Upland/Inland Spill Response:
Use of Underflow Dams

By

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ABSTRACT

On December 20, 1999, at approximately 10:45 a.m. crude oil was discovered in the Leaf River near Collins, Mississippi. The investigation determined the discharge was approximately 8000 Barrels originating from a source in the vicinity of State Highway 28 and Summerland Road, Jones County, Mississippi. The point of the release was located inland and in an upland type environment approximately 8 miles from the discovery location (Highway 84 bridge) near Collins, Mississippi.

After the line was shut-in and control of the source was certain, it was determined there were three distinct types of work areas remaining for the cleanup operations: an upland marsh type environment, an ephemeral flow creek bed, and a limited access river environment. Strategic objectives for the response included prevention of any further migration of oil down the Leaf River and prevent any additional oil from being flushed (during the next rain event) out of the upland marsh area down the unnamed creek and entering the Leaf River.

The focus of this paper is on the measures pursued by operations and the Unified Command that were designed to prevent any further oiling of the Leaf River in the event oil is flushed out of the upper marshy area as a result of the clean up operations or from a rain event. Operations installed a series of underflow dams at the confluence of the unnamed creek and the Leaf River as well as between the unnamed creek and the upland marsh area. These two stopgaps provided the necessary containment for the anticipated rain events forecast to occur early in the New Year. The series of dams were successful in controlling the total fluid flow, containing flushed oil and preventing additional oiling of the Leaf River during the first rain and throughout the remainder of the response.

Background

On December 20, 1999 crude oil was observed in the Leaf River near Collins, Mississippi from the bridge of Highway 84 heading east out of Collins. After notification and initial response by two pipeline operators with personnel in the Collins, Mississippi area, the source of the spill was determined to be from a pipeline operated by a third party. After a detailed search of the area (the search included the use of both rotary wing and fixed wing aircraft, and extensive land search) it was determined the release originated from a source near Highway 28 and Summerland Road, Jones County, Mississippi (Latitude 31^0 47.1' N and Longitude $89^0$22.9'W) southeast of Taylor, MS.[re1]

Incident Description

Over a certain period of time oil leaked from a small (0.25") hole in a 8" pipeline running between Soso and Gwinville Junction Mississippi. The line was a welded, 8 5/8 inch line used for intermittent transport of crude oil. The hole was located approximately 5 miles east of Soso at a low point in the line in an upland marsh area. The line moved approximately 1500 barrels of crude per day. During transfer operations oil seeped out of the hole and began a down gradient migration (via pore spaces) through the sandy loamy soil in the upper marsh area. It appears that this migration pathway, in conjunction with the vegetation overgrowth in the area severely hampered the visual observation of the oil during the regularly scheduled over flights.

When 1.27 inches of rain hit the area on December 19, 1999 (from USACOE Leaf River data) [re2] it appears the oil was flushed out of the marsh area, and began flowing down the unnamed creek into the Leaf River. The combined watershed acreage contributing to the ephemeral flow in the unnamed creek is substantial and the depth and flow of water in the creek increases significantly during rain events.

Operational Response Objectives

While the initial response operation focused on containment and recovery of the oil in the Leaf River, key strategic objectives in the command center included the following:

- Prevention of further migration of oil in the Leaf River, and
- Prevention of additional oil from entering the Leaf River, and
- Containment and recovery of oil in the un-named intermittent tributary that connects the source of the leak to the Leaf River.

The response operation was divided into three primary action plans. The operation in the Leaf River concentrated on the containment and recovery of oil contained at the Highway 84 location. Initially, Two additional collection and recovery operations were located (in sequence) downstream of the Highway 84 site. While the river operation was being implemented, the un-named tributary and the upper marshy field operational plans were also being implemented. The upper marsh cleanup involved trenching and vacuum recovery operations, passive type mitigation operations and excavation, repair of the leak location. The un-named tributary connecting the upper area to the Leaf River also had significant operational activities being implemented as well. All three of these key areas had operations underway simultaneously.

Personnel involved in the response had increased from 34 to 350 personnel in the first 4 days of the response. By the day after Christmas Unified Command was managing over 500 personnel during 24-hour operations.

