Mine Closure 2026 – AB Fourie, G Boggs, J Heyes & M Tibbett (eds)

doi:10.36487/ACG_repo/2615_43

Mine closure in Colombia: the complexity of overlapping artisanal mining liabilities

Julián Santiago Forero Zuluaga [a,*], Sebastián Martínez Aristizabal [a], Felipe Forero García [a], Francisco Correa Giraldo [a]

[a] *SRK Consulting, Colombia*

Abstract

Colombia's mining sector is expanding. Gold production reached approximately 1.82 million ounces in 2024, positioning the country as the fourth-largest gold producer in Latin America. However, the regulatory framework for mine closure has not evolved at the same pace. Closure obligations remain embedded within general legislation that lacks binding technical criteria, and for small- and medium-scale mining – which accounts for 97% of active mining titles – closure obligations are, in practice, largely absent.

The consequences of this regulatory gap are more visible in practice than in policy reviews. Investors entering gold projects in Colombia rarely arrive at undeveloped ground; instead, they enter territories where informal and artisanal mining has existed for decades – and in many cases for centuries. This historical footprint does not disappear when a formal operator arrives; rather, it becomes part of the project context. Environmental legacies overlap, responsibility becomes contested, and companies attempting to plan closure responsibly must navigate conditions that the regulatory framework has not fully addressed.

This paper draws on technical experience documented across several gold districts in Colombia. Without identifying specific operations, these examples illustrate how regulatory gaps translate into real technical challenges: inherited liabilities that alter closure planning, undefined closure criteria, the absence of post-closure obligations, and the particular difficulty of planning closure in areas where artisanal mining continues both during and after formal operations.

Rather than representing isolated situations, these conditions form part of the normal operating context of Colombia's principal gold districts. Building on this practical foundation, the paper identifies the most critical gaps faced by professionals and offers practical guidance for those structuring or evaluating mining projects in Colombia.

Keywords: *Colombian mining regulatory framework, artisanal and small-scale mining, ASM, inherited environmental liabilities; mine closure planning, regulatory gaps*

1 Introduction

Colombia has increasingly established itself as an attractive jurisdiction for international mining investment, driven by high global commodity prices, sustained exploration activity, and the strategic role of mining in the national economy. Mining exports reached approximately USD16.9 billion in 2024 (Asociación Colombiana de Minería 2026), representing nearly one quarter of Colombia's total exports. Gold alone generated around USD3.7 billion during the first 11 months of the year (National Mining Agency [Agencia Nacional de Minería, ANM] 2025) and accounted for 32.5% of mining exports, second only to coal. With production of approximately 1.82 million ounces in 2024 (ANM & UPME 2025), Colombia ranks as the fourth-largest gold producer in Latin America (Figure 1).

* Corresponding author. Email address: szuluaga@srk.co

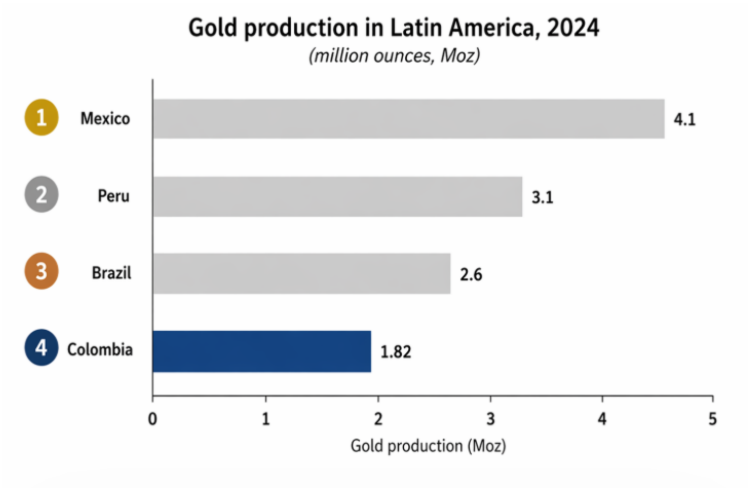

Figure 1 Gold production in Latin America (2024). Source: USGS (2025) and ANM & UPME (2025)

However, the Colombian mining sector is not defined exclusively by large-scale mining. As of January 2025, small-scale mining titles accounted for just over 50% of all active mining titles in the country, medium-scale mining 46.5%, and large-scale mining only 3.3% (ANM 2025). Gold and precious metals represent 47% of all mining titles. This structure is particularly relevant for the gold sector: investors entering Colombia with the objective of developing a mining project frequently operate in territories where ASM, much of it informal, has existed for decades and coexisted with legally granted concessions over long periods.

Understanding the role of ASM in Colombia requires looking beyond production figures. In many territories, artisanal mining is not merely an economic activity; it represents a source of subsistence for families and rural communities facing high levels of poverty, and in several regions, it constitutes the most accessible, and sometimes only, income-generating activity available (Fundación Atabaque& Transparencia por Colombia 2022). In the department of Chocó, for example, artisanal gold and platinum mining along the San Juan, Condoto and Atrato rivers has for centuries formed part of the cultural identity of ethnic communities, shaping social relations and family-based forms of organisation that transcend purely economic considerations. In districts such as Marmato, Segovia-Remedios or Bajo Cauca, the situation is similar: artisanal mining did not begin when formal operators arrived, and it is unlikely to end when they leave.

This reality, often overlooked when regulatory frameworks for mine closure were designed under the assumption of formal operators working in areas without a prior history of artisanal mining, forms the starting point of this paper.

This paper examines these challenges through technical experience documented across several gold districts in Colombia, derived from the authors' direct participation in closure planning, operational support and environmental management processes for mining projects.

2 Colombian regulatory framework for mine closure

2.1 Development of mine closure regulation in Colombia: from omission to partial recognition

Mine closure obligations in Colombia have developed incrementally over the past 3 decades through successive legislative instruments, none of which constitutes an autonomous technical framework. Figure 2 summarises this regulatory evolution.

