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Response to an emergency caused by a TSF failure

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ABSTRACT

The emergency operation, in response to a failure of a Tailings Storage Facility (TSF) is often a multi-disciplinary, multi-organisational operation, impacting multiple jurisdictions. Capacity of organisations expected to contribute to the operation may vary, e.g., due to background flooding caused by wet weather.

Within the mining industry it is common to treat a response to a major emergency, such as TSF failure as an isolated short-term operation with a technical focus, and as a solution develop Trigger Action Response Plans (TARP). In contradiction to this practice, the GISTM clearly focuses on a “shared state of readiness”, “immediate response to save lives, supply humanitarian aid and minimise environmental harm”, and the ability to execute “long-term recovery”.

The paper elaborates on the concept of “principal duties and timescales” applicable to an emergency, and the importance of defining and communicating a Strategic Intent. A model is presented for an advantageous Strategic Intent and how to apply it.

It is the combination of understanding the Concept of Operation, and the ability to develop and deliver a clear Strategic Intent, which via the Plan Inventory is turned into executable plans, that forms one of the corner stones for the emergency preparedness.

Finally, the interconnections between organisations participating in a response to an emergency caused by TSF failure, the concept of coordination, and the application of the Strategic Intent within that concept, is described.

Preparedness to deliver a response to an emergency is the product of Plans, Organisation, and Competency. To benefit this Emergency Preparedness, the plans need to give support on how to execute the entire emergency operation over time. If the plans are incomprehensible and overly complicated, the organisation will never gain the Competency.

“Plans are nothing; planning is everything”, the famous quote by Dwight D. Eisenhower is just as valid today as it was when he uttered it in 1957. (Eisenhower 1957)

Introduction

The Global Industry Standard on Tailings Management (GISTM, 2020) came as an industry response to some of the infamous tailings facility failures during 2015-2020. It strives to achieve the ultimate goal of zero harm to people and the environment with zero tolerance for human fatality. The standard requires an owner/operator of a Tailings Storage Facility (TSF) to take responsibility and prioritise the safety of tailings facilities, through all phases of a facility’s lifecycle, including closure and post-closure. It also requires the disclosure of relevant information to support public accountability.

This paper touches upon the concept of “shared readiness” and explains in detail how an emergency response operation is planned and executed, and which parameters are important for a successful response. It elaborates on the concept of Principal Duties and Timescales, further described, and detailed below in the section Principal Duties and Timescales applicable to an emergency, and the importance of defining and communicating a Strategic Intent. A model for an advantageous Strategic Intent and how to apply it is presented.

“Shared state of readiness” is in the GISTM, Requirement 13.3 described as: *“Considering community-focused measures and public sector capacity, the Operator shall take all reasonable steps to maintain a shared state of readiness for tailings facility credible flow failure scenarios by securing resources and carrying out annual training and exercises.”*

The standard places a responsibility of the operator to take the lead in creating the shared state of readiness.

This paper describes how a response to a TSF failure would look. Initially by describing the nature of a TSF failure, the Concept of Operation, and the nature of a response to an emergency caused by a TSF failure. Thereinafter how an emergency operation is developed, based on the What, When and Where. And finally, the hierarchy of strategy, tactics and technique is described, and a model for a Strategic Intent delivered.

In this paper, the term Emergency Response Plan (ERP) will be used in the context as defined by Emergency Management Australia: *“A plan which sets out the roles and responsibilities of agencies in emergency response and the coordination arrangements which are to be utilised.”* (EMA, 1998). For the purpose of this paper the term is interchangeable with the term Emergency Preparedness and Response Plan (EPRP), which is used by the GISTM.

Responding to an Emergency caused by a TSF failure

The nature of a TSF failure

The failure scenarios for a TSF can be categorised broadly into “rainy day” and the “sunny day” scenarios, whilst each scenario can involve one or more of many causes of failure, including earthquake, slope instability, erosion, seepage, overtopping, or foundation failure. The extent of the impact following a TSF failure may vary widely depending on to which level the dam is filled, and its location in relation to people, environment, and property.

Depending on the nature of the cause of the failure, the surveillance system in place, and the owner/operator’s ability to interpret, react and respond to the failure, the impact from a failure can be near instant, a drawn-out situation, or totally avoided.

Some of the more recent and more pronounced TSF failures in the world, have presented themselves as “actual or imminent”, with little or no warning. This is however far from always the case. Many failures do give warning, such as overtopping or piping failure. Depending on the available time from detection to breach, the operational conditions may vary widely.

Taking into consideration the above, and that many TSFs have potential to fail in multiple directions, it is apparent that there may be an array of potential failure scenarios, both in terms of the impacted area, and the timeline for a failure event to occur.

Concept of Operations

The GISTM expresses a clear focus on “*shared state of readiness for tailings facility credible flow failure scenarios”*. The intent of this is to *“In the case of a catastrophic tailings facility failure, provide immediate response to save lives, supply humanitarian aid and minimise environmental harm”.*

In the unlikely event of a TSF failure, the emergency response will most likely be a joint operation, as the impact will probably affect areas outside of the owner’s/operator’s footprint.

Looking at history, the emergency response operation will be prolonged, and the extent of the impact can follow one of many plausible scenarios. Add to this the long-term recovery operation, which ideally should be commenced before the emergency response is terminated, and a total time span of many months or more is involved.

It is worth noting that if public authorities and emergency services are planned to be part of the emergency response, they may already have their resources exhausted at the onset of an TSF failure. This is especially the case if the scenario is a rainy-day event, as the rain most likely has been falling for some time and inundated the surrounding areas and the community.

The nature of a response to an emergency caused by a TSF failure

The GISTM states that an owner/operator shall: *"In the case of a catastrophic tailings facility failure, provide immediate response to save lives, supply humanitarian aid and minimise environmental harm."*

In most countries, with some minor variations in wording, an emergency is defined as *"an event, actual or imminent, which endangers or threatens to endanger life, property or the environment, and which requires a significant coordinated response"* (Emergency Management Australia, 1998).

Hence the objective of an emergency response to a TSF failure is to mitigate the threat to life, environment, and property, caused by a TSF failure. That operation may comprise maintenance and repair of the TSF, but as one of the tools to reduce the threat to life, environment, and property.

For many TSFs, a failure would impact areas outside of the mine lease, and impact both the owner/operator's personnel and assets, as well as environmental values, cultural values, neighbouring companies, private property, and damage both the public and public assets.

Developing an emergency response operation

To be able to plan and execute a proactive emergency response, it is imperative to understand the *"*Three Ws*"*, namely: *What* has happened? (or will happen), *When?* and *Where*? In the following sections, the "Three Ws" are briefly explained.

What?

It is important to know what hazard will be impacting the operational area and causing the threat to life, environment, and property, in the unlikely event of a TSF failure, tailings will release and inundate an area. The inundation area will be impacted by tailings to certain depth. The danger of this can be estimated from Figure 1 below (The Australian Institute for Disaster Resilience, 2017).

