SURVEILLANCE PLAN

Revision: 2

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ABBREVIATIONS

ABBREVIATION	DESCRIPTION
BC	British Columbia
BCMoE	British Columbia Ministry of Environment
BAOAC	Bonn Agreement Oil Appearance Code
CCG	Canadian Coast Guard
CSA, 2001	Canada Shipping Act, 2001
CWS	Canadian Wildlife Service
DFO	Department of Fisheries and Oceans
ECCC	Environment and Climate Change Canada
EOC	Emergency Operations Centre
FOG	Field Operations Guide
IAP	Incident Action Plan
IC	Incident Commander
ICP	Incident Command Post
ICS	Incident Command System
IMH	Incident Management Handbook
IMP	Incident Management Plan
IMT	Incident Management Team
IPIECA	International Petroleum Industry Environmental Conservation Association
OSRP	Oil Spill Response Plan
SRM	Spill Response Manager
UAV	Unmanned Aerial Vehicle
WCMRC	Western Canada Marine Response Corporation

STRATEGIC DOCUMENT CONNECTIVITY

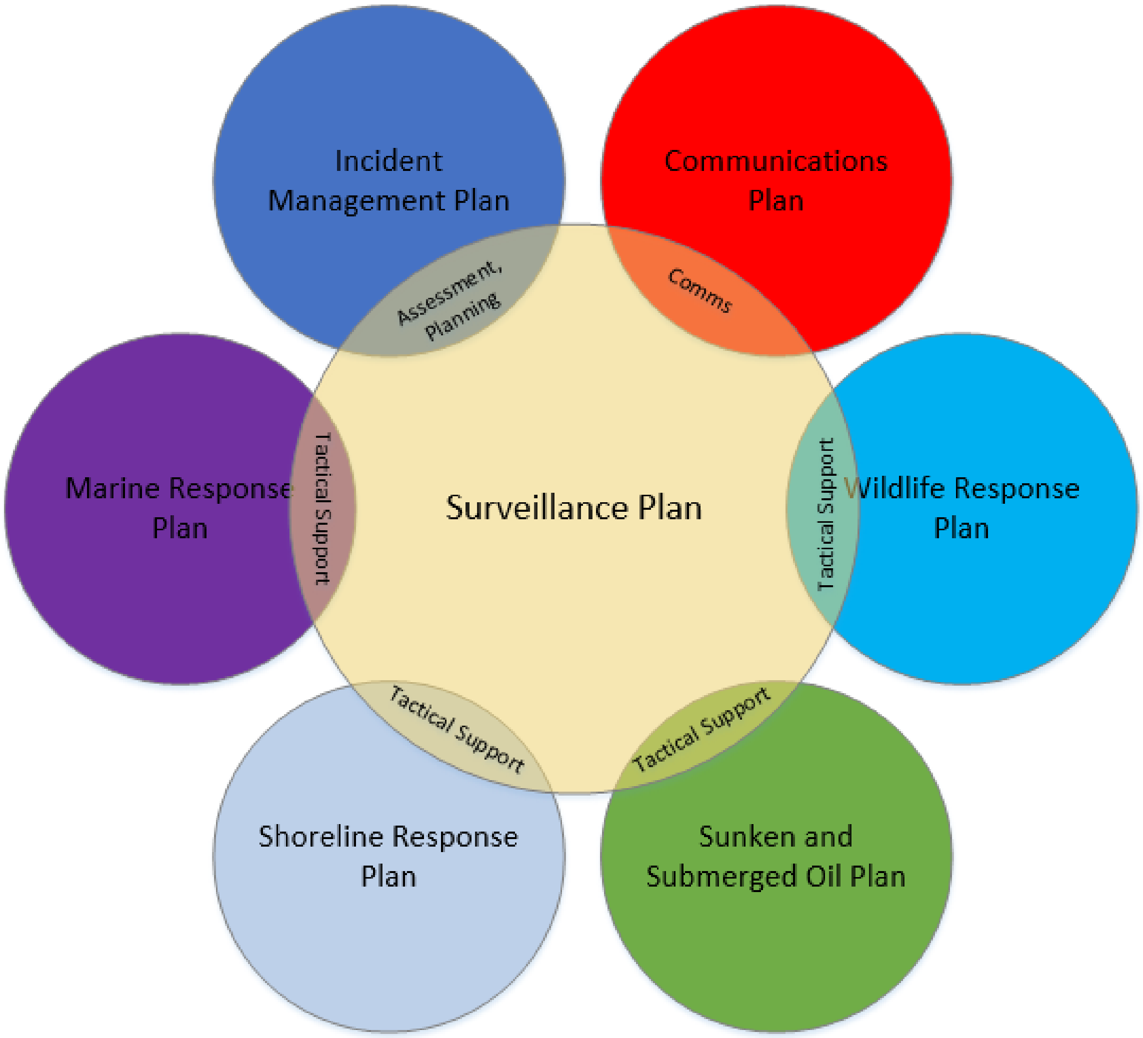

Figure 1 - Representations of the connections between strategic plans and their association to the central plan

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1.0 INTRODUCTION

This plan is one of multiple Strategic Response Plans (SRPs) which Western Canada Marine Response Corporation (WCMRC) has developed to support its operations, namely:

- Marine Response Plan
- Shoreline Response Plan
- Waste Management Plan
- Wildlife Response Plan
- Sunken & Submerged Oil Plan
- Communications Plan
- Surveillance Plan
- Alternative Countermeasures Plan
- Convergent Volunteer Plan
- Decontamination Plan
- Coastal Response Program
- Vessel of Opportunity Program
- Staging Area Program

These plans cover all major areas of response operations and aim to support WCMRC in identifying:

- The appropriate incident management structure and response organization for the applicable response strategy
- The likely resource requirements
- The likely logistical and support requirements.

As illustrated by Figure 2, all SRPs listed above are underpinned by the principles and response methodology outlined in the WCMRC Incident Management Plan (IMP) and wider response fundamentals outlined in the WCMRC Oil Spill Response Plan (OSRP).

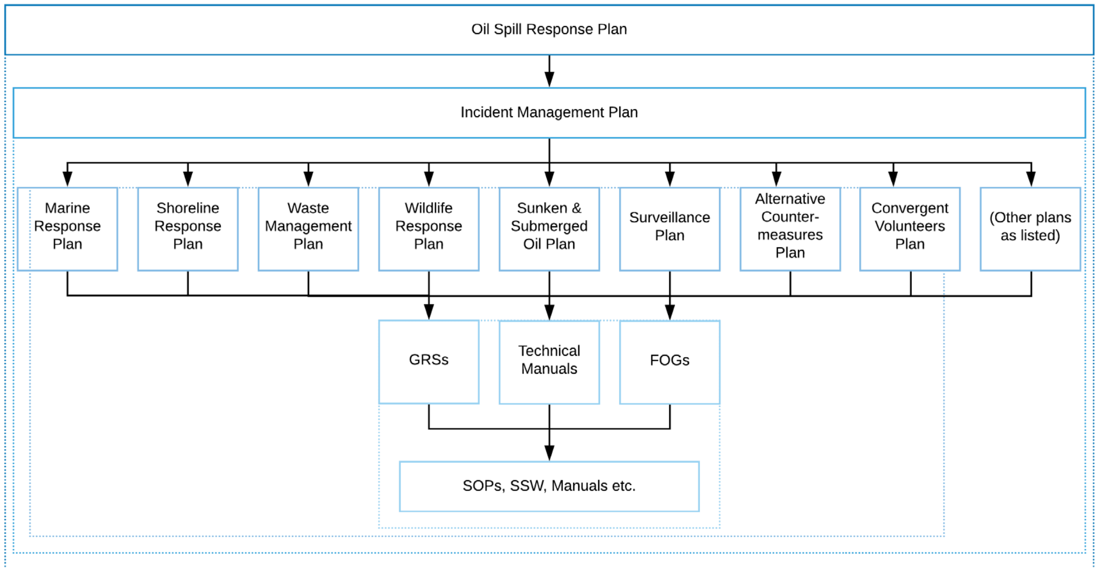


Figure 2 - WCMRC response documentation framework and hierarchical plan linkage

There are also several technical manuals in place which assist with implementing the strategies outlined in each SRP. The following technical manuals are relevant to this SRP and are used by WCMRC to enact the measures outlined in this plan.

- WCMRC Aerial Surveillance SOP
- WCMRC Trajectory Modelling SOP
- MDA Emergency Oil Tracker Activation for WCMRC
- Inland Response
- Dispersants and In-Situ Burning (strategy not currently undertaken by WCMRC).

Additional technical manuals which may be referred to in support of operations are:

- ITOPF Technical Information Paper 01: Aerial Observation of Marine Oil Spills
- IPIECA Satellite Remote Sensing of Oil Spills at Sea
- IPIECA Aerial Observation of Oil Spills at Sea
- IPIECA In-Water Surveillance of Oil Spills at Sea
- Current Status of the Bonn Agreement Oil Appearance Code
- Shoreline Cleanup Assessment Technique (SCAT) Manual
- Underwater Seabed Cleanup Assessment Technique (uSCAT) Technical Reference Manual
- Underwater Seabed Cleanup Assessment Technique (uSCAT) Guide

1.1 Purpose

This Surveillance Plan demonstrates the various aerial, on-shore, on-water and subsurface capabilities available to WCMRC support effective response operations for a spill up to the 20,000 tonne (Tier 5) level. This requirement as determined by the Canadian Energy Regulator (CER), is in addition to Transport Canada's (TC) Response Organization (RO) Standards TP 12401.

The purpose of this document is to demonstrate WCMRC's level of capability by:

- Outlining the high-level goals of surveillance as part of an oil spill response
- Describing the various surveillance methods and strategies available to WCMRC during a spill incident
- Describing how WCMRC will implement those response strategies in support of response operations
- Describing the framework WCMRC will establish to manage surveillance operations and ensure that up to date information is efficiently communicated and available to decision makers within the Incident Management Team to support planning and response.

