PLUME DELINEATION, LAND

OBJECTIVE & STRATEGY

PD

The objective of the Plume Delineation tactic is to determine the extent and trajectory of an oil spill plume both on the surface and subsurface. This tactic may be used on land and on solid ice.

The general strategy used in performing Plume Delineation is to:

1. Identify the approximate location of the spill.
2. Assess the site characteristics and determine equipment and personnel needs.
3. Deploy equipment and personnel to the location.
4. Commence delineation operation.
5. Repeat as necessary to determine oil movement and trajectory.

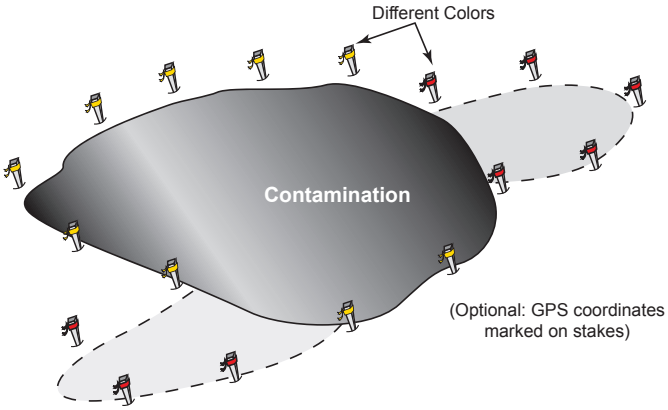

Figure PD-1. Marking different layers in the plume.

TACTIC DESCRIPTION

When oil spills on land or solid ice it behaves in predictable ways; it will begin to spread laterally and it will sink through soil or snow. Given sufficient quantity and time, the plume will migrate down until it reaches an impermeable layer or a water table. The oil plume will migrate over time, driven by topography, wind, and water movement. The rate and direction of oil plume movement is dependent on the characteristics of the oil, air temperature, soil temperature, water table hydrology, and the permeability of the soil.

The extent and movement of the sub-surface oil plume can be very different from the surface plume. Oil spilled on porous gravel may show little surface contamination, yet sink to a flowing water table and spread over a large area. Oil spilled on a wetland will usually remain on the surface, floating on the water-saturated soil. Oil spilled on solid ice may find its way through cracks, reach the water below, and migrate away from the surface site. Oil deposited on a mixed sand and gravel shoreline may sink down to a fine sand layer, migrate down slope, and resurface on an incoming tide. Oil spilled during the winter may be covered by subsequent snowfall or wind blown drifting snow.

Plume Delineation, Land

The purpose of the Plume Delineation tactic is to use simple methods to quickly assess the spatial extent of surface and subsurface oil to aid in response planning during the emergent phase of the spill response. Repeating the delineation will establish the direction and rate of any movement of the plume, establishing a trajectory. A more detailed quantification of the spill plume for the cleanup and remediation phases of the response may be required and those techniques are not covered in this manual.

Operating Environments

Plume Delineation can be used in the following operating environments:

- Solid Ice,
- Marsh,
- Tundra,
- Shoreline, and
- Other Land.

Deployment Configurations

THE SPILL PLUME IS VISIBLE AND ACCESSIBLE

The tactic is deployed by mapping the edges of the plume. If the plume has distinctly different levels, layers, or concentrations, then each facet of the plume is mapped separately. The edges of the plume are marked and labeled with surveyor's stakes, wooden laths, or something similar (Figure PD-1). Different color paint or flagging tape may be used to indicate different layers or concentrations in the plume. Simultaneously, a record is made of the location of each stake with a handheld GPS. This may be done by setting waypoints in the GPS, using the same label as marked on the stakes. The same GPS may be used to record a track of the plume edge. A hand drawn map is sketched in the field to assist in developing final maps with the aid of computer software. The Situation Unit in the Planning Section may have map software. Repeating the delineation procedure after a period of time has passed will aid in the assessment of the direction and rate of movement of the spill.

