The Theory and Practice

of

Perpetual Care of Contaminated Sites

This report has been written for submission by Alternatives North
to the Mackenzie Valley Environmental Impact Review Board as part of the Giant Mine EA,
but it is also intended for public use.

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SUMMARY

What is the problem?

Modern industry has been able to make lots and lots of products. At the same time, some industry has also made tons of unsafe waste – like arsenic. The science for taking care of the waste lags behind. Until science catches up, all we can do is keep the contamination safe. We may need to keep it safe for hundreds or thousands of years – or forever.

What is this report?

In fall 2010, Alternatives North hired Dr. Joan Kuyek to do a study. Giant Mine in Yellowknife, Canada, has 237,000 tonnes of arsenic trioxide to take care of. There is a plan to freeze this arsenic, so it can't leak out and hurt the people and the land. For the Environmental Assessment of this plan, Alternatives North asked for a study of how contaminants are managed in other places.

How was the study done?

The study was done in 5 ways:

- search the Internet for information
- read printed documents in English
- talk to people in affected communities
- talk to people from responsible agencies
- do case studies for places in Canada and the US

"Perpetual care" is a new problem. There is no long-term experience to look at. The only human construction to study is a building like the pyramids, and even the pyramids are not so old.

Who are the 'responsible agencies'?

In Canada and the US, there are many government agencies responsible for long-term contaminated sites. Each agency works in its own way, and that way can be very complicated. Politics also plays a part in how an agency works. In Canada, government information is kept secret and released slowly.

How long is 'long-term'?

The case studies in the full report include some nuclear waste sites. For these sites, perpetual care means 10,000 years. Arsenic is like nuclear waste in many ways. Both have no colour, taste, or odour. Both may cause death. Both can be breathed in or eaten. The dangers from these two toxic wastes are not easy to see.

Why did you talk about communities?

Most of the sites we studied are near communities who have pressed for a clean-up for many years. Often these are native communities. These people are still working toward clean-up. They expect to be living with the toxic site forever. The work of leaders of these communities is important and often unnoticed.

It is scary to study contaminated sites. How did a place like Chernobyl turn into a huge 'sacrifice zone' – a place with so much poison that nobody can live there? Fukushima in Japan has just turned into such a place.

This is a big problem. A government report in 2003 said that there are more than 217,000 toxic sites in the US. It goes on to say that most of these places will never be cleaned up enough to be safe. Perpetual care for these places is not good enough. The poisons will last longer than the safeguards.

LESSONS LEARNED

Most of the full report tells about 9 case studies. From these cases and other research, we have learned many things.

What Reports Say

1. Most plans for toxic waste look at less than 100 years in the future. The Giant Mine plan is for 50 years. Perpetual care (for thousands of years) needs a different plan. It needs to be part of the clean-up from the start.

2. Papers about toxic waste care agree that this is a big problem. There is not much else they have in common.

3. Nuclear waste has made people start to think about 10,000 years of safety. We don't know about any human buildings that have lasted so long. Some of the oldest buildings are mysteries. We don't know why they were built. In native cultures, there are special places you must not go into. When new people come, they ignore the rules and settle where they want. Sometimes, new religions cause people to harm the forbidden area.

Communities

1. Experts agree that local communities need to be part of any long-term plan. This is even more true when native people care about the land where the toxic waste sits.

2. However, a native community may be angry at the people who are asking for cooperation. After a history of trespass and abuse, the trust needed for working together may be missing.

3. Sometimes local people find out, too late, that the land and people have been made sick. Knowing this changes how they feel about themselves and their memory of times past. It is important that the people understand where the sickness comes from, so they can grieve, tell the story, and heal. The long-term plan for the waste site must include ways for the people to heal their spirit.

4. In most communities, there have been problems between pro-development and pro-cleanup sides. Even after we all know that toxic waste must be stored on site, the arguments may go on. Some people will worry about the toxic waste giving the town a bad name. To them, this is more important than the health of the people or the land.

5. The wish to keep the toxic waste a secret may be made worse by others. Government and industry may want to keep the secret in order to avoid costs of clean-up and perpetual care.

6. In each of the communities studied there had been a risk assessment. (This compares dangers to costs in dollars.) Because an insurance model was used for the risk assessments governments decided there was no proof that the toxic waste was connected to the very poor health of local people. The lesson learned is that the risk assessment model needs to be thought about some more.

Control of Access

1. The first step to take care of the waste is to keep people away. This means signs and fences, for example. After a long time, these ways of controlling access will likely fail. Usually, backup controls are also used.

2. Research papers tell about many ways to control access. Case Study 2 in the full report tells about most ways to control access.

3. Case Study 8 tells about the Waste Isolation Pilot Project in New Mexico. It includes a plan for special signs and markers intended to last 10,000 years.

Management

1. The laws for toxic waste sites are not good enough for long-term care. The laws need to cover:
    - emergency response
    - keeping records
    - regular environmental assessment
    - how to decide which government is responsible

2. Who should be in charge of long-term care? It has to be a High Reliability Organization (HRO), which must stress safety and reliability first, not profit, prestige or efficiency.

3. Being the organization in charge is a hard job.
    - How do you stay alert when nothing needs to be done for years?

- Can you still work well when responsibilities are split up over time?
- How do you deal with groups that keep secrets from you?
- Can you handle a sudden crisis?

4. The group in charge can't be too proud. They must admit to mistakes and ignorance. They should be able to change their ideas. When a method fails, it is important to be able to change to a different solution.

5. The name Adaptive Management means being able to learn and change over time. When a crisis happens, there is no time to slowly learn and change. It is important to be able to see warning signs too. It is important too that you don't hide being lazy and cheap by calling it 'adaptive management.'

6. Good adaptive management can be part of teaching people and changing their ideas.

7. Communities near a toxic waste site should be part of the management, but not have to pay for long-term care. This may cause problems with government officials. They may not like the community being in charge.

Records

1. Public access to records is not easy. There are many laws and agencies responsible for the records of waste sites.

2. How can records be kept despite major changes? Changes like earthquake, fire, revolution, electrical failure, new computer systems. There are no good answers yet.

3. Who will have access to the records in the future? How easy will it be for the public to see them? Having a website isn't enough. The records need to be complete and up to date. In Canada, the Access to Information Act is very hard to use.

Inspections and Data Analysis

1. Waste sites must be watched carefully and regularly. In this way, early leaks and other problems can be found. What is sampled? Who does it? How often? Most places use 5-year contracts. There is a danger that someone might want to save money by cutting the contract.

2. A well-funded independent monitoring group is a good model. They need to be responsible to the local community.

3. Collecting data isn't enough. It needs to be studied at regular times. If this work is done by contract, responsibility must be fixed. Think about how this can be done over centuries.

Maintenance

1. The small parts of a system can fail in odd ways. When 2 or more parts fail, they might make the whole system fail. No matter how careful you are and how much safety is built in, surprising small failures can bring it all down.

2. There are many maintenance questions.
    - How is the protection system maintained?
    - Who does it?
    - Who is responsible for taking real action on inspection results?
    - How do you consult the community on technical things over a long time?
    - Does the public have a way to get technical advice?

    It is important that skills and materials are available to fix later problems.

Emergencies

1. It is very clear that people have to be watchful and activist to get attention for toxic contamination. There is no reason to think this might change. A slow leak or failure will still need political action to get a response.

2. A disaster can be caused by:
    - neglect over time
    - earthquake, fire or flood
    - riots
    - many small equipment failures

    Perpetual care has to know who is in charge of acting in a disaster and who will pay for the response.

3. Most of the case studies show that local people had been lied to many times about how toxic the waste was. The risks had been down-played until the truth was forced out. How will the long-term plan make sure this doesn't happen?

Money

1. It is hard to keep adequate funding for long-term care. Most programs in the case studies have to renew their funding every year. And each year they have to compete for the money in a political arena.

2. Some people recommend trust funds to fund perpetual care.
    - How is the bond set?
    - How is it renewed?
    - Does this funding depend on economic growth?
    - How do you avoid losing the bond to crime?

3. However, these funding ideas have a false basis. They assume that economic growth will never end. They don't make any room for changes in the environment. They also count on smaller costs, which is not fair to future generations.

More than One Generation

1. Many writers say that it is important that native people be able to carry on the story of the site. They need to be able to train the next generation to guard the site.
2. Keeping toxic waste protected (or frozen) just passes on the responsibility to future generations. Even if there is enough funding, some day centuries from now the protection system will fail. Funding will not make up for the huge dead zone that will result.
3. We must admit that long-term care will require support from many generations. Several Native American tribes have issued a statement that talks about taking care of the land for the seventh generation to come.
4. Some of the people alive today are suffering from bad decisions made in the 1940s and 1950s. If it is possible today to make toxic waste non-toxic, it should be done – no matter what the cost. The long-term cost of taking care of the toxins will always be more.
5. In the future if new ways are found to neutralize toxic waste, does the plan allow them to be used? Or does it make it difficult? How does the plan treat new ideas, so the toxins can be neutralized some day?

Using the Lessons

1. There needs to be planning for the short and long-term future. Experiences with toxic sites need to be shared with the public, between governments, and between other who make decisions. The case studies can help with this planning.
2. The UNESCO World Heritage sites program has many resources to help. They are from many countries, in many languages. They tell about ways to save things and how to repair them. UNESCO also has experience with the politics of protecting places and how to share what you have learned.
3. Perhaps the most important lesson learned is not for the future, but for right now. The lesson is to include future costs and risks into current planning. The costs to the people and the land should not less important than economic growth.

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Long Term Stewardship, the caretaking of hazardous materials, is one of the main unanticipated challenges of high modernity...It arises from the recent realization that the full remediation of contaminated waste sites is beyond scientific knowledge, best technologies or available resources...in all cases, LTS comprises systems and materials that have the potential for catastrophe, for environmental contamination, or for inflicting injury, ill health or death on exposed humans." [1] -Eugene Rosa

Introduction

In the fall of 2010, Alternatives North engaged the author to undertake a study of "The Theory and Practice of Perpetual Care of Contaminated Sites" as a part of the Environmental Assessment of the remediation plan for the Giant Mine in Yellowknife, Canada. The alternative being assessed by the EA is to create a block of permafrost to immobilize 237,000 tonnes of arsenic trioxide – the wastes from roasting arseno-pyrite ores in order to extract gold over a fifty year period- currently stored in underground drifts. Until an alternative plan is developed, the frozen block will have to be maintained "in perpetuity".

Perpetual care is also called "long-term stewardship" and "post-construction completion". The research undertaken for this report included searching literature available on the internet, reading relevant English language print materials and conducting structured interviews with key informants from responsible agencies and affected communities. In addition to the literature review, nine case studies of situations in the US and Canada were also developed. Each case study was peer-reviewed by experts familiar with the case, and their suggestions have been incorporated. Many interviewees and reviewers asked that their names be withheld.

The problem of "long term stewardship" of contaminated sites is a relatively modern problem, so there is no real experience to draw on. It is still an experiment. Our only experience is with built archaeological sites like the pyramids or the Acropolis.

Early in the process, the author sent requests for suggested case studies reflecting best practices in "the theory and practice of perpetual care" to a number of government, industry and environmental organizations and individuals involved with contaminated site management. Most of the case studies selected were suggested through this process, and their relevance to the report was confirmed through the literature review.

An attempt was made to ensure that the case studies reflected the practices and forward-thinking of key organizations dealing with these sites. In the US, this meant Superfund, the Department of Energy, the Bureau of Land Management, and in Canada - provincial and federal

[1] Eugene A. Rosa, "Long-Term Stewardship and Risk Management: Analytical and Policy Challenges", in Thomas M. Leschine (ed). *Long Term Management of Contaminated Sites*, (Emerald Press. 2008).

regulators of abandoned mines, the Federal Contaminated Sites Action plan (FCSAP), uranium mine and nuclear waste regulators and the Nuclear Waste Management Organization. Although there is also interesting work associated with brownfields and landfills, this report does not address them, due to limitations on study resources.

In the United States and Canada, long-term contaminated sites are the legal responsibility of a number of different government bureaucracies with their own structures, cultures and idiosyncrasies, which have to be understood in order to present the case study. The organizations that are charged with care of these sites tend to be complex and politically vulnerable. In Canada especially, information is managed in a secretive manner and information is handled selectively and released slowly.

A number of the case studies look at perpetual care issues at nuclear waste sites. The 10,000 year time frame associated with these sites has stimulated some of the most imaginative thinking about long term stewardship. There is also a significant similarity between the long term threat from the stored Giant arsenic and nuclear wastes: the most serious contamination from both is colourless, tasteless and odourless, and may cause total system failure to humans on exposure. Both can be absorbed through ingestion, inhalation and through the food chain. Unlike sites where toxins remain ugly, smelly or oozing after initial cleanup, the dangers from radiation or arsenic trioxide will not be immediately evident to those exposed.

The UNESCO World Heritage Sites case study describes the challenges inherent in attempts to preserve structures that were built millennia ago, and the "System Accidents" study sets the stage for understanding the complex issues that must be considered in long term stewardship planning.

Most of these contaminated sites are situated in or near a communities - often indigenous - which have advocated for the clean-up of a site, usually for decades. The surrounding communities continue their advocacy to the present time and are also faced with living with a toxic isolation facility forever. The efforts of the people who provide leadership for their communities often goes unacknowledged, but they drive change on local and national levels. The case studies attempt to give voice to their unique struggles, concerns and solutions.

Researching contaminated sites that require perpetual care is traumatic and difficult work. It means understanding the history of the "most contaminated places on earth": Chernobyl, Chelyabinsk, Hanford, the Nevada Test site, Uranium City, Faro, Sydney; interpreting the complex and often contradictory government practices and policies that are (or are not) in place to remediate and forever to contain the enormous wastes from our industrial economy; and recognizing the effects on the ecosystem and people where the sites are located. Many of these places have become "sacrifice zones" – land and communities sacrificed for economic progress (Edelstein 2008). In the midst of the research, the earthquake and tsunami struck Japan; the Fukishima nuclear power plant faced a meltdown in at least four of its reactors. An entire part of

Japan, like areas of Belarus and the Ukraine, like the Nevada test site, and Bikini Atoll, will now be uninhabitable for centuries.

The extent of the problem is also sobering. A 2003 US National Research Council Report estimated that there were 217,000 contaminated sites in the US (NRC, 2003). The NRC studies found that "most of these legacy sites...will not be cleaned up to the point where they can support unrestricted access; that most will require care into the indefinite future because of residual risks; that the needs of what has come to be called 'long term stewardship' are not being adequately taken into account in current site planning; and that the lesson of history is that neither engineered controls nor institutional management measures can be counted upon to remain effective for as long as many of the most dangerous contaminants will remain."[2]

The report is organized as follows:

Introduction: methodology, challenges in the research, how the work is organized.
Lesson Learned: a summary of the key learnings about the theory and practice of long term stewardship from the literature review and case studies. Many of these learnings are posed as questions, as there are not yet satisfactory answers/solutions identified.
Case studies:

- System Accidents
- Love Canal and Superfund
- The Hanford Nuclear Reservation and the US Department of Energy
- Zortman-Landusky Mines and US abandoned mines
- Uranium Mine and Mill Tailings in Saskatchewan
- Faro Mine and Abandoned Mines in Canada's North
- Port Radium and the Sahtu Dene of Déline
- Managing Nuclear Wastes: Deep Geological Disposal
- UNESCO World Heritage Sites

Bibliography: print and web-based resources reviewed for the report.

[2] Thomas Leschine, *Long-Term Management of Contaminated Sites* (Emerald Publishing. 2008), page 2.

Lessons Learned from the Case Studies and the Bibliography

The State of the Literature

1. Most discussion of post closure mining looks 100 years or less into the future; most not more than 25 years. The Giant Mine plan looks 50 years in the future. Long term stewardship – centuries and millennia ahead - requires a different kind of planning and should be integrated into clean-up planning from the beginning. There is a dearth of analysis in Canada. (Edelstein 2007, Leschine 2007, Cowan and Robertson 2010, Probst n.d.)

2. The writing on the subject is multi-disciplinary, ranging from psychology, ethnography and community studies to nuclear physics, engineering political science and accounting. Many of these disciplines do not relate to one another. The few expert panels that have been convened to address these issues provide some insight into the huge challenges that long term stewardship presents, but not much else.(Benford 2000, Edelstein 2007, Leschine 2007, Faro 2010, CDUT 2005)

3. The desire to build nuclear waste repositories has stimulated some thinking for 10,000 years into the future, although this has tended to focus on signs and markers for future generations. To date, we have no examples of human-made structures that have lasted this long. Archaeological sites have been vandalized, destroyed by natural events and war, crumbled due to entropy. We no longer understand the meaning of many of the longest lasting structures – except those that say "look at me". In indigenous cultures, there are places that are "tapu"- areas where the people are not supposed to go - but they are ignored and trespassed upon by settler cultures. In some cases, their very existence is a challenge to the religious beliefs of others, which invites their despoiling. (Benford 2000, UNESCO 2011, de Merode 2003, Carlson 2004, IIIRM 2004)

Community Involvement

1. There is a general consensus amongst all writers and case studies that local communities need to be involved in planning for long term care; in particular, the indigenous communities who have strong attachment to the very land upon which the waste repository sits. (Déline First Nation2005, Edelstein 2007, Gerrard 1995, IIIRM 2002, Leschine 2007, Macey 2007, Rekmans 2003, IIED 2002., EPA 2001, Keeling and Sandlos 2005)

2. While best practice actively involves local indigenous communities in long-term care, there may be resentment and resistance to involvement, since these affected indigenous communities have come to this point through a long history of trespass and pillage by the very structures of colonialism that now seek their counsel. (IIIRM 2002, Faro 2010, Marcotte 2006)

3. Where communities discover - after the fact- that their land and people have been irretrievably contaminated , it alters their perceptions of themselves, their cultural memory. The need for understanding how the site came to be; for healing, telling the history, for lament, for commemoration, is essential. The opportunity for peoples to heal themselves culturally, spiritually, politically and socio-economically has to be part of any long term stewardship plan. (Van Wyck 2005, CDUT 2005, NRC 2003)

4. In most communities there is a history of tension between those who want to get on with "economic development", and/or don't want to acknowledge the pollution problems in the community and those who advocate to get it remediated. This may not go away once it is recognized that the toxics have to be stored on site. Some community members will be more concerned about the economic and social implications of "environmental stigma", (the shunning of local people, property and crops as a result of public knowledge of contamination) than they are about long-term health and ecological effects from the contamination. (Edelstein 2008)

5. Unfortunately this tension may be exacerbated by government and industry interests in keeping the matter quiet. Effective advocacy for cleanup and effective long term stewardship will likely result in increased clean-up costs, which will have to be borne by these interests.(Edelstein 2008, CHEJ n.d., Leschine 2007, IIIRM 2004)

6. In the cases studied, the risk assessments undertaken to estimate costs for long-term health problems all use a cost-benefit "insurance" model. In all the communities studied, risk assessments concluded that there was no provable relationship between the contaminants of concern and the shockingly poor health of the local people, except for psychological reactions like "radiophobia". "The standard of proof for causality is set at such a high level that even if a near perfect correlation exists between local health problems and proximal levels of pollution or contamination, many communities still cannot prove causality."[3] The entire process of health risk assessment needs to be rethought. (Rosa 2008, Guth 2010, Edelstein 2008, CHEJ)

[3], Nicholas D. Martyniak, citing Williams (1998), "The Case of the Pinewood Landfill" in Edelstein (2008), page 76.

Institutional Controls

1. The first efforts to manage the toxic site over the long term are simply to keep people away from the site. This means a reliance on various institutional and administrative controls, such as fencing, signs, restricted access, registering contaminants on the property deed, and zoning. Over the long term, most of these controls can be expected to fail for one reason or another. Most organizations attempt redundancy of controls so that there are always backups when one fails. (NRC 2003, Macey 2010, Leschine 2007, IAEA 2010)

2. There are many detailed studies/discussions of various institutional controls in the literature. Many of these are enumerated in the Superfund case study. (EPA 2001, NRC 2003, Cowan and Robertson 2010)

3. Markers such as those envisaged for the Waste Isolation Pilot Project in New Mexico (WIPP) are extreme attempts to provide an institutional control over a 10,000 year time frame.(Sandia 2003, Science Illustrated 2008, Sebeok 1984,Van Wyck 2005)

Management and Governance

1. There is generally consensus that the laws and regulations we need for long-term care of toxic waste isolation structures are inadequate. Laws and regulations need to be in place to govern long term stewardship requirements, which set out emergency response, record-keeping, the need for periodic environmental assessment, and how inter-jurisdictional conflicts are to be dealt with (especially in an emergency). (NRC2003, Cowan and Robertson 2010, Macey 2007, Moody 2007, IIED 2002)

2. The organization that is charged with long term stewardship of the site will determine the introduction, management and control of the technology. It needs to be a High Reliability Organization (HRO) with access to appropriate resources in the event of catastrophic failure. There is an entire literature about HROs .which describes organizations with an "unwavering commitment to safety and reliability...other organizational goals, such as efficiency, organizational prestige or profit-making must be continuously subordinated to avoiding serious organizational failures."[4] (Rosa 2008, Macey 2007, Leschine 2007)

3. The responsible organization will be subject to particular challenges: the atrophy of vigilance in an environment where the need to act is intermittent (maybe spanning decades), the splintering of responsibility amongst different actors (organizational silos,

[4] Rosa, page 242.

jurisdictional differences, contractor relationships), and structural secrecy (the need to protect the institutional reputation, national security issues, fear of producing panic). It needs to be able to operate flexibly in a crisis, with many redundant features. (Macey 2007, Lescines 2007, Edelstein 2008, NRC 2003)

4. Long term stewardship requires humility about our errors and ignorance, as well as the flexibility to change direction. Because engineered structures are likely to fail at some time in the future, crucial is the ability to retrieve materials from these sites and/or to shift to a different remedy if necessary. (MiningWatch 2003, NEPI 1999, Wallace 2010, Faro 2010)

5. Adaptive Management is designed to "cope with the uncertainty of ecosystems by creating spaces in which reflection and learning can occur and by allowing management systems to take action in light of new information."[5] However, problems are often identified at moments of crisis, when there is neither time nor resources to stop and reflect. Being able to recognize warning signs that emerge as part of a slower moving process is also an issue. In addition, 'adaptive management' is often used as a euphemism for stumbling along, and keeping costs to a minimum.(Macey 2007,NRC 2003, Leschine 2007, IIIRM 2004)

6. Proper adaptive management can contribute to *social* learning — the often messy and confusing process by which societies embrace knowledge, turning emergent understandings into cultural shifts, institutional arrangements and policies, and creating new technological and social capabilities. Bridging the diverse approaches and languages, organizational cultures and modes of decision-making over time is an enormous challenge to the management of these sites. (Macey 2007)

7. Generally there is a consensus that the affected community should be formally involved in governance, but be free of financial responsibility. This may create conflict for government agencies and officials who may see community interests as challenging their institutional roles or jeopardizing their work-plans.(NRC2003, Macey 2007, Leschine 2007)

[5] Torrell (2000). quoted in Macey, Gregg P. and Jonathan Z. Cannon, *Reclaiming the Land* (Springer 2007), page 10.

Record-Keeping and Transparency.

1. Because of the plethora of laws, regulations and institutions responsible for long-term waste sites in the US and Canada, public access to records is already difficult. (Van Wyck 2010, Cowan and Robertson 2010)

2. How are records to be kept so everything is not lost when/if there is an environmental or social catastrophe, or a major change in computer software, or a failure of the electrical system? The case studies reveal that there are currently no consistent answers. (Maest and Kuipers, 2006)

3. Are the records publicly available? Over time, who will have access to them and how simple is that access? Even those sites with websites, generally have very selective public access to documents. DOE and Superfund are the most sophisticated. However, in Canada, information on these sites is very limited, and often quite out of date. Library and Archives Canada is subject to the *Access to Information Act,* a cumbersome and difficult process to navigate, even for academics. (Van Wyck 2010)

Monitoring/Inspections and Periodic Deep Analysis of Data

1. Monitoring of the site must be done extensively and on a regular basis so that even early problems with leakage can be identified. What is sampled? By whom? How often? Five year monitoring by contractors appears to be the norm, but cost-cutting always trumps effectiveness over time. (Affolder 2011, Leschine 2007, Harding 2007, Raffensperger 1999, NRC 2003)

2. An endowed independent monitoring agency with responsibility to the affected community appears to be the most effective model. (Affolder 2011)

3. The responsibility to analyze the monitoring data in depth on a regular basis when/if the work is contracted out has to be clearly established and sustainable. How is this to be sustained over centuries? (NRC 2003)

Engineering and maintenance

1. Engineered "system components can react in unexpected and unpredictable ways. Two or more small component failures often combine in unimagined ways to produce failures in the entire system – 'system accidents'. This is "not supposed to happen" because technological systems have many built-in safety features: redundancies, back-up systems, control devices, and procedures of vigilance. Yet, small multiple failures can defeat the most elaborate safety systems. Because multiple failures are unexpected, they are not

visible to the system designers and are, therefore, outside a conscious purview of design and control."[6](Faro 2010, Rosa 2008, Macey 2007, IIIRM 2004)

2. How are the physical works maintained? By whom? Who is responsible for translating monitoring results into real action? What is the process for community consultation on engineering matters over the long term? Does the public have resources for technical advice? It is important to ensure the long-term availability of materials, skills and technology to fix unfolding problems. (NRC 2003, Leschine 2007)

Emergency Response/ Contingency Planning/ Catastrophic Failure.

1. It is abundantly clear from the case studies that it takes enormous vigilance and mobilization of citizens to get attention to the problems of toxic contamination. There is no reason to assume this will change in the near or far future. A response to slow leakage or gradual failure of containment (whether it is identified in monitoring results or not) will still require political action to get a response.

2. Catastrophic failure can be the result of neglect over time, of earthquake, fire, flood, or civil unrest, or all of these together. Or it can result from a series of minor, unrelated failures. Long term stewardship has to clearly identify, and have a means of continuing to identify, which organization is responsible to act and where the resources will come from to respond. (IAEA 2010)

3. Most of the case studies reveal that the affected citizens had been consistently lied to about the severity of the pollution they were facing, that risks had been down-played and minimized until advocacy forced the truth to surface. How will the long term strategy ensure that this will not be the case? (CHEJ n.d., Abel n.d., Ashton 2010, Baton 1998, GAO 2005, Kenny-Gilday 1998, Kuipers and Maest 2001, Nikiforuk 1998, VanWyck 2010, Online Ethics n.d., Paynter 2010)

Financial Assurance/ Bonding

1. The difficulties in maintaining adequate funding for long term stewardship is raised by most of the case studies. Most programs renew their funding through annual appropriations which have to compete with politically more attractive projects. (Kempton 2010, Cowan and Robertson 2010)

[6] Rosa, citing Perrow, page 239.

2. A number of authors recommend the use of trust funds or endowments to protect resources for long term stewardship. How is the bond set? Renewed? Is the model dependent on continued economic growth? How is losing the bond to corruption avoided? (Saskatchewan 2010, Probst n.d., Bauer and Probst 2000, Guth 2010, Tonne 2001)

3. All of these funds are based on net present value and discounting calculations which assume very long-term endless economic growth, take no account of growing ecological degradation, and unfairly minimize the costs to future generations of today's pollution. (Guth 2010)

Intergenerational Equity

1. Creating opportunities for indigenous peoples to carry on the story of the site and building the capacity of youth to be effective guardians is suggested repeatedly in the literature. (IIIRM 2004, SEHN 2006, Faro 2010, Harding 2007)

2. The isolation of toxic wastes passes the externalized costs and responsibilities of modern industrial production onto future generations. Even if the financial assurance were adequate to cover the costs when the isolation facility fails centuries or millennia in the future, it will not make up for enormous sacrifice zones that its failure will create. (Guth 2010)

3. Intergenerational guardianship is important to perpetual care sites. In July 2006, representatives of several Native American tribes issued the 'Bemidji Statement on Seventh Generation Guardianship'. This statement assigns "responsibility to the current generations to protect and restore the intricate web of life that sustains us all, for the Seventh Generation to come." This concept and examples from other countries are described in a paper published by the Science Environment and Health Network. (SEHN 2006, IEN 2006)

4. In many of the cases, this generation is suffering the consequences of errors in judgment that were made during the 1940s, by previous generations. If an option for neutralizing the toxins is available to this generation, no matter what the current cost, then it should be seriously considered (Edlstein 2008, Leschine 2007)

5. If there are new remediation technologies discovered in the future, or if resources are found to make remediation cost effective, have we ensured that the clean-up plan allows them to be implemented? Or does the plan obviate them? How does the long term stewardship plan drive innovation so that the site may eventually be neutralised? (Macey 2007, NRC 2003)

Applying Lessons Learned

1. There needs to be planning for the short and long-term future to share the lessons learned from experience dealing with these sites with the public, between governments and other decision-makers. A number of the case studies provide examples of means to accomplish this.(NRC 2003, DOE, UNESCO)

2. UNESCO has a wealth of resources from all countries and in many languages available on conservation, preservation, and remediation strategies for archaeological sites, heritage buildings, as well as knowledge of preservation engineering, and archiving materials over the long-term. It also has varied and useful experience with political interventions to protect heritage, and with the sharing of learnings with others.(UNESCO)

3. Perhaps the most significant lesson to be learned from these perpetual care contaminated sites is not for the future, but for the present; it is to integrate the costs and risks that will be borne by future generations into current economic and social planning; to understand the real costs of an economy that treats human and ecological costs as secondary to the imperatives of economic growth.(IIIRM 2004, Leschine 2007, Diamond 2005, Gerrard 1995, IIED 2002, Raffensperger 1999)

Case Study One: System Accidents

"To understand risk is to understand not the individual decision-maker, but the conditions and circumstances under which decisions are made." [7]

Summary

This case study summarizes work on the role of organizational culture and systems failure in the creation of two serious disasters - Three Mile Island and the Space Shuttle Challenger, and provides some thought around the creation of High Reliability Organizations.

Eugene Rosa, a sociologist from the Thomas F. Foley Institute for Public Policy and Public Service at Washington State University, makes the point that current forms of risk analysis for long term stewardship have serious flaws:

- The risk management efforts of stewards will extend far into the future, with literally no precedents as a guide. Over long enough periods of time our knowledge of the risks is effectively zero.

- The risk literature is overwhelmingly dominated by the Rational Actor Paradigm (RAP), with its emphasis on individuals and its meagre attention to organizations. Stewardship over the long term will rest on the shoulders of institutions not individuals.

- The RAP treats the individual as an abstract calculating decision-maker, unmindful of social and political concerns and committed to making reasoned judgements. This requires a suspension of historical knowledge and a naïveté about how people actually make decisions, especially in organizational cultures.

- The attention to actuarial analysis, cost-benefit analysis and probabilistic risk assessment in long term stewardship planning depends on the RAP paradigm, and does not pay enough attention to organizational analysis.

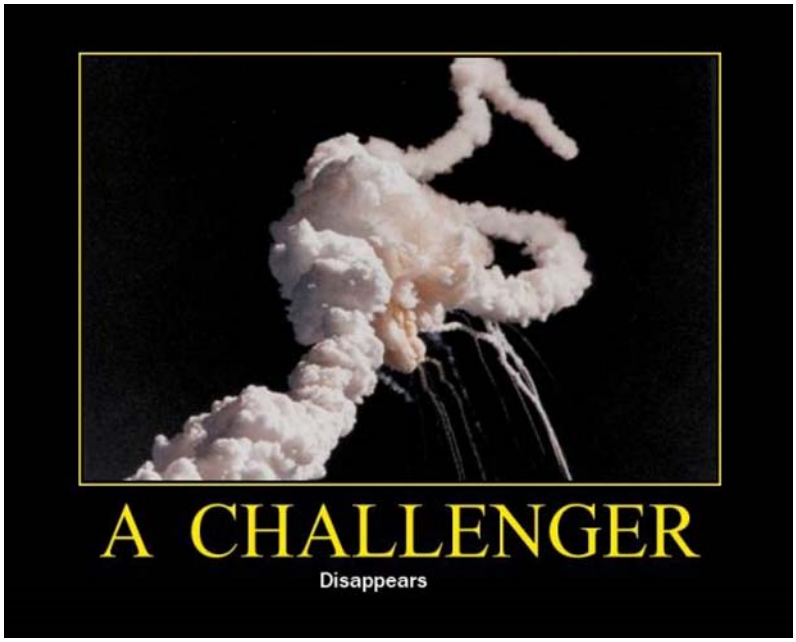
- "The role of organizations is pivotal to the study of risk. The introduction, management and control of technology are overwhelmingly in the hands of organizations. The importance of organizations – their structure, culture and operations - to the management of technological risks is clear."[8]

[7] Eugene A. Rosa, "Long-Term Stewardship and Risk Management: Analytical and Policy Challenges", in Thomas M. Leschine (ed). *Long Term Management of Contaminated Sites* (Emerald Press. 2008), page 248.

