Professional Judgment in Mineable Oil Sands Reclamation Certification: Workshop Summary

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Oil Sands Research and Information Network

OSRIN is a university-based, independent organization that compiles, interprets and analyses available information about returning landscapes and water impacted by oil sands mining to a natural state and provides knowledge to those who can use it to drive breakthrough improvements in reclamation regulations and practices. OSRIN is a project of the University of Alberta's School of Energy and the Environment (SEE). OSRIN was launched with a start-up grant of $4.5 million from Alberta Environment and a $250,000 grant from the Canada School of Energy and Environment Ltd.

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- **Governments** with the independent, objective, and credible information and analysis required to put appropriate regulatory and policy frameworks in place
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REPORT SUMMARY

On June 18, 2012, the Oil Sands Research Information Network (OSRIN) convened a workshop to solicit the expert views from about 50 technical specialists from a variety of disciplines representing about 850 years of experience. The workshop, entitled *Information That Professionals Would Look for in Mineable Oil Sands Reclamation Certification* sought to document the field experience and "common sense" that a seasoned field specialist brings to the reclamation certification decision process.

The workshop was coordinated with the Reclamation Working Group (RWG) of the Cumulative Environmental Management Association (CEMA) to provide additional information in support of their Criteria and Indicators Framework project.

With some basic information on the hypothetical lands subject to a reclamation certificate application being considered, the groups were given three different scenarios to analyze from the viewpoint of their professional experience and technical knowledge:

Session One: You are going to visit a reclaimed oil sands mine site and decide if a reclamation certificate should be issued. You have only your five senses, experience and common sense to guide your decision.

- What positive and negative features do you look for?
- How confident (%) would you be that your decision is correct (i.e., mean and range)?

Session Two: Next, when you go onto the site you can bring one piece of equipment or one tool.

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Session Four: For the final session in the workshop, the groups were asked to provide their comments on one of seven questions:

1. What do we need to know about contamination and remediation?
2. What advice can you give CEMA on criteria and the certification process?
3. Do expectations and process needs change depending on the reclamation goal(s)?
4. Do expectations and process needs change depending on when the site was reclaimed (i.e., older sites, currently reclaimed sites, sites reclaimed in the future)?

5. How long do we monitor for before applying for a reclamation certificate?
6. Do expectations and process needs change based on landform type (e.g., dump, tailings pond, Dedicated Disposal Area, plant site)?
7. What disciplines are missing from the discussion today?

The original intent of the workshop was to supplement the science-based reclamation certification criteria and indicators being developed by the Reclamation Working Group of the Cumulative Environmental Management Association with the knowledge and experience used by people with significant field experience. Although valuable suggestions about criteria were received, the discussions seemed to focus more on the information needs and process for assessing certification, suggesting the need for a *Guide to the Reclamation Certification Process*.

The workshop also sought to determine how confidence in decision making is affected by the use of field equipment/tools, and the value of background data and reports in increasing confidence. Given the extensive experience of the workshop participants, it was surprising to see how little confidence they had in using only their knowledge and experience to make reclamation certification decisions. Their confidence in making decisions increased somewhat if they were able to bring a piece of equipment into the field with them. If they were able to review a high quality report and supporting data from the site's historical file prior to going into the field their confidence increased substantially. This confirms the need for the CEMA RWG Criteria and Indicators work and suggests the need for a *Guide to Reclamation Certification Application Content*.

It is not simply enough to know intuitively that something is correct; humans desire external confirmation

Priesler, J., 2001. Tom Clancy's Power Plays: Cold War. Berkley Books, New York, New York. p. 164.

ACKNOWLEDGEMENTS

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OSRIN is grateful for the time spent by the participants in the workshop and the review of the draft report.

1 INTRODUCTION

On June 18, 2012, the Oil Sands Research Information Network (OSRIN) convened a workshop to solicit the expert views from about 50 technical specialists from a variety of disciplines representing about 850 years of experience. The workshop, entitled *Information That Professionals Would Look for in Mineable Oil Sands Reclamation Certification* sought to document the field experience and "common sense" that a seasoned field specialist brings to the reclamation certification decision process.

The workshop was coordinated with the Reclamation Working Group (RWG) of the Cumulative Environmental Management Association (CEMA) to provide additional information in support of their Criteria and Indicators Framework project (Poscente 2009).

1.1 Workshop Format

Prior to the workshop, those invited were organized into self-nominated specialist categories:

- Wildlife and habitat
- Geotechnical and hydrology
- Wetlands and water bodies
- Soils
- Vegetation
- Landscape integration (two groups) – The Landscape Integration groups were composed of a variety of experts, including a number of current and former Reclamation Inspectors, who were asked to look at the exercise through the eyes of an Inspector required to receive and consider the input of the various discipline experts before making the certification decision.

At the workshop, those in each category were provided with a brief description of a hypothetical landscape that is the subject of a reclamation certificate application, with some maps, photos, and diagrams to portray a general setting for the task (Figure 1):

- The site is forested with at least one lake and an inlet and outlet stream.
- It has been at least 10 years since the last reclamation work was completed, and over 25 years since the original work was initiated.
- A portion of the site is underlain by Clearwater overburden and a portion was used as a dedicated disposal area for mine tailings.

