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Defining best management practices for conservation of reclamation materials in the mineable oil sands region of Alberta

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Abstract

In the mineable oil sands region of northeastern Alberta the bitumen-bearing McMurray formation is extracted by open-pit mining using trucks and shovels. Given increasing concern over environmental impacts, more assurance is demanded in the overall reclamation process. As part of the response to this situation, a task-group was formed to define Best Management Practices (BMPs) for conservation of reclamation materials in the mineable oil sands region of Alberta.

This paper describes the setting in which the task-group was formed, the process by which BMPs were defined and the structure of the BMP document. It also provides a retrospective analysis of the exercise, identifying what the challenges were and assessing how and to what degree they were overcome.

The task-group faced three specific challenges when trying to define BMPs. Firstly, it was impossible to define BMPs based solely on effective implementation at an operational scale. Secondly, it was difficult to anticipate all possible operational constraints and define BMPs in consideration of the full extent of the mine disturbance. Thirdly, reclamation of entire landscapes is an ecologically complex task. In the face of these challenges, it was easier to define BMPs for salvage than placement of reclamation materials.

1 Introduction

1.1 Mineable oil sands region

In the mineable oil sands region of northeastern Alberta the bitumen-bearing McMurray formation occurs close enough to the land surface to be extracted by open-pit mining using trucks and shovels. Mining effectively removes much of the pre-disturbance landscape, replacing it with overburden dumps and tailings deposits that require reclamation to self-sustaining locally common boreal forest ecosystems. Between 1977 and 2009 oil sands mining in northeastern Alberta has disturbed approximately 663 km^2 (66,342 hectares) of the 4,800 km^2 of land available for mining (Alberta Environment, 2009). The number of projects and the total extent of disturbance continue to increase. These factors, and the duration of each project over multiple decades, complicate reclamation of disturbed land.

Conservation of reclamation materials is one component of a successful reclamation strategy; how this material is placed is another. The region is composed of complex landscapes of different surficial geology. As a consequence, a variety of reclamation materials can be used to construct the surface layer and rooting zone on the post-disturbance landscape. Reclamation materials available for use as coversoil include an organic horizon, peat-mineral mix, upland surface soil and transitional soil. Upland subsoil, suitable overburden and tailings sand are available as subsoil. Reclamation materials can also include woody debris, roots and seed cones. Reclamation practices for upland have evolved over more than forty years and currently target ecosites (or groupings of ecosites) defined by moisture and nutrient regime. Moreover, stakeholder expectations for the reclaimed landscape are more sophisticated and diverse than before.

1.2 Regulatory context

The Government of Alberta regulates large industrial developments (e.g. coal and oil sands mining) through a number of Acts and Regulations. Reclamation is primarily regulated under the Environmental Protection and Enhancement Act (EPEA) administered by Alberta Environment (AENV), and the Public Lands Act administered by Alberta Sustainable Resource Development (ASRD). The EPEA approval regulates all aspects of air, land and water; examples of which includes: dust, water quality, dam safety; land conservation and reclamation which includes relationships with fish, wildlife and biodiversity. The approval from ASRD provides access to the land through a Mineral Surface Lease. At present the Energy Resources Conservation Board (ERCB) regulates mine development and recovery of resources including landform design and tailings management.

The requirement for Best Management Practices (BMPs) emerged from the 2006 Alberta Energy and Utilities Board public hearings for three applications for oil sands mines. In these hearings the government proposed that reclamation practices be improved over time by implementation of BMPs. Given this direction, AENV and ASRD requested that the Cumulative Environmental Management Association (CEMA), an appropriate multi-stakeholder forum, proceed to define BMPs for upland reclamation. The BMPs were to be compiled into a guidance document and recommended to government upon completion.

Several documents provide guidance for upland reclamation in the mineable oil sands region: e.g. Land Capability Classification System for Forest Ecosystems in the Oil Sands (Alberta Environment, 2006) and Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region (Alberta Environment, 2010). Definition of BMPs was intended to complement these guidelines by describing practices that will help achieve specific goals set out in them. Definition of BMPs will also support several plans required by EPEA approvals for achieving specific conservation and reclamation objectives. The most recent EPEA approvals state that operators should consider any guidelines prepared or provided by the director related to the development of soil salvage and placement strategies. Hence, BMPs will be used for developing annual Soil Salvage and Placement Plans. They may also inform the Mine Reclamation Plan and the Life of Mine Closure Plan with a focus on the reclamation material balance. It should be noted that BMPs are not regulations and are not intended to replace approval conditions.

