirmed, as required in Part I, Item 6 of the NWB Type A water license.

3.1.1 General Sampling and Analysis Program

Samples are collected in clean laboratory-supplied containers and preserved as directed by the analytical laboratory. During all phases, samples are analyzed offsite at an accredited commercial lab (ALS in Burnaby BC, Maxxam Analytics in Ottawa, AquaTox in Puslinch, or H2Lab in Val d'Or). Samples sent to commericial laboratories may change as the site matures and additional requirements occur.

Table 3.3 summarizes the minimum sample volumes, container, preservation, and holding times for each analyte. This information is from the *USEPA Methods for Chemical Analysis of Water and Waste Water* (*EPA-600/4-79-020, 1979*).

Table 3.1: Monitoring Program

Station	Description	Phase	Monitoring Parameters	Frequency
Mine Site				
MEL-D-1	Dewatering: Water transferred from lakes to Meliadine Lake during dewatering of lakes	Construction	As defined in the Water Management Plan referred to in Part D, Item 12	Prior to discharge and Weekly during discharge
			Volume (m3)	Daily during periods of discharge
MEL-SR-1 to TBD	Surface Runoff – runoff downstream of Construction areas at Meliadine Site and Itivia Site, Seeps in contact with the roads, earthworks and any Runoff and/or discharge from borrow pits and quarries	Construction, and Operation	As defined in the Water Management Plan referred to in Part D, Item 18 and Part I, Item 11	Prior to Construction, Weekly during Construction
			Group 1	Monthly during open water or when water is present upon completion
MEL-11	Water Intake from Meliadine Lake	Construction, Operation, and Closure	Full Suite	Monthly during periods of intake
			Volume (m3)	Daily during periods of intake
MEL-12	Water treatment plant (pre-treatment) coming from CP1, off the pipe and not in the pond	Construction (prior to release), Operations, and Closure	Group 1	Monthly during periods of discharge
MEL-03-01 (and AEMP Stations)	Mixing zone in Meliadine Lake, Station 1; and MDMER exposure stations for final discharge point within mixing zone	Construction (prior to release), Operations, and Closure	Full Suite, Group 3 (MDMER)	Monthly during periods of discharge
MEL-14	Water treatment plant from CP-1 (post-treatment), end of pipe (before offsite release) in the plant before release.	Construction (upon effluent release), Operations, and Closure	Full Suite, Group 3	Prior to discharge and Weekly during discharge

			Volume (m3)	Daily during periods of discharge Once prior to discharge and Monthly thereafter
			Acute Lethality	Once prior to discharge and Monthly thereafter
MEl-15	Local lake E-3	Operations, and Closure	Group 2	Bi-annually during open water
MEL-16	Local Lake G2	Construction, Operations, and Closure	Group 2	Bi-annually during open water
MEL-17	Local Pond H1	Construction, Operations, and Closure	Group 2	Bi-annually during open water
MEL-18	Local Lake B5	Construction, Operations, and Closure	Group 2	Bi-annually during open water
MEL-19	CP-2 Collection of natural catchment drainage from the outer berm slopes of the Landfarm and industrial pad	Construction, Operations, and Closure	Group 1	Monthly during open water or when Water is present
MEL-20	CP-3 Collection of drainage from dry stacked tailings	Operations, and Closure	Group 1	Monthly during open water or when Water is present
MEL-21	CP-4 Collection of drainage from WRSF1	Operations, and Closure	Group 1	Monthly during open water or when Water is present
MEL-22	CP-5 Collection of drainage from WRSF1 and WRSF2	Construction, Operations, and Closure	Group 1	Monthly during open water or when Water is present
MEL-23	CP-6 Collection of drainage from WRSF3	Construction, Operations, and Closure	Group 1	Monthly during open water or when Water is present
MEL-24	Seepage from the Landfill between the landfill and Pond H3	Construction, Operations, and Closure	Group 1	Monthly during open water or when Water is present
MEL-25	Secondary containment area at the Itivia Site Fuel Storage and Containment Facility	Construction, Operation, Closure	Group 4, Volume (m3)	Prior to discharge or transfer of Effluent