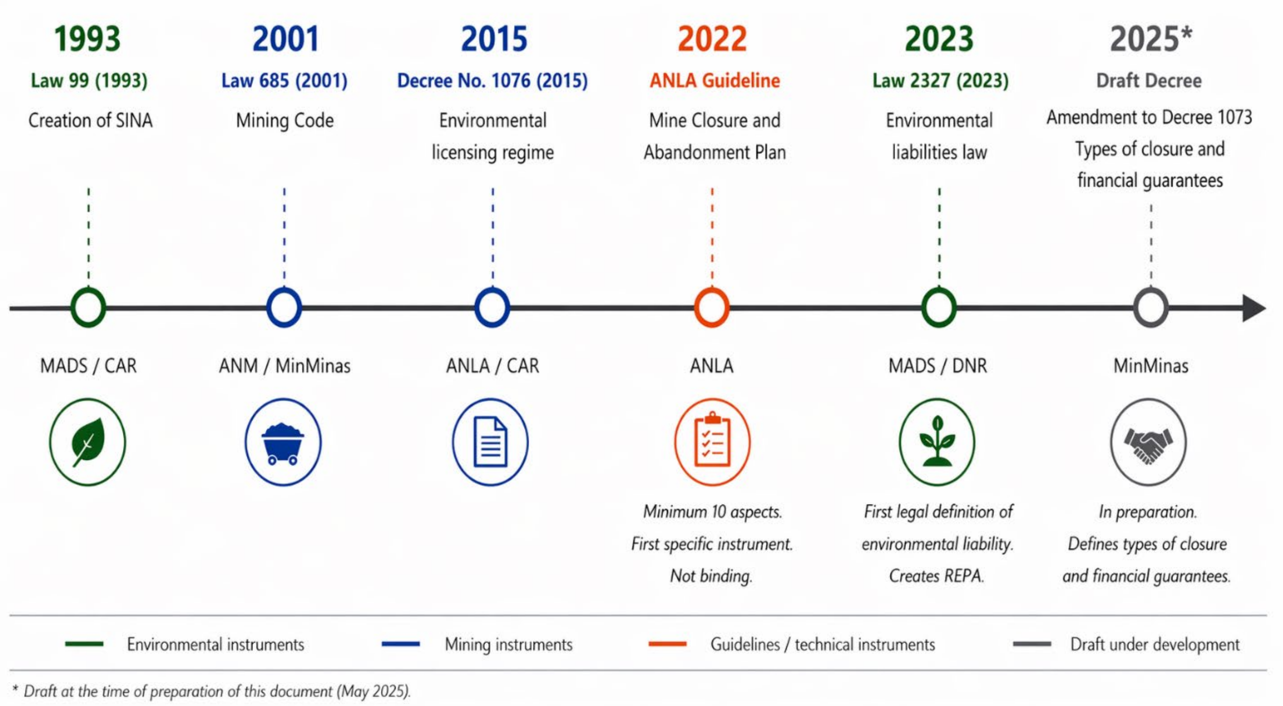

Figure 2 Evolution of regulatory instruments related to mine closure in Colombia (1993–2025)

Law 99 of 1993 (Ley 99 de 1993) (Republic of Colombia 1993) marked the starting point: by establishing the National Environmental System (SINA), it introduced in Article 60 the principle that the exploitation of non-renewable resources must not cause irreversible environmental deterioration. This provision became the environmental foundation for reclamation obligations, although without operational criteria for its implementation. Eight years later, Law 685 of 2001 (Ley 685 de 2001; the Mining Code) (Republic of Colombia 2001) articulated the obligations of mining operators, including the recovery and rehabilitation of areas affected at the end of operations, but it also failed to define technical standards, success criteria or financial assurance mechanisms.

In a related effort to support small-scale formalisation, Law 2250 of 2022 (Ley 2250 de 2022) (Republic of Colombia 2022) established measures for the formalisation of subsistence and small-scale mining, although it does not address closure obligations directly.

The consolidation of environmental licensing through Decree No. 1076 of 2015 (Decreto 1076 de 2015) introduced the formal requirement to include a decommissioning and abandonment plan within the environmental impact assessment (EIA) for projects subject to licensing by the National Environmental Licensing Authority (Autoridad Nacional de Licencias Ambientales, ANLA). However, the level of detail required remained limited, and closure continued to be treated as just another component of the licensing process. The situation did not change substantially until September 2022, when ANLA published its *Guideline for the Preparation of Mine Closure and Abandonment Plans*, the first specific technical instrument produced by the Colombian environmental authority for this purpose.

The 2022 ANLA guideline systematised for the first time 10 minimum components of the mine closure plan and helped establish a common technical language between operators and regulators. However, the guideline itself explicitly states that it 'is not binding nor mandatory'. This ambiguity, technical guidance without regulatory backing, captures the current state of the Colombian framework: there is direction, but no obligation; there is guidance, but no enforceability.

An important development in this regulatory evolution is Law 2327 of 2023 (Ley 2327 de 2023) (Republic of Colombia 2023), the first Colombian law to formally define the concept of environmental liability and to establish the Environmental Liabilities Registry (REPA). In the mining sector, its potential relevance is significant, as it introduces for the first time a legal instrument that could support the identification and management of inherited environmental liabilities. However, its implementing regulations remain under development, and its operational integration with the closure cycle of formal mining projects has not yet been clearly defined.

In parallel, the Ministry of Mines and Energy has advanced the preparation of a draft decree aimed at regulating mine closure more specifically through the incorporation of a new chapter into Decree 1073 of 2015 (Decreto 1073 de 2015). The proposal seeks to introduce definitions related to different types of closure, as well as provisions concerning the preparation and updating of closure plans and the estimation of associated costs. Nevertheless, at the time of writing this paper the instrument was still under development and its final technical scope had not yet been formally adopted.