1.3 Objective

The objective of this paper is two-fold. Firstly, it describes the process used by the task-group to define BMPs. Secondly, it provides a retrospective analysis of the exercise, identifying what the challenges were and assessing how and to what degree they were overcome. In this second element the views expressed in this paper are those of the authors and not of the task-group. They represent the perspective of some, but not all, of the task-group members. Similar challenges will be faced in other exercises intending to standardise mine reclamation practices amidst changes in stakeholder expectations and regulatory requirements. Our experience may inform and expedite those exercises.

2 Defining best management practices

2.1 Task-group process

Within CEMA, the Terrestrial Sub-Group of the Reclamation Working Group struck a task-group for defining BMPs for salvage and placement of reclamation material. The task-group included members from industry, government and other stakeholders. It drew on a wide range of expertise, including that derived from scientific research and field experience. The task-group elected two co-chairs, one from industry and the other from government, and contracted a consultant to act as the facilitator and writer for the group. The task-group drafted the project terms of reference, clearly identified the goals and objectives of the exercise and developed an appropriate schedule. Thereafter they provided feedback to the consultant through meetings and review of status reports and the initial draft of the document. The co-chairs set the agenda for each meeting based on the overall schedule with input from the consultant. They also worked with the consultant and technical experts to refine subject matter where needed. The co-chair representing government provided some regulatory direction on goals and objectives. The consultant reviewed literature and conducted interviews, composed an initial draft of the document, collated information as it was brought forward at meetings, responded to comments from the task-group and provided status updates. The CEMA provided an administrative and a technical program manager. The administrative program manager took meeting notes and recorded all important decisions. The technical program manager assisted the co-chairs in their responsibilities, provided careful oversight of comments on and edits to the successive drafts of the document and completed final editing of the document. Meetings were facilitated by the consultant and co-chairs, with the assistance of the program managers.

Prior to the actual work of the task-group, historical and current practices were reviewed to capture existing knowledge and experience in upland reclamation at oil sands mines. While the report, Comprehensive Report on Operational Reclamation Techniques in the Mineable Oil Sands Region (Macyk and Drozdowski, 2008), summarised historical and current practices, it did not specify BMPs.

It was important to clearly identify the target audience. The document was intended to provide technical information to reclamation specialists as well as other professionals from industry, government and non-governmental organisations. Industry will need to incorporate the BMPs into their operational practice. For example, they may develop standard operating procedures or implement training courses for field supervisors and equipment operators. They may also choose to establish field trials to demonstrate the application of the BMPs in an operational context. Each company must select the best strategy for incorporating the BMPs into operational practice.

The consultant conducted an extensive literature review on the topic scheduled for discussion and drafted potential BMPs before each meeting. Several members of the task-group developed a focus exercise intended to determine if a particular practice was a BMP. During the meetings the focus exercise allowed the task-group to effectively review the background, objectives and principles behind the practice. The certainty attached to each practice strongly influenced whether it was presented as a BMP or an adaptive management technique. Practices were more readily accepted if there was empirical evidence available from trials in the mineable oil sands region and they were operationally feasible. Uncertainty about specific practices pointed to knowledge gaps that were identified in the document.

The document was initially scheduled for completion over a single year with monthly meetings. The table of contents followed the sequence of mining and reclamation operations. While this was a logical process for defining the BMPs, there was considerable overlap of topics given how interconnected salvage practices are with stockpiling and placement. A first draft of the document was completed within one year. Thereafter the document required substantial revisions to the overall structure and wording of specific BMPs. Initially the BMPs were conceived of as “how to” statements and the document itself was intended to be very brief. When confronted with the complexity of the subject matter, the task-group decided that a more detailed description of the rationale along with citations of scientific references was required. These changes were intended to enable the reader to better understand the rationale behind a BMP.