Table 3.2: Monitoring Parameters

Group	Parameters
1	pH, turbidity, hardness, alkalinity, chloride, fluoride, sulphate, total dissolved solids (TDS), total suspended solids (TSS), total cyanide, ammonia nitrogen, nitrate, nitrite, phosphorus, orthophosphate, Total Metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, and zinc).
2	**Total and Dissolved Metals**: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc. **Nutrients**: ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, orthophosphate, total phosphorus, total organic carbon, dissolved organic carbon, and reactive silica. **Conventional Parameters**: bicarbonate alkalinity, chloride, carbonate alkalinity, turbidity, conductivity, hardness, calcium, potassium, magnesium, sodium, sulphate, pH, total alkalinity, TDS, TSS, total cyanide, free cyanide, and weak acid dissociable (WAD) cyanide..
3	**MDMER parameters**: total cyanide, arsenic, copper, lead, nickel, zinc, radium-226, TSS, pH, total ammonia and temperature. **MDMER additional requirements**: Effluent volumes and flow rate of discharge, Acutely Lethality tests (Rainbow Trout and Daphnia magna) and environmental effects monitoring (EEM).
4	Total arsenic, total copper, total lead, total nickel, TSS, ammonia, benzene, toluene, ethylbenzene, xylene, total petroleum hydrocarbons (TPH), and pH
Full Suite	Group 2, Total Petroleum Hydrocarbons, Turbidity. Non Acutely-lethal (Rainbow Trout and Daphnia magna) for discharge only.
Flow	Flow data-logger
Field measurements	Field pH, specific conductivity, dissolved oxygen, and temperature.

Table 3.3: Summary of Sampling Requirements for each Analyte

Parameters	Matrix Holding Time				Type of Bottle	Preservative	Volume
	Drinking Water	Waste Water	Surface Water	Ground Water (1)			
Microbiology							
Escherichia coli, total coliforms, A.A.H.B	48h	48h	48h	48h	PPS	TS, E	250ml
Enterococcus	48h	48h	48h	48h	PPS	TS, E	250ml
Thermo tolerant coliforms (fecal)	48h	48h	48h	48h	PPS	TS, E	250ml
Inorganic Chemistry							
Absorbance UV, Transmittance UV				24h	P. T. V	N	125ml
Alkalinity, Acidity, Bicarbonates, Carbonates	14d	14d	14d	14d	P, T, V	N	250ml
Ammonia nitrogen (NH_3-NH_4)	28d	28d	28d	28d	P, T, V	AS	125ml
Kjeldahl ammonia (NTK)		28d	28d	28d	P, T, V	AS	125ml
Anions (Cl, F,SO_4)	28d	28d	28d	28d	P, T, V	N	250ml
Color, Free & total Chlorine	48h	48h	48h	48h	P, T, V	N	125ml
Conductivity	28d	28d	28d	28d	P, T, V	N	250ml
Cyanides total/available, Cyanides	14d	14d	14d	14d	P, T, V	NaOH	250ml
BOD_5/Carbonated BOD_5 (2)		48h/4°	48h/4°		P, T, V	N	250ml
COD (chemical oxygen demand)		28d	28d		P, T, V	AS	125ml
Mercury (Hg)	28d	28d	28d	28d	P, T, V	AN	250ml
Total/dissolved metals (filtered on field)	180d	180d	180d	180d	P, T, V	AN	250ml
Dissolved Metals (filtered in the laboratory)	24h	24h	24h	24h	P, T, V	N	250ml
Total suspended solids & Volatile TSS		7d	7d	7d	P. T. V	N	500ml
NH_3 or NH_4		24h	24h	24h	P.T.V	N+AS	2/125ml
Nitrites (NO_2), Nitrates (NO_3), Turbidity	48h	48h	48h	48h	P, T, V	N	250ml
Nitrites-Nitrates (NO_2-NO_3)	28d	28d	28d	28d	P, T, V	AS	250ml
O-Phosphates (O-PO_4)	48h	48h	48h	48h	P, T, V	N	500ml
pH	24h	24h	24h	24h	P, T, V	N	125ml
Total Phosphorus (P-tot)	28d	28d	28d	28d	P, T, V	AS	125ml
Dissolved solids (TDS)		7d	7d	7d	P. T. V	N	250ml
Total solids		7d	7d	7d	P. T. V	N	250ml
Sulphides (H_2S) (3)	28d	28d	28d	28d	P. T. V	AcZn + NaOH	125ml
Thiosulfates	48h	48h	48h	48h	P. T. V	N	125ml
Radioactive & Organic Chemistry							
Fatty resin acids (S-T)	--	28d	28d	--	VA, VT	AS	1L
Congeners PCB (S-T)	28d	28d	28d	28d	VA, VT	N	1L
Chlorobenzene	28d	28d	28d	28d	2 Vial+1 blank	TSS	2/40ml
Total Organic Carbon (TOC)	28d	28d	28d	28d	P, T, V (B)	AC	100ml
Dissolved Organic Carbon (DOC)	48h	48h	48h	48h	P, T, V (B)	N	100ml
Total Inorganic Carbon (CIT)	48h	48h	48h	48h	P, T, V (B)	N	100ml
Phenolic compound (GC-MS)	28d	28d	28d	28d	VA, VT	AS	1L
Glyphosate (S-T)	14d	14d	14d	14d	P.T	N	500ml
PAH	28d	28d	28d	28d	VB	AS	1L
Oil & Greases (total and non-polar)	28d	28d	28d	28d	VA, VT	AS	1L
C10-C50 HP and/or Petroleum Product Identification	28d	28d	28d	28d	VA, VT	AS	1L

