

PROTECTING VILLAGE WATER SUPPLY IN YUNNAN

PILOT REMEDIATION OF ARSENIC MINING AREAS



SEPTEMBER 2009

Implemented with the support of the
Millepede Foundation of Hong Kong

OVERVIEW

CONTEXT AND OBJECTIVES

This project was initiated in late 2006 through dialogue between Blacksmith Institute and the Yunnan Environmental Protection Bureau, based on previous successful collaboration on an environmental project in Fubao Village, just outside the provincial capital of Kunming. The key problem identified for the project is the contamination of local water supplies, high in the head-waters of major river systems, by severe pollution from small, abandoned metal mines and associated metal processing facilities. Yunnan has abundant rainfall and a mean annual precipitation of up to 1,750 mm. The wet season of May to October accounts for more than 80% of the annual precipitation, with major storms, flooding and erosion. These processes drive the spread of pollution from small sites into local water supplies and then from the mountains into the broad river systems.

Three villages were proposed by Yunnan EPB, with its local counterparts, to be included in the project. These were selected as problems in their own right and also as test cases for a significant number of other similar problems in the mountains of Yunnan. The objective was to develop practical approaches for these cases, in collaboration with the Yunnan and local EPBs, which would be models for other mountain villages with similar problems. The three village sites identified are in Huaning County, Nanhua County and Wenshan County. The first of these areas was visited in 2006 by the Blacksmith Regional Coordinator for Asia and YEPB officials. At the time, weather and logistics difficulties prevented the other two sites being reached.

Typically, the core problem is a relatively small abandoned mining site high in the mountains with an owner who cannot easily be traced. Toxic heavy metals, including arsenic, cadmium and lead are being released into the local environment from the mine operations and particularly from abandoned processing facilities and insecure tailings ponds and heaps. The local pollution problems are severe and, because heavy metals do not degrade in the environment, erosion adds to the cumulative pollution load on river system of which it is in the head-waters. Each individual case is too small to gain much political support but a narrow focus on the local problem misses the broader environmental impacts of the large number of such sites, spread though a mountainous area which has widespread mineral resources. For this reason, the project was structured to provide direction and momentum for a wider effort by the Province to address mining pollution and water contamination challenges.

The focus of the work is on health impact for humans, since these sites typically drain heavy metal contaminated water into local waterways that are sources of drinking water for local populations.

Support

In the development of the project, support for its implementation was sought from and committed by the Millepede Foundation of Hong Kong. A contribution of US\$35,000 was approved by the Foundation in 2007, on the basis of a proposal to design and implement first stage remediation of the identified site at Huaning. Blacksmith agreed to provide technical design, supervision, and overall project management from its own resources. A contribution from the local government to the actual costs of remediation works, in kind or in cash, was anticipated.

Initiation of efforts

Planning for detailed site investigations and discussion took place in late 2006 but a number of difficulties, including problems of coordinating international and local technical specialists and of scheduling travel on rain damaged mountain roads prevented the project team from carrying out a full technical survey until the 2007 dry season.

TECHNICAL STUDIES

In May 2007, a technical team from Blacksmith, together with officials from Yunnan EPB and from local governments, made visits to the three mine related sites in the mountains. The Blacksmith team included Peter Hoskins (Regional Coordinator for Blacksmith Institute), Ian von Lindern (Blacksmith Technical Advisory Board Member), Tom Bourque and Mike Sauer. The latter three are very experienced specialists with relevant expertise in risk assessment, engineering and mine site remediation from TerraGraphics Environmental



Engineering, (Idaho, U.S.A.), which has been a long term supporter of Blacksmith's work. Director Zhou Bo of YEPB hosted the visitors and provided introductions and contacts at Provincial, Prefecture and County levels, as well as access to expertise and contacts at various local institutes. Engineers and technical staff from the different level governments joined the visiting specialists for the site visits.

The three sites visited were:

Nan Hua Arsenic Mining and Smelting Site: This is a former arsenic trioxide mine and processing plant that closed in 2000. An estimated 50,000 tons of arsenic residue and 500 tons of rock remain on the site, covering an area of around 53,000 m². The site is located at the head of a valley about 5 kilometers (km) upstream from the nearest village. In October 2004 residents from Long Tan Village (population about 1400) transported residue by trucks and dumped it outside the local government office in protest against the pollution caused by the waste remaining at the site.