[8] Rosa, page 233.

System accidents

democraticunderground.com



- Humans intend to make rational decisions. However, we often do not. This can be a result of our ignorance or self-interest. But it can also be a result of expectations imposed by organizations that conflict with safety, of division of labour, of routinization, of ideological indoctrination, or an unresponsive authority structure.

- Engineered "system components can react in unexpected and unpredictable ways. Two or more small component failures often combine in unimagined ways to produce failures in the entire system – "system accidents'. This is not supposed to happen because technological systems have many built-in safety features: redundancies, back-up systems, control devices, and procedures of vigilance. Yet, small multiple failures can defeat the most elaborate safety systems. Because multiple failures are unexpected, they are not visible to the system designers and are, therefore, outside a conscious purview of design and control."[9]

- There are challenges for organizations attempting to build a high reliability culture:
  - The atrophy of vigilance, when most practice is routine, until the rare crisis erupts;
  - Fracturing of responsibility amongst organizational actors: silo decision-making, etc;
  - Structural secrecy.

[9] Rosa, citing Perrow, page 239.

- The appropriate strategy for understanding the risks of long term stewardship is to examine the organizations that are charged with that stewardship. Organizations that do this well are "High Reliability Organizations".

- The context of decision-making is important, because it provides the setting for the exercise of power: the distribution of choice, prerogatives and resources. These are unfairly distributed within any organization. In organizations that are driven by schedules, have insufficient resources to do a job properly, have ineffective communications, and are unresponsive to criticism, the ability to learn by trial and error is almost non-existent.

Two examples that reflect the problem:

Three Mile Island:

According to Peter Van Wyck, the partial meltdown of the Three Mile Island reactor in March 1979 is an "extraordinary testament to the 'improbable'", fraught with complexity.

First the secondary cooling system failed – the system responsible for removing particulates from the secondary cooling water leaked into another system that controlled instruments. The now-damp instruments reported a nonexistent error and fed that information into a pump shutdown sequence. Without the pumps, the secondary system was no longer circulating water. This resulted in a build up of heat in the primary system. When the pumps shut down, so did the heat-transfer turbine. This meant that no heat was being released from the core. The valves in the backup system, for some reason, had been left shut. The control panel indicator gauges were obscured by a repair tag hanging on the console, so the operators didn't see what was happening. With no heat reduction in the core, the reactor dropped graphite control rods into the core to slow the reaction. However, without the cooling systems operating, the core continued to heat up. The operators opened a safety valve to release pressure, but after the steam was released, the valve failed to reset to the closed position. As a result, about 40% of the water from the core was expelled, and the core was becoming exposed. "The operators however, knew none of this. Nor could they, because on the one hand the instrumentation reported conflicting and non-related errors, and on the other hand, the failure-mode assumptions that they had been trained to make did not include the failure mode they were in fact experiencing...The system performed in a way that was outside the universe of belief of the operators...the fact that various warning alarms, buzzers, and thousand or so warning lights were simultaneously flashing, honking and buzzing only made the situation more chaotic."[10]

[10] Peter Van Wyck, *Signs of Danger* (University of Minnesota Press, 2005),. page 10.1-10.2.

The Space Shuttle Challenger disaster, **January 28, 1986**

Wikipedia describes this disaster as follows: "The Space Shuttle *Challenger* broke apart 73 seconds into its flight, leading to the deaths of its seven crew members. The spacecraft disintegrated over the Atlantic Ocean. " Disintegration of the entire vehicle began after an O-ring seal in its right solid rocket booster (SRB) failed at liftoff. The O-ring failure caused a breach in the SRB joint it sealed, allowing pressurized hot gas from within the solid rocket motor to reach the outside and impinge upon the adjacent SRB attachment hardware and external fuel tank. This led to the separation of the right-hand SRB's aft attachment and the structural failure of the external tank. Aerodynamic forces promptly broke up the orbiter."[11]

In February 1986, Presidential and Congressional Commissions were established to investigate the accident. Both commissions went beyond the O-ring analysis to investigate the circumstances that gave rise to this technological failure. Rosa crystallizes the following from these two reports:

"Political pressures to demonstrate the safety of the shuttle program (i.e., it was now safe enough to invite civilians aboard) combined with production pressures (namely compliance with launch schedules necessary to ensure profitability of the self-sustaining shuttle program) shaped NASA administrators' actions. This resulted in decisions at lower levels involving rule violations and individual wrong-doing. Cost-benefit calculations were shaped by these conditions, resulting in decisions that sacrificed safety for political and economic gain."[12]

Rosa makes the following points:

The Commissions viewed the managers' decision to launch based on cost-benefit calculation as rational and amoral. However, this assumes that managers within organizations are free to make a rational cost-benefit calculation. "Instead, all organizations reduce the uncertainty of individual actions by imposing expectations, routines and rules of choice on action. Decision-making is, therefore, constrained by premises of permissible choice embedded in the structure and culture of organizations."[13]

Diane Vaughan, who conducted a thorough analysis of the accident in 1996, found that the cause of the accident was in the very structure and culture of NASA itself. "The rules of that culture included bureaucratic procedures that permitted the acceptance of engineering performance that did not meet design standards, a structural secrecy where the left hand was out of communication with the right, and the acceptance of risk of serious failure based, not on positivistic foundations, but on a cultural construction. In short, people were doing their jobs exactly as prescribed by the NASA bureaucracy and culture." [14]

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[11] http://en.wikipedia.org/wiki/Space_Shuttle_Challenger_disaster
[12] Rosa, pages 230-231.
[13] Rosa, page 231.

[14] Vaughan, in Rosa, page 231.

Case Study Two: Love Canal and Superfund

"*Even enlightened programs like Superfund...run up against a fundamental problem. Once pollution has been released, it is expensive and perhaps impossible to corral it. The result is a perpetual burden for the environment, local communities and future generations. As I have shown, the key ingredient in making such a program work effectively has been the strong grass roots citizen movement."* –Madelyn Hoffman[15]

Summary

This case study investigates the failure of a long-term stewardship plan at Love Canal in New York State that led to the establishment of Superfund, the world's most effective contaminated sites remediation program in the United States. The gruelling efforts of local citizens to bring attention to the site took over twenty years to bear fruit. The containment of the toxics took thirty years to complete. Some of the features of the Superfund Post-Construction Completion program are described. Since Superfund transfers sites requiring long term stewardship to individual states, a study reporting on the success of those programs is also summarized.

Key points

- It was the failure of long term stewardship at a toxic waste site (Love Canal) that led to the creation in 1980 of the Superfund program for the clean-up of large toxic sites.
- The clean-up was the result of strong and effective unpaid citizen advocacy that had to be sustained over years.
- It took twenty years for government to respond to the problem at Love Canal, and then, not until the problem became clearly and shockingly visible.
- The clean-up and containment of even this small site took over 16 years to be completed.
- The health effects of the toxins were never clearly established, despite many studies.
- Increasingly, the remediation of toxic sites means the isolation of large amounts of toxic and hazardous materials either on site, or in a designated repository which will have to be managed and maintained for millennia.

[15] Madelyn Hoffman, "A Grassroots Perspective on the Brownfields and Superfund Programs", in Edelstein, Michael et al., *Cultures of Contamination (*Emerald Press, 2008), page 330.

Love Canal

journeyofthelizardking.blogspot.com

Love Canal

cr4.globalspec.com

- Superfund does have a Post Construction Completion program where the key components are Operations and Maintenance, Long Term Response Action, Institutional Controls and Five Year Reviews.

- Superfund itself does not carry out Long Term Stewardship, but transfers the responsibility to States, Tribes or federal agencies. Long Term Stewardship is still being developed, and most of it is seriously underfunded and understaffed.

Love Canal

Thirty years after the Superfund legislation became law, Love Canal is still the icon of hazardous waste, despite the fact that it was not the largest, most toxic, or most expensive of Superfund sites. "The significance of Love Canal lies in its being the first place where a neighbourhood citizens' organization drew attention to toxic wastes in a residential neighbourhood and made effective use of media and politics to gain redress."[16]

It was the watershed event that catalyzed change in toxics management across the United States.

"Love Canal was originally meant to be a dream community. That vision belonged to the man for whom the three-block tract of land on the eastern edge of Niagara Falls, New York, was named--William T. Love. Love felt that by digging a short canal between the upper and lower Niagara Rivers, power could be generated cheaply to fuel the industry and homes of his would-be model city."[17] The canal was built in 1894.

The canal was abandoned for economic reasons in 1910. From 1942 to 1950, it was used as an industrial chemical dumpsite by Hooker Electrochemical Corporation. "More than 21,000 tons of chemicals, including such potent toxins as benzene, the pesticide Lindane, polychlorinated dioxins, PCBs and phosphorous were deposited in the canal, which Hooker had lined with cement."[18]

In 1953, the company, owners of the property since 1947, covered the canal with "an impermeable cap that was supposed to prevent water from entering and promoting seepage of the

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[16] Society for Applied Anthropology, *Case Study One: Love Canal Superfund Site, Niagara Falls, New York,* (New York: March 2001). http://www.sfaa.net/eap/lovecanel.pdf

[17] Eckhardt Beck, "The Love Canal Tragedy", EPA Journal (January 1979). http://www.epa.gov/history/topics/lovecanal/01.htm

[18] On line Ethics Centre for Ethics and Research, Pre-college Materials. *Case Study 6: Love Canal*, http://www.onlineethics.org/CMS/edu/precol/scienceclass/sectone/cs6.aspx

toxins"[19] and sold it to the Niagara Falls School Board for one dollar. The School Board then sold most of the land to a developer, retaining land to build the 99th Street Elementary School. In the late 1950s, about 100 homes and a school were built at the site. Over a few years, it became a solid blue-collar community with 7400 residents.

At closure, zoning restrictions were placed on the area forbidding residential use, and Hooker placed a deed notice on the property when it transferred the land to the Board of Education in 1953. The deed notice included a "hold harmless" clause that stated that "the Board of Education had been advised by the Hooker Chemical Company that the premises described above have been filled to the present grade level thereof with waste production resulting from the manufacture of chemicals". Despite all of these controls, the Board of Education built a school directly on top of the landfill, and many houses were constructed adjacent to the site.

The first known case of exposure to the chemicals was in 1958, when three children suffered burns from chemical wastes that had resurfaced on the site. "Both Hooker Chemical and city officials were officially informed, but neither the Niagara Falls Health Department nor any other public agency took any action in response to that event or to numerous other complaints during the next twenty years. Hooker's records reveal that the company investigated the initial incident and several other reports, and quickly became convinced that the very large reservoir of toxins was not likely to be contained. Hooker did nothing to convey this knowledge to the Love Canal homeowners, who had never been informed about the nature of the potential hazard. In testimony two decades later, Hooker acknowledged that its failure to issue a warning was due to concern that this might be interpreted as liability for possible harm despite the clause in its property sales deed."[20]

Residents of 99th Street whose homes abutted the canal site were the first to take action on their concerns. Karen Schroeder and Tom Heisner took the lead. The Schroeder and Heisner families, living next door to each other, both had children with congenital defects. In 1977 they began complaining to the city about the visible chemical problems in their back yards. Niagara Gazette reporter Michael Brown started writing about their plight in May 1978.[21] The residents by now had chemical ooze seeping into their backyards and basements, and had begun to organize.

Wrote Eckhardt Beck of EPA: "I visited the canal area at that time [1978]. Corroding waste-disposal drums could be seen breaking up through the grounds of backyards. Trees and gardens were turning black and dying. One entire swimming pool had been popped up from its

[19] On line Ethics Centre for Ethics and Research.
[20] Ibid.

[21] Society for Applied Anthropology. (March 2001)

foundation, afloat now on a small sea of chemicals. Puddles of noxious substances were pointed out to me by the residents. Some of these puddles were in their yards, some were in their basements, others yet were on the school grounds. Everywhere the air had a faint, choking smell. Children returned from play with burns on their hands and faces."[22]

"The Love Canal Homeowners Association grew out of another group established in June 1978, the Love Canal Parents Movement. The Parents Movement was started by Lois Gibbs, who lived in the neighbourhood and whose children attended the 99th Street School. Ms. Gibbs was first alerted to the landfill by newspaper articles describing the wastes and their proximity to the 99th Street School. Having a small sickly child attending the school, Gibbs became very concerned about the danger the landfill posed to the school and to her son's health.

"Gibbs first approached the School Board armed with notes from two physicians recommending the transfer of her child to another public school. But the Board refused to transfer her child stating that if it was unsafe for her son, then it would be unsafe for all children and they were not going to close the school because of one concerned mother with a sickly child. Gibbs was angered and began talking with other parents in the neighbourhood to see if they were having problems with their children's health. After speaking with hundreds of people, she realized that the entire community was affected."[23]

On August 2, 1978, a public health emergency was declared, by the New York State Commissioner of Health, and a few days later, the New York Governor announced to the residents of the Canal that the State Government would purchase the 239 homes nearest to the canal. On that same day, President Carter approved emergency financial aid for the Love Canal area, and the U.S. Senate approved a "sense of Congress" amendment saying that federal aid should be forthcoming to relieve the serious environmental disaster which had occurred.

Within weeks, an 8-foot-high chainlink fence was installed around the 16-acre site. A 40-acre clay cap covered the chemically contaminated area to keep rainwater from intruding. A system of barrier drains was installed that would collect leachate for treatment. Because the toxins were left in place, it would be necessary to monitor and treat the water leaching from this area perpetually—wells, pumps, treatment filters and monitoring equipment were installed.[24]

The EPA describes the thirty year clean-up of the 70 acre site as taking place in stages:

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[22] Beck, Op.cit.
[23] http://www.chej.org/wp-content/uploads/Documents/love_canal_factpack.pdf
[24] EPA, Love Canal New York NPL Listing History EPAID #NYD000606947. http://www.epa.gov/region2/superfund/npl/0201290c.pdf

- 1978: the emergency response – immediate fencing and covering of the canal area, drainage ditches and preliminary water treatment, purchase of homes and relocation of 100 families, destruction of the homes and 99th Street School;
- 1982-1985: landfill containment – 40 acre cap, leachate collection and upgraded water treatment facility;
- 1985-1989: remediation of sewers, creeks and berms;
- 1987-2000: destruction of the dioxin laden sediments and off-site shipping of some -- toxic wastes to landfills and incinerators in other parts of the US;
- dealing with the 93rd Street School contaminated lands (where materials from 99th Street School had been used as fill);
- purchase and rehabilitation of the homes surrounding the directly affected canal area;
- return of the property to the custody of the site owner-- now Occidental, which had bought Hooker-- with an agreement to conduct yearly monitoring of wells installed for the purpose, with reports submitted to the New York State Department for Environmental Conservation and the federal Environmental Protection Agency.

The site was removed from the National Priorities List on September 30, 2004. The latest five year review by Superfund took place in September 2008.[25] The site will have to be monitored and managed in perpetuity. Information is stored at the EPA Western New York Public Information Office in Buffalo NY.

In the over 50 acres outside the fenced area were another 800 homes. These homeowners watched the 1978 emergency response and argued that they were also affected; they formed the Love Canal Homeowners Association by fall 1978.

"The community quickly began to express their anger and concerns. Even quiet and retiring residents suddenly found themselves raising their voices in public protest. The protests included mothers and fathers with their babies and seniors who were ready for retirement. They marched into the streets on Mother's Day, carried symbolic coffins to the state capitol, and held prayer vigils. The residents also picketed at the canal every day for weeks in the dead of winter, hoping someone would hear them and someone would help. Their children were sick, their homes were worthless and they were innocent victims. Because of the pressure created by the protests and the persistence of the community, the state was forced to address the community's concerns."[26]

[25] Ibid.
[26] Centre for Health Environment and Justice, *Love Canal Fact Pack*. http://www.chej.org/wp-content/uploads/Documents/love_canal_factpack.pdf

The community worked with Dr. Beverley Paigan to undertake a study of health effects with the residents, which showed higher rates of miscarriages, asthma and neurological problems among these residents.[27] The LCHA undertook another lengthy battle which led to a declaration of their neighbourhood as an "Emergency Declaration Area" (EDA), and to the remediation of contaminated areas within the neighbourhood by site-owner Occidental, under the supervision of the EPA.

The Love Canal Area Revitalization Agency (LCARA) was established by the New York Governor on June 18, 1980 to organize the rehabilitation effort of the properties in the Emergency Declaration Area of Love Canal. In early 1994 it was announced that the cleanup (and destruction) of the condemned homes in the Love Canal EDA had been completed and it was safe to move back to the area.

After the area was determined to be habitable, LCARA developed a Master Plan and Generic Environmental Impact Statement (GEIS) for the new planned community. With federal subsidies for their mortgages, the inexpensive refurbished homes sold quickly, and "Black Rock Village" became a functioning neighbourhood. In the low lying area of the EDA, the houses were bulldozed into their own basements, and the land was zoned for light industry. LCARA was officially disbanded in 2003 by New York State Legislation.

Over $200 million of the costs were eventually recouped through settlement of the government's lawsuits against Occidental Chemical Company in 1995, 1996, and 1999. Because the settlements did not include punitive damages, Occidental was able to recover much of the cost of cleanup from its insurance companies. The New York Department of Environmental Conservation transferred the operation and maintenance of the pumps and treatment equipment in the containment area behind its chain link fence to Occidental in 1995. In 1998, Occidental assigned operational responsibility to its subsidiaries Miller Springs Remediation Management, Inc., and Glenn Springs Holdings, Inc. [28]

What happened to the key actors in the struggle? Lois Gibbs, the leader of the LCHA, went on to organize the national Center for Health, Environment and Justice. Dr. Paigan had her research funds curtailed; the Department of Environment Regional Director – who had sided with the residents-- was demoted.[29] By 1981, the Love Canal Homeowners Association was little more than a skeleton. The University of Buffalo has an extensive archive, which includes records, a newspaper database, and a photo database of images available online with images of the school, homes, and toxic waste barrels.

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[27] LR Goldman, B. Paigen, M.M. Magnant, & J.H. Highland, "Low birth weight, prematurity and birth defects in children living near the hazardous waste site", Love Canal Hazardous Waste Hazardous Materials (1985), 2:209–223.

[28] http://www.sfaa.net/eap/lovecanel.pdf

[29] On Line Ethics case study. Op cit.

It is noteworthy that: "Most key decisions at Love Canal were made in the absence of clear knowledge of what the impact on the health of residents had been from the chemical wastes at Love Canal. At the time of these urgent decisions, the health information available was fragmentary and controversial. The homeowners organization [through Dr. Paigan] had surveyed the neighbourhood and recorded many illnesses and reproductive problems, but comprehensive health studies were not undertaken until much later. A large study was proposed by the medical school at the State University of New York at Buffalo to continue work started by the Centers for Disease Control in 1980, but federal funds earmarked for the study were never released. Although there was a major effort on the part of the New York State Department of Health to collect human health data in the neighbourhood early in the controversy, most of the samples were not analyzed. Results were not made available either to residents or in scientific publications. In 1997 the Department received an $8 million grant from the Agency for Toxic Substances and Disease Registry (ATSDR) and finally began a study that will continue until 2002. They have contacted some 5000 former residents and will look at some of the long-term health effects".[30]

The results of the ATSDR mortality study were released last year. The researchers found:

"We were unable to demonstrate differences in all-cause mortality for either comparison population for 1979-1996....The role of exposure to the landfill in explaining these excess risks is not clear given limitations such as multiple comparisons, a qualitative exposure assessment, an incomplete cohort, and no data on deaths prior to 1978. ... However, direct cardiotoxic or neurotoxic effects from landfill chemicals or indirect effects mediated by psychological stress cannot be ruled out. Revisiting the cohort in the future could reveal patterns that are not yet apparent." [31]

Superfund

The publicity generated by Love Canal catalyzed federal action to deal with a growing list of environmental disasters involving toxics, ranging from industrial workers stricken by nervous disorders and cancers to the discovery of toxic materials in the milk of nursing mothers. The Environmental Protection Agency drew up a chain of Congressional acts around the toxics problem, including the Clean Air and Water Acts, the Safe Drinking Water Act, the Pesticide Act, the Resource Conservation and Recovery Act, the Toxic Substances Control Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) better known as Superfund.

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[30] http://www.sfaa.net/eap/lovecanel.pdf, page 9.

[31] Gensburg et al, "Mortality among former Love Canal residents", Environmental Health Perspectives. 2009 Feb;117(2):209-16. Epub 2008 Oct 1. . (University at Albany, State University of New York)..

CERCLA was passed by Congress in 1980, and was intended to address problems like the one faced at Love Canal; to protect human health and the environment. It was – and is- the most effective hazardous waste cleanup program in the world. The scope of the problem it was created to address is also enormous. "Roughly one in four Americans, including ten million children live within four miles of a toxic waste dump. And while estimates vary, at least 200,000 and probably more than 500,000 sites (sometimes referred to as 'brownfields') in the United States contain either soil or groundwater that may require remediation to overcome the negative effects of past industrial operations...these sites do not include large expanses of land operated by the Department of Defence and the Department of Energy [nuclear power plants, nuclear weapons and nuclear waste]. For example, DOE spends between $5.6 and $7.2 billion per year on the environmental management of sites." [32]

Superfund assesses and works on toxic sites, which qualify for the National Priorities List. It is empowered to force any current or past owners of the sites to pay for the clean-up. Superfund is supplemented by a number of state initiatives and other federal acts. The U.S. Environmental Protection Agency (U.S. EPA) requires in its regulations assurance that passive physical (engineered) controls be effective for at least 200 years.[33]

By 2005, Superfund had cleaned up over 900 closed or abandoned sites and reduced health risks for tens of thousands of people.[34] Many of the sites that have been remediated are "being used in every way imaginable". Site reuse has created tangible economic opportunities, tax revenues and raised property values. Some neighbourhoods have been able to come back to life. However, unlike Love Canal, many of the worst sites that remain to be remediated are vast geographic areas with multiple and complex sources of contamination – such as mining and smelter regions. They can be entire watersheds.

The other enormous problem faced by Superfund is that remediation usually means the consolidation of hazardous and toxic wastes in some kind of isolation facility on site or elsewhere, with long-term monitoring and treatment of surface and ground water to remove contaminants.

It should be noted that in 1995, the US did not renew the authorizations that collected taxes from polluting corporations. These special taxes had been placed in a trust fund (worth $6 billion when the reauthorization was cancelled) to pay for some of the activities of Superfund. The trust fund was depleted in 2003 and clean-ups are now funded out of annual appropriations from general revenues.

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[32] Gregg P. Macey, *Reclaiming the Land: Rethinking Superfund Institutions, Methods and Practices* (Springer: 2007), page 1.
[33] http://www.ptcinc.com/Content/Downloads/Publications/Watson_Chris_UMTRA_1993.pdf (2.1.1)
[34] Macey, Foreword.

Superfund "Post-Construction Completion"

Superfund "Post-Construction Completion" is the name given for several activities generally undertaken at sites following the construction of response actions. These activities include: operation and maintenance and long-term response actions (or LTRAs), institutional controls, five-year reviews, optimization of remedies, and deletion from the National Priorities List.

Most sites are transferred to the State governments or to the appropriate federal agency, once "response actions" are complete. They may also be transferred to a Tribe. The EPA can operate water treatment systems for up to ten years; it can perform five year reviews of the performance of the site after it is transferred to the State or returned to a federal Agency. External "stakeholders" may also review performance.

The following are key components of Superfund's Post-Construction Completion plans:[35]

Operations and maintenance-- O&M activities include: maintaining engineered containment structures; operating leachate and gas collection systems; operating ground water containment and restoration systems remedies; monitoring to ensure that the remedy is performing as expected and the environment is protected; and maintaining and enforcing institutional controls and access restrictions. Superfund's responsibility is to ensure that the work is adequately performed by States, federal agencies, or private operators. Specific EPA actions may include ensuring that O&M and monitoring reports are submitted through routine oversight or enforcement when necessary; reviewing reports and evaluating monitoring results; performing on-site inspections and documenting the results. When appropriate, EPA may also troubleshoot problems, and develop or evaluate proposals for additional response actions or adjustments to existing remedies, to achieve objectives, improve performance, or reduce costs. Superfund has developed manuals that set out how this work should be performed.

Long Term Response Action (LRTA)-- If cleanup (and water treatment) is not completed in the ten year period envisioned, the system is transferred to the State. The EPA role is to ensure that the State is performing as anticipated. Performance and monitoring data should be collected to support analysis and decision-making. Specific areas of interest may include: ensuring that the public is being protected (e.g., the plume capture zone is being maintained); ensuring that restoration of the aquifer is progressing as planned; determining whether there are significant changes to the assumptions that were relied upon when selecting the remedy; and determining when the active portions of the remedy can be terminated. The Superfund guidance document

[35] Most of the next section abridges information provided in: EPA, Superfund: Post Construction Completion: An Overview. (June 2001): http://www.epa.gov/superfund/cleanup/postconstruction/pcc_over.pdf

"Presumptive Response Strategy and Ex-situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites" describes a phased approach for ground water restoration.

Institutional Controls. Also called 'land use controls' or 'activity and use restrictions', institutional controls are non-engineered, administrative or legal instruments that minimize the potential for exposure to contamination by limiting land or resource use. They are used in conjunction with engineering measures for treatment or containment. They are intended to minimize potential exposure when contamination remaining on-site restricts the unimpeded use of a site or a ground water aquifer. Institutional controls also can be used to ensure that engineered remedies are not adversely affected by activities at the site. Examples of institutional controls include "proprietary controls" (e.g., easements and restrictive covenants), "governmental controls" (e.g., zoning restrictions, special permit requirements), "informational devices" (e.g., State registries of contaminated property, deed notices, advisories), and "enforcement controls" (e.g., orders and consent decrees issued under CERCLA). EPA is required to ensure that appropriate ICs are in place and to review them on a five year basis when the site is transferred to the State, a Tribe or another federal agency for long term care.

Five-Year Reviews-- Five-year reviews generally are required when hazardous substances, pollutants, or contaminants remain on-site above levels that allow for unlimited use and unrestricted exposure and/or when the remedy will take longer than five years to reach cleanup levels. The purpose of a five-year review is to evaluate the implementation and performance of a remedy in order to determine if the remedy remains protective of human health and the environment. Five-year reviews provide an opportunity to identify potential problems or issues with the remedial action, and to adjust O&M where necessary. Through cooperative agreements, EPA can provide funding to a State or Tribe to conduct five-year reviews.

The review involves examining three questions:
• Is the remedy functioning as intended by the decision document?
• Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?
• Has any other information come to light that could call into question the protectiveness of the remedy?

Answers to these review questions may be determined through visual observation during site visits; interviews with site stakeholders, local citizens and officials; review/evaluation of response decision documents and existing O&M and monitoring information; and, when necessary, collection of new data. Findings of the review are documented in a report which is expected to include an identification of issues; recommendations and follow-up actions; and a determination of whether the remedy is, or is expected to be, protective of human health and the environment. The report is expected to identify the party responsible for implementing

recommendations and follow-up actions. Once completed, the five-year review report should be made available to the public.

Optimization of Remediation Systems-- The purpose of optimization is to identify potential changes that will improve the effectiveness of the system and/or reduce operating costs, without compromising the protectiveness of the remedy or other response objectives, through a comprehensive evaluation of system performance.

State responsibility for Superfund sites

In most cases states assume responsibility for long-term stewardship of Superfund sites. In November 2002, the Environmental Law Institute published a detailed report on the performance of State Superfund programs. Chapter Three of the report deals with Long Term Stewardship Issues. [36] In summary, they found that (in 2001):

- Long-term stewardship is of growing importance due to the increasing use of remedies--in mandatory, voluntary, brownfields, and other cleanup programs--that allow hazardous substances to remain in place at levels that do not allow for unrestricted use.
- 41 states, including the District of Columbia, have long-term stewardship programs for one or more of their state cleanup, voluntary cleanup, or brownfields programs. 26 of these states have specific statutory authority for long-term stewardship of sites. Three additional states undertake some long-term stewardship activities but disclaim having such a program.
- Institutional controls are the most common long-term stewardship activity, with 43 states relying upon these measures to manage risks from residual contamination. 38 states reported using proprietary institutional controls. Informational systems, including signs, educational materials, published notices, warnings about consumption of fish or wildlife, site registries, and databases, were used by 33 states. 29 states used governmental or regulatory institutional controls, such as zoning, local ordinances, building permits, and well drilling or groundwater use restrictions. 20 states report layering or using more than one type of institutional control at least at some sites.
- Even though states recognize the importance of long-term stewardship, this study demonstrates that they are not always fully equipped to implement long-term stewardship. Only 17 states report that a specific amount of staff time is allotted to long-

[36] The following section is abridged from the ELI document. Environmental Law Institute, An Analysis Of State Superfund Programs: 50-State Study, 2001 Update (November 2002): www.elistore.org/data/products/d12-10a.pdf

term stewardship activities and nine of those devote less than one full-time equivalent to such activities. Moreover, 28 of the 34 states that responded reported that there is no separate funding for long term stewardship activities. Just fewer than half of the states with programs reported that long-term stewardship is part of the assigned duties of some staff members.

- One of the reasons why institutional controls have failed in the past has been because people forgot the contamination existed, because information about it was unrecorded, lost, or ignored. Many states have therefore created systems for keeping track of institutional controls and the sites where they are in use. 24 states reported that their long-term stewardship program includes a system for recording and maintaining information about which sites have institutional controls. In most states this system relies on a database, but in at least one state the information is recorded in a notebook.
- Most of the states (19) that have such tracking systems make them available to the public, although for most of them the primary intended user is state staff. A majority of the states that have a tracking system use it for all sites covered by their long-term stewardship program, and many states also include federal facilities in their tracking system. State tracking systems most commonly include information about monitoring institutional controls at the site (12 states), followed by implementation information (8 states), and enforcement (7 states).
- Although states generally consider cleanup to be complete when institutional controls have been implemented, most states (39) reserve the right to require additional work at a site under certain conditions. Among the conditions for which states reserve the right to reopen a cleanup decision are: the owner chooses to remediate the site to meet the residential (unrestricted use) standard; discovery of new contamination; discovery of previously unknown contamination; change in land use; new information; fraud; changes in standards; failure to record proprietary controls in property records; failure to maintain the engineering or institutional controls; off-site migration of contamination; violation of deed restriction or other institutional control; failure of the remedy to protect human health or the environment; and a new release at a non-industrial site where treatment, removal, or destruction has become economically or technologically feasible.

Case Study Three: The Hanford Nuclear Reservation and the US Department of Energy

" Ulrich Beck and others[37] have conceptualized modern technological cultures as the risk society, marked by the ubiquity and invisibility of risk....This risk is magnified culturally by the absence of institutionalized reflection on risk in both the professional sphere and in scientific knowledge, as well as in any regular analysis of the social and natural costs of personal activity. Meanwhile, there is a need to spend an ever increasing proportion of society's material and intellectual resources on the creation of procedures capable of regulating the level of risk built in to the process of social manufacturing. It follows that the acceptance of risk comes to be viewed as an inescapable condition of human existence. To Oleg Yanitsky, such risk acceptance must be viewed as a form of pathology." [38]

Summary

This case study looks at the US Department of Energy, which is responsible for US nuclear waste sites (other than weapons), and at some of the thinking that has been generated about long term stewardship at DOE sites, by the International Institute for Indigenous Resource Management, the National Research Council and Resources for the Future and DOE's own Office of Legacy Management. The DOE response to citizen advocacy about Hanford Nuclear Reservation is described.

Key Points

- The US Department of Energy (DOE) is faced with remediating and containing the wastes from over 50 years of US production of nuclear weapons, nuclear power and nuclear research.

- A code of secrecy prevailed about the sites until the end of the Cold War. Strong and effective citizen advocacy resulted in the release of documents about the risks from these sites.

[37] Ulrich Beck, *Risk Society: On the Road to Another Modernity* (Progress Tradition, Moscow: 2000).
[38] Oleg Yanitsky, "Russia: Risks and Dangers faced by a Transitional Society", quoted in A. Kulyasova and I. Sokol, "Seeing the Forest for the Trees in Cultures of Contamination: Legacies of Pollution in Russia and the US" (Research in Social Problems and Public Policy, volume 14), page 49.

Hanford site

http://en.wikipedia.org/wiki/Hanford_Site

- Technical controls and physical barriers will have to be replaced (often many times) before a site ceases to be hazardous. Historical, cultural and spiritual attachments to place may effectively transmit knowledge about contamination to future generations, and can be an effective part of "defence-in-depth" controls.

