As a high river flow was expected around the middle of March due to melting snow, the beginning of March was targeted for the beginning of operations. It was decided to take the stretch of river from the scene of the spillage, where riverbed pollution was high, to a point 5 km downstream, and to set up a river filter just upstream of the Nanmonbara Bridge that is located near this 5 km point. This location was considered to be ideal, as the riverbed was flatter than at other locations, affording an area where the work could be effectively carried out.

5. Final Phase

5.1 River Cleaning

The setting up of the river filters was started on March 1 and took five days to complete. On March 7, the river cleaning operations began. In carrying out the cleaning, high pressure pumps and fire truck pumps were used to clean the oil that had settled on the riverbed and areas surrounding the river so that the oil was carried downstream on the river surface where it was recovered using the oil fences that had been previously set up, as well as oil mats, ceramic absorbent materials, straw mats, and suction pump trucks. Vegetation that had become coated with oil was also cleared. The cleaning operations were accomplished by a team of 20.

With regard to the supervision of the operations, Chugoku Electric and Geihoku Town cooperated in water quality tests conducted both before and after the cleaning operations, to investigate the effects on the flow downstream and thus obtain a quick grasp of the results.

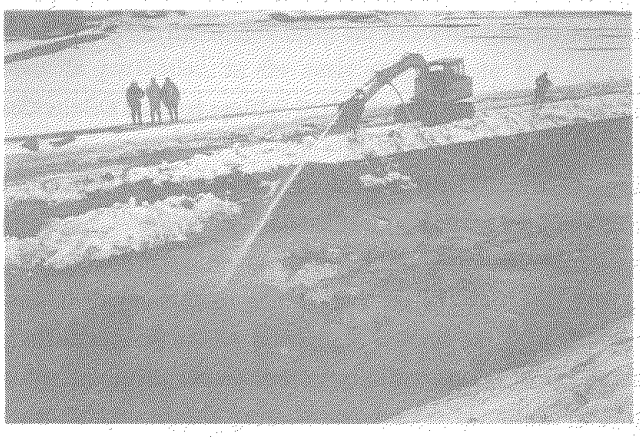


Photo.3 Cleaning operations using a high pressure pump (March 9)

Photo.4 Cleaning operations using rakes (March 7)

To prevent the possibility of secondary pollution, the recovered fuel oil was placed in oil drums and stored at a temporary storage area provided at the Saioto Ski Ground.

The cleaning operations, although a little slow on the first day, progressed steadily as the workers became accustomed to the job. In the five days from March 7 to March 11, work progressed a distance of 2.6 km. Although it was initially planned to proceed a distance of 5 km, for reasons described below, the operations were brought to a close at that point.

i) Based on the results of the water quality tests carried out concurrently with the cleaning operations, it was found that the level of pollution dropped significantly with distance downstream, and the impact of the fuel oil spillage on the water downstream and in the dam reservoir was judged to be negligible.

ii) The environmental impact of the cleaning operations themselves on the river and ecosystem was considerable.

iii) The water level of the river more than 2.6 km downstream is higher due to the confluence of other rivers as a result of which the use of high pressure pumps for cleaning becomes impossible and cleaning within the river would also be difficult.

5.2 Disbanding of the On-site Committee

After completion of the river cleaning operations, prevention of the pollution source from permeating underground, stopping of the surface flow and flow into the watercourse, and carrying out of regular water quality tests, the Saioto River Fuel Oil Spillage Incident Countermeasures Committee was disbanded at noon on March 25 after making the declaration below. The 36 days following the occurrence of the spillage incident saw the earnest efforts of about 3,600 people from national, prefectural, and town bodies, as well as from industry and the local community.

With regard to the disbanding of the Saioto River Fuel Oil Spillage Incident On-site Countermeasures Committee

On this day, having confirmed that the treatment of the source of the pollution and of the river course have been successfully completed with regard to this incident, and judging that there remains no danger of the spread of this pollution, the on-site countermeasures committee is hereby disbanded.

It is certain that, from the time of the occurrence of this incident, the various organizations involved made every effort, with the limited manpower and materials at their disposal and working under harsh environmental conditions, to minimize the resulting damage.

We hereby pledge our continued efforts in restoring the beauty of the Saioto, Takiyama, and Odomari regions so loved by the people.

March 25, 1994
Saioto River Fuel Oil Spillage Incident
Countermeasures Committee

Receiving this declaration, at 2 o'clock in the afternoon of the same day, the Ohtagawa River Anti-pollution Committee opened their third meeting, and after announcing the following appeal, the Oil Spillage Incident Sub-committee was also disbanded at 3 o'clock.

Appeal for the Preservation of the Water Quality of the Ohtagawa River

1. The waters of the Ohtagawa River are of prime importance in the lives of more than 1.6 million inhabitants of four cities, twenty seven towns and two villages, providing their source of domestic water, as well as supporting manufacturing, agricultural and fishing industries. The river also plays an

important role in providing the habitat for an abundance of wildlife and supports the catchment's natural ecosystem. For these reasons it is of vital importance to make every effort to preserve the water quality and prevent pollution incidents from occurring throughout the entire length of the river from its upstream origin to its downstream estuary.