Village officials and local environmental and health department officials all expressed serious concerns over the risks posed by the wastes. It is clear that the arsenic wastes on the site represent a significant and ongoing threat to downstream water quality and human health. The waste piles are unstable and their collapse would result in the release of toxic materials into the local water supply. A feasible remediation option for the site would involve stabilizing existing waste piles using local clay and gravel sources, and excavating and armoring diversion channels to prevent further erosion during the rainy season. A broad outline of potential remediation strategies was discussed on-site with local officials.

Huaning Mining/Smelting Waste Recovery and Recycling Plant: This factory recovers metals from mine and smelter waste through a rotary kiln fuming process. Large residues of ash and slag have accumulated around this plant during its operational history. Villagers living below the plant had complained to local officials that their water supplies had become unusable due to run-off from the processing area. Yunnan officials had earlier been informed that the plant had been closed. However, at the time of the visit, there was evidence that the site was being used again for reprocessing material. The size of the residue piles had increased noticeably, new equipment had been installed, and the kiln was still hot, indicating operations just before the visit. There was also evidence of a caretaker living on-site.

This change in status from the time of the first visit meant that the site could no longer be considered “abandoned” and so initial plans for intervention had to be reconsidered.

Wenshan Arsenic Refinery Complex (Plants 1-4): This is an extensive former mining complex, consisting of four arsenic processing plants located on different sites in the same area, which was in operation from 1958-2004. In 2002, the surrounding countryside was designated as a national biodiversity reserve and the County government ordered the factory to be moved out of the reserve. However, the accumulated waste from over 40 years of smelting operations remains on site and continues to threaten the local environment and public health. Since the closure of the complex, some work has been done to stabilize the residues by constructing a retaining dam and associated revegetation effort

at one of the sites, undertaken by a joint team from the Prefecture EPB and Water Resources Bureau. This work was response to an incident that occurred after local heavy rains, when a number of water buffalo in the local village died after drinking contaminated water.

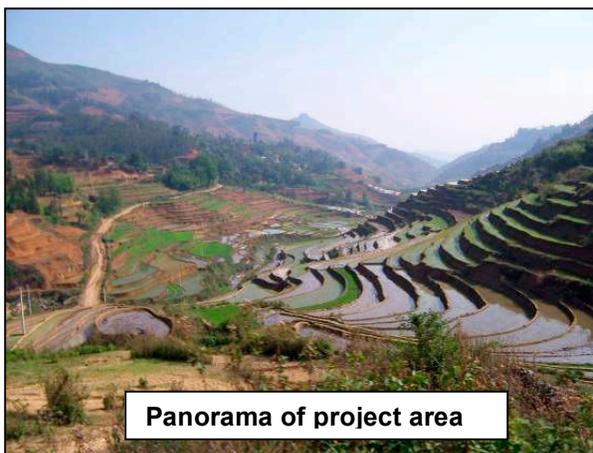
Technical Report

A comprehensive and detailed technical report was prepared by TerraGraphics, on the basis of the visits, and this was shared with YEPB and the local authorities. The report presented a technical review of each site, together with a discussion of human health risks and objectives for remedial actions. Alternatives for practical interventions were addressed, including preliminary costings, and recommendations were presented for each site.

This report provides not just an analysis for each of the three areas but also a blueprint for dealing with the other isolated mine pollution problems in the mountains of Yunnan.

AGREEMENT ON PILOT

The initial plan, before the detailed site evaluations, had been for the first remediation pilot to be carried out at the metal processing site in Huaning, as agreed with Millepede. However, the technical visit to that site discovered that the site had been out back into production (with unknown operators), which created institutional and technical problems. The technical team also recommended that the arsenic contamination problems associated with the other two sites were more needful of immediate attention.



On the basis of these points, the priorities for the pilot project were reviewed by Blacksmith and YEPB jointly. The problems in both Wenshan and Nanhua are broadly similar since they both result from arsenic mining and processing. After consultation with the local level governments, it was agreed that the first physical intervention should be in Wenshan county. Millepede was consulted and agreed to the change of focus for the project.

It was agreed that the pilot remediation would be implemented at one particular site, known as Wenshan no.4. Its formal name (from the Chinese) is Production Area 2 (Furnace 4), Former Wenshan White Arsenic Factory. The site location is

at BaiYiZhai village, HuiLong township, Wenshan county. The GPS coordinates are 103⁰57'14" east longitude and 23⁰16'51" north latitude.

