

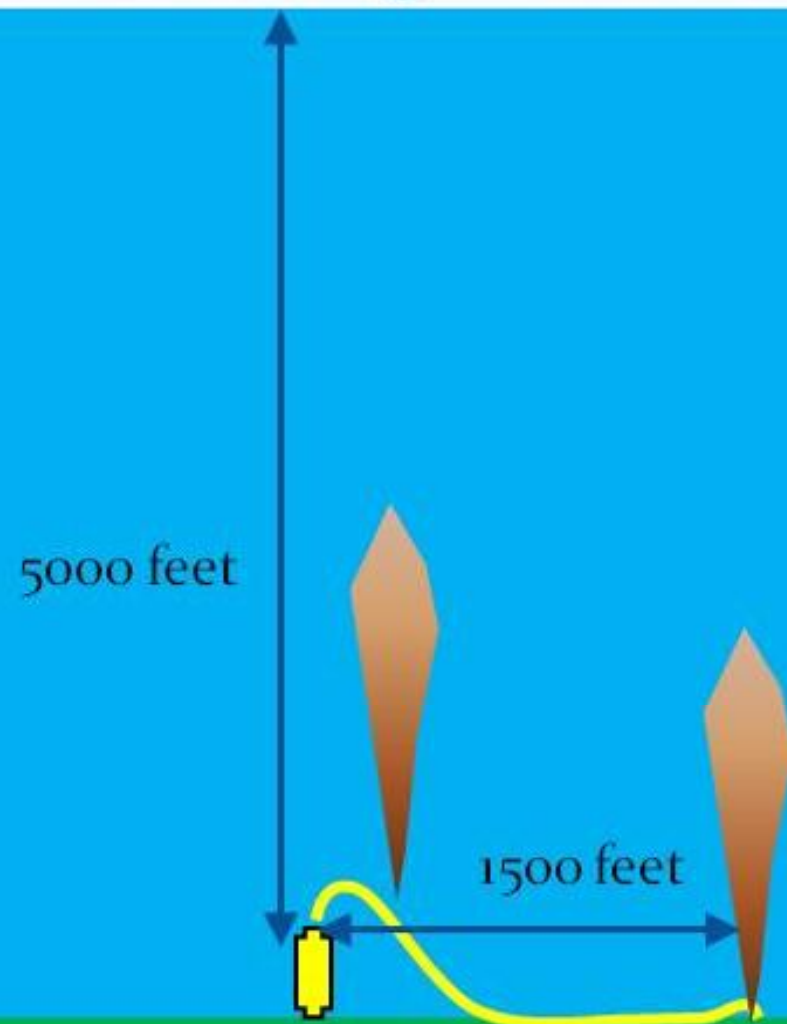
Lessons learned about dispersant use at the *Deepwater Horizon* incident

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Oil and gas leaking from the riser



Not to scale

E: N:

11/05/2010 12:40:03

Depth: 4957.5 Alt: 5.1

Hdg: 156.2

H14: Measurement Ops



What made this incident different from other oil spills?

- The total amount of oil that could be released and the flow rate at which the oil was being released
 - Total amount of oil that could be released was enormous
 - It was not possible to measure the flow rate of oil
- The time for which the oil release could continue
 - Source control efforts
 - Drilling a relief well
 - The sub-sea well-head source was very difficult to access

Date	Oil flow rate estimates	US Govt. FRTG estimates
April 22 nd	Explosion and fire	
April 24 th	Oil seen on sea Estimated as 1,000 bbls oil/day	
April 28 th	“As much as 5,000 bbls oil /day”	
May 12 th	30 second sub-sea video	
May 21 st	Live video feed established	
May 27 th	Many different estimates made by different people: <ul style="list-style-type: none"> • 10,000 to 50,000 bbls oil/day • 36,090 bbls oil/day • 25,000 to 50,000 bbls oil/day 	12,000 to 25,000 bbls/day
June 2 nd		12,000 to 25,000 bbls/day
June 10 th		20,000 to 40,000 bbls/day
June 15 th		35,000 to 60,000 bbls/day
July 15 th	Oil flow stopped	
August 2 nd		62,000 bbls/day ($\pm 10\%$) initially and declined to 53,000 bbls/day ($\pm 10\%$)

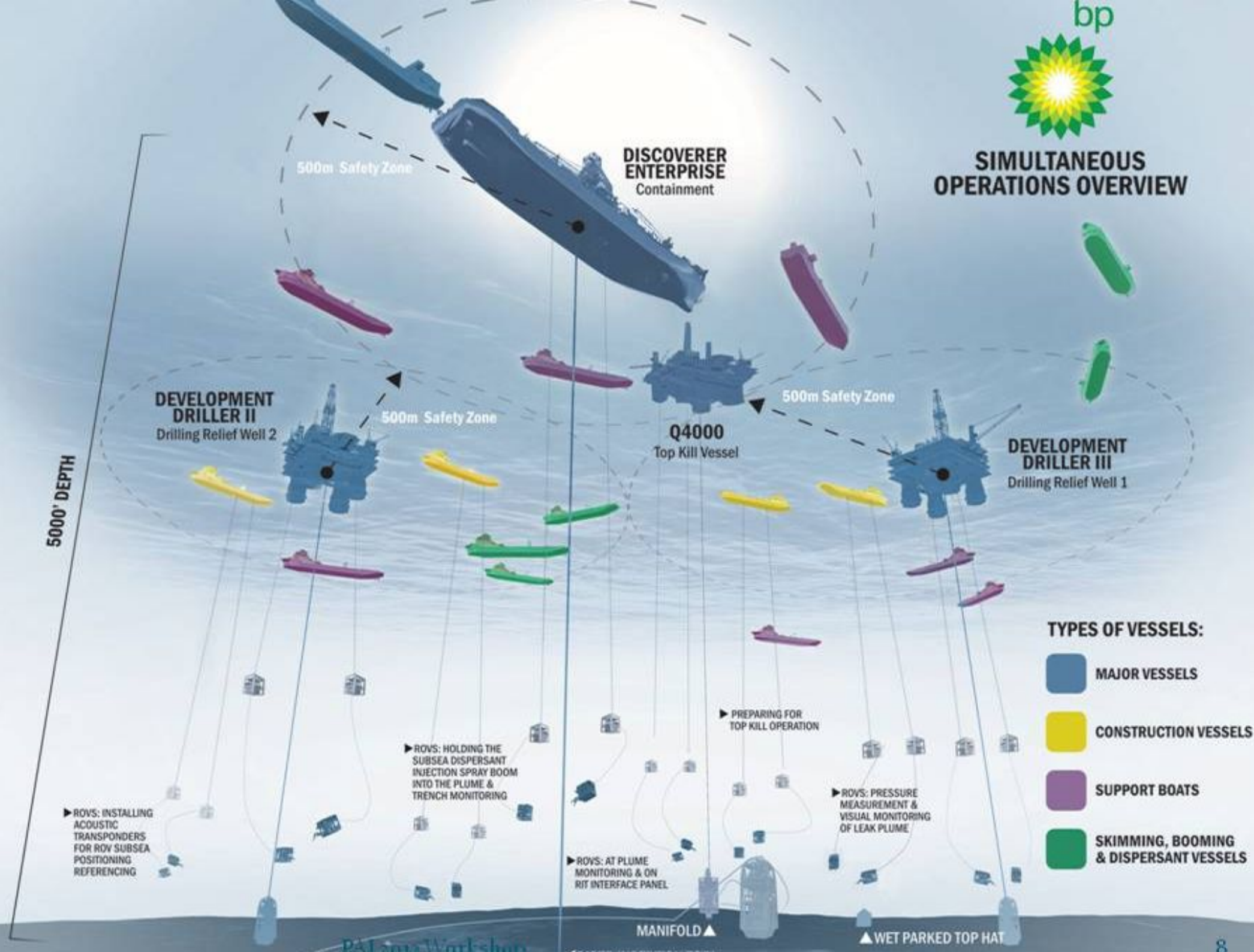
The *Deepwater Horizon* incident:

The response:

- 48,200 responders at peak
- 9,700 vessels at peak
 - 6,500 government and commercial vessels
 - 3,200 vessels of opportunity
 - 127 surveillance aircraft
- 3.8 million feet of hard boom and 9.7 million feet of soft boom deployed
- **1.8 million gallons of dispersants used**
- 411 in-situ burns conducted
- 1.4 million barrels of liquid waste and 92 tons of solid waste collected



SIMULTANEOUS OPERATIONS OVERVIEW



Use of dispersants on oil on sea surface

- The oil spill response contingency plans applicable to the Gulf pre-authorized the use of a list of specific dispersants
- At the direction of the Federal On-Scene Coordinator, responders first sprayed dispersants on the oil slick on the sea surface on April 22nd

Purpose of using dispersants on spilled oil on sea surface

- To prevent oil from drifting ashore and contaminating oil-sensitive marshes and coasts
- Transfer oil from the sea surface and into water column
 - As very small oil droplets (of 70 microns diameter or less) that would be retained in the upper 10 to 20 metres of the water column
 - Dispersed oil would be rapidly biodegraded by the naturally occurring micro-organisms in the waters of the Gulf of Mexico

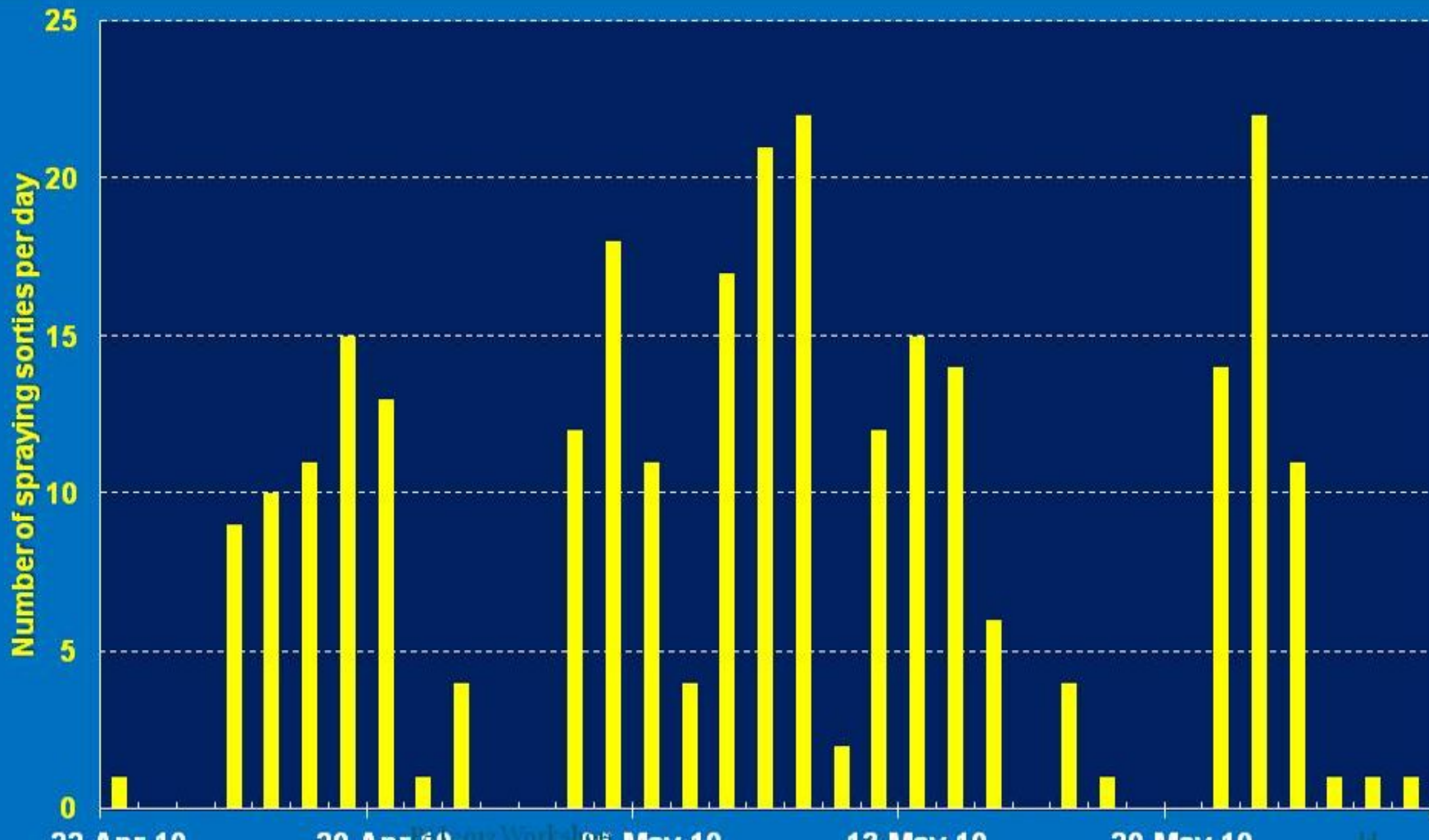
Use of dispersants on oil on sea surface

- Spraying from aircraft
 - Away from the exclusion zone around vessels
 - Various types of aircraft used
- Spraying from ships and boats
 - To suppress VOCs (Volatile Organic Compounds) from oil on sea surface to protect the responders





Aircraft dispersant-spraying sorties



Dispersant sprayed on surface oil



How effective was dispersant spraying?

