CROWN CONTAMINATED SITES PROGRAM

2014 BIENNIAL REPORT

Sustainable benefits for British Columbians through land restoration



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MESSAGE FROM THE MINISTER

B.C. CELEBRATES DECADE OF SAFEGUARDING ENVIRONMENT AND PROTECTING HEALTH OF BRITISH COLUMBIANS.



B.C. is committed to safe and environmentally responsible natural resource management practices. And nowhere is this commitment more important than in the Province's approach to cleaning up sites that have been contaminated by industrial activities like mining and heavy industry.

A cleaner, healthier British Columbia. That's the objective we started with a decade ago when the Province created the Crown Contaminated Sites Program. The goal was clear: to protect land and water for future generations by identifying and cleaning up contaminated sites on Crown land in B.C. With a focus on innovation, action, and collaboration, we have made a difference.

Managed by the Ministry of Forests, Lands and Natural Resource Operations, the program is part of an integrated approach that allows Government to understand and respond to contaminated sites from historical resource development activities on the provincial land base.

It's been a productive 10 years for the Crown Contaminated Sites Program. To date, B.C. has committed more than $277 million to the program, investigated 84 contaminated sites, and identified and managed risks to human health and the environment on 34 sites. This includes major environmental concerns like the Britannia Mine site, a closed mine on the Sea-to-Sky corridor that was once one of the largest sources of metal pollution in North America. It was a barren stretch of shoreline in Howe Sound where, for years, the only sign of life was the copper-resistant algae growing along the rocky shoreline. Today, thanks to hard work and focused remediation, fish have come back to Britannia Creek and a host of other marine plants and animals have returned to the area.

It's just one example of the exemplary work the program has been doing – work that has been recognized by numerous awards and citations, including Premier's Awards in 2007 and 2010. The former was for facilitating a public-private partnership to finance, build, and operate a water treatment plant at Britannia Mine. The latter award was for a pilot program to train First Nations youth in mining and mineral exploration. These projects exemplify how we are harnessing innovation and science-based methods to help clean up contaminated sites.

I am pleased to present the 2014 Crown Contaminated Sites Program Biennial Report, reconfirming the Province's commitment to protecting the health of British Columbians and safeguarding the environment we all cherish.



Steve Thomson
Minister

INTRODUCTION

The Crown Contaminated Sites Program manages high-risk contaminated sites located on provincial Crown land to ensure the protection of human health and the environment.

British Columbia has an active history of mining, manufacturing, forestry, agriculture, and many other industrial activities.

While development activities have built a modern and vibrant province, there have been some detrimental impacts to public lands.

Some historic industrial sites are contaminated with metals, acid rock drainage, hydrocarbons, and other substances harmful to human and environmental health. These sites can become the responsibility of the Government of British Columbia if they are on publicly owned land. To protect the public interest, the Government undertakes activities such as removing contaminated soils, diverting watercourses away from toxic materials, capping hazardous areas with natural or synthetic materials, and replanting vegetation to create habitats for birds, animals, insects, and fish.

For 10 years, the Crown Contaminated Sites Program has coordinated and overseen rehabilitation of contaminated sites on lands that the Government is responsible for. This report describes the activities of the Program between 2012 and 2014.

THE PROVINCE IS COMMITTED TO:

- *Demonstrating leadership in managing Crown contaminated sites*
- *Using a consistent risk-based approach to protect human health and the environment*
- *Improving the availability and quality of information on contaminated sites*
- *Instituting regular reporting to provide transparency and accountability for liabilities and progress*

Crown Contaminated Sites Program is responsible for cleanup on provincial land

Crown land makes up 94 per cent of the total land area of British Columbia. This includes the vast majority of resource areas, wilderness, waterways, parks, and ecological reserves in the province. Remediation of contaminated sites located on this land becomes the Province's responsibility if the persons or companies responsible for their cleanup cannot be found or no longer exist.

In 2002, a report of the Auditor General, Managing Contaminated Sites on Provincial Lands, noted that contaminated sites that fall under the jurisdiction of provincial ministries and agencies, including Crown lands, were being managed separately by diverse groups including the ministries responsible for forests, mines, sustainable resources, transportation, and the environment, as well as the B.C. Buildings Corporation. The Government therefore did not have the information to provide oversight, or to manage contaminated sites in a consistent manner. The Auditor General concluded that the Province should establish a framework for managing work on contaminated sites; gather information to develop management plans and support resource allocations; and account for its overall performance.

In response, the Government established the Crown Contaminated Sites Program (CCSP) in 2003. The CCSP was developed to take appropriate actions and provide public accountability on the management of contaminated sites that the Province is responsible for. The program manages high-risk contaminated sites to ensure the protection of human health and the environment. It uses a scientific risk-ranking method to determine which sites need remediation on a priority basis.

For a contaminated site located on Crown land, the CCSP attempts to identify the organizations or individuals responsible for causing the

contamination so that they can be held accountable for the cost of cleanup. Public funds are used only if private parties no longer exist and the site has defaulted to the Province, or if the site poses an immediate unacceptable high risk to human health or the environment.

Meeting ministry goals and priorities

The CCSP is administered by the LNG, Crown Land Opportunities and Restoration Branch of the Ministry of Forests, Lands and Natural Resource Operations. The Ministry is responsible for developing policies and programs to ensure that forests, land, and natural resources are managed in a sustainable manner so they can continue to provide environmental, social, and economic benefits to all British Columbians now and into the future.

The Ministry Service Plan for 2014/15 – 2016/17 outlines key goals and objectives that relate to the CCSP:

Goal 2:
Coordinated and sustainable management, use and stewardship of B.C.'s natural capital.

Objective 2.3:
Safe and environmentally responsible natural resource management practices.

- Remediate Crown contaminated sites to ensure clean land and water for the protection of human health and the environment.

Guided by cabinet policy

The CCSP operates under a policy approved by cabinet, "Management of Provincial Contaminated Sites."

This government-wide policy defines the guiding principles that underlie all actions to manage contaminated sites on Crown lands:

- Reducing and eliminating risks to human health and the environment and minimizing liabilities
- Applying standards that are cost effective, consistent, and in keeping with the legislation
- Applying the "polluter pays principle" *
- Working cooperatively among ministries and consulting with stakeholders and First Nations
- Acting consistently and fairly
- Acting accountably and transparently
- Using innovative strategies for managing contaminated sites, such as public-private partnerships (P3s)
- Minimizing the creation of future contaminated sites
- Applying sound science and technology to guide management

* The CCSP follows the "polluter pays principle" outlined in British Columbia's *Environmental Management Act*. Under this principle, the costs associated with environmental remediation are borne by the parties responsible for the contamination when any of those parties can be identified and are still in existence.

TYPES OF PROGRAM SITES

- *Remediated: Crown sites where cleanup activities are completed*
- *Priority: Crown sites that have been identified for action based on site investigation and potential risk to human health and the environment*
- *Candidate: Crown sites on which initial investigation has begun to determine the degree of risk*
- *Other: Sites that the Province manages in order to fulfill obligations established under legal agreements or other commitments*

The sites reviewed in this report are primarily Priority sites where investigation or cleanup activities have been carried out in the past two years.



RISK RANKING METHODOLOGY

Sites that present a high risk to human health or to the environment receive priority in the allocation of resources.







The number and variety of contaminated sites on Crown land exceeds the resources available within the Crown Contaminated Sites Program to clean up all sites at once.

As a result, the CCSP allocates its resources systematically to work on the highest priority sites and identify other sites for future action. Sites that present the highest risk to human health or to the environment receive priority. Sites that pose a lower risk will receive attention as higher-risk sites are remediated. In some cases, investigations determine that sites do not present a risk and do not require remediation.

Because of the potential for risks to human and environmental health, determining an appropriate methodology for assessing and prioritizing the risks is one of the CCSP's key responsibilities. The methodology determines what sites will receive action, what resources each candidate site will receive, and when each site will be scheduled for attention.

Setting Site Priorities

In 2007, the Crown Contaminated Sites Program developed a risk ranking methodology (RRM) as its principal tool to establish program priorities and allocate the funds available for remediation.

