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**Creating value from uncertainty**

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## Case study: Root cause analysis of environmental incidents

One of our clients operates sites that must comply with local environmental legislation that requires any releases of waste above threshold levels to be reported promptly to the regulator. Several small releases had resulted in the regulator imposing minor penalties. The company wanted to examine the root causes for a small selection of incidents, with the aim of identifying general lessons from them and specifying areas in which the business could improve its performance.

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## 1 Background

One of our clients operates sites that must comply with local environmental legislation that requires, amongst other things, any releases of waste, contaminants or potential contaminants above threshold levels to be reported promptly to the regulator. The regulator also conducts inspections.

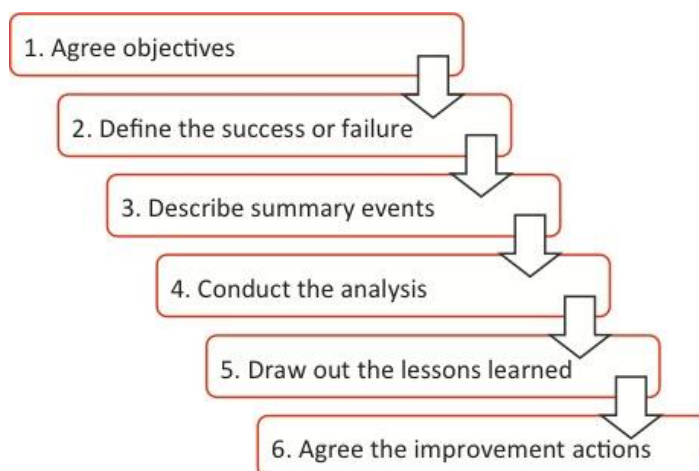
Several small releases had resulted in the regulator imposing minor penalties. The company wanted to examine the root causes for a selection of incidents, with the aim of identifying general lessons from them and specifying areas in which the business could improve its performance.

The details of the individual incidents were of limited interest in themselves as in each case remedial actions had been undertaken on site, but they were of interest as pointers to longer-term company-wide issues. Broadleaf facilitated a process to focus on the lessons that could be learned from them to allow the company to address broader organisational and procedural matters rather than incident-specific ones.

## 2 Root cause analysis process

The steps in a simple root cause analysis process for examining a success or a failure are outlined in Figure 1. The steps were modified slightly for this case.

**Figure 1: Root cause analysis steps**



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relatively minor, but there had been several of them. The intent of the analysis was to identify the root causes of several incidents, and then to:

- Determine whether there were any key organisation-wide controls that appeared to be missing;
- Develop recommendations for actions that would lead to broad improvement across the company, with benefits across all sites and not just those that were studied here.

In all, we examined six specific incidents, of which three were representative of similar incidents that had occurred at other sites. All involved minor releases of liquids, all had been discovered and rectified quickly without significant environmental impacts, and all had been reported to the regulator. Two had been the subject of Regulatory Notices of Infringement with associated minor penalties.

The people who were involved in the process are listed in Table 1.

**Table 1: People involved in the analysis**

Area	Interests represented
Environment and sustainability	Environmental managers and team leads from head office and from site Site HSE manager Sustainability manager Water manager
Compliance and regulatory affairs	Regulatory compliance managers Risk advisor
Operations	Production manager Site operations manager and team leads Maintenance manager

## 3 Initial analysis

### Document review and timelines

We began by reviewing documents relating to the incidents and developing timelines for each. Documents included:

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- Site incident reports, which included descriptions of the incident, how and by whom it was discovered, the immediate responses to contain the incident, and any medium and longer-term responses;
- Communications with the Regulator about the incident and follow-up activities, and the Regulator's responses;
- Equipment details, including technical descriptions, incident histories and inspection and maintenance records.

Documentary information was supplemented by site inspections and discussions with the people involved.

The intent of the review and the discussions was to document facts, with a focus on *what* had occurred, *where* and *when*. Opinions about *why* something might have happened, people's views on possible causes for each incident, were omitted – the agreed causes would emerge later from the analysis.

Facts included in the timeline included such things as observations, inspections, repairs, specific weather events and communications with stakeholders. Other facts that were not time-related, such as topography, were recorded separately.

We summarised the facts as annotated timelines in tables, with one line of the table for each fact. The tables showed:

- An item number, to facilitate identification and easy referencing;
- A short description of the occurrence or the fact;
- The date of the occurrence (and on occasion the time of day, where that was relevant);
- Further details, discussion and notes about the occurrence or fact;
- The source of the information or the evidence provided.