- The traditional knowledge and practices of indigenous people provide guidance on how to communicate about unseen hazards across generations; but this is impossible without a reckoning about the history that led to the disaster.

- Today's regulations do not match the challenge of long term stewardship of contaminated sites. Probability and harms associated with inevitable failures at these sites must be factored into decisions about the scope, extent, redundancy and diversity of controls and other long-term stewardship provisions. All risks are not created equal.

- The involvement of the community and other "stakeholders" adds value to decision-making and is crucial for the effectiveness of long-term stewardship.

- It needs to be noted that "the community" is already involved and it is likely their activism that has forced government and industry to respond to the issues of

contamination. Once the remediation begins, however, their voice can be increasingly marginalized and silenced by the languages of science and bureaucracy. The official history of the site may either remove or distort the role they play.

- "Trust" plays a crucial role in long term stewardship, but the government and industry forces involved historically have done little or nothing to merit trust from affected peoples.

- Financial assurances required for long-term cleanup are unprecedented and daunting. Trust funds are recommended, so that long term stewardship demands do not have to compete with other public priorities in the annual appropriations process.

- The Department of Energy set up an Office of Legacy Management in 2003 to handle these perpetual care sites. [This case study presents a brief outline of its responsibilities and programs].

- DOE's long term stewardship planning is based on an understanding that – over time – institutional and engineering controls will inevitably fail. Engineering failures may be caused by seismic, climactic or hydrological changes in the environment, or they may be caused by inadequate design, process errors, or inability to deal with entropy. Institutional controls may fail because of lack of oversight, inadequate public disclosure, information management, site security, record- keeping, and a myriad of other factors. The ability to respond effectively when these failures happen is key to long term stewardship.

- There are three key challenges during the transition from clean-up to long term stewardship of these dangerous sites: 1) remedy design and regulation were usually inadequate for long term processes; 2) clean-up goals are often focused on accelerating cleanup in the short-term and not on long term stewardship effectiveness (often increasing risk for future generations); and 3) the remediator often operates in a social environment of public distrust, yet trust is needed to undertake long term stewardship effectively.

- In 2003, DOE's Office of Environment, Safety and Health issued guidelines to help DOE field staff establish a consistent approach, which called for a "defence-in-depth" strategy, or a "layering" of controls to ensure that if one control temporarily fails, another control will be in place to mitigate any harmful effects.

History of the DOE clean-up program

"During World War II and the Cold War, the US federal government developed and operated a vast network of industrial facilities for the research, production, and testing of nuclear weapons, as well as for other scientific and engineering research. These processes left a legacy of radioactive and chemical waste, environmental contamination, and hazardous facilities and materials. The Department of Energy (DOE) is responsible for cleanup and care of over 140 sites contaminated with radioactive and chemical wastes, the residue of a half-century's production of nuclear weapons and research. Hundreds of thousands of acres of residually contaminated soils, contaminated groundwater, surface water and sediment contamination, and contaminated buildings are present at many sites across the country."[39]

"More than 100 sites cannot be cleaned up enough to permit unrestricted human access and will require long-term management, in some cases indefinitely. DOE thus faces the challenge of protecting human health and environmental quality at these "legacy" sites, a process it calls "long term stewardship".[40]

Most of the nuclear sites operated under a strict code of secrecy until the end of the Cold War. In the Soviet Union, the openness occasioned by Glasnost and Peristroika in the mid-1980s enabled access to historic files about nuclear facility operations.. In the US, the Chernobyl disaster in 1986 heightened public concern about nuclear facilities and led to a raft of information requests about them. Learning about leaks, stored wastes and long term dangers at these sites catalyzed (in many cases) demands for change. Government secrecy, lies and misinformation about the effects of the nuclear program were challenged by citizen groups and Tribes.[41]

In response to strong citizen advocacy at specific sites such as Rocky Flats, Hanford and Oak Ridge, DOE eventually funded a number of organizations and initiatives to research and report on these issues. In 1994, "Environmental Justice" became official US policy.[42] At DOE, this meant activities such as capacity building in communities affected by their legacy activities, grants to institutions of higher education, and "communications outside of DOE".

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[39] International Institute for Indigenous Resource Management, *Taking Control: Opportunities for and Impediments to the Use of Socio-Cultural Controls for Long-Term Stewardship of U.S. Department of Energy Legacy Waste Sites*, (November 2004): http://www.iiirm.org/publications/Articles%20Reports%20Papers/Environmental%20Restoration/resolve.htm

[40] http://www.nap.edu/catalog.php?record_id=10703

[41] Michael R. Edelstein, "Hanford: The Closed City and Its Downwind Victims" in Edelstein, Michel R.. Maria Tysiachniouk and Lyudmila V. Smirnova (eds), *Cultures of Contamination: Legacies of Pollution in Russia and the US* (Emerald Publishing, 2007), pages 253ff.

[42] Executive Order 12898 in 1994 directed 11 federal agencies to have an environmental justice strategy.

Some innovative projects were funded in the early 2000s. Reports from three of them are discussed here: a 2004 conference on long term stewardship convened by the International Institute on Indigenous Resource Management, the National Research Council Report of 2003, and a 2000 report from Resources for the Future.

The International Institute for Indigenous Resource Management

In November 2004, the International Institute for Indigenous Resource Management (IIIRM) "brought together 25 indigenous and other storytellers, songwriters, poets, and dancers with historians and other representatives from a variety of tribal and disadvantaged communities in proximity to DOE legacy waste sites, along with policy makers from various public agencies with an interest in addressing environmental problems through the humanities."

After they were briefed on the types of persistent contamination from the DOE legacy sites, future hazards for human health and the environment, and the limitations of standard institutional controls, they participated in facilitated discussions to look at "how historical, cultural, and spiritual attachments to place [might be used to] transmit information about environmental contamination that is crucial for safeguarding future generations."[43]

The IIIRM Workshop also provided significant advice on the value of Traditional Ecological Knowledge in planning and maintaining long term stewardship. Some key quotes from the document are below:

"...Technical controls and physical barriers will very likely not endure or maintain their current integrity as long as wastes are hazardous. Documents outlining dangers and regulations governing human access and intrusion to sites may be destroyed, forgotten, or misinterpreted as generations pass. Even the governments that oversee and enforce them may fail well before the wastes are no longer a danger. It seems to us today that a deep geologic repository could never be forgotten. But, more central and visible cultural icons have been forgotten before—only to be rediscovered hundreds of years later. In this century humans have uncovered entire communities, temples, and other structures from ancient Rome, China, and Java. Such finds have been buried under less than 2,000 years of political and topographical change. ...Consider our society's similarly advanced efforts to build deep geologic repositories. In addition, consider that our advanced scientific and engineering practices are also coupled with a reluctance to develop accompanying stories and historical accounts of activities and responsibility for contamination. Now, fast-forward a millennium or two: The stories have not been told about historically monumental activities such as nuclear research and development during the era that we call the

[43] International Institute for Indigenous Resource Management (November 2004).

Cold War. What if an archaeological find uncovered is not an innocuous religious structure or simple ruin of a home or building, but a site of long-buried spent nuclear fuel rods?" [44]

" Traditional Ecological Knowledge can also be integrated into a defence-in-depth approach to long-term-stewardship. It is based on observations and experience, evaluated in light of what one has learned from one's elders, stories, and songs. Native peoples have relied on this detailed knowledge for their survival—they have literally staked their lives on its accuracy and repeatability... The potential to mobilize these traditions to create socio-cultural controls that can supplement the more conventional institutional controls proposed by DOE for long-term stewardship. "

"More broadly, it will be impossible to expect communities and peoples to consider the implications for their histories, future generations, cultural practice and beliefs without discussing responsibility for the problem at hand. For example, the application of tribal practice and philosophies to long-term stewardship efforts will begin with a reckoning that will involve both cathartic acts and acts of differentiation. Tribes will want to spend some time lamenting, engaging in memory, and setting themselves apart from a history that many Indian people find objectionable and oppressive. Solely future and information oriented approaches to stewardship cannot deal with responsibility for the past; they obscure the contemporary politics of contamination and waste management. But, given the need for tribes and local communities to discuss memories and political understandings of past activities, meaningful involvement of those communities is impossible without bringing into stewardship the past and the responsibility that goes with that."[45]

National Research Council Report 2003[46]

The United States National Research Council established a Committee on Long Term Institutional Management of DOE Legacy Sites in the last decade at the request of the DOE. This report established much of the key thinking in the US on the management of long term care sites, and is therefore summarized extensively below. Their 2003 report stated:

"The word "stewardship" has been readily accepted by many people who have different understandings of the word. In this committee's view, stewardship comprises several tasks: A steward of very long-lived hazards acts as:

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[44] Ibid.

[45] International Institute for Indigenous Resource Management (November 2004).

[46] The following section is abridged from the National Research Council 2003 Report: *Long-Term Stewardship of DOE Legacy Waste Sites: A Status Report* , Executive Summary http://www.nap.edu/catalog/10703.html,

- a *guardian*, stopping activities that could be dangerous;
- a *watchman* for problems as they arise, via monitoring that is effective in design and practice, activating responses and notifying responsible parties as needed;
- a *land manager*, facilitating ecological processes and human use;
- a *repairer* of engineered and ecological structures as failures occur and are discovered, as unexpected problems are found, and as re-remediation is needed;
- an *archivist* of knowledge and data, to inform the future;
- an *educator* to affected communities, renewing memory of the site's history, hazards, and burdens; and
- a *trustee*, assuring the financial wherewithal to accomplish all of the other functions.

This range of activities requires the human and institutional capacity to fulfill these roles as needed, through the decades and centuries in which the risks persist. The human and institutional demands of these activities are broader than the traditional engineering expertise of DOE, so questions arise regarding how best to meet the federal government's responsibilities over the long term."

The NRC Report was highly critical of DOE long term stewardship planning and practice, and its chief recommendation was that DOE should explicitly plan for its stewardship responsibilities, taking into account stewardship capabilities, when making cleanup decisions. DOE should also implement steps to anticipate and carry out those responsibilities in concert and conjunction with the cleanup process. DOE's plans and practices today fall short of meeting the requirements of stewardship, in part because the Department focuses narrowly on complying with regulations. While compliance is necessary, it is not sufficient, because today's regulations do not fully address long term stewardship challenges. Accordingly, the committee calls for a national dialogue on the broad challenge presented by the stewardship of industrial legacies and natural resources, and on the federal government's responsibilities.

Transition from clean-up to long-term stewardship

The NRC Report emphasizes the key differences between cleanup and long term responsibilities (summarized below).

Many geological processes such as weathering take place slowly over hundreds of thousands of years or even longer. Others such as floods are infrequent, unfold rapidly at unpredictable intervals, and are sometimes of sufficient magnitude to alter landscapes. Both kinds of process are important influences on hazards that persist over long time scales. Some of these processes are readily mitigated by engineered barriers and preventive actions, while others will proceed without significant human intervention, leaving stewards to react. Current

regulations are written for time periods where historical experience provides a baseline of institutional experience; as a result, slow geological change is ignored and simplified analyses are used to bound stochastic change. The aim in remedy design must instead work toward remedies that are resilient to slow change, as well as toward ways to maintain response capabilities to react to sudden disturbances. Human activity, too, is dynamic. Land use can undergo rapid changes, as illustrated by the recent encroachment of residential communities toward Rocky Flats and by the commercial growth of ecotourism in Moab.

The probability and harms associated with failures must be factored into decisions about the scope, extent, redundancy, and diversity of controls and other long term stewardship provisions. All risks are not created equal. A failure of one type could result in an increase in human health risk that, while undesirable, is not catastrophic.

At any given point in time, each DOE site imposes a mix of risks, costs to maintain the risk within acceptable levels, and uncertainty as to future risks and costs. Consequently, each decision at the site incorporates compromises and tradeoffs among these factors, and should reflect and implement societal values concerning each. Long-term costs, liabilities, and benefits are difficult to take into account: Their estimates are inherently uncertain, and there is no consensus on how to value their consequences and translate those as a guide to current decisions. Yet, DOE's cleanup program cannot entirely eliminate the risks; the program only alters the mix of risk and costs to be borne at different places and times. As noted near the beginning of this report, all remediation decisions are choices that affect that mix and what burden is borne in cleanup and in long-term stewardship. Thus, DOE has been making decisions that affect the well-being of this and future generations, usually without recognizing that fact or explicitly weighing its implications.

The 2003 NRC Report identified three key problems with the transition at DOE from clean-up to long term stewardship of these dangerous sites. First, it found that remedy design and regulation were inadequate for long term processes. Secondly, they said that DOE was not considering long term stewardship effectiveness when it was establishing goals for clean-up, but was focused on accelerating cleanup in the short-term, often increasing risk for future generations. Thirdly, the report also found that "At many of its contaminated sites, DOE operates in a social environment of public distrust. Yet DOE needs public trust if the agency is to have sufficient flexibility to reach its cleanup objectives and to undertake long term stewardship."

Trust and stakeholder involvement

The National Research Council Report made a number of important points about stakeholder involvement which have informed work at Hanford. "Site remediation aims to improve the environmental circumstances of local communities. Remediation often entails significant changes, however, and for this reason, members of the community often have interests to advance or defend.

Yet the community as a whole can also add value to the decision-making process in the following ways and for the following reasons...

- they often have relevant information (e.g., about past activities on-site, about desirable or potential future uses of the site);
- they often have creative solution options, including alternatives difficult for a federal agency to propose or develop;
- they may have institutional capabilities to undertake cleanup or long term stewardship activities, including ones unavailable to a federal agency or available at a much lower cost; and
- their values must be a factor in any responsible effort to balance costs, benefits, and risks, both as a matter of right and because they have political power to make the process easy or difficult for DOE;
- in a democracy, the local community also has a right to know what remediation measures will have been taken, what are the risks of failure for both the remedy and long term stewardship, and what contingencies have been provided; and
- to the extent that local communities or other non-DOE stewards are to exercise stewardship responsibilities, adequate resources (information, expertise, and funding) must be assured, and DOE would be prudent to confirm that other stewards have the capacity to fulfill the long term stewardship functions they seek to assume.

Long-term management of the legacy wastes remaining after cleanup will be shaped by two precarious societal conditions: trust in implementing institutions, and confidence that those institutions will exercise stewardship satisfactorily over many generations...High-reliability organizational tasks, such as air-traffic control, require high levels of trust, both within the operating organization and in its social environment. A central finding of studies of high-reliability organizations is that public confidence reflects the way in which the operations of an organization are carried out. In the present context, this means that how planning and cleanup are carried out shapes the confidence the public, stakeholders, and political leadership will place in DOE as cleanup ends. Not only is the substance of long term stewardship affected by choices made in the cleanup process, but so is the social setting in which long term stewardship will be conducted. That setting is critically important to the ability of the steward to discharge its responsibilities.

If the implementing institutions face a deficit of public trust and confidence, conflict is likely to rise (even over technical issues), regulatory constraints can multiply, and resources can become more difficult to obtain. The greater the deficit the more institutional leaders are pressed to recover it. Where there is a great deficit, some argue that recapturing trust may be impossible...it especially challenging to cultivate trust in institutions implementing long term stewardship. The longer a project, and the more generations of managerial leadership required, the greater the likelihood of a loss of institutional memory and diffusion of commitment—and

the greater the need for institutional constancy. No formal human institution has endured as long as the projected life of some of these hazards.

NRC recommendations

In terms of incorporating long term stewardship into each phase of environmental management, the Report recommended:

- Recognize that both natural and social environments will change at the legacy sites. Design and select remedies that accommodate or benefit from natural communities and processes, so as to enhance the durability of remedies.
- Involve the stakeholders from the earliest phases of decisions that involve risk management. DOE should foster a positive working relationship with interested parties to work together to achieve common goals of protecting human health and the environment.
- Plan for fallibility, because unforeseen events and some failures of remedies will occur at DOE's legacy waste sites over the long term. Analyze the consequences of failures in engineered barriers and institutional controls, and the implications of environmental changes at the sites, to inform decisions.
- Tailor monitoring to the specific risks and circumstances of each site, while providing national-level guidance for reporting formats and record preservation protocols.
- Build understanding of DOE's approach during the remaining period of cleanup, so as to make long term stewardship a welcome step as sites are closed. Activities during the ground water cleanup phase provide important opportunities to build credibility.
- Given the uncertainties of stewardship, it is important that DOE make learning a part of the mission of cleanup and long term stewardship.
- Select remedies recognizing that cleanup and long term stewardship are complementary stages in the long-term management of hazards that cannot be eliminated completely. The task is to allocate risks and costs over time in ways that will protect health and environment over the decades and centuries to come.
- Initiate a national dialogue, involving DOE and other agencies facing stewardship responsibilities, on these enduring responsibilities for wastes created by industrial activities.[47]

Resources for the Future: Financial Mechanisms

"RFF is a non-profit and non-partisan organization that conducts independent research – rooted primarily in economics and other social sciences – on environmental, energy, natural resource

[47] NRC 2003 update report, page 4.

and environmental health issues. Founded in 1952, RFF was created at the recommendation of William Paley, then head of the Columbia Broadcasting System, who had chaired a presidential commission that examined whether the United States was becoming overly dependent on foreign sources of important natural resources and commodities. RFF became the first think tank devoted exclusively to natural resource and environmental issues."[48]

In 1999, the DOE funded Resources for the Future to research financing mechanisms for long term stewardship. One of the most serious issues facing DOE was the need to renew on an annual basis appropriations for continuing management and maintenance of contaminated sites, while these funds were subject to other political priorities and interests.

The 2000 report from that research: *Long-Term Stewardship of Contaminated Sites: Trust Funds as Mechanisms for Financing and Oversight,*[49] made the following observations:

" While the need for long-term stewardship has become more widely accepted, major issues remain about how to pay for it, exactly what activities are included, and who will be responsible for assuring that these activities are in fact implemented...

" The ultimate question is whether the resources needed for stewardship will be available once the spotlight on cleanup has been turned off. What makes stewardship an unusual and especially difficult problem is the time horizon involved: at some sites (particularly those contaminated with radionuclides and other long-lived contaminants), long-term stewardship activities will be required for many decades, if not hundreds or thousands of years. Thus, a robust and reliable stewardship system will have to endure changes in property use and ownership, as well as changes in politics and government institutions. Assuring funding over such long time periods is an unprecedented and daunting problem—one that calls for innovative solutions (or innovative adaptations of familiar solutions).

" To compare the strengths and weaknesses of different kinds of trusts in addressing financing and oversight of long-term stewardship, we use five evaluative criteria. Each of the criteria addresses the characteristics of a successful long-term stewardship program. The five criteria are as follows:

1. financial security;
2. clear rules, roles, and responsibilities;
3. public information;
4. enforceability;
5. permanence.

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[48] www.rff.org

[49] Carl Bauer and Katherine N. Probst, "Long-Term Stewardship of Contaminated Sites: Trust Funds as Mechanisms for Financing and Oversight", (December 2000), Discussion Paper 00–54, www.rff.org.

" The trust funds that might serve as models for institutional mechanisms to assure long-term stewardship fall into three basic categories: private trusts, federal trust funds, and state trust funds. The final recommendation from the research was that legal authority should be obtained for US federal sites requiring long term stewardship to establish trust funds either for each site or for all sites, and that such trust funds should be set up sufficient to provide protection for future generations.[50] In the report, a number of specific steps are set out about how to get there.

DOE Office of Legacy Management

In December 2003, the DOE established the Office of Legacy Management, which is "responsible for ensuring that DOE's post-closure responsibilities are met and for providing DOE programs for long-term surveillance and maintenance, records management, work force restructuring and benefits continuity, property management, land use planning, and community assistance." The Office goals are as follows:

- Protect human health and the environment through effective and efficient long-term surveillance and maintenance;
- Preserve, protect, and make accessible legacy records and information;
- Support an effective and efficient work force structured to accomplish departmental missions;
- Implement departmental policy concerning continuity of worker pension and medical benefits;
- Manage legacy land and assets, emphasizing safety, reuse, and disposition;
- Mitigate community impacts resulting from the cleanup of legacy waste and changing departmental missions; and
- Actively act as liaison and coordinate all policy issues with appropriate departmental organizations.

Current DOE plans for long term stewardship fall into one of the following categories:

- Government ownership (e.g., Federal or State);
- Warning notices (e.g., no trespassing signs, notification signs for hazardous and sensitive areas);
- Entry restrictions and physical barriers (e.g., requirements for security badges, fencing, training for persons entering hazardous or sensitive areas);
- Resource-use management (e.g. land use and real property controls, excavation permits, ground water use restrictions, deed restrictions, and zoning controls);

[50] Bauer, , page xii.

- Site information systems (e.g., information tracking systems on the location and nature of waste sites or geographic based-information archives); and
- Methods to preserve data in order to inform current and future generations about site hazards and associated risks.

The long term stewardship planning by DOE is based on an understanding that – over time – institutional and engineering controls will fail. Engineering failures may be caused by seismic, climactic or hydrological changes in the environment, or they may be caused by inadequate design, process errors, or inability to deal with entropy. Institutional controls may fail because of lack of oversight, inadequate public disclosure, information management, site security, record-keeping, and a myriad of other factors. The ability to respond effectively when these failures happen is key to long term stewardship. In 2003, DOE's Office of Environment, Safety and Health issued guidelines to help DOE field staff establish a consistent approach, which called for a "defense-in-depth" strategy, or a "layering" of controls to ensure that if one control temporarily fails, another control will be in place to mitigate any harmful effects.

Hanford Nuclear Reservation

The Hanford Superfund Site is perhaps the DOE "flagship" site for Long-Term Stewardship. The 586 square mile Hanford site straddles the Columbia River in northeast Washington State. The site was selected in 1943 to be the Manhattan Project's manufacturer of plutonium for nuclear weapons. "Within an 18 month period, residents of White Bluffs were ordered to leave and the City and its orchards were razed, the first reactor built and 50,000 new residents arrived." [51]

The first plutonium was separated from irradiated fuel by the end of 1944.[52] In all, 9 reactors were built along the Columbia River and five different facilities to retrieve plutonium. Many other facilities were also built on the site. When plutonium production ended in 1989 at Hanford, the site was left with 350 million curies of radioactivity, some 23 million cubic meters of contaminated solids and 1.2 billion gallons of contaminated water.

The plutonium separation process also resulted in the release of radioactive isotopes into the air, which were carried by the wind throughout southeastern Washington and into parts of Idaho, Montana, Oregon, and British Columbia. Downwinders were exposed to radionuclides, particularly iodine-131, with the heaviest releases during the period from 1945 to 1951. These radionuclides filtered into the food chain via contaminated fields where dairy cows grazed;

[51] Edelstein,page 254 ff.

[52] Max S. Power, "Long term stewardship for the Hanford Nuclear Site", in Edelstein et al (eds) (2007).

hazardous fallout was ingested by communities who consumed the radioactive food and drank the milk. Most of these airborne releases were a part of Hanford's routine operations, while a few of the larger releases occurred in isolated incidents. In 1949, an intentional release known as the "Green Run" released 8,000 curies of iodine-131 over two days. Another source of contaminated food came from Columbia River fish, an impact felt disproportionately by Native American communities who depended on the river for their customary diets. A U.S. government report released in 1992 estimated that 685,000 curies of radioactive iodine-131 had been released into the river and air from the Hanford site between 1944 and 1947.[53]

Although there are many issues raised by the Hanford site, the following three will be examined: stakeholder involvement, long-term funding and information transfer to future generations.

Stakeholder Involvement

In 1982, the Nuclear Waste Policy Act unleashed an effort to site a national high level nuclear waste repository. Hanford was one of the proposed locations. This triggered an outraged response from people living around the facility. The State of Washington was also concerned as it would have to deal with the consequences over the long term, when the "response action" at Hanford was complete.

Faced with the plans for the repository and fears raised by the Three Mile Island partial meltdown in 1979, Tribes and citizens took advantage of new freedom of information laws passed near the end of the Cold War to demand historic documents about Hanford operations. A new organization, the Hanford Education Action League (HEAL), was formed in 1984 in Spokane to oppose the repository. In January 1986, HEAL and the Environmental Policy Institute filed Freedom of Information requests about Hanford and received 19,000 pages of formerly classified documents. As the information was analyzed, a reporter from the Spokane Spokesman-Review made the findings public. A year after the Chernobyl disaster, another request was filed in April 1987 that had similar results, and more documents were sought. The formerly secret information documented leaks, releases, radiation exposures and knowledge of serious health concerns.[54] A new "Downwinders' Coalition" was formed in 1989. As more information became public, a significant number of inside whistleblowers passed information to activists.[55] The Hanford Nuclear Reservation was transformed from a source of pride for residents to a "social and political pariah institution".

[53] Power, in Edelstein (2007).

[54] Edelstein, Mpage 254 ff.

[55] Edelstein,page 254 ff.

The activity of the Downwinder Coalition in the late 1980's significantly shifted DOE's strategies with regard to stakeholder involvement. In 1990, a community relations plan was developed between DOE, the State of Washington and the EPA. In 1992, the State of Washington released a report documenting employee concerns (mostly contractors worried about safety and health, lack of pensions and benefits) and a Hanford Joint Council on Resolving Significant Employee Concerns was set up. From 1995-7 public interest groups and Tribes advocated for an ongoing openness panel.

From 1997 to 2000 a series of nine workshops were held to identify and discuss stakeholder access to information about public health, the environment and decision-making at Hanford.[56] The workshops included representatives from the Umatilla, Yakama and Nez Perce Tribes, from a whistleblower advocate, the Downwinder community, a Colombia River protection group, former employees, and some "ad hoc members". Technical support was provided from government agencies. The workshops looked at barriers to citizen access to information about Hanford, encompassing jargon, how the documents were classified and filed, how information might be shared most effectively, and security issues. Professional facilitation was provided as well as secretarial and administrative services. All meetings were open to the public, and made available on an internet site. They were regarded as successful by the participants. DOE accepted most of the recommendations, but rejected those dealing with contract employee concerns. Demands from Tribes to be treated in a government-to-government relationship were only modestly acknowledged.

By 2000, the Congressional Government Accountability Office was looking at the historic cover-up, and made a number of recommendations regarding openness and stakeholder involvement.

The current Hanford DOE website (www.hanford.gov) is up-to-date and provides access to most key documents.

In 2008, Hanford Challenge was organized to deal with ongoing stakeholder issues at the Hanford site. "Hanford Challenge works to hold Hanford accountable. We do this by protecting whistleblowers, promoting discovery of common ground among traditional opponents, conducting environmental sampling, and generating creative resolutions and collaborative opportunities for improving the cleanup. Our goal for Hanford is a site that performs its cleanup obligations in a transparent, efficient, creative manner at a reasonable cost to the taxpayer and in a fashion that protects health and safety, the environment, and future generations....(It) works closely with concerned employees, insiders, retired employees, and whistleblowers to assure that their voices can be safely heard within the Department of Energy and contractor communities.

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[56] Christina Drew, Micheal Kern, Todd Martin, Max S. Power, Elaine M. Faustman, "The Hanford Openness Workshops: Fostering open and Transparent Decision-Making at the Department of Energy" in *Long-term Management of Contaminated Sites*, (Elsevier Ltd: 2007),page 13 ff.

We conduct investigations and create public and private venues for disclosure and discussion. We use dialogue when possible to resolve conflict, and litigation when less contentious methods fail."[57]

At Hanford (as with other DOE sites), Tribes have reserved treaty rights to resources. They often assert that these rights have precedence over remedial decisions that leave in place restrictions on these rights. They also argue that they are disproportionately affected by the potential for future contamination via environmental pathways due to cultural practices.[58] In February 2010, the Yakama Tribe launched a lawsuit contending that the DOE has failed to protect the Columbia River from pollution from the Hanford nuclear reservation.[59]

Long-term funding

John Price, a spokesperson for the State of Washington Department of Ecology Nuclear Waste Program, said in 2002 that "[c]ontractors at Hanford repeatedly urged action to retrieve, treat, or stabilize liquid high-level wastes during the 1950's to 1970's, but waste management always ranked lower in priority than defense production. Much of the enormous environmental threat and cost now required to remedy Hanford tanks is due to past failure to deal with tank wastes on a timely, year-by-year basis. In recent years, the federal government has spent about $2 billion annually on the Hanford project. About 11,000 workers are on site to consolidate, clean up, and mitigate waste, contaminated buildings, and contaminated soil. Originally scheduled to be complete within thirty years, the cleanup was less than half finished by 2008...."[60]

He went on to express the State of Washington's concerns about long term funding and intergenerational transfer at the Hanford site:

" Financial assurance is a fundamental concept of environmental regulation. The federal government is always exempted from those requirements. That exemption is at odds with the reality of the annual appropriations process. Long-term stewardship must continually compete in the budget process with other needs, programs, and interest groups, and funding therefore depends on pressure from local and state governments, as well as from elected federal officials...

Exemption from financial assurance only works if Congress honours long term stewardship obligations each & every year in perpetuity, or, if states are willing to litigate to

[57] http://www.hanfordchallenge.org/about-us/
[58] Power, 2007.
[59] Linda Ashton, "Yakama Nation intends to sue over Hanford pollution", The Associated Press 02-25-2010 http://www.avatar-forums.com/archive/index.php/t-7867.html.
[60] John B. Price, "A Washington State Perspective On Long-Term Stewardship At Hanford" Wm'02 Conference, February 24-28, 2002, Tucson, AZ.

enforce obligations. The state will have to budget for congressional liaison staff and technical support staff to assure annual appropriations for long term stewardship. Those liaison costs could either be cost-reimbursable by USDOE as a legitimate long term stewardship cost, or, could be borne by the state general fund. A long term stewardship trust fund would remove the need for a liaison staff, and thus would reduce long term stewardship costs either for the USDOE or the state of Washington."

Information Transfer to future generations

Proposals for transferring knowledge about the Hanford site were also made by Price who suggested:

" The site-specific circumstances at Hanford present the opportunity to use two proven institutional forms for inter-generational transfer of information about residual hazards: these are a national park/monument and a museum respectively.

"The Hanford Reach National Monument was created by Proclamation on June 9, 2000. It includes most of the Hanford Site within ½ mile of the Columbia River, and is the responsibility of the U.S. Fish and Wildlife Service... The U.S. Fish and Wildlife Service and the USDOE are co-managing candidate lands, with the anticipation that much of Hanford will be added to the National Wildlife Refuge system."

Price also suggested three visitors centres be set up at various access points to Hanford, as well as the integration of a B Reactor museum into the National Monument—both of which would include information on residual site hazards. He recommended the visitors centres and museum be independently endowed, to ensure stable long-term funding and to provide incentive for future scholars/researchers to "mine" and publish information. While the B Reactor museum would be redundant to other official record archives, it would be the "active" archive that would keep residual hazards in the public eye. [61]

This plan is also supported by Max Power, who adds that either the visitor centre or the Museum might also house a centre for research on the Manhattan Project, that would draw scholars to reinterpret the site for future generations.[62]

[61] John B. Price, op cit.
[62] Power, Op cit. P. 97.

Case Study Four: US Abandoned Mines and Perpetual Care – The Zortman and Landusky Mines

Mining is a waste management industry: more than 99% of the rock taken out of the ground ends up as tailings or waste rock. Until recently, when a mine was no longer economic, the owners walked, leaving their mess behind. Where the owner cannot be found or is unable to pay, the mine is considered to be "abandoned", and the government assumes the liability to reclaim it and to manage the wastes over the long-term. -author

Summary

This case study looks at an iconic abandoned mine in the US –the Zortman-Landusky Mine – and discusses: inadequate financial assurance and reliance on annual appropriations for clean-up; the unreliability of water quality predictions for such sites over the long term; and the role of advocacy and legal action by the Fort Belknap tribe to ensure the containment at the site happens.

Key Points

- The huge cost to taxpayers to remediate these mines and then to manage their wastes in perpetuity has focused attention on the adequacy of financial assurance.

- Annual appropriations from government are an inadequate means by which to ensure costs in perpetuity.

- There are serious problems with discounting and net present value as a basis for establishing long-term financial security, as they assume very long-term continuing economic growth, take no account of ecological destruction, and unfairly minimize the costs to future generations if/when something goes wrong.

- The remediation at Zortman-Landusky Mines is unlikely to have happened without the sustained advocacy and legal battles undertaken by the Fort Belknap indigenous communities.

Zortman Landusky

meic.org

- The accuracy of water quality predictions and the effectiveness of mitigation measures is always questionable. Real world emergencies will continue to occur during and after remediation.

- Health effects will be minimized by government and will be subject to political interpretation.

- The information we need to monitor and evaluate these programs is difficult to obtain from government records.