1.2 Use

This plan should be used by WCMRC personnel to, as effectively and efficiently as possible, establish and enact surveillance strategies appropriate to the requirements of the incident and the response. It provides a clear guidance on choosing response organization structure to fit the strategies to be established. This plan is an operational document and as such acts as a guide to establishing surveillance activities in the 24-48 hours which follow initial notification of an incident, particularly when escalating to a Level 2/3 response (see Section 3). This plan does cover specific tasks and arrangements required during the surveillance operations nor does it cover operations as they move into the 'project phase' as sites become established for long term recovery.

The document is intended for use at the Incident Management Team level in order to inform and aid decision making and assist selection of appropriate methods for the situation at hand; it is not intended to be a prescriptive or incident specific plan.

This SRP is applicable to all WCMRC response personnel at strategic level and above and is shared internally as 'required reading'. This ensures all response personnel are aware of the procedures and guidance which have been put in place to ensure any response is conducted in accordance with that described in the OSRP.

1.3 Background

In the oil spill response industry, the concept of surveillance is commonly associated with helicopters and planes, acting as 'eyes in the sky' - communicating with responders at ground level in order to help them assess spills and track down the leading edge of the slick. While aerial surveillance remains a crucial element of oil spill response, surveillance as a whole encompasses numerous methods of getting information on: what **has** happened, what **is** happening, and what **may** happen. We want this information to be as up-to-date and accurate as possible – the better the information, the better we can plan, deploy and direct resources.

To support the achievement of this, surveillance can be seen to have a number of distinct goals.

1.3..1 Incident Assessment and Volume Estimation

When an incident occurs, an accurate assessment of the scale, complexity and incident potential is critical for responders to organize and plan a safe and effective early response and determine possible impacts and issues to be accounted for. WCMRC uses a methodology outlined in the Incident Management Plan (IMP) in order to continually assess available information about the incident and situation, in order to ensure an appropriate level of response and management is in place.

Effective surveillance can provide critical inputs of information to this assessment, especially in the early stages – locating and confirming the incident area, giving a general sense of scale, identifying likely area of impact, and providing estimates of oil volume on the water, both during the initial stages of an incident, and on an ongoing basis – volume estimation can be conducted according to the methodology outlined by the Bonn Agreement Oil Appearance Code (BAOAC). As the response progresses, it is critical for the Incident Management Team to continually monitor developments and progress, and constantly reassess the situation to ensure that appropriate and effective actions are being taken, and that large scale priorities can be determined. In this sense, while information provided by surveillance may be used by decision makers to escalate response to an incident, it can also be used to de-escalate the response when appropriate to do so.

Effective surveillance will help decision makers in the field and in the Incident Command Post gain an overall understanding of the incident and allow them to collaboratively plan and adjust the response accordingly.

1.3..2 Situational Awareness and Change Detection

In order to develop and implement effective response plans, an up-to-date picture and awareness of the situation is required in order to ensure resources are being directed to areas of highest priority and highest efficiency, and that measures in place remain effective. A key component of the ICS Planning P as described in WCMRC's Incident Management Plan (IMP) is understanding the situation – situational awareness provides information which helps ensure plans being developed meet the needs of the response.

In a spill response there will often be instances where a critical decision needs to be made within a strict time frame, or where a developing situation can be mitigated or accounted for if it is recognized or detected early enough – examples could include an increase in the rate of release, of oil, a change in direction of the oil trajectory, or the failure of a boom which is containing the oil ; in these instances, the awareness and knowledge of the decision makers is important in order to ensure effective response actions can be maintained or adjusted as needed.

Surveillance can assist in building and maintaining situational awareness by providing up to date and accurate information on the location and status of the spilled oil, current and projected weather and conditions, impacted or potential to be impacted sensitivities or areas of concern, and location and status of response resources and assets.

1.3..3 Tactical Support of Operations

At the ground level, responders can maximize the effectiveness and efficiency of their containment, recovery, protection and cleanup operations through close collaboration and support from surveillance assets. Classic examples of this would be aerial surveillance assets helping guide recovery task forces to the thickest parts of the oil, or helping rapidly survey and prioritize impacted shorelines for more detailed and time consuming foot surveys. Providing the On-Water Supervisor with enhanced situational awareness allows for effective direction of available resources to achieve operational goals. In this sense, surveillance is a key strategy within WCMRC's Marine Response Plan (MRP), as well as a supporting strategy of the Shoreline Response Plan (SRP), Sunken and Submerged Oil Plan (SSOP) and Wildlife Response Plan (WRP).

2.0 ESTABLISHING THE RESPONSE

2.1 Supporting the Planning Process

As described in full in WCMRC's Incident Management Plan (IMP), the Incident Management Team, under Unified Command, will use the ICS Planning Process to develop strategies, tactics and plans in order to meet incident objectives. From the initial stages of response, surveillance helps support the planning process, by contributing information which allows responders to continually assess the incident and understand the situation, allowing for the development of more effective response plans, and support more effective response operations. Figure 3 below illustrates where the Surveillance Plan ties in to the ICS 'Planning P'.

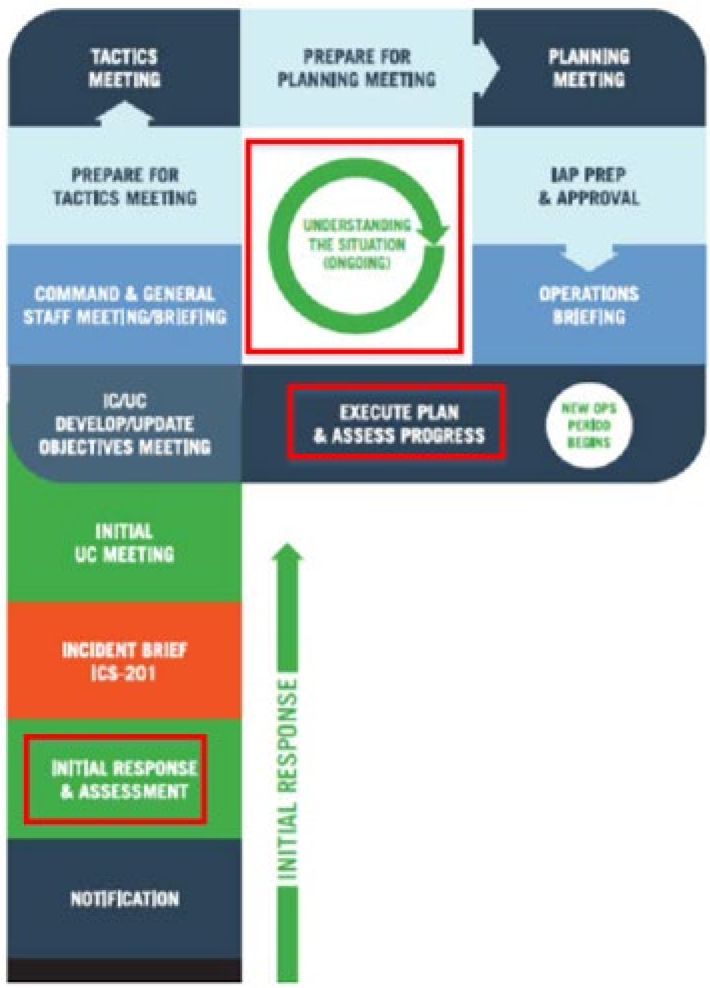


Figure 3 - The ICS 'Planning P', demonstrating where surveillance contributes information to decision makers

For these reasons, establishing robust surveillance measures should be a priority of Unified Command from the initial stages of response. Information gained through surveillance measures should be widely shared throughout the Incident Management Team to build situational awareness, and inform plans being developed and operations being conducted. As the response progresses, it will be ideal to coordinate, where possible, surveillance reports to reach planners prior to key meetings, such as the Tactics and Planning meetings, to ensure that up-to-date information can be acted upon and efficiently incorporated into plans.

Within the Incident Command System (ICS) and the Incident Management Team (IMT), Surveillance falls under the purview of the Planning Section, and more specifically the Situation Unit. An effective Surveillance structure can be complex to establish, given that the majority of the operational resources collecting the information will be under the authority and direction of other ICS sections or units, yet an interface is required where information is efficiently passed to the Situation Unit, and coordination guidance can be fed from the Situation Unit out to the other sections in order to help align planning.

It is recommended to activate and staff the position of Surveillance Manager, reporting to the Situation Unit Leader, in order to have awareness over all surveillance activities and be responsible for developing and implementing an incident specific Surveillance Plan to ensure that all the activities can be most effectively coordinated and aligned to achieve the desired goals. While the Surveillance Manager will not direct the tactical application of surveillance resources, the position can work with and assist the various Sections, Branches and Units responsible in order to achieve the best possible surveillance outcomes for the response. The Surveillance Manager will work closely with the rest of the Situation Unit to ensure that any situational updates are plotted on the Common Operating Picture, situation board or status display, and briefed or reported on at scheduled meetings as appropriate for Incident Management Team use and to share information as effectively as possible within the Incident Command Post.

This arrangement will be discussed in further detail within Section 3.0 of this document.

2.2 Layered Surveillance Concept

Achieving all the goals of surveillance and establishing an effective incident specific surveillance structure will require the implementation of a varied and robust array of surveillance methods; this is due to the fact that different surveillance methods will provide information of different scale and level of detail, at different frequencies and will be oriented towards specific goals or purposes. As such, there is no single surveillance method which can support all the desired outcomes; rather, a combination of several different methods is required to enable an accurate, up-to-date understanding of the incident situation and allow for effective planning and operations.

It can be useful to conceptualize surveillance as a series of 'layers' or levels, with methods selected to provide varying scales or levels of information. While each layer and the resources and methods employed may be utilized to support a specific goal, the layers are interrelated in that they can assist and support a 'lower' layer by helping prioritize areas for operations or where greater detail is desired. In general, a 'higher' layer can be imagined to provide information covering a much greater area, but with less detail, while 'lower' layers progressively focus on more specific areas and provide more accurate and detailed information.