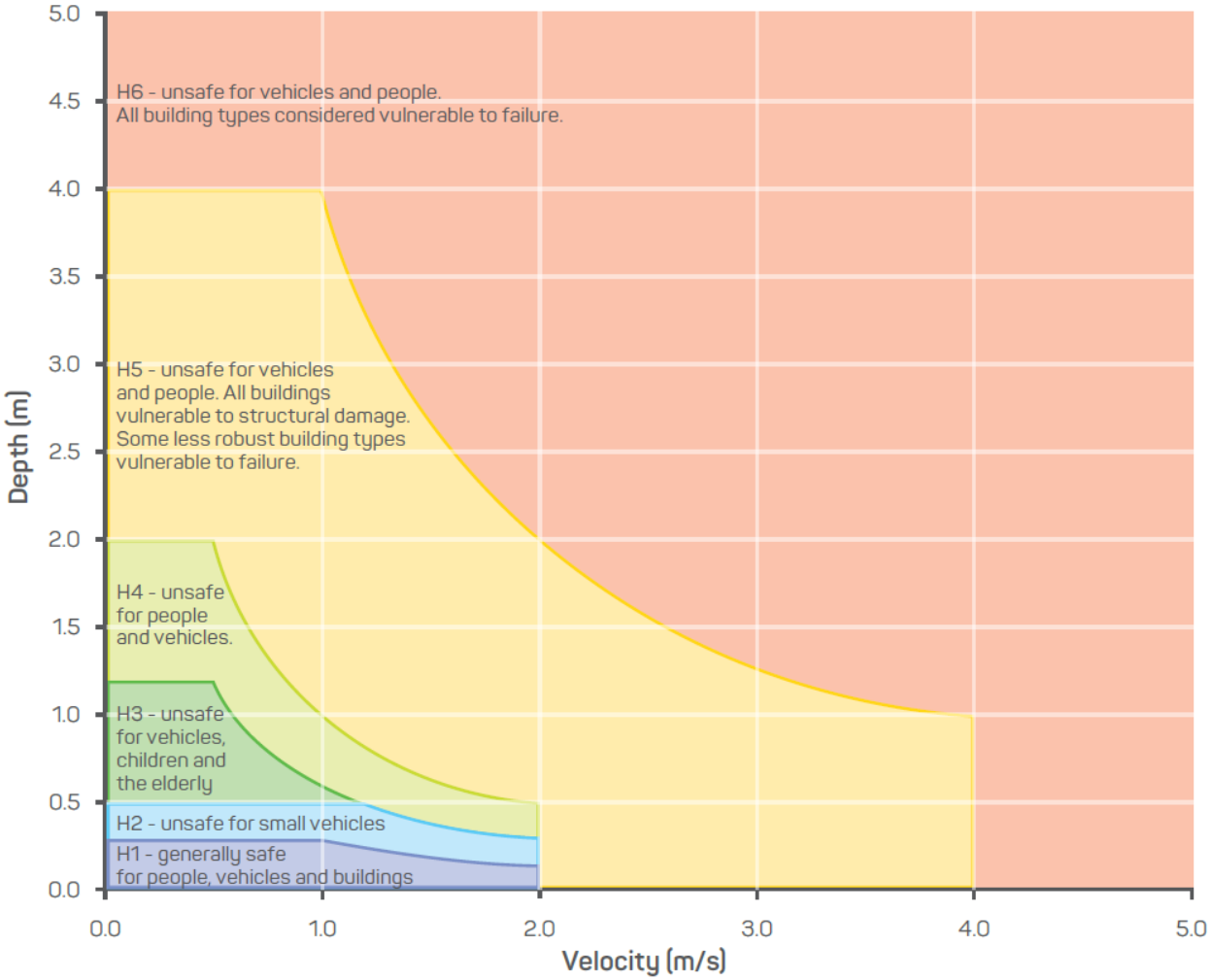

Figure 1 ***General flood hazard vulnerability curve. Source: (The Australian Institute for Disaster Resilience, 2017)***

Note that the graph above shows the flood hazard vulnerability pertaining to water. Tailings can be expected to be somewhat more dangerous, as the density is higher. But a good rule of thumb is that water or tailings deeper than 25 cm, if moving faster than 1 m/s, is a threat to life for anyone being caught in it. An average member of an emergency response operation will not have much use for detailed velocity predictions, as determining the actual velocity is difficult. As a rule of thumb, if it is moving and is deeper than knee height – do not try to enter.

Hence, it is the depth of the inundation that forms the “What”.

When?

A timeline of the TSF failure should not only illustrate the time from breach to impact, but the estimated time from detection, via breach, and to impact. The difference can for many scenarios be substantial.

Looking at a graph of reported TSF incidents over time, in Figure 2 below, and their failure causes, it is possible to approximate how many TSF failures were *“actual or imminent”*, i.e., they could occur without any warning signs or undistinguishable signs, and how many had a *“warning time”*, often referred to as *“estimated time from detection to breach”*.