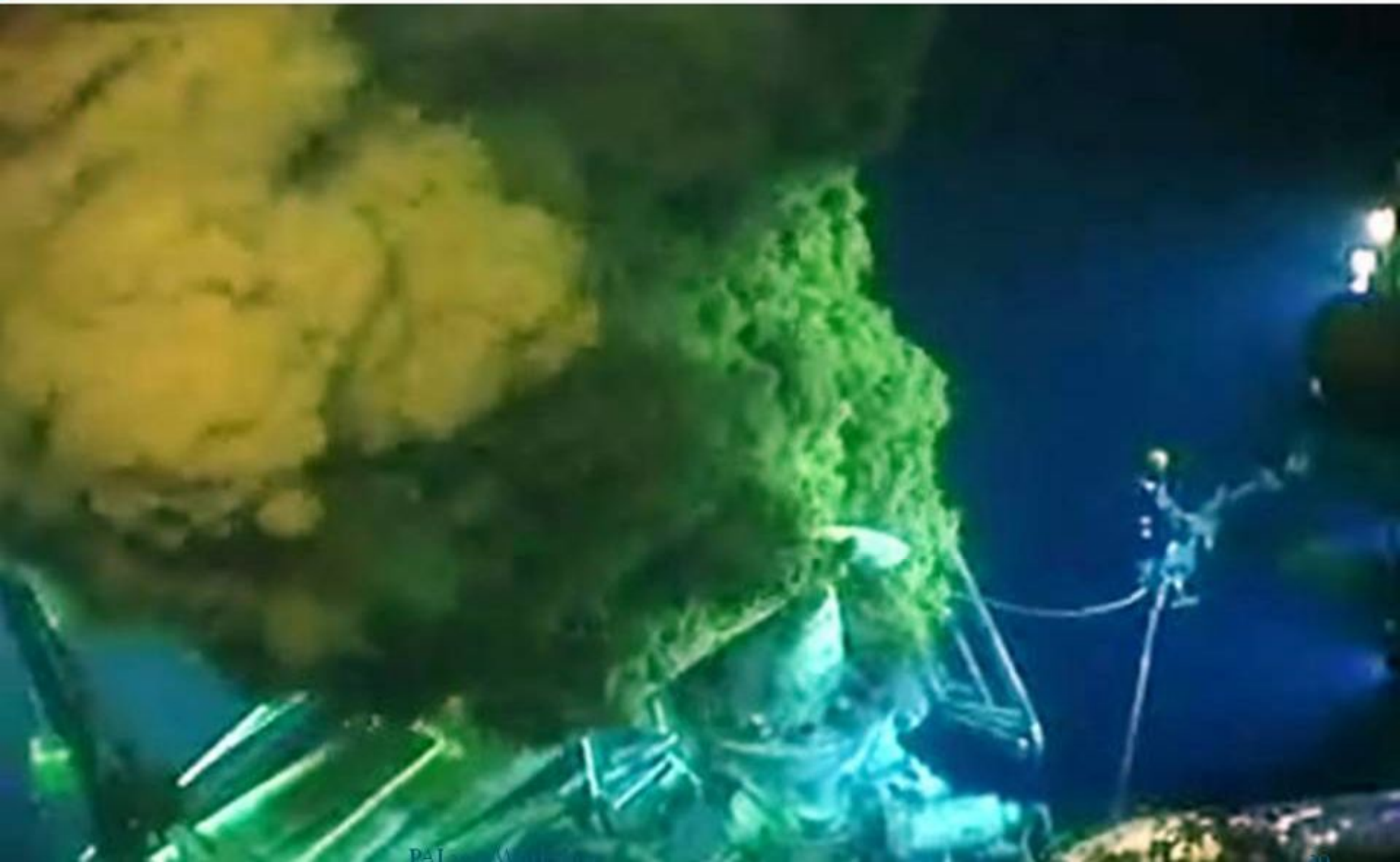
- The effectiveness of dispersant spraying **cannot** currently be directly measured at sea
- It is currently **not possible** to:
 - Quantify the total amount of oil dispersed into the water at any time, or
 - Quantify the amount of oil remaining on the sea surface at any time
- Indications of effectiveness are possible, but accurate quantification is impossible

Challenges to dispersant spraying

- Oil on sea surface was not present as a single massive oil slick
 - Oil on sea surface was present as small oil slicks scattered over a huge area
 - Targeting the thicker oil patches was difficult
- US Government Agencies introduced an increasingly complex system that required specific permission to be granted before spraying could be done
 - Permission had to be sought the day before spraying was conducted



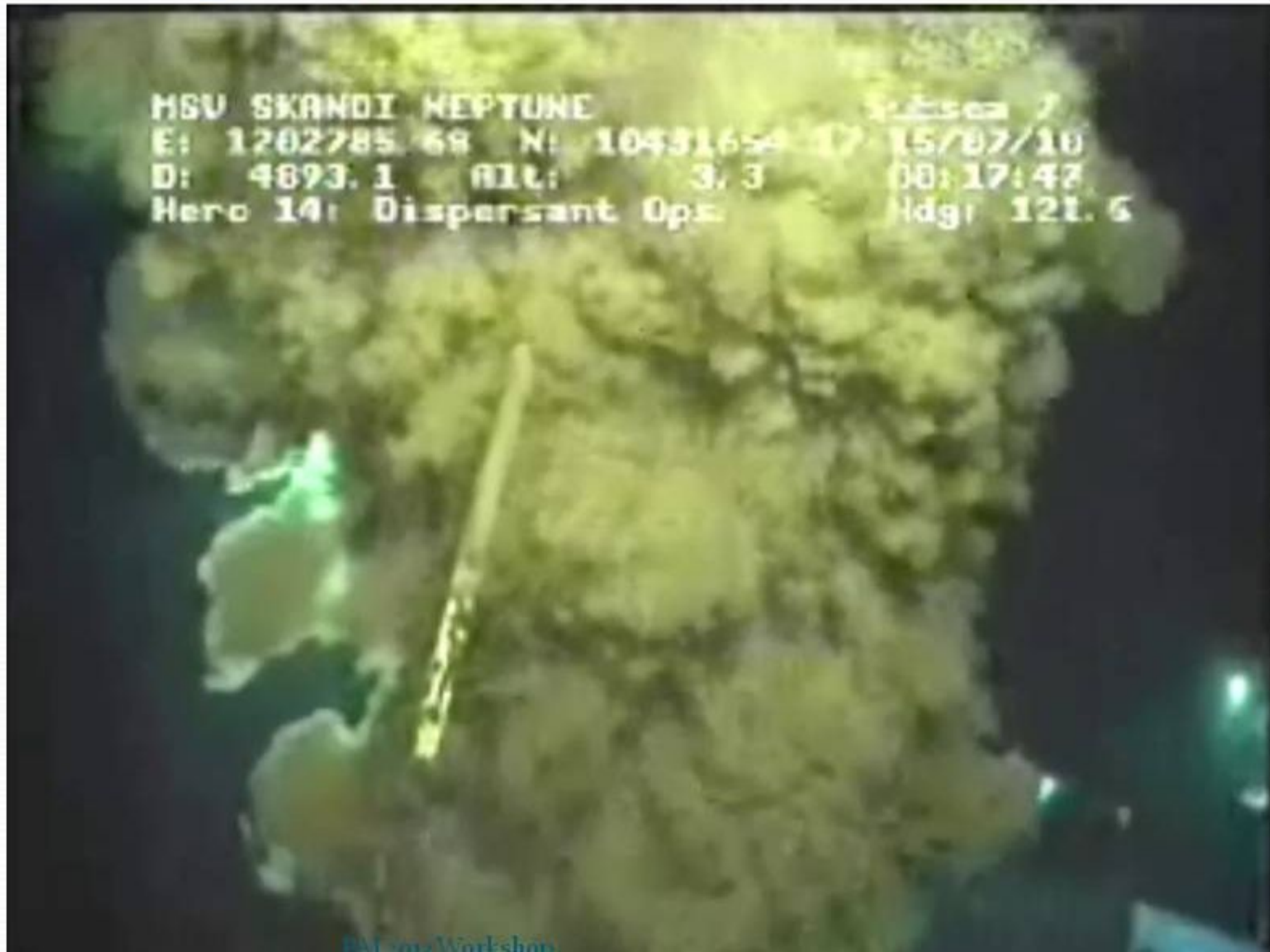
Sub-sea dispersant use



Sub-sea dispersant use

- Sub-sea dispersant use was first tried out on May 1st
- Sub-sea dispersant use had never been used before
 - No regulations existed about sub-sea dispersant use
- Aim was to prevent the oil from reaching the sea surface,
 - Or to at least reduce the amount of oil that reached the sea surface
 - So that the oil could not drift ashore and pollute the coast and marshes

Oil being dispersed sub-sea



MSV SKANDI NEPTUNE Subsea 7
E: 1202786.36 N: 10431617.19 11/06/10
D: 4888.7 Alt: 3.3 10:30:47
Herc 14: Dispersant Ops Hdg: 121.4

MSV SKANDI NEPTUNE Subsea 7
E: 1202786.94 N: 10431660.64 14/07/10
D: 4888.7 Alt: 3.3 19:15:22
Herc 14: Dispersant Ops Hdg: 135.6



Why use sub-sea dispersant addition?