Phenol index	28d	28d	28d	28d	VA, VT	AS	500ml
Radium-226	180d	180d	180d	180d	P, T. V	AN	1L
VOC (MAH, CAH, THM, BTEX) (3)	28d	28d	28d	28d	2 Vial+1 blank	TSS	2/40ml

Type of bottle:
P.S.V.T.: plastic bottle, bag or glass bottle with Teflon cap
P, T: Plastic bottle or plastic bottle with Teflon cap
P.T.V.: Plastic bottle or glass bottle with plastic or Teflon cap
PPS: Sterile propyl ethylene bottle
VA: Clear or amber glass with aluminium or Teflon seal
VB: Amber glass (or clear glass covered with aluminium paper) aluminium seal of Teflon
VT: Clear or amber glass bottle with Teflon seal
Preservative:
AC: 0.1ml (100µl) of HCl per 100ml of sample
AcZn: 0.2ml zinc acetate 2N per 100ml of sample and NaOH 10N to pH >9
AN: HNO3 to pH <2
AS: H2SO4 to pH <2
E: 2.5ml EDTA 1.5% (p/v) per 100ml of sample if heavy metals are suspected
ED: 0.1ml diamine ethylene 45 mg/l per 100 ml of sample
EDTA: 1ml EDTA 0.25M per 100ml of sample
N: No preservative
NaOH: NaOH 10N to >12
TS: Sodium thiosulfate final concentration in the sample of 0.1% (p/v)

3.1.2 Compliance Monitoring Stations and Discharge Criteria

Further details of the specific CM stations and discharge criteria stipulated under the License are provided below.

3.1.2.1 *Dewatering Activities*

All Waters from dewatering activities at Monitoring Program Stations MEL-D-1 through MEL-D-TBD shall be directed to Meliadine Lake and shall not exceed the quality limits presented in Table 3.4 as stipulated in Part D, Item 12 of the License.

Table 3.4: TSS and pH Criteria at CM Stations MEL-D-1 through MEL-D-TBD

Parameter	Maximum Average Concentration (mg/L)	Maximum Concentration of Any Grab Sample
TSS	15.0	30
pH	6.0 to 9.5	6.0 to 9.5

All surface runoff and/or discharge from drainage management systems, at the Monitoring Program Stations MEL-SR-1 to MEL-SR-TBD during the Construction/Operation of any facilities and infrastructure associated with this project, including laydown areas and All-weather Access Road, where flow may directly or indirectly enter a Water body, shall not exceed the Effluent quality limits presented in Table 3.5, as stipulated in Part D, Item 18 of the License.