2.2 Structural weaknesses of the current framework

Beyond the regulatory chronology, 3 structural weaknesses define the current situation. The first is the differentiation in supervision depending on project scale. Small-scale operations are regulated by the ANM and the Regional Autonomous Corporations (Corporaciones Autónomas Regionales), while large-scale projects are evaluated by ANLA. This creates inconsistencies in closure requirements, environmental standards, monitoring obligations and follow-up practices. For an investor assessing multiple projects across different regions, this fragmentation creates uncertainty regarding which regulatory standard must ultimately be met.

As illustrated in Figure 3, environmental regulatory jurisdiction in Colombia is territorially fragmented across numerous Regional Autonomous Corporations. Not all mining projects are evaluated by ANLA; many fall under the jurisdiction of these regional authorities, which operate with varying institutional capacities and do not always apply unified technical terms of reference. This further contributes to variability in how closure-related requirements are interpreted and implemented.

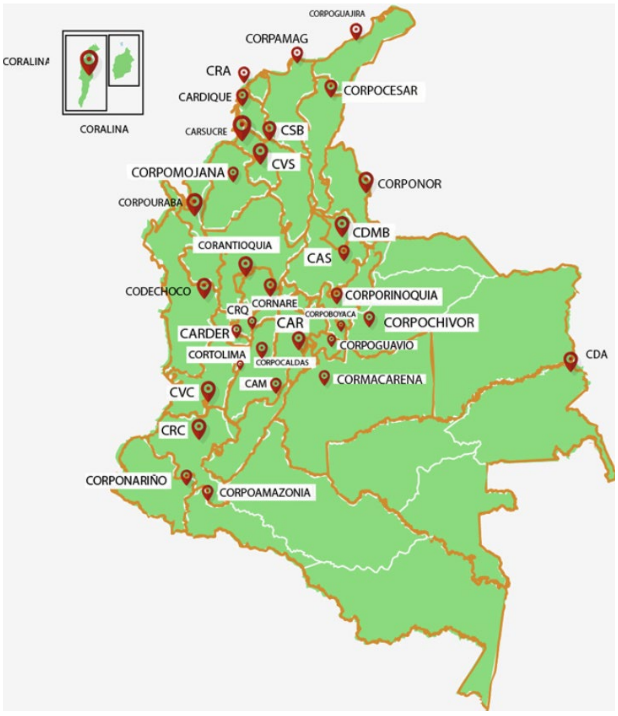

Figure 3 **Regional Autonomous Corporations responsible for environmental regulatory jurisdiction in Colombia (not to scale) (MinAmbiente n.d.)**

The second weakness is the absence of binding financial assurance. Performance bonds included in some concession contracts are not calibrated to the estimated cost of closure, and there is no dedicated fund or mechanism that guarantees the resources necessary to close a project if the operator disappears or becomes insolvent. This gap is discussed in greater detail in Section 5 (B3).

The third weakness is the rigidity of certain requirements without the technical or financial support that would make them viable. The obligation to periodically update the closure plan every 5 years creates uncertainty for companies, yet the evaluation criteria for those updates are not standardised. Similarly, labour reconversion and full rehabilitation requirements may prove difficult to achieve in territories with limited economic alternatives, without state support mechanisms or proportionality criteria that allow regulatory requirements to be adapted to territorial realities. The result is paradoxical: a framework that generates formal closure obligations, but lacks the instruments needed to make them technically rigorous, financially sustainable and territorially viable.

3 Implications of artisanal and small-scale mining for mine closure planning

Artisanal mining in Colombia is not only a legal and social issue; it is also a direct mine closure challenge. In many regions, formal projects are developed in areas with a long mining history, where mineralised systems have been intermittently exploited for decades. Gold deposits, vein systems, alteration zones and structurally controlled mineralisation frequently extend beyond the boundaries of a single concession. As a result, even when a formal project is properly closed, adjacent mineralised areas may continue to attract artisanal mining activity.

This situation is particularly prevalent in districts such as Marmato, Segovia-Remedios, Bajo Cauca, Sur de Bolívar, Chocó and parts of Cauca. Together, these 6 districts account for more than 70% of Colombia's gold production, and in all of them ASM actively coexists with formal operators. This is not a marginal condition; it is the structural reality of Colombian gold mining. As Figure 4 shows, investors entering any of these territories are not assuming an exceptional risk; they are assuming the normal operating conditions of the sector.

Figure 4 Major gold districts in Colombia and areas with active artisanal and small-scale mining (UPME n.d.)

The informality associated with ASM is not primarily the result of cultural preference or unwillingness to formalise. Rather, it is largely a consequence of a regulatory framework that was not designed to accommodate traditional forms of gold extraction (Hruschka & Echavarría, cited in Güiza 2014; Fundación Atabaque & Transparencia por Colombia 2022). The technical, environmental and financial requirements for formalisation remain inaccessible for most artisanal miners, which explains why their presence persists regardless of the arrival of formal mining operations.

One of the main closure challenges is that formal operators may inherit disturbed areas before the project itself begins. Historical impacts may include unstable slopes, abandoned underground workings, active erosion processes, contaminated soils and groundwater, uncontrolled tailings deposits, deforestation and altered drainage systems. In many cases it becomes difficult to determine which impacts are attributable to the current operator and which predate the project. This creates direct uncertainty regarding the allocation of responsibilities and the scope of closure obligations.

An additional challenge is the possibility of continued or renewed mining activity after formal closure, both within mining titles and their immediate areas of influence, as well as in surrounding areas. Artisanal miners may return to closed sites, re-open old workings, excavate waste rock dumps or access zones with remaining mineralisation. In Siguiri, ASM damaged approximately 82% of 12 rehabilitated waste rock dumps, forcing the suspension of progressive rehabilitation efforts in 2020 (Wanenge et al. 2025). In Colombian gold districts with high artisanal mining pressure, this risk is not hypothetical; it is the expected scenario if closure planning does not explicitly consider coexistence with ASM.