- Spraying the oil with dispersant from aircraft when the oil arrived at the sea surface was proving difficult; it was too scattered
 - Why wait for the oil to come up before dispersing it back into the sea?
- Sub-sea addition of dispersant was into turbulent mixing zone as the oil and gas flowed out into the water
 - The dispersant was very effective in these mixing conditions
 - Less dispersant would be needed
- Sub-sea dispersant addition could be carried out 24 hours a day, 7 days a week

Sub-sea dispersant addition stopped

- *“It was unclear whether the National Contingency Plan’s pre-approval of the use of dispersants in the Gulf applied to subsea use in addition to surface use and therefore whether additional EPA approval and NOAA consultation were required”*
- *“Notwithstanding those uncertainties regarding governing law, on May 7, 2010, EPA halted subsea dispersant operations, awaiting additional test results”*

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling
THE USE OF SURFACE AND SUBSEA DISPERSANTS DURING THE
BP DEEPWATER HORIZON OIL SPILL
Staff Working Paper No. 4

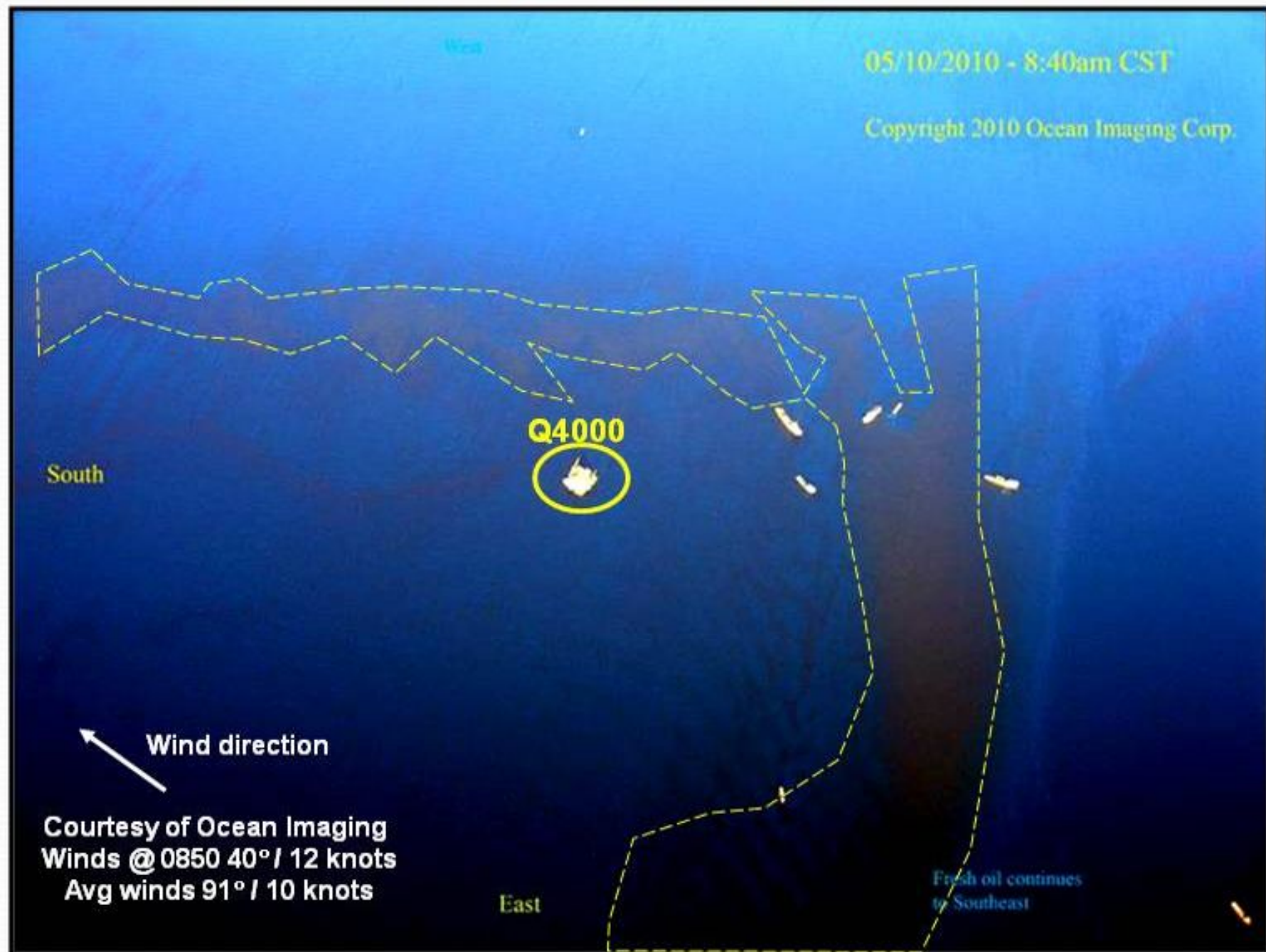
How effective was sub-sea dispersant addition?

- The effectiveness of sub-sea dispersant addition **could not** be directly measured
 - For similar reasons to those about dispersant spraying onto oil on the sea surface
- Various methods gave indications that oil was being dispersed by dispersant addition
 - Sonar images of oil coming from well-head disappeared as small oil droplets were below detection limit
 - Dispersed oil in water concentration increased when dispersant was added
 - Less oil reached the surface when dispersant was added sub-sea

May 9th: before sub-sea dispersant addition



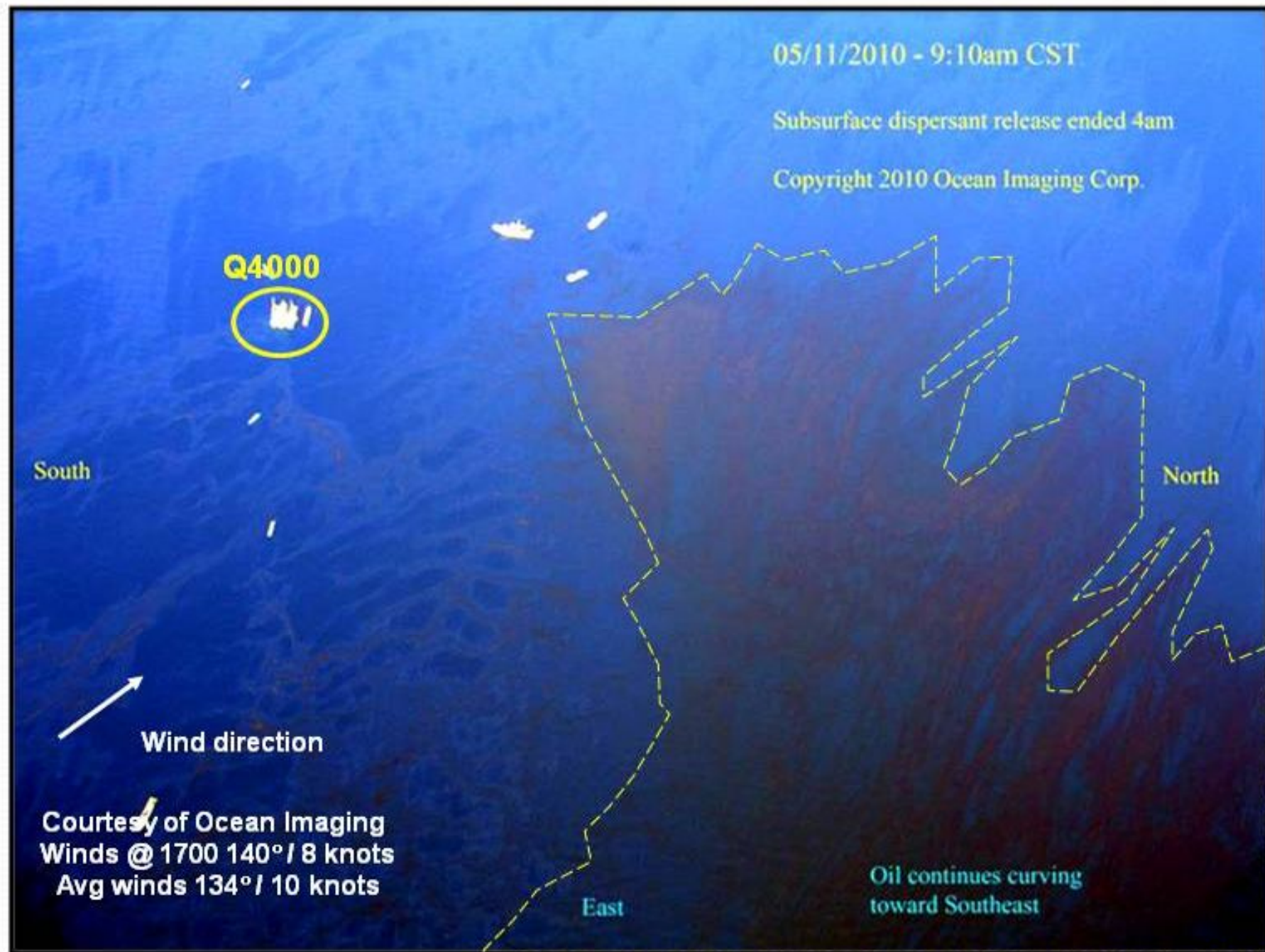
May 10th : After 3 hrs of sub-sea dispersant addition