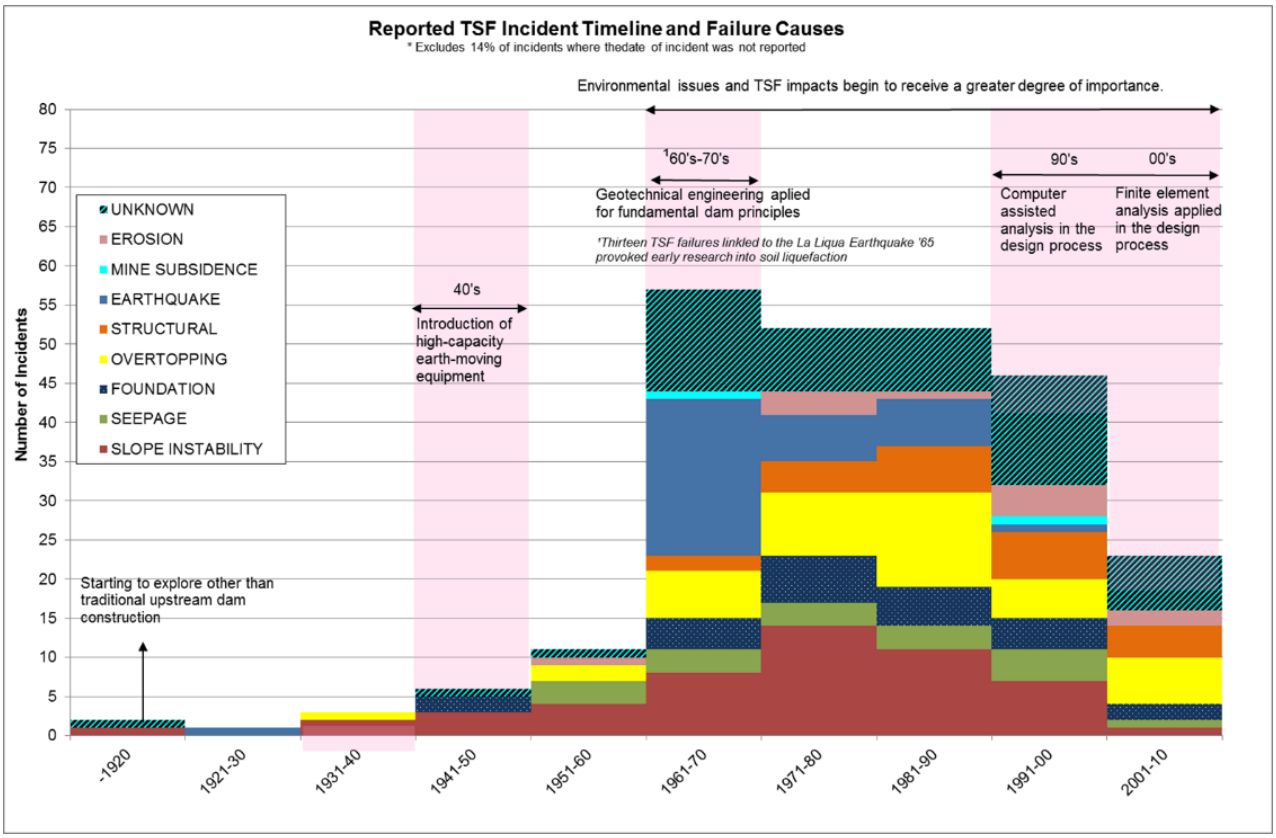

Figure 2 ***Reported TSF Incident Timeline and Failure Causes, (Brett, 2019)***

Studying the graph in Figure 2 above, a common cause of failure was “overtopping”. For an overtopping failure to occur, water in large quantities needs to be added to the TSF, normally as precipitation. This would in no way be an instantaneous process, hence these scenarios would offer a time from detection to breach, if the TSF was subject to functional surveillance. The graph shows that approximately a third of the reported incidents appear to be of this type.

For some of the other causes the scenario in general would have required some time to develop, e.g., cracking leading to a failure and slope instability, which appears, in the graph, to be at a declining trend since the 1980s.

To better support the planning and execution of the emergency operation the “When” can be classified into three categories:

– A failure is *actual or imminent*, impact has hit or is likely to hit the surroundings within the next few hours,
– A failure is imminent and the impact to the surroundings is expected to occur *within the next 48 hours*, and
– There is an *elevated risk* of a failure, which if it occurs, is likely to happen beyond 48 hours, and could impact the surroundings.

An estimate based on the data presented in Figure 2, would indicate that approximately 50% of failures would have had sufficient warning to qualify for the category *Elevated Risk*, i.e., a potential failure is more than 48 hours away.

Another 25% would be found in the category *within the next 48 hours*, and the remainder in *actual or imminent*.

That leaves approximately 25% in the category *actual or imminent*.

It is worth mentioning that ignoring warning signs from the operation and surveillance, that indicate the TSF is at risk of failure, will sooner or later put the emergency in the category of *actual or imminent*.

For an emergency operation, when time is of the essence and often scarce, it is essential to supplement the inundation maps (see next section) with an estimated timeline showing both the estimated *time from detection to breach* as well as *the time from breach to impact*. On that timeline, the current time of the planning process, the "now" should be presented for planning purposes. As time moves, the "now" have to be moved along that timeline to make sure that planning is focusing on future.

As an example, digital modelling of a near identical condition to the Brumadinho TSF failure (Lumbroso et. al., 2020), concluded that *"a warning received 15 minutes before the failure could have reduced the number of deaths to zero"*. This was *"if the evacuees knew what to do"*. The competency level for "knowing what to do" is comparable to the one gained by a passenger from an inflight safety video aboard a plane. The Brumadinho TSF failure killed approximately 300 people.

Where?

Each modelled scenario used in the Emergency Response Plan (ERP), needs to be presented as a map, intended for the emergency response to the potential failure. These maps will mostly be used by individuals with other professions and expertise than dam engineers.

An overview map, as illustrated in Figure 3, showing the modelled alternative scenarios is a good start and should be included in the ERP.

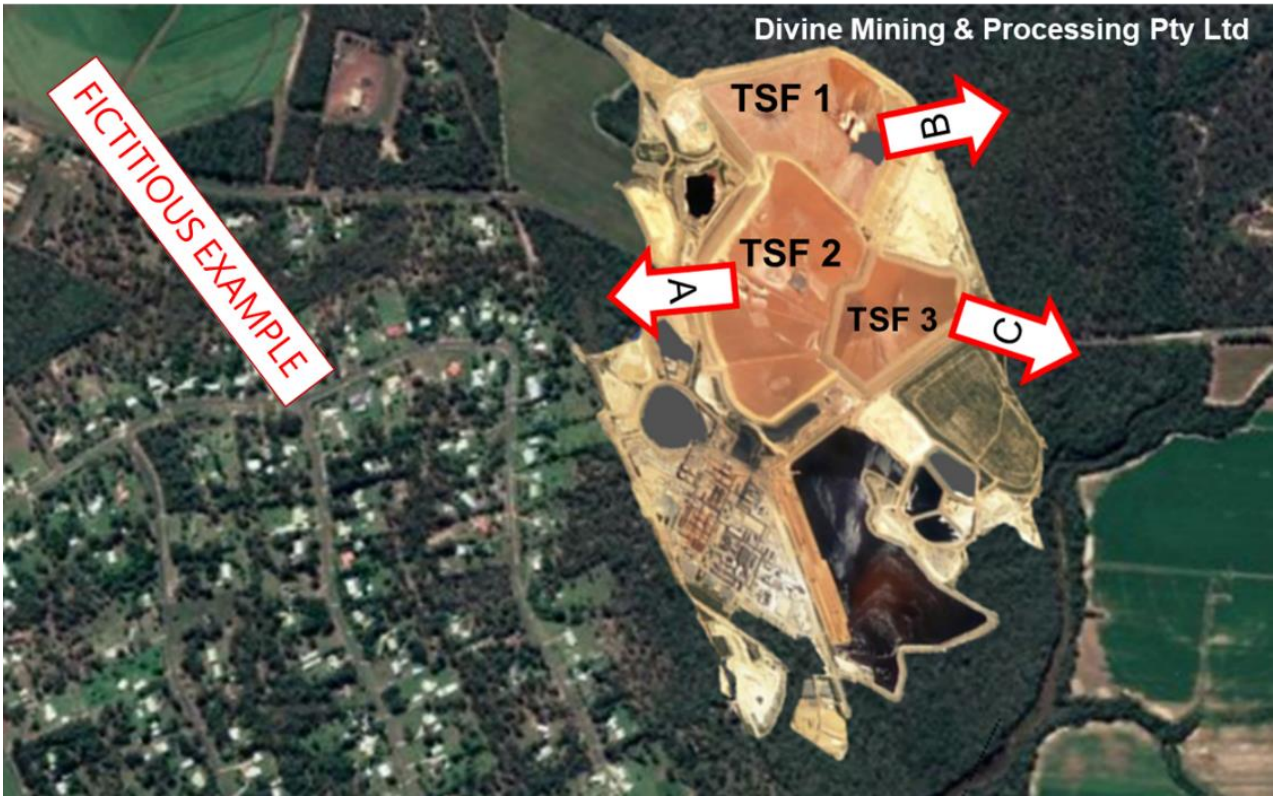

Figure 3 ***Overview map showing the modelled scenarios. Fictitious example***

The ERP should comprise individual inundation maps for each scenario, as illustrated in Figure 4, below.