It is important to note that the boundaries of layers tend to blur and are relative to the nature, scale and severity of the incident; where resources fit into the concept can be very response or task specific, as well as dependent on the resources available at any given time. Individual surveillance measures or strategies are flexible to fit into different layers depending on the overall scale, complexity or needs of the specific incident response.

One system of layers or levels which could be used derives from military theory, and results in division into three layers: Strategic, Operational and Tactical. An overview of each layer and its focus from an oil spill response perspective is presented below in Table 1, and surveillance methods have recommended layers discussed within Section 4.

DETAIL / MORE OFTEN

SCALE / LESS OFTEN

STRATEGIC SURVEILLANCE
Overall incident assessment, analysis and monitoring
Development of high-level objectives and plans
Prioritization of major operational resources
OPERATIONAL SURVEILLANCE
Link between strategic objectives and tactical employment of resources
Achieve strategic objectives through overall support of tactical assignments
Local area situational awareness, assessment and monitoring
Aid prioritization of tactical resources to discrete areas
TACTICAL SURVEILLANCE
Execution of field level assignments and tasks
Detailed site assessment and monitoring

Table 1 - Layered Surveillance Concept

An example of how the Layers can be interrelated and supporting can be explained through the example of a 'tip and cue' chain originating at the Strategic layer;

- Strategic Layer: Satellite Surveillance detects a number of possible oil slicks in the area of an ongoing response
- Operational Layer: This information is used by the Air Operations Branch to task a fixed wing aircraft to conduct an overflight of the area to verify the detection and provide additional details
- Tactical Layer: The fixed wing asset conducts their overflight assignment and relays their report in real time to the Incident Command Post and on-water response assets; based on the confirmed sighting and location of the thickest patch of oil, an on-water recovery task force is directed to the scene, where it deploys a UAV to assist in pinpointing the location of the target slick, guide the asset to the slick and give the vessel master an overhead view of the skimming operation to ensure effective recovery

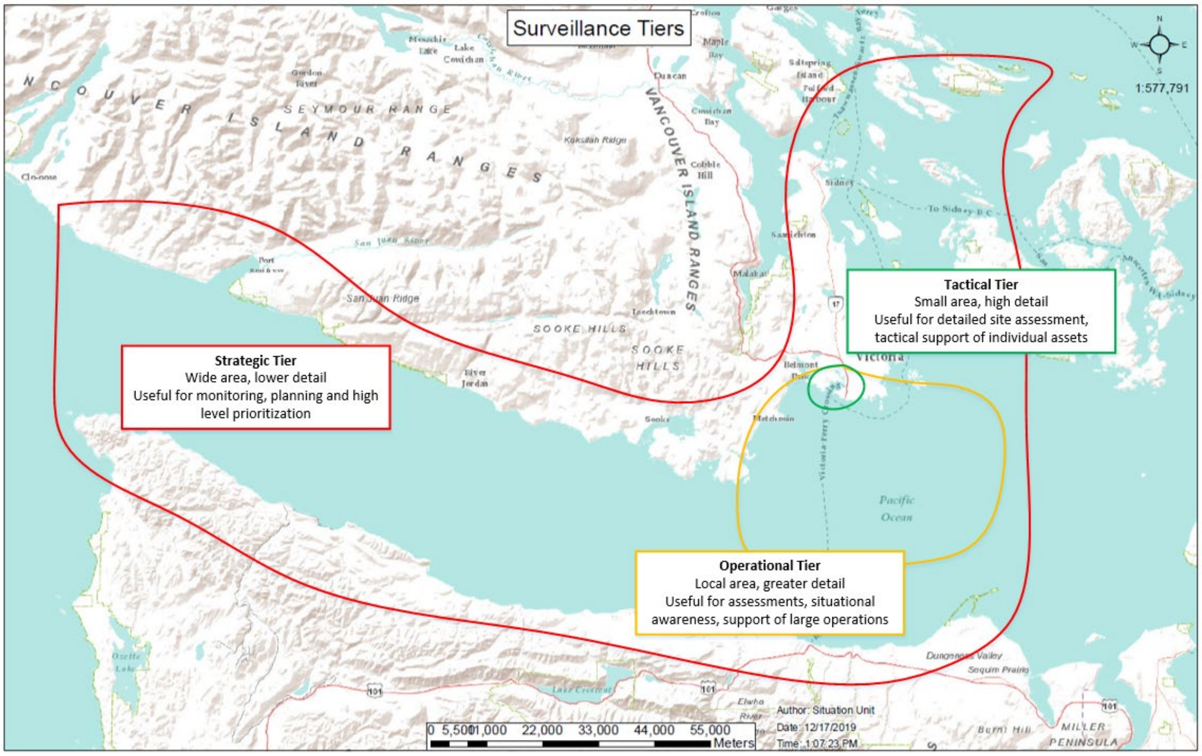


Figure 4 - Example of the Layered Surveillance Concept, demonstrating sense of scale

3.0 RESPONSE STRUCTURE

3.1 Scale of Response

In the initial stages of a response, WCMRC will use the methodology outlined in the IMP to assess the requirements of the incident and select the appropriate response level based on incident complexity and Polluter requirement. This approach applies holistically to appropriately managing all elements of the response, surveillance included. As an incident increases in terms of size, scale and complexity, an increasingly robust surveillance structure will be required in order to properly understand the situation and address the various complex issues that need to be considered; thus, the structure required to adequately manage surveillance activities will expand in turn.

Generally speaking, for small scale and less complex incidents a core 'Level 1' response organization (Figure 5) will be required, comprising predominantly of 'essential' response personnel who support on-water (or 'on-scene') operations. This 'essential' IMT will act as support to the On-Water Supervisor (who manages the response at tactical level) and manage all aspects of the strategic response as required. For response at this level, surveillance requirements could be very minimal to support an effective response – field observation by on-water crews may be sufficient to continually assess and understand the situation, and any aerial observation required (for example a UAV or an overflight) could report directly to the On-Water Supervisor; through communications with the Planning Section, in the absence of a specific Situation Unit, an adequate situation map or Common Operating Picture could be developed and maintained to meet the needs of the response.

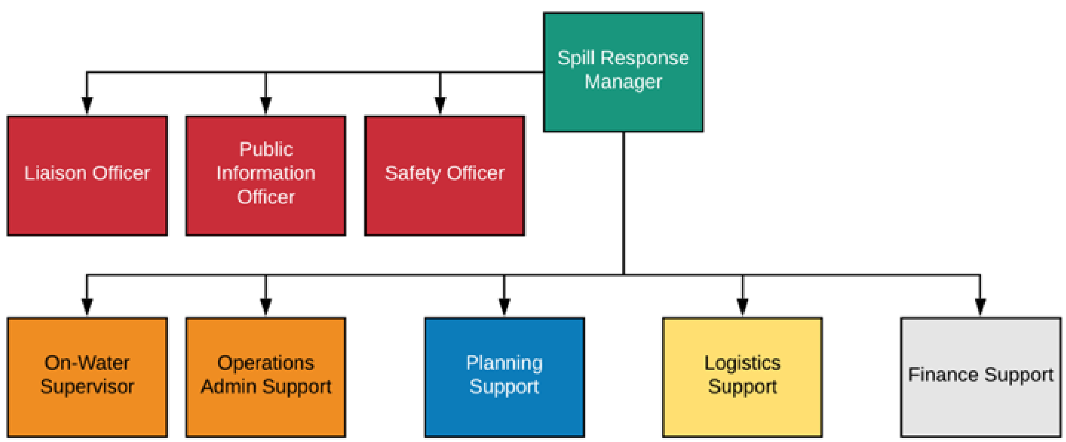
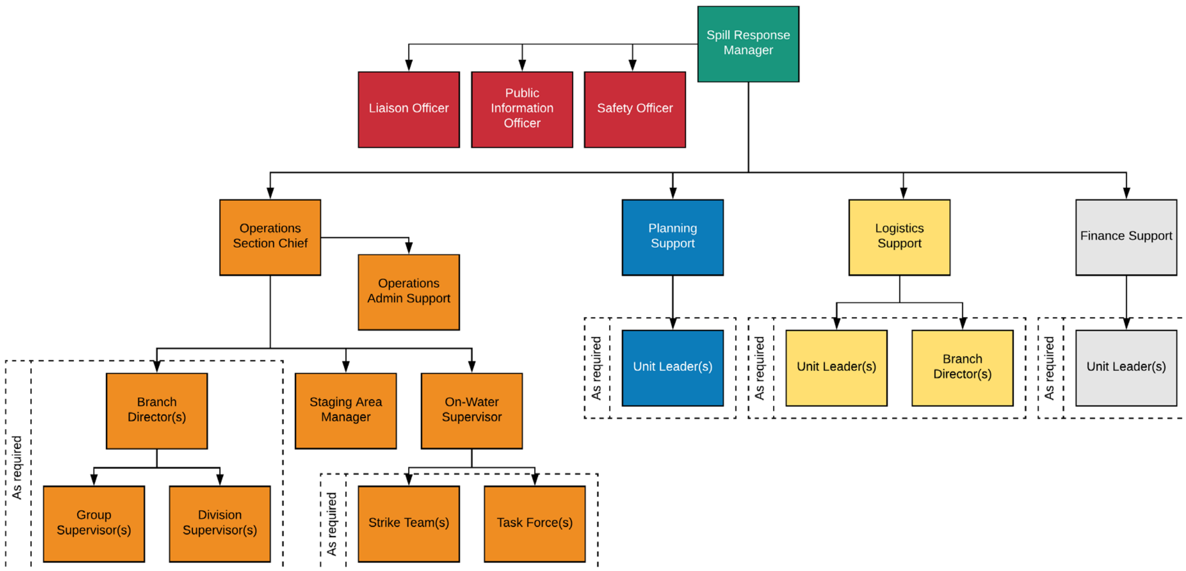


Figure 5 – Recommended Initial IMT Organization: Essential Response ('Level 1')

For larger and more complex incidents, a 'enhanced' (Level 2) or 'expanded' (Level 3) response organization (Figure 6) is likely to be required. Given the additional complexity factors, Polluter requirements and/or limitations and constraints which impact the required scale of response, IMT functions specific to the nature of the incident will be required. It is within these 'enhanced' and 'expanded' response organizations that additional functions and measures specific to surveillance will be established. In these cases, a dedicated Situation Unit will likely be established, and various surveillance measures, with their accompanying management structures will be activated and stood up to meet the needs of the response. At this point, it could be recommended by Unified Command or the Planning Section Chief to develop an incident-specific Surveillance Plan, in order to ensure that the needs of the ICS Planning Process and the tactical response operations are being effectively supported.