Given complex and in some cases controversial subject matter, more time was required than anticipated to finalise the document. Two years later the third draft was accepted. Over that time industry representatives of the task-group had other specialists within their organisations critically review the document. Comments from all the reviewers were compiled and the consultant took each comment into consideration when making revisions. Consensus was reached on most but not all BMPs. This was sometimes the result of the wording: BMPs that included "all" or "must" did not readily receive consensus.

At the end of the exercise after the technical content of the document was set, it was edited for language and style. The document was titled Best Management Practices for Conservation of Reclamation Materials in the Mineable Oil Sands Region of Alberta and will be recommended to government. Upon government acceptance, the document will be published by AENV and available on its website.

2.2 Document structure

The document was structured to follow activities from pre-disturbance site assessment to post-placement site preparation. It consists of 24 BMPs listed under 13 headings: pre-disturbance data collection, seed collection, woody debris, upland surface soil salvage, transitional surface soil salvage, peat-mineral mix, subsoil and overburden salvage, segregation of reclamation material, stockpiling, direct placement, soil placement, soil quality degradation and post-placement site preparation. There is some overlap of subject matter among the following three headings: segregation of reclamation material, direct placement and soil quality degradation.

Each BMP was presented as a fact sheet comprised of the following six sections: the rationale, current practices, state of knowledge, management implications that can limit implementation, adaptive management concepts and knowledge gaps (whether scientific or operational).

This structure provided a means for capturing important information while recognising any uncertainty about a specific practice. While it led to some repetition, it also made it easier for users to understand how the different BMPs link with each other and consider how one BMP affects another. Throughout the document links to related BMPs have been provided to prompt the user to take a comprehensive approach. The finalised BMPs were primarily focused on reclamation objectives and the document structure provides the background and guidance for their application.

3 Challenges to defining best management practices

3.1 Terminology

The term "Best Management Practice" itself presented a challenge to the task-group. Definition of BMPs was complicated by recent changes in expectations for reclaimed land and regulatory requirements. The task-group recognised the necessity of describing emerging practices that are being developed by operators for implementing new conservation and reclamation requirements in recent approvals. This background, and the extended temporal duration of the reclamation scenario (decades, not years), made it impossible to define BMPs based solely on effective implementation at an operational scale. This situation is not unique to oil sands mines but occurs for other mines where the reclamation target is native forest and ecosystem goods and services (Zipper et al., 2011). While working within these constraints, the task-group retained the term 'Best Management Practice.' Selecting an alternative term such as 'Leading Practice' would not have resolved this problem.

In this exercise BMPs were based on historical and current practices, relevant empirical studies, monitoring, professional experience at various scales and established scientific principles. Some BMPs are important for achieving a specific end land-use but have not been proven through operational practice. While these BMPs need to be tested for operational feasibility, including them as BMPs supports adaptive management. Identification of BMPs was not intended to preclude continuous improvement through innovation and testing. Finally, the BMP exercise was valuable in itself as a unique forum for sharing information among government, industry and other stakeholders.

3.2 Operational constraints

Operational constraints may preclude application of a BMP in specific situations. Operational constraints may derive from cost, safety, accessibility, trafficability and weather conditions. For example, steep slopes present a safety hazard that may prevent salvage of reclamation materials or achieving an optimal salvage depth. Trafficability on organic soils has a direct impact on the cost of salvage. Salvaging organic soils or peat-mineral mixes during non-frozen months is costly and rarely achievable. Optimising the salvage depth of surface soil or subsoil can be difficult, if not impossible, if the depth of frost is greater than the prescribed salvage depth.