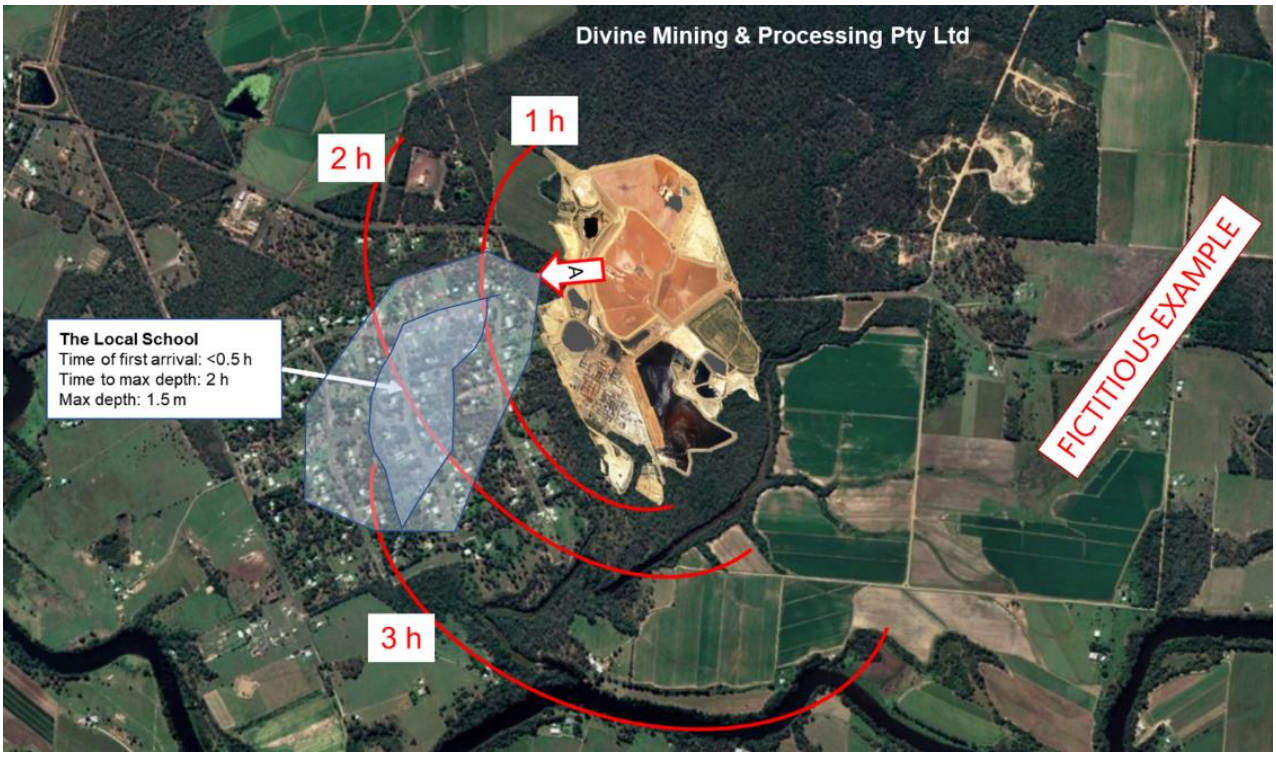

Figure 4 ***Individual inundation map with points of interest and isochrones, showing estimated time of arrival. Fictitious example***

It is important not to clutter the maps with too many details. Estimated arrival time for the inundation can be illustrated with isochrones, lines showing the same arrival time from the breach point. It is typical to use half or one-hour intervals.

Landmarks and Points of Interest may be indicated to visualise the potential extent of the inundation and support orientation. Coloured tones may be used to show the expected depth.

The inundation maps should ideally deliver a representation as realistic as possible of the *What*, *When* and *Where*, for each scenario, noting that the *When* will be counted from the time of breach. Hence the timeline needs to supplement the maps.

Presenting the What, When and Where

As an Incident Management Team (IMT) Leader in the owner/operator's organisation, in charge of an emergency response to the impact of a TSF failure, it is important to select the applicable "When" category. The choice should be between prepared distinct alternatives; *actual or imminent*, *within 48 hours*, or somewhere e*levated risk beyond 48 hours*, and which of the inundation maps is to be basis for the planning and execution.

Strategy

Strategy is a plan of action designed to achieve a long-term or overall aim. (Oxford Languages, 2023)

A good strategy must precisely diagnose the problem being solved, set a guiding policy that will address that problem, and propose a set of coherent actions which will deliver that policy. (Rumelt, 2011)

Often strategy is described as visualisation of the "end game", with a few main steps to reach there. The longer and more complex an emergency operation becomes, the more important a clear strategy becomes.

Strategic Intent

It falls upon the IMT Leader to formulate a Strategic Intent for the operation. A good Strategic Intent should comprise two main parts, the objective of the operation, and the implementation steps, no more than three, to reach the objective. These steps are often formed along a timeline, as “initially”, “thereafter” and “finally”. The Strategic Intent may also deliver limitations or directives over time. Well formulated, and communicated, the Strategic Intent should be the guidance for the entire operation. For the strategy to become a useful input into the response to, and the long-term recovery from, an emergency caused by a TSF failure, the strategy must be made clear, understandable, and visual to the organisation, especially the emergency management function. Compare emergency management in Figure 8, in section Principal Duties and Timescale, below.

This is in line with one of the basic principles of the Australasian Inter-Service Incident Management System (AIIMS), namely “management by objectives”.

Strategic Intent is in many organisations referred to as an Incident Objective (AIIMS 2004). However, an Incident Objective does not comprise the elements of crisis management, such as business continuity, finance, reputation and/or legal standing, which the IMT Leader must consider. Hence, there is a clear difference between Incident Objective and Strategic Intent.

A good example is the Strategic Intent formulated, by the Incident Controller, in the initial stages of the Piny Point emergency response, Florida US, April 2021:

> *Objective*
>
> *To prevent a catastrophic failure of the dam. Prepare for a collapse of the wall and ensure no people are harmed.*
>
> *Implementation*
>
> *Initially, remove all people that may come in harm’s way, should the dam fail.*
>
> *Thereafter, attempt to rectify the piping failure, to avoid a total wall collapse.*
>
> *Finally, secure the dam and return evacuees.*
>
> *Over time, all evacuated areas shall be protected from intrusion or looting.*

This text has been reconstructed from multiple open sources. The actual text has not been made publicly available.