Wenshan county is about 200 kilometers southeast of Kunming, near the Vietnamese border. The mining area itself is about 50 kilometers from the Wenshan County Seat and 13 kilometers from the regional administrative center of HuiLong Township. It is at an elevation of 2335 meters. (See the maps in Annex 1 and 2 for location details.)

Site 4 is the original Wenshan "arsenic factory" and was operating from 1958 to 1986. It employed a 'beehive' kiln technology in which the kiln were charged with ore and charcoal and were fired in batch operations. Oxidized arsenic fume was recovered from cooling chambers and residues were shoveled from the kilns and dumped over the hillside next to the parking lot. About 60-70,000 tons of residue are estimated to exist across this disused area..

Studies by the Wenshan County EPB have identified ten key arsenic residue sites associated with past mining, threatening the water supply of 20,000 villagers in 54 local villages, as well as the supplies for about 170,000 urban residents of the county. The selected site is one of the two highest priority areas for the local government.

These results for the Technical Studies indicated that the waste materials are capable of releasing significant amounts of arsenic to surface and groundwater. The studies noted that many of the samples that were collected show extremely high arsenic concentrations, are corrosive in nature, and should be considered hazardous and extremely toxic. Pre-remediation testing confirmed an arsenic levels of 1.07 mg/L, about 21 times the relevant limit of 0.05 mg/L

IMPLEMENTATION

The changes from the original site to Wenshan and the subsequent discussions on budgets and on technical priorities resulted in delays which prevented the physical works commencing before the beginning of the wet season in mid-2008.

The local authorities in Wenshan agreed to match Blacksmith's grant with an additional \$75,000 in equivalent currency. The total budget of \$100,000 was considered sufficient to complete the pilot, and serve as a model for additional work by YEPB in the other sites.

Preparation

During this time, organisational arrangements were put in place where YEPB, through the Yunnan Environmental Development Institute (YEDI), were

contracted to manage the release of funds to Wenshan and to provide oversight. Formal contracts were also put in place with Wenshan for the construction works.

Wenshan officials prepared detailed engineering construction drawings for the major works on the site. The key elements, which follow the recommendation of the Technical Report, were a retaining wall to stabilise the toe of the main waste slope and surface treatment to prevent erosion as a result of water flowing down the slope. The designers decided to construct a more substantial retaining wall than envisaged in the Technical Report, on the basis of more detailed information on the site conditions. In addition, drainage works were planned to divert water away from the major waste areas. Within the available budget, dismantling and removal or burial of the remaining structures is not possible but the County proposed to secure the site to prevent open access.

A local technical expert was selected and contracted by YEDI to help with oversight review of technical details and inputs on the engineering aspects. He visited the Wenshan at the end of October and confirmed that the final design is acceptable.



Surface water drainage samples were taken by Wenshan County EPB, at the request of Blacksmith, to provide a baseline level against which the post-remediation contamination could be compared. The reported arsenic concentration in the drainage from the sites was 1.07mg/L, 21.4 times above the limit (0.05mg/L).

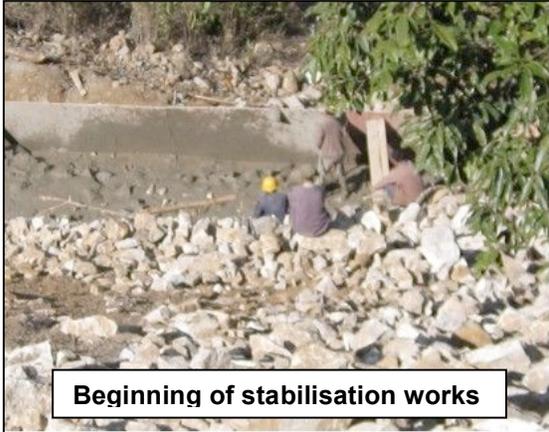
Construction and completion

Initial site work began on site at the end of November 2008, using contractors working for Wenshan County. Upgrading of the access road had to be carried out to allow efficient transport of materials. Limited progress was made through the period of the western and Chinese New Years. After the holiday period work restarted at a rapid pace and the main construction works were substantially complete by the middle of February 2009.