In the United States there are over 500,000 abandoned hard rock mines, mostly in the western States. In Canada there are over 10,000. They pollute waterways and aquifers, occupy land that was once productive and dust from their tailings and waste rock piles blows

everywhere. The total cleanup cost for these mines in the US is anywhere from $32 to $72 billion.[63]

The huge cost to taxpayers to remediate these mines and then to manage their wastes in perpetuity has focused attention on the adequacy of financial assurance for closure and cleanup posted by companies during the life of the mine, as well as on the accuracy of predictions made during environmental assessment and permitting. Both are found to be sadly lacking.

Financial Assurance:

In 2005, the US General Accountability Office released a report on the adequacy of financial assurance to cover reclamation costs for mines on Bureau of Land Management (BLM) lands. It said (in part):

"As of July 2004, hardrock operators were using 11 different types of financial assurances, valued at approximately $837 million, to guarantee reclamation costs associated with approximately 2,500 existing hardrock operations on BLM (Bureau of Land Management) land in 12 western states, according to our analysis of survey results. Surety bonds ($384 million), letters of credit ($238 million), and corporate guarantees ($204 million) accounted for almost all of the $837 million in financial assurances. However, these financial assurances may not fully cover all future reclamation costs for these existing hardrock operations if operators do not complete required reclamation. BLM reported that, as of July 2004, some existing hardrock operations do not have financial assurances, and some have no or outdated reclamation plans and/or cost estimates on which financial assurances should be based....

"Financial assurances were not adequate to pay all estimated costs for required reclamation for 25 of the 48 ceased operations for several reasons. First, operators did not provide required financial assurances for 10 operations, despite BLM's efforts in some cases to make the operators provide them. Second, financial assurances that were provided were less than the most recent reclamation cost estimates for 13 operations. Third, financial assurance providers went bankrupt and did not have the funds to pay all reclamation costs for two other operations. In addition, cost estimates may be understated for about half of the remaining 23 operations because the cost estimates may not have been updated to reflect inflation or other factors that could increase reclamation costs."[64]

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[63] http://www.earthworksaction.org/AbandonedMineLegacy.cfm

[64] GAO, 2005. "Hardrock mining: BLM Needs to Better Manage Financial Assurances to Guarantee Coverage of Reclamation Costs." Report to the Ranking Minority Member, Committee on Homeland Security and Governmental Affairs, US Senate. U. S. Government Accountability Office. GAO-05-377, June 2005. www.gao.gov/cgi-bin/getrpt?GAO-05-377.

Kempton, Bloomfield et al wrote in 2010: In the US, "[m]ines are regulated at the federal and state level. Owners are primarily liable for hazardous impacts from their mines (under *CERCLA*). However, these laws generally fail to adequately protect the public because remediation costs often greatly exceed the resources available to operators or regulators after the cessation of mining."[65]

This is however not the only problem. No matter how well it is regulated or how much the reclamation bond is, most mines leave huge expanses of toxic materials that result in lost opportunity costs and risks to public health, social relationships, culture and the ecosystem that will have to be managed in perpetuity. Money does not compensate for everything.

Joseph Guth of the Science Environment and Health Network has developed an extensive critique of the current practices of using discounting and net present value as a basis for establishing long-term financial security. He argues that the practice assumes very long-term "endless" economic growth, takes no account of growing ecological degradation, and unfairly minimizes the costs to future generations of today's pollution:

"Because it is based on an outdated pre-analytic vision, our cost-benefit structure for making environmental decisions must be discarded. No rate of discounting, whether positive, negative, zero, or variable, can mold that structure into a form that can manage large-scale ecological degradation. Regardless of how discounting is employed, that structure remains saddled always with the paradox inherent in attributing definite and finite values to individual increments of environmental damage, and then projecting endless growth of such damage onto a finite biosphere."[66]

Accuracy of predictions about water quality.

Maest and Kuipers looked at the history and accuracy of water quality predictions for major hardrock mines in the United States and published an extensive report in 2006.[67] They compared predictions in Environmental Impact Statements to actual performance. Their study identified the most common causes of water quality impact and prediction failures, and looked to

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[65] Houston Kempton, Thomas A. Bloomfield, Jason L. Henderson and Patty Limerick. "Policy Guidance for indentifying and effectively managing perpetual environmental impacts from new hardrock mines" (2010). Downloaded from http://centerwest.org/wp-content/uploads/2010/10/Kempton-et-al-Policy-Guidance-2010.pdf . page 4

[66] Joseph H. Guth, Resolving the Paradoxes of Discounting in Environmental Decisions. (SEHN) www.sehn.org/pdf/DiscountingParadoxesTLCP.pdf

[67] This section paraphrases findings in Anne S. Maest & James R. Kuipers, "Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements", (Kuipers and Associates, Buka Environmental: 2006).

see if there were inherent risk factors at mines that may predispose an operation to having water quality problems.

Their comparison found that 60% of the case study mines (15 out of 25) had mining-related exceedances in allowable levels of toxic substances in surface water. "Of the mines with surface water quality exceedances, four (17%) noted a low potential, seven (47%) a moderate potential, two a high potential, and three had no information in their EISs for surface water quality impacts in the absence of mitigation measures. Only one mine was correct in predicting a moderate potential for surface water quality impacts with mitigation in place. However, this mine predicted low acid drainage potential, yet acid drainage has developed on site. ..."

They went on to find that most mines predict no impacts to groundwater quality after mitigation was in place, but in the majority of case study mines, impacts had occurred. "Therefore, as with surface water, the predictions made about groundwater quality impacts without considering the effects of mitigation were somewhat more accurate than those made taking the effects of mitigation into account... Again, the ameliorating effect of mitigation on groundwater quality was overestimated in the majority of the case study mines...."

In this comparison of 25 case study mines, to date nine (36%) had developed acid drainage problems on site. Nearly all of these mines (8 out of 9) that developed acid drainage either underestimated or ignored the potential for acid drainage in their EISs.

Of equal importance were the Maest and Kuipers findings on how difficult it was to get the information to do their study: "As part of the study, requests were made to federal and state agencies to provide National Environmental Policy Act (NEPA) documents and information on operational water quality. The effort required to obtain the documents and information, although initially expected to be onerous, was more arduous and protracted than we imagined. We were surprised to find that no single repository exists for NEPA documents, although the Environmental Protection Agency does have most EISs on microfiche. Technical reports associated with EISs were extremely difficult to obtain. Similarly, the availability of operational water quality information was uneven, ranging from disorganized paper-only copies in some states to user-friendly electronic information in others." [68]

[68] Maest & Kuipers, pages 144-148.

The Zortman-Landusky Mines

The Zortman and Landusky open pit heap leach gold and silver mines are located in the Little Rocky Mountains of north central Montana, just south of the Fort Belknap Reservation - home to the Gros Ventre and Assiniboine Tribes. The mines' owner, Pegasus Gold Corporation, also held other mines in Montana, including the Beal Mountain Mine. Pegasus was incorporated in British Columbia and raised funds on the Toronto Stock Exchange. Its directors were associated with a number of other mining companies, including Placer Dome.

After an initial Environmental Impact Statement in 1979, the mine permits went through 21 amendments without another full scale EIS, only a series of lesser Environmental Assessments.[69] The mine footprint grew from 256 acres to 1215 acres, about one half on Bureau of Land Management (BLM) lands.[70]

During the same period, the mines had over a dozen cyanide spills, including the following incidents:

- A leach pad pipe broke in 1982, causing the release of about 50,000 gallons of cyanide solution into Alder Gulch. Following the spill, cyanide was detected in the water supply of the town of Zortman's trailer court.
- Ore slippage in 1985 on one heap leach pad resulted in a breach of the lining system, resulting in loss of cyanide solution. Low concentrations of cyanide were then detected in Ruby Gulch.
- The Landusky barren cyanide solution pond experienced a liner leak in 1988 and cyanide was detected in a monitoring well adjacent to the pond.
- A seam failure occurred on a new process pond liner, which was installed in 1993 by a third party contractor, leading to a release of cyanide.
- "In July 1993, a flood resulting from unusually heavy rainfall sent King Creek waters flowing over the Cumberland Dam spillways into the Town of Zortman. The beaver dams located further down the King Creek drainage were washed out, releasing tailings that were previously contained by the beaver dams. Theamount of tailings that moved and the ultimate resting place are not known.[1] Four 100 year storm events occurred in twenty years of mine operation."[71]

By 1992, the mine had developed a serious acid mine drainage (AMD) problem as it began to mine sulphide ores, despite initial assurances that there would be no AMD problems.

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[69] *Final Supplemental Environmental Impact Statement for Reclamation of the Zortman and Landusky Mines*, Phillips County, Montana, Bureau of Land Management, State of Montana Department of Environmental Quality, December 2001, Section 1.2: Project Location and History.
[70] Ibid.
[71] James R. Kuipers, "Financial Assurance for Hardrock Mine Cleanup", CSP2, 2003.

The state determined that water pollution generated by the mine is so severe that expensive water treatment systems will have to be operated forever. [72]

Said Maest and Kuipers about water quality predictions at this mine: "The 1979 EIS indicated no potential for contaminants other than cyanide, based only on oxide ore being mined... the 1993 EA identified the potential for impacts from acid drainage, sulphate, metals, arsenic and nitrate... the 2001 EIS indicated a high potential to generate acid drainage from waste rock with pH, sulphate, metals and metalloids long with cyanide and nitrate..." [73]

A lawsuit was filed on August 30, 1993, by the Montana Department of Health and Environmental Science against Pegasus Gold for violations of the Montana Clean Water Act. Eventually EPA and several groups from the reservation (the Gros Ventre Tribe, the Assiniboine Tribe, the Fort Belknap Community Council, and citizens groups Red Thunder and the Island Mountain Protectors [74]) joined this lawsuit.

On July 22, 1996, a settlement was signed by all the parties. The settlement provided for Pegasus to pay $4.5 million in penalties to EPA and the state of Montana, as well as a partial cash settlement with the tribes and several supplemental environmental projects, including a community health evaluation, an aquatic study, and improvements to the drinking water systems on the Fort Belknap Reservation. The settlement included requirements for a Ground Water Study Plan to determine whether there are impacts from mine waste water on the area's groundwater. The company also agreed to provide a bond or surety totalling $32.3 million to the state of Montana to cover the costs of long-term water treatment.[75]

However, in January 1998, the company filed for bankruptcy, leaving the state of Montana with a reclamation bond that was $8.5 million less than needed to implement the preferred reclamation option.[76] During their bankruptcy, Pegasus appealed this amount. In November 1998, after more litigation by Fort Belknap to try to force BLM and Montana DEQ to accept more effective reclamation alternatives, the Interior Bureau of Land Administration (IBLA) ordered the BLM to work with the Tribes on the selection of the reclamation alternative. In 2003 the Fort Belknap tribes filed suit against the federal government under the *Clean Water Act* because the defunct mine site has continued to discharge toxic pollutants into water resources.[77]

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[72] For a thorough analysis of the gaps between predictions of water quality in the company EIS and the actual water quality, see: Maest & Kuipers, pages 144-148.
[73] Ibid.
[74] Heather Abel, "The Rise and Fall of a gold mining company", High Country News. (no date) http://www.hen.org/issues/121/3860/
[75] http://www.atsdr.cdc.gov/HAC/pha/pha.asp?docid=1223&pg=1
[76] Mitchell, Zortman and Landusky Mines, "HJR43 Water Quality Impacts", page 5.
[77] http://www.earthworksaction.org/zortman_landusky.cfm

The reclamation alternatives desired by the tribes were the most expensive ones, and government determined it would cost $22.5 million more to implement than was available in the Pegasus reclamation security. It had previously been decided that a Trust Fund for long term care of the water treatment plant should be funded until 2080. However, when BLM recalculated the actual costs, it was found that the amount Pegasus had been forced to post for long term care after 2017 (when the reclamation period would end) was $11 million less than would be needed. The taxpayers were over $33 million short.

During this time, reclamation of the site proceeded, and the earth works were completed by Spring 2005. Re-vegetation and monitoring are currently on-going, as is water treatment. The discharge from the treatment plants still do not meet water quality discharge standards for the State of Montana.[78]

The annual costs for water treatment ($1.5 million) are twice the amount estimated for the bonds.[79] The reclamation bonding put up by the company is gone[80], and the site is now dependent on annual appropriations and stimulus grants to maintain water treatment and continue the work. And the mines continue to discharge pollutants into the ground and surface waters.[81]

Writes Kempton: "The bankrupt Zortman-Landusky Mine in Montana, USA, is a particularly useful example [of problems with financial assurance] because the bond structure and causes of cost overruns are well documented (McCullough, 2005; GAO, 2005). ...Following the operator's bankruptcy in 1999, the state and the BLM took on water treatment using surety funds, but the project became an example of underfunding caused by inadequate initial assumptions in the 1990s and earlier".[82]

Talking about lessons learned from the fiasco over the closure of the Pegasus mines, Montana DEQ staffer Warren McCullough said in 2005:

- "Indirect costs (administrative overhead, engineering design, inflation, contingencies, etc) are a much higher part of total reclamation costs than DEQ previously assumed;
- Real-world emergencies will continue to occur under agency management; and
- The geochemistry of solutions in leach pads, tailings impoundments and waste dumps may continue to evolve during reclamation, complicating treatment and increasing costs. When bond calculations include a component for long-term water treatment, DEQ runs the calculation out to 100 years. Projected expenditures beyond one hundred years have little effect on net present value."[83]

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[78] David Chambers, personal communication, February 14, 2011.
[79] Mitchell, et al, page 24.
[80] http://deq.mt.gov/recovery/remediation/ZortmanLandusky/default/mcpx
[81] David Chambers, personal communication, February 14, 2011.
[82] Kempton Houston et al (2010).
[83] W. McCullough, "Financial Assurance and Bonding: What Happens When Bankruptcy Hits" in *Mining in New Mexico – The Environment, Water, Economics, and Sustainable Development, Decision-Makers Field Guide* (2005), pp. 121-124. http://geoinfo.nmt.edu/publications/decisionmakers/2005/DM_2005_Ch3.pdf

The Fort Belknap Story

If mines cannot be remediated and their toxic effects contained, then it is future generations that will have to deal with the result. In many cases in North America, this disproportionally affects indigenous peoples upon whose land the mine was built, usually without their consent. During the mine's operation and when the mine closes, they demand and need recognition of the role of the mine in the history of their peoples and an understanding of what has been lost, so that they may engage in rebuilding their community and culture, undertaking ecological healing. They also need the environmental destruction stopped, as well as reparations, and adequate resources to undertake the healing and rebuilding. Tribes are forced into the courts time and again to get any respect for and satisfaction of these needs. Without the hammer of litigation, everything stalls.

Wrote Andrew Schneider in the Seattle Post-Intelligencer on June 12, 2001:

" Gus Helgason stands atop Spirit Mountain and scans the gashes, pits and piles of rock that once was his tribe's most sacred land. The strong man weeps. More than 115 years ago, his ancestors were forced to give up the ground where he stands – 40,000 acres of the most hallowed part of their reservation. In return the government promised to feed, clothe and care for them. Federal agents said nothing about the gold they knew was buried in the mountain, but they made it clear the tribes could either agree or starve."[84] At the time of the interview, Helgason was the president of Island Mountain Protectors, a tribal environmental and cultural organization.

Gold was discovered in 1884, and in 1895, a congressional commission was sent to Fort Belknap to negotiate the purchase of the Little Rockies from the two tribes that lived there. The Gros Ventre and the Assiniboine vehemently opposed the "sale of the mountains," which was advocated by federal commissioners who were assigned to negotiate the sale of the gold mining country in 1896 (Indian Claims Commission, Undated). The Assiniboine and Gros Ventre representatives were told by the commissioners that they would no longer be provided "beef, cattle, flour, wagons, or anything else" if they did not sell a strip of land, 7 miles long and 4 miles wide for $360,000. Eventually an agreement was reached on October 9, 1895, which sold the southern portion of the Little Rockies to the United States. It was known as the Grinnell Agreement, 1896. [85]

[84] Andrew Schneider, "A Wounded Mountain Spewing Poison", June 12, 2001. http://www.seattlepi.com/specails/mining/27076_lodgepole12.shtml

[85] American Toxic Substances and Disease Control Registry, *Petitioned Public Health Assessment for Kings Creek* (aka Fort Belknap Indian Reservation/Zortman Mining Incorporated), Lodgepole, Baline County, Montana. http://www.atsdr.cdc.gov/hac/pha/pha.asp?docid=1223&pg=1

"Within a year, Spirit Mountain was honeycombed with tunnels and shafts. The biggest mining camp was Zortman...Today it is a ghost town."[86] There was some shaft mining over the decades, but nothing major until Pegasus Gold appeared in 1977.

The reservation is located in north central Montana about 36 miles from the Canadian border, and encompasses approximately 638,000 acres of land. As of 2004, there were 6,528 tribal members: 2,697 Assiniboine and 3,730 Gros Ventre. The tribes' economy is based on agriculture, which includes farming, ranching, and land leasing, including grazing permits. Crops include wheat, hay, and barley.[87]

Says Helgason: "They destroyed this place, took their gold off in armoured trucks and left us a wounded mountain spewing poison."[88]

Health problems at Fort Belknap--from asthma and emphysema to thyroid problems and diabetes--have been on the rise on the reservation over the past 25 years, especially among children. Other health impacts have been reported that could be linked to the mining, such as lead poisoning and chemical burns from swimming in the water that flows out of the mining area. There is concern about both the environmental impacts and human health risks of using cyanide as a processing agent. [89] A study undertaken by American Disease and Toxic Substances Registry in 1995-6 failed to find a relationship between the mines upstream and these health problems.[90]

Nevertheless, Fort Belknap with Island Mountain Protectors, Red Thunder and the Indian Law Resource Centre have acted aggressively to control the worst effects of the mines, going to court, negotiating and finding technical support from groups like Earthworks (formerly Mineral Policy Institute) and the Center for Science in Public Participation (CSP2). It was the Tribes' unrelenting pressure that led to the actions taken by the BLM and the Montana DEQ. As of 2010, the community was again in court trying to force the authorities to act.[91]

The outcry engendered by the Zortman-Landusky Mines has been a key factor in changes to reclamation bonding practices throughout the United States and Canada and to public awareness of the dangers of Acid Mine Drainage and inadequate water quality predictions.[92]

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[86] Schneider. Op. cit.

[87] Erin Klauk, *Cultural Heritage of the Fort Belknap Indian Community* http://serc.carleton.edu/research_education/nativelands/ftbelknap/culture.html.

[88] Schneider, Op cit.

[89] Klauk, op cit.

[90] American Toxic Substances And Disease Control Registry, op cit.

[92] Jared Diamond, *Collapse: How Societies Fail to Choose or Succeed* (Penguin, 2005), pages 456-7.

Case Study Five: Uranium Mine-Mill Tailings in Saskatchewan

"The aim of searching for long term solutions is to limit risk to future generations and minimise the commitment of future resource requirements. Design requirements for disposal longevity generally range from a few hundred to a thousand or more years. For example, the USA EPA promulgated standards for long term stabilization and control of uranium mill tailings require that the remediation be designed to be effective for up to 1000 years to the extent reasonably achievable, but at a minimum for 200 years."[93]-International Atomic Energy Association, Report on Uranium Mill Tailings.

Summary

This case study presents:

- the story of the ongoing decommissioning of closed uranium mines in the region of Uranium City, Saskatchewan;

- an overview of the uranium mine and mill waste management regime in Canada;

- a discussion of Saskatchewan's Institutional Control Program - the long term stewardship program that is touted as "the most comprehensive planning for perpetual management (of hard rock mines)"[94] in North America; and

- discussion of key long term stewardship recommendations from the US and the International Atomic Energy Association (IAEA).

Key Points

- According to a 2004 IAEA report: "Any engineering solution has a finite life-span, which may be shorter than desirable from a radiological or toxicological safety point of view...Engineering solutions need to consider long term care and maintenance as an integral part of planning and design. In turn, this may require active institutional control and stewardship over very long periods of time."

[93] International Atomic Energy Association, *The Long Term Stabilization of Uranium Mill Tailings. August 2004. (European Examples*), p. 1. http://www-pub.iaea.org/MTCD/publications/PDF/te_1403_web.pdf.
[94] Kempton et al,, page 6.

Uranium City

esask.uregina.ca

- The Beaverlodge Mine and Mill has now been in decommissioning for more than twenty years. A cursory review of documents from Canadian Nuclear Safety Commission (CNSC) licensing for the sites in the Beaverlodge drainage area raises a number of concerns about mistaken predictions, lack of community involvement and the effectiveness of institutional controls.

- The endless numbers of public hearings for renewed licensing of closed facilities are a drain on the resources of the Dene and Métis peoples, as well as the community groups and NGOs that worry about uranium and abandoned mines. Participant funding is rare, the documentation is voluminous, and the progress slow.

- Two freeze wall applications at Saskatchewan uranium mines have had serious failures.

- In Saskatchewan, the owners and developers of these uranium mines have enjoyed enormous political power and impunity for decades.[95]

- The Saskatchewan Institutional Control Plan was the product of three years of interdepartmental discussions about how to satisfy industry demands to be rid of the responsibility for the long-term management of their decommissioned uranium mines while quelling public concerns about the safety of these sites.

- The International Atomic Energy Association Report on the Long Term Stabilization of Uranium Mill Tailings provides a summary of experience, case studies and recommendations from around the world.

- Neither regulations, design specifications, nor management systems can be relied upon in isolation to provide assurance against containment failure: all three must be applied, in a framework of quality assurance and post-closure care and maintenance, to deliver a high probability of tailings containment security.

The International Atomic Energy Association Report on the Long Term Stabilization of Uranium Mill Tailings doesn't pull any punches when it describes the problem of long term management of uranium mine and mill sites:

"Typical environmental problems arising from mill tailings are radon emanation, windblown dust dispersal, and the leaching of contaminants, including radionuclides, heavy metals and arsenic, into surface and groundwaters. Radon (Rn) emissions are due to exhalation from the waste materials and the Rn can reach the ambient atmosphere when free circulation of air in the material and its cover is possible. Emissions to water bodies occur when infiltration of precipitation is unhindered, bottom-liners are absent, and no collection of drainage waters is installed. The leaching of contaminants is usually exacerbated by acid formation from pyrite oxidation under conditions of varying degrees of saturation with water. Additional effects from acid rain have also been observed. In many instances contaminants other than radionuclides may be the real problem, and a comprehensive and holistic assessment of the impoundment inventory and all processes may be necessary...

"Any engineering solution has a finite life-span, which may be shorter than desirable from a radiological or toxicological safety point of view. Apart from the structural degradation and/or weathering of the material impounded, failure of retaining structures, such as dams, must

[95] Chronicled in compelling detail by James Harding, *Canada's Deadly Secret: Saskatchewan uranium and the global nuclear system* (Fernwood Publishing, 2007).

be considered. Erosion of cappings and other engineered structures may be a problem in certain settings. Engineering solutions, therefore, may need to consider long term care and maintenance as an integral part of planning and design. In turn, this may require active institutional control and stewardship over very long periods of time. Engineering solutions, long term care and maintenance and institutional control should together strive for an optimization of economic, technical, risk reduction and societal factors."[96]

Saskatchewan — Uranium City

The Athabasca basin in northern Saskatchewan is home to the richest mineable uranium deposits on earth. The Canadian Nuclear Association enthuses: "The enormous bounty of uranium buried in the Athabasca Basin is almost beyond reckoning and can provide substantial wealth to the province of Saskatchewan and Canada for decades to come. It is estimated that the energy contained in these deposits is equivalent to 17 billion barrels of oil or at a typical 2008 oil price of $130 per barrel about $2.2 trillion."[97]

The area is home to Aboriginal Dene and Metis peoples on both sides of the Alberta-Saskatchewan border. Lake Athabasca is one of the world's largest lakes, and used to host a major commercial fishery. Now the fishery is replaced by tourism, including sport fishing and hunting. The first uranium discoveries were made in the early 1950s, and the Beaverlodge Mine was opened in 1953. Eventually Uranium City was built to house the miners.[98] "In 1954 the local newspaper *The Uranium Times* noted that 52 mines were operating and 12 open pit mines were next to Beaverlodge Lake" [99] including Gunnar (1955-1964) and Lorado (1957-1960). The ore from all the mines around the lake was taken to Beaverlodge, Gunnar or Lorado for milling. There were no regulations governing mining, and the tailing were dumped in nearby waterbodies and left there. The owner of the mines and mills was the federal government's crown corporation, Eldorado Nuclear and Refining.

Commercial production started in 1953 at the Beaverlodge mine on Beaverlodge Lake. The town of Uranium City was established in 1952 to service the Beaverlodge mine and over 60 others that followed. All of the mines in the vicinity fed into three processing facilities, at Beaverlodge, Lorado, and Gunnar. Lorado, in operation from 1957 to 1960, is the smallest, with 0.6 million tonnes of tailings covering 14 hectares. Gunnar was in operation from 1955 to 1964, and left 4 million tonnes of tailings over 75 hectares, while the Beaverlodge operation left 6 million tonnes over 25 hectares. Although the uranium ore was not of a high grade (unlike the

[96] International Atomic Energy Association, page 1.
[97] Canadian Nuclear Safety Association website. www.nuclearsafety.gc.ca
[98] Graham Parson and Ron Bars. "Uranium Mining in Saskatchewan: A Public-Private Transition (Part 2)" downloaded from http://www.idrc.ca/fr/ev-28035-201-1-Do_Topic.html.
[99] http://en.wikipedia.org/wiki/Uranium_City,_Saskatchewan

newer mines), the tailings still contain 85% of the radiation of the original ore (thorium, radium, polonium and other radionuclides were left behind when the uranium was extracted) as well as other metals and, in the case of the Lorado and Gunnar sites, they are also acid-generating.[100]

By 1982, Beaverlodge and the other mines in the area were all closed and Uranium City's population fell from 5000 to less than 100 people, mostly Dene.

In the 1950s and 60s, there were no environmental regulations governing the closing or "decommissioning" of uranium mines, and the radioactive and acidic wastes (or "tailings") were simply dumped, often in nearby lakes, and left there. At the Gunnar site, the tailings were simply bulldozed into a small lake, which eventually overflowed into Lake Athabasca. At the Beaverlodge mine, tailings were dumped into Beaverlodge Lake. Cameco Corporation, formed when Eldorado Nuclear was partially privatised, is the contracted operator for the care and maintenance of the closed sites.

In 1993, Alberta Premier Ralph Klein called the situation one of Canada's "worst environmental nightmares." An acrimonious debate between Saskatchewan and the federal government about who should take responsibility for the mess and how much should be invested in cleaning it up lasted for decades. [101] Finally, in September 2006, the Governments entered into a Memorandum of Agreement that defined roles and responsibilities for the remediation of certain cold war era uranium mine sites, principally the Gunnar mine and mill site, in northern Saskatchewan. Neither the private sector companies nor the Crown companies (Eldorado and Saskatchewan Mining and Development Corporation) that operated these sites from the 1950s until the early 1960s were still in existence.

The Beaverlodge Mine and Mill has now been in decommissioning for more than twenty years. A cursory review of documents from CNSC licensing for the sites in the Beaverlodge drainage area raises a number of concerns about mistaken predictions, lack of community involvement and the effectiveness of institutional controls:

- "Flow data collected in the Ace Creek and Fulton Creek watersheds over the period 1985 to 2005 have demonstrated that run-off rates estimated during the decommissioning phase were seriously underestimated." (Transcript 2004-R. Phillips, representing Cameco)
- Investigations in Fulton Creek have shown (that) an increase in the radium 226 levels in Fookes and Marie Lakes is attributable to radium released from ...tailings and in Greer Lake from redissolution of barite and barium sulphate precipitates...the barite precipitate was formed after the affluent was treated with barium chloride, in the presence of sulphate, to form barium radium sulphate." (2004 Phillips page 16)

[100] MiningWatch Canada and Sierra Club of Canada. *Canada's Toxic Thirteen* (June 20, 2001). www.miningwatch.ca
[101] Kuyek personal files.

- "Uranium concentration in Beaverlodge Lake has recently been identified to be of potential concern with respect to use of the lake as a drinking water source during the decommissioning recovery period. This was not anticipated at the time the decommissioning plans were being formulated." (2004 transcript Phillips page 17)
- "The elevated levels of selenium are of particular concern because they are believed to have resulted in a relatively high incidence of deformities in fish...CNSC staff is of the view that the levels of selenium are also high enough to cause significant reproductive failure in the fish population..." (CNSC ROD April 5, 2005.)
- "Radium concentrations in the Fulton Creek tailings system were expected to increase for the next 20 to 30 years." (CNSC 2009 page 3)
- "The Commission asked Cameco to elaborate on the fact that it was reported that the population around Beaverlodge area could only consume half a pound of fish coming from Beaverlodge Lake every two weeks to avoid contamination." (2009 ROD CNSC page 5)
- Institutional controls consisted of public advisories on drinking water and fish around the contaminated sites. All signage was in English. (2009 ROD CNSC page 9-10)
- The Metis Nation of Saskatchewan argued that "the lack of resources to participate in the consultation process was preventing the Metis from understanding the contamination issues...and was putting them at risk with regards to their health." (2009 ROD CNSC page 14)

The endless numbers of public hearings for renewed licensing of closed facilities are a drain on the resources of the Dene and Metis peoples, the community groups and NGOs that worry about uranium and abandoned mines. Participant funding is rare, the documentation is voluminous, and the progress slow. The public hearings often only reinforce the feelings of powerlessness in the citizenry, as they are "consulted", but have no real power to influence the outcomes. [102]

On April 2, 2007, Canada and Saskatchewan announced the first phase of the cleanup. The total cost was to be $24.6 million, shared 50/50 between the two governments. Natural Resources Canada (NRCan) advanced $1.13 million as its share of Phase 1 of the project, and a comprehensive study environmental assessment of the project began on June 15, 2007. In October 2007, the Government of Saskatchewan and Encana Corporation entered into an agreement for the decommissioning and reclamation of the nearby Lorado uranium mill site. Encana is the current owner of the Lorado site and will fund the project. On February 15, 2011, the Saskatchewan government committed an additional $36.2 million to the Gunnar cleanup and the federal government is expected to match this amount.

[102] Harding, 2007. Confirmed by Randy Fleming, personal Communication, April 2011.

Other uranium mines in Saskatchewan

In the 1970s and 80s, the power of the uranium mining industry in Saskatchewan grew with the discovery of much richer uranium deposits further south and east in the Lake Athabasca Basin. The Rabbit Lake deposit was in operation by 1975. It included three separate open pits, two of which have now been mined out. The Cluff Lake mine operated from 1980-2002. In 1983 the enormous Key Lake mine went into production–the highest grade and largest uranium mine in the world. Although it closed only fourteen years later in 1997, low grade ore continues to be milled with ore from the McArthur River Mine. The Cigar Lake deposit was discovered in 1981 and construction started in the summer of 1997.

"The Cigar Lake ore body is the richest undeveloped uranium deposit in the world, with an average ore grade of 18% U_3O_8 (uranium oxide). It is also one of the largest, with geological reserves totalling 103,000 tonnes of U_3O_8. It will be mined from tunnels above and below the ore zone, using a water-jet boring technique on ore after is has been frozen. The ore will be crushed, ground, mixed with water, and then pumped as slurry to the surface for transportation to the mill. Special remote-control mining methods will be necessary due to the high radiation fields." [103]

However, the Cigar Lake mine flooded during construction in October 2006 due to a rock fall that caused its freeze wall to fail. Production is now scheduled to start by 2011.

The McArthur River mine commenced production in July 1999 and is operated by Cameco Corporation. At a depth of 550 metres, it is mined by underground methods similar to those to be used at Cigar Lake. It has also had problems with failure of its freeze wall and flooding. Other uranium mines are also proposed. The Millenium underground mine and the Midwest Mine (now part of the McClean Lake Mine) are currently being permitted. In addition the area is the subject of massive exploration.

In Saskatchewan, the owners and developers of these uranium mines have enjoyed enormous political power and impunity for decades.[104] In the late 1970's, dewatering for the Key Lake Mine began years before permits were issued; eight spills happened within a few months after it went into production and a massive spill one year later.[105] At the Cluff Lake Mine, the owner, Uranez Corporation also began dewatering before permitting was complete. Then in 1989, there was another enormous spill at Cameco's Rabbit Lake Mine into Wollaston Lake; two million litres of contaminated water spilled from a 10km pipeline. The spill went undetected for 16 hours. It overflowed the catchments meant to protect the surrounding land, went over the frozen ground to Collins Creek and then into Wollaston Lake. Demands for an inquiry grew, and other stories of accidents and spills surfaced.

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[103] Canadian Nuclear Safety Commission website. http://www.cna.ca/curriculum/cna_can_nuc_hist/uranium_sask-eng.

[104] Chronicled in compelling detail by Harding, 2007.