The risk ranking methodology is a scientifically based method for assessing the ecological and human health risks presented by contaminated sites in British Columbia. The process uses two components to prioritize sites:

- A risk ranking support tool, which is a data entry and calculation spreadsheet that compares contaminants in soil, water, and sediment to regulatory standards
- An annual risk ranking workshop, which brings together experts on contaminated sites, including geologists, engineers, biologists, and toxicologists, to review and assess the information available on candidate sites

Key steps in assessing Crown contaminated sites

The process of assessing sites and the actions required follows these steps:

- Identify potential candidate sites
- Determine land ownership and responsibility for cleanup
- Develop a list of candidate sites
- Conduct preliminary site investigations
- Enter field observations and analytical data into the risk ranking support tool
- Hold an annual risk ranking workshop to rank sites, identify priority sites, and recommend next steps based on a group consensus
- Develop management action plans appropriate for priority sites, subject to available financial resources

Recommendations for action or investigation

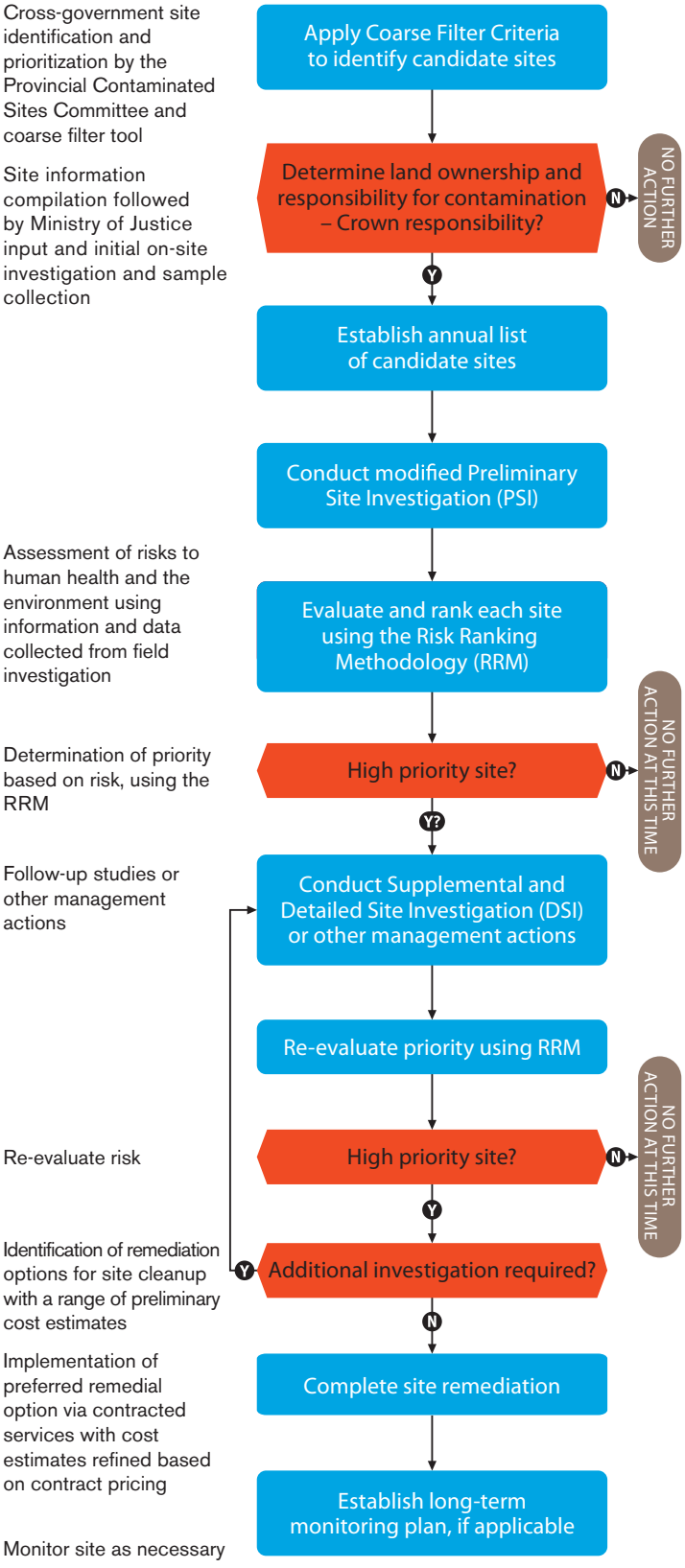
Field researchers gather the available data on contaminated sites to fill in the risk ranking tool. The information allows workshop participants to rank sites based on risk and to make initial recommendations on management actions for identified high-priority sites. Using the expert guidance of the workshop participants, a level of action appropriate for each site is selected. The workshop participants can recommend any of the following actions:

Possible levels of action

- **Immediate action:** The workshop recommends immediate action for sites where health or safety risks require urgent attention.
- **Detailed site investigation:** Where the information indicates that a potential risk may exist, the workshop recommends a more detailed site investigation.
- **Supplemental investigation:** When analysis shows a need for action for a ranked site, but requires additional information to determine the most appropriate steps, the workshop recommends specific, targeted investigations. These can include further study of various risks, sample-taking, or other types of site analysis.
- **Reduce uncertainty:** Where the data in the tool are too uncertain for the site to be ranked, the workshop may recommend gathering more information or performing analyses about specific issues.
- **Lower priority:** Low-priority sites are those with the lowest risks where management action can be deferred.

The recommendations from the workshop guide the CCSP in planning future actions.

STEPS FOR PRIORITIZING AND EVALUATING CONTAMINATED SITES



CROWN CONTAMINATED SITES DATABASE

The CCSD is a centralized system for viewing, managing, and tracking, data on Crown contaminated sites.



Information on the status of Crown contaminated sites is critical for management and for public confidence in the program.

To provide British Columbians with information about Crown land, the Government of British Columbia maintains an Integrated Land Resource Registry (ILRR), a comprehensive map-based register of information relating to Crown land, as well as certain information on reservations (such as parks) and private land.

CCSP data

Since 2004, the CCSP has recorded its actions on the remediation of priority Crown contaminated sites in British Columbia in a Crown Contaminated Sites Database (CCSD), creating a central repository of information on Crown contaminated sites.

In 2013, the CCSP completed work required to integrate the Database into the Integrated Land Resource Registry. Additional enhancements to the Registry are currently in progress.

Users can access the ILRR at *http://geobc.gov.bc.ca/rsd/ilrr/*

2012 – 2014 PROGRAM FINANCES

The table below shows funding for the Crown Contaminated Sites Program for the past two fiscal years. Program funds are used to investigate candidate contaminated sites and to remediate identified priority sites.

Fiscal Year	Program Funding
2012/2013	$4,006,000
2013/2014	$3,825,000

Crown contaminated sites where the Province has accepted responsibility for cleanup represent a liability. As of December 31, 2013, the Crown Contaminated Sites Program had booked a total of approximately $277 million of public funds in a liability account. Of this, $167 million has been expended to remediate high-risk priority Crown contaminated sites.

INTERNATIONAL INFORMATION EXCHANGE BUILDS PROGRAM INFLUENCE

MANAGING MINING LEGACIES FORUM, BRISBANE, AUSTRALIA, JULY 16 AND 17, 2012

British Columbia contributed as one of the keynote speakers at an international forum on reclaiming contaminated mining sites in July 2012.



David Mulligan, Gilles Tremblay, Corinne Unger, Gregg Stewart



Flooded pit, Mt. Todd Mine, Northern Territory, Australia

Managers of orphaned and abandoned mines, stakeholders, and researchers from a range of disciplines came together at the Managing Mining Legacies forum at the Centre for Mined Land Rehabilitation, Sustainable Minerals Institute at the University of Queensland in Australia. The experience of British Columbia's Crown Contaminated Sites Program was relevant to both of the forum's central topics: leading practices in site rehabilitation and the use of inventories and spatial databases to support risk management and decision-making.

Gregg Stewart, Manager of the CCSP, described the management practices for contaminated sites in the province, and the program's use of inventories and risk ranking methodology (described on page 4).