This simple Strategic Intent stayed valid over the entire operation, which lasted for over a week, and gave a clear directive for two tactical prongs: one repairing the dam, and one keeping the residents out of harm’s way. The respective persons in charge of each tactical prong were managed by objectives, and free to develop the best tactical and technical solution.

It is an art to develop a Strategic Intent with substance enough to guide and steer the emergency operation over its duration, without becoming a set of meaningless value statements on one hand, or a set of detailed instructions and tasks on the other. The road to mastering this is training.

A well formulated Strategic Intent would take a competent IMT Leader perhaps a fraction of the time that the emergency operation will run but is a crucial investment for successful operations.

A generic template for a Strategic Intent is included in Appendix 1.

Tactics and Technique

Following the choice of a strategy as per Figure 5 below, expressed in a Strategic Intent as described in the section above, is the choice of tactics. What tactics are available to achieve the Strategic Intent? The choice of tactics requires detailed knowledge on the subject, such as emergency response, TSF maintenance, etc.

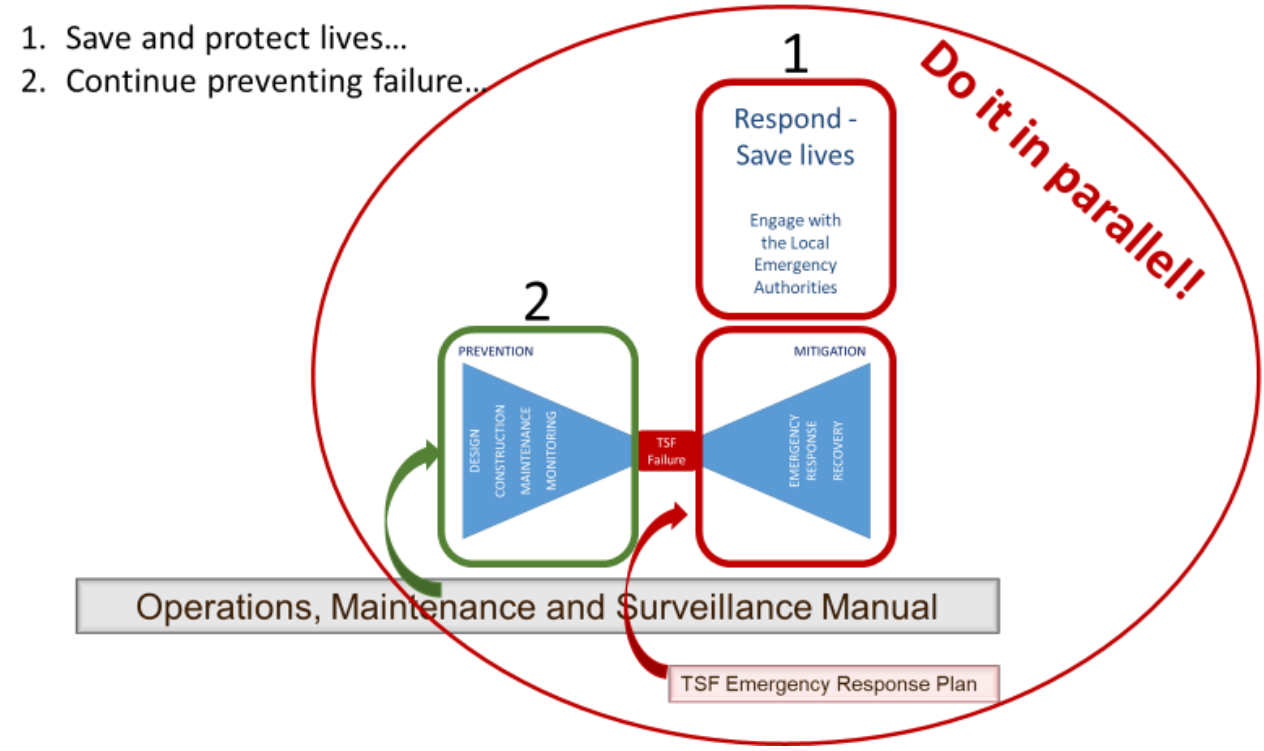

Figure 5 *Generic Strategy example for an emergency response operation to the impact of a TSF failure*

Based on the choice of tactics made, the technique for executing this can be selected. For example, if the tactical choice for the first part of the strategy is “Evacuation” very different techniques are applied compared to if the tactic of “Self-Rescue” is selected.

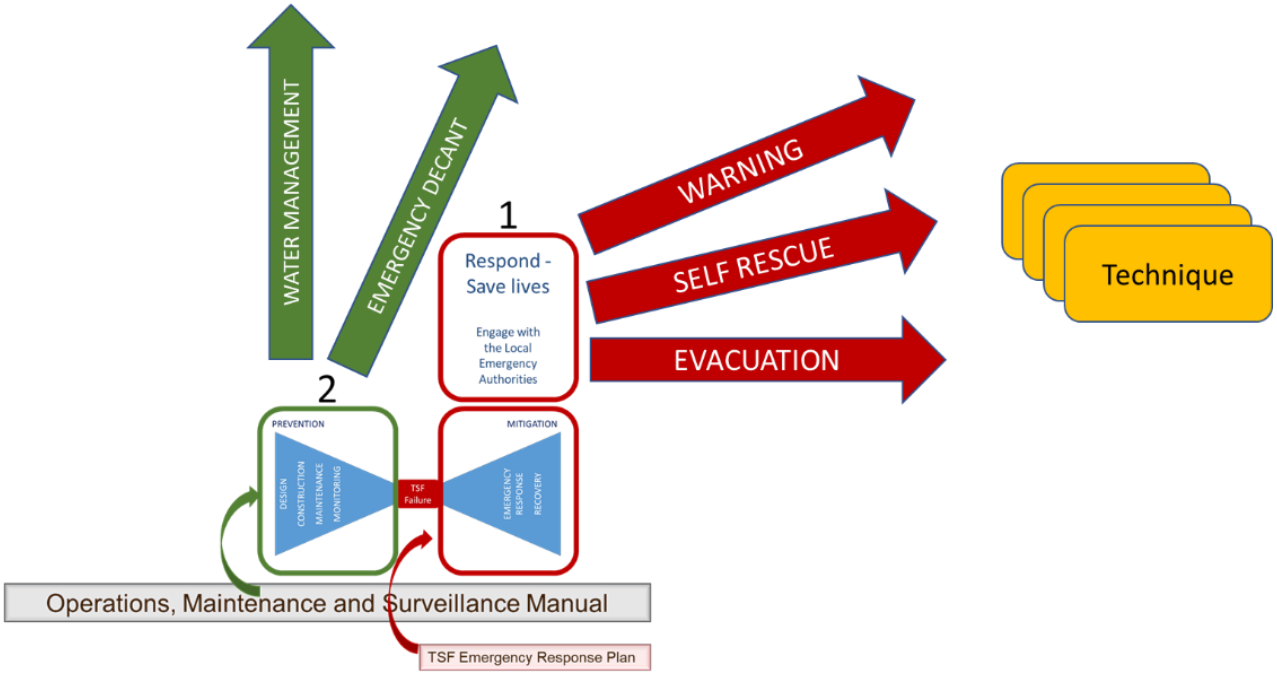

Figure 6 *Choice of tactics and technique*

Starting the process of developing and executing an emergency response at the technique end of the flow, will generate an infinite number of tasks, without any coherence. This only leads to success if the organisation has infinite resources and the strategic and tactical alternatives are limited or none, or as it is referred to in fire and rescue tactics: an over-strong response in a closed system. The proper planning of an