Closure planning in these contexts must therefore extend beyond the formal boundaries of the mine and requires a broader understanding of the district context, including historical mining patterns, social and cultural conditions, current artisanal activity, overlapping mining rights and the realistic likelihood of post-closure informal extraction. Post-closure land use planning must also recognise that many communities depend economically on artisanal mining. As a result, closure may generate land use conflicts that undermine the effectiveness of rehabilitation measures.

4 Documented technical experiences in Colombian gold districts

Based on the technical experience documented by the authors in several Colombian gold projects, it is possible to identify a series of conditions that directly influence closure planning in districts with a long history of mining activity. The following sections present representative examples of how inherited infrastructure and ongoing traditional mining activities can influence physical, geochemical, geomechanical and hydrological stability during closure.

From the perspective of closure planning, the mining disturbances observed in Colombian gold districts can be grouped into 2 main categories.

The first corresponds to mining infrastructure inherited within the mining title, developed by previous operators and assumed as part of the current operator's responsibility when the project is acquired. These may include tailings deposits, waste rock dumps, or historical underground workings – structures that do not always meet appropriate design or operational standards.

The second category corresponds to disturbances generated by active traditional mining within the same district, but outside the direct control of the mining title holder. These activities may generate underground excavations, tailings discharges, or waste rock accumulations that affect the same operational environment where the formal project operates.

Although both situations may generate similar environmental impacts, they differ significantly in terms of operational control and direct responsibility during closure planning.

4.1 Physical stability of inherited mining infrastructure

One of the most frequent challenges for closure planning in historical gold districts is the presence of tailings storage facilities (TSFs) associated with small-scale operations that later become part of the area of influence of larger projects. These facilities were often developed without formal geotechnical design criteria, without systematic drainage control, and without construction records that would allow reconstruction of their operational history.

In one of the cases documented by the authors, a Colombian gold project that evolved from an artisanal operation into a larger-scale operation inherited a tailings deposit of approximately 150,000 m³. The original tailings management system included a primary sedimentation stage to remove part of the process water, followed by natural dewatering under open-air conditions before the material was disposed of at surface, mixed with waste rock. The deposit was developed without construction records, without liner systems, and without hydrogeological studies to evaluate potential interactions with the local water system.

In another small-scale gold project later acquired for the development of a larger operation, the new operator inherited a tailings deposit of approximately 8,000 m³ that was originally constructed using partially lined ponds for the conventional discharge of tailings. Although the deposit had been built during earlier operational stages, a stability failure occurred later under the new project owner's management. This event required the operator to implement stabilisation and control measures and to evaluate the potential environmental consequences associated with the incident.

In addition to the geotechnical issues associated with the failure, the absence of detailed geochemical characterisation of the deposited materials introduced additional uncertainty regarding the long-term behaviour of the deposit and the potential impacts on water quality, both in the mitigation of the event and in the future.

Situations have also been documented in which tailings accumulated during early stages of exploitation contains relatively high metal grades due to the low metallurgical efficiency of the original processing plants. In one of the projects analysed, approximately 28,000 m³ of historical tailings were subsequently reprocessed with economically positive results, allowing partial recovery of the contained metal value while reducing the volume of the environmental liability. Although reprocessing allowed the recovery of economic value, these materials still represented inherited infrastructure that had to be considered within the project's closure planning.

In all these cases the underlying issue is the same: inheriting a structure without design documentation, without records, without monitoring, and with the potential to generate acid drainage or affect water quality for decades. When this occurs, the closure plan cannot begin at the point where formal operations ended; it must begin by reconstructing basic information that under normal conditions would already exist.

This inherited deficit in documentation and design stands in direct contrast to international best practice, such as the Global Industry Standard on Tailings Management (GISTM) (ICMM et al. 2020), which requires comprehensive design records, liner specifications, and hydrogeological assessment as baseline conditions for responsible tailings management.

4.2 Historical waste rock dumps

Waste rock dumps represent another significant challenge for closure planning in historical gold districts. In many cases, these deposits were developed without formal geotechnical design criteria or drainage control, either as part of historical operations associated with a mining title or as the result of the progressive accumulation of waste generated by ongoing traditional mining activities within the district.

In one of the cases documented by the authors, a gold project inherited a waste rock dump containing approximately 180,000 m³ of waste material that had been constructed during earlier operational stages without modern engineering standards. The deposit is located close to a populated area and, although recent assessments indicate acceptable conditions of physical stability, no formal systems exist to ensure geochemical stability or to control potential impacts on water quality.

During intervention and progressive removal activities, different types of materials have been identified within the deposit, including soils derived from landslides, organic material, mud, and rock fragments from various sources. This heterogeneity reflects the incremental and poorly controlled manner in which the dump was originally constructed.

In contrast to these inherited structures associated with specific mining titles, other waste rock deposits in Colombian gold districts primarily correspond to accumulations generated by ongoing traditional mining. The sector known as Cien Pesos, in the Marmato district, constitutes a well-documented example of the historical accumulation of waste rock in small drainage basins that flow toward the Cauca River, as shown in Figure 5.