2. The Ohtagawa River Anti-pollution Committee, while entreating the various organizations concerned to fulfill their obligations toward the preservation of water quality and prevention of pollution incidents, plan to pursue a stronger policy of contact and cooperation in the future. Furthermore, learning from this incident, it is intended to make assurance doubly sure by promoting a campaign for the prevention of water pollution and providing training in water pollution countermeasures.

6. Summary of the Incident

6.1 Report from the Persons Responsible

The report from the person who discovered the incident took a little over two hours to reach the river management authorities. This resulted in delays in the measures taken at the crucial initial stages and had an effect on subsequent recovery operations.

To cope with this deficiency, it is considered necessary to educate the night-watchmen with regard to emergency contact procedures, and also to make industry and the general public aware of where to report to, including police and fire services.

6.2 Integration of Information Processing

In the case of a serious river pollution incident, there is a good possibility that the countermeasures will extend over a considerable period of time, and the associated information arising from the incident is multifarious and extensive. In particular, in the early stages there is a concentration of information exchange and considerable efforts were made to integrate the reception and transmission of this information.

At the site of the incident, a patrol car equipped with a mobile radio was used for the transfer of information as a means of securing close communication between the clean-up groups, patrol groups, and countermeasures committee. In the future it is essential to improve mobility through the use of portable radios and telephones.

6.3 Choosing the Most Suitable Methods

Countermeasures dealing with the source of the pollution are of prime importance, and the discharge into the river should be stopped in the shortest time possible. In the case of this particular incident, the initial response was delayed and considerable time was required to completely stop the discharge into the river. However, the provision of the retention ponds enabled effective oil recovery. Once the discharge has entered the rivers, the clean-up and recovery operations are greatly restricted by the prevailing natural conditions, so it is therefore of considerable importance to make every effort to stop the discharge of the pollution at the source.

With regard to the river course countermeasures, the main methods adopted were the setting up of oil fences in the river to stop the flow of fuel oil downstream and the use of absorbent oil mats to recover the oil. However, the optimum water flow speed of 20 cm/min, at which the most effective recovery is achieved, was exceeded at most locations. Particularly when melting snow caused an increase in the river flow there were cases where overspill of the oil fence occurred, and in extreme cases the fences had to be temporarily removed to prevent them being swept downstream. As a location of relatively slow water flow, the vicinity of water intake weirs was found to be suitable.

The locations chosen for setting up the oil fences was mainly in the vicinity of bridges where transportation access was available in the snow. While the setting up of the fences does not particularly

require experience, to be effective in the case of an emergency, some degree of training and knowledge is called for.

The mats used for the recovery were in most cases single oil mats, the mats being recovered by hand using such things as bamboo poles. There were problems in locations where the flow was rapid, and there were cases where mats went over the top or underneath oil fences and were swept downstream. In such cases, the use of curtain type mats was found to be effective. Also, as the work was carried out during severe wintry conditions, the surface of the mats in use froze overnight reducing their effectiveness by half, it was therefore necessary to turn over the mats by hand.

The proposed river filter method prevents not only surface oil, but oil at the middle and lower layers of the river from being swept downstream. In the current case, the filters were not set up until 16 days after the incident occurred, so they played no part in the initial response to the problem. However, as a means of river cleaning, their performance fully matched expectations.

There were some objections within the river management authorities over the cleaning of the river. It was pointed out that most of the oil had been recovered and only a relatively small quantity of oil remained on the riverbed, which, even if it were to flow into the dam reservoir, would have no significant effect on the water quality. Also, as the oil on the riverbed is stable, it could be considered inadvisable to take positive steps to remove this oil and cause it to flow downstream. Not only that, but the effects of the cleaning operations on the natural environment should not be ignored. These opinions were give n adequate consideration by the On-site Countermeasures Committee who decided, "In line with the initial policy, the discharge downstream of the oil will be kept to a minimum, and every effort will be made to recover the oil and return the river environment to its original condition."

Counter measures and Results

	Recovery Method	Site Conditions	Effect - Applicable Action - Results
Pollution Source	Withdrawal of contaminated snow and soil Recovery using retention ponds	• The presence of snow made the assessment of the conditions difficult and the discharge into the rivers continued • Permeation of the fuel oil covered a large area and the discharge was not stopped	• Excavation and withdrawal were performed with a back hoe. • Discharge into the rivers was sharply reduced • Recovery in the retaining ponds stopped the discharge into the river.
Dam Reservoir	Oil fences Oil mats	• Snow was considerable and the steep topographical conditions made work difficult and dangerous	• Assignment of the SDF to the site requested • Four oil mats were set up • Oil mat recovery operations were carried out
River Course	Oil mats, curtain type mats Oil fences River filter method	• The flow was rapid, mats went over the fences • Mats went under the fences. • Water level increased due to melting snow. • As it was the winter season, freezing occurred at night • Recovery performance was halved. • Fuel oil settlement occurred • Fuel oil flowed downstream in the middle and lower layers of the river • There was a necessity for river cleaning	• The vicinity of water intake weirs is suitable • Effective recovery • Temporary removal. • Mat turning carried out • Recovery from all levels of the river made possible • Flow downstream is prevented • Time is taken to set up.