[105] Harding, pages 64-65.

Today, the biggest players are Cameco (privatized after a merger of crown-owned Saskatchewan Mining and Development Corporation and federal crown–owned Eldorado in 1988) and Areva (a French-based company). These two companies are multinationals with interests in all stages of the nuclear cycle. They have a strong interest in shaping laws and policy regarding uranium mining and milling in the province.

Saskatchewan Institutional Control Plan

In 2006, Eric Cline, then the Minister of Industry and Resources for the Government of Saskatchewan, presented a new provincial initiative to the World Nuclear Association meeting in London. [106] The Saskatchewan Institutional Control Plan was the product of three years of interdepartmental discussions about how to satisfy industry demands to be rid of the responsibility for the long-term management of their decommissioned uranium mines while quelling public concerns about the safety of these sites.

It has been hailed by one review of North American policy for perpetual mine management as: "the most comprehensive planning for perpetual management". [107]

In Canada, regulating uranium mines and mills is a federal responsibility exercised through the Canadian Nuclear Safety Commission, although provincial laws and regulations pertaining to the environment, labour, health and water use also have to be obeyed. In order for Saskatchewan to undertake the task of perpetually managing some of the most dangerous uranium mines in the world, it had to develop an arrangement with the CNSC and the federal government that would meet the requirements of the International Atomic Energy Association's *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (2001)[108].

How are radioactive wastes from uranium mines and mills regulated in Canada? [109]

Since uranium mining is a federal responsibility in Canada, the government has a structure of legislation, regulations and institutions that govern the management of radioactive waste. The 1996 *National Framework for the Management and Regulation of Radioactive Waste and*

[106] Eric Cline, "The Long Term Management of Former Uranium Mine Sites", presented to the World Nuclear Association, 2006, London.
[107] Kempton, Bloomfield, Hanson and Limerick. Op cit. page 6.
[108] IAEA Joint convention: http://www.iaea.org/Publications/Documents/Infcircs/1997/infcirc546.pdf
[109] This section is abridged from Canadian Nuclear Safety Commission, "Radioactive Waste Management and Decommissioning in Canada", Report to the OECD, March 2008. www.oecd-nea.org/rwm/profiles/**Canada**_report_web.pdf.

Decommissioning in Canada [110] sets out federal responsibilities, and provides a set of principles "to ensure that the management of radioactive waste is carried out in a safe, environmentally sound, comprehensive, cost-effective and integrated manner."[111]

The governing piece of legislation for uranium mining and millings is the *Nuclear Safety and Control Act* and its regulations. Under the law:

- Waste owners are responsible for the funding, organization, management and operation of long-term waste management facilities required for their wastes.
- Different arrangements are established for different categories of radioactive waste: nuclear fuel waste, low and intermediate level radioactive waste and for uranium mine and mill tailings.
- The lead department for oversight of the *Act* and *Regulations* is Natural Resources Canada.
- The Canadian Nuclear Safety Commission (CNSC) is the federal regulator.

The CNSC is an "independent, quasi-judicial administrative tribunal and court of record." The Commission's seven members are appointed by Cabinet for terms not exceeding five years and may be reappointed. The President of the CNSC is a full-time Commission member and other members generally serve on a part-time basis. A Cabinet decision to fire the President in 2010 made it clear that the Board sits at the will of the Government. The Commission's key roles are to:

- establish regulatory policy on matters relating to health, safety, security and the environment;
- make legally-binding regulations; and
- make independent decisions on the licensing of nuclear-related activities in Canada.

The Commission administers the *Nuclear Safety Control Act (NSCA)* and its associated regulations. Among these regulations are the *CNSC Rules of Procedure*, which outline the public hearing process, and the *CNSC By-laws,* which outline the Commission's meeting process. There are four major branches of CNSC staff: Regulatory Operations, Technical Support, Regulatory Affairs and Corporate Services.

CNSC's Research and Support program provides staff with access to independent advice; expertise, experience, information and other resources, via contracts or contribution agreements made with private sector companies as well as other agencies and organizations in Canada and internationally. The CNSC Research and Support Program claims to be independent of research and development programs conducted by industry.

[110] Ibid.
[111] Ibid.

Uranium Mines and Mills Regulations (UMMR)

One of the regulations under the Nuclear Safety and Control Act enforced by the CNSC is the Uranium Mines and Mills Regulations.[112] The Uranium Mines and Mills Regulations are implemented by their own Division of the CNSC located in Saskatoon, close to Canada's major uranium mining operations.

The *Regulations* apply to all uranium mines and mills, including mill tailings. They do not apply to uranium prospecting or surface exploration activities. Each stage - including mandated annual or five year reviews - requires licensing by the CNSC. The regulations explicitly include the information needed to apply for different types of licences for uranium mines and mills, which match the life cycle of a facility, including site preparation and construction, operation, decommissioning and abandonment. These regulations also include requirements for a code of practice, the obligations of licensees, and records to be kept and made available. They contain information on decommissioning licensing requirements.

There are no separate regulations for waste management. In keeping with the 1996 *Policy Framework*, Canadian uranium mining companies are responsible for the funding, organization, management, and operation of facilities required for their wastes.

CNSC Regulatory Policy P290 identifies the need for long-term management of radioactive waste and non-radioactive hazardous waste arising from licensed activities. In December 2006, *Regulatory Guide G-320 "Assessing the Long Term Safety of Radioactive Waste Management*" was published to assist licensees to address the long-term storage and disposal of radioactive waste. The guide addresses long term care and maintenance considerations, setting post-decommissioning objectives, establishing assessment criteria, assessing strategies and level of detail, selecting time frames and defining assessment scenarios (including institutional controls), identifying receptors and critical groups, and interpretation of assessment results. The guide was developed using provincial, federal and international documents, following a pre-consultation with the nuclear industry in Canada.

Regulatory Guide G-219, Decommissioning Planning for Licensed Activities provides guidance on the preparation of plans for the decommissioning of activities licensed by the CNSC. Proponents and operators of all nuclear facilities including uranium mines and mills, and spent fuel and radioactive waste management facilities are required to propose decommissioning plans and funding measures.

Decommissioning plans must be sufficiently detailed in order to:

[112] Available from www.nuclearsafety.gc.ca

- demonstrate that they will remediate all significant impacts and hazards to persons and the environment in a technically feasible fashion;
- ensure compliance with all applicable requirements and criteria established in acts, regulations, and other regulatory standards; and
- enable credible estimates of financial guarantee amounts.

The *NSCA* (subsection 24(2)) requires the Commission to hold a public hearing before making a licensing decision "where it would be in the public interest to do so". A public hearing is a structured proceeding where interested members of the public have an opportunity to make submissions in relation to the matter to be decided by the Commission. The *CNSC Rules of Procedure* apply to these proceedings and set out the requirements for, among others, the notification of public hearings and publication of decisions from public hearings.

Owners of closed uranium mines are required to ensure that their sites are properly decommissioned. In keeping with the *Policy Framework*, the CNSC attempts to identify the uranium producer or property owner of the site. In instances where remedial actions are required at uranium mine and mill tailings facilities where the owner no longer exists, the Government of Canada and provincial governments ensure that the sites are safely decommissioned. In Ontario, home of the former Elliot Lake uranium mining complex, the Governments of Canada and Ontario entered into a Memorandum of Agreement in 1996 outlining their respective roles in the management of "abandoned" uranium mine and mill tailings, including a 50/50 sharing of costs associated with any necessary remediation.

To date, these arrangements have not been necessary as all Ontario sites have owners that are complying with their responsibilities. As an example, Rio Algom and Denison Mines have decommissioned and remediated the extensive Elliot Lake uranium-mining facilities that were the centre of Canada's uranium mining industry from the 1950s through to the early 1980s.

The activities covered by the financial assurance under the *NSCA* include not only dismantling, decontamination and closure, but also any post-decommissioning monitoring or institutional control measures that may be required as well as subsequent long-term management of all wastes.

How does the Saskatchewan Institutional Control Management Framework work?[113]

The Institutional Control Plan (ICP) was established in 2007 to manage and monitor mine sites (mostly uranium) once decommissioning has been completed. The ICP applies to

[113] This section is abridged from Saskatchewan Ministry of Energy and Resources, "Institutional Control Program: Post Closure Management of Decommissioned Mine/Mill Properties on Crown Land in Saskatchewan" (December 2009). http://www.er.gov.sk.ca/Institutional_Control-Decommissioned_Mines/Mills

decommissioned mine and mill sites on provincial Crown land. The owner of the site is enabled to transfer custodial responsibility to the Province "upon which the site will be monitored and maintained in perpetuity." According to Minister Eric Cline, the ICP was developed because: "If companies were to be responsible for perpetual care and maintenance at former uranium mines, this would be a significant barrier to investment in new uranium developments." [114] It was also considered that companies would not last as long as governments.

At the time the ICP was being developed there were no formal arrangements to transfer custodial custody to the Provinces. Under the *Nuclear Safety and Control Act,* only the CNSC had jurisdiction, so formal agreements had to be drawn up province by province.

In 2006, The Reclaimed Industrial Sites Act was passed, and *Regulations* to the *Act* quickly followed (May 2007), The *Act* and *Regulations* established the legal authority of the ICP, and recognize the authority of the CNSC for uranium sites.

There are two primary components to the ICP: the Institutional Control Registry and the two Institutional Control Funds--the Monitoring and Maintenance Fund and the Unforeseen Events Fund, held separately from the province's revenues. Both funds are handled by the Ministry of Finance.

The registry maintains a formal record of closed sites, manages the funding and performs any monitoring and maintenance work. Registry records include the location and former operator, site description and historic records, site maintenance, monitoring and inspection documentation and future allowable land use at the site. It also references CNSC documentation and decisions.

The Monitoring and Maintenance Fund will pay for long term monitoring and maintenance. Both funds are established based on Net Present Value calculations "in perpetuity".[115] The Fund has dedicated site specific funding established by the previous operator.

The Unforeseen Events Fund will pay for events such as damage from tornados, fire, floods and earthquakes. The money in this fund is not tracked by individual site contributions and can be drawn on for contingencies at any of the registered sites. It is established through operator contributions of 10-20% of their total contribution to the Monitoring and Maintenance Fund. The Unforeseen Events Fund monies are invested in bonds to target a specific return.

"A financial assurance requirement has been implemented to minimize the ICP's financial risk during the initial years while the Unforeseen Events Fund is building value. In negotiation with industry, while implementing a condition to reduce its risk, the province also

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[114] Cline, op cit..

[115] For an excellent analysis of the shortcomings of Net Present Value as a basis for long term stewardship financial assurance, see Joseph H. Guth, *Resolving the Paradoxes of Discounting in Environmental Decisions* (SEHN) www.sehn.org/pdf/DiscountingParadoxesTLCP.pdf

took steps to minimize the impact on good corporate citizens through acceptance of corporate guarantees... A good corporate citizen is define as one with a credit rating of BBB(low) or higher." [116] The amount of financial assurance must be equal to the cost of "a maximum failure event" at the site, or "such reduced amount agreed to by the Minister". The assurance will be reviewed every five years. The level of discretion given to the Minister for both these funds could substantially undermine their purpose.

Before the ICP can accept a site, it has to meet the following requirements set out in the Reclaimed Industrial Sites Regulations:

(a) the site holder satisfies the minister that the site holder has completed and complied with the conditions of any environmental assessment;

(b) the site holder has submitted a monitoring and maintenance plan that is satisfactory to the minister and that identifies:

(i) the monitoring and maintenance obligations that need to be undertaken when the closed site is accepted into the Institutional Control Program; and

(ii) the present value of the future costs associated with the monitoring and maintenance obligations mentioned in subclause (i);

(c) the site holder satisfies the minister that the site holder:

(i) has completed the required decommissioning, reclamation and transitional-phase monitoring activities requirements imposed pursuant to The Mineral Industry Environment Protection Regulations*, 1996;*

(ii) is eligible to be released from the decommissioning, reclamation and transitional-phase monitoring requirements pursuant to The Mineral Industry Environmental Protection Regulations*, 1996; and*

(iii) will be released pursuant to The Mineral Industry Environmental Protection Regulations*, 1996 from the requirements or obligations set out in a decommissioning and reclamation plan on the closed site entering the Institutional Control Program;*

(d) the site holder satisfies the minister that the site holder is eligible to receive a release or exemption from any and all licences that are issued by the Government of Saskatchewan or any of its agencies or commissions and that are associated with the closed site;

(e) the site holder satisfies the minister that the site holder is eligible to receive a release from any and all licences that are issued by the Government of Canada or any of its agencies or commissions and that are associated with the closed site;

[116] Ibid, page 11.

(f) if the closed site is required to be licensed pursuant to the Nuclear Safety and Control Act (Canada)*, the Canadian Nuclear Safety Commission has agreed, in writing, to grant the Government of Saskatchewan an exemption from the obligation to hold a licence under the Nuclear Safety and Control Act (Canada) for the closed site if the minister accepts the closed site into the Institutional Control Program;*

(g) the site holder satisfies the minister that:

(i) the site holder is eligible to receive a release from the surface lease agreements or any portion of them associated with the closed site; and

(ii) the site holder will receive the release at the time the minister accepts the closed site into the Institutional Control Program;

(h) if the site holder owns the mineral rights associated with the closed site, the site holder surrenders or transfers those mineral rights to the minister at the time the minister accepts the closed site into the Institutional Control Program.

This is very early days for the program, and it is impossible to assess its effectiveness at this stage. The first site accepted into the program was the former Contact Lake gold mine. In October 2009, five former uranium mines (without tailings and previously exempted from CNSC licensing requirements) at the Beaverlodge operation were accepted.[117] Most Saskatchewan sites are likely to remain under CNSC licensing for the foreseeable future. A five year review is mandated by the legislation.

International Atomic Energy Association (2004) Coordinated Research Project on Uranium Mill Tailings

This useful report provides a summary of experience, a number of case studies and recommendations from around the world for the long-term effectiveness of uranium tailings management (up to 2004). A brief summary of its findings regarding long-term management of these tailings is below.

Legislation aimed primarily at protecting the health of workers was developed as early as the 1940s, but it was not until the mid 1960s that concern for impacts on the wider community and on the environment led to a major change in the way that the risks and hazards of uranium mill tailings were perceived, including the long term nature of those risks and hazards. From this time a major change took place in the approach to design of tailings containments. A new approach gradually developed that considered issues such as climate, possible agents for containment failure, long term containment, and the values and sensitivity of the surrounding

[117] "CNSC Record of Proceedings including Reasons for Decision in the Matter of Cameco Corporation Application to Renew the Beaverlodge Mine and Mill Site Waste Facility Operating Licence", November 30, 2009. Page 9.

environment in order to reduce the risk of containment failure and potential hazards to the environment.[118]

Probably the most extensive early work on uranium mine and mill tailings has been undertaken in the United States. The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 gave the U.S. Department of Energy (DOE) the responsibility of stabilizing, disposing of, and controlling uranium mill tailings and other contaminated material at twenty-four uranium mill processing sites located across ten states and at approximately 5,200 associated properties. Under the *Act*, the DOE established the Uranium Mill Tailings Remedial Action (UMTRA) Project to monitor the cleanup of uranium mill tailings. The UMTRA used on-site disposal methods for eleven of the mills, while excavating and disposing of the wastes found at the remaining thirteen sites to remote off-site disposal locations owned by the DOE. [119]

The IAEA Report concluded that there is no such thing as 'fail-safe' facilities for tailings management. Neither regulations, design specifications, nor management systems can be relied upon in isolation to provide assurance against containment failure: all three must be applied, in a framework of quality assurance and post-closure care and maintenance, to deliver a high probability of tailings containment security. Examples exist of failure related to containments not being built as designed; regulators not checking that all requirements were provided for in construction and operation, and worst-case scenarios not being taken into consideration in deriving design specifications.

It is therefore critical to ensure that:

- containment design is based on comprehensive, site -specific risk analysis;
- containment construction follows design specifications rigorously;
- appropriate operating procedures, coupled with quality assurance, are adhered to, including a regulatory system that checks that all design and operational requirements are applied during construction, throughout operational life, remediation, close-out and during the stewardship stage.[120]

"The use of the term 'passive systems' reflects the hope that the level of intervention required at closed sites in order to achieve adequate levels of environmental protection would be minimal or none. However, there is little information available on the sustainability and time dependent effectiveness of these natural processes. It is likely that the capacity for such systems to continually take up contaminants has a finite limit...It may be worthwhile to keep an open mind for the possibility of future impoundment design and placement techniques that may

[118] IAEA, page 76.
[119] Paraphrased from http://www.eoearth.org/article/Uranium_Mill_Tailings_Radiation_Control_Act_of_1978%2C_United_States
[120] IAEA, page 56.

harness natural processes to reduce long term risk of failure and environmental harm by effectively assimilating the tailings pile and containment into the environment."[121]

In terms of long-term stewardship, the IAEA Report's key recommendation is:

" Design approaches that develop concepts that offer confidence beyond a 1000 year design life provided through conventional engineering design. Such concepts of containment performance and containment life may include features that enable natural processes to interact with the containment and the tailings within it in a way that improves long term stability rather than diminishing it (ecological design)".[122]

[121] IAEA, pages 59-60.
[122] IAEA, page 57.

Case Study Six: Faro Mine - Abandoned Mines in Canada's North

" Soil covers at ARMC should be planned to function for thousands of years. They are not "walk-away" solutions as ongoing care and proactive maintenance will be required to maintain their design function. If there were a significant degradation in the covers there is the potential for a metal release rate from an accumulated reservoir of secondary mineral precipitates that could exceed that occurring in the absence of a cover placement. There are presently many unknowns and challenges, and the mining industry has limited experience with proactive cover maintenance (e.g., do not wait until the cover leaks and discharge increases to make repairs). Challenges include predicting repair costs, difficulty in detecting leaks, predicting future settlement of the underlying waste rock and monitoring changes in buried layers within the cover." [123] -Report of the Independent Peer Review Panel for the Faro Mine

Summary

This case study summarizes the state of long term stewardship plans for abandoned mines in Canadian jurisdictions with particular reference to the Faro Mine in the Yukon. Faro is one of North America's worst abandoned mines, and – like Giant – is a federal responsibility. Some of the thinking from the Faro Independent Peer Review Panel about long term stewardship challenges is summarized. The study also discusses the relationship between closure planning and First Nations interests.

Key Points

- Remediation and long-term care of mine sites like Faro require public engagement and activism in order to create the political will for the enormous funding that is required.

- It took decades of advocacy work at the territorial and national levels to make sufficient funds available to deal with the problems at the mine site.

[123] Independent Peer Review Panel, *Review of Remediation Alternatives for the Anvil Range Mine Complex Final Report* (April 2007), page xi. http://faromine.ca/assets/files/IPRP_FINAL_REPORT_Apr_07.pdf

Faro Mine Site

Source: Kevin O'Reilly

Faro Pit

Source: Kevin O'Reilly

- There is tension between the urgent need to contain and limit further damage from the mine and the development of sustainable planning for perpetual care.

- Engineered covers, water treatment and drainage options all require expensive and constant care (and probably periodic replacement) for millennia.

- The use of independent experts will enhance remediation planning and build public trust; the Independent Review Panel provided excellent insights into perpetual care requirements.

- Partnerships with affected First Nations are essential but may be difficult for governments to achieve. There must be a conscious effort to restore the 'spirit of place' even though the physical and biological features may be different than they were pre-mining.

- "Adaptive Management" of long term sites should not be a rationalization for reducing costs.

- "There are presently many unknowns and challenges at the Faro site, and the mining industry has limited experience with proactive cover maintenance (e.g. do not wait until the cover leaks and discharge increases to make repairs). Challenges include predicting repair costs, difficult in detecting leaks, predicting future settlement of the underlying waste rock and monitoring changes in buried layers within the cover."[124]

- Financial surety is essential: (1) to avoid continued deterioration of the physical and chemical conditions at the site, which, if left unchecked, would lead to more severe adverse environmental impacts; (2) to support the implementation of adaptive management which demands a capacity to adjust in a timely manner to avoid significant problems that are discovered through the learning process; and (3) to achieve the societal goal of minimizing costs imposed on future generations related to current activities.

[124] Independent Peer Review Panel, page xi.

Long Term Stewardship of Abandoned Mines in Canada

In Canada, the most recent and extensive analysis of Long Term Stewardship of mines was undertaken by Dick Cowan and John Robertson for the National Orphaned and Abandoned Mines Initiative (NOAMI) in 2010.[125] This valuable study surveyed policy, regulations and laws in all jurisdictions in Canada regarding mine closure and post-closure monitoring and maintenance, and provides a "Policy Framework" that might be followed.

Cowan and Roberson found that most jurisdictions now require closure or "reclamation" plans before mines are permitted, as well as some form of financial security against closure liabilities. The only jurisdiction to specifically address long term care and monitoring in Canada through legislation is Saskatchewan, which has a "Reclaimed Industrial Sites Act". There is little discussion or consideration of catastrophic events or contingency response planning in any jurisdiction's legislation. When it comes to financial assurance, there is no consistent method. Some jurisdictions use Net Present Value and elaborate spreadsheets and models. There is no consistent approach for storing critical maps and other information about the sites. There is a greater focus on Aboriginal consultation than there was a decade ago.

Their recommendations regarding long term care include the following:

- **Mining for closure:** Greater emphasis needs to be placed on post-closure policy, regulations and procedures. A jurisdiction needs a clear policy on mine closure objectives. The spectrum between "good enough" and "highly desirable" is vast and must be able to be assessed against a jurisdiction's policy.
- **Closure Plans:** These must be able to evolve as the site changes and must ensure the site will be safe and chemically and physically stable. Closure plans require investigation and enforcement.
- **Financial Assurance:** Monies put aside by the proponent to guarantee the work set out in the closure plan is an "absolute must". The monies must be enough to complete the work if the proponent can't or won't do it. Periodic review of assurance is necessary. For long-term care and maintenance--risk assessment, time frames and discount rates are major considerations.
- **Post-closure care**: Although the ideal is no post-closure care, there are sites where on-going care and maintenance will be necessary. Clear policy is required about who will pay for it and how, and who will manage it.
- **Relinquishment:** This is the return of the mineral title to the Crown. Jurisdictions require clear policy on how the public will assume this responsibility.

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[125] Dick Cowan and John Robertson, *The Policy Framework in Canada for Mine Closure and Management of Long Term Liabilities: A Guidance Document* (2010), National Orphaned and Abandoned Mines Initiative. www.abandoned-mines.org

- **Institutional Custodianship:** This is essential when sites require on-going supervision. It may range from fencing and registered land use restrictions to water treatment for significant periods of time. It requires authorization by legislation and clear rules around management, record management and funding over time. It involves identification of appropriate land use controls and mapping for public access and planning processes.
- **Consultation:** Consultation with stakeholders throughout a mining project must be required, with the responsibility of the government to undertake this clearly spelled out. Consultation with Aboriginal groups must also be undertaken. Where the system is very complicated, jurisdictions might consider a referee system.
- **Risk and Contingency/Emergency Response**: For sites requiring long-term/perpetual care the potential for environmental failure remains. "A risk assessment process should be employed to identify potential risks and contingency/response plans should be developed".[126]

The Faro Mine

The Faro lead-zinc mine is one of Canada's largest abandoned mine sites. Located in the Yukon, it operated off and on from 1968 to 1998, with four different corporate owners: Cyprus-Anvil, Dome Resources, Curragh Resources and Anvil Range. When it went into receivership and closed for good, the reclamation security was only $14 million, and the company had received over $53 million in subsidies from the federal government[127]. At its peak, the mine had employed up to 900 people--15% of the Yukon's workforce--and produced 40% of the Yukon's annual GDP. An entire town, Faro, was built to house mine workers – but it was decimated when the mine closed. Faro now has less than 400 residents.

The mine is on the lands of the Ross River Dene (part of the Kaska Dene Tribal Council). About 65 km east of the mine complex is the community of Ross River. "Ross River is home to the Ross River Dena, members of the Kaska Nation. The mine complex is located in the traditional territory of the Kaska people and is an area of significant cultural importance. Before the mine was built, the Kaska considered the surrounding area as their 'breadbasket'. Here they fished and hunted for moose, caribou and sheep, collected wild berries and traditional plants and set up trap lines for lynx, mink and other animals. The traditional territory of the Selkirk First Nation is located downstream of the complex, centered on the community of Pelly Crossing.

[126] Cowan and Robertson, Page 50.

[127] Ed Struizik, "A Deep Pit for Tax Dollars", *Edmonton Journal* ,December 21, 2003.

Waters draining from the complex flow into the Pelly River which is utilized by Selkirk First Nation for hunting, fishing and cultural activities."[128]

Huge amounts of mine tailings were dumped in Rose Creek, which flows into the Pelly River. Wildlife, fish, and other subsistence activities have already been seriously disrupted by the mine. There are three open pits at the mine site, with 70 million tonnes of acid-generating tailings and 396 million tonnes of sulphide waste on the site. There is urgency to the containment of these materials, as they have already been oxidizing for 30 years. "[T]he majority of the sulphide materials are yet to be oxidized. With continued exposure of the sulphidic mine rock to air and water and as geochemical conditions continue to evolve, the mass of soluble contaminants stored in the wastes will increase, more of the drainage will become acidic and concentrations of acidity and potentially toxic elements in the seepage will dramatically increase."[129] The ability of the peat below the tailings to neutralize metals is also being depleted.[130] The gravest danger is contamination of ground water and poisoning of the Pelly River system.

Concerns about the Faro Mine pollution issues had been raised for many years by the Yukon Conservation Society and line staff in the government departments, but there was no political will to fund clean-up. In 1999, newly formed MiningWatch Canada, with YCS, began to lobby the federal government to remediate northern abandoned mines like Faro. In 2001, the National Orphaned and Abandoned Mines Initiative (NOAMI) held its first workshop in Winnipeg. In 2002, the Auditor-General`s office released a damning report on abandoned mines under federal jurisdiction in the North. Faro was one of the case studies.

The federal government had created the Contaminated Sites Management Working group in 1995, but neglected to fund it for more than a few staff positions. In 2003, $175 million over two years was allocated to the program. At the end of 2003, the Edmonton Journal published a series of articles on northern abandoned mines written by Ed Struzik, which were syndicated nationally. In 2004, federal government accounting systems were changed to an accrued liability model so that contamination of federally owned sites became a liability on the public accounts. Since investing in site clean-up could then be counted as paying down the federal debt, the government committed $3.5 billion to the Federal Contaminated Sites Action Plan- an interdepartmental program headed by the Ministry of the Environment and Treasury Board.[131] It is this money that made a cleanup of the sites in the Yukon and NWT possible. There has not yet been an agreement to extend the designated funding, which is running out.

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[128] Faro Mine Project Office brochure. "Faro Mine Complex: a Plan for Closure" (2010). http://www.faromine.ca/assets/files/brochure-en.pdf

[129] Faro Mine Project Office, "Anvil Range Complex Independent Panel Report", page viii. http://www.faromine.ca/assets/files/brochure-en.pdf .

[130] Independent Peer Review Panel op cit, page vi.

[131] http://www.federalcontaminated sites.gc.ca/history_historique/index-eng.aspx

During the devolution of federal powers to the Yukon, while the Faro Mine land was transferred to the Territorial Government, contaminated sites such as Faro remained the responsibility of the federal government, although water licences have to be obtained from the Yukon Water Board. The court-appointed interim receiver for the bankruptcy, Deloitte and Touche, was charged with receiving, preserving and protecting the assets of Anvil Range. It oversaw the care and maintenance program for the site until the receivership was wrapped up in early 2009. The Yukon Government now manages the site and has issued a five year contract to Denison Environmental Services to conduct care-and-maintenance activities. Canada pays the bills.

After the mine's closure in 1998, the possibilities of re-opening the mine or re-processing the tailings were considered for a few years, but in 2002, the Project Office began a multi-interest review toward the development and implementation of a final closure plan for the site. From 2003 to 2008, a number of workshops were held with the various groups involved in the site, some to plan the required technical studies. Over 100 technical studies were undertaken to characterize the site and its hazards. Among these studies was a human health and ecological risk assessment undertaken by SENES Consultants Ltd, which concluded that "the current risks and impacts associated with the ARMC [Anvil Range Mining Complex] are low for resident aquatic life, terrestrial wildlife, and humans." [132] However, inside the risk assessment was disturbing data about excessively high levels of lead in berries, beaver, ptarmigan and moose.[133]

In 2004, the federal and territorial governments entered into agreements with Selkirk First Nation and the Ross River Dene Council to work together on a closure plan. The parties established the Faro Mine Closure Project Office in Whitehorse with community offices in Ross River and Faro[134]. The project office reported to an Oversight Committee, made up of representatives from Indian and Northern Affairs Canada (INAC), the Yukon government, Selkirk First Nation and the Kaska Tribal Council (represented by Ross River Dena Council). In early 2007, the Project Office was closed and the Yukon Government took over the overall management role for closure.

In a study of Independent Environmental Oversight, Affolder et al looked at the Faro Oversight Committee and drew these conclusions:

"The title "Oversight Committee" can be misleading. The Faro Mine Oversight Committee ("Oversight Committee") was composed of representatives from the Government of Canada, the Yukon Government, Selkirk First Nation, and the Ross River Dena Council. The Liard First Nation had been included since mid 2008. The committee did not oversee monitoring

[132] Independent Peer Review Panel. *Review of Remediation Alternatives for the Anvil Range Complex.* April 2007.
[133] Tim Querengesser, "Faro`s lead spread far and wide", Yukon News. March 30, 2007. http://yukon-news.com/news/6843
[134] Ellie Marcotte, Kathlene Suza and Stephen Mead. "Faro Mine Closure: A Community Perspective", presentation to NOAMI, October 2006: http://www.abandoned-mines.org/pdfs/presentations/FaroMineClosureFARO.pdf.

or provide any community communication. Rather, the Oversight Committee for the Faro Mine Closure project was put in place to guide the selection of closure alternatives. The affected governments would be deciding in the future what sort of governance would be needed once the remediation is underway. The Oversight Committee did not function as a watchdog agency….

"Despite the lack of independent oversight function, the Oversight Committee provides affected Aboriginal groups a role in the formation of the remediation plan, which was important in the context of Canadian Aboriginal law. In a presentation on the mine clean-up, the opportunity for governments to work directly with Aboriginal groups in developing options was identified as a positive outcome, as this allowed both trust and a sense of joint undertaking to develop which would permit the project clean-up to move ahead." [135]

Funding for the planning and remediation of closure comes from the federal government Federal Contaminated Sites Action Plan, through Indian and Northern Affairs Canada (INAC).

A website, www.faromine.ca, was set up to communicate information about the project.

Ross River Dena Council, Selkirk First Nation, Liard First Nation and the Town of Faro received funding to participate and acquire technical advice from INAC. However, there continue to be considerable challenges for the participating First Nations. Selkirk First Nation representative Ellie Marcotte listed the following issues at a NOAMI workshop in 2006:

- Time frames are different in the communities, and the people have other agendas;
- The complexity of the project makes it difficult to understand and even more difficult to convey to the rest of the community; and
- Asserting the importance of traditional knowledge and getting it respected are on-going issues. [136]

In 2006, a team of independent experts were contracted through Deloitte and Touche to serve as an Independent Peer Review Panel.[137] They were asked to review and comment on the *Example Alternatives Report* which had been prepared by SRK consulting, and to report directly to the Oversight Committee. After the review, a four-day visit to the site, meetings with

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[135] Natasha Affolder, Katy Allen and Sascha Paruk. *Independent Environmental Oversight: A Report for the Giant Mine Remediation Environmental Assessment* (February 2011), pp. 55-57.

[136] http://www.abandoned-mines.org/pdfs/presentations/FaroMineClosureFARO.pdf

[137] The members of the Panel included:

- Dr. Laurie Chan, Professor University of Northern British Columbia
- Dr. Kenneth Froese, Golder Associates Limited
- Dr. Anthony Hodge, P. Eng., Anthony Hodge Consultants Inc.
- Mr. Randy Knapp, P.Eng., SENES Consultants Limited (Retired)
- Mr. Kenneth Raven, P.Eng., P.Geo., Intera Engineering Limited
- Dr. Terry Mudder, CHCM, IPRP Chairman, TIMES Limited
- Dr. Bill Price, Natural Resources Canada
- Dr. Andrew Robertson, P. Eng. Robertson GeoConsultants Inc.
- Dr. Leslie Smith, Professor University of British Columbia

representatives of the First Nations, staff from the FMCPO, the Yukon Government, INAC, SRK, members of the Oversight Committee and intensive discussion, the Panel submitted its report in April 2007. Chapter Five of the report is entitled "Addressing the Long Term Horizon", and is explored in more detail below.