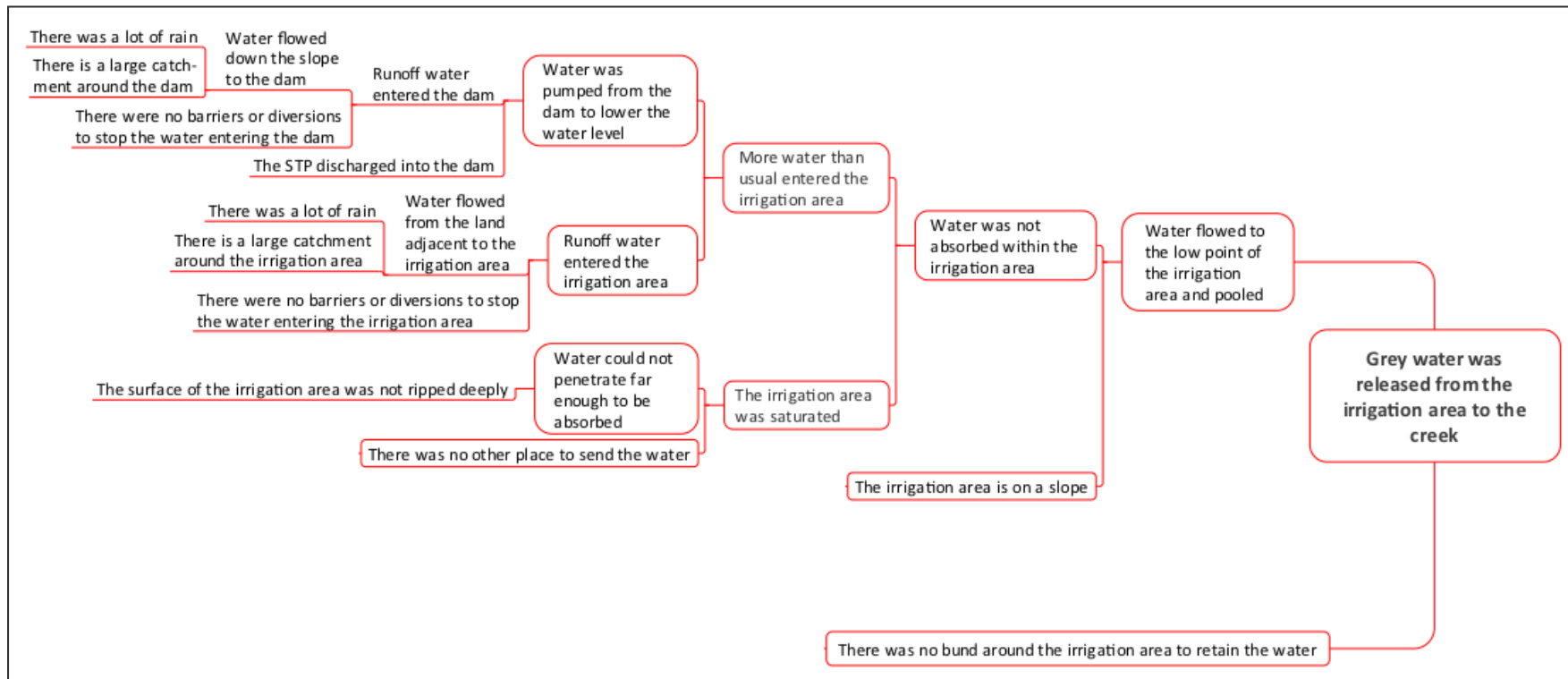
## Initial causal analysis

The timelines provided the basis for developing simple cause-effect trees, one for each incident. These trees were focussed on the specific incidents and the specific sites.

Figure 2 shows the cause-effect tree for one of the incidents, simplified slightly for this case study. This tree related to an overflow of water from an irrigation area to a creek during heavy rain. This was a reportable incident because some of the water in the irrigation area came from a dam used to store grey water – water discharged from the site camp's sewage treatment plant (STP).

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Figure 2: Example of a cause-effect tree



## 4 Root cause analysis workshop

Broadleaf facilitated a workshop to analyse each of the six specific incidents. The cause-effect trees and the annotated timelines formed the information base from which the discussions and analyses proceeded.

From the initial information, and wider discussions about each specific incident and similar ones, a set of lessons was extracted and associated actions were recorded. Table 2 shows selected lessons and actions that related to the irrigation area incident described above.