Table 3.5: Effluent Criteria at CM Station MEL-SR-1 to MEL-SR-TBD

Parameter	Maximum Average Concentration	Maximum Concentration of Any Grab Sample
Total Suspended Solids (TSS) (mg/L)	50.0	100.0
Oil and Grease	No Visible Sheen	No Visible Sheen
pH	6.0 to 9.5	6.0 to 9.5

3.1.2.2 *Water Collection System*

A water collection system comprised of berms, dikes, containment ponds, channels, culverts and sumps was developed to control water at the Meliadine project (Section 3 of the *Water Management Plan*). Diversion berms, diversion channels and culverts will direct surface water towards containment ponds and associated dikes. Pending salinity levels, water in containment pond CP5 will be treated by a Reverse Osmosis (RO) treatment plant prior to be discharged in CP1.

Contact water from the Underground Mine is collected in underground sumps and recirculated for use in various underground operations. Underground contact water that is not used for operations is stored underground and any excess water that cannot be stored underground is pumped to the Saline Ponds. Saline water collected in the Saline Ponds is temporarily stored and then actively evaporated or pumped to the SWTP for treatment prior to being pumped to CP1.

At CP1, the water is treated for total suspended solids (TSS) at the Effluent Water Treatment Plant (EWTP) and either transferred to the process plant for use as make-up water or discharged through the diffuser located in Meliadine Lake

Effluent discharged from CP1 at CM station MEL-14 shall be directed to Meliadine Lake through the Meliadine Lake Outfall Diffuser and shall not exceed the effluent quality limits presented in Table 3.7, as stipulated in Part F, Item 3 of the License.

Table 3.6: Effluent Criteria at CM Station MEL-14

Parameter	Maximum Average Concentration	Maximum Concentration of Any Grab Sample
pH	6.0 to 9.5	6.0 to 9.5
TSS (mg/L)	15	30
TDS (mg/L)	1400	1400
Total (T)-Al (mg/L)	2.0	3.0
T-As (mg/L)	0.3	0.6
T-CN (mg/L)	0.5	1
T-Cu (mg/L)	0.2	0.4
NH_4-N (mg/L)	14	18
T-Ni (mg/L)	0.5	1
T-Pb (mg/L)	0.2	0.4
T-P (mg/L)	2.0	4.0

T-Zn (mg/L)	0.4	0.8
Total Petroleum Hydrocarbons (TPH) (mg/L)	5	5

The Discharge of Effluent from the Final Discharge Point at Monitoring Program Station MEL-14 shall be demonstrated to be non-Acutely Lethal under the following test in accordance with the Schedule I of the License:

a. Acute Lethality of Effluents to Rainbow Trout (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13 July 1990, published by the Department of the Environment, as amended in December 2000, and as may be further amended from time to time.

Itivia Marshalling Area

Surface water runoff from the bulk fuel tank storage areas is collected within the tank's secondary containment enclosures that are equipped with an HDPE liner; these are designed to contain petroleum products released due to spill events. Water collected in the secondary containment enclosures at CM station MEL-25 is discharged to land in a controlled manner according to the Nunavut Water Board Type A water license # 2AM-MEL16331.

All effluent being discharged from the secondary containment enclosures at the itivia marshalling facility shall not exceed the effluent quality limits presented in Table 3.9, as stipulated in Part F, Item 5 of the water license.