In February 2009, the final remediation decision was chosen. The overall estimated cost of the project is estimated to be more than $700 million over four decades.[138] It involves a "stabilize-in-place approach": upgrading tailings dams, re-sloping waste rock, and installing engineered soil covers on all tailings and waste rock. Collection and treatment systems for water will have to be managed in perpetuity.[139] The $3.5-billion Federal Contaminated Site Action Plan fund will be paying for the cleanup, and the project will only secure the funding once a finished plan is written over the next several years. The government spends $7.2 million a year just to maintain the site.

In July 2008, the care and maintenance contract for Faro was awarded to Denison Environmental Services.[140] Although a draft project closure proposal was prepared in early 2010, the mine closure plan has not yet been submitted to Yukon Environmental and Socio-Economic Assessment Review Board (YESAB). When it is submitted and declared adequate by the Board, the proposal will be available through the YESAA Online Registry.

What the Independent Peer Review Panel said about Understanding the Long Term Context[141]

In thinking about the long–term implications in 2007, the Panel found:

> "Soil covers at the Anvil Range Mine Complex should be planned to function for thousands of years. They are not "walk-away" solutions as ongoing care and proactive maintenance will be required to maintain their design function. If there were a significant degradation in the covers there is the potential for a metal release rate from an accumulated reservoir of secondary mineral precipitates that could exceed that occurring in the absence of a cover placement. There are presently many unknowns and challenges, and the mining industry has limited experience with proactive cover maintenance (e.g., do not wait until the cover leaks and discharge increases to make repairs). Challenges

[138] Chuck Tobin, "Plans for abandoned mine called bitter-sweet" Whitehorse Daily Star, 12 February 2009.
[139] Faro Mine Remediation Project, *Recommended Closure Plan for the Faro Mine Complex*, February 9, 2009. www.faromine.ca/nes/2009/02/recommended_closure-plan_for_t.html
[140] Yukon Government. *New Care and Maintenance Contract Awarded for Faro Mine Complex*, July28, 2008. http://www.gov.yk.ca/news/2008/08-186.htm
[141] The following section is abridged/paraphrased from the Report of the Independent Peer Review Panel, op cit.

include predicting repair costs, difficult in detecting leaks, predicting future settlement of the underlying waste rock and monitoring changes in buried layers within the cover."[142]

They also said "It is inevitable that long term treatment of seepage, groundwater, and open pit waters will be required, possibly as long as 500-1000 years, a situation amounting to "perpetual care". This will be the case regardless of the remediation alternatives implemented at any mine site within the ARMC." This long term understanding had been part of the design from the beginning. All members of the planning team recognized that this would be the case – no practical options for any other solution were identified by any parties, and the IPRP acknowledged and agreed with this.

The Panel went on to say: "Alternatives need to be assessed against the potential future physical and social conditions which they may face. In addition to seismic and hydrologic conditions that are part of standard engineering practice and have been included in analyses to date, the following factors need consideration:

- Variations and instabilities in the nature of society and various institutions including the capacity for knowledge transfer, the availability of needed human resource capacity, and the potential evolution of science and technology.

- Variations in environmental conditions such as gradual geomorphologic change and/or extreme episodic and long term climate change.

- Variations in the management of the closure plan addressing such issues as citizen participation in decision-making."[143]

They strongly recommend a process using *scenario futures* to look at potential risks and opportunities ahead. ``Scenarios evaluation has an added benefit as well. It provides a safe place for varying interests to explore and find common ground when it comes to choosing the preferred alternative.``[144]

The Panel identified the following Key Long Term Management Issues:

• *Ensuring the availability of trained and experienced personnel* for site operation through the full project life cycle, predicted to be several hundred years.
• *Financial surety for site operation, for project regulation and oversight, and for dealing with unforeseen problems*. Financial surety is essential: (1) to avoid continued deterioration of the physical and chemical conditions at the site, which if left unchecked would lead to more severe adverse environmental impacts; (2) to support the implementation of adaptive management which demands a capacity to adjust in a timely manner to avoid significant problems that are

[143] Independent Peer Review Panel, op cit., page 28.
[144] Ibid, page 29.

discovered through the learning process; and (3) to achieve the societal goal of minimizing costs imposed on future generations related to current activities.

• *Surety of transportation systems, power supply, supplies of needed materials and services.*

• *Contingencies for addressing fire and other potentially traumatic events.*

• *Clarification of the role of various interests in closure plan implementation.*

The Panel also briefly discussed Adaptive Management for the long-term: "a formal process...with an explicit objective of continuous learning and improvement... If effectively applied, such an approach can lead to reduced costs. However, if rationalized simply on the basis of reducing costs and not on the basis of applying best judgment and consciously and carefully putting in place the system and support resources to apply results learned from experience over time, its use will undermine rather than reinforce public trust....A fully developed adaptive management plan (AMP) for the overall ARMC remediation will be required addressing the technical, environmental and human implications over the long term. A general outline of the adaptive management approach for each alternative should be included as part of the assessment process."

Their Long Term strategy makes reference to First Nations interests. "The traditional values of First Nations people regarding the ecosystem need to be respected. Even though First Nations are undergoing rapid social and economic change, a profound relationship to the land is maintained and is reflected in the maintenance of many traditional activities and spiritual practices. This connection to the land needs to be captured through a conscious effort to restore the spirit of place even though the physical and biological features may be different than they were pre-mining[145]

[145] Ibid, page 30.

Case Study Seven: Port Radium– The Sahtu Dene of Délı̨nę

Peter van Wyck writes about the effect of discovering, years after the fact, that one's homeland has been contaminated: *"It is as though our senses, our very own perception, had been expropriated, rendered useless and vestigial in the face of threats that cannot be seen, heard, smelled, tasted, or touched. The appeal to the eyewitness comes to have little value here. There is nothing there, nothing to be seen, leaving us dependent on others (often the same others, that is the institutions that produced the threats) to determine the appropriate means (instrumentation) with which to represent it back to us and for us…what is dangerous and what is safe, what dosage is hazardous and what is not, such thresholds and limits obscure the fact that they are foremost creatures of politics and not the test tube, objects of persuasion, not measurement."*[146]

Summary

More than fifty years after their exposure to radionuclides and other toxins, the Sahtu Dene of Délı̨nę discovered what had been done to them by the radium and uranium mine. The traumatic effects of this knowledge and the need to deal with the contaminants through clean up and long term stewardship led the community to embark on a number of healing initiatives. This case study looks at the Canada-Délı̨nę Uranium Table, a collaboration between the Sahtu Dene of Délı̨nę and Indian and Northern Affairs (representing the federal government).

Key points:

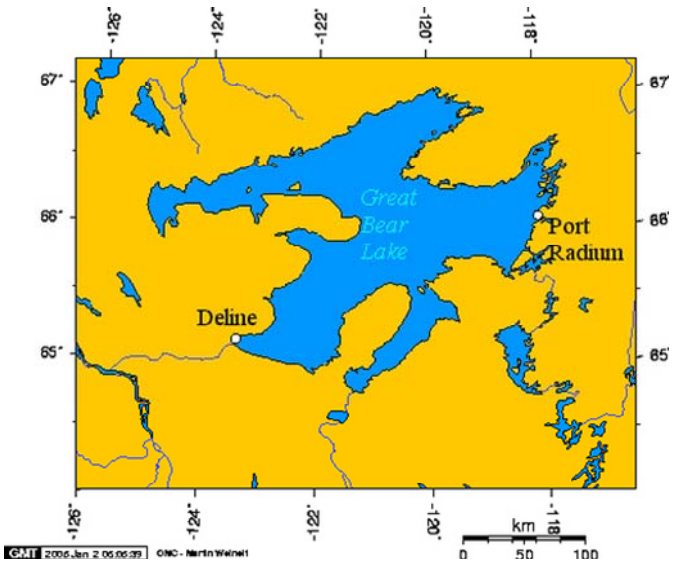
- This case study highlights a relationship between the federal government and the Déline First Nation over the remediation of the Port Radium mine and mill tailings on Great Bear Lake.

- Since radiation cannot be seen or tasted by our unassisted senses, communities become reliant on science (like Geiger counters) to reveal contamination. Often this technology is controlled by the very professions and institutions that created the problem in the first place.

[146] Peter Van Wyck, "Signs of Danger: Waste,Trauma and Nuclear Threat", *Theory out of Bounds* (Volume 26, 2005), pages 82-3.

Port Radium

en.wikipedia.org



Port Radium
Pitchblende concentrate for shipment

pwnhc.learnnet.nt.ca

- Almost sixty years after their exposure to radiation began, the Sahtu Dene of Délı̨nę learned of the dangerous substances to which they had been exposed. While they were familiar with prophecies warning of the dangers, and had traditionally used a sense of smell to protect themselves from uranium, both had gone unheeded. This was traumatic in its effect on the Dene.

- Only after intense national and international advocacy by the affected community was there a response to their appeals for help. Official reports of the events omit any reference to the prior advocacy role the community played in making the clean-up and containment possible.

- Access to official archival records about Port Radium was denied by Library and Archives Canada until 2006 (when the Accountability Act was passed).

- The refusal by "white" Canada to take responsibility for what happened was "a very Canadian exercise in forgetting".[147]

- The Canada Délı̨nę Uranium Table was formed by the federal government and the Dene to plan the clean-up and containment of the Port Radium site, to supervise health and environmental studies and long-term monitoring and to look at healing and compensation for the community. The outcomes of the process were mixed. Remediation and monitoring have been undertaken. The health studies found that there was inadequate information to link community cancers to the mine, and – on that basis-- determined that the link did not exist. The healing process did help the community deal with what had happened to them, but no compensation or apology was forthcoming from the federal government.

- Cultural memory is essential to remembering the places of danger and for the long term stewardship of the buried mine wastes. The healing workshops, the Déline Knowledge Program, work to protect the watershed, the establishment of protected areas and cultural renewal programs will be significant contributors to this process over time.

[147] Peter Van Wyck, *The Highway of the Atom* (McGill-Queen's University Press, 2010), page 11.

The Early Warnings

George Blondin (1990) recorded an ancient story prophesying the grim legacy of Port Radium, which the Dene called Soḭbak'ə (literally "The Money Place"):

> *"In the old days, the Sahtu Dene used to travel across the lake towards the Barrenlands every summer, to hunt caribou. Some of these Dene hunters were paddling near the shore on the east side of Sahtu (where Port Radium is today) and they came to a place where rocky cliffs rise high over the water. Like all Dene, they believed it was bad medicine to pass in front of this rock: it was said that loud noises came from within it. These particular hunters pulled their canoes out of the water, but decided not to portage.... instead they camped near the cliff. During the night everybody was awakened by the singing of the medicine man... In the morning, when the medicine man stopped singing the people at last spoke to him..."Why did you sing all night...?". "I foresaw many things and I was disturbed," replied the medicine man... The medicine man told them of his strange vision. "I saw people going into a big hole in the ground –strange people, not Dene. Their skin was white... [and] they were going into a hole with all kinds of ... tools and machines... On the surface where they lived, there were strange houses with smoke coming out of them... I saw ... big boats with smoke coming out of them, going back and forth on the river. And I saw a flying bird -a big one. They were loading it with things...". "I watched them and finally saw what they were making with whatever they were digging out of the hole -it was something long, like a stick. I wanted to know what it was for -I saw what harm it would do when the big bird dropped this thing on people -they all died from this long stick, which burned everyone... But it isn't for now; it's a long time in the future. It will come after we are all dead".*[148]

There was another prophecy recounted by Andrew Nikiforuk in 1998 :

> "……*In immaculate white-walled bungalows, the elders nod at a stark photograph of a bearded figure and say in hushed and saddened tones, "Yes, Grandfather told us. Until his death in 1940, Louis Ayah, one of the North's great aboriginal seers, repeatedly warned his people that the waters in Great Bear Lake would turn a foul yellow. According to "Grandfather," the yellow poison would flow toward the village, recalls Madelaine Bayha, one of a dozen scarfed and skirted "uranium widows" in the village. The prophet spoke*

[148] George Blondin, quoted in Canada-Déline Uranium Table, *Action Plan To Address Concerns Raised By The Community Of Déline About Risks To Human And Environmental Health From Exposure To Radiation And Heavy Metals From The Former Port Radium Mine* (Great Bear Lake (NWT): December 2002), 2nd Edition, p. iv. Prepared For The Déline Band Chief And Council and the Minister Of DIAND.

> *about that poison. He said that there would be sickness and that people would go through hard times and that there would be deaths," says Bayha, 82. Her husband, Joseph, worked for years at the uranium mine and died as many white miners did: coughing himself to death…"*[149]

There are stories from Elliot Lake (Ontario) and from Denendeh (land of the Dene) that indicate that the people were able to smell pitchblende/ uranium ore. In Lorriane Rekman's book about Elliot Lake, [150] she writes: "It was said that Anishnabe people could actually smell the veins of uranium underground. They said it stunk, smelt bad and would not live on the ground above the veins. They scouted with geologists to help locate sites for mine development."

Hugh Spence reported that northern Dene could also smell the mineral: "This particular find [at Great Bear Lake] is said to have occurred through the agency of smell. Tradition states that Indians, who had been accustomed to camp at Labine Point long before it was named, claimed to have noticed a particular smell. They reported they had noticed a similar spot at Beaverlodge Lake, and offered to show a prospector the place…When the snow was cleared, there was a vein of pitchblende." [151]

The Mine

The radium and uranium mining industry began in Canada in 1930 with the discovery of the Port Radium deposit in the Northwest Territories, when a Dene man named Beyonnie found the black rock east of Great Bear Lake. Beyonnie gave the rock to a white trapper, who rewarded him with bags of flour, baking powder and lard.[152]

Eldorado started off as a radium mine in 1932, extracting radium from pitchblende. Radium ores were highly valued at the time; the price of radium salts was US$70,000 per gram. The first concentration plant was erected at the site in 1933, with a radium refinery built at Port Hope, Ontario. Concentrates were shipped by barge and air plane to Fort McMurray, Alberta, then by train to Port Hope. The mine was secretly expropriated by the Canadian government in 1943-44, to provide material for the Manhattan project, where the bombs were manufactured to

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[149] Andrew Nikiforuk, "Echoes of the Atomic Age: Cancer Kills Fourteen Dene Workers", Calgary Herald, March 14, 1998. http://www.ccnr.org/deline_deaths.html

[150] Lorraine Rekmans, *This is my Homeland: Stories of the effects of nuclear industries by the people of Serpent River First Nation and the north shore of Lake Huron* (Serpent River First Nation, 2003), page xiv.

[151] Hugh S. Spence, "Radium Discoveries in Northwest Canada" pages 8-13, quoted in Peter Van Wyck (2010), p. 114.,

[152] Paul Baton, testimony before the House of Commons committee on Environment and Sustainable Development, June 11, 1998: http://www2.parl.gc.ca/HousePublications/Publication.aspx?DocId=1038878&Language=E&Mode=1&Parl=36&Ses=1

drop on Hiroshima and Nagasaki.[153] Uranium mining at Port Radium ceased in 1962, and then the mine reopened in the late 1960s and operated as a silver mine until 1982. In all, about 7,000 tons of radioactive material was shipped from the mine at Port Radium. Canadian documents reveal that another 1.7 million tons of uranium waste was either left exposed at the mine site or simply dumped into Great Bear Lake.

While the mine operated, Déline Dene men were hired for unskilled labour around the mine site and to carry sacks of ore to barges and over portages for $3 a day. Recounting 12-hour days of grinding work, 84-year-old Dene former ore carrier Paul Baton said, "The dust coated you like flour, it covered our clothes, our heads, our hands. We would sleep on the sacks. No one told us anything about it being dangerous. No one told us about cancer."[154]

Although white miners at Eldorado mine wore protective clothing and were required to shower off the uranium dust after every shift, Dene labourers, referred to as "coolies," did not have the same privilege. Neither the white workers nor the Dene were told of the dangers.

Cindy Kenny Gilday told a Parliamentary Committee in 1998: “it was not just the men who came into contact with the radioactive dust…This is a tribe that takes the family wherever they go. In the '70s, the men began to die of all kinds of cancers. It was the first time the people of Great Bear Lake ever heard of cancer…We now have a village of widows…Dene in the village no longer have grandfathers to pass down the spiritual practices, nor uncles to slap their wrists when they do something wrong. Now, Dene fear that their fish, caribou and moose at Great Bear Lake are contaminated by radioactive waste and tailings." [155] Said one community member: “The Geiger counter just went off scale where the caribou migrate."[156]

The Dene started raising questions in the 1970s when the men started to die, but written documentation of their fears doesn’t start until 1982. In 1989, a motion was passed at a Dene leadership meeting to engage the Minister of Health to “investigate the circumstances of the old Port Radium Mine”.[157]

As Van Wyck says, “An imperceptible tide of suspicion washed over the past. In a stroke lives lived around the mine, on the river, the portage, and the lake, were transformed into

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[153] http://en.wikipedia.org/wiki/Eldorado_Mine

[154] Paul Baton, Op cit.

[155] C. Kenny-Gilday, testimony before the House of Commons committee on Environment and Sustainable Development, June 11, 1998: http://www2.parl.gc.ca/HousePublications/Publication.aspx?DocId=1038878&Language=E&Mode=1&Parl=36&Ses=1

[156] Brenda Norrell, Indian Country Today, June 18, 1999: http://www.indiancountry.com/B3.html

[157] Van Wyck (2010), page 40.

something quite different…Domestic life, the very intimacy of the home..was also and retroactively contaminated….In this way, the past, their past, was itself rendered toxic by a virtue of a radioactive catastrophe of knowledge."[158]

In 1997, the people took their questions and a couple of government studies they had found to Cindy Kenny-Gilday, a community member who knew her way around the outside world. She was appalled. And she started organizing. The community formed the Dɬįnę Uranium Committee, and Kenny-Gilday "started running around Canada"[159] trying to get support, information and analysis. Lawyers Andrew Orkin and Murray Klippenstein volunteered their help as did a number of academics and medical doctors.

In 1997-8, environmental reporter Andrew Nikiforuk[160] went through recently declassified documents on the nuclear industry in the United States and came to the conclusion that federal officials on both sides of the border were aware of the health risks involved in uranium mining, yet did not warn the workers. He revealed these findings in a series of articles in the Calgary Herald:

> "…In 1945, a federal research team from Montreal sent to monitor radon in the mine found conditions at Port Radium appalling. They reported that "the radon content seems to be so high as to be definitely dangerous to the health of those working in the mines… …Despite the installation of some fans in 1946, concerns about protection for miners at Great Bear Lake even became the subject of several 1949 memos at the U.S. Atomic Energy Commission, which at that time bought all the mine's ore. This information was so confidential that one memo said: "It should not be quoted in any published report." ….A 1991 government survey found the Déline people were twice a sick as any other Aboriginal community in the country. Yet no government study was commissioned to find out why. "[161]

The Dɬįnę Uranium Committee wrote a 106 page report documenting their story, entitled: "They Never Told Us These Things". In March 1998, they held a community meeting to share what they had found out and to approve an Action Plan. The news release from the meeting stated: "We the Dene have been subjected to over 60 years of horrible injustice because of apparent national interests. Our people have paid for this with our lives and the health of our community, lands and waters. We have set out a 'Plan for Essential Response and Redress"."[162]

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[158] Van Wyck (2010) page 49.
[159] Ibid.
[160] Nikiforuk, op cit.
[161] Ibid.
[162] Déline Dene Band Council, "Dene of Great Bear Lake call for Federal Response to Radiation Deaths at Great Bear Lake", News release March 23, 1998.

The media were engaged. Peter Blow produced a documentary called "the Village of Widows". Journalists from the CBC undertook an investigative report. MacLean's, the Toronto Star and other outlets took up the story.

By June 1998, the Délı̨nę Dene had a meeting in Ottawa with three cabinet ministers and an appearance before a sympathetic Parliamentary Committee on Environment and Sustainable Development. They presented their 14 point Action Plan. The plan asked for immediate crisis assistance, environmental and social assistance, full public disclosure of government actions, cleanup of Great Bear Lake and the surrounding area, acknowledgment that the government was responsible for the situation and funding and assistance for community healing and cultural regeneration.

The Dene of Great Bear Lake had never been told that they were transporting a secret weapon - uranium - which the United States would use to produce the first atomic bomb. Appealing for world peace, Dene elders visited Hiroshima in August, 1998 - the 53rd anniversary of the atomic attack - and expressed their sorrow. They said the Dene were a peaceful people and would never have been involved in production of a weapon of mass destruction, had they been told.

The Délı̨nę-Canada Uranium Table[163]

The Déline Uranium Committee June 1998 meetings in Ottawa led to the preparation of three draft papers by the federal Department of Indian Affairs and Northern Development in consultation with the Délı̨nę Dene. The purpose of the papers was to

- produce terms of reference for structuring a Déline/Canada Committee;
- collectively identify the types of health and environmental assessments required to address the community's concerns; and
- engage a fact-finder(s) to establish a common understanding on the factual information relating to Déline's concerns.

The process then stalled for nearly one year until August 1999, while the Déline First Nation passed a Band Council Resolution which highlighted the three main areas of concern to the community:

- clean-up and containment of the Port Radium site;
- health and environmental studies and long-term monitoring; and
- compensation.

[163] The following quotes extensively (and selectively) from the CDUT Action Plan.

In October 1999, the Canada Délı̨nę Uranium Table (CDUT) was formed by Canada's Department of Indian Affairs and Northern Development (DIAND) and Déline. The DIAND representatives were part of the Déline/Port Radium Interdepartmental Committee composed of representatives from DIAND, Health Canada, Natural Resources Canada and the Government of the Northwest Territories--Health and Social Services.

Over $6 million was set aside by DIAND for this consultation process.[164] This money was in addition to on-going remediation costs and regulatory costs.

In March 2000, CDUT held the first full meeting in Déline, and a series of workshops were organized. They were:

- *Traditional Knowledge* – With this two-day workshop the CDUT members were able to develop an appreciation for the need to proceed with studies that would consider both scientific and traditional knowledge.
- *Fundamentals of Radiation* – Since radiation exposure and cancer are two of the main concerns of the community of Déline, this day long workshop taught the CDUT the basics of different sources and forms of radiation exposure and related some of this information to the possibility of developing various cancers.
- *Environmental and Health Risk Assessment and Communication* –The workshop provided a comprehensive overview of environmental and health risk assessment, including definitions, principles and methods, as well as risk communication issues.

In October 2000, the CDUT hosted an Experts and Community Workshop in Délı̨nę. The major goal of the workshop was to provide a framework for an Action Plan that would guide the CDUT in addressing human and environmental health and related community issues in Délı̨nę. Ten scientific experts[165] were selected by the CDUT, and invited to the workshop to address questions and issues about Port Radium.

The workshop started with an opening ceremony and introductions. For the first two days, expert panel members gave presentations on how each of their areas of expertise can contribute to address the community's concerns. The Délı̨nę community members were invited

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[164] Canada-Déline Uranium Table. Op cit, page iv.

[165] The experts were:
Dr. Ronald Brecher - Risk Assessment/Management
Ms. Cindy Jardine -Risk Communication
Mr. Randy Knapp- Mine Site Remediation (Uranium/Heavy Metals)
Dr. Victor Clulow- Environmental Fate & Pathways Analysis of Radionuclides & Metals
Dr. Colin Macdonald - Wildlife and Aquatic Health
Dr. Rafik Gardee -General Human Health
Dr. John Mclaughlin -Epidemiology
Dr. Doug Chambers- Health Physics
Dr. Raul Urtasun -Oncology
Dr. Peter Usher -Use of Traditional Knowledge in Environmental and Health Studies

to ask questions as well as to share their concerns and experiences. During the third day, the experts met to discuss priority studies and make recommendations.

It was decided that the recommended overall objectives of the studies would be:

1. to test whether the health of the Délı̨nę people is being or will be affected by contamination from the Port Radium site;

2. to verify that the fish, plants and animals in the Port Radium area have levels of chemical and radioactive elements that are safe to eat and that animals are not harmed by exposure to these potential contaminants;

3. to provide information about the mine site to enable the CDUT to do what is necessary to stop the release of contaminants from the Port Radium mine site in the long-term;

4. to provide the healing that has long been sought by the widows of ore carriers, elders and families directly affected during the period that they lived at Port Radium.[166]

From the studies the CDUT developed an Action Plan to address the following questions:

- What should be done about the mine site with regard to clean-up and containment?
- What should be done about licensing and ongoing monitoring of the mine site?
- What steps need to be taken for ongoing health care for individuals?
- How do we go forward with questions about historical exposure?

The workshop report stated (in part): “The community of Délı̨nę is severely affected by the issues addressed during the workshop. Not only is the presence of the Port Radium mine in their traditional territory a threat to them, but their past experiences as mine workers, ore carriers or families living near or at the mine site had important repercussions on the entire community. The concerns are particularly related to human health but also to the health of their environment. The Dene rely strongly on their environment for their survival and their connection with the land is strongly reflected in their language and spiritual culture: "*If the land, the water, the fish, the caribou are healthy, us Dene people will be healthy*". The Great Bear Lake area is the larder of the Dene peoples to whom traditional food is essential. "*The environment is worth a lot of money for us*" says Charlie Neyelle, the spiritual leader of the community. "*We have to find solutions to heal the soul, the mind, the land and the wildlife*".

One of the most critical issues appeared to be the reestablishment of trust between the Délı̨nę Dene and the government of Canada. Even though an official promise to 'heal the land'

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[166] Canada-Déline Uranium Table. Action Plan To Address Concerns Raised By The Community Of Déline About Risks To Human And Environmental Health From Exposure To Radiation And Heavy Metals From The Former Port Radium Mine, Great Bear Lake (NWT). Prepared For The Déline Band Chief And Council and the Minister Of DIAND. 2nd Edition, December 2002

was made, the community remained sceptical. More than twenty years after the mine closure, little activity was deployed to address their concerns and several questions were still unanswered. "The need for an acknowledgement of the problem and an official apology from the government was raised by several members of the Dene community and appears to be a potential significant contributor to their healing process."

At the end of the workshop, the scientists acknowledged that there were still a lot of troublesome issues about what happened in the past and questions about health and the environment. The concerns were separated into five main issues, addressing different time periods:

1. Effects on ore carriers (past);
2. Effects on people who lived at or near the mine site (past);
3. Effects on Déline residents (present and future);
4. Safety of the environment (present and future); and
5. Mine site clean-up and containment (future).

The other area that was addressed was healing. It was agreed that

" A program of bereavement and grief counselling, as well as professional psychological counselling, should be instituted in Déline to address the obvious psychological and emotional distress and suffering being endured by widows and other people affected by cancer deaths. Such a program should be run in conjunction with a series of workshops and retreats conducted by Déline's Traditional Healer, Charlie Neyelle (with the possible assistance of outside organizations). It is important to adopt a holistic approach to healing and to promote psychological well-being throughout the community."

Almost $500,000 was budgeted for the healing process, including a counsellor for three years, three community workshops and three retreats, which were later called "Healing Journeys".

The Fact-finder

The CDUT chose Intertec Management Limited as the fact-finder mandated to look at the archival record.

However, there were serious problems with access to information during the inquiry. Van Wyck describes the problems. The 34 metre long archive had been stored at Library and Archives Canada (LAC) in Ottawa. Because Eldorado was once a Crown Corporation, the collection was deemed to be subject to the *Access to Information Act.* This means that every document had to be separately requested and screened to see if it could be released. Understaffing meant that it was exceedingly slow. However, Eldorado had been privatized as Cameco in 1995. During the period of the CDUT investigation, Cameco was assumed to be the donor of the Eldorado papers, and was therefore considered to be the "owner" of the archive,

with the right to deny access to the collection. "In 2004, the "donor" pulled the plug on the entire collection; its formal status became 'closed". No access without permission and no permission would be granted." [167]

The fact-finder's request for access was formally denied. The company history was now limited to two corporate biographies written by Robert Bothwell under contract to the Eldorado and then to AECL.

As Van Wyck writes: "To read the final report of the CDUT "is to remark how little the authors were able to discover about the mine and its operation. Even after engaging a fact-finding consultant, so little was known to them. And yet the report is cloaked in a language of adequacy….the poverty of the facts become the facts nonetheless."[168]

The second problem was that the lead fact-finder, Walter Keyes of Intertec Management was "vocally pro-nuclear and anti-regulatory, a former deputy minister in the pro-uranium Saskatchewan government (with Indian and Native Affairs and Northern Affairs) and an active member of the lobby group the Canadian Nuclear Association, and the editor of a pro-nuclear press."[169] What kind of objectivity could he possibly bring to this work?

A third problem, and perhaps the most serious, was the enormous disconnect between the oral history of the community and the Intertec findings. The oral history volume from the CDUT, released in 2005, was entitled "If Only We Had Known: The History of Port Radium as told by the Sahtuot'ine." It carried the memories and stories from the ore carriers and their families.

Van Wyck describes the CDUT final report as " A tragic piece of work that chronicles the disappointments suffered upon a community. Its main reported finding was that there was insufficient evidence to link the Dene's work for the mining company, Eldorado, to the cancers in the community. Sorry."[170]

What the Final Report said about health[171] is abridged below:

- No employment records were available for Délı̨nę Dene people involved with ore transport or other activities to support the mine at Port Radium. Information about working conditions and employment histories was largely gathered from oral histories.
- No Délı̨nę Dene people were ever directly employed by Eldorado at the Port Radium mine or mill.

[167] Van Wyck (2010), pages 9-10.
[168] Ibid, page 185.
[169] Ibid, page 186-87.
[170] Van Wyck (2010), page 183.
[171] Abridged/paraphrased from CDUT final report unless otherwise noted.

- Oral histories contain many testimonies of exposure to "yellow powder". This was originally assumed to be uranium concentrate (yellowcake), but further research indicated that it was most likely sulphur powder, which was shipped to the mine site from 1950-1960 for use in the acid leach plant. Yellowcake was produced at the Port Radium site from 1958-60 only, and was shipped out by air in metal drums. This finding had implications for the dose reconstruction and epidemiology projects because it means that Délı̨nę Dene people were exposed to sulphur powder, not yellowcake.
- There is no evidence that Dene people were treated differently than non-Dene with respect to occupational health and safety standards.
- There is no evidence that Dene or non-Dene transportation route workers were informed about the potential hazards of the products they were handling.
- During the uranium mining period, knowledge of radiation health effects, particularly with respect to low-level exposure and long-term effects, was not very advanced and as a result Canadian and international radiation protection standards were much lower than they are today.
- During this period, health and safety standards were implemented for certain occupations that involved radiation exposure, particularly radium refining (c.1930) and radium/ uranium mining and milling (c.1950). Also, uranium ore became subject to federal regulations governing the safe transport of radioactive materials in 1946. However, at that time, none of these standards or regulations was applicable to workers involved in the transport of uranium ore.
- The Port Radium uranium mine was generally in compliance with regulations relevant to the mining and milling of uranium.
- Early theories about the health effects of radiation exposure focused on short-term, acute effects. A major advancement in the understanding of long-term radiation health effects occurred around the time of the closure of the Port Radium uranium mine in 1960.
- A key finding of the community health profile was that the overall cancer rates for Délı̨nę are not statistically significantly different from the Northwest Territories (NWT). However researchers acknowledged that cancer statistics should be interpreted cautiously because of gaps in the NWT cancer registry prior to 1990 and the small populations in both Délı̨nę and the NWT.
- Community-based health studies demonstrated that fear and anxiety about the human health and environmental impacts of Port Radium have severely affected the community of Délı̨nę. Analysis of collected oral histories showed that the majority of significant past and present health problems within the community continue to be strongly associated with perceived environmental threats. The perceptual link between exposure to mining activities and illness and death has affected people's sense of harmony with nature, which is a crucial component of their cultural identity.

The Health Study concluded that "It is not possible to know for certain if the illness or death of any individual ore carrier was directly caused by radiation exposure, due to the small number of predicted excess cancers and the presence of other risk factors. The risk of radiation-related cancer to family members is small compared to the increased risk to ore carriers, and for both groups the risk of radiation-related cancers is not much greater than "normal" cancer risk."