Gilles Tremblay, from the federal government's National Orphaned/Abandoned Mine Initiative (NOAMI), based in Ottawa, Ontario, discussed a multi-stakeholder initiative that reviews issues and makes recommendations regarding the remediation of orphaned and abandoned sites across Canada. NOAMI participants include representatives from the Canadian mining industry, federal, provincial, and territorial governments, non-government organizations, and Aboriginal Canadians.

Both models provide useful approaches for international jurisdictions to consider how to manage orphaned and abandoned mines, although the CCSP addresses a wider spectrum of contaminated sites.

A variety of key themes emerged from meeting of experts and stakeholders:

- The management of abandoned mines is a critical social and environmental responsibility around the world.
- Financial accounting for sites where responsibility has defaulted to government helps to put perspective on the scale of orphaned and abandoned mines across jurisdictions. This accounting forms the basis to develop policies and well-focussed programs, engage appropriate expertise, and report on performance (improvements and expenditure).
- The same high standard that is applied to active mines should be applied to the regulation of abandoned mines.
- Mines, health, environment, and heritage departments all have responsibilities for abandoned mines. These departments and their expertise should be actively engaged by a lead agency.
- Successful projects provide valuable lessons for observers worldwide. Stakeholders such as Australian community groups were able to lobby for action by providing well-defined information on impacts, consequences, and solutions from successful projects outside of Australia, including British Columbia's Britannia Mine Remediation Project.

The exchange also provided an opportunity to examine the remediation approaches taken in orphaned and abandoned mines in Australia's Northern Territory. In one instance, mining activities at the Rum Jungle Mine led to acid rock drainage and other environmental impacts, resulting in pollution of the Finniss River.

PROJECT SITE REPORTS

This past year, the CCSP continued its work to achieve its goal:
Protecting human health and the environment by returning land to a clean and usable state.



Presently:

- A total of 84 sites have been investigated since the program began in 2003.
- There are currently 17 priority contaminated sites warranting further study and investigation.
- Remediation has been completed at 17 sites. Many of these require ongoing monitoring to ensure that the remediation is meeting the desired results and to ensure long-lasting integrity of the remedial works.

The following site summaries document program activities on priority sites in fiscal years 2012/13 and 2013/14.

49º 15′ 46″ N, 117º 12′ 32″ W

HOWARD MINE TAILINGS SITE

PLAN DEVELOPED TO MANAGE TAILINGS AND MINE WASTES FROM SILVER-LEAD MINE



A conceptual remedial plan was developed and work will begin in 2014.

Howard Mine in B.C.'s West Kootenays, about 30 kilometres south of Nelson, produced gold, silver, and lead during its operation from 1937 to 1938 as part of a mining history in the region that began in the mid-1800s.

The mine transported ore over a 7.5-kilometre aerial tramway to a processing mill at the confluence of the Salmo River and Porcupine Creek. The mill operation left behind many tonnes of mine tailings, much of which has since been washed away by the river.

Between 2009 and 2013, the CCSP commissioned a series of studies to assess the extent of the mine wastes and their potential risk to human health and the environment. The investigations showed that the mine wastes contained lead and other metals at concentrations that pose a potential risk. Groundwater and surface water in the Salmo River directly adjacent to the tailings deposit contained elevated concentrations of cadmium and zinc. However, Porcupine Creek and the main channel of the Salmo River have not been affected by the mine wastes.

The results showed that management of the mine wastes was necessary.

In order to determine the best approach, the CCSP analyzed a number of different management options in late 2012 and early 2013 and evaluated them against specific environmental, practical, social, and cost criteria. A conceptual plan to manage the wastes was presented at an open house in August 2013, and local community members agreed with the recommended remedial option.

The CCSP recently established a list of qualified environmental waste management contractors and engineers, and will invite them to submit proposals to clean up the mine site. Remedial work is expected to take place in the summer and fall of 2014.

WORK COMPLETED

- *Detailed investigations of potential hazards*
- *Presentation and community acceptance of a conceptual remedial plan*

NEXT STEPS

- *Selection of contractors to carry out the remedial plan*
- *Development of final engineering designs*
- *Regulatory authorizations*
- *Further communications with the community*

1. Mine tailings on eastern bank of Salmo River
2. Test pit excavation through tailings
3. Aerial view of mill and tailings area



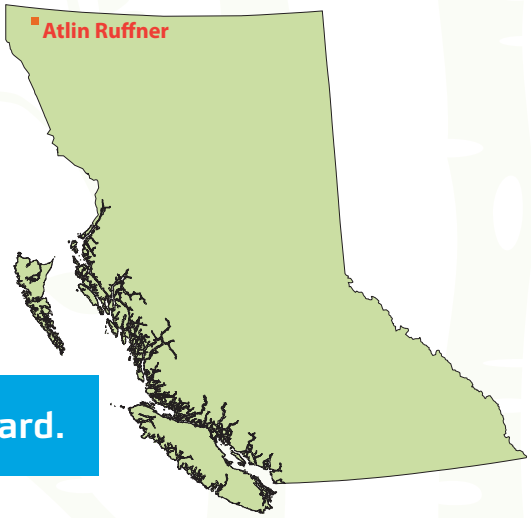




59º 44' 22" N, 133º 30' 50" W

ATLIN RUFFNER MILL AND TAILINGS SITE

CONTAMINATED SOIL AND MATERIALS CAPPED



Cleanup of historic mine site receives reclamation award.

B.C.'s innovative and cost-effective approach used to manage mine wastes at an abandoned mine site on Crown land near the Alaska-B.C. border won an award at the 2013 mine reclamation conference.

When minerals were found in the Atlin region of northwestern British Columbia in the late 1800s, miners opened many small mines. At the Atlin Ruffner mine site, about 20 kilometres from the town of Atlin, miners operated on and off until 1981, producing silver, lead, zinc, and smaller amounts of other metals. The site was abandoned, and it became an attraction for hikers and snowmobilers. Initial studies found that the site contained metal-contaminated soils, and the CCSP ranked it as a priority site.

Throughout the site, many metals exceed the permitted standards in soil. However, no significant concerns were identified in surface water or groundwater, with concentrations meeting required standards less than 100 metres from the site.

To provide a long-term solution and keep contaminants separate from people and animals, consultants recommended covering the contaminated soils with one metre of erosion-resistant gravel. Although no signs of leaching were found, test results categorized the soils as leachable hazardous waste. This required an application to change the typical provincial requirements to allow the soils to be remediated as proposed. A permit application was made to operate a secure landfill with specifications unique to the site. It was the first time a permit based on these conditions was granted.

The permit was granted, and contractors began work in August 2012 to remove hazardous building materials from the mine site. Contractors demolished the former mill buildings and consolidated the debris with the contaminated soils, then covered and capped them with gravel. Access to the site for public recreation was discouraged by placing rocks and earthworks across entry routes. Water will be monitored and the cover will be inspected once a year for the first five years, and every five years after that. Revegetation is underway.

In September 2013, the British Columbia Technical and Research Committee on Reclamation (BC TRCR) awarded the CCSP and consultant AECOM Canada Ltd. the Metal Mining Reclamation Award in recognition of the work to create a cost-effective remediation plan for a small, yet significant, historic mining site.

WORK COMPLETED

- *Hazardous wastes removed*
- *Contaminated soils capped*

NEXT STEPS

- *Ongoing surface and groundwater monitoring*
- *Revegetation*















1. Atlin Ruffner site prior to remediation
2. Site following remediation
3. Tailings pond and dam prior to remediation
4. Settling ponds prior to remediation
5. Test pits to confirm depth of cover
6. Tram tracks leading out of main adit prior to remediation
7. Mill building prior to removal of hazardous materials and demolition

49º 36' 05" N, 123º 07' 48" W

FURRY CREEK SITE

SUCCESSFUL BRITANNIA MINE CLEANUP EXPANDS TO FURRY CREEK WATERSHED



Beta Portal seepage will be remediated as part of the 2014 Britannia Mine remediation program.

The historic Britannia mine site, once the largest copper producer in the British Empire, has become one of the successes of British Columbia's contaminated sites program.

After the mine shut down in 1974, surface water flowing through the mine created millions of cubic metres of acid mine drainage that leached tonnes of copper and zinc and lesser amounts of other metals. The dissolved metals contaminated nearby streams and creeks that drain to Howe Sound.