The main components of the works as completed were the construction of a retaining wall to create a stable tailings storage area and the installation of an impermeable lining to the area. The main arsenic residues were then moved to this area and placed in compacted layers to ensure stability. The surface of the completed storage area was then vegetated, using local species which are suited

to the conditions. Drainage ditches were installed along the sides of the final storage area to divert away the surface water flows.

Controls to access are in place to prevent unauthorised access and to deter efforts at salvage and scavenging of the remaining structures, until resources are found to complete the full restoration of the site.



In the middle of March, following the end of the major works, a field inspection was carried out by YEDI officials, with the Blacksmith Country Representative. The team also met with local officers of both Wenshan Prefecture and Wenshan County.

In general, the field inspection confirmed that the main works have been completed as planned, although some areas that remain unfinished

were identified by the YEDI technical expert. The minor works required to bring the site up to the intended standard were discussed and agreed with Wenshan county and have now been completed.

Results of the works

The waste rock heap which had been eroding and releasing contaminated material in every storm has now been stabilised and surfaced. Drainage on the site has also been upgraded, which will divert stormwater away from the area of contaminated material. Therefore the major physical remediation objectives have been met.

Testing of arsenic content in the drainage systems after remediation (according to the local EPB) was 0.048mg/L, which is just within the limit of 0.05mg/L. This value represents a twenty-fold reduction.

Post completion data was limited, due in part to the sensitivity of arsenic issues in Yunnan, as a result of a completely unrelated pollution incident in September 2008 which contaminated drinking water supplies in Kunming City.

The local EPB has planned a programme of sampling during the coming year (to cover both wet and dry seasons) which will provide a better picture of the success of the works in containing the contamination and reducing off site transport.

Finalisation of the work

The final contracted physical remediation costs are considerably higher than those estimated at the beginning of the project. The reasons for this are related to both an increase in the revised detailed technical estimates and also to additional overheads and local taxes and costs.



However, the increases are balanced by the much larger contribution from Wenshan County than was originally envisaged. As a result the impacts on the external budget required have been limited, apart for a much greater overall management overhead than expected, given the various delays in undertaking the construction. Despite the high final costs of the project construction work at the site, Wenshan County EPB agreed to carry out minor additional works on site 4 in order to provide a good showcase for the overall remediation efforts.

Implementation lessons

The logistics of working at a long distance from the capital, on roads which become impassable in the wet season, were a concern at the beginning of the project and proved to be a significant constraint.

Despite the best efforts of all involved, coordination across continents and several layers of government was difficult and took more time than anticipated. Local supervision at the remote site was difficult and limited and increased the costs of the works substantially. During this period Blacksmith appointed a China Country Coordinator (based in Beijing), Mrs. LeYan Wang, which simplified the day to day monitoring and reporting. In similar circumstances in future, it would probably be advisable to contract a full time management/technical person in Kunming in order to ensure better communication with the local authorities and more regular supervision.

A challenging task was the calculation of fair remediation costs, as the location of the site was most remote and road conditions very bad most of the year round. This added substantially to the initial estimates of costs.

MOVING FORWARD

This project has always been seen by Blacksmith and by YEPB as a pilot for a broader programme of remediation for toxic pollution problems related to metal mining in the mountains of Yunnan. The success of the pilot project has been

recognised by authorities at all levels in Yunnan and has reinforced the value of the approaches and the potential for developing the broader programme.

A large part of the success of the pilot is also due to the commitment and efforts of the Wenshan County Government, with the backing of Wenshan Prefecture and the Province. Wenshan County had already carried out some remediation at one site before this project commenced and have been a very good partner throughout this work.

According to the Wenshan County EPB, there are at least five old smelters in the country which need to be addressed and there is an estimated one million tons of polluted materials that needs to be controlled. Ten specific white arsenic residue dumps have been identified by the EPB. Measures are planned to deal with the two worst: Former ErHeGou White Arsenic Factory (which contains 184,000 tons of waste); and Production Area 4 (Big Furnace) of Former Wenshan White Arsenic Factory (assessed by the Blacksmith Technical team as Wenshan Site 1 and identified as a major threat).