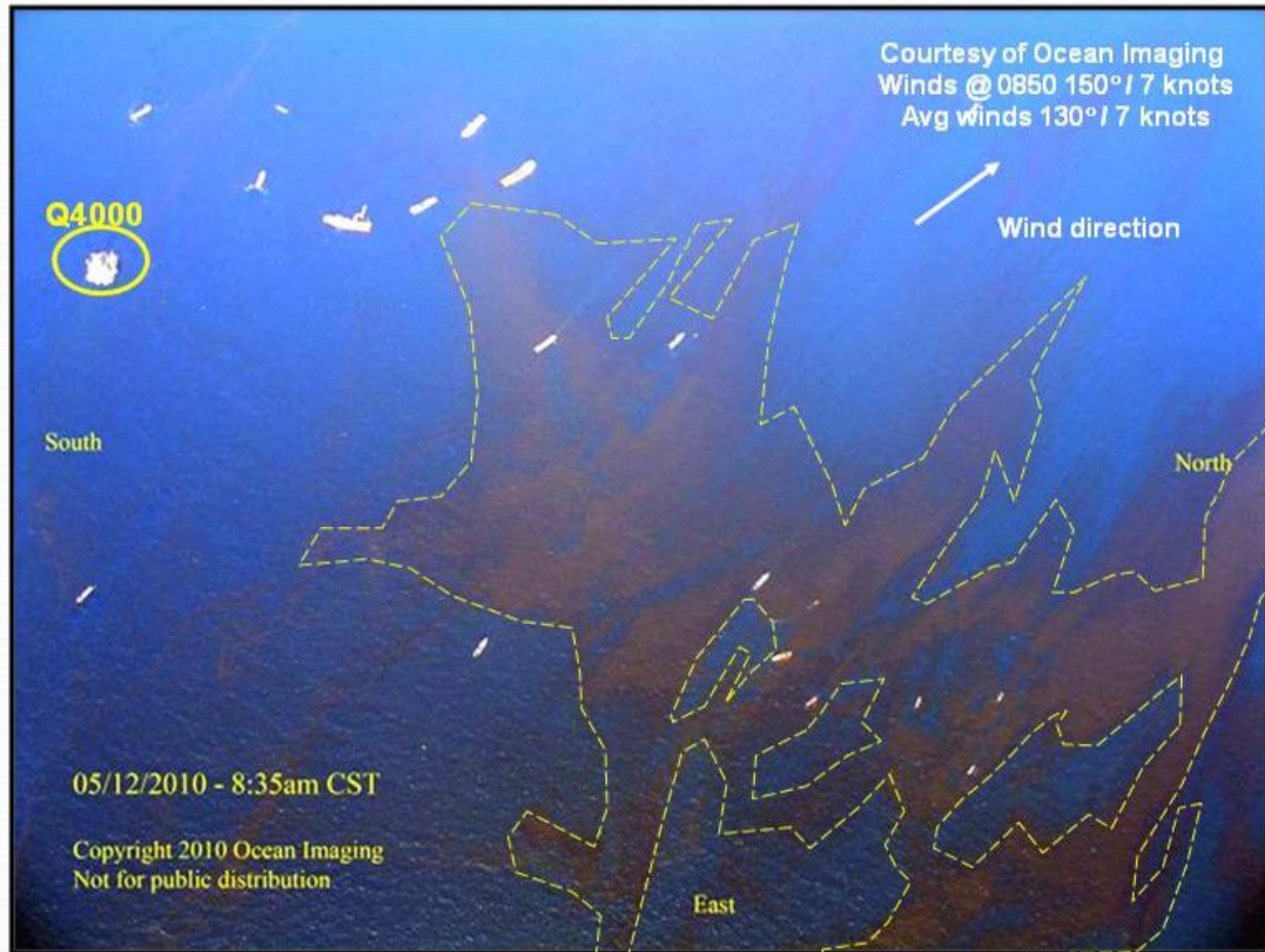
May 10th : After 11 hrs of sub-sea dispersant addition