emergency response is formulation of Strategic Intent followed by development of tactics to match strategy and the application of specific plans to achieve the tactical objectives.

Planning Process

Whilst an operation with few alternatives and short duration may be suited for a simpler pre-set step-by-step plan, sometimes referred to as a Trigger Action Response Plan (TARP) or Trigger Response Plan (TRP) where very little adjustment or adaptation is required, a long-term operation where many steps will require decisions and judgement, requires a clear steering through an understandable strategy. This strategy is best expressed and communicated, in the section above, as a Strategic Intent.

The Strategic Intent is the base for the Plan Inventory, which is a simple list of the plans required or activities that will need planning, to achieve the objective stated in the Strategic Intent. The Plan Inventory is a live document, or rather a list of the plans and planning activities that the IMT needs to achieve.

There might initially be a limited number of actions that are to be executed directly and without further orders or planning. These are referred to as “Immediate Actions”. However, one must be careful not to build the entire operation on such, as this will limit the operational alternatives and exhaust the organisation in reactive mode.

Some plans might be pre-existing, and only require launching, whilst some, such as evacuation plans may exist, but need to be adjusted for the current situation. The plan inventory is normally managed by the Planning Officer in the IMT. Each plan or planning task is allocated to one of the IMT members, potentially supported by other capacities internal or external to the organisation.

Following on the Planning Inventory, the plans are adjusted, developed, and launched.

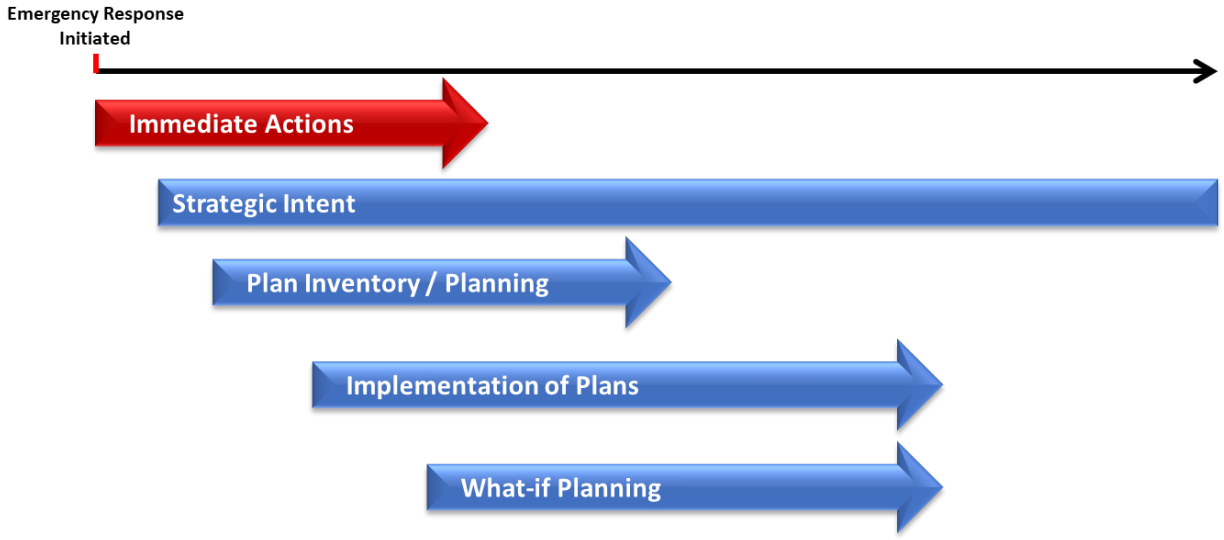

Figure 7 *Graphic representation of the Planning Process in the Incident Management Team*

“No plan survives first contact with the enemy” (Moltke, 1880), which today in civilian context has been transformed into: *“No plan survives first contact with reality”*. One must keep a preparedness for what is referred to as “What-if Scenarios”.

Not to overwhelm the planning work What-if Plans are normally developed for:

– The most **likely** change of the situation calling for a new plan,
– The most **dangerous** change of the situation or conditions, and
– The most **different** development realistically imaginable.

Principal Duties and Timescale

In the unlikely event of a catastrophic TSF failure, the response to the emergency will most likely draw a high level of public and media attention, the emergency may well develop a crisis in parallel. A crisis being an: *"Abnormal and unstable situation that threatens the organisation's strategic objectives, reputation or viability."* (BS 11200, 2014)

To succeed in mitigating a larger scale emergency, potentially escalating to a crisis, one should move the operation forward with three *"Principal Duties"*. Emergency Response, Emergency Management and Crisis Management (Wennstrom & White 2021), as illustrated in Figure 8 below.

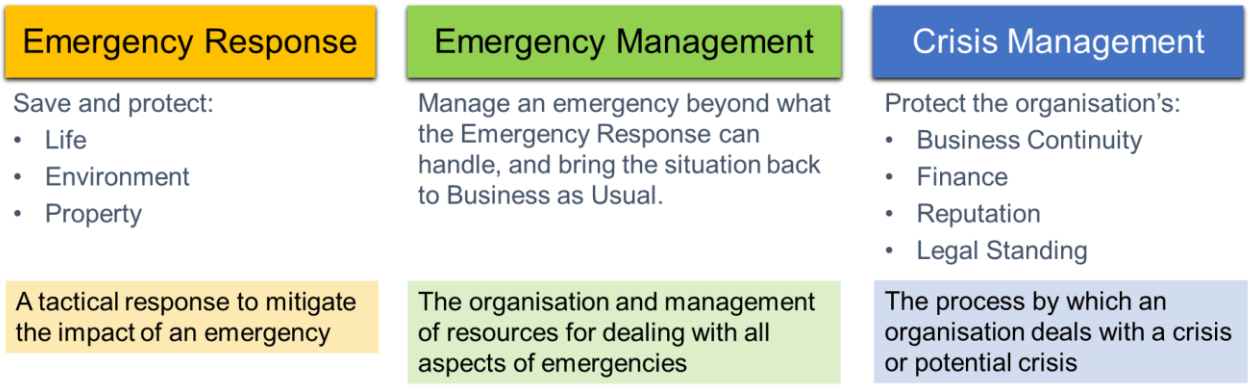

Figure 8 ***Principal Duties (Wennstrom & White 2021)***

Emergency Response is the *Tactical response to the impact of an emergency*.