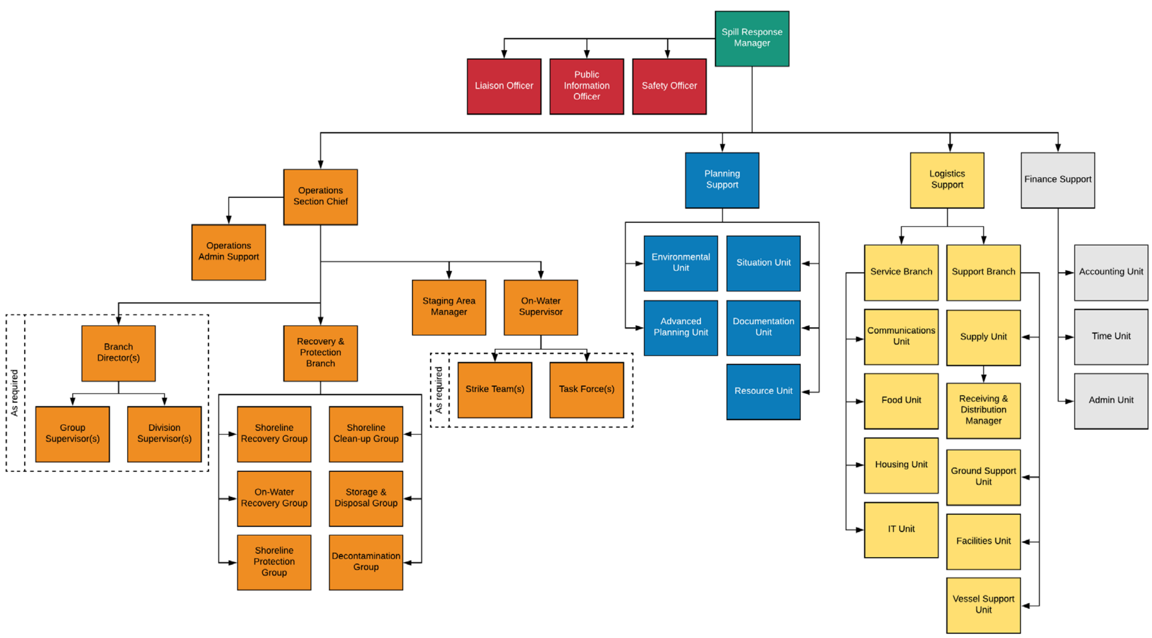


Figure 6 – Recommended Initial IMT Organizations: Enhanced Response ('Level 2') and Expanded Response ('Level 3')

3.2 IMT Functions for Surveillance

The ICS Functions outlined in Table 2 are key to establishing and conducting successful surveillance measures and are therefore likely to be required as part of an enhanced or expanded response organization, depending on the specific needs of the response and the subsequent surveillance methods activated.

In particular, the Surveillance Manager, under the Situation Unit Leader, has the critical role of having awareness over all surveillance activities and being responsible for developing and implementing an incident specific Surveillance Plan to ensure that all the activities can be most effectively coordinated and aligned to achieve the desired goals and incident objectives.

Complete job aids and checklists for all IMT functions listed in Table 2 are contained within tactical plans and supporting documentation (e.g. 'Field Operator Guides) as part of the WCMRC document hierarchy outlined in Section 1.

POSITION/SECTION	SURVEILLANCE ROLE
Initial Response Phase	
On-Scene Supervisor	**Begin initial assessment of spill and establish appropriate response; request activation of additional surveillance measures to further assess and build situational awareness as required**
Planning Section	
Planning Section Chief	Management and direction of all Planning activities; oversight over all functional units within Planning Section, to be activated as appropriate for the needs of the response; participate in the ICS Planning Process
Situation Unit Leader	Oversee the activities of the Situation Unit; Responsible for developing and maintaining situational awareness within the ICP to support the ICS Planning Process; develop and maintain Common Operating Picture and situation displays, brief IMT during scheduled meetings
Surveillance Manager	Develop and maintain incident specific Surveillance Plan; maintain awareness of surveillance methods currently operational; act as a central point to gather and consolidate information gathered by surveillance for display by the Situation Unit; provide recommendations, guidance and assistance to coordinate ongoing surveillance activities to best support planning and operations
Satellite Surveillance Analyst/Technical Specialist	Provide subject matter expertise and interpretation of data from satellite surveillance by the Situation Unit

Environment Unit Leader	Oversee the activities of the Environmental Unit; ensure that surveillance methods activated and undertaken by the Environmental Unit are communicated to the Situation Unit
Modelling Technical Specialist	Develop and maintain spill trajectory models and fate and effect analysis to support effective planning and operations
Weather/Meteorology Technical Specialist	Develop regular incident specific weather forecasts and information to support effective planning and operations
SCAT Coordinator	Develop and maintain incident specific SCAT Plan; organize and direct all SCAT resources in the field; communicate information gathered to Situational Unit as appropriate for display
uSCAT Coordinator	Develop and maintain incident specific uSCAT Plan; organize and direct all uSCAT resources in the field; communicate information gathered to Situational Unit as appropriate for display
Operations Section	
Operations Section Chief	Management and direction of all Operations activities; oversight over all function Branches/Groups within Operations Section, to be activated as appropriate for the needs of the response; participate in the ICS Planning Process
On-Water Supervisor	Direct on-water resources; conduct field level assessments and observations, communicate information gathered to Situation Unit or Surveillance Unit as appropriate for display and brief within ICP
Air Operations Branch Director	Develop and maintain incident specific Air Operations Plan; organize and direct all aerial resources, including fixed wing, rotary wing and UAVs; conduct aerial surveillance – assess extent and severity of oiling; communicate information gathered to Situation Unit or Surveillance Unit as appropriate for display and brief within ICP
Wildlife Branch Director	Develop and maintain incident specific Wildlife Plan; organize and direct all resources conducting wildlife reconnaissance, surveys, hazing etc.; communicate information gathered to Situation Unit or Surveillance Unit as appropriate for display and brief within ICP
Logistics Section	
Service Branch	Management of all service activities (e.g. communications, food, medical provision etc.)
Communications Unit	Develop and maintain incident specific Communications Plan, accounting for all operational on-water, on-shore and aerial resources, including communications links for air-to-water, air-to-shore, water-to-

	shore, water-to-ICP, air-to-ICP, shore-to-ICP as appropriate to maintain situational awareness and support operations
Supply Unit	Ensure distribution of all supplies for the incident and maintaining an inventory
Finance Section	
Accounting Unit	Ensure all costs recorded

Table 2 - Key IMT functions for Surveillance

3.3 Example Organization Including Surveillance

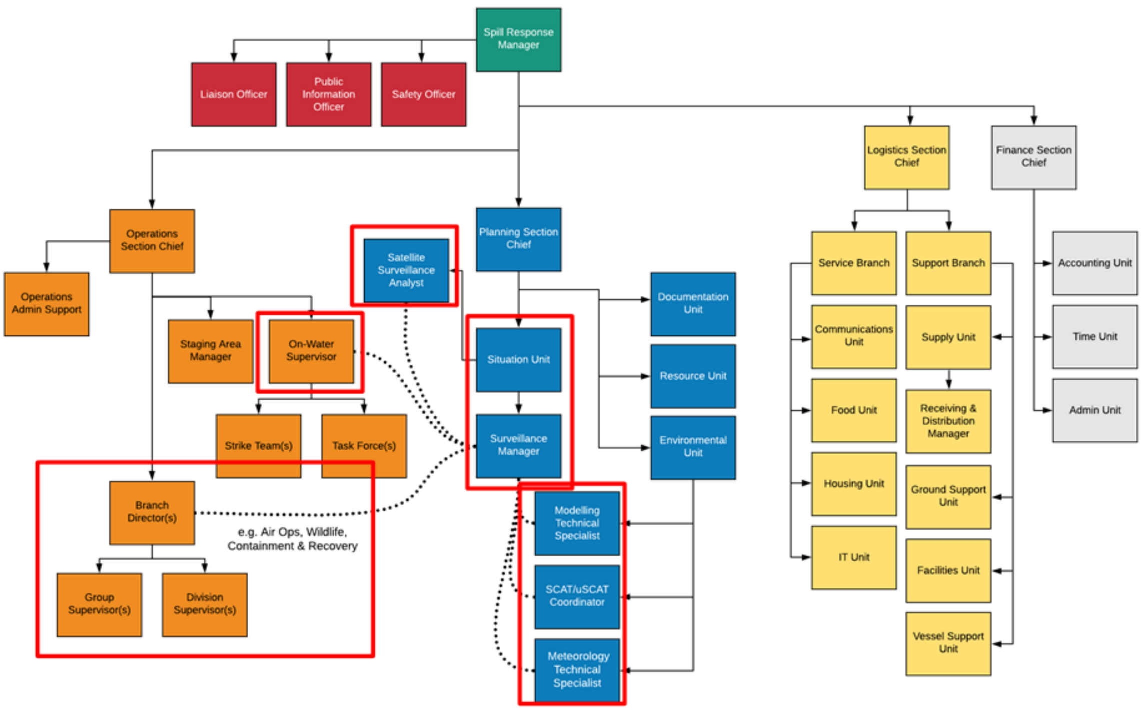


Figure 7 - Example Organization Including Surveillance

4.0 RESPONSE STRATEGIES

4.1 Spill Modelling

Spill modelling (also known as trajectory modelling) is used to develop predictions for where spilled oil may travel on-water and impact on shorelines, based on forecasted surface currents and winds; it is also used to assess the potential fate and effects of the spilled oil, predicting the amounts of oil expected to evaporate, disperse or otherwise weather over time. Spill modelling can be invaluable early in a response to assess potential scale of a spill incident and assist both immediate response actions and longer-term planning by predicting likely areas to be impacted. Spill modelling fits into the Strategic and Operational Layers - as response escalates and unfolds, field observations and assessments, as well as various aerial surveillance options will supplant modelling by providing real-time situational awareness on the scale and location of the spill and impacted areas, contributing true tactical support. Spill modelling is also a valuable tool to support strategic and operational planning and preparedness in advance of an incident by examining various scenarios under different tidal and wind conditions in order to determine potential response requirements and options.