Un-Named Tributary Operations

The source of the leak was approximately 8 miles up gradient of the Leaf River. The migration pathway the oil followed was initially through a gradual slope through a marshy area for a distance of approximately 2.0 miles where the slope increased significantly. The tributary connecting the upper marshy areas with the Leaf River was largely inaccessible to any type of equipment and it was necessary to conduct extensive clearing of small trees and underbrush so that equipment and personnel would be able to set up needed containment and recovery operations. While this tributary is ephemeral in nature, it does provide drainage for a significant watershed area. Therefore, when it does rain the watershed channels the collected rain from the saturated ground directly to the Leaf River via this unnamed tributary. Water levels in the un-named tributary (during rain events) increased as much as 5 feet in the upper end to 10 feet in the lower part of the tributary at the confluence.

Underflow Dam Construction

Crews comprised of welders, equipment operators and construction personnel were organized within the Incident Command System (ICS) under the Emergency Response Branch[re3] Director's supervision and both construction and installation was conducted at each dam site.

Dams were installed in both the upper and the lower end of the creek. The dams installed at the upper end of the creek were constructed using typical (albeit heavy duty) earthen construction methods that were reinforced and strengthened by the addition of polyvinyl sheeting and sand bags. The upper dams were located where the impact of rain could be characterized as follows:

- The rain induced flow would be manageable with the dams installed, and
- The expected volume and rate of any rain induced flow would be manageable with the earthen dam construction methods, and
- The removal rate (e.g. skimmer recovery and vacuum truck work cycle) was expected to be greater than the oil encounter rate.

An additional three dams were installed in the lower creek.

Drainage from the entire watershed is through lower end of the un-named tributary into the Leaf River. The drop in elevation from the upper marsh area to the Leaf River is approximately 150 feet over a distance of approximately 2.0 miles.

Dams constructed in the upper area had a lower and wider[re4] suitable for containment, oil recovery and total fluid management with a relatively lower flow rate than required at the lower end of the unnamed creek. The topography at the lower end of the creek consisted of a narrow, deeper channel, and in this location the forces associated with the increased water flow would be significantly greater and more concentrated requiring a different design strategy in order to successfully manage the water flow. Additionally, the dams at the lower end would have to manage the entire drainage volume, while the upper series of dams would only be required to manage roughly one third of the total volume. The general construction of the lower dams included the following items:

- Materials:
  - Fill material - sand
  - Gravel support and erosion control
  - ½ in 4'X8' carbon steel sheets – schedule 40 (ANSI Standard Rating)
  - 10" Inside Diameter carbon steel piping – schedule 40 (ANSI Standard Rating)
  - 10" Inside Diameter carbon steel 90^0Joint - schedule 40 (ANSI Standard Rating)[re5]
  - 10" Inside Diameter Gate Valves
  - Polyvinyl Sheeting – (minimum thickness - 6 mil)
  - Miscellaneous carbon steel materials were used for the construction of personnel stairs and safety railing providing access to the valves.

- Personnel:

  Personnel involved in the installation process included welders, helpers, oil spill technicians, and un-skilled laborers. These personnel were organized using ICS and housed in the Emergency Response Branch of the Operations Section. Under the direction of a work group supervisor, the teams were assembled for the site preparation, readiness, design and assembly of the steel reinforced underflow dams.

The operation utilized two three dam systems designed for containment and recovery of oil and provide sufficient flow of added water to prevent overflow of the oil / water mixture. By using three dams at both ends of the drainage there would be enough system redundancy to provide the necessary collection and recovery capability, fail-safe capability and an improved capability to successfully manage the increased oil / water flow during rain events. Table 1 provides a comparison of the number of pipes necessary to provide equal flows based on the inside diameter of the available pipes.

Underflow Dam Pipe Size Chart
(Equivalent Number of Pipes)

Pipe Size (inches)	4" Pipe Size	6" Pipe Size	8" Pipe Size	10" Pipe Size	12' Pipe Size
12" Pipe Size	9 Pipes	4 Pipes	3 Pipes	2 Pipes	1 Pipe
10" Pipe Size	7 Pipes	3 Pipes	2 Pipes	1 Pipes	2 Pipes

(Adapted from TEEX Oil Spill Control School Manual training manual)
Table 1

Proven Success

The National Weather Service[re6] predicted the next rain event would occur during the last week in December 1999 or the first week in January 2000. The rain began in earnest about 2000 hours on January 2, 2000 and continued until approximately 0300 hours on January 3, 2000. This rain event delivered a reported 2.11 inches (from USACOE Leaf River data) [re7] to the watershed on January 4, 2000.