Since 2001, the CCSP has managed a long-term program to investigate and control the contaminants. A wastewater treatment plant now removes contaminants before returning purified water to the environment. Today, fish including pink salmon and trout have returned to Britannia Creek.

Waste rock and mine portals located within the Furry Creek watershed remain areas of environmental concern. Seepage from one of the mine openings – the Beta Portal – has a significant impact on Furry Creek water and sediment. Located in the southeast portion of the Britannia Mine area, the creek supplied water to the mine for mining processes and for power generation. The majority of the Furry Creek watershed is covered by coniferous forest, except for areas disturbed by mining or logging. Today, in addition to the mine remediation, people use parts of the Furry Creek watershed for logging and recreation.

Site investigations conducted between 2002 and 2011 provided the information used to conduct a human health and ecological risk assessment, which was completed in 2013. This risk assessment did not include the area impacted by the Beta Portal seepage, since this seepage will be diverted back into the mine. There, it will drain and be treated in the water treatment plant that was built to manage the Britannia Mine water discharge. The diversion work will commence in 2014.

The risk assessment suggests that risks to human health and aquatic wildlife from contamination in the Furry Creek watershed will be negligible. Additional work will be conducted in 2014 and 2015 to refine risk estimates for aquatic plants, invertebrates, fish, soil invertebrates, terrestrial plants, and wildlife and to assess the effects of the Beta Portal diversion.

WORK COMPLETED

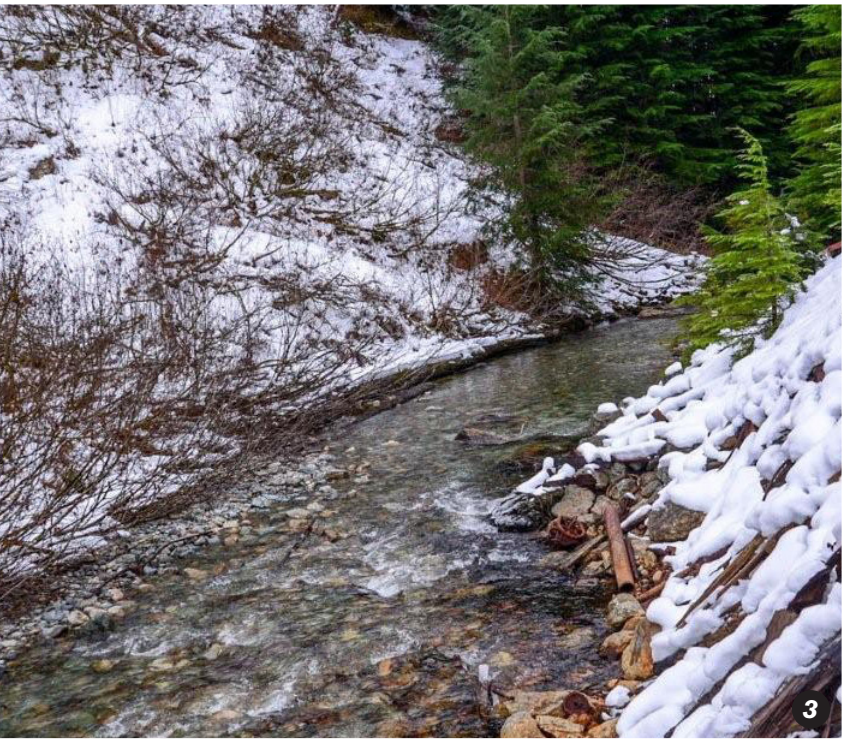
- *Detailed site investigation*
- *Human health and ecological risk assessment*

NEXT STEPS

- *Site investigation to refine the risk and to assess the effects of the Beta Portal diversion*







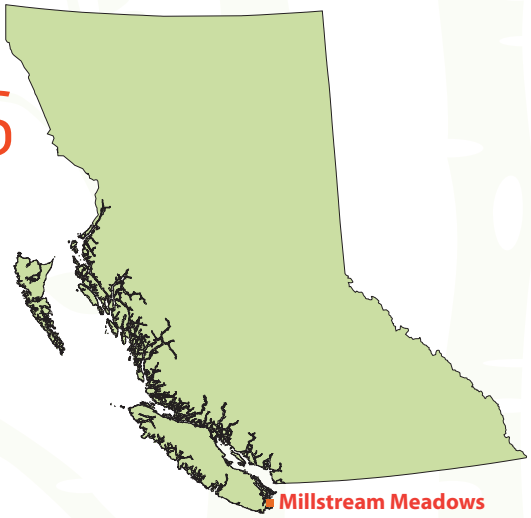


1. Waste rock pile and mining debris
2. Sampling waste rock
3. Furry Creek above Beta Portal discharge
4. Measuring discharge from Beta Portal

48º 28' 52" N, 123º 30' 33" W

MILLSTREAM MEADOWS

FORMER SEPTAGE LAGOONS REMEDIATED TO PROTECT GROUNDWATER RESOURCES



Following removal of the worst contamination in 2008, groundwater monitoring continues as remediation progresses.

The Millstream Meadows site, about 20 kilometres northwest of Victoria, B.C., in the District of Highlands, operated as a privately owned disposal facility for septage wastes.

Until the 1970s, the Millstream Meadows site received material such as waste from septic systems and other trucked liquid wastes, including oily wastes. The liquid wastes were discharged with few controls into a series of three lagoons. The Capital Regional District (CRD) took over the site in 1974, and, in the late 1980s, filled in two of the lagoons with construction debris materials and covered them with soil, forming the meadows.

The provincial government and the CRD have conducted environmental investigation and remediation at the site since 1995. They identified contamination associated with all of the lagoons, including groundwater contaminated with hydrocarbons.

The CRD, with the support of the Province of B.C., began work to clean up the site in 2008, when the worst of the contaminated soils from Lagoon 1 and a portion of Lagoon 2 were excavated. In 2009, the CRD began removing the remaining hydrocarbon-stained water, silty sands, and gravels from low-lying areas of the excavation. In 2011, the excavation was filled in with clean gravel. A well to recover contaminated groundwater was also installed.

Since the remedial excavation in 2009, the CRD has continued to monitor groundwater, surface water, and soil gas quality. Additional investigations are planned to assess remaining site risks at the untreated lagoon areas and to confirm deep groundwater quality.

The CRD and the CCSP are currently looking at innovative and cost-effective methods to locate fracture zones in bedrock that might transport contaminants. They will use this information to ensure that long-term deep perimeter monitoring wells are correctly located to identify any possible migration pathways for contaminants.

WORK COMPLETED

- *Excavation of contaminated soils*
- *Monitoring of groundwater, surface water, and soil vapour quality*