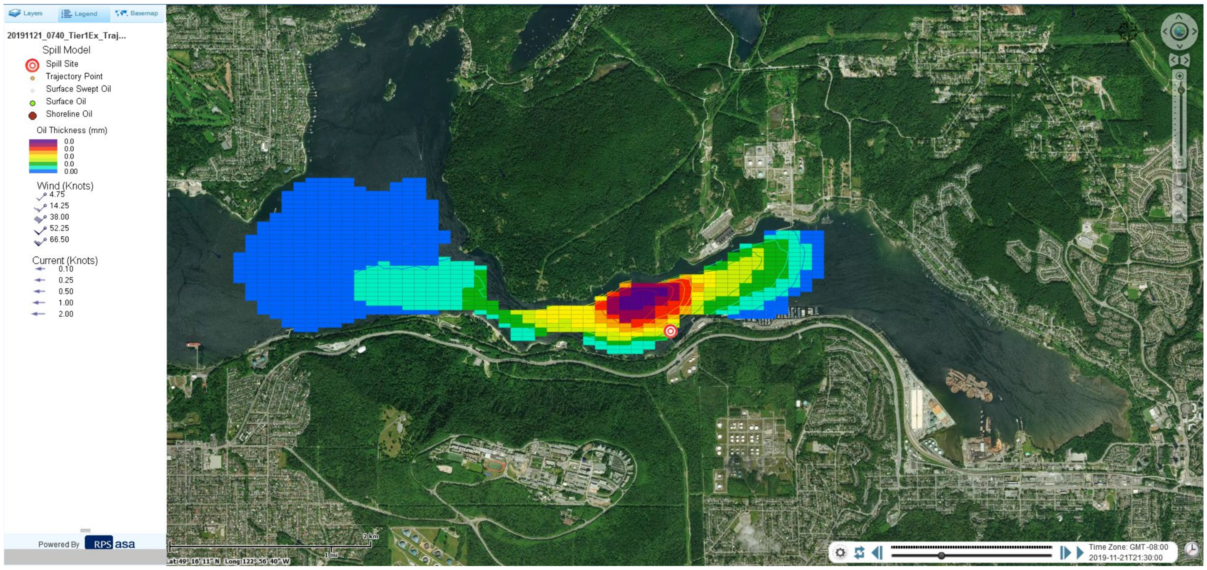
WCMRC employs the OilMapWeb application in order to run spill models - although the OilMapWeb application is an industry standard tool, WCMRC's ability to make use of the tool is limited by the available hydrodynamic models which forecast surface currents to which WCMRC has access – models are typically only available for larger bodies of water, for example the Strait of Juan de Fuca, Haro Strait, Boundary Pass, Strait of Georgia, Queen Charlotte Sound, Hecate Strait, Dixon Entrance etc.; smaller bodies of water such as harbours, inlets and channels will lack the available data for the application to function correctly.

Given the limitations around access to models, WCMRC strategy in regards to internal OilMapWeb use is that trajectory models developed with the application will be utilized to provide initial information to support response efforts, but modelling support will be requested as soon as possible from Environment and Climate Change Canada (ECCC) as soon as possible; when reports and information from ECCC become available, they will supersede any other model available. Depending on the nature of the spill and ongoing response, other modelling subject matter experts may be engaged through an Incident Command Post to provide modelling support.

NEEC will provide several support services to the Incident Management Team during a response, primary through Environment Unit or Scientific Support Coordinator roles. NEEC also fulfills the primary trajectory modelling expertise that ECCC provides. The Situation Unit should establish contact with the Environmental Unit to ensure that any modelling produced is available for display on the Common Operating Picture and use by the entire Incident Management Team.

NEEC may be contacted and activated by WCMRC during a spill incident, however it is more likely that NEEC will be activated internally through ECCC, or through Canadian Coast Guard (CCG) request. In these cases, WCMRC's Spill Response Manager should request through CCG or ECCC representatives responding to the incident to have NEEC provided information shared if it is not already shared through integration at the Incident Command Post.

Figure 8 - Spill Modelling Output



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4.2 Field Observations / Assessments

Early in the spill response, the initial site assessment, essentially getting experienced eyes on scene, is one of the critical milestones which will drive the course of future actions. Up until there is a site assessment, information that responders have to work with will typically be second-hand from various types of incident reports or notifications, therefore first-hand observations from responders reaching the scene are needed to provide immediate and up to date reports in order to verify spill status and situation, identify potential safety risks and hazards, confirm on-scene conditions, determine the nature and scale of the spill, potential impacts (shorelines, wildlife etc.), and inform immediate and further response actions and escalation.

Along with various aerial surveillance methods, continuous field observations and reports are the most important means by which to monitor spill status, maintain situational awareness, and support effective operations. Due to their continued importance during all stages of a response, field observations and assessments can be considered contribute to all three of the Strategic, Operational and Tactical levels of surveillance.

First responders to reach the site of the incident will conduct air monitoring and safety analysis to ensure the scene is safe to work. Responders will then observe the nature of the spill and report their assessment back to the On-Water Supervisor, Operations Section Chief, or Spill Response Manager as appropriate via a suitable communications method, including pictures showing the situation and extent of the spill. The responders can then discuss with their superiors next steps and receive further direction as required for immediate actions. During night operations, field observations may be assisted using Forward Looking Infrared (FLIR) cameras to discern oil upon the water. A very simple and effective way to pass situational information to the Incident Command Post is through the means of georeferenced and time-stamped photos, which can be displayed and plotted on the Common Operating Picture.

Continuous reporting from the field is crucial to maintain situational awareness and drive both immediate response actions and future response planning. All response resources in the field including individual vessels, strike teams, task forces, shore teams and other assets should continuously be conducting observations and assessments, and relaying reports as appropriate – the On-Water Supervisor should establish a reporting procedure via radio or other suitable means of communication to maintain situational awareness and direct operations as needed, and should maintain continuous contact with the Operations Section Chief or other superior within the Incident Management Team to relay situational awareness and ensure effective planning of future operations. The Operations Section and Situation Unit should establish a close working relationship to ensure that necessary situational updates are shared amongst the Incident Management Team as effectively as possible and displayed on a Common Operating Picture or other display as appropriate. Operations Section and the Situation Unit should also ensure to use reports from such sources as the ICS 201 and radio traffic to keep the Common Operating Picture up to date based on current and future actions.

4.3 Drifter Buoys

Drifter Buoys (also known as tracker buoys) are designed to provide a method of tracking oil spills in real-time through satellite transmitted GPS positional data. The buoys are typically designed so that current and wind forces act on them in the same manner as oil floating on water, to ensure as realistic tracking as possible. The GPS positional data can be plotted in a Common Operating Picture by the Situation Unit to support situational awareness on the location of oil. Although drifter buoys are in theory expendable, ideally they can be retrieved once no longer needed, provided it is practical to do so.

The ideal use of drifter buoys early in a spill incident is for the initial responders on scene conducting the assessment to deploy the drifter buoy into the slick, providing instant and accurate data on the exact location of the spill to Incident Management personnel supporting the response, and allowing responders to track the spill over time. Drifter buoys can also be valuable preparedness tools in advance of, or during a spill by deploying them in an area to gain an understanding of the local currents over a period of time, and during various tidal and wind conditions – this can be useful to validate or correct spill modelling done during response planning. In both cases, deploying a greater number of buoys increases the sample size of the data and can provide more accurate results. Using these methods, drifter buoys can contribute to Operational and Tactical level surveillance.