Emergency Management is *the organisation and management of resources for dealing with all aspects of emergencies* (Emergency Management Australia, 1998), hence arranging for a continuity when the initial emergency response has exhausted its capacity.

Crisis Management is *the process by which an organisation deals with a crisis or potential crisis* (Bundy et al, 2017). All three principal duties should be initiated early and function in parallel.

It is important to initiate all three Principal Duties, if not simultaneously, at least early in the operation. The timescale they will operate in are however very different. The Emergency Response till operate in a timescale from seconds to hours, whilst the Emergency Management in days and the Crisis Management can sometimes work in timescales measured by weeks or longer.

In a very small organisation, all three principal duties will potentially have to be managed by one person, whilst in a larger organisation it is often split up on different teams and team leaders.

Coordination with External Organisations

If a TSF failure threatens to inundate areas outside of the operational boundaries i.e., the mine lease, the responsibility for mitigating the emergency may rest with public sector agencies, such as emergency services, police, and local government. The emergency response will become a joint operation.

When conducting a joint operation, where different organisations participate, with geographic and legislative differences, and difference in area of responsibility and operation, it is essential to establish a well-functioning mechanism for coordination.

Coordination is *"The bringing together of organisations and elements to ensure an effective response"* (Emergency Management Australia, 1998).

If a catastrophic TSF failure is expected to impact areas outside of site, which is the case for many locations, a concept for coordination with the organisation/s responsible for these external areas needs to be in place. The responsibility for the different organisations does not always follow geographic boundaries but can be based on the function of the organisation.

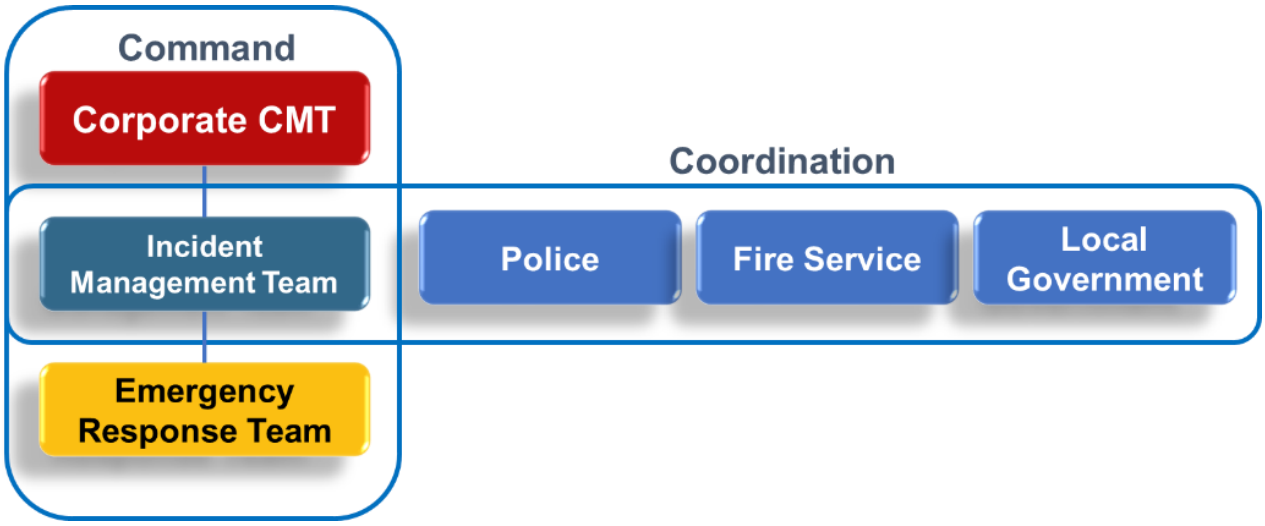

Figure 9 *Concept of coordination*

The coordination should take place, for the whole of operation, on the site/IMT level. Routines and mechanisms are to be developed, described, and trained for. For a jurisdiction where many sites are located, a local government body is in place for this purpose. These are often referred to as the Local Disaster Management Group (LDMG), or Local Emergency Management Committee (LEMC). These bodies are developed for coordination of different organisations engaged in an emergency operation.

The mechanism for establishing coordination through these pre-arranged bodies, is for the IMT Leader to send a Liaison Officer (LO) to the group. The LO remains with the coordination group for as long as the operation is ongoing and is to be the only link to the IMT. Individual points of coordination can be advised such as an Emergency Response Team Captain to coordinate directly with a Foreman from the Fire Service on a site. This should not be confused with the coordination of the operation.

Successful coordination relies upon understanding the other organisations' objectives, area of responsibility, legislative framework, capacity, and limitations. This understanding is developed as an ongoing process and is part of developing the emergency preparedness. It cannot be developed in the moment when an emergency is occurring.

Each organisation participating in the joint operation requires its own plan, as a plan is written for a specific target group, with its own organisation, competency, professional language, and needs. Sharing plans with other organisations has limited value, but keeping the coordination partners informed and up to date on your plan is beneficial and in line with the GISTM concept of shared state of readiness.

Emergency Preparedness

"The objective of emergency preparedness is to ensure that the strategic direction and required building blocks for an eventual emergency response are in place." (United Nations Human Rights Council, 2007)

Preparedness to deliver a response to an emergency, or Emergency Preparedness, is the product of Organisation, Plans, and Competency. (Wennstrom & White 2021)

– Organisation – A suitable Emergency Management and Emergency Response Organisation
– Plan – An understandable plan to guide the operation
– Competency – Capability to execute the emergency operation

Organisation

The role of an Emergency Response Organisation is to execute the emergency response, based on strategic and tactical decisions by the Emergency Management Organisation. To deliver a functional emergency response, the Emergency Management Organisation needs to understand the capabilities and limitations of the Emergency Response Organisation.

Most major mining companies have an Existing Emergency Management Organisation, with emergency management or incident management teams. In the following these teams, headed up by General Manager or Site Manager, will be referred to as an IMT irrespective of the company/site nomenclature.

This Emergency Management organisation should be dimensioned for management of all conceivable emergencies at site, hence also management of a response to a potential catastrophic TSF failure. The organisation should be built on a reputable Incident Management System, e.g., Australasian Inter-Service Incident Management System (AIIMS), National Incident Management System (NIMS), Incident Command System (ICS), or similar.

Plan

The GISTM requires the emergency preparedness to be *"based on credible flow failure scenarios and the assessment of potential consequences"*. Hence, one or more credible flow failure scenarios need to be selected for modelling.

