A REVIEW OF ENVIRONMENTAL IMPACT STATEMENTS AND THEIR UTILITY FOR SURFACE COAL MINE RECLAMATION IN ALBERTA AND BRITISH COLUMBIA

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ABSTRACT

Adequate pre-disturbance baseline information upon which to develop decisions is crucial to the environmental impact assessment (EIA) process and to environmental management of surface coal mines. Forty-four coal mine development or expansion Environmental Impact Statements (EISs) from Alberta and British Columbia were obtained, and their environmental information content and applicability to post-development reclamation planning were reviewed. The objective of the study was to determine the relevance and utility of the technical information contained within mine development EISs for reclamation planning.

Content analysis was used as the mechanism of data collection. Content categories for thematic coding were developed through a document review process. The data collected were qualitative in nature with presence or absence of pre-determined category codes chosen as the units of measurement. All documents were read three times after coding and prior to data collection in order to ensure reliability. Data summarization involved simple tabulations of the presence/absence data.

The studies were prepared over a 30-year period from 1975 to 2005. In general, the technical basis of the EIS document needs to be improved with specific reference to reclamation planning, implementation, and monitoring. All of the EISs contained vague narrative generalizations based, for the most part, on poorly described methods. The approaches taken reflected a static perspective of ecosystems, and the information collected appeared to be a part of a ritualized 'fill-in-the-blanks' process.

Although variable, most EISs did not contain sufficient information (content and quality) upon which to base project approval with respect to reclamation. Standardization of data collection parameters and methodology as well as the development of appropriate data analysis and presentation protocols is necessary. Recovery indices and chronosequence studies should be required as part of the EIA process.

INTRODUCTION

Although reclamation is frequently considered as a separate issue temporally detached from the immediate concerns of the project review process, it is, nevertheless, important to be included as part of the Environmental Impact Assessment (EIA) decision-making process (Haigh 1993). Since reclamation of surface mine disturbances is often difficult, and successful reclamation is not a certainty, the time to assess and minimize the risk of unsuccessful reclamation is when engineers are developing their conceptual designs (Ripley et al. 1982). As part of a comprehensive environmental program, reclamation potential should receive special consideration in the mine development approval process because landscape reclamation is influenced by and is influential upon the social, economic, and physical milieu of the mine development surroundings.

Information upon which to base decisions is crucial to the impact assessment and environmental management of surface mines. The environmental information collected during the EIA process or feasibility phase is also an asset to the coal development proponent in determining post-mining land uses for reclamation (Adepoju and Fleming 1987, Carolan 1992).

The primary purpose of this paper is to examine the information contained in mine-specific EISs and to determine its applicability to post-development reclamation planning. The objective of the review is not to comment on the regulatory process but rather to examine the information content of the EISs with specific reference to reclamation planning.

LITERATURE REVIEW

Reclamation planning as a component of the mine development review process can be understood best by an examination of the relationship between the conventional views of EIA and environmental management and that of surface mine reclamation practice.

Environmental Impact Assessment Process

The EIA process is defined as a systematic process whose purpose is to inform decision-makers of the potential effects that a program or project might have on the biophysical environment. The specific functions of impact assessment are to reduce the frequency of unexpected change, to reduce unexpected and undesirable consequences of developments, and to develop mitigation planning for unavoidable negative changes. EIAs should include studies of all relevant physical, biological, economic, and social factors. Planning and implementation of appropriate mitigation measures for adverse biological impacts represent important activities in the environmental impact process (Weaver and Caldwell 1999).

Environmental Impact Statement

The EIS is an administrative tool used in most jurisdictions as part of the formal phase of assessment and is the source of information for regulatory decision-making (Weaver and Caldwell 1999). For a project that eventually proceeds, the EIS should aid regulators in the environmental management of the project (Ross 1987). In addition to the general biophysical inventories and impact information, EISs for mine developments include site-specific reclamation assessments (Vizayakumar and Mohapatra 1989/1990). Pre-mining assessments of reclamation potential should include attributes of the physical environment that may influence the success of stabilization and revegetation at a given site. To assess reclamation potential, knowledge of hydrology, erosion, geology, and climate must be applied to the problems of stabilizing mine waste materials (Snyder and Potter 1981). Assessments of reclamation potential within the EIS document should provide a comprehensive overview because unexpected difficulties and expenses may reduce the benefit-cost ratio of mining as a land use (Broadbent et al. 1996).