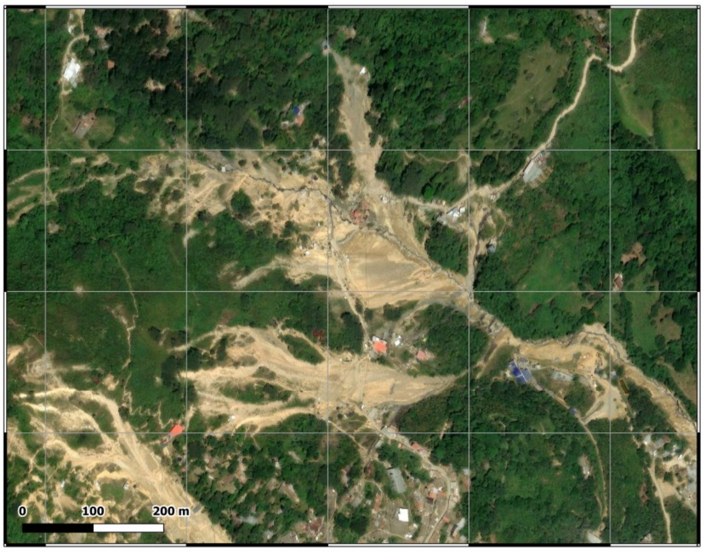

Figure 5 Waste rock accumulation associated with traditional mining in the Cien Pesos sector, Marmato district (Google Earth)

In this area, material has been disposed of for decades through the direct discharge of waste rock onto streams and steep hillsides. The instability conditions associated with these deposits have been identified by authorities for several years and, following significant landslide events that occurred in the mid-2000s, institutional processes were promoted to relocate the urban centre of the municipality to the sector known as El Llano (Colombia Plural, 2018).

However, a significant portion of the population remained in the area and traditional mining activities continued to develop in the sector. As a result, waste rock deposits continue to evolve, and during different periods of the year recurrent landslide events occur. These events affect downstream infrastructure and generate high-risk conditions for both the population and mining activities in the district.

This represents one of the most complex situations for formal operators: waste rock dumps generated by ASM continue to grow outside their control, yet they affect the same territory where operators must demonstrate environmental recovery. Currently, no specific regulatory mechanism exists in Colombia to address this condition.

4.3 Geomechanical stability in historical underground mining

Geomechanical stability represents one of the most complex challenges for closure planning in gold districts where underground mining has been active for long periods. In these contexts, it is common to encounter extensive networks of underground workings developed at different historical stages, under different mining methods and with varying levels of technical documentation.

In general terms, 2 types of underground developments can be distinguished that influence closure planning. The first corresponds to inherited workings associated with the mining title, developed by previous operators and incorporated into the project's infrastructure when the title changes ownership. Although these workings may have been developed without modern engineering standards, in many cases some level of documentation or knowledge exists regarding their location and extent, allowing them to be incorporated into stability analyses and closure planning measures.

The second type corresponds to underground workings associated with traditional or illegal mining that occurs outside the direct control of the mining title holder. These excavations are typically developed progressively and without formal technical records, meaning their actual extent is often unknown. As a result, it is common that previously unknown underground workings are encountered during the development of formal mine workings or during exploration and operational activities.

This situation introduces significant uncertainty for mine-scale geomechanical analyses. Rock mass stability models and subsidence assessments typically rely on the known geometry of underground excavations. However, when undocumented networks of workings exist, any global stability assessment may be incomplete due to the uncertainty regarding the true extent of underground excavations.

In addition to the uncertainty associated with undocumented workings, in some districts direct interactions have been observed between traditional mining and workings belonging to formal mining titles. In at least 2 cases documented by the authors, informal miners gained access to underground excavations belonging to the mining title holder and proceeded to extract material in areas originally designed to serve structural functions within the mining layout, particularly support pillars intended to maintain the stability of the rock mass.

The partial or complete removal of these structural elements can significantly alter the stability conditions originally considered during mine design. Although these interventions are not part of the planned operation of the mining title holder, they can modify the geometry of underground excavations and introduce additional uncertainty regarding rock mass stability. Furthermore, historical underground workings that have not been fully identified may pose risks for new operators who, lacking knowledge of these developments, may plan surface infrastructure, such as waste rock dumps or TSFs above these underground networks, creating potential long-term stability risks, as illustrated in Figure 6.

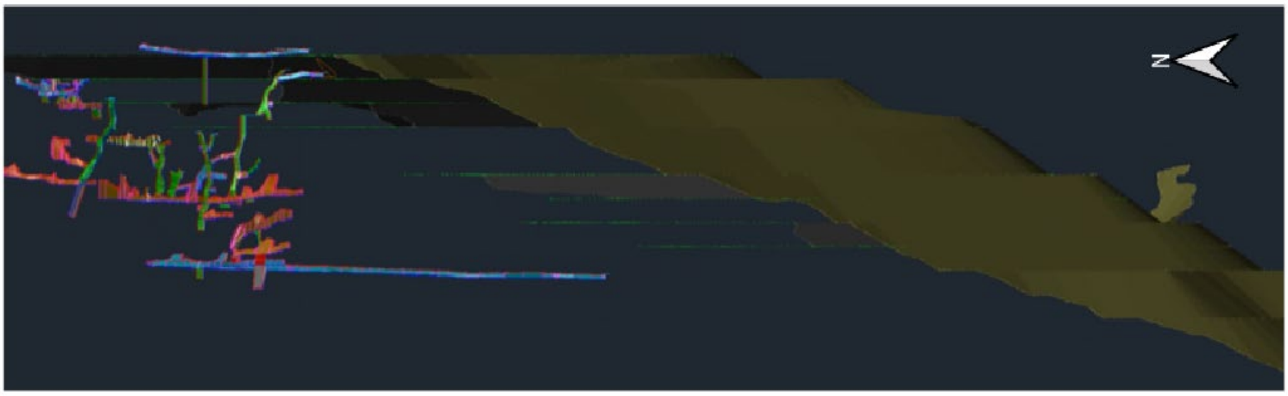

Figure 6 Overlap between surface stacking installation and existing artisanal operation

In one of the districts evaluated by the authors, underground mining has generated complex excavation systems developed over more than a century of mining activity. In this district, the formal mine currently operates with 47 exploitation levels, with workings extending to approximately 1,000 m below the elevation of the main portal, illustrating the scale that underground developments can reach within these mineralised systems.

In districts with this scale of underground development, the question of how to safely seal mine accesses, and how to manage the remaining underground voids, does not have a standard answer. Each situation requires an individual assessment, and the closure plan cannot be designed without first understanding the actual geometry of the system, including workings that do not appear in any available plans.

