Teck’s Elkview Operations: visualising an integrated approach to conceptual closure and reclamation planning

D. Harrison  Golder Associates Ltd., Canada
D. Crockett  Golder Associates Ltd., Canada
L. Eykamp  Teck Resources Ltd., Canada

Abstract

Surface mining has the potential to impact both natural and cultural landscapes. Hence, reclamation and closure planning is an integral part of the mine development process — one that presents an opportunity for increasingly effective and sustainable solutions. Reclamation and closure planning, including landscape design, can address post-mine scenarios as they relate to a range of environmental and social objectives. This study examines the role of landscape design and visualisation techniques to support an integrated reclamation planning process that increases landscape performance and better communicates technical information related to post-mine scenarios. Teck’s Elkview operation provides a case study of progressive integrated landscape design and visualisation techniques in closure and reclamation planning. This study examines landscape design efforts that help create more naturalistic landforms and their potential benefits related to environmental management and building strong community relationships.

Regulators and stakeholders are placing increasing demands on mining companies to develop post-mining landscapes that demonstrate a more natural appearance. Post-mine landform design can meet this objective while concurrently providing other benefits such as enhanced wildlife habitat. This study explores methods for developing diverse landforms and revegetation patterns that blend with adjacent natural landscape character; these effectively integrate drainage systems to control surface flows, reduce erosion, minimise long-term maintenance, and create micro-topography that supports wetlands and tree, shrub, and forb cover that promotes biodiversity.

While the contribution of visual aesthetics to landscape performance is difficult to evaluate, the use of data-driven three-dimensional (3-D) visualisations can support improved public acceptance of post-mine landform and revegetation design options by illustrating design intentions and reclamation strategies. Visualisations play a role in communicating technical project design information, supporting community involvement by identifying interests and priorities, and building awareness and understanding of post-mine reclamation scenarios. Advanced visualisation techniques are able to adapt to changes in project design and play a role much larger than graphic support.

1 Introduction

Proactive management during mine closure is important to the discharge of environmental and social responsibility in the mining industry and has an important influence on the landscape. Leading industry practice is to commence closure planning well before mine closure is anticipated; this not only enables improved environmental and social outcomes but also helps guide mining operations towards post-mining landscapes that avoid expensive earthwork activities after closure (Government of Western Australia, 2011). Mine closure in British Columbia is guided by the Health, Safety and Reclamation Code for Mines in British Columbia (British Columbia, 2008). Closure plans for mines are required to allow for progressively reclaiming areas and must focus on the development of geotechnically and hydrologically stable landscapes. An important consideration in closure planning is the development of post-closure landforms that address visual impacts caused by mining operations. One of the challenges for mining companies is to communicate potential visual changes to the landscape, which result from mining activity over the life of the mine.
operation, to regulators and the public in order to identify reclamation and landform design options that can return a post-mining landscape to an acceptable level of natural appearance.

The township of Sparwood, with a population of approximately 3,667 (British Columbia, 2011), is located in southeastern British Columbia, within the Elk Valley region of the Southern Canadian Rocky Mountains (Figure 1). This scenic region is characterised by the wide Elk River valley, forested slopes, and rocky ridgelines at higher elevations. The area has a long history of industrial use, including forestry and coal mining. Mining at the Elkview mine site, adjacent to Sparwood, commenced in the late nineteenth century and progressed in 1969 to the first large-scale open-pit operation in the Elk Valley. Teck Resources Limited (Teck) today continues open-pit coal mining at its Elkview Operations (Elkview), which is one of five active steelmaking coal mining and processing operations owned and operated by Teck in the Elk Valley.

![Location map of Teck's Elkview Operations and communities within the Elk Valley](image)

**Figure 1** Location map of Teck’s Elkview Operations and communities within the Elk Valley

Elkview is located approximately 2.5 km east of downtown Sparwood, and mining occurs on three north-south trending ridgelines. Baldy Ridge is the closest ridgeline to Sparwood and the most visually prominent, forming the eastern skyline of the community. To sustain mining at Elkview, Teck is proposing to extend mining operations by developing the Baldy Ridge Extension project. This project will see mining continue along the remainder of Baldy Ridge, resulting in the lowering of the ridgeline and development of waste rock spoils in the mined-out pits; mining operations will reach very close to Sparwood. Permitting of the project is proceeding via the British Columbia (B.C.) government-led regulatory process, which prescribes regulatory and public consultation as part of the approval process.