Post-audit Program

The complexity of natural processes means that there will always be a substantial degree of uncertainty in the accuracy of predictions (Epp 1995). Monitoring and audits are not only necessary for compliance but also for assessing the performance of mitigation (reclamation plans and techniques). Monitoring is a response to the uncertainty of continued ecosystem functioning when faced with developmental perturbations.

Most EIA procedures administered by provincial and federal governments in Canada have some form of 'requirement' that monitoring be undertaken following project approval. Yet the formal review mechanisms included within general EIAs usually terminate at the project approval stage. In contrast, the mine-permitting processes in Alberta and British Columbia have compliance monitoring for air and water quality as well as for effects monitoring for reclamation. Reclamation permit monitoring is essentially a hybrid of effects and compliance monitoring.

Legislative Requirements of Environmental Assessment for Mine Development

EIA requirements for coal mine developments in North America are variable. In Canada, federal and provincial regulations set general criteria for the needs of an environmental impact assessment of mining operations and for the reclamation of mine sites (Sheehan 1994).

Currently, the mine development process as implemented in Alberta and British Columbia is a variant of the EIA process; it contains many similarities with the conventional EIA process but has some very specific differences in terms of the recognition of temporally exclusive land use and in the post-audit follow-up. The project review process for mine developments is similar in both Alberta and British Columbia.

Although numerous studies have examined the EIA process, the EIS as a reclamation-planning document has not been examined (Potter 1986). Since the greatest potential environmental impact of surface coal mining is the post-mining landscape (Haigh 1993), the importance of 'reclamation potential' to project approval or rejection should be explored.

STUDY OBJECTIVES

The objective was to determine the relevance and utility of the technical information contained within mine development EISs for reclamation planning.

METHODS

EISs prepared for either new mine projects or mine expansions were identified through personal communication with government regulators and industry representatives. A total of 44 new project and/or project expansion "EISs" were obtained, and their environmental information content and applicability to post-development reclamation planning were reviewed. The criteria (parameters) examined were those outlined in the guideline documents for Alberta (Energy Resources Conservation Board 1978). The parameters are similar in British Columbia.

Content analysis was chosen as the mechanism of data collection. Vizayakumar and Mohapatra (1989/1990) used a similar approach in their environmental impact study in India. Thematic coding (Krippendorf 2003) was considered appropriate for this form of research. The content categories were developed through a review process and were expanded (more detailed components of the parameters described) by Fisser and Ries (1979) and Natsukoshi (1984).

The data collected were qualitative in nature with presence or absence of pre-determined category codes chosen as the units of measurement. All documents were read three times after coding and prior to data collection in order to ensure reliability. Data summarization involved simple tabulations of the presence/absence data.

RESULTS AND DISCUSSION

Project Descriptions

A total of 10 EISs were reviewed from Alberta and 34 from British Columbia. Twenty-four of the EISs were for existing mine expansions while 20 were for new projects. The sizes of the various surface coal mine disturbances were considerably larger than the estimated surface disturbance created by the proposed underground mines. Projected cumulative disturbance over the life of each respective mine varied from 36.5 hectares for the Willow Creek Project to 2662.00 hectares for the Monkman Project. Total surface disturbance is dictated by contract tonnage as well as stripping ratio and, consequently, waste material disposal. Mainly montane and subalpine vegetation would be disturbed by the mining activities of these mines although significant above treeline disturbance is part of the Quintette Coal Mine.

In general, new project EISs contained more comprehensive biophysical inventories and were based on project proponent initiated studies rather than on literature or unpublished data supplied from external sources. Hence, information quality within the reviewed EISs varied. Consistent omissions and poor quality information prevailed with the paraphrasing of general ecology textbooks used frequently to describe successional or population processes.

Although regulation-based EIA requirements directed specifically towards mining in Alberta and British Columbia have changed since their introduction, comparisons are possible because the focus has not changed significantly with the new or amended regulatory requirements. The changes in regulatory guidelines and practices primarily have been process-oriented rather than content-oriented and directed toward a formalization of the process, particularly with respect to public involvement.

However, several consistent patterns emerged from the content analysis of the environmental impact statements. The quality of the information was very difficult to determine because of the paucity of methodological descriptions.

Discussion with regard to environmental impact identification and mitigation was, for the most part, spread throughout the text rather than in a separate section in earlier EISs, but the more recent documents typically contained well-defined impact sections.

Since the mine plans developed at this stage of project development are tenuous due to incomplete geological information and the dynamic nature of mine planning, several EISs provided only very general reclamation planning information and were not willing to commit to particular practices.