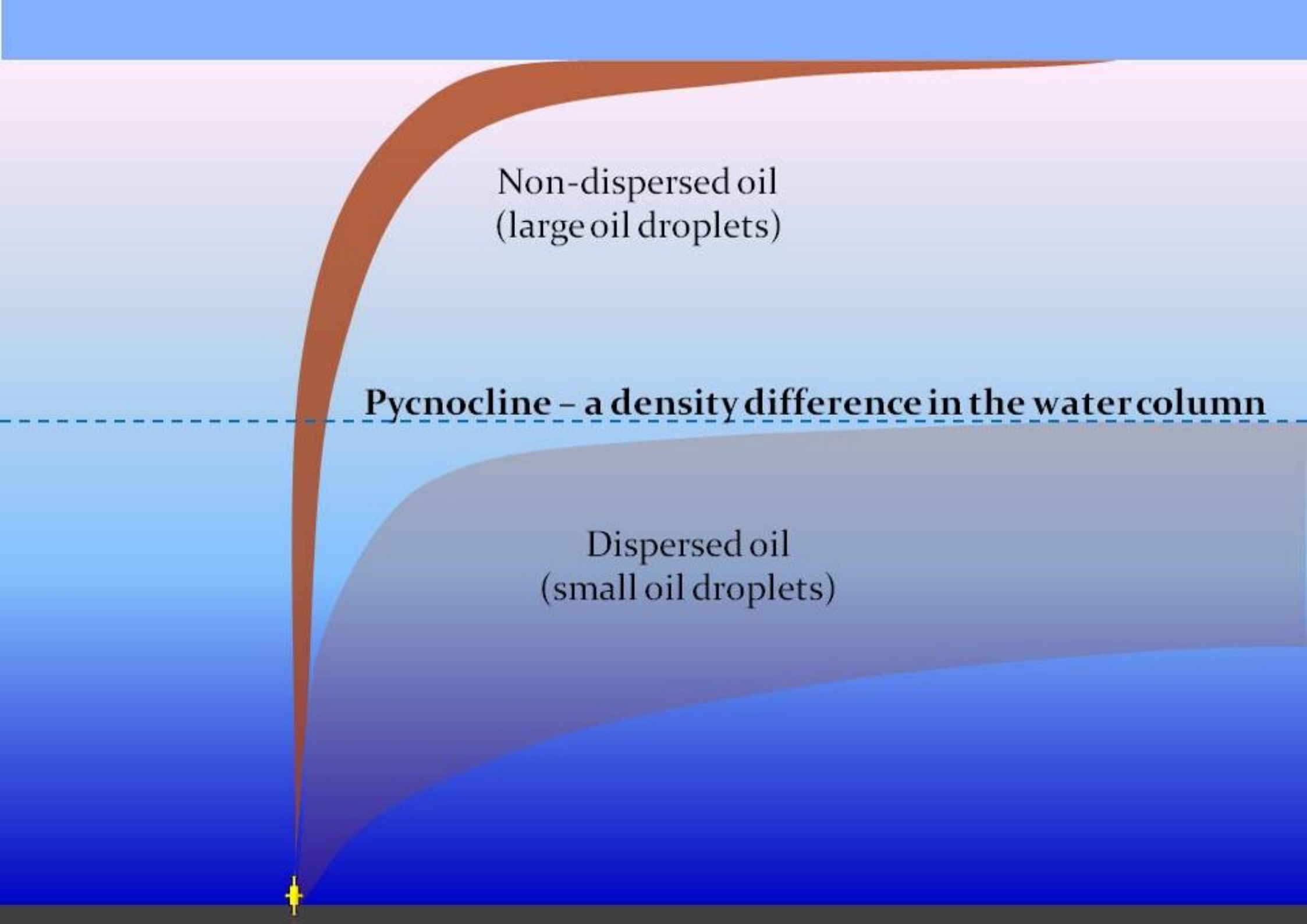


May 11th: 5 hrs after sub-sea dispersant addition ended



May 12th : 28 hrs after sub-sea dispersant addition ended





The diagram illustrates the vertical distribution of oil in a water column. A yellow oil rig is shown at the bottom left, with a thick brown plume of non-dispersed oil rising from it. This plume curves to the right and then levels off at the surface. A horizontal dashed blue line, representing a pycnocline, intersects the plume. Below the pycnocline, a lighter blue, cloud-like region represents dispersed oil droplets. The background is a vertical gradient from light blue at the top to dark blue at the bottom.

Non-dispersed oil
(large oil droplets)

Pycnocline – a density difference in the water column

Dispersed oil
(small oil droplets)

Sub-sea dispersant addition resumed

- On May 15th, after laboratory testing for effectiveness and toxicity had been conducted, and the tests that I have just described were carried out at sea, sub-sea dispersant use was allowed to resume

Concerns over dispersants

- Many people, including the general public, pressure groups and some administrators in the US Government, began expressing concerns about the scale and duration of dispersant use
- These concerns were magnified by misinformation circulating on the internet and in the media
 - Dispersant composition was not known to public
 - Concerns about possible toxic effects of dispersants to marine organisms and to humans (including people far from the response)

US EPA Limits dispersant use

- **May 24th**

- EPA issued Directives that demanded “a 75% reduction in dispersant use” and “elimination of surface application of dispersants, except in exceptional circumstances”
- EPA restricted sub-sea dispersant use to 15,000 gallons/day (357 bbls/day) of dispersant
 - At oil flow rate of 5,000 to 10,000 bbls/day the dispersant treatment rate would have been approximately **1 part dispersant to 21 parts of oil**
 - If, as was estimated by the FRTG on 2nd August, the oil flow rate was 53,000 bbls/day the dispersant treatment rate would have been **1 part dispersant to 148 parts of oil**

Continued dispersant use

- Under the direction of the NIC (National Incident Commander), USCG Admiral Thad Allen, sub-sea dispersant use continued until the oil flow was stopped on July 15th
- Sub-sea dispersant addition stopped on July 15th
- Dispersant spraying from aircraft stopped 2 days later as there were no more easy oil 'targets' to be sprayed

Total amounts of dispersant used

Dispersant	US gallons	Barrels	m ³
Sprayed from aircraft	976,249	23,244	3,696
Sprayed from ships	96,264	2,292	364
Sub-sea	771,288	18,364	2,920
TOTALS	1,843,800	43,900	6,980

Effectiveness of dispersant use

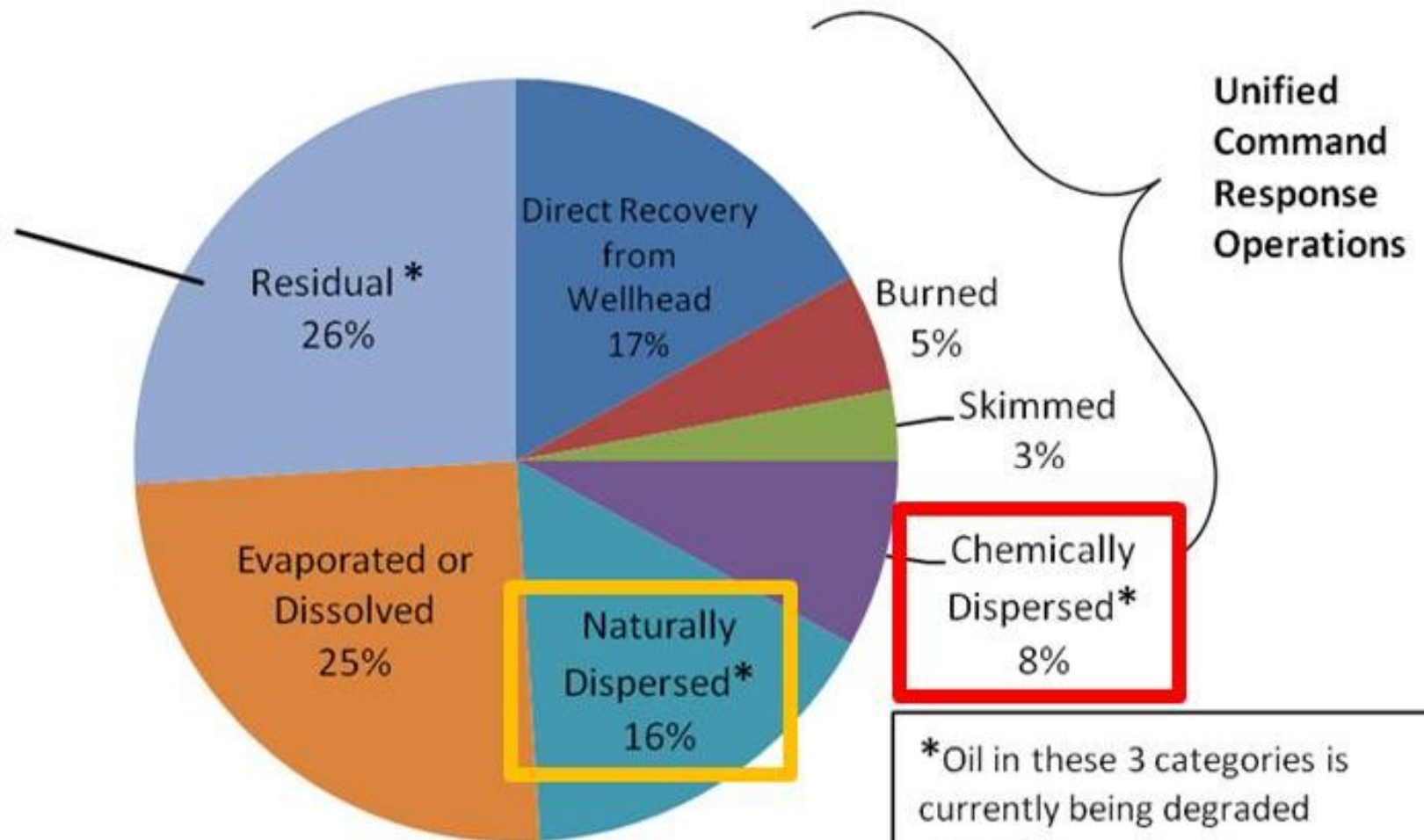
- How much oil was dispersed by the use of dispersant?
 - This is still not known with any degree of certainty
 - It could not be measured directly
- US Government has published two Oil Budgets with **estimates** of the fate of the oil
 - August 4th 2010
 - November 23rd 2010: The Federal Interagency Solutions Group, Oil Budget Calculator Science and Engineering Team, *Oil Budget Calculator: Deepwater Horizon-Technical Documentation*, November 2010.