The Remediation[172]

By the end of February, 2003, 60 years after the Dene had been unknowingly exposed to the radioactivity, the community of Délı̨nę signed a three-year $6.7 million agreement for the remediation Action Plan including the clean-up, monitoring requirements and future community health needs.[173]

On September 6, 2005, Délı̨nę community members were given the findings of the five-year effort to examine the health and environmental impacts of the government-owned radium and uranium mine that operated at Port Radium from 1931 to 1960. The studies showed that the mine had an impact on water quality at the site and in the immediate vicinity of Great Bear Lake. Elevated metal levels were found in soil at the site. But the report said studies showed the water and fish in Great Bear Lake were safe for people to consume. The report called for the immediate sealing of mine openings, safely disposing of equipment and demolishing structures on the site, dealing with exposed tailings, which was refuse from ore processing, and continuing environmental monitoring.[174]

In January 2007, a further $6.8 million contract for remediation work at the former Port Radium mine was awarded by the federal Department of Public Works and Government Services to Aboriginal Engineering of Yellowknife. Remediation work would involve demolition of the standing structures, cleaning and stabilizing waste material on site and sealing mine openings. The remediation stage of the project was to completed by the fall of 2007.[175]

There are a number of other abandoned mine properties in the Great Bear Lake watershed, including Silver Bear, Contact Lake, El Bonanza, Bonanza and Sawmill Bay (a former trans-shipment point). These properties have also been undergoing assessment and remediation began in 2010. All will require long term care and maintenance.[176]

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[172] CDUT Final Report.
[173] "Agreement reached on assessment of impacts from Port Radium mine tailings", Northern News Services, March 10, 2003.
[174] CDUT Final Report.
[175] "Contract awarded for remediation work at former Port Radium mine", Northern News Services, Jan. 8, 2007, http://www.wise-uranium.org/udcdn.html#PORTRADIUM
[176] Abridged from http://www.ainc-inac.gc.ca/ai/scr/nt/cnt/cln/csr/stu/sb/index-eng.asp

Long term monitoring was seen as a very important commitment in the Port Radium Remediation Plan. During the first four years of monitoring, inspectors travelled to the site twice a year to make sure that the site remained in a stable condition, and that the remediation solutions were working. As well, water was to be sampled at the site once a year.

In year four of the monitoring program (2012), inspectors and researchers will do a more detailed study of the site. They will look at the health of fish in the Great Bear Lake area around Port Radium, as well as the plants and the soil. They will examine sediments in Great Bear Lake close to the site. Finally, researchers will do a complete gamma survey of the entire Port Radium Site, to make sure that the radiation covers are working the way they are supposed to.

Depending on the results of the study, the monitoring plan will change. If the results of the monitoring program show that site conditions are stable, then inspectors will continue to monitor the site once every two years, to look at the water quality, the conditions of the site, and to study the health of the fish, and what the fish eat, in the area around Port Radium. Traditional foods will also be examined every five years to make sure they remain safe to eat.

In addition, the site is covered by a Waste Nuclear Substance License, from the CNSC, and is being monitored by them forever. INAC must file reports every year with the Commission. Signs will remain posted at the site to let people know that access is restricted. Community members have been told of the site restrictions, as have others, such as industry and exploration companies operating in the area.[177]

Rebuilding the Community

The CDUT Report said that

" *Healing activities* that focused on the affirmation of Dene culture and identity (e.g. traditional activities, healing journeys) were very successful. These healing strategies had the greatest influence on the Délı̨nę community and helped people to begin regaining collective feelings of confidence and optimism. Healing journeys on the land were particularly effective in beginning to restore people's security in their environment and fostering social cohesion. "For many years, the people of Délı̨nę did not receive appropriate information about the potential risks of their exposure to mine-related contaminants, which compounded the anxiety experienced by community members. The mistrust of government officials and scientists that developed over the years was expressed many times during healing activities and public meetings. The desire for public recognition from the federal government for the contribution of Délı̨nę Dene people to the Port Radium mine, and the legacy that this involvement has had on the community, has been

[177] http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/prrr09-eng.asp.

strongly expressed by community members. It appears that this would be a potentially significant contributor to the healing process."

This process has been continued by the Délı̨nę First Nation through a number of initiatives. It is hoped that these programs will strengthen and affirm their traditional culture, and build the will and abilities of youth to act as guardians for the future. "Running through all the research projects is the question of how traditional knowledge can inform policy and programs in the context of change. The challenge is embodied in the Dene language phrase that translates, "the words of our ancestors are our path to the future."[178]

Gúlú Agot'i T'á Kə Gotsúhʔa Gha: the Délı̨nę Knowledge Project.

Délı̨nę has been working toward the establishment of a permanent research facility in the community to promote and manage scientific and TK research conducted in Délı̨nę and surrounding districts - Délı̨nę Náoweré Dáhk'ə̀, the Délı̨nę Knowledge Centre. [179]The CDUT recommended that the DKC initiative should be considered and supported in planning follow-up activities to the Final Report (e.g. site remediation and long-term monitoring, community healing programs).[180]

In 2001, the community of Délı̨nę began a process of partnership-building with the academic community (particularly the Native Studies Program at the University of Manitoba) and strategic planning toward development of the Knowledge Centre. "The vision was for the centre to serve as a gathering of new and old knowledge to benefit everyone and shape the future. The mission was to respectfully understand, preserve, and share knowledge of the Dene environment to benefit all people past, present and future. Although the dream of establishing the Centre as a building has not yet been realized, the Délı̨nę Knowledge Project has been working since 2006 on a variety of research activities in culture, language, health and the environment. The focus has been on the role of storytelling as a vehicle for knowledge sharing and decision-making.[181]

The website www.sahtugotinegodi.ca/ shares a number of these stories in the language. Funding for the project initially came through a four year project from the Social Sciences and

[178] http://ngprc.circumpolarhealth.org/abstracts/

[179] Bayha, D., Bayha, W., Betsidea, I., Kenny, D., Mackeinzo, E., Modeste, J., and Tutcho, M. 2004. "The Déline Knowledge Centre: From vision to reality" International Journal of Circumpolar Health 63, 1: 102-104. http://ijch.oulu.fi/issues/631/631_indigenous_health.pdf.

[180] Report into former Port Radium uranium mine recommends immediate remediation .Canadian Press. Sept 6, 2005

[181] http://ngprc.circumpolarhealth.org/abstracts/

Humanities Research Council (SSHRC), but is currently patched together from different sources from year to year.

The Saoyú and ehdacho Peninsulas Historic Site.

The Saoyú and ehdacho peninsulas on western Great Bear Lake - around the size of Prince Edward Island - were designated a national historic site in April 2009, handing over title of the 5,565-square-km of land over to Parks Canada for permanent protection. The Délı̨nę community has a co-management plan for the peninsulas with Parks Canada. Part of the management agreement enables healing camps and youth camps on the land. The federal government will provide $8.75 million over 10 years to fund the development and operation of the Saoyú and ehdacho. It was the first large scale cultural landscape to be designated a national historic site in Canada. [182]

The Watershed Management Plan

In 2005, the Délı̨nę First Nation approved a Watershed Management Plan for Great Bear Lake – Sahtu in their language. The watershed plan is a key component of the healing and long term stewardship of the watershed. Following are some key comments from the Plan:

"The preparation of this Management Plan was directed by the Great Bear Lake Working Group - an *ad hoc* coalition of different organizations, regional management boards and agencies constituted in 2002....

"The elders of Délı̨nę have passed down a story through many generations. In times past, their spiritual teachers were often "mystically tied" to different parts of the environment: some to the caribou, some the wolf, some the northern lights and some the willow. Kayé Daoyé was one such person. He lived all around GBL or "Sahtu" in the Slavey language, but made his home primarily in Edaiila (the Caribou Point area), on the northeast shores of the Lake (Map 1). Kayé Daoyé was mystically tied to the loche. One day, after setting four hooks, he found one of them missing. This disturbed him — in those days hooks were rare and very valuable — and that night he traveled in his dreams with the loche in search of the fish that had taken his hook.

"As he traveled through the centre of Great Bear Lake, he became aware of a great power in the lake — the heart of the lake or the "water heart". Contemplating this heart, he became aware that it is connected to all beings — the land, the sky, plants, other creatures, people — and that it helps sustain the entire watershed of Great Bear Lake.

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[182] Mathisen, Herb. How Délı̨nę looks after its ancestors. Northern News Services. April 20, 2009 http://www.nnsl.com/frames/newspapers/2009-04/apr20_09de.html

"The elders of stress that the interconnectedness of all things includes all people — Dene and non-Dene alike. From this "universal law" of the interconnectedness of things flows the responsibility of people to care for the world in which we live. The water heart sustains the watershed of Great Bear Lake, and we in turn have a responsibility to sustain it. We do this by treating it and other beings with the utmost respect.

"Délı̨nę ̨'s elders also remind us that, in times past, laws have often been imposed upon the Dene, with little or no consultation, by the federal and territorial governments. Their exclusion from decision-making has created an unhealthy relationship between the Dene and other Canadians, as represented by the Crown. The elders want to change that relationship. They see the cooperative development of the GBL Management Plan — and its incorporation into the Sahtu Land Use Plan — as an opportunity for all three natural levels of government — Délı̨nę ̨, the Northwest Territories and Canada — to work together in the development of one law for the good of all.

'The elders ... see the Management Plan/Sahtu Land Use Plan as an opportunity to bring Dene traditional laws and values into the system of laws by which we govern ourselves. [183]

[183] Great Bear Lake Working Group, *"The Water Heart": A Management Plan For Great Bear Lake And Its Watershed*, May 31, 2005 With Caveat of February 7, 2006. Accessed At http://www.sahtulanduseplan.org/website/web-content/maps/water_heart/31.05.05_gblmgmtplanca.pdf

Case Study Eight: Managing Nuclear Wastes: Deep Geological Disposal

" Civilization has never had to consider an issue like this. No generation has had consciously to consider how its activities may produce waste that could be lethal to those living decades or even centuries from now. Civilization itself goes back perhaps no more than 5000 years (as Ronald Wright has written, only 70 lifetimes). *The idea of planning for such a lengthy period is subject to innumerable contingencies.*" –Thomas Berger, 2005, commenting as a member of the NWMO International Panel[184]

Summary

The problem of how to safely contain nuclear waste around the world has prompted investment in future thinking about the perpetual care of contaminated waste facilities. This case study will describe some of this thinking and practice in the context of the deep geological disposal of nuclear waste. Among the key projects addressed are: The Waste Isolation Pilot Project in New Mexico Canada's Nuclear Waste Management Organization Kincardine Deep Rock Vault Proposal.

Key points

- It is impossible to predict the effectiveness of contaminated waste isolation facilities centuries and millennia into the future.

- No human made structure has shown itself to be effective forever. Everything chemically changes, leaks, or fractures. Attempts to contain transuranic wastes in salt mines to date have been fraught with problems and misjudgements. Engineered covers, water treatments, storage containers, are all subject to geological, hydrological and climate changes, human intrusion and entropy.

- The usual response of governments to the possibility of accidents and disasters is to minimize their dangers and be secretive. And then to "manufacture consent".

- The money and resources to deal with contaminated sites are politically determined and flow only in response to sustained citizen advocacy. Funds for effective adaptive management are subject to political whim.

[184] http://www.nwmo.ca/uploads_managed/MediaFiles/835_NWMO_International_Panel.pdf

- For contaminated sites that are invisible to the senses, effective "go away" markers may be impossible to design. Signs and markers cannot be assured to operate apart from human practice and memory.

- Culture shapes our vision of the past and can falsify it.

The Waste Isolation Pilot Project

The Waste Isolation Pilot Plant, or WIPP, is North America's first deep geological repository and is licensed to "permanently dispose" of transuranic radioactive waste for 10,000 years that is waste left from the research and production of nuclear weapons. It is located in a massive salt deposit approximately 26 miles (42 km) east of Carlsbad, New Mexico.[185] The United States Department of Energy began planning for the facility in 1974. WIPP began operations on March 26, 1999. Disposal operations are expected to continue until 2035 with active monitoring for a further hundred years. By 2010, the facility had already processed 9,000 shipments of waste.

The project is operated by Sandia National Laboratories. "Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-AL85000. This research is funded by WIPP programmes administered by the Office of Environmental Management of the U.S. Department of Energy."[186]

Various kinds of conceptual modelling drive most planning and development at WIPP, and "by regulation, all conceptual models for WIPP must undergo independent technical peer review." [187] But conceptual predictions may be not really independent and can be very wrong. An article written by Richard Beauheim of Sandia and published in 2009, discusses some of the mistaken assumptions in the geological conceptual modelling for WIPP.

The WIPP partially depends on the "Russell formation", a rock stratum above the storage area, to keep the facility dry. Within the Russell formation is an aquifer called the Culebra. According to Beauheim:

"The original conceptual model for the Culebra assumed that it could be conservatively treated as a fully confined unit with heads that would appear to be at steady state over the operational period of the WIPP. The primary groundwater release pathway for radionuclides

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[185] http://www.emnrd.state.nm.us/WIPP/ProgramSummary.htm
[186] Richard Beauheim, "Collection And Integration Of Geoscience Information to Revise the WIPP Hydrology Conceptual Model" (2009), p. 163.. http://www.oecd-nea.org/rwm/reports/2009/AMIGO-3/PDF/16%20-%20AMIGO-3%20-%20Beauheim.pdf
[187] Ibid.

released from the WIPP repository by inadvertent human intrusion was thought to be through the Culebra, along a high-transmissivity (T) region in the southeastern portion of the WIPP site.... While many aspects of the original conceptual model remain consistent with recent observations, a few aspects have been cast into doubt. On-going monitoring has shown that Culebra heads are, in fact, rising and that they respond, at least locally, to discrete, present-day events such as major rainstorms....Furthermore, calibration of new Culebra T (transmissivity) fields for the first recertification of WIPP did not produce the high-T offsite transport pathway through the south-eastern part of the WIPP site previously thought to be present."[188]

WIPP markers

calvin-c.com

"As a result, new wells and monitoring systems were introduced to track water movements, and new conceptual models have had to be developed. Among other findings, the new research showed that "short-term, localised changes in Culebra head have been shown to be caused by drilling of nearby oil and gas wells. Additional modelling not discussed herein has shown that the long-term rising trend in Culebra heads may also be plausibly related to leakage into the Culebra through improperly plugged and abandoned boreholes."[189]

The technical standards for the WIPP are enshrined in federal regulations known as 40CFR 191. These standards require monitoring that will not jeopardize the isolation of the waste, designation by permanent markers, and avoidance of sites where drilling for mining

[188] Beauheim. Op Cit.
[189] Beauheim, page 163.

purposes or oil will not happen. However, as we have seen, the WIPP is located in an area that is subject to heavy prospecting.[190]

Future Modeling and Warning Systems

Sandia also undertakes other kinds of conceptual research, including the use of panels of experts who were to consider the nuclear repository and numerically assess the possibilities that someone might intrude on it as far as 10,000 years into the future, and a panel on warning systems that might deter these intrusions.[191] Both Panels were made up of linguists, scientists, science fiction writers, anthropologists and futurists.[192]

Insights on some of the thinking about perpetual care that took place on these Panels is provided by Gregory Benford, a physicist and science fiction writer, who participated on the Futures panel and was privy to the deliberations of the panel on warning systems. He recorded his reflections in his book *Deep Time: How Humanity Communicates Across Millenia.* Some of these reflections are abridged below:

- Quoting James Young: "to the extent that we encourage monuments to do our memory work for us, we become more forgetful"

- To be sure, in broad outline, folk memory is surprisingly long-lived, Modern Australian Aborigines recall landmarks that were flooded since the last ice age, eight thousand years ago; divers verified their existence. But much of the information is cloudy: what does the mythical beast they call the "bunyip" correspond to?

- Culture shapes our vision of the past, even grossly falsifying it. As well, memory is notoriously unreliable. Individual recollections of the past are easily and quickly shaped by others and after a while have little bearing on the once lived events.

- Recounting the stories of the "Seven Wonders of the World" identified by the ancient Greeks, he concludes;" in a sense all the Seven Wonders were messages intended to provoke in us remembrance mingled with a sense of awe, and as such, six have failed."(page 11-16) They have been plundered by vandals, destroyed by earthquakes or used to build other structures. Most have been reduced to rubble.

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[190] From Van Wyck, Signs of Danger. Pages 24.2-24.4

[191] Gregory Benford, *Deep Time: How Humanity Communicates Across Millenia* (Abbenford Associates. 1999), Part One pp 33 ff.

[192] *Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant,* Sandia National Laboratories report SAND92-1382 / UC-721 (1993) and "Danger! Keep Out! Do Not Enter!", *Science Illustrated*, May/June 2008.

- The oldest reliably dated structure in North America is a 5400 year-old earthen mound at Watson Brake, Louisiana. However the message that was meant to be sent by the structure is lost. "Such long-lived sites transmit a blunt signal of existence nothing more."(page 16)

- We usually foresee the future by reviewing the past, seeking long-term trends. Yet this can tell us little about the deep future beyond a thousand years." (Page 38)

- " There are three types of future hazards. The best are those we can identify and reduce or eliminate, such as DDT and other chemicals. More ominous are those we know little or nothing about, such as some additive or emission – for example radioactivity was not thought to be harmful a century ago. Finally there are hazards we know pose deep-future hazards but which we do not wish to ban – long-lived nuclear waste and toxic chemicals essential to industry. Instead we decide to continue producing these, and then shove them away in some dark corner, with warnings for the unwary and unaware." (page 38)

- The Panel also reflected on financial assurance over this period of time. "Economists assume that an investment can carry forward undisturbed, gaining an immense multiplier effect. But never has this happened over thousand years; banks go bankrupt, commodities crash, empires evaporate. People intuitively trust their sense of human connection more than interest rates. This is why they ignore discounting in the perspective of deep time." (page 45)

- "Are we being arrogant when we assume we can accurately anticipate far future hazards or protection mechanisms? Probably – but we have no choice. Waste of all sorts stacks up and we must do our best to offset its long-term effects." (page 48)

The Futures Panel created scenarios "detailed enough to consider the physical as well as the social environment" some 10,000 years hence. Benford describes three:

- *The Mole-Miner,* which assumed a steady rise in technology. " the societies that must concern us are advanced enough to intrude, yet not so far beyond us that the radioactive threat is trivial." The Mole-Miner creates new risks of intrusion, because it can move laterally through rock, opening pathways for radiation to escape.

- *The See-saw*. There has been devastating and long-lasting recession with famine, disease, population explosion, nuclear war, global warming, ozone depletion. "Then the rigors of institutional memory and maintenance would diminish, fade and evaporate. Warning

markers would crumble into unintelligible rubble". Later when society rebuilt, explorers would again probe the earth's crust, with no understanding of what lay beneath.

- *The Free State of Chihuahua*. Centuries from now, political upheaval has led to the breakup of the United States into a number of smaller societies that live by scavenging. While scavenging at the former site of Scandia laboratories, they find references to WIPP, and see pictures of barrels filled with tools, clothing, wires, etc. However they don't see references to radioactivity. The Free State archaeologists see the crumbling remains of markers on the site, but don't understand its dangers. "They breach the site. Groundwater gushes up the drill, driven by the long-sealed heat of radioactive decay. No one can stop the gusher. A radioactive creek winds down to the riverbed miles away." (page 43) Information is lost because of disrupted cultural continuity and massive political change.

The Expert Panel had been tasked with calculating the risks of intrusion into the site, and in the end came up with one percent total probability of this happening. The response of the DOE was to say they could live with up to 10% probability.[193] The discussion moved to warning systems.

Benford's account of the deliberations of the Panel emphasizes the limitations on our ability as a technological and un-rooted culture to communicate over deep time. The problem is further complicated by having to convey an ugly message about what lies beneath the marker. He asserts that most of our experience with long-term communication intends to say: "remember us and so pay respect."...This waste site has to send the opposite message, straight into the collective unconscious, drawing the eye yet repelling the spirit." [194]

According to Sandia, to date, the warning systems expert panel has come up with markers, called "passive institutional controls", that will include "an outer perimeter of thirty-two 7.6 m -tall granite pillars built in a 6 km square. These pillars will surround an earthen wall, 10 m tall and 30 m wide. Enclosed within this wall will be another 16 granite pillars. At the centre, directly above the waste site, will sit a roofless, 4.6 m granite room providing more information. The team intends to etch warnings and informational messages into the granite slabs and pillars. This information will be recorded in the six official languages of the United Nations (English, Spanish, Russian, French, Chinese, Arabic) as well as the Native American Navajo language native to the region, with additional space for translation into future languages. Pictograms are also being considered, such as stick figure images and the iconic "The Scream" from Edvard

[193] Benford. , page 47.
[194] Benford,, page 67.

Munch's painting."[195] The Panel has also determined that complete details about the plant will not be stored on site, instead, they will be distributed to archives and libraries around the world. The team plans to submit their final plan to the U.S. Government by around 2028.[196]

There have been other scientists who have deliberated about how to transmit information about nuclear wastes to future generations. One of these was Thomas Sebeok, who wrote in 1984: " [the truth of the site] should be entrusted to - what we might call for dramatic emphasis – an 'atomic priesthood', that is a commission of knowledgeable physicists, experts in radiation sickness, anthropologists, linguists, psychologists, semioticians and whatever additional expertise may be called for now, and in the future. Membership in the "priesthood would be self-selective over time...."[197]

Other experience with Deep Geological Disposal of Nuclear Waste

There are only three actual experiences with the deep geological disposal of nuclear wastes in the world: the WIPP, and two decommissioned German attempts. Sweden and Finland currently have projects in the advanced planning stages, and a number of other countries are considering them.

The two German experiences have been disturbingly unsuccessful.

Schacht Asse II is a former salt mine used as a deep geological repository for radioactive waste in a mountain range in Lower Saxony/Germany. Between 1967 and 1978 radioactive waste was placed in storage. The facility is operated by the German government through a private contractor. Research was stopped in 1995; between 1995 and 2004 much of the facility was filled with salt. After media reports in 2008 about brine contaminated with radioactive caesium-137, plutonium and strontium, politicians accused the operator of not having informed the inspecting authorities. The federal office for radiation protection decided to close the facility. Because of the decades of tunnelling and heat from the radiation stored inside, the salt – which had kept its form because of geological pressure - is losing its stability: "The supporting construction is softening by creep deformation, plasticity effects and local fractures from the ground pressure."[198] The shifts may lead to an uncontrollable increase in water inflow and make the continued operation as a dry pit impossible. Asse II is particularly threatened by water

[195] *Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant,* Sandia National Laboratories report SAND92-1382 / UC-721 (1993)
[196] "Danger! Keep Out! Do Not Enter!" *Science Illustrated*, May/June 2008.
[197] Thomas Sebeok, *Communication Measures to Bridge Ten Millennia*(1984), page 24.
[198] *Dreidimensionale gebirgsmechanische Modellrechnungen zur Standsicherheitsanalyse des Bergwerkes Asse*. Institut für Gebirgsmechanik GmbH, Leipzig, 2006. Cited in http://en.wikipedia.org/wiki/Schacht_Asse_II

because the salt barrier is in some places only a few meters thick. From the period 1986 to 1988 there were 29 documented water breaches."[199].

The other nuclear waste deep geological storage facility is also in a former salt mine in Germany at Morsleben. It has been receiving waste since 1978[200]. Concerns with stability and water infiltration led to its suspension in 1998. "Since the suspension of nuclear waste storage in Morsleben in 1998 the stability of the salt domes deteriorated to a state in which collapse could occur. Since 2003 salt concrete has been pumped into the mine cavities to stabilize the mine. The governmental costs for the remedial measures and closure of the mine is estimated at 2.2 billion euro, and will take more than 15 years to complete." [201]

A review of scientific journals[202] on deep geological nuclear fuel waste disposal (2010) raises a number of concerns that continue to inform the extensive and vocal international opposition to these plans. Writes Dr. Helen Wallace: "This review identifies a number of phenomena that could compromise the containment barriers, potentially leading to significant releases of radioactivity:

- Copper or steel canisters and overpacks containing spent nuclear fuel or high-level radioactive wastes could corrode more quickly than expected.
- The effects of intense heat generated by radioactive decay, and of chemical and physical disturbance due to corrosion, gas generation and biomineralisation, could impair the ability of backfill material to trap some radionuclides.
- Build-up of gas pressure in the repository, as a result of the corrosion of metals and/or the degradation of organic material, could damage the barriers and force fast routes for radionuclide escape through crystalline rock fractures or clay rock pores.
- Poorly understood chemical effects, such as the formation of colloids, could speed up the transport of some of the more radiotoxic elements such as plutonium.
- Unidentified fractures and faults, or poor understanding of how water and gas will flow through fractures and faults, could lead to the release of radionuclides in groundwater much faster than expected.

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[199] *Statusbericht des Niedersächsischen Ministeriums für Umwelt und Klimaschutz über die Schachtanlage Asse II*, Seite 11. Niedersächsisches Ministerium für Umwelt und Klimaschutz, Hannover, 2008.

[200] See http://www.endlagerung.de/language=en/3701/closure-of-the-radioactive-waste-repository-at-morsleben and see description of remediation project at http://www.wmsym.org/archives/2002/Proceedings/17/486.pdf

[201] Der Spiegel: Atom. Merkels AltlastDruckausgabe vom 20 . Oktober 2008, S. 46-48 citedin http://en.wikipedia.org/wiki/Repository_for_radioactive_waste_Morsleben

[202] Dr. Helen Wallace, "Rock Solid? A scientific review of geological disposal of high-level radioactive waste" (September 2010). Greenpeace European Unit. http://www.greenpeace.org/eu-unit/press-centre/reports/rock-solid-a-scientific-review

- Excavation of the repository will damage adjacent zones of rock and could thereby create fast routes for radionuclide escape.
- Future generations, seeking underground resources or storage facilities, might accidentally dig a shaft into the rock around the repository or a well into contaminated groundwater above it.
- Future glaciations could cause faulting of the rock, rupture of containers and penetration of surface waters or permafrost to the repository depth, leading to failure of the barriers and faster dissolution of the waste.
- Earthquakes could damage containers, backfill and the rock.
- Although computer models of such phenomena have undoubtedly become more sophisticated, fundamental difficulties remain in predicting the relevant complex, coupled processes (including the effects of heat, mechanical deformation, microbes and coupled gas and water flow through fractured crystalline rocks or clay) over the long timescales necessary.
- In particular, more advanced understanding and modelling of chemical reactions is essential in order to evaluate the geochemical suitability of repository designs and sites.
- The suitability of copper, steel and bentonite as materials for canisters, overpacks and backfill also needs to be reassessed in the light of developing understanding of corrosion mechanisms and the effects of heat and radiation."

As Peter VanWyck writes: "*The WIPP Pilot Project is replete with acknowledgement that it is not possible for it to do what it is supposed to do. That is, it is not possible to keep the wastes secure for even the legislated period of time. It's just too long. But what we have is a plan that looks like a solution even as it admits no solution is possible. As we have seen – whether we are speaking of active institutional controls, the security of salt formations, the concern for the transmission of 'information', to the constitution of future societies – we keep running up against the paradox and the very limits of 'useful' speculation."*[203]

Managing nuclear waste in the long term in Canada.

The Environmental Assessment of Deep Geological Disposal

From 1989 to 1998, *the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel* chaired by Blair Seaborn examined a disposal concept proposed by Atomic Energy of Canada Limited (AECL) to bury nuclear fuel waste in one deep geological repository in the Canadian Shield. The Panel conducted scoping sessions in 14 communities in 1990 and met with Aboriginal organizations, NGOs, faith groups, women's organisations and student

[203] Van Wyck, *Signs of Danger*, page 92

groups about what they wanted to see in the Guidelines for the Assessment. The guidelines were released in 1992, and AECL submitted its final Environmental Impacts Statement in 1994. The Panel conducted hearings in 16 communities from March 1996 to March 1997. $750, 000 in participant funding was made available and the Panel received over 500 written submissions and heard another 500 oral presentations.[204]

The Seaborn Panel report, entitled *Report of the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel,* was released on March 13th 1998. The Panel found: "From a technical perspective, safety of the AECL concept has been on balance adequately demonstrated for a conceptual stage of development, but from a social perspective, it has not. As it stands, the AECL concept for deep geological disposal has not been demonstrated to have broad public support. The concept in its current form does not have the required level of acceptability to be adopted as Canada's approach for managing nuclear fuel wastes."[205] The Scientific Review Group that has been established to support the Review Panel also released a report identifying 65 technical deficiencies with the AECL concept, many of which were very significant.

The Seaborn Report called for

- the creation of a nuclear fuel waste management agency "at arm's length" from the nuclear industry, with a board of directors representative of independent "key stakeholders";
- the development of an ethical and social framework to assess and development used fuel management approaches, and
- a full review of the use of nuclear fuel power generation in Canada

The federal government ignored all their recommendations. In 2002, *the Nuclear Fuel Waste Act* was passed. It did not include an ethical and social framework, nor did it undertake a review of nuclear power generation. It delivered the management of nuclear fuel waste directly into the hands of the nuclear industry.

The Nuclear Waste Management Organization- spent nuclear fuel [206]

Three provincial nuclear energy crown corporations, namely Ontario Power Generation (OPG), Hydro- Québec and New Brunswick Power, own 98 percent of the nuclear fuel waste in Canada, and most of the remainder is owned by AECL. They are the membership of the Nuclear Waste Management Organization (NWMO).

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[204] Sheng, Grant,Branko Ladanyi, L.W. Shemilt, "Canada's High-Level Nuclear Waste Disposal Concept: The Evaluation Process and a Review of Some Aspects of the Research Work", *Energy Studies Review*, Volume 5, Issue 3, 1994.

[205] Seaborn Panel Report, Chapter 5. www.ceaa.gc.ca

[206] This section is abridged from documents on the NWMO website unless specifically referenced differently.

The NWMO's Mission is "to develop collaboratively with Canadians a management approach for the long-term care of Canada's nuclear fuel waste that is socially acceptable, technically sound, environmentally responsible and economically feasible." [207]

From 2002 to 2005 the NWMO commissioned a number of papers and studied approaches for long-term management of Canada's nuclear fuel waste. Simply put, owners of nuclear fuel waste are responsible for developing, proposing, financing, and implementing long-term management strategies. Government oversees the owners' efforts, evaluates the strategies, and "selects a general, sound approach for Canada". The CNSC continues to be responsible for regulatory matters pursuant to the *Nuclear Safety and Control Act.*

The *Nuclear Fuel Waste Act (NFWA)* had established the NWMO in 2002 to design and implement a long-term approach for managing Canada's nuclear fuel waste. It was required to prepare and submit a study of proposed approaches for the long-term management of the waste to the Government of Canada, along with a recommendation on which of the proposed approaches should be adopted. The *NFW Act* required that the analysis of options include feedback from comprehensive public consultation, including Aboriginal peoples, and be evaluated in terms of social and ethical considerations.[208]

The NFWA also required that the major waste owners (nuclear energy corporations and AECL) establish trust funds with independent third-party trust companies to finance their long-term waste management responsibilities. In 2008, the NWMO proposed a funding formula to determine the deposits to be made each year by the waste owners to pay for APM implementation. The proposed formula was approved by the Minister of Natural Resources in April 2009.[209]

The NWMO Triennial Report for 2008-2010 reported that: "These guarantees for year 2011 total $13 billion and equal the total cost (in present value terms) of managing the decommissioning of all reactors and permanently managing all nuclear waste (including used nuclear fuel) produced to date. A large portion of these guarantees, approximately $12 billion (at year-end 2010), exist in segregated funds dedicated to nuclear waste management and decommissioning with the remainder in the form of Provincial Guarantees."[210]

The principles developed by NWMO for operation of the trust fund are as follows:

- Producer pays: Each waste owner pays based on the quantity of waste produced and usage of the repository.

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[207] OECD Nuclear Energy Association. *Canada Report 2008: Radioactive Waste Management and Decommissioning in Canada*.,Section 1.3.1 http://www.nea.fr/rwm/profiles/Canada_report_web.pdf
[208] Ibid, page 18.
[209] NWMO Triennial Report 2008-2010:
http://www.nwmo.ca/uploads_managed/MediaFiles/1721_triennialreport2008to2010.pdf.
[210] Ibid, page 195.

- Financial conservatism: The highest cost option for implementing Adaptive Phased Management, the option preferred by the NWMO, is used.
- Uncertainty analysis: Provide for reasonably foreseeable and unforeseen events; contingencies are provided in the cost estimates.
- Intergenerational fairness: Funds will be collected over the assumed economic life of the nuclear reactors producing the used fuel bundles.
- Fund growth: Reasonable assumptions are used for real growth of funds to manage the used fuel over the long term.

The NWMO also has an Advisory Council as required by the *NFWA.* The Advisory Council has a statutory responsibility for providing independent comment on the NWMO's work to the Minister of Natural Resources Canada and to the public. It is worth noting that some of these members work as consultants to the nuclear industry. The NWMO has other advisory bodies including an Aboriginal Elders' Forum, Niigani (the Aboriginal Working Group). In 2008, following the NWMO having been given full responsibility for managing and directing research on used nuclear fuel in Canada, the NWMO's Board of Directors established an Independent Technical Review Group (ITRG) to review the organization's technical research program on an ongoing basis.[211]

From 2002- 2005, the NWMO held 120 public consultations and numerous full-day dialogues on values, covering a cross-section of the population in every province and territory. All in all, 18,000 citizens contributed directly to the study, while more than 60,000 people visited the NWMO website. The NWMO also commissioned a number of expert papers, many of which can be read on the website.