Inspection of completed works

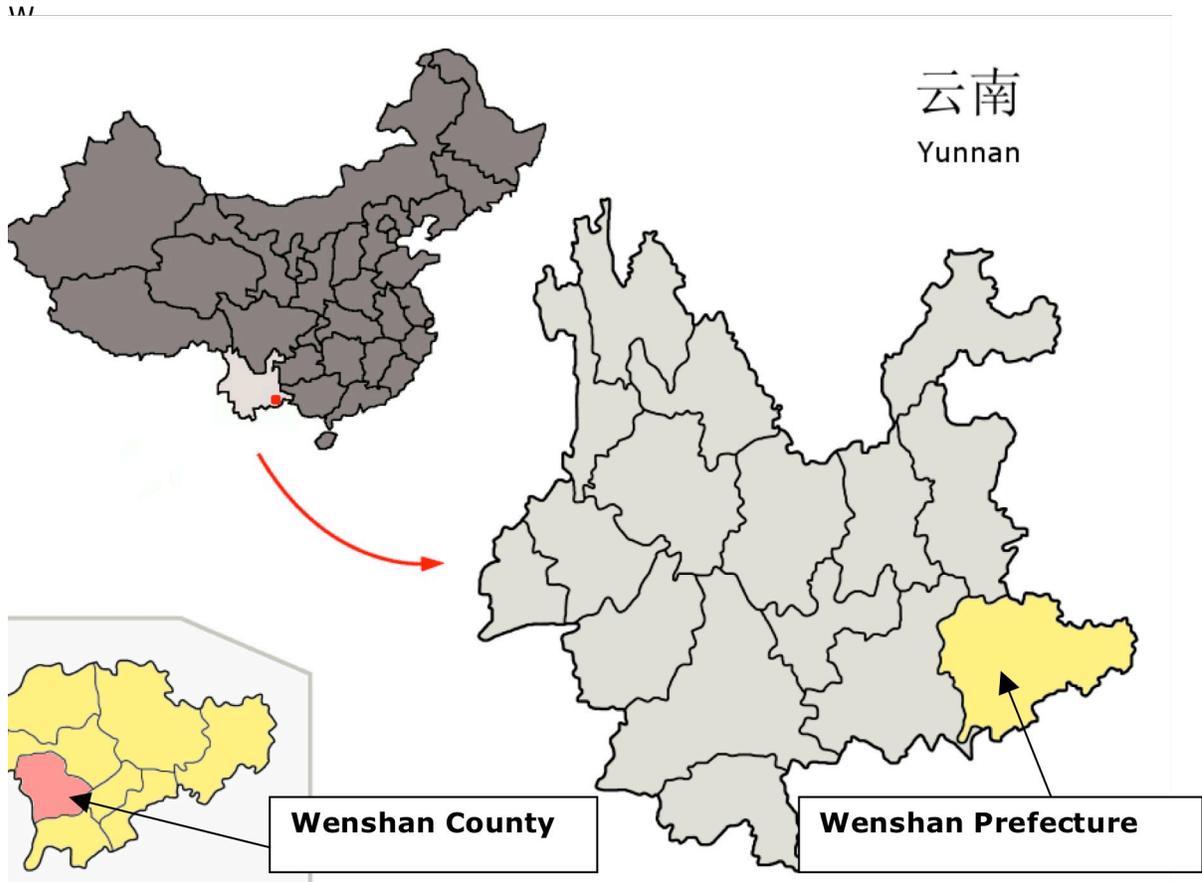
In addition to the efforts at the County level, Wenshan Prefecture is preparing a comprehensive plan to address related issues in all the counties. The new National policy on environment protection in rural areas provides a strong context to move ahead on remediation efforts.

The Prefecture is understood to have submitted a proposal to the Ministry of Environment Protection in Beijing for a total of 100m RMB (US\$12m).

Blacksmith and YEDI are continuing the dialogue with Wenshan Prefecture and County about possible ways to provide technical and financial support to the remediation efforts. It is also planned to renew discussions with Huaning and Nanhua Counties on the sites earlier identified there. The team will follow up with the Provincial authorities on the lessons learned from the project work and on how these lessons could be applied more broadly.

It is planned to have a follow-up visit by the Blacksmith Technical Team to review the work and to discuss lessons learned from the preparation process and the implementation of this first remediation work. This will also be an excellent opportunity to have high level discussions in Kunming (and perhaps also in Beijing) on an effective remediation strategy for the Province.

ANNEX 1 – LOCATION OF WENSHAN PREFECTURE AND WENSHAN COUNTY WITHIN YUNNAN



ANNEX 2 – LOCATION OF PROJECT SITE WITHIN WENSHAN COUNTY