August 4th 2010 Oil Budget

Deepwater Horizon Oil Budget

Based on estimated release of 4.9m barrels of oil

Residual includes oil that is on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments.



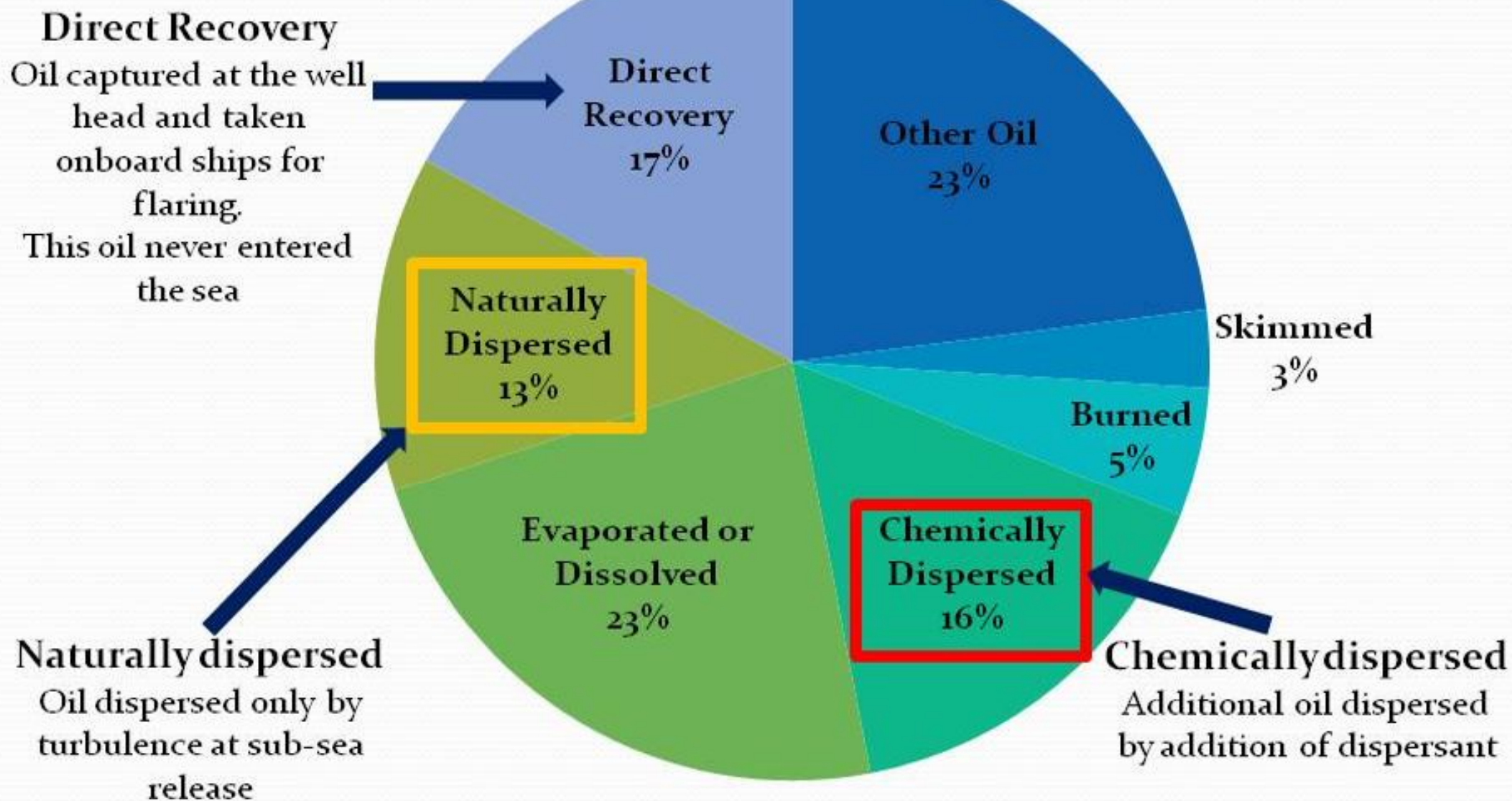
Differences between 4th August and 23rd November Oil Budgets

The Federal Interagency Solutions Group,
Oil Budget Calculator Science and Engineering Team,
Oil Budget Calculator: Deepwater Horizon-Technical Documentation,
November 2010

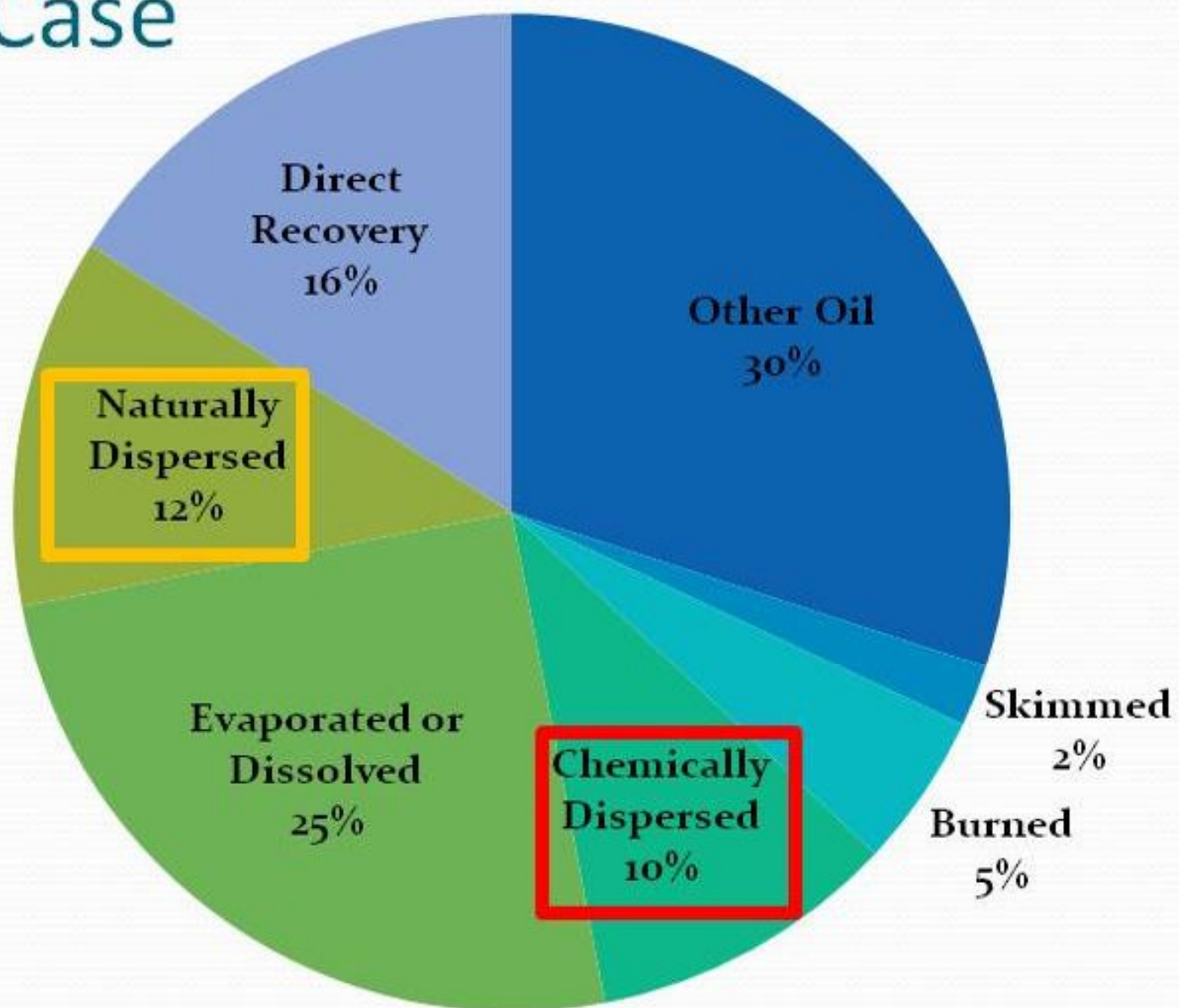
- *The most significant change is a doubling of the expected amount of oil classified as “chemically dispersed” — revised from 8% to an estimated 16% with a possible range of between 10% and 29%*
- Three estimates were given:
 - “Best” Case
 - “Expected” Case
 - “Worst” Case