NEXT STEPS

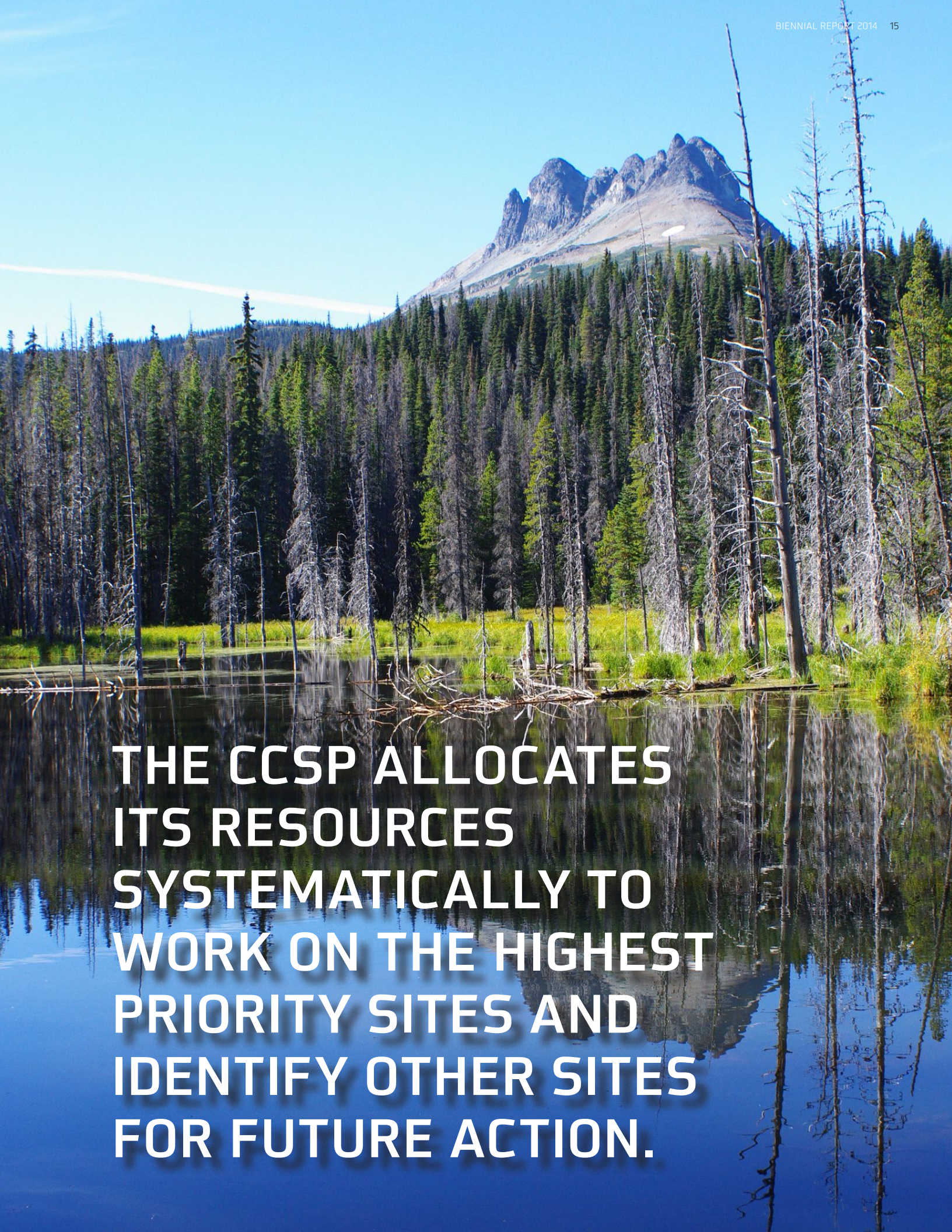
- *Investigations to identify bedrock fractures and place monitoring wells*







1. Lagoon 1 after contaminated material removed
2. Former Lagoon 1 and portion of Lagoon 2 following remediation and backfilling
3. Spreading and compacting gravel during backfilling of Lagoon 1



THE CCSP ALLOCATES ITS RESOURCES SYSTEMATICALLY TO WORK ON THE HIGHEST PRIORITY SITES AND IDENTIFY OTHER SITES FOR FUTURE ACTION.

53º 42' 46" N, 127º 14' 26" W

EMERALD GLACIER MILL AND TAILINGS SITE

REMOTE CREEKSIDE SITE RETURNING TO PRE-MINE CONDITIONS



Metals-contaminated tailings and soils were capped and the water level in the reservoir was returned to its pre-mine level.

First staked in 1915, the steep slopes and alpine meadows of the Emerald Glacier mine site produced over three million pounds of lead and zinc, and smaller amounts of gold, silver, copper, and cadmium.

Active work on the site ended in 1971, leaving a tailings pile and reservoir at a mill site in an adjacent valley about 2.5 kilometres from the mine.

The mining activity resulted in metals-contaminated soils and waste rock around the mill; an upstream reservoir dam that had supplied water to the mill, but had not been maintained since mining ended; and metals-contaminated tailings beside a creek that flowed from the reservoir. The mill site's remote location, approximately 120 kilometres by road from the nearest town of Houston (430 kilometres from the larger city of Prince George), made it particularly challenging to remediate.

Investigations between 2008 and 2011 identified a potential risk from derelict buildings; erosion from the tailings pile; and the possibility that the reservoir dam could breach and further erode the tailings pile. Using a phased remediation strategy, buildings were first demolished in summer 2012, allowing safe access for detailed assessments.

The second phase in fall 2013 involved capping all of the areas of the mill and tailings that had high concentrations of metals. The capping material, consisting of a one-metre cover of compacted glacial till, will protect the site from further erosion and prevent people and animals from being exposed to the metals-rich tailings. Due to the remote site location, an on-site source of the glacial till had to be developed for use during remediation and then be decommissioned. A berm was also constructed between the creek and the tailings to prevent any future floods from reaching the tailings.

To remove the risk of the dam breaching, contractors pumped water out to lower the reservoir level, and then built a spillway in the middle of the dam to maintain the new lower level. The spillway mimics a natural drainage channel and returns the reservoir to pre-mining levels.

The roads to the dam, ore pile, and tailings were decommissioned by placing fallen trees on the road surface and creating a ditch and berm at the road entrance. To begin revegetation, contractors planted willow stakes on the berms and reseeded disturbed areas.

The CCSP will continue monitoring the former reservoir, the covers, the creek, and groundwater. The new vegetation will be monitored and enhanced as needed.

WORK COMPLETED

- *Derelict buildings demolished*
- *Spillway created and water level in reservoir returned to pre-mine levels*
- *Metals-contaminated soils capped*
- *Roadways decommissioned*

NEXT STEPS

- *Monitoring of former reservoir, creek, groundwater, covers, and vegetation*











1. Construction of the reservoir spillway prior to revegetation
2. Consolidating tailings while building the containment berm
3. Building settling ponds and drainage adjacent to the tailings cover
4. Decommissioning the borrow area used to supply till for the covers
5. Water monitoring below borrow area

49º 14' 05" N, 115º 53' 29" W

MIDWAY MINE

IN-DEPTH ASSESSMENT INDICATES POTENTIAL RISK FROM HISTORIC MINE WASTES



Remedial options to address potential human and ecological health risks are being evaluated.

Mines located on the steep mountainsides of southeastern B.C. supported a large lead-zinc industry through much of the twentieth century from both small and large mining operations. Midway Mine, located 30 kilometres west of Cranbrook, was a smaller mine that operated intermittently between 1933 and 1962. It left behind three waste rock piles and two mine openings.

The mine site is directly adjacent to the historical floodplain of the Moyie River, including a large wetland that is south of Highway 3 and separated from the river by a rail line. The Moyie River supports several salmonid species and is an international transboundary waterway, flowing across the Canada-U.S. border approximately 45 kilometres downstream from the mine site location.

Like many of the historic silver-lead-zinc mines in this area, the mine wastes are prone to acid rock drainage. Runoff is often contaminated with trace metals such as antimony, arsenic, cadmium, lead, and zinc. Laboratory testing at the site has shown that the waste rock itself, and soils affected by waste rock and runoff, have concentrations of arsenic that are much higher than in background soils.

A substantial number of environmental studies have been completed since 2005 to gain a better understanding of contaminant concentrations in the mine waste, soil, sediment, groundwater, and surface water at the site. Among these studies was a detailed human health and ecological risk assessment, which concluded that current risks were acceptably low for aquatic life and wildlife in the wetland and Moyie River; however, possible exposures of occasional visitors to the waste rock areas were a potential concern.

Although current environmental risks to the wetland and Moyie River are low, leaching can continue for many decades, so in 2013 the CCSP also assessed whether ongoing releases and accumulation in the wetland could increase the level of contamination. To study the migration and loading of contaminants, it used an assessment approach that integrated estimated flows of surface and groundwater in the watershed with calculations of the movement of contaminants in the water and studies of arsenic geochemistry in wetland sediments. The assessment showed how contaminants from the mine site are divided between the sediments and the wetland water, and showed that they do not significantly affect aquatic life. The loading of contaminants in the ecosystem, both at present and in the future, is expected to be very low compared to historical levels.

The assessment recommended that risk management measures focus on eliminating direct exposure to the waste rock piles and reducing the transport of contaminants by surface runoff to the wetland.

The CCSP will complete an analysis to identify feasible cleanup options for the waste rock piles to address the applicable human health and environmental risks identified for the site and to further reduce the transport of contaminants into the aquatic ecosystem in the future.