The flow rate of the creek approached an estimated maximum rate of flow of approximately 6.5 to 7.0 knots per hour during the first rain event. Additionally, the water levels at the lower end of the unnamed creek raised 8 feet overall and as much as 10 feet in selected locations. The three dam system installed in the lower creek and the upper creek easily managed this increased throughput despite a partial failure of the first dam in the lower creek series, and successfully contained the oil, provided recovery locations and prevented re-oiling of the Leaf River.

With the five-pipe configuration installed in the dams, and by using a three dam system, there was the capability to manage a throughput approaching 14,532 gallons per minute at the estimated flow rate of 7.0 knots.[re8] The gallons per minute through a pipe formula is presented below:

Estimated Dam Throughput

- GPM for each pipe = (0.0408 * Pipe diameter (inches^2) * Ft. / Minute[re9], where
- Knots * 101.769 = Ft. / Minute
- GPM for each pipe = (0.0408 * 10^2 *(7)(101.769) = ~2909 gpm
- 5ea. 10" pipes per dam = ~14,532 gpm [re10]

Summary / Conclusion

Through the installation of the three dam series at both the upper and lower ends of the unnamed creek, operations was able to successfully contain and manage the flushing of oil during day to day operations and all of the ensuing rain events, thus preventing a secondary oiling of the Leaf River. This ensured the successful attainment of all key strategic objectives set forth by the Unified Command for the emergency response operations. More importantly, the operations section was able to ensure that there would be no additional oiling of the Leaf River.

Through utilization of currently recognized methods for underflow dam construction, such as the guidelines published by Texas A & M University, Texas Engineering Extension Service (TEEX), the EPA and others the use of underflow dams can provide a highly successful operational containment and control measure for inland / upland spill response operations. Planning, Operations and Logistics will be able to use these standard methods to evaluate the piping necessary to effectively manage the fluid flow requirements, operational equipment needs, define the necessary materials, and set the construction and implementation guidelines.