Table 3.7: Effluent Criteria at CM Station MEL-25

Parameter	Maximum Average Concentration	Maximum Concentration of Any Grab Sample
pH	6.0 to 9.5	6.0 to 9.5
TSS (mg/L)	15.0	30.0
Benzene (ug/L)	370	370
Toluene (ug/l)	2	2
Ethylbenzene (ug/L)	90	90
Lead (mg/L)	0.1	0.1
Oil and Grease (mg/L)	5.0 and no visible sheen	5.0 and no visible sheen

3.1.2.3 *Receiving Environment*

Receiving water quality monitoring is discussed in the Aquatic Effects Management Program (AEMP) (March 2019). Within the AEMP are numerous monitoring programs: water quality, sediment quality, benthic invertebrate communities, and fish health and fish tissue chemistry. The Meliadine Lake monitoring program was designed around the key aspects of Environmental Effects Monitoring (EEM) requirements under the Metal and Diamond Mining Effluent Regulations. Water quality data are analyzed to determine if there are differences between the Near-field exposure area, the Mid-field exposure area, and the pooled reference areas of Meliadine Lake.

3.2 EVENT MONITORING

The Event Monitoring (EM) program addresses the site specific monitoring that is required following any accidental release. A "release" may be caused by:

- Spills, including unidentified seepage (Meliadine Spill Contingency Plan; March 2018); or
- Emergencies (Meliadine Emergency Response Plan; May 2017).

The EM program is designed to verify whether contamination of the surface soil and/or any nearby receiving environment and active zone has occurred as a result of an accidental release of a hazardous material or contaminated water. Verification is done through monitoring of surface runoff and nearby receiving environment during and following remedial activity. It is anticipated that due to the presence of permafrost beneath most of the mine footprint (active layer app 1.5m in depth), there will be minimal impact to groundwater from surface spills or accidental releases.

The EM plan is developed on a site specific basis subsequent to a spill or other incident, and considers the type of product spilled, the potential receptors and the potential for any remaining contamination after clean up. The plan is coordinated by the Environmental Department.

In the event of an accidental release, the water quality of any downstream receptor as well as an upstream reference (background) is sampled to determine severity of impact. Should the spill have happened over snow cover, as much contaminated snow will be removed as possible. Verification sampling would occur in the area after thaw to determine if the clean – up is complete or if further remediation is necessary. The specific parameters monitored as part of the EM program will depend on the nature of the spill, and will be determined for the specific material released.

The EM program for a particular spill will cease upon obtaining satisfactory analytical results from the potentially affected areas or as required by regulators.

3.3 ADAPTIVE MANAGEMENT PROGRAM

Results of the water quality monitoring are reviewed by the Meliadine Environment Department. Chemical trends of constituents of interest are tracked for mine site monitoring and for the AEMP program. This allows for early detection of significant changes in water quality within the mine site prior to discharge. If triggers and thresholds, such as in the AEMP program, are exceeded in the receiving environment action plans are then implemented to ensure that environmental protection objectives are met.

An adaptive management program has been designed for the Meliadine Gold Project to evaluate the monitoring data and provide a framework for action, if necessary. The program has two levels - a trigger level to compare the monitoring data against, and an action plan of mitigative measures for identified exceedances.

The adaptive management program is divided into two sections, one for parameters with regulated discharge criteria at specific monitoring locations, as specified in the License and by the Metal Diamond Mining Effluent Regulations (MDMER). The second section is for measured parameters for which no discharge limits have been identified in the License such as those in the AEMP or EEM.

<u>Saline Water Treatment Plant Influent and Effluent</u>

Water samples are collected weekly at both the inlet and outlet of the SWTP. Samples taken at the inlet of the SWTP represent the water quality of either Sump 75 or the Saline Pond, which will vary depending on the treatment priority for saline water storage. The results of the sample analysis are used by SWTP operators to fine-tune the treatment process and ensure its optimal performance. Samples taken at the outlet of the SWTP are analyzed to provide the quality of treated water produced by the SWTP that is transferred to CP1.

Water samples are analyzed for the following parameters: pH, conductivity, temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), chloride, ammonia, nitrite, nitrate, total phosphorus, total metals, total cyanide, and total mercury.