November 23rd Oil Budget estimates

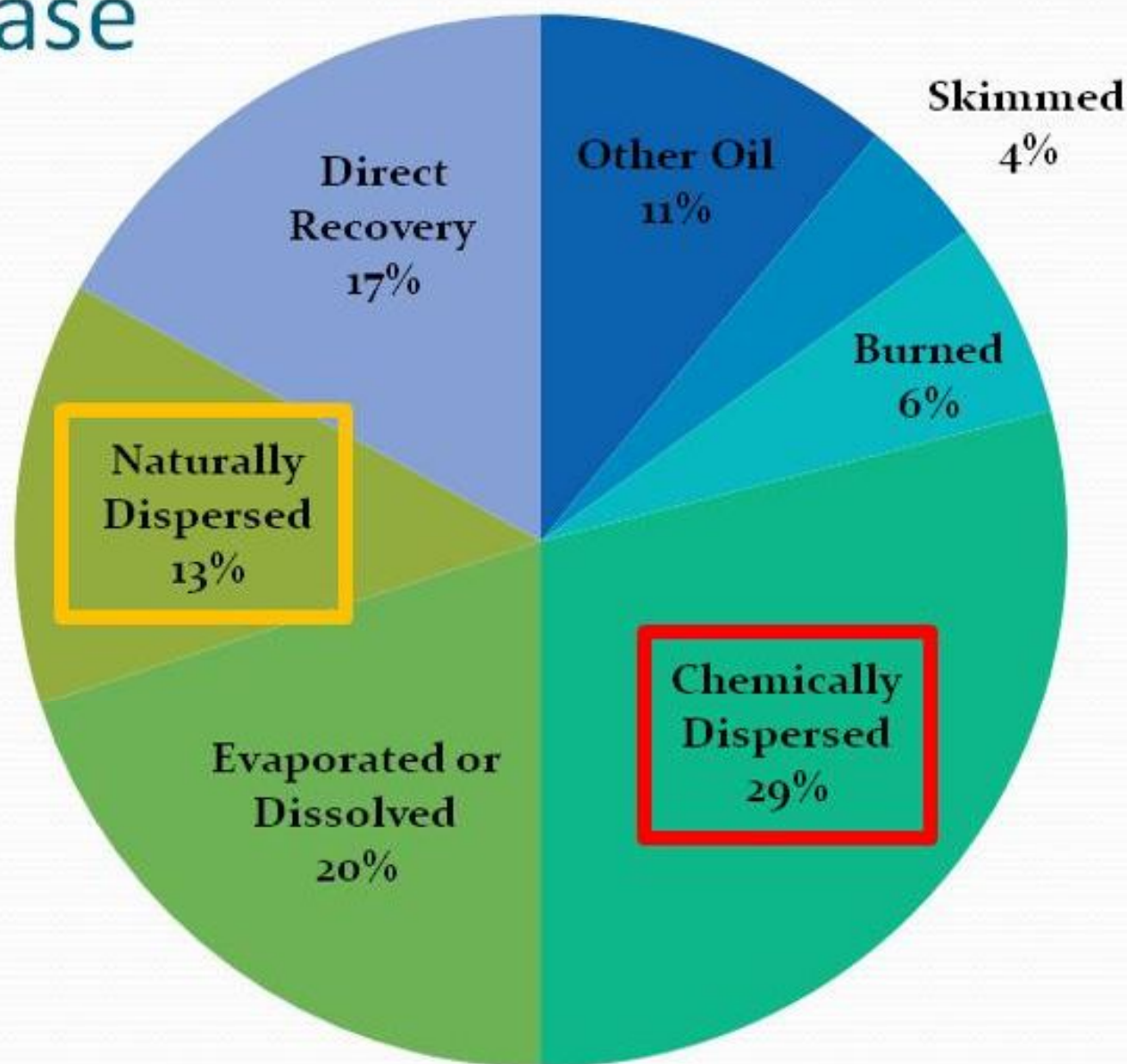
“Expected” Case



“Worst” Case



“Best” Case



Oil dispersed into the sea

	Naturally dispersed oil Oil dispersed only by turbulence at sub-sea release %	Chemically dispersed oil Additional oil dispersed by addition of dispersant %	Total Dispersed oil %
"Best" Case	13	29	42
"Expected" Case	13	16	29
"Worst" Case	12	10	22

Oil dispersed into the sea

- About 13% of the oil would still have been dispersed into the sea if no dispersant had been used
 - If a total of 4.9 million barrels of oil flowed from the well-head, approximately **640,000 barrelsof oil** was dispersed into the sea by the turbulence of the sub-sea release
- The use of dispersant (both sub-sea and on the surface) increased the amount of oil dispersed into the sea to:
 - “Best” Case Approximately **2,000,000 barrelsof oil**
 - “Expected” Case Approximately **1,400,000 barrelsof oil**
 - “Worst” Case Approximately **1,000,000 barrelsof oil**

How much oil remained after all response methods?

- **If no dispersant had been used**, and all other response methods were the same, 39% of the total amount of oil released would have remained at sea and some would have come ashore
 - 39% of 4.9 million barrels is **1.9 million barrel of oil**
- The amount of oil remaining at sea after dispersant use depends on which estimate is used:

• “Best” Case	9%	0.4 million barrel of oil
• “Expected” Case	23%	1.1 million barrel of oil
• “Worst” Case	30%	1.5 million barrels of oil

Did the dispersed oil harm fisheries?

- Fishing was banned while the oil was being released and for some time after the oil flow was stopped
 - This would have happened whether or not dispersant was used
- Fish catches were higher after the fishing ban was lifted than before
 - The area was over-fished and stocks recovered while the ban was in place

Did the dispersed oil harm marine life?

- There was (and is still) some concern over tainting of shrimp
 - Studies have found no problems
 - But some of the public remain unconvinced
- NRDA (Natural Resource Damage Assessment) studies will continue for years
- Many studies have been started
 - The *Deepwater Horizon* / Macondo is going to be the most studied oil spill in history

Conclusions 1

- A lot is still unknown about the effectiveness and consequences of dispersant use at the *Deepwater Horizon* / Macondo incident
 - Some things will never be known with any accuracy
- Dispersant use, particularly sub-sea dispersant addition, appears to have been very effective
 - At least 0.5 million barrels and perhaps 1.4 million barrels of oil were dispersed by the use of dispersant
 - This is in addition to the 0.6 million barrels of oil that was naturally dispersed

Conclusions 2

- The amount of oil that could have come ashore was substantially reduced by dispersant use
 - Studies that are still being conducted might help us to understand exactly what happened
- Dispersant use was hindered by a lack of understanding of some of the basic issues about dispersant use
 - A lot of misinformation and wild speculation about dispersants became available on the internet and this caused concern and fear in some people
- Studies currently being undertaken will clarify these concerns

Thank you
for your attention