Reclamation and the EIA Process

The mine development review process in both Alberta and British Columbia is essentially a variant of conventional EIA with significant alterations to include reclamation. The EIS used within this process contains three sections that are directly related to reclamation planning: (1) baseline data inventories, (2) impact identification, and (3) impact mitigation. Reclamation is included as a component of impact mitigation.

Unfortunately, the EIS as a planning document within these jurisdictions is directed primarily toward project review (impact identification and superficial mitigation) and only secondarily toward reclamation planning. The EIA stage is crucial to the minimization or elimination of long-term landscape degradation. Therefore, reclamation planning should receive greater attention within the EIS document. In the current study, pre-project investigations usually consisted of no more than reconnaissance studies and species abundance/distribution surveys. Experiments were seldom conducted, and statistically adequate baselines (against which subsequent changes could be detected through monitoring) were rare. Predictions normally amounted to vague generalizations, and often future work was proposed, apparently to satisfy regulatory concerns. Proposals for mitigation were limited generally to statements of known ‘good’ engineering and construction practice. Spatial and temporal boundaries for the assessments were usually restricted to the extent and duration of the project under review.

Ross (1987) suggested three criteria for EIS acceptability: (1) focus, (2) clarity of presentation and (3) scientific and technical soundness. These criteria are applicable to the present study and form the basis of discussion in the following text.

Focus and Clarity of Presentation

Readability and comprehension of environmental plans and EIS documents are important in communicating technical information to an audience with different levels of cognition and areas of expertise (Ross 1987). In general, the EISs reviewed tended to lack quantification with much of the impact identification in the form of vague narrative generalizations. Consequently, considerable subjectivity is present within the EIS evaluation processes of Alberta and British Columbia. Similar observations of non-mining projects have been reported in other parts of the world (Broadbent et al. 1996).

Scientific and Technical Soundness

In practice, it is very difficult to evaluate or check the conclusions of a technical analysis due to methodological assumptions and analytical interpretations. However, certain attributes can be used to gauge the reliability of the information presented and summarized.

Individuals or groups involved in EIAs have differing opinions as a result of their roles within the process. Government regulators administer the EIA procedural machinery and focus on guidelines and review processes while project proponents seek approvals and licenses. Within the EISs reviewed, information content and quality was variable and often questionable in terms of reliability. Most of the EISs reviewed employed a number of consultants. Although the qualifications of these individuals or organizations may have been stated during the EIS tendering process, there was no guarantee of technical competence, particularly regarding reclamation planning and practices. The low information quality of the reviewed EISs suggests, among other things, that these individuals should have instruction in reclamation which overlays their formal disciplinary training.

Information Quality

Since first introduced, the EIA process has been the subject of considerable debate regarding scientific validity. Broadbent et al. (1996) has suggested that the scientific validity of the EIA process is weak because the science used is dated. However, the paucity of scientific literature references may be more problematic (Jones 1992). The absence of conceptual and methodological reference citations was encountered frequently in the EISs reviewed. Commercial constraints in industry and environmental consulting firms make it extremely difficult for individuals to devote adequate time needed to maintain their scientific expertise.

While the scope and completeness of the EIS in Alberta and British Columbia is determined through a regulatory/proponent consultative process, considerable variation in the quality of information is possible. Most of the early EISs reviewed and some of the recent Small Mine Application EISs were entirely descriptive and very often involved anecdotal observations. The reliability issue of EIS information is not only important for overall project development but is crucial also to reclamation planning of the post-mining landscape.

A further problem related to information quality is that of statistical significance. It is important to reclamation planning that ecosystem attributes be measured or investigated with the appropriate sampling design and intensity in order to describe adequately the ecological processes occurring at the development site. Attempts must be made to include spatiotemporal considerations in all of the attributes measured. What is needed is a technique or group of techniques that clearly differentiate between the subjective and objective elements of ecological evaluation.

Applicability of Baseline Information

Land-Use – The early EISs reviewed made extensive use of the Canada Land Inventory (CLI) system. Within the mine development review process in Canada, the CLI system was used as a reference for developing post-mining land-use objectives. In the recent years, ecosystem-based mapping rather than the CLI mapping was used.

Superficial attention to aesthetics was consistent within all EIS reviewed. Landform and vegetation contribute to the spatial definition and light quality color of the visual landscape. Naturalness of a landscape is associated generally with high visual quality (McBride 1977). If the naturalness of the landscape is maximized or optimized during the reclamation planning process, a higher visual quality and improved reclamation product would result.