3.3.1 Adaptive Management Program for Regulated Discharge

3.3.1.1 *Action Plan*

In the case of an exceedance of a License limit or MDMER discharge limit, an action plan will be implemented. The adaptive management program requires that if one or more of the key monitored parameters exceed the respective limits, a staged sequence of responses will follow. Table 3.12 summarizes the staged adaptive action plan for the CM program for regulated discharge. Figure 3.1 is a logic diagram showing the decision path for evaluating analytical results for regulated discharges.

In addition to the mitigative measures listed above, a number of other possible alternatives are available to reduce or treat contaminants. These mitigation measures include:

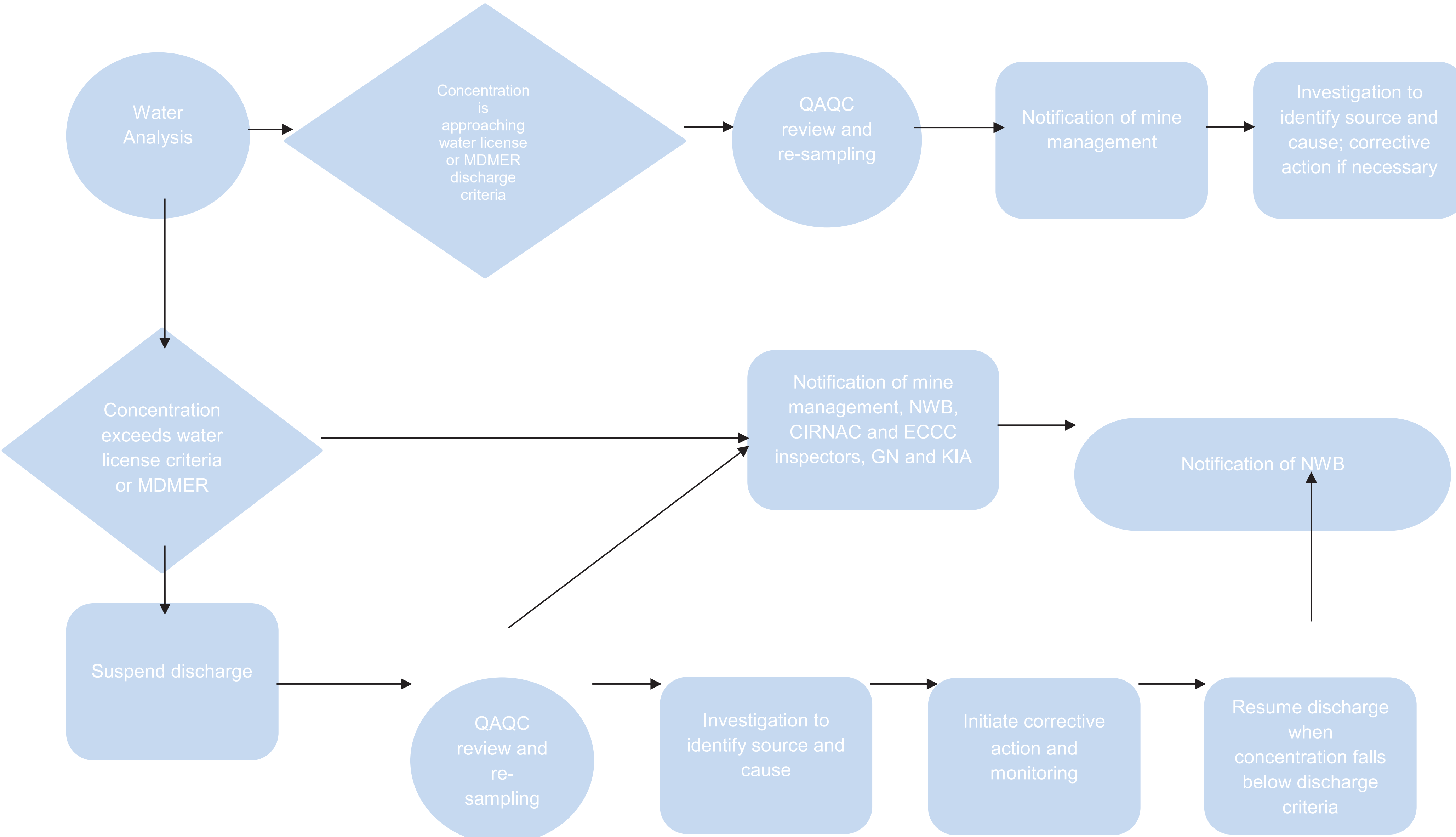
- Best management practices for sediment and erosion control would be employed to reduce TSS concentrations (i.e., flow control, sedimentation basin construction silt fencing, etc; see Sediment and Erosion Management Plan);
- Addition of a coagulant for the reduction of TSS in pond water;
- Use of geotextile or reamouring of banks to filter and reduce TSS in pond/ditch water;
- Deployment of absorbent booms and/or barriers within ponds to isolate surface petroleum hydrocarbon films for removal and/or treatment;
- Adjustments to on-site sewage treatment for the reduction of BOD and E. coli concentrations; Addition of lime to increase a low pH value or reduce metal concentrations;
- Removal of the offending source rock or the prevention of surface waters coming into contact with the offending source rock in the case of ARD; and/or
- Implementation of the *Freshet Action Plan* to proactively identify any issues around areas of concern; conduct additional monitoring, and control and contain seepage or movement of TSS on site.