4.4 Mining methods and rock mass stability

In addition to the presence of historical underground networks, geomechanical stability in old gold districts can also be affected by the evolution of the mining methods used over time.

In many mining districts with a long underground tradition, different generations of operators have applied different mining methods, often adapted to the technological and economic conditions of each period. As a result, it is common to find combinations of workings developed under different mining schemes, with varying excavation geometries and support strategies.

The arrival of larger-scale operators often involves processes of modernisation and mechanisation of underground operations. These changes may require larger excavation sections to allow equipment access and increased production rates. In districts where extensive historical workings exist, the enlargement of excavations can modify the stability conditions of the rock mass, particularly when new workings interact with older developments whose geometry or extent is not fully documented.

In one of the cases documented by the authors, an operator that acquired an existing underground operation had to address a situation associated with historical changes in the mining method used in the mine. During previous operational stages, a mining method had been implemented that generated large underground openings without initially incorporating an adequate structural backfill system to ensure the stability of the stopes.

When evaluating the existing geomechanical conditions, the new operator analysed different alternatives to control these risks. Among the options considered were the implementation of a backfill system with higher mechanical performance or the introduction of ore pillars and bridges that could reduce instability risks, even if this required sacrificing part of the exploitable reserves.

Ultimately, the operator chose to invest in a more advanced backfill system to improve the stability conditions of the existing excavations. This decision not only allowed the operation to continue under safer conditions but also reduced the geomechanical uncertainty associated with closure by limiting the presence of large underground voids that could generate subsidence or long-term rock mass instability.

4.5 Hydrology and water quality

Water management represents another cross-cutting challenge in gold districts with a long history of mining activity. In underground operations, water inflow into mine workings is common, requiring pumping and discharge to surface water bodies through authorised discharge systems.

In Colombia, these discharges are primarily regulated through permits established under Resolution 0631, which defines maximum permissible limits for discharges to surface water bodies. However, in practice, monitoring and enforcement by environmental authorities can be limited, and much of the monitoring depends on reports generated by the operators themselves.

In several projects evaluated by the authors, the arrival of operators with more stringent operational standards has made it possible to identify that some discharges associated with previous operations did not fully comply with the limits established under current regulations. In at least 4 sites evaluated, discharges with elevated concentrations of metals, sulphates, or compounds associated with cyanide use were documented.

The implication for closure is direct: if the sources of water quality impacts cannot be clearly identified, it becomes impossible to demonstrate that a closed project is no longer generating them. In a district with multiple active and informal operations, such demonstration can be extremely difficult without coordination among all parties involved – something that the current Colombian regulatory framework does not contemplate.

Taken together, these examples illustrate a reality that any professional with experience in these districts will recognise planning closure in these contexts is not simply about closing what a project itself created. It also involves responding to what others left behind, in a territory where mining activity continues. That is the normal condition, and the Colombian regulatory framework does not yet provide clear answers for it.

5 Critical gaps for mining professionals

Based on the analysis of the Colombian regulatory framework and the technical experiences documented in historical gold districts presented in Section 4, it is possible to identify 6 critical gaps that affect mine closure planning in Colombia. These gaps do not manifest solely in the regulatory framework; they also emerge in the operational practice of projects, particularly in territories where inherited mining infrastructure, historical underground networks, mining deposits constructed without formal design criteria, and ongoing artisanal mining activity coexist.

In these contexts, professionals responsible for structuring or evaluating mining projects must design closure strategies in scenarios where tailings deposits and waste rock dumps lack construction records, historical underground workings are incompletely documented, water discharges originate from multiple sources, and mining activities occur outside the direct control of the title holder. These conditions generate technical uncertainty in critical aspects such as the physical and geochemical stability of mining deposits, the geomechanical stability of underground workings, water management, and the definition of post-closure land use. Table 1 summarises the 6 critical gaps identified from this analysis.

Table 1 Critical regulatory and operational gaps affecting mine closure planning in Colombia

Gap	Problem description	Proposed approach
B1 – No specific mine closure regulation	Closure obligations are distributed across general mining and environmental legislation. The ANLA Guideline (2022), the only specific technical instrument, is explicitly non-binding.	Establish an independent and binding mine closure regulatory framework with mandatory compliance criteria, aligned with the International Council on Mining and Metals (ICMM) Closure Guide (2025) and international benchmarks.
B2 – Undefined and non-uniform closure criteria	There is no national standard defining what constitutes successful closure; performance thresholds are defined individually for each project. The ANLA guideline identifies 10 aspects but does not provide quantified values or uniform acceptance criteria for issues such as physical stability of mine deposits, geochemical stability, or long-term drainage control. In addition, projects evaluated by different Regional Autonomous Corporations may be subject to varying technical interpretations and requirements, as unified technical terms of reference are not consistently applied across jurisdictions.	Define national performance-based closure criteria with reference values for physical stability, geochemical stability, water quality, revegetation, and public safety. Adopt a risk-based approach (as low as reasonably practicable, ALARP) for sites with inherited conditions.
B3 – Absence of binding financial assurance	There is no standardised methodology or dedicated fund linked to estimated closure costs. Approximately 97% of mining titles correspond to small- and medium-scale operations with limited financial capacity, creating systemic risk of unfunded liabilities in cases of unexpected closure or insolvency.	Adopt a financial assurance mechanism with a standardised calculation methodology linked to estimated closure costs and updated throughout the life of the mine.
B4 – No post-closure obligation framework	There is no guidance on the duration of post-closure monitoring, technical conditions for site relinquishment, or a clear mechanism for transfer of responsibility once mining activities cease, even in sites where long-term geotechnical or geochemical risks may persist.	Define minimum post-closure monitoring periods by type of facility and establish a formal site relinquishment process with acceptance criteria verified by the competent authority.
B5 – Inherited liabilities and mining infrastructure without management mechanism	Formal operators entering historical districts may inherit mining infrastructure and environmental liabilities generated by artisanal mining or previous operators, including TSF, waste rock dump, or undocumented underground workings. Law 2327 of 2023 defines environmental liabilities and establishes the REPA registry, but its operational integration with formal closure processes remains uncertain.	Integrate Law 2327 of 2023 with the closure cycle of formal projects: define the scope of inherited liabilities, establish rules for responsibility allocation, and create incentives for voluntary remediation.
B6 – Coexistence with ASM and post-closure disturbance without regulatory framework	The continued presence of ASM during and after formal operations may interfere with progressive rehabilitation measures and with the effective implementation of closure strategies. In Colombia’s main gold districts this condition is structural, as a significant share of national gold production occurs in territories where ASM coexists with formal operators.	Integrate ASM formalisation into closure planning as an active component; establish monitoring and response protocols for post-closure artisanal activity and consider ASM formalisation as a viable post-closure land use alternative.