Geology and Soils – EIS surficial geology and soil survey data have been presented typically in the form of maps. However, these maps and their accompanying reports are generally pedological in nature and have not been utilized fully by surface mine operations (Jones 1992). In the present study, all of the EIS reviewed provided surficial geology and/or soils maps as well as reclamation capability indices. In the older EISs, the capabilities were simply vague descriptions, but in the more recent EISs, more detailed parameters (texture, consistence, coarse fragment content, water-holding capacity, pH, electrical conductivity, exchangeable sodium, soil depth, slope, erosion, permeability, and drainage) were utilized. Bulk sampling during the project review phase provides an early assessment of material handling requirements and a mechanism for assessing growing media capability.

Although GIS technology was not in widespread use when the early EISs reviewed were prepared, the application of GIS is universal within the recent EISs and provides the foundation for pre- and post-mining comparisons.

Vegetation – A logical interconnection exists between vegetation information and pre- and post-mining land-use information in developing revegetation plans and evaluating revegetation success for release of vegetation liability. Planning for revegetation of lands disturbed by coal mining requires an evaluation of pre-mining vegetative cover and productivity, pre- and post-mining land-use(s), determination of overburden, and topsoil/subsoil quality and quantity as well as species mix selections. Most of the EISs reviewed satisfied only a portion of this requirement.

Only the EISs prepared since the mid-1990s addressed adequately the occurrences of rare (small or sparsely distributed populations) or endangered (potential extirpation) species. The identification of rare and endangered species is important for impact assessment because project development should not proceed where they occur. When rare or endangered species are identified, subsequent reclamation activities, where appropriate, may be directed towards re-creation or enhancement of their habitats.

The absence of productivity information, particularly forage production, is inconsistent with the regulatory pre-disturbance/post-disturbance productivity requirements of reclamation. This is particularly notable in British Columbia where the post-mining landscape must have equivalent productivity on an average property basis.

The lack of plant successional process descriptions is significant since plant community responses to disturbance are necessary to identify development impacts and make recommendations for approval or proposals for alternative development plans. Relevant chronosequence and perturbation response indices should be used.

The EISs reviewed attempted to describe the current characteristics of plant communities and, therefore, provide a reference for future comparison. However, ecosystems are dynamic, so short-term studies such as these do not describe fully the complexity of vegetation and, as a result, can be misleading. In addition to temporal variation in vegetation, spatial variation in species composition is probable. Therefore, sufficient sampling is necessary to compensate for both temporal and spatial heterogeneity. Ecosystem studies should also collect information on phenology, physiognomy, plant strategies, and alpha (habitat), beta (between habitat) and gamma (landscape) diversity. This form of information would be more relevant to reclamation planning and would augment the synecological information used typically for impact identification.

Fauna – The review showed that the early emphasis in pre-mining wildlife impact assessments has changed from the analysis of population census data to the delineation and description of habitat. Faunal studies undertaken as part of the baseline data collection for the early EISs were census and home range in nature with very little habitat information. The majority of information was in the form of 'low-quality' anecdotal observations or simple literature reviews. In general, very little emphasis was placed on the animals as functional entities within ecosystems. Furthermore, significant components of the trophic levels were excluded or given only cursory mention. The paucity of non-game fauna information clearly makes the re-creation of functioning ecosystems difficult. Incorporation of insect fauna studies are particularly important since they are important indicators of ecosystem functioning. In recent years, the trend appears to be towards more integrated studies for terrestrial fauna studies. In contrast, aquatic (fish and benthic invertebrate) surveys that were conducted for all EISs have always represented a hybrid of population census and aquatic ecosystem functioning analyses.

The majority of the EISs reviewed proposed the re-creation of wildlife habitat as a post-mining land-use objective. The early EISs concentrated on population studies and relied on the CLI or cursory observations for habitat information while the later reports typically contained detailed habitat studies or literature reviews. The use of Habitat Suitability Index (HSI) models, Terrestrial Ecosystem Mapping (TEM) mapping and GIS technology in the EISs prepared in the 1990s represents a significant improvement in baseline environment characterization. However, the lack of understanding of reclaimed ecosystem recovery performance is still an impediment to impact prediction and reclamation planning for wildlife habitat re-creation as well as other post-mining land-use objectives.

The absence of post-development impacted wildlife monitoring and management programs within the EISs examined is problematic, and the absence of such programs is consistent with the literature for other forms of industrial developments (Broadbent et al 1996).