In the case of a water pollution incident, the assignment of a specialist advisor is necessary at the initial stage to determine the nature of the pollutant and the suitable countermeasures to be taken in the prevailing circumstances.

To prevent the possibility of secondary pollution, the recovered pollutant material was brought to a single designated location where it was placed in vinyl bags and stored for collective treatment. The treatment was carried out with the greatest of care under the guidance of specialists such as the staff of Kabe Health Center.

6.4 Effects on Water Quality

In the initial phase of the incident, high concentrations of n-hexane were found in the river course leading to the Odomari Dam reservoir as well as a foul odor.

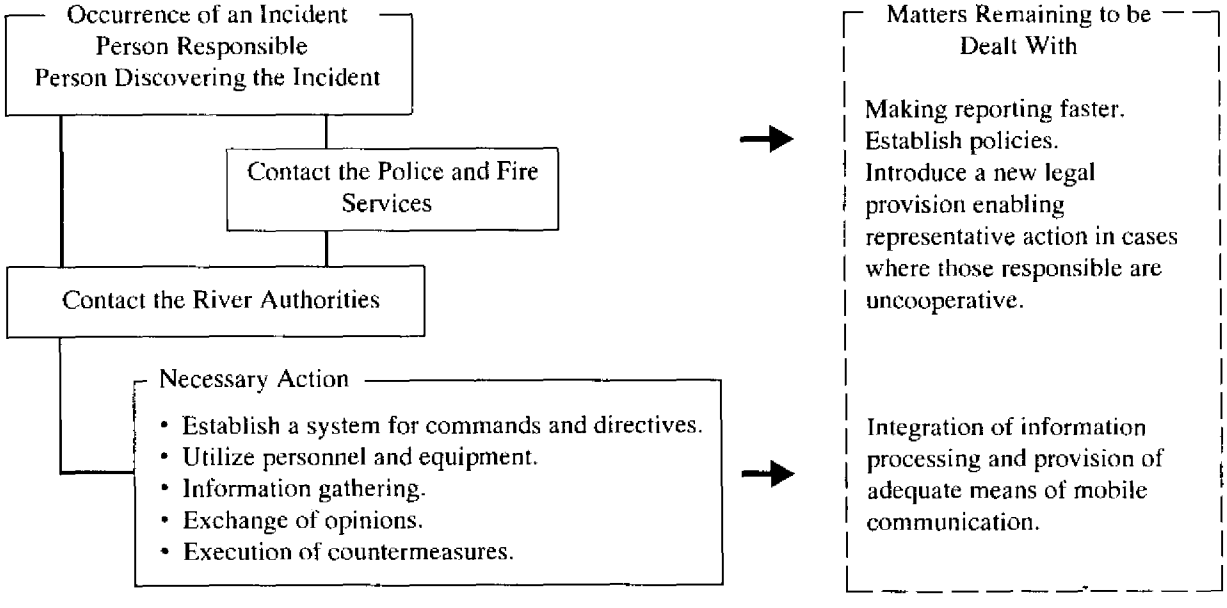
Some of the fuel oil mixed with the river water (emulsification) to form a white pollutant which settled in the river, and as the oil mats can only be used to recover the oil floating on the water surface, considerable time was required to recover the settled fuel oil.

After the river cleaning operations were completed (March 11), the odor had dropped to undetectable levels.

A degree of odor was also detected in the Odomari Dam Reservoir. After discharge from the dam began on February 27, some odor was detected downstream of the dam. However, as activated carbon was used in the treatment of the water, there was no effect on the domestic water supply. After that the level of odor dropped and by April was undetectable.

Conclusions

According to Article 18 of the River Law, any person causing damage to a river (perpetrator) is required to take the necessary recovery measures under the direction of the water management authorities. However, the measures required in incidents involving large quantities of harmful materials as in this case, are extensive and include public announcements, prevention of flow down stream, and recovery, all of which must be carried out with the greatest possible urgency. A mistake made during these operations can have an immeasurable affect on the lives and the economy of the inhabitants living downstream. Actually, it is necessary for government organizations to be mainly involved in carrying out these measures. However, the areas of responsibility of the various organizations involved are unclear and regulation is necessary.



In this particular case, those responsible for causing the incident were fully cooperative and the river authorities took direct action; however, this is not always the case. In the future, it is necessary to make legal provision for the river authorities to take representative action.

Furthermore, a system of direction and command between organizations should be established to provide more mobility of personnel, use of equipment, information gathering, and exchange of opinions necessary in carrying out the countermeasures.

References

1) Hiroshima Prefectural Public Works Office-Kake Bureau, "Saioto River Fuel Oil Spillage Incident", 1994.