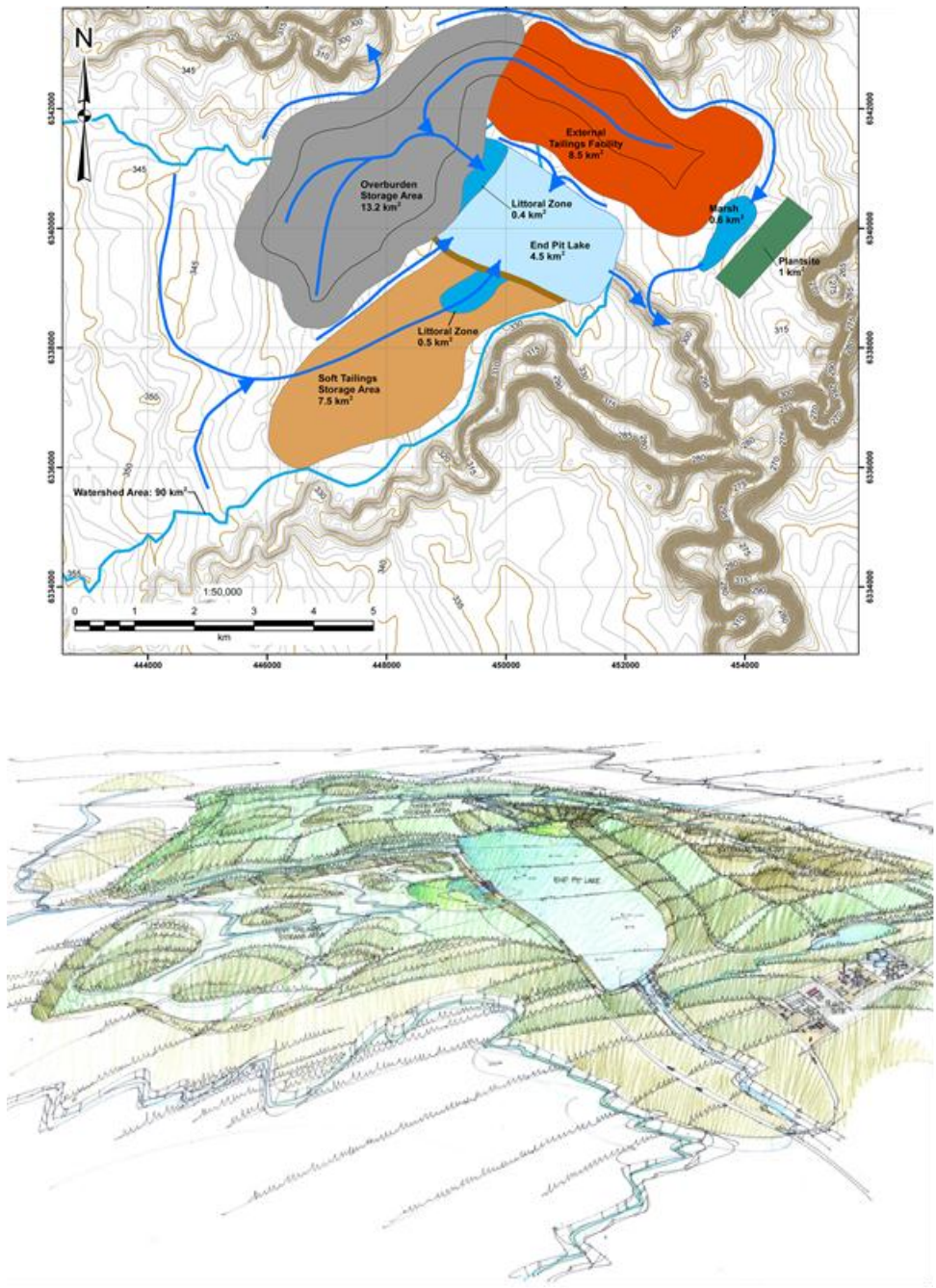

Figure 1. Hypothetical Reclamation Certificate Landscape.
Source: Draft CEMA End Pit Lake Guidance Document 2012.

With some basic information on the site being considered, the groups were given three different scenarios to analyze from the viewpoint of their professional experience and technical knowledge:

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7. What disciplines are missing from the discussion today?

During the workshop, several questions arose about the context for the exercise. These questions provide insights about the assumptions a professional would make, and the information needs they would have, when reviewing a site for reclamation certification:

- Has the reclamation certificate application been filed and read prior to field visits?

- Do we know what the approved end land use objective for the site is?
- Do we know if there is an approved closure and reclamation plan?
- Has the Energy Resources Conservation Board (ERCB) approved landform abandonment?
- What is the age of the site (construction date(s) and reclamation date(s))?

1.2 Structure of This Report

Sections 2 to 5 provide summaries of the key observations from each of the four workshop sessions.

Section 6 provides conclusions and recommendations for future work.