Ecosystem Processes – The results of the review indicated the lack of an ecosystem approach to baseline data collection. In looking for applications of such ecological concepts as trophic levels and energy flow or nutrient cycling, there was little evidence that they had been incorporated into the design of studies and reclamation planning. Much of the information presented was in the form of static descriptions. The EIA process and, more specifically, the mine development review process would be best served if the non-equilibrium nature of the environment were acknowledged.

The underlying objectives of these impact-oriented baseline studies appeared to be ecosystem characterization; however, important functional aspects of the described ecosystems were omitted. The paucity of quantitative data relevant to successional development and population studies serves only to perpetuate the 'product approach' to reclamation within the mine development process. Although the inclusion of reclamation species and growing media trials provided some information for reclamation planning, data quality was questionable, and integration with baseline vegetation data was limited. By focusing on key processes (pedogenesis, succession, nutrient cycling, population dynamics), baseline information would improve not only environmental impact assessments but also would develop a much more process-oriented approach to reclamation planning.

EISs should include a description of the 'natural' succession processes within the development area. An assessment of the native vegetation and soils found under disturbed conditions is useful in identifying potentially successful reclamation species. Baseline data collection should include a detailed study of local disturbances at equivalent altitudes and on similar material types in order to predict better the results of reclamation.

Two general approaches to pre-mining assessment are possible: (1) the conventional method (inductive approach) in which baseline data are collected and analyzed to provide predictions of reclamation potential and (2) the reverse method (deductive approach) in which native vegetation and natural successional patterns are observed to deduce the influences and interactions of climate and substrate on vegetation. Both structural (descriptive) as well as functional (process prescriptive) should be included to improve the reclamation planning process. Physical/chemical, individual organism, population (species) community and ecosystem should be included. The deductive approach is proposed here to supplement a more focused, conventional inductive approach. The deductive approach cannot replace the inductive approach because of an inability to address adequately the broader issue of comprehensive impact assessment.

<u>Predictive Power</u>

Environmental impacts of developments can rarely be predicted with certainty, but an EIS must contain some form of systematic prediction of forecasts (inferences) of the outcomes of specific development alternatives. The EISs reviewed also reflect this problem with regard to reclamation planning. Many of the reclamation predictions were in the form of vague generalizations. The conceptual reclamation plan included as part of the mine development EIS is intended as a forecast of the appearance of the post-mining landscape and a general description of the required management practices. However, this information was so weak in most cases that it had little value. Application of the 'recovery or inertia index' or the 'rehabilitation potential' in conjunction with suitability analyses would improve greatly the predictive power of these conceptual plans.

Risk Assessment

Reclamation planning uncertainty is a function of ecosystem complexity and a lack of understanding of ecosystem perturbation response. As such, reclamation planning includes an element of environmental risk.

Risk is imposed by legislative constraints (Suter et al. 1987). If there is high uncertainty of successful reclamation due to lack of knowledge, then this should be incorporated into project approval. Until recently, the risk of unsuccessful reclamation was not included in the mine development review process. Therefore, similar to ecological risk assessment, the proponent should be required to indicate before project approval the probability that their reclamation efforts will be successful.

Post-Development (Reclamation) Monitoring

Monitoring is an important component of environmental management, and reclamation monitoring, as part of the generalized EIA post-audit review process is required in both Alberta and British Columbia. Reclamation monitoring completes the 'feedback loop' involving application planning, review, approval, construction, and reclamation. In the absence of rigorous monitoring, the review and approval process lacks the capacity to assess environmental impacts or mitigation measures (reclamation success).

Assessment of successful reclamation depends upon pre-disturbance information, supervision of reclamation activities, and monitoring of the reclaimed land. However, unlike conventional static post-development monitoring, trend analysis should be employed. With surface mine reclamation, the assessment of 'trends' would cause a change in emphasis from product to process (Smyth and Dearden 1998).

CONCLUSION

Adequate information upon which to base decisions is crucial to impact assessment and environmental management of surface mines. The information collected during the EIA process or feasibility phase is considered essential for reclamation planning. Several important conclusions regarding environmental management in general and reclamation specifically can be drawn from the examination of mine development EIS documents. In general, the technical basis of the EIS document needs to be improved with specific reference to reclamation planning, implementation, and monitoring. All of the EISs contained vague narrative generalizations based, for the most part, on poorly described methods. Important information on diversity, rare and endangered species, succession, and spatial relationships of wildlife habitat were often lacking. The approaches taken reflected a static perspective of ecosystems, and the information collected appeared to be a part of a ritualized 'fill-in-the-blanks' process.

Although variable, most EISs did not contain sufficient information (content and quality) upon which to base project approval with respect to reclamation. Recovery indices and chronosequence studies should be required.

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