**Table 2: Selected lessons and actions**

Lessons	Actions
Monitoring of irrigation areas should be formalised	Environmental advisors now monitor irrigation areas monthly
Changes to environmental approvals must be communicated across all environmental and operations staff	Systematise cross-functional discussions about the implications of environmental approvals when they are issued Establish processes and responsibilities for delivering environmental approval requirements
Responsibilities for oversight of STPs and irrigation areas must be clarified	Completed
We need better understanding of environmental conditions; these must be communicated appropriately to operations staff	Complete the implementation of the new corporate database for environmental conditions
We have no business management tools, that incorporate approvals, for migrating changes in environmental approvals into tasks and responsibilities for delivery (e.g. in EMPs)	An Environmental Committee has been established; a priority of the Committee is to develop tasks and plans for achieving better processes and systems
Document access systems are slow and unwieldy for use on site	Investigate whether a simple ICT solution is feasible

The actions that the team agreed should be taken to prevent a recurrence of each of the six incidents were examined, then aggregated and grouped. Additional actions were included where systemic or company-wide matters were identified. The actions were summarised in a set of tables covering:

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- Safety and health;
- Design matters;
- Environmental approvals and conditions;
- Processes for managing change in the company;
- Monitoring and response;
- Other matters.

## 5 Lessons

### Information

It is important to start collecting information as soon after the incident as possible, while it is still fresh in the minds of those involved. Delay has several undesirable effects:

- People forget the small details, so important information about root causes may be omitted.
- People rationalise what happened, or what they think happened, and this distorts their perceptions – they develop hypotheses about why the incident occurred, they selectively ‘lose’ or forget information that does not fit into their hypotheses, and they may generate false memories to fill in the gaps in their knowledge, all forms of *confirmation bias*.

Site visits are invaluable.

- A full understanding of the context for an incident can only be gained by seeing the place where it occurred.
- It is better to interview people on site, and get them to show you what happened and where.
- Visits and photographs provide the basis for a sound interpretation of documentary evidence.

Collect as much relevant information as you can. As well as interviews and site visits, sources of information include:

- Formal letters and emails, within the organisation and with the regulator;
- Equipment descriptions, operating and maintenance procedures, and operating and maintenance histories;
- Incident reports and records.



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## Initial analysis

The focus of the initial analysis should be on what, where and when the incident occurred and who was involved. It is important that the question of why the incident occurred, the causes, not be addressed, even though it might be tempting, as this can lead to the kinds of confirmation bias noted above – information that does not ‘fit’ with the hypothesis about *why* may be ignored or given lesser weight.

It is useful to organise information in a clear timeline, as this provides a simple and transparent data structure. It also forms a useful base for developing cause-effect trees, as causes occur before any related effects. Such an approach also captures information before an event that at the time may not seem relevant but later, during the analysis may prove to be a precursor or a root cause to the event. Similarly, capturing information on a time line after the event allows the analysis to examine the post-event response and to learn lessons on how that could be improved in future.

Cause-effect trees provide simple representations of facts that are excellent for communicating, and they make it easier to spot gaps and inconsistencies. Even if they are incomplete, they provide a good starting point for a workshop because they set the scene well. They show the sequence of pre- and post-incident actions and decisions in a logical order. Separating each node into a pre-existing situation and an action that caused it allows the analysis to quickly focus on the root causes. These are the points at which further analysis is not worthwhile.

Developing detailed timelines and initial cause-effect trees takes some effort, but we find that preparatory work of this kind pays off. We include it in briefing material for workshop participants, so they have an opportunity to check facts in advance, collect more information if appropriate and engage with the incident and the root cause analysis process.

## Actions

The purpose of root cause analysis of the kind described here is to learn lessons and take actions to prevent further failures and repeat successes. This requires positive action, as organisations don’t usually learn lessons naturally.

The actions should relate to the root causes. Like all actions, they should be specific and agreed, and clear responsibilities should be allocated. They should

be recorded in the organisation's action tracking system, with regular status reports.

Actions should also focus on how the lessons learned from one incident and its root causes can be communicated across the organisation. Procedures and guidelines provide a common way of capturing and codifying the lessons so the benefits are widespread and enduring.

Root cause analyses generate information about the existing controls (or lack of them) and their effectiveness. This may require risks to be re-assessed and risk registers to be updated to incorporate the new information and lessons. The actions that arise from root cause analysis are risk treatments in that they will lead to new or improved controls.

## 6 Contact

If you would like further information about this topic please contact us. We will endeavour to reply promptly.

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