While mining has a long and economically positive association within Sparwood and the Elk Valley, local residents have voiced concern over anticipated long-term visual changes to the existing landscape associated with the mining of Baldy Ridge during operations and after closure. In addition to community concerns over visual changes to the local landscape, B.C. provincial regulators responsible for reclamation have communicated a desire to have Elkview’s post-mining landscape resemble natural land forms.

Teck engaged an interdisciplinary team of landscape design and visualisation specialists from Golder Associates to develop a reclaimed landform concept that addresses community and regulatory concerns
regarding visual aesthetics and also maintains existing environmental requirements and closure plan objectives. The team was tasked with providing recommendations to Teck’s engineering and closure planning team to consider ways to achieve these objectives in a cost effective and operationally efficient manner. To aid in communicating the proposed visual changes of the project through the permitting process and to demonstrate the post-closure landscape, Teck recognised that professionally developed and detailed landscape visualisations of operation and post-closure landforms were needed. Such images needed to show both a sequential presentation of visual changes to Baldy Ridge over the mining period, and, more importantly, the anticipated final landform and reclaimed post-mining landscape.

2 Designing natural landform appearance

Waste rock spoils are typically strongly engineered geometric forms designed with geotechnical and hydrologic stability and operational efficiency as primary concerns. The formation of waste rock spoils is typically characterised by large, uniform angled slopes with level tops and strong edges visible at their crest and along bench lines. The slopes, composed of angular mineral rock and fines, can be darker in colour, more uniform in texture, and slow to develop tree or shrub cover in comparison with adjacent natural landforms. The result is the introduction of prominent landforms that contrast with and appear unnatural in character relative to the adjacent unaltered landscape, which may include undulating, rounded, and weathered terrain such as avalanche chutes, ravines, variable clusters of mixed deciduous and coniferous trees, shrubs, open grasslands, and rock outcrops (Figure 2).

Figure 2 Example of natural landform with variations of landscape features and vegetation communities

To facilitate feedback from the public on predicted project-related visual changes, Teck began by engaging the community of Sparwood through presentations and poster displays at community consultation events in 2014; these included simulated images of an initial design concept of Baldy Ridge from key local viewing locations. Simulated visual images of the Baldy Ridge project were developed by visualisation specialists using landscape modelling software based on digital terrain data provided by Teck’s engineers. Initial designs were created to address current regulatory and operational requirements for landform design, which focused on stability and efficient waste rock movement, and demonstrated the strong engineering features described previously.

Public consultation events successfully generated feedback that identified specific community concerns related to visual aesthetics based on these initial visualisations. Figure 3 presents a simulation image used
for community consultation and illustrates the character of the initial design visible from Highway 3, near the entrance to Sparwood.

Figure 3  Initial landscape visualisation of the waste rock spoil concept design for public consultation

To address the community’s visual aesthetic concerns, the team’s landscape architect initiated a preliminary visual review of adjacent and similar landform typologies, starting with photographs and graphic images that explore potential end states for the waste rock spoils closest to Sparwood. The images were used to explore ways to diminish the strong, anthropogenic character of the engineered landforms by interrupting the large, uniform masses of the slopes with ravines or draws to simulate mountains or hillsides formed through natural environmental processes. Teck engineers were provided with recommendations to vary slope gradients, with slopes often in the 20 degree range rather than the angle of repose. Engineering methods to achieve diverse landforms included varying the width of the benches to create a more scalloped edge, which would form dump fans to simulate ravines and draws. Rounding the shoulders of the bench and pit crests would help to provide a more convincing weathered appearance. Adding large mounds of spoil material and organic soils to the top of plateaus and benches, to simulate weathered knolls and hummocky features, would help to create additional variations in slope and aspect with the potential for associated soil and moisture benefits. Figure 4 illustrates an initial concept design developed to mimic natural landform and vegetation.