Table 3.6: Action Plan for Regulated Discharge

Example	Action Plan

Exceeds water license discharge criteria or MDMER	1. Suspension of discharge activities; 2. QA/QC review and analysis, and re-sample water at the particular location if necessary; 3. Notification of mine management (General Mine Manager or designate and Environment Superintendent, or designate) and the regulators: Nunavut Water Board, CIRNAC and ECCC inspectors, GN and the Kivalliq Inuit Association; 4. Investigation to identify possible source(s) and cause(s) of the exceedance; 5. Initiation of corrective actions or water treatment, and follow up monitoring; and 6. Resumption of discharge when concentrations are below the discharge criteria

Figure 3.2: Logic Diagram for Regulated Discharge



3.3.2 Adaptive Management Program for Non-Regulated Discharge

Aside from targeted monitoring studies (i.e. "Effects Assessment Studies") such as those following construction, the AEMP is the main program aimed at measuring and assessing potential impacts of contaminants in the receiving aquatic environment that are not regulated under MDMER or NWB. This program combines with the Environmental Effects Monitoring (EEM) required under MDMER.

The program is designed to take an integrated, ecosystem-based approach that links mitigation and monitoring of physical/chemical effects to key ecological receptors in the receiving environment. It addresses key issues identified in the Meliadine EA (i.e., mining-related activities with the potential to affect water quality, fish habitat and fish populations). Monitoring results are intended to inform the "adaptive management" process", supporting the early identification of potential problems and development of mitigation options to address them by comparing results to established threshold and trigger levels.

3.3.2.1 *AEMP Action Level and Significance Threshold*

The AEMP Response Framework links monitoring results to management actions, with the purpose of maintaining the assessment endpoints within acceptable ranges. It is a systematic approach for evaluating AEMP results and responding appropriately, such that potential unexpected effects are identified and mitigation is undertaken to reduce or reverse them, thereby preventing the occurrence of a significant adverse effect. This is accomplished by continually evaluating monitoring data and implementing follow-up actions (e.g., confirmation, further study, mitigation) at pre-defined levels of change in measurement endpoints (i.e., Action Levels). For purposes of this Response Framework, the following terms are used: effect, normal range, benchmark, Action Level, and Significance Threshold.

Action Level – Action Levels (Low, Moderate, and High) are pre-defined levels of environmental change that exceeds normal ranges or benchmarks, or results of statistical tests, or a combination of these. For example, exceedance of the normal range and approach of a benchmark by a water quality parameter in the near-field exposure area may be defined as the Low Action Level. A change that falls within the normal range of variability for the study area would not trigger an Action Level.

Significance Threshold – The Significance Threshold, for the purposes of an AEMP Response Framework, is a magnitude of change that would result in significant adverse effects. It is a clear statement of environmental change that must never be reached. The AEMP Response Framework is designed to prevent reaching the significance threshold for all assessment endpoints.