PHOTOGARAPHIC SERIES

Photographic Series

Collins, MS
12/30/99 – 12/31/99
Site: Area 1A
Underflow Dam Construction

Collins, MS
12/30/99 – 12/31/99
Site: Area 1A
Underflow Dam Construction

Collins, MS
12/30/99 – 12/31/99
Site: Area 1A
Dam Construction

Collins, MS
12/31/99
Site: Area 1A
Dam Construction

Collins, MS
12/30/99 – 12/31/99
Site: Area 1A
View of Creek From Dam

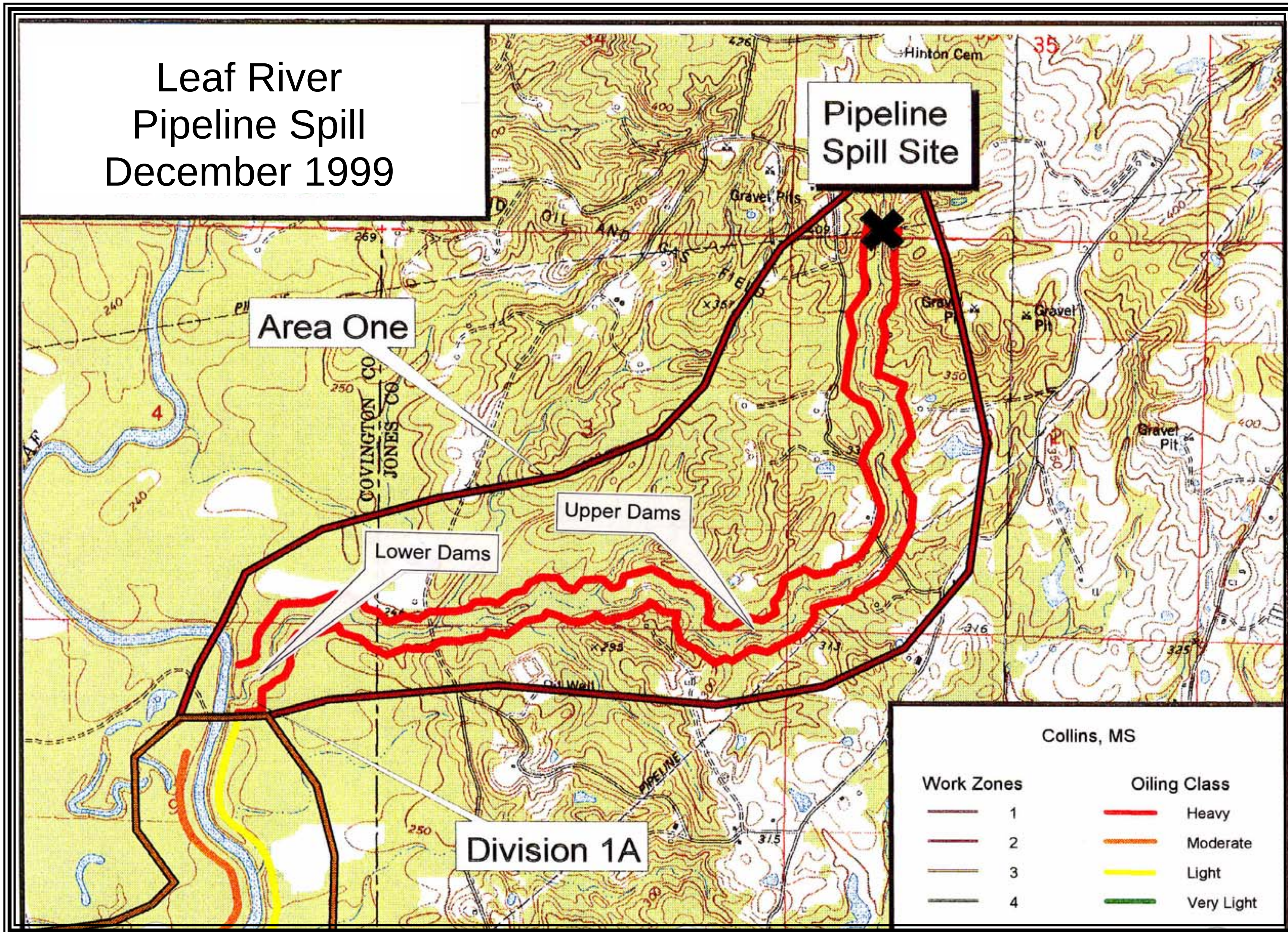
Collins, MS
12/30/99
Site: Area 1A
Outfall – Underflow Pipes - Construction

Collins, MS
12/23/99
Site: Area 1A
Dam 2 – Underflow Pipes

Collins, MS
01/01/00
Site: Area 1A
Dam 2 – Underflow Pipes

Collins, MS
12/31/99
Site: Area 1A
Second Underflow Dam

Collins, MS
01/01/00
Site: Area 1A
Dam 3 Outfalls – Underflow Pipes


Leaf River
Pipeline Spill
December 1999
Pipeline
Spill Site
Area One
Upper Dams
Lower Dams
Division 1A
Collins, MS
Work Zones
1
2
3
4
Oiling Class
Heavy
Moderate
Light
Very Light

References

Incident Action Plans during the response

TEEX Inland Oil Spill Control Course Student Manual

Glover, TJ, Pocket REF Second Edition, Sequoia Publishing, Inc. May 1998

[re1]Put the map on page 16 here.
[re2]Recommend deleting table 2. It's confusing to interpret. Provide a link or reference.
[re3]Standard ICS terminology
[re4]Word(s) missing?
[re5]Consider spelling out inside diameter and explaining "schedule 40."
[re6]The Weather Bureau became the National Weather Service in 1970 when NOAA was created.
[re7]Recommend deleting table 2. It's confusing to interpret. Provide a link or reference.
[re8]Show this calculation. I calculate 17,354gpm. See review form comment.
[re9]Where does this formula come from?
[re10]1kt=6076ft/60min/hr=101.27ft/min