Figure 9 - Drifter Buoys Deployed On-Water

4.4 Satellite Surveillance

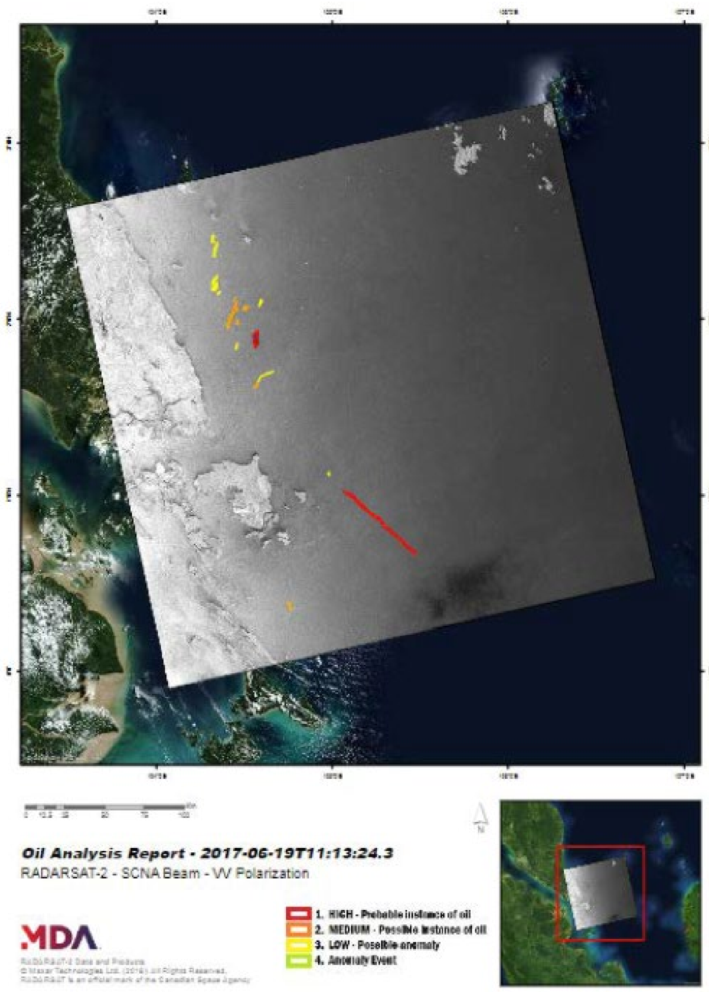
Satellite surveillance, conducting via remote sensing by radar (via the RADARSAT system within Canada), is an effective means to get information for the widest possible area in a relatively short period of time; in this sense, satellite surveillance contributes primarily to the Strategic level of surveillance, as the data will be most valuable more overall assessment and monitoring of the incident, and helping to prioritize resources for future planning – typically the detail of information and turnaround time for reporting are not sufficient to support immediate, on-water tactical decisions.

Satellite surveillance functions by way of earth observation with a synthetic aperture radar, capable of producing imagery day or night, including during weather conditions such as cloud cover, haze or smoke. From an oil spill response perspective, the radar imagery is then processed and analyzed by trained experts who can identify potential oil slicks on the surface and filter out 'false positives'. Imaging can be carried out using a variety of different 'beam modes', which essentially image a larger area at a less detailed resolution, or a smaller area in greater detail; in any case, satellite surveillance is the means by which a vast area can be rapidly assessed – depending on the beam mode used and resolution required, an area measuring 20km by 20km or up to 100km by 100km can be imaged in a single pass. As an example, the 'Extra Fine' beam mode can image ~15,000km^2 at 5m resolution. Turnaround times for data processing and analysis are typically on the order of one to four hours.

The major disadvantage of satellite surveillance is that the Radarsat-2 satellite (operated by MDA under Maxar Technologies) has a return cycle typically on the order of 4 days, meaning that the satellite will only pass over the same point on Earth every 4 days. Therefore there will be a significant period in which satellite surveillance will not be available during a response. This disadvantage typically will relegate satellite surveillance to the Strategic level of surveillance, where information can be extremely valuable for large scale planning and prioritization of resources, but less valuable for operational or tactical support. However, satellite surveillance can be very useful as the top link in a 'tip and cue' chain, where detection of oil is passed on to other surveillance assets such as aircraft, who can assist recovery assets in locating and skimming the oil. Satellite surveillance is often used as a pre-spill monitoring tool in order to detect unreported or unnoticed spills.

Satellite surveillance can be activated on a just-in-time basis. Ideally a dedicated analyst should be integrated into or maintain direct contact with the Situation Unit, so that data from surveillance can be incorporated into a Common Operating Picture and disseminated within the Incident Management Team for use. Satellite surveillance may also be initiated by government agencies in the event of an incident.

Figure 10 - Example of Radarsat Oil Spill Analysis Report



4.5 Fixed Wing Aircraft

Fixed wing aircraft are one of the most critical assets for surveillance during a spill response. Due to their speed and endurance, they can cover relatively large areas in a short time and are flexible enough to contribute at each of the Strategic, Operational and Tactical levels of surveillance, especially for offshore or remote areas. Fixed wing aircraft can be staffed with trained observers who can identify oil on water and report on observations using the methodology outlined in the Bonn Agreement Oil Appearance Code (BAOAC), providing an ability to discern areas of greater thickness and concentration, and conduct rough volume estimate calculations. An ideal altitude for fixed wing aircraft of 300m (1000') gives a good balance of visibility and detail for observers. Fixed wing aircraft are typically restricted to operating during daylight hours and good conditions and visibility.

At the Strategic level, fixed wing aircraft can conduct wide area reconnaissance surveys in order to assess overall scale of the incident report back to inform response priorities and allocation of resources to areas where they will be most effective. In the absence of satellite surveillance, fixed wing aircraft will typically be the most important Strategic surveillance asset. Fixed wing aircraft are an excellent tool to quickly respond to spill reports, verify the presence and location of oil, and conduct a rapid initial assessment of incident scale to inform on-water response. In a similar manner, fixed wing aircraft can also be used to rapidly assess shorelines or presence of wildlife for potential impact and prioritize ground level surveys.

At the Operational level, fixed wing aircraft can be used to maintain situational awareness and provide local reconnaissance within an area prioritized for recovery operations; this is the ideal tasking for fixed wing aircraft for the bulk of the response. At this level, fixed wing aircraft can form an effective 'tip and cue' chain with recovery assets by locating thicker concentrations of oil and relaying the position to on-water recovery assets, who may have attached Tactical support to assist. In this case, the fixed wing aircraft can communicate directly with an On-Water Supervisor to provide immediate reports.

Fixed wing aircraft are not the ideal method to support at the Tactical level of surveillance, but may be the only asset available at the time. Due to their inability to fly at lower speeds and lower altitudes, it is difficult to loiter over a specific area and make detailed observations, or shadow vessels for operational and tactical support. Nevertheless, they can be used to assist on-water recovery efforts through direct communication with recovery task forces, strike teams or single resources if needed.

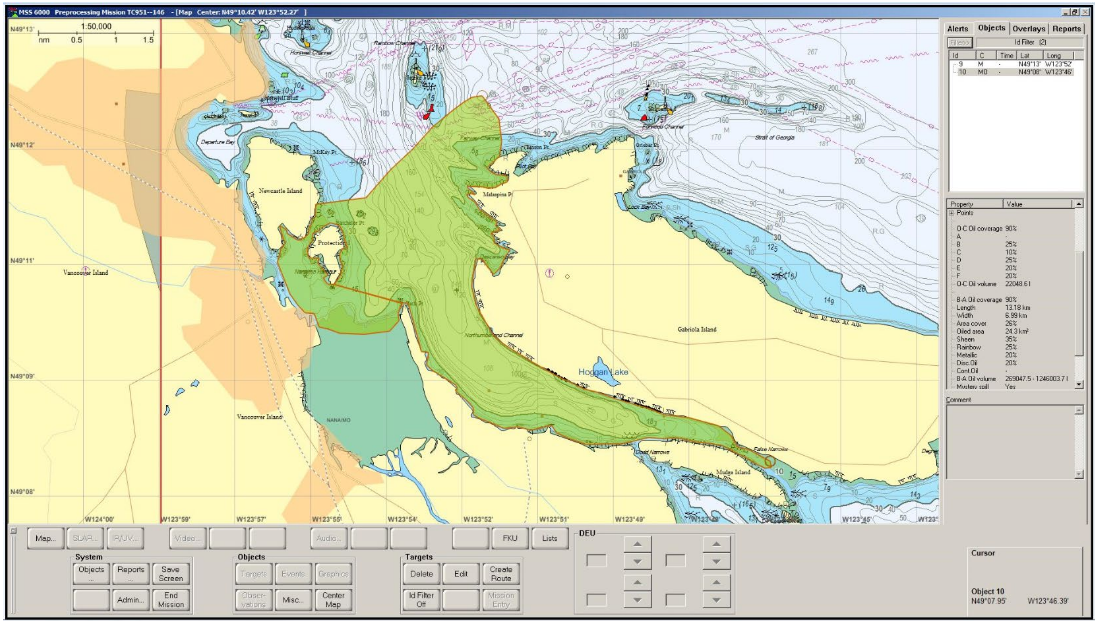
Operation of fixed wing aircraft is managed by the Air Operations Branch within the Operations Section – this Branch will manage planning of operations and taskings, sourcing of the aircraft, scheduling and coordination of different methods. The Air Operations Branch will work closely with other Branches within the Operations Section and the Communications Unit to establish communications methods, likely via VHF or UHF radio, to communicate with the On-Water Supervisor and other on-water on shore based assets as needed.

Within Canada, primary fixed wing aircraft for oil spill response is provided by the National Aerial Surveillance Program (NASP) managed and operated by Transport Canada, who operate three aircraft, one based out of Vancouver International Airport (YVR). Amongst other missions, the aircraft conduct regular patrols along the coast of British Columbia to monitor for pollution events. The aircraft is crewed by technicians trained in observation and reporting of oil on water, and equipped with additional remote sensing gear including side looking radar, ultraviolet infrared line scanner, and powerful infrared and optical cameras, as well as an onboard console which can rapidly produce and communicate reports. The NASP aircraft will typically be activated through the Canadian Coast Guard to assess the incident and support operations.

Air Operations Branch and Situation Unit should establish a close working relationship to ensure that necessary situational updates are shared amongst the Incident Management Team as effectively as possible and so that spatial data and reports collected by aircraft can be plotted on a Common Operating Picture or other display as appropriate.

Figure 11 - Transport Canada NASP Aircraft

Figure 12 - Example of Observation Report Produced by NASP during an Exercise



4.6 Rotary Wing Aircraft (Helicopters)

In a similar sense to fixed wing aircraft, rotary wing aircraft, also known as helicopters, are one of the most critical assets for surveillance during a spill response. Due to their ability to fly at low altitudes and speeds, and loiter over specific areas, helicopters are flexible and valuable assets to contribute at the Operational and Tactical levels of surveillance. Helicopters can be staffed with trained observers who can identify oil on water and report on observations using the methodology outlined in the BAOAC, providing an ability to discern areas of greater thickness and concentration, and conduct rough volume estimate calculations. An ideal altitude for fixed wing aircraft of 150m (500') gives a good balance of visibility and detail for observers, however they can fly lower to provide more detailed observations if safe to do so. Helicopters are typically restricted to operating during daylight hours and good conditions and visibility.