3.3.2.2 *Action Levels*

The proposed Action Levels are designed to provide an early warning indication of potential adverse effects to plankton and benthos (i.e., food for fish), to fish health, and to the assurance of normal ecological function (including water quality and sediment quality). The proposed Low Action Levels (Table 8-2 and 8-3) are designed such that changes of sufficient magnitude to trigger a Low Action Level response are reported, documented, investigated, and ultimately addressed (i.e., mitigation measures or operation changes are implemented) before Significance Thresholds would ever be reached; if a Low Action Level is reached, Medium and High Action Levels (with response actions) are developed to provide further adaptive management guidance to the Mine to avoid reaching the Significance Thresholds. The type of management response taken after reaching an Action Level will depend on the type and magnitude of effect observed.

Further details on the integrated aquatic effects action plan are provided in Golder, 2018.

SECTION 4. FLOW VOLUMES

Flow volumes within the mine footprint will be measured daily during periods of discharge. Flow volume measurements will be conducted using volumetric flow meters attached to applicable pumps. For permanent pumping arrangements such as fresh water pumping systems flows will be measured using permanent in line flow meters. For periodic batch discharges, such as secondary containment sumps, portable flow meters or calculated pump time and capacity methods will be used.

Detailed pump records are maintained including date, pond/sump number, receiving location of pumped water, pump ID, duration of pumping, and total volume pumped. The average flow rates, total discharge per event and total cumulative discharge will be reported annually.

The monitoring locations for water flow volumes, in accordance with Part I, Item 9, and Table 2 of the Water License, include:

- The volume of fresh Water obtained from Meliadine Lake at Monitoring Program Station MEL-11;
- The volume of fresh Water transferred to the Meliadine Lake during lakes' dewatering activities;
- The volume of fresh Water obtained along the road and Meliadine River for dust suppression activities;
- The volume of Effluent discharged from Final Discharge Point at Monitoring Program Station MEL-14;
- The volume of reclaim Water obtained from CP1;
- The volume of Effluent discharged onto tundra at Monitoring Program Station MEL-25 or transferred to CP1 from the Itivia Site Fuel Storage and Containment Facility; and
- The volume of Effluent and Fresh Water transferred to the pits during pits' flooding.

SECTION 5. REPORTING

Reporting of water quality results is to be conducted on two levels a) monthly and annually with the results of the monitoring program and per MDMER requirements and b) in response to exceedances.

5.1 ANNUAL REPORTING

An annual report is to be submitted to the NWB, KIA, Department of Fisheries and Oceans, Crown-Indigenous Relations and Northern Affairs Canada, Nunavut Impact Review Board, Government of Nunavut, and other interested parties by March 31st of the following year. The report is to summarize the following:

- Monitoring results for each sampling station during the year and for the life of mine (construction to end of closure); activities during the year at each station; and any exceedances at stations, the action plan applied to the exceedance, and the results of the action plan;
- Annual seep water chemistry results; including location of the samples, sources of the water collected, and results of chemical analyses of the samples;
- Receiving water monitoring results;

- Spills and any accidental releases; event monitoring activities conducted following containment, remediation, and reclamation; and the results of EM program, any exceedance in EM results, and the action plan following the exceedance;
- Measured flow volumes;
- Effluent flow rates, volumes and calculated chemical loadings following the requirements of MDMER; and
- Results of QA/QC analytical data.

5.2 EXCEEDANCE REPORTING

Any measured concentration at a CM station exceeding a regulated discharge criterion stipulated in the License or MDMER will be reported to the NWB and Environment Canada and Climate Change upon receipt of the analysis. In addition, results of the action plan will be reported and, where necessary, mitigation options identified within 90 days after receipt of the analyses.

Exceedances in the concentration of a parameter in receiving water will be reported as specified in the AEMP and EEM – MDMER accordingly.

SECTION 6. REFERENCES

Golder Associates Ltd. 2016. Aquatic Effects Monitoring Program (AEMP) Design Plan. Version 1. June 2016. 6513-REP-03.