The most contentious BMP dealt with selective salvage of subsoil (B horizon) separate from the underlying suitable overburden. In this case definition of the BMP balanced judgments based on risk management and basic science with operational feasibility and logistical constraints. Arguments for selective salvage of subsoil recognised that subsoil in the region was much less likely to include constraints such as salinity, sodicity and elevated pH than the underlying overburden. This difference was particularly important in the absence of site-specific information characterising the salvage quality of the underlying overburden. Subsoil may also have beneficial attributes developed through pedogenic processes that are absent from the underlying overburden. For example, subsoil may contain more plant-available nutrients and soil biota than the underlying overburden. The above rationale along with some empirical studies from outside the oil sands region was used to support selective subsoil salvage as a BMP. Arguments against selective salvage recognised operational constraints to salvage of a relatively thin lift of subsoil. Excessive traffic during winter months can push the frost layer deep into the subsoil and preclude salvage of a thin lift of subsoil. Conversely, excessive wetness during non-frozen conditions limits equipment accessibility for soil salvage. One of the logistical arguments against selective salvage of subsoil emphasised the need to consider the scale of operations. The volume of subsoil obtained in a relatively shallow lift must be large enough to justify selective handling and stockpiling. Given the very large volume of reclamation materials in stockpile, it was doubtful that this would occur. Arguments against this BMP also indicated that reclamation research outside the oil sands region was viewed with caution. There was uncertainty about whether the results of such research were applicable to oil sands mine activities. In some states and countries selectively salvaging subsoil is considered a best practice (Norman et al., 1997; McRae, 1989; Koch, 2007). Research in other countries shows mixed results (McSweeney et al., 1981; McSweeney et al., 1987).

There was no empirical evidence in the mineable oil sands region indicating that selective salvage of subsoil did result in a better ecological outcome than salvaging subsoil and suitable overburden together. Given this uncertainty, arguments based on operational feasibility and logistical constraints outweighed arguments for selective salvage based on risk management and basic science. As a consequence, the practice was placed into the adaptive management section. There was agreement that selectively salvaging subsoil could result in a better environmental outcome but the net benefit of using this practice was unknown. The practice may be applied on a site-specific basis and for specific reclamation objectives. The adaptive management section stressed the importance of collecting pre-disturbance subsoil and overburden data to determine the maximum depth of salvage. Deeper salvage of subsoil and suitable overburden together should only be carried out if pre-disturbance subsoil and overburden data indicate that mixing of the two in salvage does not compromise salvage quality.

3.3 Ecological complexity

Whereas the task-group initially intended to define BMPs for both, salvage and placement operations, the complexity of reclamation to locally common boreal forest precluded identification of a comprehensive set of BMPs for placement of reclamation materials. The major exception was the BMP for direct placement of surface soil.

Ecological constraints typically derive from the physical and chemical properties of the materials used to construct landforms, the landform itself as it influences storage and movement of water and the reclamation materials placed on it. Ecological constraints can be managed in design of landforms, selection of reclamation materials and the revegetation plan. Because soil moisture and nutrient regime are linked to ecosite and site type in revegetation plans, they may not constrain establishment of specific vegetation communities: e.g. a subxeric moisture regime will not constrain establishment of a dry, poor site type. In contrast, salinity or sodicity, where present, is potentially constraining for most if not all ecosites. Addressing constraints and risk complicated discussions and made definition of a BMP for placement very difficult. Barbour et al. (2007) synthesised information from regional research on the afore-mentioned constraints and their influence on coversoil quality and reclamation success. The task-group used their synthesis to define a framework for handling reclamation materials to minimise the risk due to specific constraints.

Some members of the task-group thought the document put too much emphasis on direct placement and conservation of plant propagules. Nevertheless, the “life” contained in upland surface soil, transitional soils and in upper layers of organic soils, if properly conserved, could enable operators to achieve better ecological outcomes over a shorter period of time. This potential should not be dismissed. Seeds, plant propagules and soil organisms are much more difficult to replace than nutrients. Hence, conserving the biological properties of reclamation materials is important. New mines do not have the opportunity for direct placement of much of their reclamation materials.

3.4 Building consensus

The CEMA is a consensus-based organisation. Trying to reach consensus in the task-group increased the length of time required and complicated the structure of the document. All BMPs required agreement from all task-group members. Obtaining consensus from individuals who have different educational and professional experience proved challenging at times. This was aggravated by confusion between basic science and empirical trials. In some cases basic science was not convincing and techniques proven outside of the mineable oil sands region received little support. Definition of a "hard" BMP depended on research done within the mineable oil sands region or certainty about its success based on operational experience. "Soft" BMPs included practices for which there was greater uncertainty about the outcome. Many of the adaptive management concepts had originally been proposed as a BMP but did not achieve consensus. Although obtaining consensus increased the time required to finalise the document, it also identified knowledge gaps. There were few BMPs that did not generate opposing points of view within the task-group. There were iterative revisions of wording and format for many BMPs. Given increasing public scrutiny of oil sands mines, it was necessary to explicitly state that BMPs were not intended as evaluation criteria for arbitrary assessment of any particular operator. Yet this disclaimer by itself did not alleviate genuine concerns about perceptions that attach to the designation "BMP."