WORK COMPLETED

- *Hydrological and geochemical studies*
- *Assessment of impact of contaminants on aquatic life*

NEXT STEPS

- *Analysis of cleanup options to reduce exposures and future runoff from waste rock*









1. Acid rock drainage from adit
2. Mine and waste products on the north side of Highway 3
3. Large wetland and Moyie River on the south side of Highway 3
4. Waste rock pile with remnant rail cart track

55º 34' 07" N, 125º 23' 26" W

BRALORNE TAKLA HISTORIC MERCURY MINE

THE PROVINCE WORKS WITH TAKLA LAKE FIRST NATION AND CONSULTANTS TO ADDRESS MERCURY CONTAMINATION



The Takla Lake First Nation participates in sampling and selecting cleanup options.

In 1942, in B.C.'s north-central region, about 180 kilometres northeast of Fort St. James, prospectors discovered an outcropping of cinnabar, the ore from which mercury is produced. Bralorne Mines operated a mercury mine on the site for about nine months in 1943 and 1944. One of only a few mercury mines in Canada, it produced almost 60 tonnes of mercury.

Since the mine closed, its workings and wastes have produced a variety of contaminants including mercury, antimony, arsenic, cadmium, and chromium. Mercury is a particular concern because it can become concentrated through biological processes – called bioaccumulation – and its effects on wildlife become more serious as the concentration increases. In addition, the region is rich in many minerals, and the naturally high levels of several metals exceed the standards for permitted contaminants. This posed challenges in assessing the mine contaminants and in designing an appropriate remediation strategy. The remoteness of the site, almost 400 kilometres by road from Prince George, B.C., added to the logistical difficulties.

The mine site is located within the traditional territory of the Takla Lake First Nation (TLFN). The Province of British Columbia and the CCSP have been working with the TLFN to identify contaminants and assess the site. TLFN technicians worked as members of the sampling team to assist with sample collection in 2012 and 2013. A joint technical working group made up of government and TLFN representatives, supported by expert consultants, is working to identify and select a cleanup option that is effective, practical, and acceptable to the TLFN and the Province.

At community meetings in Takla Landing and Prince George in 2012 through 2014, the joint working group reported its findings to the members of the First Nation and asked for their comments.

By the end of 2013, objectives for the cleanup had been developed, and several options for remedial actions were identified. The joint working group plans to recommend a preferred option in the spring of 2014. When an option has been chosen, cleanup work will begin, followed by ongoing monitoring.

WORK COMPLETED

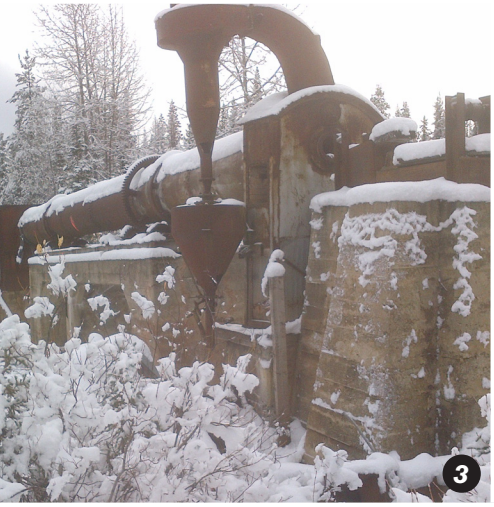
- *Extensive site investigations*
- *Planning and community meetings*
- *Identification of cleanup options*

NEXT STEPS

- *Selection of preferred option*
- *Remediation work and monitoring*















1. Demonstration of sampling a groundwater monitoring well at the mine site
2. Consultants and Takla Lake First Nations technicians collecting samples
3. Rotary kiln and cyclone separator at former mill site
4. Aerial view of the collapsed mill equipment and road, with the calcine (mine waste) in the background
5. Former mine cabin
6. Takla Lake First Nations elders sharing their knowledge during site visit
7. Glacial kettle lake located adjacent to the mine site, and sampled as part of the investigations

49º 35' 31" N, 124º 52' 54" W

UNION BAY

IRON STAINING FROM HISTORIC PILE OF WASTE COAL IS BEING MONITORED



Impacts of acid drainage along the beach are being monitored and assessed by regular mapping and photography of iron staining.

Coal was a key economic resource on eastern Vancouver Island until the middle of the 1900s. The remnants of the industry are still seen in places such as the waste coal pile at Union Bay on Baynes Sound, about 20 kilometres south of Comox, B.C.

Coal mined in the region was washed and shipped from Union Bay from approximately 1890 to 1960. In the cleaning process, workers separated and sent rock and low-grade coal to a nearby waste pile. The pile on the shore of Baynes Sound eventually grew to cover around 13 hectares, to a depth varying from 3 to 18 metres.

As rainwater and groundwater seep into the pile, acid drainage and leached metals migrate from the waste coal pile to the beach. Two iron-stained areas resulting from the leaching are visible on the beaches on the north and east sides of the pile.

Together with the current landowner Kensington Island Properties, and tenure holder West Fraser Timber, the CCSP is is studying the site and the foreshore. The CCSP has been focussing studies on the foreshore since 2009, while the other parties study the coal pile itself. The site is technically challenging due to the acid rock drainage and proximity to both Hart Creek and Baynes Sound. The parties have submitted a proposed remedial plan to the B.C. Ministry of Environment for review and are currently integrating remedial and development plans. The CCSP continues to monitor the beach through ongoing mapping and aerial photographs of the iron staining, which has been shown to be an excellent indicator of impact to the beach ecosystem.

1. Sampling porewater on the beach to measure metal concentrations
2. Iron staining and iron precipitates on the beach
3. View along the beach

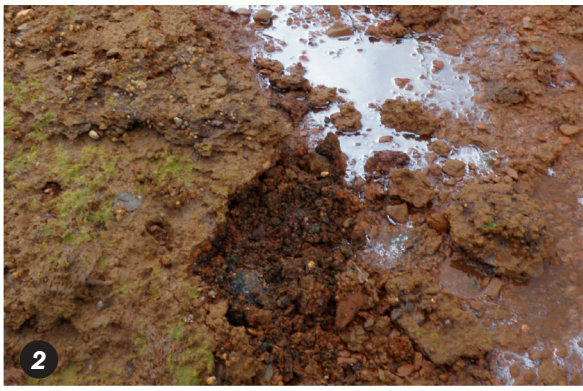
WORK COMPLETED

- *Monitoring of the foreshore including mapping of iron staining and aerial photographs*

NEXT STEPS

- *Continued monitoring of beach*
- *Work with land owner, tenure holder, and Ministry of Environment on remedial plans*







49º 01' 08" N, 125º 21' 32" W

TOQUAHT BAY MARINA AND CAMPGROUND

CONTAMINANTS FOUND AT OCEANSIDE RECREATION SITE



Campground is under remediation due to arsenic and other metals associated with tailings from the closed Brynnor mine.

Toquaht Bay recreation site includes a wilderness campground, marina, and kayak launch site on the west coast of Vancouver Island.

The site became popular for public recreation use after the nearby Brynnor iron ore mine closed in the late 1960s. Sheltered from the open ocean in Barkley Sound near Ucluelet, it was transferred under the 2011 Maa-nulth Treaty to the Toquaht Nation.

In the treaty, the Province agreed to undertake environmental investigations and, if necessary, to clean up any contamination. Preliminary investigations in early 2013 found arsenic, selenium, and cobalt in soil at unacceptable levels, and also identified iron as a concern. The site was closed to assess the risks to humans. The contaminants were found to be associated with mine tailings produced from the former Brynnor mine, an unexpected result as iron mine tailings typically contain little arsenic.

The CCSP began detailed site investigations of all media at the site and adjacent beach to determine the extent of contamination. A report on the findings is expected early in 2014. The CCSP is also working in partnership with the federal Pacific Region Interdepartmental Shellfish Committee to analyse clam, oyster, and geoduck tissues from around Toquart Bay (the body of water has a different spelling).

The CCSP is communicating closely with Toquaht Nation officials to share information and plans. In late summer of 2013, the Toquaht Nation opened a campsite nearby to provide a replacement for the recreation facilities.