Sunny-day and rainy-day scenarios will most likely behave differently, hence both need to be considered. In addition, many TSFs have multiple directions where a breach may occur. It is not uncommon to end up with several modelled scenarios for the same TSF.

If the scenarios comprise a "rainy-day" scenario, it is beneficial to illustrate the effects of the modelled rain depth on the surrounds, as the rain will not fall solely on the TSF. This is commonly referred to as a "base case".

The Emergency Response Plan (ERP) for a TSF failure should be written for and be given ample support from the owner/operator to the organisation that is to lead the emergency operation. In most cases this is the IMT, headed up by site manager or General Manager (GM).

The TSF team, tasked with the mission to operate, maintain, and survey the TSF should find support and guidance from the Operations Maintenance and Surveillance (OMS) Manual. Content and instructions given in the OMS for the purpose of the TSF team and their work should as far as possible not be duplicated in the ERP, as the ERP and the OMS are written for different target groups.

There are however parts that needs to be correlated between the two plans. Such items are the "operational conditions"; and the "trigger points" moving from one operational condition to another. These should come from the OMS and be used in the ERP. A generic scale of Operational Conditions is illustrated in Figure 10, below. Trigger points are the criteria defining the transition from one operational condition and to the next.

Figure 10 Generic example of operational conditions for a TSF

Competency

Competency for the personnel that are to lead the operation, should be gained through training and exercise. It is especially the decision making, command and control and the coordination that must be well functioning. This requires realistic exercise scenarios, where the different stakeholders are working from their respective command posts and centres. Round table meetings and discussions may be beneficial to the relationships but does very little for the competency of running an operation.

Knowing the plan, your role and the objective of the operation is of the essence. This is created by good training, delivered by instructors who are experienced in planning and executing large scale emergency operations.

To support the IMT and the IMT Leader, in planning and executing an emergency response to the impact of a TSF failure, the ERP should comprise simple and understandable checklists. These checklists should be

written for the IMT and the IMT Leader and be available for each of the timely alternatives described in Section *When* above as it is the estimated time to impact that is one of the key factors in the operation.

To benefit the Emergency Preparedness, the ERP need to give support on how to execute the entire emergency operation over time, not just how to initiate it, through e.g., a call-tree. If the plans are incomprehensible, overly complicated, and cluttered with details, the organisation will never gain competency in handling TSF failures.

Conclusions

The emergency response to mitigate the impact of a TSF failure is often a multi-disciplinary, multi-organisational operation, impacting multiple jurisdictions.

As the scenario can vary widely, the plan must have several alternatives, both in terms of inundation extent and the time to impact.

Imperative from any emergency management perspective, to be able to plan and execute a proactive emergency response, is the *"Three Ws"*, namely: *What* has/will happen, *When,* and *Where*.

The *What* can be modelled to the inundation areas and the depth of the inundation. The *When* is a function of the monitoring on the TSF and the type of failure mechanism. The *Where* is also possible to model to some degree of certainty.

Many TSFs have several failure scenarios, and the time at hand may vary, from a somewhat predictable overfilling and overflowing scenario to a sudden earthquake. Hence a good plan needs to have a set of simple *What* and *Where*, presented in a manageable number of modelled and inundation mapped scenarios.

The *When* alternatives should be approximate and not more than three, for example "actual or imminent", "within the next 48 hours" and "elevated risk – beyond 48 hours".

As the person in charge of an emergency response to a TSF failure, normally the GM or the Site Manager, in the role as IMT Leader, one does not need technical superiority in the field of tailings dams but need to be able to get many people to do different things, that they are good at, in one direction. An instrument to gain this clear focus for the broader operation, is the early delivery of an understandable and clear Strategic Intent.

The most valuable tool to achieve such a coherent operation, is to develop and communicate a Strategic Intent. Starting the process of developing and executing an emergency response at the technique end of the flow, is likely to generate an infinite number of tasks, without any coherence. This only leads to success if the organisation has infinite resources, and the strategic and tactical alternatives are limited or none, or as it is referred to: an over-strong response in a closed system.

The use of a strategic intent is in line with the principle of management by objective, which is the first of the founding principles in AIIMS and many other international incident management systems.

A multi organisational operation requires good coordination with external stakeholders participating in the operation. In many local government areas initiatives and arrangements are in place for coordination in case of major emergencies or disaster. In line with the GISTM the operator/owner of a TSF should reach out and initiate coordination when and where required.

If public authorities and emergency services are to be part of the operation, they may already have their resource exhausted at the onset of an TSF failure. If the scenario is a rainy-day event, the rain most likely has been falling for some time and inundated the surrounding areas and the community. The emergency services might be otherwise engaged.

The key function to understand and adjust the emergency operation is good communication between the stakeholders. This is achieved through a common concept for coordination and a suitable number of trained Liaison Officer.

The emergency preparedness, which the GISTM requires, is a product of the organisation, plans and competency, and the responsibility rests heavy on the site's IMT Leader. Emergency preparedness requires good training, delivered by instructors who are experienced in planning and executing large scale emergency operations.

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Appendix 1

Strategic Intent Template for Incident Management Team Leader

A Strategic Intent (SI) is to be formulated by the IMT Leader. The SI is a comprehensive yet compact way of explaining the IMT Leader's intent and overall plan for the combat of the incident and return to Business as Usual.

Before developing the SI, create a Problem Picture to understand the situation in broad.

The SI issued by the IMT Leader shall cover the entire area of responsibility for the IMT, i.e., the entire site/operation.

An SI comprises of two parts the 'Objective' and the 'Implementation'. Ideally an SI is formulated to be valid over the entire period of the incident and the recovery. It is always written and expressed in first person.

– Objective
  (What is the overall objective of the operation?)
– Implementation
  (State what you want to see happen in a few timely stages.)
  - Initially
  - Thereinafter
  - Finally
– Restrictions or directives over time.
  (Is there something you want to be happening all the time or something that you don't want to see in the operation/operations?)

Note!

The SI shall cover the entire "area of responsibility" for the IMT Leader, not just the ongoing incident.

Fire Service and Emergency Services uses a similar term called Incident Objective, but this does not comprise the crisis management elements, the business continuity, or the recovery phase, hence it is different from the SI.

Appendix 2

List of abbreviations

AIIMS	Australasian Inter-Service Incident Management System
EMA	Emergency Management Australia
ERP	Emergency Response Plan
GISTM	Global Industry Standard on Tailings Management
GM	General Manager
ICS	Incident Command System, USA
IMT	Incident Management Team
LDMG	Local Disaster Management Group
LEMC	Local Emergency Management Committee
LO	Liaison Officer
NIMS	National Incident Management System, USA
OMS	Operations Maintenance and Surveillance Manual
SI	Strategic Intent
TARP	Trigger Action Response Plans
TRP	Trigger Response Plan
TSF	Tailings Storage Facility