One or two crews walk around the perimeter of the spill, placing stakes in the ground every 50 to 100 feet while recording the stake locations with a handheld GPS. Setting waypoints on the GPS is a convenient way to record the stake locations. Once the stakes are set, a track of the spill edge can be recorded with the GPS. Many GPS have a function to calculate the area of a track that forms an enclosure. Digital photographs of the site, taken from several perspectives after the color-coded stakes are in place, are also very useful.

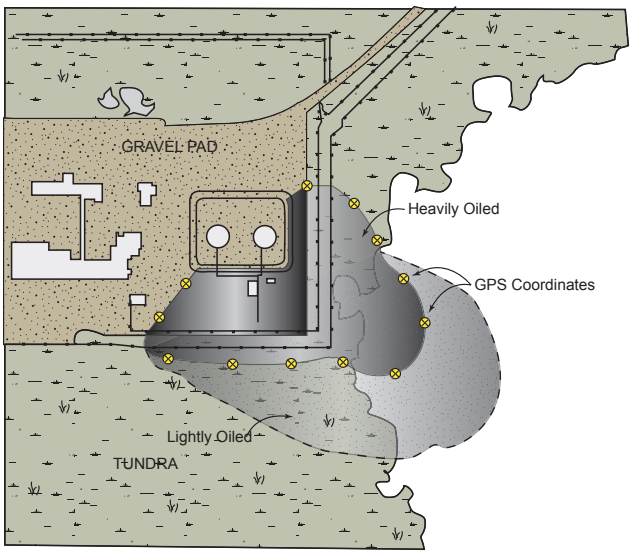

Figure PD-2. Plan view of plume delineation map.

For large spills, an ATV or snow vehicle can be used to assist in moving around the spill, if vehicle use is approved and will not damage the environment. Very large spills may require a helicopter.

An initial hand-drawn sketch is best drawn on a topographic map, as-built survey, aerial photograph, or other depiction of the site. Contingency plans usually have line drawings and maps of facilities. The sketch should have as much detail and labeling as possible. Make sure to note the time, date, and person making the drawing. The sketch can be used to produce more precise maps when combined with GPS data (Figure PD-2).

THE SPILL PLUME IS NOT VISIBLE

If the perimeter of the spill cannot be seen, because it is below ground or under snow or ice, then a different approach is required. First assess the probable location of the spill and the surrounding terrain to determine the likely migration path of the plume. In this case a grid may be used to delineate the plume (Figure PD-3). The grid is first laid out from a starting point where the spill is known or suspected to have occurred. From this origin, the grid is set in all directions. The grid is established with stakes set a consistent distance apart. If the spill is thought to be less than an acre in size, the grid should be set on a 25 foot spacing. If the spill is over one acre, the grid spacing can be increased accordingly.

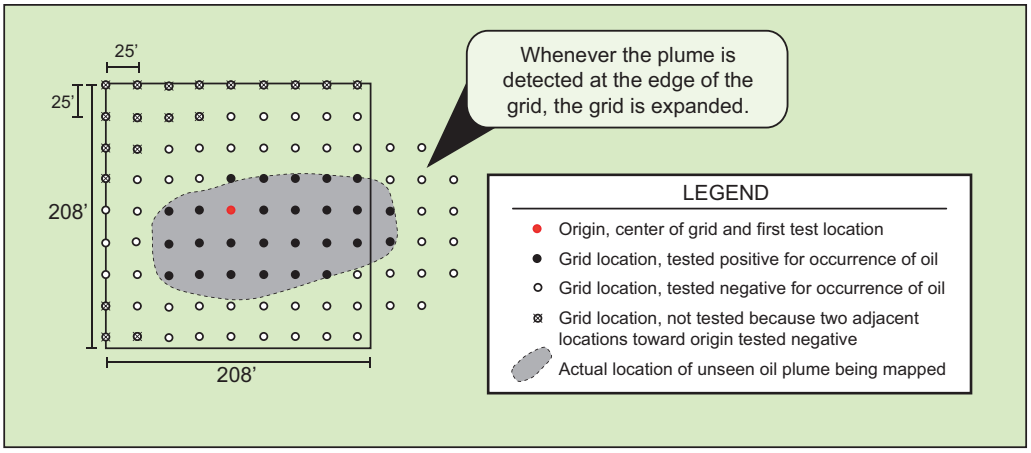

Figure PD-3. Plume Delineation using a grid for a location about one acre in size.