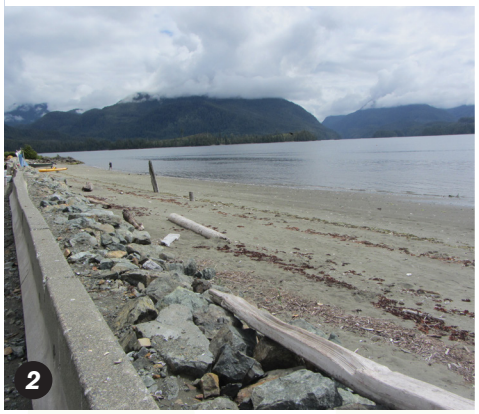
WORK COMPLETED

- *Detailed investigations at the site and foreshore are underway*
- *Human health and ecological risk assessment*

NEXT STEPS

- *Reporting and assessment*
- *Development of a remediation plan*







1. The campground during low season
2. Sandy beach in front of the campground
3. View south along the beach at low tide

50º 54' 30" N, 122º 45' 04" W

MOWSON POND

CLEANUP WORK REMOVES HAZARDOUS WASTES FROM FORMER MERCURY MILL



Investigations revealed contamination including hazardous waste from a mercury ore processing facility that operated between 1963 and 1966.

Mowson Pond today is a back-country recreation site that supports camping, fishing, boating, horseback riding, biking, skiing, and snowmobiling.

Located 12 kilometres northeast of Gold Bridge, B.C., and approximately 200 kilometres north of Vancouver, the hillside above the small lake was the site of a small mercury ore processing facility from 1963 to 1966.

Field investigations starting in 2008 identified a rotary kiln and mine waste contaminated with metals, primarily mercury. Some of the soil, waste rock, ore, and calcines exceeded the permitted concentration of mercury in soil. Since these wastes were within one metre of the surface, the site was considered a high-risk site. A small amount of soil and concrete was also identified as leachable hazardous waste.

To eliminate exposure to the contaminated materials, the CCSP carried out cleanup activities in October 2013. Hazardous waste was transported off-site and disposed of in a permitted facility. Mine structures were demolished. High-risk wastes were consolidated on-site and capped with a one-metre engineered cover. The top layer of the cover was a growth medium, which was seeded with a mixture of native plant species. Metal from the former kiln was cleaned to remove residual mercury and transported to a recycling facility.

In 2014, the CCSP will inspect the site to assess the overall conditions and revegetation.

WORK COMPLETED

- *Hazardous wastes removed to a permitted facility*
- *Other wastes consolidated and capped on-site or sent to a recycling facility*
- *Structures demolished*

NEXT STEPS

- *Post-remediation assessment*

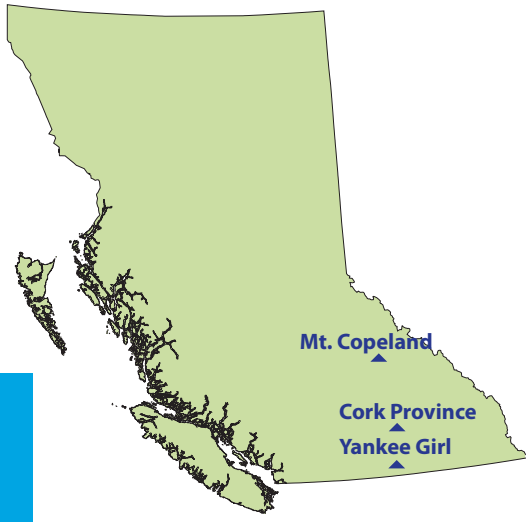
1. Waste material being loaded for disposal off-site
2. Installation of the engineered cover
3. Hand excavation of contaminated soil







UPDATE ON PRIORITY SITES



The CCSP monitors program sites to ensure that remediation work in previous years continues to protect human health and the environment. Key monitoring sites in 2012 and 2013 were:



Mount Copeland

51° 06' 03" N, 118° 27' 57" W

A molybdenum mine and processing facility operated on Mount Copeland, approximately 32 kilometres northwest of Revelstoke, B.C., from 1970 until 1974. The mountain site is accessible only by helicopter and is covered in snow from approximately October to July. An evaluation of the tailings containment facility in 2006 led to work in 2008 to improve water management and reduce the risk of dam failure, which could release tailings to a fish-bearing creek below the site.

Annual site inspections identified issues such as erosion and tears in the spillway geotextile liner. The runoff was redirected and the liner tears were patched. The tailings containment facility remains in a stable condition.



Yankee Girl

49° 17' 09" N, 117° 12' 50" W

The Yankee Girl Mine operated south of Nelson, B.C., near the community of Ymir, from the late 1800s until the 1950s. Tailings deposited on the banks of the Salmo River and Ymir Creek contained elevated concentrations of heavy metals including lead, zinc, cadmium, and arsenic. In 2009, the CCSP consolidated the site's large volume of mine tailings into a single area, treated them with lime, and added an impermeable cover. Additional works included creating a flood erosion barrier; an engineered wetland that reduces metal concentrations through natural processes; and site-wide revegetation. Since 2009, long-term monitoring and maintenance has found that the remedial works are performing as designed and that the environmental improvements from the work have been maintained.



Cork Province

49° 54' 31" N, 117° 04' 36" W

The Cork Province Mine, which produced zinc, cadmium, gold, and silver from 1900 to 1966, left a mass of mine tailings near Keen Creek, a secondary potable water source for the nearby town of Kaslo, north of Nelson, B.C. The tailings impoundment was at risk of failing and endangering the Keen Creek water. In 2008 and 2009, the tailings were moved to a new location upland and away from the creek.

The new tailings impoundment was then covered with a metre of soil and the entire site was replanted.

Long-term monitoring and maintenance following the work has shown that the remedial program has removed the risk of tailings release.

A TIME FOR REFLECTION

THE FIRST 10 YEARS OF THE CROWN CONTAMINATED SITES PROGRAM

Providing sustainable benefits for British Columbians through land restoration

When it was established in 2003, British Columbia's Crown Contaminated Sites Program inherited a legacy of contaminated sites – land, water, and air from previous times when the impacts of industrial development were not well managed. Compounding the problem, information on many of these sites was wanting, opening questions such as which were the most highly contaminated, which required immediate attention, and what kinds of remediation would be needed.

This situation required two main efforts: a system for gathering information and ranking the urgency of the sites, and action on each site.

After 10 years, a tremendous amount of progress has been made. To date, we have identified and managed risks to human health and the environment at sites across the province. Our innovative and flexible approach has created a comprehensive and coordinated government-wide framework for managing contaminated sites on publicly owned lands.

Since the program was established in 2003, leadership has been demonstrated in:

- Using a risk-based approach to assess and prioritize sites and protect ecological health
- Improving the information available on contaminated sites through site research and an electronic database of sites and activities related to them
- Reporting regularly to government and the public on the progress of work and the financial burden of contaminated sites
- Working collaboratively with First Nations, communities, environmental organizations, and other levels of government to tackle problems together

Progress on Site Remediation

We have investigated 84 Crown contaminated sites since the CCSP began. Of these, we have completed remediation on 17 sites. Additional investigation and remediation are ongoing at 17 priority contaminated sites. Assessments have shown that 48 previously investigated sites do not need immediate action as they have been classified as lower risk.

BY THE NUMBERS

What is the current status of the CCSP sites (on March 31, 2014)?