The absence of binding regulation and the lack of standardised criteria constitute the structural foundation of the problem. Without an instrument that establishes mandatory closure criteria, all other improvements remain discretionary and depend on the judgment of authorities during environmental licensing processes.

The financial assurance gap (B3) represents the most immediate practical risk. With the vast majority of mining titles in the country held by small- and medium-scale operations, the absence of a mandatory mechanism calibrated to the estimated cost of closure creates a situation in which potential environmental liabilities may be significant, yet adequate financial provisions are not in place.

Gaps B5 and B6 are particularly relevant in historical gold districts. In many cases, formal operators must simultaneously manage mining infrastructure inherited from previous operators and the continued presence of active artisanal mining within the same territory. These conditions introduce uncertainty regarding the allocation of environmental responsibilities, the actual scope of closure measures, and the long-term viability of rehabilitation programs.

6 Practical guidance for investors and project developers

The existence of gaps in the Colombian regulatory framework does not mean that responsible closure planning is impossible. It means that closure planning must be undertaken earlier and with a greater reliance on project-specific information. The recommendations that follow are based on the authors' direct experience in Colombian projects, rather than solely on what existing guidelines suggest should be done.

Due diligence on ASM-related liabilities from project entry. In Colombia, information on historical and ongoing artisanal mining activity is not centralised in a single official source. Technically rigorous due diligence should combine several sources: review of the ANM mining cadastre to identify small-scale mining titles overlapping or adjacent to the project area; consultation of the Colombian Mining Information System (SIMCO) to estimate historical artisanal production in the district; review of the environmental files held by the relevant Regional Autonomous Corporation to identify documented environmental liabilities; and fieldwork in the district to map active workings, informal waste dumps and processing structures that do not appear in any official records. This last component is essential, as administrative information systematically underestimates the extent of artisanal activity on the ground. These initial steps should ideally be supported by consultants or local professionals with experience in the project area who can readily identify potential risks.

Proactive negotiation of closure scope with ANLA or the relevant Regional Autonomous Corporation. In the absence of binding criteria, the scope of closure required for a project depends largely on how it is negotiated with the authority from the early stages of the environmental licensing process. The practice that has shown the best results in Colombia is to include in the EIA an explicit proposal defining the limits of inherited liabilities, clearly distinguishing between impacts that predate the project and those generated by the formal operation. This proposal should be supported by a temporal baseline – historical aerial imagery, cadastral records, and community testimony – that documents the condition of the site before the operator's entry. Although no regulation obliges authorities to accept such delineation, presenting it proactively establishes a negotiated reference that reduces uncertainty later in the project life. These negotiations must be supported by studies and analyses that allow the operator to defend the proposed allocation of inherited liabilities.

Financial provisions proportional to actual liabilities, including inherited artisanal impacts. Closure cost estimates for projects located in districts with a history of artisanal mining should explicitly include: the cost of characterising and treating informal tailings deposits within the area of influence; additional geotechnical assessment for inherited waste rock dumps without design documentation; the cost of extending the period of active post-closure care in areas where ASM remains active; and the cost of long-term geochemical monitoring systems for structures with potential acid drainage risks. In projects evaluated using the ICMM Closure Guide (2025) as a reference, these items should be included in the closure cost estimate with a minimum confidence level of ± 30 % at the pre-feasibility stage.

ASM as a design variable, not only a social condition. Experience in the districts evaluated indicates that the most common mistake made by formal operators in Colombia is treating ASM as a social issue to be managed separately from the technical closure plan, rather than incorporating it as a design variable from the outset. In districts with high artisanal mining pressure, 2 technical questions should be addressed during closure design rather than at the end of operations:

- Which physical closure measures (covers, seals, revegetation) are compatible with the possibility of post-closure artisanal activity in adjacent areas?
- Is there a post-closure land use configuration that allows coexistence between formalised ASM and environmental rehabilitation measures?

Addressing these questions during the design stage avoids situations where a closure plan is approved but its most critical component remains unresolved.

Recognising the ethnic, ancestral and subsistence dimensions of ASM. One aspect that closure plans in Colombia rarely address explicitly is that, in many territories, artisanal miners are not merely informal economic actors with whom land use must be negotiated. They are often ethnic or Afro-descendant communities for whom artisanal mining forms part of their cultural identity, livelihood systems, and relationship with the territory. In regions such as Chocó, Bajo Cauca, and parts of Cauca, practices such as barequeo, mazamorreo, or vein mining have territorial rights dimensions that formal operators must consider from the closure planning stage. This should not be treated only as a community relations issue, but as a legal and technical variable. Ignoring this dimension in closure planning exposes operators to potential conflicts with communities that hold recognised ancestral rights over the territory, regardless of whether they possess formal mining titles. The legal framework that most clearly addresses this dimension is the requirement for prior consultation, which is mandatory for projects affecting ethnic communities – and closure planning, as a modification of post-closure land use, may trigger this obligation (Fundación Atabaque & Transparencia por Colombia, 2022).