Once the grid is established, a method to test for the occurrence of oil must be established. The method usually involves digging or drilling a hole to the water table or some pre-determined depth to assess for the presence of oil. Other remote sensing technology, such as infrared cameras or Photo Ionization Detection (PID), can be used. The test method is first applied at the origin/center of the grid and then to adjacent grid locations in a systematic fashion. If oil is not detected at the origin, re-assess the most likely location of the spill and re-set the grid if necessary. If oil is detected, the adjacent untested grid locations are tested too. When an adjacent location tests negative for oil, its adjacent locations are also tested. When two successive locations test negative for oil, subsequent locations in the direction away from the oil are not tested. If a location on the edge of the grid tests positive for oil, then the grid must be expanded. This tactic may have to be modified depending on the terrain and situation.

Once the tests are completed, the stakes marking the grid locations should be color coded to indicate if they were tested and if so, the results of the test. A hand sketch and digital photographs, as described above, should also be completed for the site.

DEPLOYMENT CONSIDERATIONS AND LIMITATIONS

SAFETY

- PPE is required of all personnel in the Hot Zone; consult the incident-specific Site Safety Plan for requirements.
- Worker exposure to contaminants should be minimized.
- The buddy system should always be used in the Hot Zone.
- If heavy equipment is used, a spotter should be present.

DEPLOYMENT

- If wildlife or historic properties are encountered, see Wildlife Checklist on page A-19 or Historic Properties Checklist on page A-20.

REFERENCES TO OTHER TACTICS

Other tactics that may be involved in Plume Delineation include:

- PPE Personal Protective Equipment
- SEC Site Entry Criteria
- Dp Personnel Decontamination

EQUIPMENT AND PERSONNEL RESOURCES

PD

Resources for delineating a plume include hand-held GPS, a digital camera, a diagram or map, marking pens/pencils, log book, paint or flagging tape, stakes, and a hammer to drive stakes. If the oil is not visible, test holes will have to be dug with an auger, rock drill, excavator, or other equipment suitable to the situation.

Equipment	Function	Quantity	Notes
Hand held GPS	Determine locations	1 or more	Personnel should be familiar with operation for the model and the Situation Unit should be capable of downloading data from the GPS. Extra batteries and antenna.
Digital camera	Capture images of the stakes, once color coded	1	Extra batteries and media.
Surveyor stakes or equivalent	Marking the edge of the plume or locations in a grid	100 for a one acre spill, more if the spill is larger	Make sure the stakes are long enough to be seen above snow, grass and terrain
Paint or flagging tape	Color coding stakes	4 different colors	Bright colors work best
Log book and maps or diagrams	Taking notes, drawing sketches, and recording data	As necessary	
Hand tools	Driving stakes, digging holes, clearing brush	Situation specific	
Digging system (hand tools, auger, rock drill, excavator, or other)	Digging holes to determine the presence of oil	Situation specific	Only needed if subsurface oil is to be detected
Vessel/Vehicles	**Function**	**Quantity**	**Notes**
ATV or Snow Vehicle with or without a trailer	Access the site and move around the perimeter of the spill	1 to 2 optional	Vehicles should only be used if they will not cause damage to the environment
Personnel	**Function**	**Quantity**	**Notes**
Field Team Leader	Supervises operations under the Direction of the Operations Section Chief	1 or more	Should be trained in plume delineation
Skilled Technicians	Work under the direction of Field Team Leader	1 to 2	Depending on situation/activities
General Technicians	Work under the direction of Skilled Technician	0 to 3	Depending on size of spill
Operators	Operate heavy equipment or drilling equipment	0 to 3	Depends on equipment utilized

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