84 Contaminated sites investigated

48 Low priority sites identified as not requiring immediate attention

17 Sites remediated

17 Priority sites undergoing investigation and remediation

Key activities among the remediated sites include:

- Managing acid mine drainage from the Britannia Mine site by treating water before it is released into Howe Sound, which has resulted in improved marine habitat for all aquatic organisms
- Excavating contaminated industrial sites in urban settings such as Vancouver's False Creek (Pacific Place), and landscaping sites for parks, community centres, and residential development
- Moving, encapsulating, and revegetating mine tailings piles that have leached metals into surface and groundwater
- Diverting and rechanneling surface water that eroded or threatened to undermine contaminated sites
- Removing contaminated soils and refuse from substandard landfills and placing them in approved disposal facilities

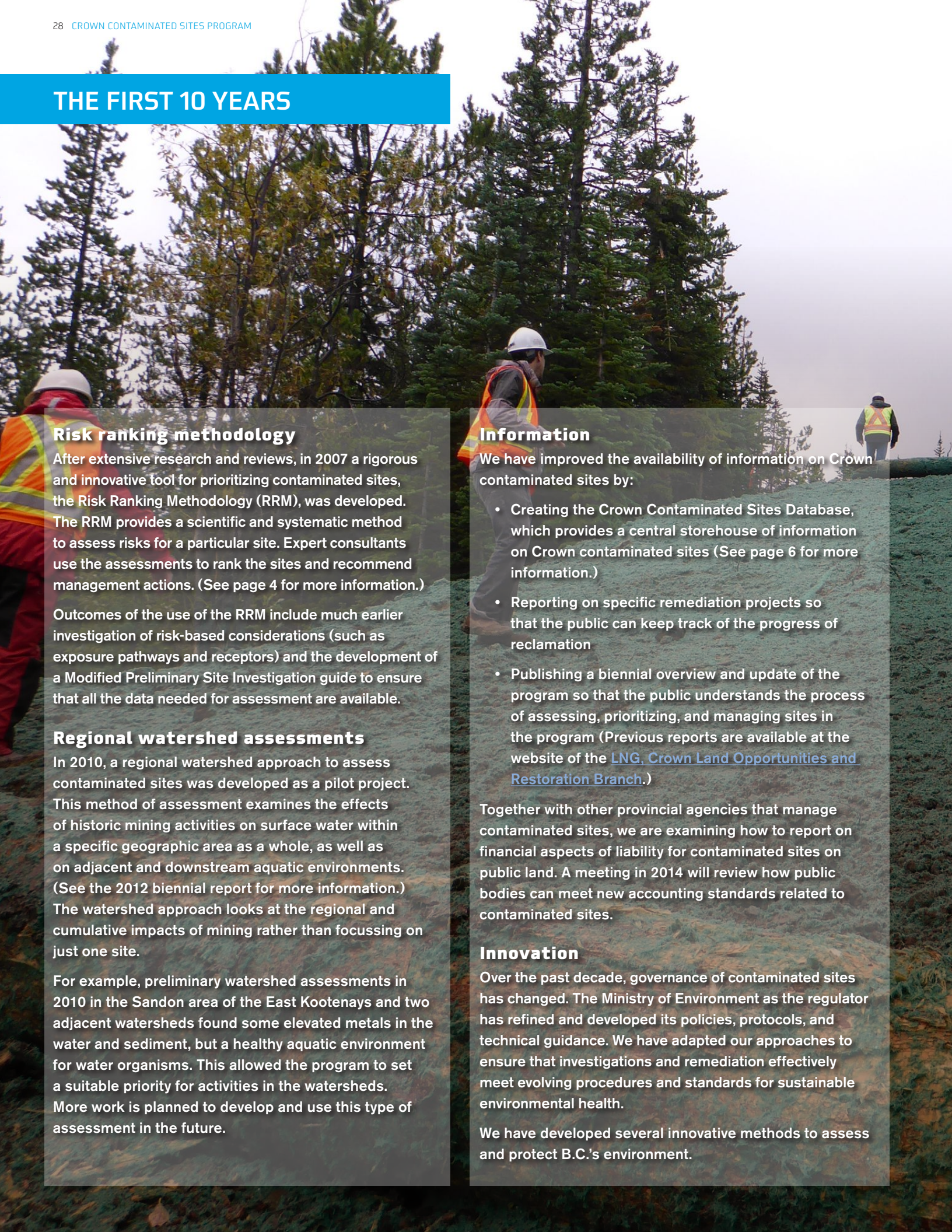
In addition, the CCSP is managing some high priority environmental issues regarding chemicals and reagents at pulp mill sites in Port Alice and Prince Rupert.

These activities have allowed aquatic species to return to acidified water; prevented toxic contaminants such as arsenic, mercury, and other metals from threatening wildlife and human health; and allowed residential and recreational use on formerly contaminated lands.



TO DATE, WE HAVE IDENTIFIED AND MANAGED RISKS TO HUMAN HEALTH AND THE ENVIRONMENT AT 34 SITES ACROSS THE PROVINCE.

THE FIRST 10 YEARS



Risk ranking methodology

After extensive research and reviews, in 2007 a rigorous and innovative tool for prioritizing contaminated sites, the Risk Ranking Methodology (RRM), was developed. The RRM provides a scientific and systematic method to assess risks for a particular site. Expert consultants use the assessments to rank the sites and recommend management actions. (See page 4 for more information.)

Outcomes of the use of the RRM include much earlier investigation of risk-based considerations (such as exposure pathways and receptors) and the development of a Modified Preliminary Site Investigation guide to ensure that all the data needed for assessment are available.

Regional watershed assessments

In 2010, a regional watershed approach to assess contaminated sites was developed as a pilot project. This method of assessment examines the effects of historic mining activities on surface water within a specific geographic area as a whole, as well as on adjacent and downstream aquatic environments. (See the 2012 biennial report for more information.) The watershed approach looks at the regional and cumulative impacts of mining rather than focussing on just one site.

For example, preliminary watershed assessments in 2010 in the Sandon area of the East Kootenays and two adjacent watersheds found some elevated metals in the water and sediment, but a healthy aquatic environment for water organisms. This allowed the program to set a suitable priority for activities in the watersheds. More work is planned to develop and use this type of assessment in the future.

Information

We have improved the availability of information on Crown contaminated sites by:

- Creating the Crown Contaminated Sites Database, which provides a central storehouse of information on Crown contaminated sites (See page 6 for more information.)
- Reporting on specific remediation projects so that the public can keep track of the progress of reclamation
- Publishing a biennial overview and update of the program so that the public understands the process of assessing, prioritizing, and managing sites in the program (Previous reports are available at the website of the LNG, Crown Land Opportunities and Restoration Branch.)

Together with other provincial agencies that manage contaminated sites, we are examining how to report on financial aspects of liability for contaminated sites on public land. A meeting in 2014 will review how public bodies can meet new accounting standards related to contaminated sites.

Innovation

Over the past decade, governance of contaminated sites has changed. The Ministry of Environment as the regulator has refined and developed its policies, protocols, and technical guidance. We have adapted our approaches to ensure that investigations and remediation effectively meet evolving procedures and standards for sustainable environmental health.

We have developed several innovative methods to assess and protect B.C.'s environment.

BY THE NUMBERS

What types of sites has CCSP investigated in its first 10 years?

70 Mine sites
9 Industrial sites
2 Landfill sites
2 Pulp mill sites
1 Forestry site

Awards and Recognition

In our first 10 years, we have won recognition for the CCSP's work, including:

- A special citation from the Technical Research Committee on Reclamation for our complex interdisciplinary work at the Yankee Girl mine tailings site (See the 2010 biennial report.)
- A 2013 award from the Technical Research Committee on Reclamation for creating a cost-effective remediation plan at the Atlin Ruffner mill and tailings site (See page 10.)
- A Premier's Award in 2007 for facilitating a public-private partnership to finance, build, and operate a water treatment plant at the Britannia Mine site (See the 2008 biennial report.)
- A Premier's Award in 2010, with several partners, for a pilot program to train First Nations youth in mining and mineral exploration (See the 2008 biennial report.)

Procurement of environmental services

Since 2006, we have used a master standing offer to hire environmental consultants for work on investigations, risk assessments, and remediation plans. The standing offer system reduces the time and effort needed to efficiently and fairly obtain the specialized scientific services required to assess and clean up contaminated sites.

Looking forward

The Crown Contaminated Sites Program works to protect human health and the environment by managing contaminated sites on Crown land. Building on the accomplishments of the first 10 years, we will continue to look for innovative and cost-effective ways to assess and manage potential risks and to return Crown land to a healthy, productive state.

Our experience will guide us in new and upcoming projects. Our systematic, scientific approach will help us meet our mandate as we complete and monitor existing projects and plan for new ones. We have learned and accomplished a great deal in the past 10 years, and will continue to work for a sustainable environment and economy for the benefit of all British Columbians.



BRITISH COLUMBIA

Crown Contaminated Sites Program
LNG, Crown Land Opportunities and Restoration Branch
Ministry of Forests, Lands and Natural Resource Operations

PROTECTING HUMAN HEALTH AND THE ENVIRONMENT BY RETURNING LAND TO A CLEAN AND USABLE STATE

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