Figure 4  Illustration of waste rock spoil concept design on Baldy Ridge to mimic natural landform and vegetation

3  Use of 3-D landscape modelling and reclamation design data in community and regulator engagement

The three-dimensional (3-D) landscape modelling technique uses geographically specific information to develop recognisable, simulated graphic images. There are a diverse range of technologies and techniques
available to develop and present these geographic visualisations, ranging from tools like Google Earth to more advanced landscape simulation software capable of nearly photorealistic levels of detail. These powerful data exploration tools can help represent the composition of landscape elements based on data-driven modelling information. Data-driven landscape models provide a high degree of spatial accuracy in their representations, which allows predictions of post-closure landscape simulations to be both defensible and reliable illustrations of closure designs (MacEachren, 2004).

While landscape modelling and visualisations can present accurate and recognisable landscapes, they also allow for modelling of alternative landscape design scenarios. These scenarios may be geographic in nature and demonstrate alternative closure designs and/or they may be temporal and demonstrate changes over time. This approach is useful for characterising post-closure designs to assess potential alternatives for landscape performance. Where designs are not seen to be effective, landscape modelling enables specialists to adapt the design or portions of the design to improve its overall effectiveness and then to reassess its ability to meet objectives such as reducing visual impacts.

As outlined above, portions of the project are highly visible at sensitive viewing locations within the community of Sparwood and along Highway 3, a popular tourist route between British Columbia and Alberta. The concerns of regulators and the public over the potential visual impacts of current landform practices place an increasing demand on mining companies like Teck to communicate post-closure landscape designs and demonstrate that they understand and respect local stakeholder’s values in the process of gaining social acceptance for a project. The use of 3-D landscape modelling and visualisation in community consultation supports opportunities to gather constructive input that identifies community interests and priorities and builds awareness and understanding of post-closure landscape aesthetics.

Technical complexity is a characteristic of developing and communicating reclamation and mine closure plans. The design process involves a large amount of detailed information and studies from a variety of technical disciplines. Proponents rely on this approach to provide sound and transparent strategies; however, communicating the technical detail used to define mine closure plans and their implications for community values such as visual aesthetics to the broad range of stakeholders involved may present a barrier to a clear understanding of the post-closure environment. Designing for geophysical and hydrological stability is important, but what does that look like? This can make it difficult to gather information from stakeholders, and it may result in adverse reactions to a project’s legitimacy (Garcia, 2008). Community consultation in the closure planning process is an opportunity to explain the objectives and technical scope of a design. Landscape modelling can support this process by presenting technical information accurately and in a recognisable graphic format, allowing for a higher degree of understanding and a higher potential for consent. Advanced landscape modelling capable of producing highly realistic simulation images can provide easily understood representations of post-closure design aesthetics. Conveying subtle and detailed landscape information that is easily recognisable to stakeholders who are familiar with these landscapes is critical to local perceptions of the land, and this has been found to enhance the ability to achieve fair and meaningful discussion on local values during the consultation process (Lewis and Sheppard, 2006). For the Baldy Ridge Extension project, the use of geographic visualisation tools to depict landform design and reclamation has been valuable in developing awareness and involvement from stakeholders and identifying issues and options.

Teck’s mining engineers at Elkview worked collaboratively with reclamation and landform experts to facilitate changes to the initial Baldy Ridge waste rock spoil concept design based on community feedback. Landform design principles were interpreted and applied to mine design data resulting in a revised 3-D landscape model and simulated images. Available information on the conceptual reclamation design related to vegetation and land cover components and their prescriptive locations was also incorporated into the landscape model. Using geographic allocation methods and vegetation composition parameters within the 3-D landscape modelling environment, specialists added the conceptual reclamation vegetation plan to the new landform design; this provided a more complete visual representation of Baldy Ridge’s evolution during operation and post-closure phases and demonstrated the visual effects of progressive reclamation and closure. The changes
focused on developing a final landform that better met the community’s and regulators’ desire for a post-mining landscape that resembles the natural landscape.

Updated images of the revised mine design were used in posters presented at consultation events in 2015 to communicate the redesign of the project to the community. Figure 5 illustrates an updated concept design. This iterative process allowed Teck to demonstrate to the public the changes made to the initial designs. These visual images form part of the permitting application for the project and are still subject to government review and approval.