7 Conclusion

Colombia has a growing mining sector and a closure framework that has not evolved at the same pace. Three decades of accumulated legislation, from Law 99 of 1993 (Ley 99 de 1993) to the ANLA guideline (ANLA 2022) and Law 2327 of 2023 (Ley 2327 de 2023), have produced guidance without enforceability, principles without defined criteria, and laws without operational regulation. The 6 gaps identified in this study are therefore not abstract. They are reflected in closure plans that cannot be implemented technically, in environmental liabilities without clearly assigned responsibility, and in closure costs that cannot be estimated with certainty because the true scope of the operator’s obligations remains unclear.

The technical experiences documented in historical gold districts show that closure planning in Colombia faces particularly complex conditions. In many cases, formal projects are developed in territories where inherited mining infrastructure exists, including tailings deposits and waste rock dumps constructed without modern technical standards, extensive networks of historical underground workings, and hydrological systems influenced by multiple generations of mining activity.

These conditions introduce additional uncertainties related to the physical and geochemical stability of mining deposits, the geomechanical stability of the rock mass, and water management – aspects that must be addressed during closure planning even when the disturbances were not generated by the current operation.

In addition, the coexistence between formal mining and ASM represents a structural characteristic of many Colombian gold districts. This condition may interfere with the implementation of closure and rehabilitation measures and raises questions about the viability of conventional closure strategies in territories where mining activity continues in parallel with formal operations.

In this context, closure planning in historical gold districts requires approaches that integrate technical, regulatory, and territorial considerations from the early stages of project development. Explicit recognition of inherited infrastructure, long-term geotechnical and geochemical risk assessments, and interaction with ASM formalisation processes emerge as key elements for advancing toward more realistic and effective mine closure strategies in Colombia.

References

ANM 2025, *Estadísticas de Títulos Mineros, Enero 2025* (Mining Title Statistics, January 2025), Bogotá.

ANM & UPME 2025, *Boletín Estadístico Informativo: Minería en Cifras, Enero de 2025* (Statistical Information Bulletin: Mining in Figures, January 2025), Bogotá.

Asociación Colombiana de Minería 2026, *Minería en Cifras* (Mining in Figures), Bogotá.

Autoridad Nacional de Licencias Ambientales (ANLA) 2022, *Guía para la Elaboración del Plan de Cierre y Abandono de Proyectos Mineros* (Guideline for the preparation of mine closure and abandonment plans), Bogotá.

Colombia Plural 2018, *Marmato: Después de la Avalancha* (Marmato: after the landslide), viewed 20 January 2026, https://colombiaplural.com/marmato-despues-la-avalancha/

Decreto 1073 de 2015 (Colombia), *Decreto Único Reglamentario del Sector Administrativo de Minas y Energía* (Single Regulatory Decree of the Mining and Energy Administrative Sector), Ministerio de Minas y Energía, Bogotá.

Decreto 1076 de 2015 (Colombia), *Decreto Único Reglamentario del Sector Ambiente y Desarrollo Sostenible* (Single Regulatory Decree of the Environment and Sustainable Development Sector), Ministerio de Ambiente y Desarrollo Sostenible, Bogotá.

Fundación Atabaque & Transparencia por Colombia 2022, *Marco Normativo Minero en Colombia para la Minería Artesanal y de Pequeña Escala (MAPE) y su enlace con criterios internacionales de Transparencia* (Colombian mining regulatory framework for artisanal and small-scale mining (ASM) and its link to international transparency criteria), Mesa de la Sociedad Civil para la Transparencia de las Industrias Extractivas en Colombia, Istmina.

Güiza, L 2014, 'La pequeña minería en Colombia: una actividad no tan pequeña' (Small-scale mining in Colombia: a not-so-small activity), *Dyna*, vol. 80, no. 181, pp. 109–117.

ICMM 2025, *Integrated Mine Closure: Good Practice Guide*, 3rd edn, London.

ICMM, UNEP & PRI 2020, *Global Industry Standard on Tailings Management*, London.

MinAmbiente n.d., *Corporaciones Autónomas Regionales* (Regional Autonomous Corporations), viewed 20 January 2026, https://archivo.minambiente.gov.co/index.php/noticias/2067

Republic of Colombia 1993, Ley 99 de 1993 (Colombia), *Por la Cual se crea el Ministerio del Medio Ambiente y se Reordena el Sector Público Encargado de la Gestión Y Conservación Del Medio Ambiente* (Law establishing the Ministry of the Environment and reorganising the public sector responsible for environmental management and conservation), Bogotá.

Republic of Colombia 2001, *Ley 685 de 2001 (Colombia), Código de Minas* (Mining Code), Bogotá.

Republic of Colombia 2022, *Ley 2250 de 2022 (Colombia), Por la Cual se Establecen Medidas Para La Formalización De La Minería De Subsistencia Y Pequeña Minería* (Law establishing measures for the formalisation of subsistence and small-scale mining), Bogotá.

Republic of Colombia 2023, *Ley 2327 de 2023 (Colombia), Por Medio De La Cual Se Establece La Definición De Pasivo Ambiental, Se Fijan Lineamientos Para Su Gestión Y Se Dictan Otras Disposiciones* (Law establishing the definition of environmental liability, setting guidelines for its management, and other provisions), Bogotá.

Unidad de Planeación Minero Energética (UPME) n.d., *Distritos Mineros Especiales Para La Diversificación Productiva* (Special mining districts for productive diversification), viewed 20 January 2026, https://www.upme.gov.co/simco/distritos-mineros/

United States Geological Survey (USGS) 2025, *Mineral Commodity Summaries 2025: Gold*, Reston, https://doi.org/10.3133/mcs2025

Wanenge, MT & Mashiyi, N 2025, 'Assessing the impacts of artisanal and small-scale mining on rehabilitated land', in S Knutsson, AB Fourie & M Tibbett (eds), *Mine Closure 2025: Proceedings of the 18th International Conference on Mine Closure*, Australian Centre for Geomechanics, Perth, https://doi.org/10.36487/ACG_repo/2515_25