4 Conclusions

Defining BMPs for conservation of reclamation materials in the mineable oil sands region was a valuable exercise for stakeholders. Yet it was complicated by three factors among others. Firstly, significant changes have occurred in expectations for reclaimed land and regulatory requirements. Under adaptive management operational practices will continue to change. Add to this the decades required for assessing forest regeneration, and it was impossible to define BMPs based solely on effective implementation at an operational scale. Secondly, it was difficult to anticipate all possible operational constraints and define BMPs in consideration of the full extent of the disturbance, not just at a point on the landscape with no spatial context. Thirdly, reclamation of entire landscapes is an ecologically complex task. In the face of these challenges, it was easier to define BMPs for salvage than placement of reclamation material. These constraints are not unique to oil sands mines. They have and will be encountered in other settings when defining BMPs for reclamation of mines to native forest. They also point to a degree of uncertainty that it may be better to acknowledge than dismiss.

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References

Alberta Environment (2006) Land Capability Classification System for Forest Ecosystems in the Oil Sands, Third Edition, Volume 1: Field Manual for Land Capability Determination, Prepared for Alberta Environment by the Cumulative Environmental Management Association, Fort McMurray, Alberta, viewed 27 February 2011, http://environment.gov.ab.ca/info/library/7707.pdf.

Alberta Environment (2009) The Reclamation Process: Status of all Disturbed Land in Oil Sands Mining, http://oilsands.alberta.ca/reclamation.html, site date 30/09/2009, viewed 19 April 2011.

Alberta Environment (2010) Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition, Prepared by the Terrestrial Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, Alberta, viewed 27 February 2011, http://environment.gov.ab.ca/info/library/8269.pdf.

Barbour, L., Chanasyk, D., Hendry, J., Leskiw, L., Macyk, T., Mendosa, C., Naeth, M.A., Nichol, C., O'Kane, M., Purdy, B., Qualizza, C., Quideau, S. and Welham, C. (2007) Soil Capping Research in the Athabasca Oil Sands Region, Volume 1: Technology Synthesis, Draft.

Koch, J.M. (2007) Alcoa's Mining and Restoration Process in South Western Australia, Journal of Restoration Ecology 15, pp. 11–16.

Macyk, T.M. and Drozdowski, B.L. (2008) Comprehensive Report on Operational Reclamation Techniques in the Mineable Oil Sands Region, Prepared for the Cumulative Environmental Management Association, Fort McMurray, Alberta, pp. 381.

McRae, S.G. (1989) The Restoration of Mineral Workings in Britain: A Review, Soil Use and Management 5, pp. 135–142.

McSweeney, K.I, Jansen, J. and Dancer, W.S. (1981) Subsurface Horizon Blending: An Alternative Strategy to B horizon Replacement for the Construction of Post-Mine Soils, Soil Science Society of America 45, pp. 794–799.

McSweeney, K.I., Jansen, J., Boast, C.W. and Dunker, R.E. (1987) Row Crop Productivity of Eight Constructed Minesoils, Reclamation and Revegetation Research 6, pp. 137–144.

Norman, D.K, Wampler, P.J., Throop, A.H., Schnitzer, E.F. and Roloff, J.M. (1997) Best Management Practices for Reclaiming Surface Mines in Washington and Oregon. Washington Department of Natural Resources Division of Geology and Earth Resources, Olympia, WA, Report 96–2.

Zipper, C.E., Burger, J.A., Skousen, J.G., Angel, P.N., Barton, C.D., Davies, V. and Franklin, J.A. (2011) Restoring Forests and Associated Ecosystem Services on Appalachian Coal Surface Mines, Environmental Management 47, pp. 751–765.