Due to their lower speed and shorter range compared to fixed wing aircraft, helicopters are less suitable for the Strategic level of surveillance, however can conduct verification and initial assessment overflights for incidents closer to shore or in less remote areas in the absence of fixed wing aircraft or satellite surveillance. However, helicopters can be logistically easier to support than fixed wing aircraft, as they do not require a runaway to land, so can be operated and serviced in areas farther away from airfields.

At the Operational level, helicopters can be used to maintain situational awareness and provide local reconnaissance within an area prioritized for recovery operations. In this case, the fixed wing aircraft can communicate directly with an On-Water Supervisor to provide immediate reports and assist direction of on-water recovery assets within the area. Helicopters can also be used to assist Shoreline Cleanup Assessment Technique (SCAT) teams to rapidly survey shorelines in an area for potential impact and assist them in prioritizing shoreline surveys.

Helicopters are the ideal method to support at the Tactical level of surveillance due to their ability to fly at lower speeds and lower altitudes, and to loiter over a specific area and make detailed observations, or shadow vessels for operational and tactical support. At this level an observer can maintain direct communication with on-water recovery assets and assist them in locating and targeting thicker concentrations of oil in order to maximize effectiveness. Helicopters can also be employed at the Tactical level to assist in wildlife reconnaissance surveys.

Operation of helicopters is managed by the Air Operations Branch within the Operations Section – this Branch will manage planning of operations and taskings, sourcing of the aircraft, scheduling and coordination of different methods. The Air Operations Branch will work closely with other Branches within the Operations Section and the Communications Unit to establish communications methods, likely via VHF or UHF radio, to communicate with the On-Water Supervisor and other on-water on shore based assets as needed.

Within Canada, primary helicopters for oil spill response are provided by the Canadian Coast Guard, who operate various helicopters based in British Columbia. The helicopters will typically be activated through the Canadian Coast Guard to assess the incident and support operations. WCMRC's Spill Response Manager or Operations Section Chief can coordinate with the Canadian Coast Guard Spill Response Officer in order to receive reports and information from overflights early in a response, and to request a spot for a WCMRC trained observer on a helicopter if feasible. Commercial helicopter operators based in British Columbia may be chartered to provide additional helicopter resources if required.

Air Operations Branch and Situation Unit should establish a close working relationship to ensure that necessary situational updates are shared amongst the Incident Management Team as effectively as possible and so that spatial data and reports collected by observers can be plotted on a Common Operating Picture or other display as appropriate.

Figure 13 - Canadian Coast Guard Helicopter

4.7 Unmanned Aerial Vehicles (UAVs)

Unmanned Aerial Vehicles, also known as UAVs or 'drones', are fast becoming one of the most versatile and flexible tools for surveillance available to responders. Common 'quadcopter' and more complex commercial UAVs can operate from much smaller platforms, including small vessels, and carry a variety of sensors, including optical and infrared camera or LIDAR scanners, which can enable them to operate at night and gather other kinds of data for Incident Management Team use. Along with their small logistical footprint, this flexibility makes UAVs an extremely useful application for small, less complex spills, but allows them to effectively fit into the Operational and Tactical levels of surveillance in a variety of ways.

The major disadvantages to UAV operations are endurance limited by battery life, and operational range limited by current regulations to within visual line of sight (VLOS) of the operator and spotter. The ability for an operator to carry multiple batteries and quickly change and recharge them can help to mitigate endurance limitations to an extent, and operating the UAV from a mobile platform such as a vessel can allow the UAV to cover more range by maintaining the VLOS. Future regulations may allow for beyond line of sight operations (BVLOS), which combined with fixed wing UAVs with significantly greater speed, endurance and range could soon allow for even greater flexibility for operators and planners; however, the operations will depend on radar airspace management which by necessity increases the complexity of implementing the operations.

At the Operational level, the ideal deployment for a UAV would be on a suitable vessel - either a vessel of opportunity (VOO) or WCMRC operated. The UAV operator may be co-located with the On-Water Supervisor onboard the 'command and control' vessel, but this is not necessary given the ability to transmit near real time video from the UAV camera. Once the UAV is deployed, the vessel can provide mobile support to on-water recovery operations and the On-Water Supervisor by helping locate and assess concentrations of oil and relaying the position to assets for recovery, and by providing increased situational awareness for all assets in the area. In this sense, the UAV operator should maintain constant radio contact either with the On-Water Supervisor or individual task forces, strike teams or single resources as necessary. UAVs can also be used to assist Shoreline Cleanup Assessment Technique (SCAT) teams to rapidly survey shorelines in an area for potential impact and assist them in prioritizing shoreline surveys, and can do so by being operated from land with vehicle support or from a vessel.

At the Tactical level, the ideal usage is for UAV and operators can be deployed on an individual on-water recovery asset to assist the vessel master in locating concentrations of oil and effectively recovering it, providing a task force, strike team or single resource with an 'organic' aerial surveillance capability. The UAV can also be deployed in a static position to verify the effectiveness or function of an operational strategy, for example containment or protection booming at a particular location.

Given the complexity of current regulations surrounding UAVs, WCMRC utilizes commercial UAV operators to provide the service as required.

Figure 14 - Common Quadcopter Type UAV

Figure 15 - Image Taken by UAV during Exercise

4.8 Aerostats

Aerostats are tethered, lighter-than-air aircraft which can provide persistent aerial surveillance and monitoring, typically in a localized area. The helium filled balloon can be operated at altitudes up to 300m (1000') in wind speeds up to 50 knots – typical operating altitudes in the range of 150m (500') give an ideal balance of sufficient height to give wide area visibility, but low enough to maintain an ability to accurately assess oil or other features on the surface. Aerostats can be fitted with single or multiple digital or infrared cameras which allow for identification of oil on water during the day or during darkness. Video is typically transmitted wirelessly a short distance to a receiver and a ground station where imagery from the cameras can be viewed in real time, providing an 'eye-in-the-sky' view to a vessel captain or an operational supervisor, enhancing situational awareness and assisting operational effectiveness.

In a functional sense, aerostats trade mobility and flexibility for endurance compared to a UAV or other aircraft. Once deployed, the aerostat can remain aloft indefinitely – typically it will only be required to be brought down approximately every 12 hours to replace the battery and top up the helium as needed. However, it is important to note that the aerostat will require a minimum of two trained personnel to safely deploy and service, and one on constant standby to operate the cameras and monitor the operation. When deployed on a vessel, the vessel's mobility will be restricted due to the need to monitor and mind the tether and ensure it does not interfere with the mast, antennae or vessel structure, and the need to avoid putting undue strain on the tether and balloon.

Aerostats will typically be employed either at the Operational or Tactical Layers to support surveillance efforts. At the Operational level, the ideal deployment for an aerostat would be on a suitable vessel - either a vessel of opportunity (VOO) or WCMRC operated. The aerostat may be co-located with the On-Water Supervisor onboard the 'command and control' vessel, but this is not necessary or recommended as it will reduce the mobility of the vessel. Once the aerostat is deployed, the vessel can provide mobile support to on-water recovery operations and the On-Water Supervisor by helping locate and assess concentrations of oil and relaying the position to assets for recovery, and by providing increased situational awareness for all assets in the area. In this sense, the aerostat operator should maintain constant radio contact either with the On-Water Supervisor or individual task forces, strike teams or single resources as necessary. At the Tactical level, the aerostat can be deployed and attached to an individual on-water recovery asset to assist the vessel master in locating concentrations of oil and effectively recovering it. Tactically, the aerostat can also be deployed in a static position, for example at a casualty site to monitor containment and recovery activities at a fixed site, or on an impacted shoreline to monitor cleanup activities.

Figure 16 - Aerostat Being Operated From a Vessel

4.9 Wildlife Reconnaissance

While any field observer will report the presence of wildlife in the vicinity of a spill incident, it typically requires specialized knowledge, training and expertise in order to correctly identify the species and determine through appearance or behaviour whether the animal has been impacted or otherwise disturbed by the spill or response.

Operating under the Wildlife Branch, specialized wildlife reconnaissance teams can be deployed in the field, either on vessels or on shore, to observe and report back on the presence of birds, terrestrial or marine wildlife. Their findings contribute important information to the development of Wildlife Plans within the Incident Management Team, and can help responders prioritize areas of concern and resources at risk when developing response strategies. The assessments made during wildlife reconnaissance are often the first phase in a more complex wildlife response. The Wildlife Branch can also make use of specialized reporting networks such as the Whale Report Alert System (WRAS) in order to monitor activity in the area, and to 'tip and cue' reconnaissance assets to verify the reports.

As wildlife reconnaissance contributes to overall impact assessment, monitoring, prioritization of response resources, as well as time sensitive information required to appropriately respond to impacted or potentially impacted wildlife, wildlife reconnaissance can be seen to contribute to all of the Strategic, Operational and Tactical Layers of surveillance.

Similar to other field assessments and reports, wildlife reconnaissance teams should report any sightings and transmit any information gathered through the Wildlife Branch. The Wildlife Branch typically will be activated upon direction from Unified Command or request from the Operations Section or Environment Unit, and will be made up of a mix of subject matter experts from government agencies and professional wildlife response organizations. The Wildlife Branch and Situation Unit should establish a close working relationship to ensure that necessary situational updates are shared amongst the Incident Management Team as effectively as possible and displayed on a Common Operating Picture or other display as appropriate.

For more information regarding wildlife reconnaisance and how it integrates into a broader wildlife response, reference WCMRC's Wildlife Response Plan.