Figure 5  Updated landscape visualisation of the Baldy Ridge Extension waste rock spoil concept design for community engagement

4 Opportunities for an integrated approach to landform design

Addressing concerns related to visual aesthetics in the context of Teck’s goal to develop mining areas transformed by human activity into functioning ecological landscapes provides an opportunity to address other ecological and social objectives. As part of its Sustainability Strategy for Biodiversity, Teck has made the goal to achieve a Net Positive Impact (NPI) on biodiversity. In pursuit of this goal, Teck’s closure planning aims to reestablish ecological landscapes that become self-sustaining over time. To address this need, it must consider varied aspects of natural systems related to landform design. These include creating microclimates, varied vegetation communities, and related wildlife habitats; considering soils and the dynamics of local hydrologic regimes such as surface erosion; and reestablishing natural ecological process. Landscapes are rarely static but develop over time; hence, incorporating naturally evolving processes into landform design systems is expected to aid in reestablishing natural systems and a naturalised post-closure landform aesthetic. Reclamation work at Teck’s operations to date has incorporated trials of machine roughening of finished terrain surfaces, which encourage microclimate variations that have the potential to retain fines and moisture and improve plant success. While the roughened surfaces will likely not contribute significantly to the landform as it is seen from a distance, on-site observations suggest the practice is important for reducing plant mortality and encouraging the different visual effects that come from natural vegetation patterns and textures.

Achieving an acceptable natural landform aesthetic in post-closure phases of mine remains a topic of interest. In the development of the Baldy Ridge reclamation design, the landform aesthetic is addressed by simulating adjacent natural landforms and vegetation patterns to the extent possible so that the resulting mine-related landforms contrast minimally with the existing landscape context. While achieving pre-mining conditions is not possible, the design reflects an approach where form follows function; the efforts to create an acceptable visual aesthetic reflect the parallel efforts to address multiple technical constraints and ecological objectives. Understanding post-closure landscape design objectives will allow mine operators to initiate measures during mining operations and at early stages of progressive reclamation that could potentially result in reduced maintenance cost and improved long-term landscape performance while satisfying the public’s desire for a suitable landscape aesthetic.
The mine operator may also balance potentially competing land use objectives with other land uses and land capability interests that may be of value to the community, especially at Elkview where the mine is located immediately adjacent to Sparwood. Land may be considered both a liability and an asset in the post-closure context. While current mine closure requirements focus on geotechnically stable landforms, hydrologic function, and long-term ecological integrity, consideration of other environmental services and land uses that support local economic diversity (for example, commercial, industrial, agricultural, or recreational uses) are strong determinants for the local community. Listening and responding to community aspirations to the extent possible will help build trust and social acceptance of the project.

5 Conclusions

An emerging aspect in reclamation and mine closure planning is the development of post-closure landforms that reduce visual impacts caused by mining operations. Community concerns over visual changes to the local landscape and recent comments from regulators have communicated a desire for post-mining landscapes to resemble natural land forms. The challenge for mining companies is to design reclamation and landform environments that succeed in reducing visual impacts from mining operation while meeting existing environmental requirements, ongoing mine operations requirements, and closure plan objectives.

To support landscape design and aid in communicating predicted visual impacts related to the Baldy Ridge Extension project, Teck recognised that detailed, data-driven landscape visualisations of operation and post-closure environments should be created. It used 3-D landscape modelling and visualisations to improve public understanding and community involvement by illustrating design intentions, communicating technical design information, and facilitating the identification of interests and priorities for the post-mine reclamation landscape. Images were developed from a key viewing location near the community of Sparwood for initial open-house events in 2014; these demonstrated potential visual changes to Baldy Ridge landscape features over the mining period and illustrated the anticipated reclaimed post-mining landscape. Feedback identifying specific community concerns related to visual impacts that, along with a design review by Golder’s landscape architect, informed Teck’s mining engineers’ efforts in redesigning the landform.

Updated visualisations were prepared based on new landscape model data, and these were presented at subsequent open-house events in 2015. The revised mine design has demonstrated the potential for reclamation and landform design to broadly support environmental and social responsibility by addressing aesthetic concerns, providing opportunities for increased ecological landscape performance, and supporting an enhanced community and regulatory engagement process.

References


Bibliography