The extensive consultation by the Seaborn Panel had taken place only a decade previously. The NWMO process was clearly designed to manufacture consent for deep geological disposal. Consultation was not open-ended, participatory or thorough. If used focus groups and website commentary to substitute for real debate. It consulted, but did not allow for democratic decision-making about the ultimate recommendation.

On November 3, 2005, the NWMO submitted its study of options for nuclear fuel waste management to the Government of Canada. The NWMO presented four options: namely long-term storage at the reactor sites, central shallow or below ground storage, deep geological disposal, and a fourth option called the *Adaptive Phased Management (APM)* approach which essentially combines the three listed options within a "flexible adaptive management decision-making process".

The NWMO plan combined all three of the federal government's "options" in a 300-year phased approach moving from storage at nuclear plants, to centralized storage, and finally to

[211] Ibid.

deep rock disposal. In the first phase of the NWMO plan, the waste will remain at nuclear plants for 30 years while a centralized site is selected. "The site will have rock formations allowing shallow underground storage, an underground research laboratory, and a deep geological repository. In the second 30-year phase of the NWMO plan, either a shallow underground facility will be built at the identified site and waste transportation will begin, or waste will remain at the nuclear plants pending completion of a site research facility and construction of a deep geological repository at the site. In either case, the waste will be moved to the selected site. The repository may or may not be closed after the following 240 years."[212]

NWMO states that: "The APM technical method is based on an end-point of centralized containment and isolation of the used fuel in a deep geological repository in a suitable rock formation. It provides for continuous monitoring of the used fuel and the potential for retrievability for an extended time. There is provision for contingencies, such as the optional step of shallow storage at the selected central site, in the event that circumstances favour early centralization of the used fuel before the repository is ready. The APM management system is designed to provide "Flexibility in the pace and manner of implementation... with each step supported by continuous learning, research and development, and public engagement."

The federal government accepted this recommendation on June 14, 2007.

NWMO describes their next steps as: "An informed, willing community will be sought to host the centralized facilities. Sustained engagement of people and communities is a key element of the plan, as the NWMO continues to work with citizens, communities, municipalities, all levels of government, Aboriginal organizations, NGOs, industry and others.... The APM approach recognizes that people benefiting from nuclear energy produced today must take steps to ensure that the wastes are dealt with responsibly and without unduly burdening future generations. At the same time, it is sufficiently flexible to adjust to changing social and technological developments" [213]

However, Northwatch, an environmental watchdog in northern Ontario. argues:

" The Nuclear Waste Management Organizations "fourth option" combines the worst of all three [options]!

- the option encourages continued production of nuclear waste
- it assumes that the waste will eventually be buried, letting the industry off the hook for long term management
- communities will be put at risk by the transport of nuclear waste, potentially very long distances

[212] Summary from the Northwatch website at http://www.web.ca/~nwatch/nuclear_waste/index.html

[213] www.nwmo.ca

- a site will be selected before research is completed
- it will be hundreds of years before the community that is made "host" to the disposal facility will know what kind of a facility they are being made "host" to"[214]

NWMO has now determined that a waste repository should be built in one of the four "nuclear provinces": Ontario, Quebec, New Brunswick and Saskatchewan, and in May 2009 began to develop "a process for identifying a suitable site in an informed, willing host community, with discussion around the principles on which a process should be based. Siting will not begin until the siting process has been discussed and confirmed, and the readiness of the NWMO's public engagement program has been confirmed."[215]

Saskatchewan and Quebec have already said that they will not accept a nuclear fuel waste geological disposal site.

Low and Intermediate-Level Radioactive Waste Disposal

In Canada, low and intermediate-level radioactive waste (LIRW) comprises all forms of radioactive waste except for nuclear fuel waste and waste derived from uranium and thorium mining and milling. It falls into three broad categories:

- Ongoing Waste: Low and intermediate-level radioactive waste that is generated by the ongoing activities of companies currently in operation, such as nuclear electricity generators.
- Nuclear Legacy Liabilities: Legacy radioactive wastes at AECL sites date back to the Cold War and the birth of nuclear technologies in Canada. These include shutdown contaminated buildings and contaminated lands, and are managed by AECL on behalf of the Government of Canada. *The nuclear legacy liabilities include some high-level waste,* in particular research reactor fuel and 280 m3 of high-level liquid waste.
- Historic Waste: Low-level radioactive waste that was managed in the past in a manner that is no longer considered acceptable and for which the current owner cannot be reasonably held responsible. Canada's historic waste inventory consists largely of radium and uranium contaminated soils.

The Low-Level Radioactive Waste Management Office (LLRWMO) was established by the Government of Canada in 1982 to carry out the federal government's responsibilities for low-level radioactive waste management in Canada. It reports through Natural Resources Canada. The mandate of the LLRWMO is fairly broad. In practice, its function is to resolve historic low-

[214] http://www.web.ca/~nwatch/nuclear_waste/index.html

[215] OECD, page 19.

level radioactive waste problems that are a federal responsibility; and "to address public information needs concerning low-level radioactive waste". For example, the LLRWMO is the proponent for the Port Hope Area Initiative.

While the LLRWMO receives its funding from Natural Resource Canada, organizationally it is a division of Atomic Energy of Canada Limited (AECL).[216]

AECL generates approximately 17 percent of the annual volume of "Low and Intermediate-Level Radioactive Waste" and also accepts waste from a number of small producers and users of radioactive materials for long-term management, which amounts to a further 3 percent of Canada's annual volume. Cameco Corporation's uranium processing and conversion facilities in Ontario, New Brunswick Power and Hydro-Québec, which own and operate the other 2 CANDU reactors in Canada generate the rest. The owners of ongoing low and intermediate-level radioactive waste are currently all managing and operating storage facilities for their wastes.

Case Study: A Willing Community? Deep Geological Repository at Kincardine[217]

Ontario Power Generation, which owns 20 of Canada's 22 CANDU reactors, is responsible for about 77 percent of the ongoing waste generated in Canada annually. Ontario Power Generation's LIRW (Low and Intermediate Level Waste) is currently stored at the Western Waste Management Facility at the Bruce Nuclear Generating Station, which also includes reactors owned by Ontario Power Generation but leased to Bruce Power Development located in the Municipality of Kincardine, Ontario, on the shores of Lake Huron. Spent fuel rods from the Bruce Plant are stored under water on site or in dry storage at the Western Waste Management Facility.

Kincardine has been targeted by Natural Resources Canada, the NWMO and Ontario Power Generation as the site for Canada's first deep geological nuclear waste depository.

Many residents of Kincardine work for Ontario Power Generation or Bruce Power. "As part of the community consultation, an independent poll was conducted with Kincardine. Every resident, 18 years and older was interviewed, via telephone. The results of the poll were that 60 per cent supported the proposal, 22 per cent were opposed, and 18 were neutral or did not know. A total of 72 per cent of eligible residents participated in the poll."[218]

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[216] OECD, page 6.

[217] See http://www.nwmo.ca/dgrkincardine and John Nicholson, *"IMBY-ism": How to gain public acceptance for projects,* January 2007. http://www.hazmatmag.com/issues/story.aspx?aid=1000208427&type=Print%20Archives

[218] Nicholson.

In April 2002, Ontario Power Generation and the Municipality of Kincardine signed a Memorandum of Understanding to jointly study options for the long-term management of nuclear wastes at the Kincardine. The vault will be designed to hold OPG's current and future "low and intermediate level waste" from its 20 CANDU reactors. OPG considered geology of the Bruce site to be ideal for the deep waste disposal option. In April 2004, Kincardine Council passed a resolution to select the "Deep Rock Vault option as the preferred course of study" for the management of "low and intermediate level waste" because it "had the highest margin of safety and is consistent with best international practice".

The Deep Geological Repository involves "the construction of rock vaults within stable, low permeability bedrock using conventional mining techniques. The rock vaults would be positioned at a depth of approximately 700 meters in relatively flat-lying sedimentary rock formations that have remained tectonically stable and undeformed for hundreds of millions of years. Support buildings would be located on ground surface above the underground workings. Access to the repository would be through a vertical, concrete-lined shaft. A second shaft would be constructed for ventilation and emergency egress purposes."

Bruce Power station

dgr.homestead.com

The Kincardine Hosting Agreement, which sets out the terms under which the project would proceed, was signed on October 13, 2004. "By signing the hosting agreement with OPG, Municipality of Kincardine has secured itself of a 20-year windfall in payments totaling $35.7-million that are inflation protected. It has also added jobs that will be spending an estimated $800-million over the life of the deep geological vault. The vault project is now proceeding through a joint panel review Environmental Assessment.

The NWMO has a real stake in the success of this project, and is deeply involved in making it happen. Their 2008-2010 Triennial Report states:

" In 2009, the NWMO became responsible for the multi-phase geoscientific investigation that had been launched by OPG in 2006 to confirm the suitability of the Paleozoic-age sedimentary bedrock at the Bruce nuclear site to safely implement the proposed DGR for L&ILW. During the 2009–2010 reporting period, the NWMO oversaw:

- the drilling and coring of two steeply inclined deep boreholes to characterize the nature of the vertical bedrock structure and its effect on DGR implementation; and
- borehole testing, including geophysical logging and hydraulic testing of the two steeply inclined boreholes to determine the different bedrock layers and bedrock permeabilities.

Collection of data to describe the baseline environment began in 2007 and was continued by the NWMO in 2009. Field work was undertaken to update information previously compiled on surface water quality, aquatic and terrestrial species populations, social and economic conditions, and public attitude. These data provide the starting point from which the potential effects of the DGR project on the environment, including the physical, cultural, social and economic components, are being assessed."[219]

" DGR (Deep Geological Repository) communication activities conducted by the NWMO since 2009 have included the continued issuance of DGR project newsletters and other publications, a new DGR website, speaking engagements, open houses, briefings to key stakeholders and attendance at public events. The DGR mobile exhibit is present at local community events. In September 2009, the NWMO, in conjunction with OPG, undertook a series of engagement activities in Michigan to provide key politicians, officials and environmental groups with information on the DGR. Engagement activities continued with the Saugeen Ojibway Nation, with a protocol completed in March 2009, including the SON, OPG and the NWMO as signatories."[220]

[219] NWMO Triennial Report 2008-2010.

[220] Ibid, page 137.

Perpetual Jeopardy

In Cultures of Contamination, Michael Edelstein reflects on the *perpetual jeopardy* faced by communities with at least one serious long-term contaminant problem. Although his comments are about Hanford, they apply to Kincardine, Yellowknife, and other host communities:

" In short, Hanford minus operating industry was just a highly contaminated place – a negative for the appeal of the regional economy and future safety of the environment. The repository concept suggested a double bind for all of the concerned parties, whether Hanford booster or opponent, whereby it was necessary to bring in more waste to assure that the existing contamination was cleaned up...The double bind discussed above illustrates a form of Environmental Stigma that I call Perpetual Jeopardy. Contamination invites, in this case, even demands, more contamination. ...The need to reign in the damage done and control the materials on site is an opportunity for self-perpetuating eco-industry. For thousands of years, there will be jobs (assuming a society to fund them) in cleanup and containment. Additionally there will be proposals to concentrate existing hazards in a place that is already so hazardous and to develop new hazardous activities. Such locations attract danger like magnets attract filings." [221]

[221] Edelstein,. page 300.

Case Study Nine: UNESCO World Heritage Sites

"Historic preservation or heritage conservation seeks to preserve, conserve and protect buildings, objects, landscapes or other artifacts of historic significance. It has much to teach us about mitigation and rehabilitation strategies and long-term stewardship. There are also examples that could be drawn from national parks and heritage sites and from the Canadian Species at Risk program." – conservation archaeologist[222]

Summary

United Nations Education, Science and Culture Organization (UNESCO) has a wealth of experience from around the world in the preservation engineering of archaeological sites, as well as archiving over the long term. This case study summarizes some of that experience with a view to learnings that may applicable to the long term stewardship of isolation facilities for contaminated waste. Although stewardship of contaminated sites has never been in its mandate, UNESCO may provide a focus for thinking about how such an international program might operate. UNESCO works in Canada through Parks Canada.

Key Points:

- The United Nations Education, Science and Culture Organization (UNESCO) has a wealth of resources from all countries and in many languages available on the conservation preservation, and remediation strategies for archaeological sites, heritage buildings, and preservation engineering, as well as for archiving materials over the long-term. It also has varied and useful experience with political interventions to protect heritage.

- The threats to long term care sites from corrupt governments and industrial expansion are on-going. The World Heritage Convention has been a powerful tool to rally international attention and resources through international safeguarding campaigns, although it does not provide funding.

- UNESCO has considerable experience working in Canada (through Parks Canada) and with Aboriginal organizations and community groups to ensure long-term protection of significant sites and landscapes.

[222] Interview February 2011 (anonymous).

- Although UNESCO has never considered World Heritage Site designation for a contaminated site or a contaminated community, it might be induced to do so. [223] The Klondike Gold Rush is on the UNESCO Tentative Sites list (at the request of Parks Canada) with no mention of tailings or waste left behind.[224]

- A special class of World Heritage Sites might be considered that recognized danger spots where humans should not go and where human intervention will be probably be required forever.

- This case study also provides a number of examples of long term care of historic/archaeological sites.

UNESCO- the United Nations Educational Scientific and Cultural Organization.

Founded in 1945, at the end of the Second World War, UNESCO's mission is "to contribute to the building of peace, the eradication of poverty, sustainable development and intercultural dialogue through education, the sciences, culture, communication and information."[225] "UNESCO works to create the conditions for dialogue among civilizations, cultures and peoples, based upon respect for commonly shared values." It is funded by its member states.

Although UNESCOs activities encompass everything from lifelong learning to dialogue on climate change, most of us are familiar with the organization's culture program "preserving humanity's shared heritage in both its tangible and intangible forms". A set of Conventions (international agreements on policy and practice) has been put in place over the years to do this.

The 1954 Convention for the Protection of Cultural Property in the Event of Armed Conflict, and its Second Protocol of 1999, helps "rebuild broken communities, re-establish their identities, and link their past with their present and future". Although this Convention has not been extended to include the damage wrought by the low-intensity conflict of colonialism, this interpretation might be considered.

The Convention concerning the Protection of World Cultural and Natural Heritage was passed in 1972. The fact that this Convention deals with both cultural and natural resources makes it a unique and powerful tool for the protection of heritage. The Convention states that 'each State Party to the Convention shall endeavour … to adopt a general policy which aims to

[223] Personal communication with UNESCO expert on built heritage, January 2011.
[224] http://whc.unesco.org/en/tentativelists/1941/
[225] Abridged and paraphrased from UNESCO website. http://www.unesco.org/new/en/unesco/about-us/who-we-are/introducing-unesco/

give the cultural and natural heritage a function in the life of the community and to integrate the protection of that heritage into comprehensive planning programmes' (Article 5).

Insofar as monuments and sites are also spaces for sustainable development and reconciliation, UNESCO coordinates actions of its partners by administering the World Heritage Convention (1972). "Reflecting the natural and cultural wealth that belongs to all of humanity, World Heritage sites and monuments constitute crucial landmarks for our world. They symbolize the consciousness of States and peoples of the significance of these places and reflect their attachment to collective ownership and to the transmission of this heritage to future generations."

Inscription of a property on the World Heritage List is not just a recognition of its 'outstanding universal value' but, above all, 'acknowledgement of a commitment by the State Party to protect the heritage'. One of UNESCO's mandates is to pay special attention to "new global threats that may affect the natural and cultural heritage and ensure that the conservation of sites and monuments contributes to social cohesion".

UNESCO World Heritage sites in northern Canada

In Canada, Parks Canada plays a key role, nominating sites to UNESCO and partnering to maintain them. Sites include natural, built and cultural heritage/landscapes or combinations of all three.

Recently, there is encouragement to State Parties concentrate on "categories of heritage that are still under-represented" and to resubmit them every 5–10 years.

How are World Heritage Sites established?

- A national Tentative List is prepared by Parks Canada (Historic Sites and Monuments Board) and submitted to Cabinet for approval. A detailed nomination dossier is prepared by those responsible for the site.
- Consent from affected Aboriginal people is essential to the nomination proceeding.
- The nomination dossier is submitted to the World Heritage Centre, which checks that nominations are complete. The centre may ask for additional information from the nominating State Party.
- Experts from the International Council on Monuments and Sites (ICOMOS) for cultural sites and from the World Conservation Union (IUCN) for natural sites visit the nominated site to evaluate its heritage values, its protection and management regime, and to confirm the level of support of the various stakeholders. The international experts prepare a technical report, which includes recommendations for consideration by the World Heritage Committee.
- The World Heritage Committee makes a decision on the nomination. It can *inscribe* the site on the World Heritage List; *refer* the nomination back to Canada for more

information; *defer* it until further research work is conducted; or *not inscribe* the site on the list.

- The timeframe from the reception of a nomination dossier by the World Heritage Centre to the Committee's decision is at least 18 months. Currently, however, only one site a year is being accepted from Canada and the waiting list is quite long.[226]

Parks Canada's approach to Aboriginal Issues

Dr. Christina Cameron, speaking for Parks Canada in 2003, said:

"Canada's system of national historic sites finds its roots in designations that began in 1917, near the end of the First World War. At the very first meeting of the Historic Sites and Monuments Board of Canada in 1919, historic places linked to Aboriginal history figured prominently. However, it must also be noted that for much of the first seventy-five years, Aboriginal history was commemorated mainly at sites marking early encounters between Europeans and native populations, and through archaeological sites, presented by professional archaeologists – and not by Aboriginal people. Consequently, Aboriginal people did not have a stake, did not easily recognize their achievements and felt that the persons, places and events did not well represent their history.

"In order to achieve a more representative system, Parks Canada refocused the programme to identify new proposals for designation, this time in consultation with Aboriginal peoples. No proposal is now placed before the Historic Sites and Monuments Board of Canada without the endorsement of the relevant Aboriginal group or groups. While the process has taken a long time to gain momentum and trust, statistics from the last five years suggest that it is beginning to produce positive results....Guidelines to structure these relationships were outlined in 1998 in a 'Statement of Principles and Best Practices'. This document discusses responsibilities and roles to be played by each party commemorating Aboriginal history. The principles call for the recognition of traditional knowledge (often oral tradition), a respect for community structures and values, and Aboriginal participation in the development and presentation of proposals for commemoration.

"Particularly helpful in this renewal has been the concept of cultural landscapes. Following UNESCO's lead, Canada developed its own cultural landscape definitions and criteria, including a specific one for Aboriginal cultural landscapes:

An Aboriginal cultural landscape is a place valued by an Aboriginal group (or groups) because of their long and complex relationship with that land. It expresses their unity with the natural and spiritual environment. It embodies their traditional knowledge of spirits, places,

[226] http://www.pc.gc.ca/eng/progs/spm-whs/page4.aspx

land uses and ecology. Material remains of the association may be prominent, but will often be minimal or absent.

To support this definition, Parks Canada developed some specific guidelines to identify historically important Aboriginal cultural landscapes. The guidelines include the recognition of traditional knowledge and Aboriginal participation in the selection process; in addition, they require that these places have significant interrelated cultural and natural attributes, and significant associations with the spiritual, cultural, economic or environmental values of the associated group."[227]

UNESCO has been involved in two projects with Dene people in the NWT.

- A language retention project with the Déline Dene First Nation, The Déline Language Plan (2008)
- Recognition of Nahanni National Park as a UNESCO World Heritage Site (2004)

Capacity building project: Déline language and self-government [228]

The Dene Language Plan, in Déline, Northwest Territories, Canada, is designed to help maintain a distinct cultural identity as Dene people, with a focus on understanding, appreciating and passing on traditional skills, ceremonies, values, history and laws as well as communicating and sharing knowledge in the traditional language. Community language coordinators plan and develop community programs, with an emphasis on youth and elders, through a wide range of activities.

Projects include: development of an oral history digital archive, oral history CDs for daily listening, caribou traditional knowledge, oral histories on governance, student-elder radio work, historical place names mapping.

All meetings are carried out in the Dene language, and all materials are recorded in the language. As part of UN International Year of Languages, the community celebrated Dene Language Month in March 2008, with a literacy and writing contest in the school and community, a Dene focus group on concepts of wellness, GIS work, and language awareness posters, among other activities. The project is focusing on hearing, speaking, reading, and

[227] Christina Cameron ,quoted in Eléonore de Merode and Carol Westrik, "Linking Universal and Local Values: Managing a Sustainable Future for World Heritage", presented at a conference organized by the Netherlands National Commission for UNESCO, in Collaboration with the Netherlands Ministry of Education, Culture and Science, 22–24 May 2003.

[228] http://portal.unesco.org/culture/es/ev.php-url_id=37475&url_do=do_printpage&url_section=201.html

writing the Dene language as well as the development of partnerships and a team approach to all community building and language work.

The Main partners for the program are: Déline Basic Awareness Program, Déline Land Corporation, Ehtseo Ayah School, University of Manitoba, University of Toronto, Aurora Research Institute, and the NWT Archives

Nahanni National Park Reserve (Gahnihtah)[229]

" The tufa mounds and hotsprings have featured in Dene legend for thousands of years. Nahanni National Park Reserve of Canada is home to several rare and powerful places, where natural beauty and First Nations legend come together in an awe-inspiring landscape. 'Among the most striking features of Nahanni National Park Reserve of Canada are the sinuous, shining mineral formations at Rabbitkettle Hotsprings known as Gahnihthah in the Dene language...The tufa mounds and hotsprings have featured in Dene legend for thousands of years. Tales of the mysterious, fierce Naha people - from whom the park takes its name - centre around the tufa mounds, as do stories about the giant Yampa Deja, the protector of the Dene, who was said to use the mounds as his dinner plate."

Relevant research on local community involvement from UNESCO

A UNESCO conference held in 2003 to reflect on the involvement of local communities in all aspects of the management of World Heritage properties, and identify opportunities for their sustainable economic and social development, predominantly at the grass-roots level brought together scholars from around the world who had been immersed in these issues. [230]

The conference summary states: " Among the challenges facing UNESCO and the international community is to make the national authorities, the private sector, and civil society as a whole recognize that World Heritage conservation is not only an instrument for peace and reconciliation, for enhancing cultural and biological diversity, but also a factor of regional sustainable development. New approaches to integrated management of World Heritage have proved successful and promoted economic growth and benefits to local communities. We need to help support the capacity of countries in crisis to protect their heritage, respond to emergency situations and maintain our day-to-day efforts for heritage conservation all around the world."

For this case study a few of the presentations may be particularly useful.

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[229] http://www.pc.gc.ca/canada/pn-tfn/itm2-/2004/2004-12-20_e.asp: December 20,2004

[230] Abridged/paraphrased from de Merode, op cit.

- An examination of the role of *Community-Based Legal Systems in the Management of World Heritage Sites* by Albert Mumma recognized the necessity to manage and protect sites in a holistic manner. He stressed the need for an internal regeneration of communities as integral entities in a fundamental step towards the protection of heritage sites, and consequently the reinterpretation of their values.

- Cor Dijkgraaf presented *How World Heritage Sites Disappear: Four Cases, Four Threats.* He used case studies in Ghana, Sri Lanka and Yemen to demonstrate that more often than not conservation of heritage is not a priority of the local inhabitants if no economic benefits are forthcoming, and to say that former colonial powers have a responsibility to contribute to the safeguarding of heritage in their former colonies.

- María Isabel Hernández Llosas presented *Pintoscayoc: A Case Study in Quebrada de Humahuaca* where a project initiated by the Consejo Nacional de Investigaciones Cientificas y Tecnicas (CONICET), in collaboration with local communities, aims to reconstruct visibility of the erased past. The reconstruction process is based on a dialogue between local communities and scientists, and is ensured by the establishment of an Interpretation Centre managed by the local communities.

- Martine Tahoux-Touao analysed the *Contribution of Sacred Sites to the Conservation and Sustainable Management of Biodiversity and Social and Cultural Values,* in Côte d'Ivoire. She emphasized the importance of sacred forests for the endurance of social and cultural values and demonstrated the effectiveness of traditional management mechanisms, such as inviolable principles, taboos and totems.

- Bulu Imam contributed *Case Study for the Protection of Living Heritage in India: The North Karanpura Valley...*This paper focused on the threat posed by coal-mining projects and the construction of a huge dam to the sacred grove, burial grounds, dancing grounds and rock-art sites in the area.

- Webber Ndoro presented *Traditional and Customary Heritage Systems: Nostalgia or Reality? The Implications of Managing Heritage Sites in Africa.* In a series of examples from the United Republic of Tanzania, Uganda and Zimbabwe, he suggested an innovative approach to analysis and planning of management systems for living traditional sites.

- Beatrice Kaldun presented *Partnerships for Empowered Participation: Mainstreaming a Community-Based Paradigm for World Heritage Management.* This paper examined UNESCO's ten-year programme in Asia to catalyse a shift in the way the region's cultural resources are managed, away from elite central planning towards community responsibility for stewardship.

How UNESCO protects heritage sites

"In the past, thanks to the proactive position of UNESCO, many unique cultural sites have been saved for future generations. "The World Heritage Convention is not only 'words on paper' but is above all a useful instrument for concrete action in preserving threatened sites and endangered species. By recognizing the outstanding universal value of a site, States Parties commit to its preservation and strive to find solutions for its protection. If a site is inscribed on the List of World Heritage in Danger, the World Heritage Committee can take immediate action to address the situation and this has led to many successful restorations. The World Heritage Convention is also a very powerful tool to rally international attention and actions, through international safeguarding campaigns**."**[231]

The Pyramids of Giza, along with the Sphinx, (1979) became a World Heritage Site. The Giza pyramids have been the most recognisable icon of Egypt for the past four thousand years. At Giza are three giant-size pyramids, and numerous smaller ones. The Pyramid of Khufu was built over a 20-year period, completed around 2560 BC. Also constructed with the pyramid were two mortuary temples in honour of Khufu. These pyramids were threatened in 1995 by a highway project near Cairo that would have seriously damaged the values of this archaeological site. Negotiations with the Egyptian Government resulted in a number of alternative solutions that replaced the disputed project.

The Ngorongoro Conservation Area in the United Republic of Tanzania This huge crater with the largest concentration of wild animals in the world was listed as an endangered site in 1984 because of the overall deterioration of the site due to the lack of management. By 1989, thanks to continuous monitoring and technical cooperation projects, the situation had improved.

The Archaeological site of Delphi in Greece At the time of its nomination in 1987, plans were underway to build an aluminium plant nearby the site. The Greek Government was invited to find another location for the plant, which it did, and Delphi took its rightful place on the World Heritage List.

The Wieliczka Salt Mine, near Cracow in Poland This property was inscribed in 1978 as one of the first twelve World Heritage sites. The mine had been worked since the 13th century. Its 300 kilometres of galleries contain famous works of art with altars and statues sculpted in salt, all of which were seriously threatened by humidity due to the introduction of artificial ventilation at the end of the 19th century. The site was placed on the List of World Heritage in Danger in 1989. During nine years of joint efforts by both Poland and the international community, an efficient dehumidifying system was installed.

[231] http://whc.unesco.org/en/107

Royal Chitwan National Park in Nepal This Park provides refuge for about 400 greater one-horned rhinoceros characteristic of South Asia. The World Heritage Committee, in the early 1990s, questioned the findings of the environmental impact assessment of the proposed Rapti River Diversion Project. The Asian Development Bank and the Government of Nepal revised the assessment and found that the River Diversion project would threaten riparian habitats critical to the rhino inside Royal Chitwan. The project was thus abandoned and this World Heritage site was saved for the benefit of future generations.

The Old City of Dubrovnik in Croatia The 'pearl of the Adriatic', dotted with beautiful Gothic, Renaissance and Baroque buildings had withstood the passage of centuries and survived several earthquakes. In November and December 1991, when seriously damaged by artillery fire, the city was immediately included on the List of World Heritage in Danger. With UNESCO providing technical advice and financial assistance, the Croatian Government restored the facades of the Franciscan and Dominican cloisters, repaired roofs and rebuilt palaces.

1992: Creation of the Memory of the World Programme to protect irreplaceable library and archive collections. It now also includes sound, film and television archives.

Angkor, Cambodia. Angkor Archaeological Park contains the magnificent remains of the different capitals of the Khmer Empire, from the 9th to the 15th century. In 1993, UNESCO embarked upon an ambitious plan to safeguard and develop the historical site. Illicit excavation, pillaging of archaeological sites and landmines were the main problems. By 2004, the site was no longer in danger.

Mount Kenya National Park/Natural Forest in Kenya The nomination of this site was first referred back to the State Party on the basis of findings during the evaluation that suggested there were serious threats to the site, primarily illegal logging and marijuana cultivation inside the Park. The State Party responded with an action plan that included provision of additional vehicles, increased patrols, community awareness projects, training of forest guards and a review of the policy affecting the adjacent forest reserve. Based on these assurances, the Committee inscribed the site in 1997. Today, some threats still remain but there has been significant progress in the management of the site.

Whale Sanctuary of El Vizcaino in Mexico In 1999, the World Heritage community campaigned against a plan for enlarging an existing salt factory to commercial scale in Laguna San Ignacio in El Vizcaino Bay, the last pristine reproduction lagoon for the Pacific grey whale. The UNESCO World Heritage Committee forewarned the Mexican Government of the threats posed to the marine and terrestrial ecosystems, the grey whales as key species as well as the overall integrity of this World Heritage site by locating saltworks inside the Sanctuary. As a result, the Mexican Government refused permission for the saltworks in March 2000.

International Safeguarding Campaigns

"Sites for which international campaigns were launched in the 1960s, often became World Heritage sites, and the World Heritage concept itself developed from these first international campaigns launched by UNESCO...Over the years, 26 international safeguarding campaigns were organized, costing altogether close to US$1 billion."

Nubia Campaign in Egypt 1960: decision to move the Great Temple of Abu Simbel to keep it from being swamped by the Nile after construction of the Aswan Dam. During the 20-year campaign, 22 monuments and architectural complexes are relocated. This is the first and largest in a series of campaigns including Moenjodaro (Pakistan), Fez (Morocco), Kathmandu (Nepal), Borobudur (Indonesia) and the Acropolis (Greece).

Venice, Italy The longest running international safeguarding campaign has been on-going since 1966 when UNESCO decided to launch a campaign to save the city after the disastrous floods of 1965, a task requiring time, a high degree of technical skill and, above all, money. The international synergy that arose from this project was an important source of inspiration to the founding efforts of the Convention.

Temple of Borobudur, Indonesia An international safeguarding campaign was launched by UNESCO in 1972 to restore this famous Buddhist temple, dating from the 8th and 9th centuries. Abandoned in the year 1000, the temple was gradually overgrown with vegetation and was not rediscovered until the 19th century. With the active participation of the Japan Trust Fund for the Preservation of World Cultural Heritage and other partners, the restoration of Borobudur was completed in 1983.

The 1,700-year-old Aksum Obelisk, transported to Rome by Mussolini's troops in 1937, is reinstalled in its original setting in northern Ethiopia in 2008.

Lake Baikal, a World Heritage site in Russia, and the world's fresh water lake by volume, was threatened by the Russian government's decision to reopen the Baikal Pulp Plant in 2010. Petitioned by representatives of the For Baikal coalition, uniting dozens of Russian public and environmental organizations, UNESCO asserted its considerable power to stop the project. "We will inform the Russian government of our opinion and hope that Russia as a conscientious state and signatory of the Convention will take measures so that Lake Baikal does not lose its world value as a result of being polluted by the plant," said the UNESCO president.

Hungary. When one million cubic metres of red toxic mud erupted over six villages after a mining waste dam burst at the Ajkai Timfoldgyar alumina plant in Hungary in October 2010, it affected many World Heritage sites, including the Banks of the Danube, the Buda Castle Quarter

and Andrássy Avenue in Budapest, the Srebarna Nature Reserve in Bulgaria and the Danube Delta in Romania, as well as potential sites for inscription on the World Heritage List.

The Director of the World Heritage Centre Francesco Bandarin wrote "We deeply deplore the impact of this disaster, especially the loss of lives. I would like to convey our solidarity with the site managers and people struggling to safeguard their heritage and environment. UNESCO is ready to assist by providing technical and expert advice, wherever needed, together with its partners, especially the International Union for the Conservation of Nature (IUCN) and the Convention on Wetlands (Ramsar Convention, 1971) to safeguard the precious and irreplaceable heritage of future generations." [232]

[232] Francesco Bandarin, UNESCO Assistant Director-General for Culture http://portal.unesco.org/culture/en/ev.php-url_id=41332&url_do=do_topic&url_section=201.html

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