Figure 17 - On-Water Wildlife Reconnaissance Team

4.10 Shoreline Cleanup Assessment Technique (SCAT)

Shoreline Cleanup Assessment Technique, also known as SCAT, is a systematic process by which shorelines are surveyed for impact by oil, and the impacts assessed and delineated. Observations and data gathered during SCAT surveys are then used to inform and develop shoreline treatment recommendations, used by Operations in order to effectively clean the shorelines.

SCAT surveys are conducted by teams typically made up of representatives from the Polluter, Federal government, Provincial government, local government, local First Nations, and often a professional from an environmental organization with SCAT experience and expertise. During their shoreline surveys they will collect very detailed information on the shoreline type, operational and logistical considerations, oiling extent and description, as well and any further environmental, cultural or wildlife issues. The surveys are time consuming and place a focus on collecting ground level detail; as such, the main Layer of surveillance SCAT will operate at is the Tactical level – however, due to a focus on impact assessment, monitoring, as well as prioritizing usage of resources in a major event, SCAT can be considered to contribute to the Strategic and Operational levels as well. Recent developments in processes around 'rapid SCAT' have allowed initial SCAT surveys to be more flexible and conduct less time consuming overviews of an area to more rapidly prioritize areas where further detail is required – SCAT teams can work effectively with other aerial surveillance assets in this regard.

Data gathered by SCAT teams in the field is passed to the SCAT Coordinator or the SCAT Data Manager working within the Incident Management Team in the Environment Unit, where the data will be processed and entered into a database where it can be more effectively managed and analyzed. SCAT and Situation Unit should establish a close working relationship to ensure that necessary situational updates are shared amongst the Incident Management Team as effectively as possible and so that spatial data can be plotted on a Common Operating Picture or other display as appropriate.

SCAT will typically be activated upon direction from Unified Command or request from the Environment Unit or Operations Section – however WCMRC can be proactive in notifying SCAT professionals to standby where appropriate or recommending activation to the Polluter or Unified Command. WCMRC maintains relationships with various subject matter experts who can be activated to undertake and manage SCAT activities during a response. For more information regarding SCAT and how it integrates into a broader shoreline response, reference WCMRC's Shoreline Response Plan.

Figure 18 - SCAT Team Conducting a Survey

4.11 Underwater Seabed Cleanup Assessment Technique (uSCAT)

Underwater Seabed Cleanup Assessment Technique, also known as uSCAT, is considered the subsurface counterpart to SCAT. The uSCAT concept focuses on detecting and delineating sunken and submerged oil which could be suspended in the water column or sunken to the seabed, and assessing the potential to recover it.

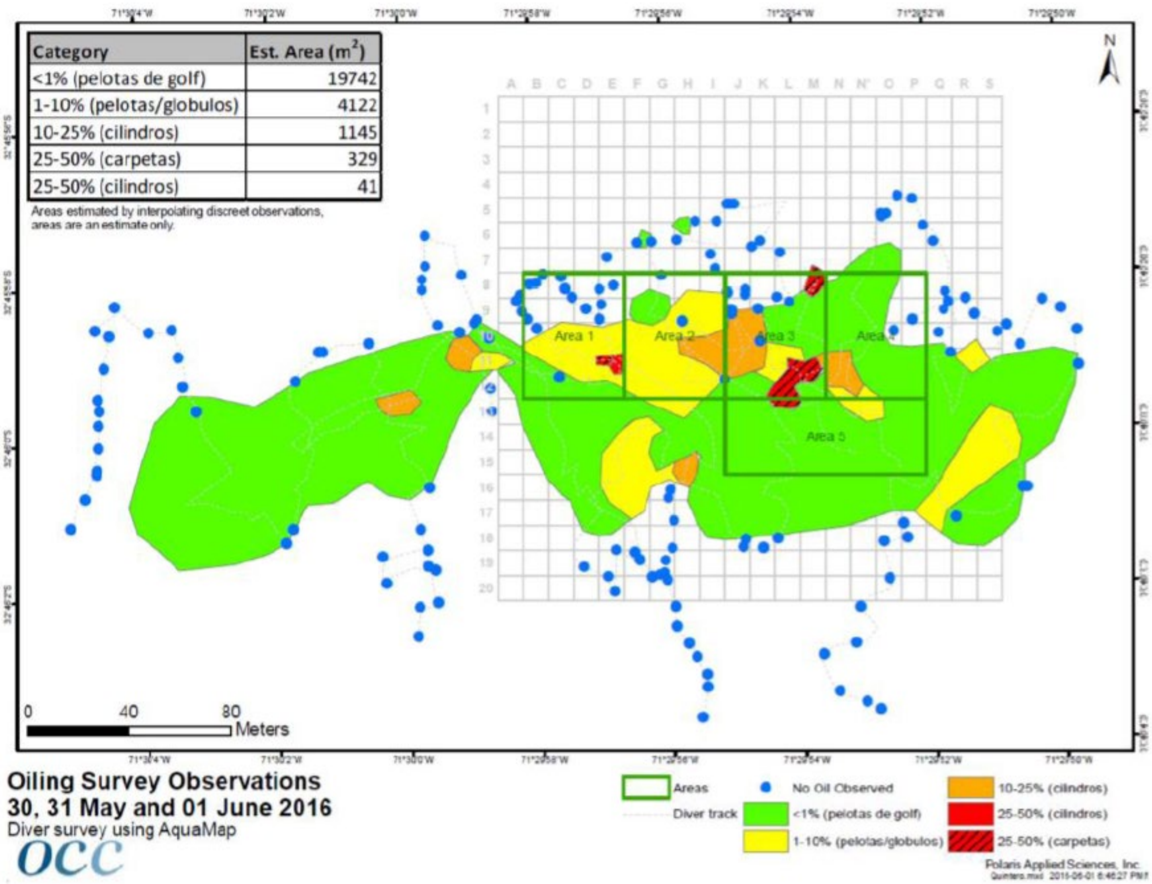
Due to the complexity of detecting sunken and submerged oil, uSCAT is not a specific method and process in the same way as conventional SCAT; rather, it is an umbrella concept utilizing a number of different methods with different advantages, disadvantages and approaches in order to effectively detect subsurface oil given the situation and resources available. In this way, uSCAT could be considered a subsurface surveillance counterpart to 'above the surface' surveillance, and will contribute to Strategic, Operational and Tactical levels of surveillance.

The uSCAT approach commences with a risk assessment based on spilled product type and geographic and environmental factors to determine if there is a probability of oil to sink. Methodologies to then attempt to detect and delineate sunken oil range from relatively simple, passive techniques such as sorbent sentinels, simple active techniques such as sorbent drags, poling and grab samples, more complex visual identification with drop cameras, divers or Remotely Operated Vehicles (ROVs), to complex technological solutions such as side-scan or multibeam sonar, fluorometers or induced polarization. Each method has different considerations which are overviewed in uSCAT documentation. Similar to SCAT, data collected will be processed and stored in a database by the uSCAT Coordinator or uSCAT Data Manager, where it can be analyzed in order to recommend suitable and feasible recovery techniques.

uSCAT and Situation Unit should establish a close working relationship to ensure that necessary situational updates are shared amongst the Incident Management Team as effectively as possible and so that spatial data can be plotted on a Common Operating Picture or other display as appropriate.

uSCAT will typically be activated upon direction from Unified Command or request from the Environment Unit or Operations Section – however WCMRC can be proactive in notifying uSCAT professionals to standby where appropriate or recommending activation to the Polluter or Unified Command. WCMRC maintains relationships in order to integrate uSCAT and sunken oil recovery subject matter expertise into an Incident Management Team when required. For more information regarding uSCAT and how it integrates into a broader sunken and submerged oil response, reference WCMRC's Sunken and Submerged Oil Plan.

Figure 19 - Example of Subsurface Survey Results Conducted by Divers and ROV



4.12 Sampling

Environmental sampling is typically undertaken prior to an incident, or at the outset of an incident, in order to gain 'baseline' information about the state of a shoreline or other environment, and assist with long term impact assessments and monitoring, and potentially inform ground level treatment and recovery techniques. Sampling is normally conducted for water, sediment, tissue and potentially air in order to determine level of contamination, with the ability to directly relate contamination to a spill of a certain oil product through its 'fingerprint'. For legal reasons, sampling follows strict methodology and chain of custody from the time it is taken to the time it is analyzed in a lab setting.

Sampling is conducted using a very systematic approach at specific, discrete locations, meaning it fits into the Tactical level of surveillance; however, given the long term monitoring and impact assessment it contributes to, it also fits into the Strategic level. From a WCMRC perspective, sampling activities will not have a major impact on oil recovery operations.

Sampling will typically be conducted by government agencies or specially trained technicians from commercial organizations at government direction. Sampling activities and the development of a Sampling Plan is usually initiated by Unified Command and undertaken by elements of the Environment Unit.

4.13 Weather and Conditions Forecasting and Monitoring

A critical task to be undertaken by the Situation Unit is forecasting and monitoring of weather conditions, and ensuring this information is available for planners, decision makers, and those in charge of operations. Typically the Situation Unit will account for this by pulling information from Environment Canada marine and local weather forecasts and tide predictions, and ensuring that up to date information is available on the situation display and briefed to the Incident Management Team regularly.

Because an accurate understanding of weather forecasting has impacts both on high-level response planning, as well as decisions made at the field level, weather forecasting can be seen to contribute to all Layers of surveillance.

Many WCMRC vessels have onboard weather stations and monitoring equipment which can provide real time measurements on scene, and combined with verbal reports from vessel crews to the On-Water Supervisor, regular reports should be relayed to the Operations Section Chief and Situation Unit for planning use.

In major incidents, Environment Canada can provide site specific forecasting and projections by assigning meteorologists to support the response. This support can be requested through the Canadian Coast Guard, Unified Command or the Scientific Support Coordinator, and ideally the meteorologist should be integrated directly into the Incident Management Team either reporting to the Situation Unit or Environment Unit, tasked to provide up to date briefings during regular meetings.