Appendix 1 provides a list of participants. Appendices 2 to 5 provide details from the flipcharts and presentations of each group.

Green shaded call out boxes are used to highlight specific comments and observations made at the workshop. Yellow shaded call out boxes indicate comments received during the review of the draft of this report. Pink shaded call out boxes indicate input from workshiop invitees who were not able to attend.

2 SESSION ONE – FIVE SENSES

Session One: You are going to visit a reclaimed oil sands mine site and decide if a reclamation certificate should be issued.

- What positive and negative features do you look for?
- How confident (%) would you be that your decision is correct (i.e., mean and range)?

Confidence in decisions based only on experience and observations was quite variable amongst the groups, ranging from 0% to 80%, though most groups were in the low end of the range. At least one group noted different confidence levels based on site type (ranked from more confident to less confident): marsh > upland >> bog/fen.

Workshop Comment

I hate going out "blind"

5 senses can tell us something – lots of judgment is possible without data

Although the groups were set up to represent specific sets of expertise (disciplines) there were common features identified by a number of groups – vegetation is a good example as it was identified as a key parameter by the Wildlife, Geotechnical and Hydrology, Soils, and Wetlands

and Water Bodies groups. This confirms the interdisciplinary nature of reclamation and the need for the Criteria and Indicators Framework to specifically address the interactions between parameters, not just have a suite of independent parameters.

Several groups noted more confidence in picking failures than successes, with particular difficulty assessing sites that are neither obvious failures nor obvious passes. One group noted that confidence depends to a great degree on the attitude you bring to the decision and the number of positive and negative indicators of success encountered (Figure 2); even with positive indicators a negative attitude will result in less confidence. One group also noted it is easier to be qualitative than quantitative.

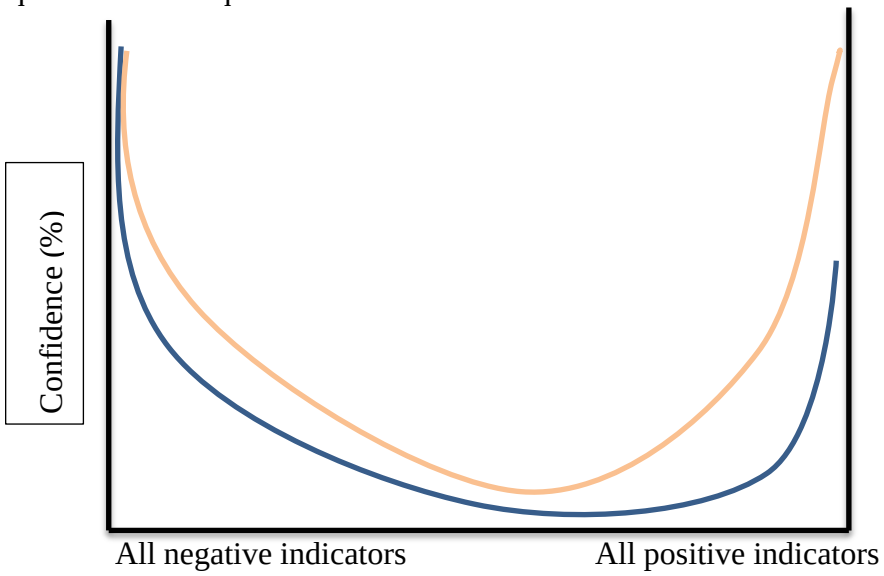

Figure 2. Level of Confidence Affected by Attitude and Indicators
The orange line is how a positive attitude reacts to indicator type; the blue a negative attitude

Workshop Comment

Confidence – extremely high when very bad; much lower if no obvious issues (easier to fail than pass)

Easy to see bad work, harder to see good work

Look for negatives (what isn't right) as this is easier to do; then move to find what is right

Confidence in a pass increases with the number of positive observations; confidence in rejection increases with the number of negative observations

Visual problems indicate lack of success, no visual problems means to dig deeper

Review Comment

I'm not sure you can go into an inquiry with no rules without a focus on the negative. It's not because the regulator has a gloomy outlook, I think it is a desire to prevent the false positive. This is where rules come in handy. What we need to do I think is make sure the rules are efficient, effective and are applied at the right time. Then sunny or gloomy becomes irrelevant and the time aspect leads to no surprises.

If I see a wetland that is supposed to be a persistent marsh, but it goes dry by July every year, then I know there is a hydrological problem. Similarly, if I see oil on the water, then I know there is a contaminant problem. If I see salt crusts, then I know there is a salinity problem. Conversely, if the marsh maintains its water, has no oil on the water surface, and I see no salt, that doesn't necessarily mean that there is no problem. It might just mean that I didn't look hard enough or visit enough times, or visit under enough different weather conditions.

I would continue to examine a site until one of two conditions were satisfied:

I found a problem

I had pursued enough investigations with no findings that the chance I had missed something was acceptably small

Several groups also noted the value of time since reclamation (exposure of the site to a variety of ecological stressors) and previous familiarity with the site (site inspections, milestone performance assessed) in increasing their confidence. The groups also noted that performance expectations are set in part by the time since reclamation and the type of reclamation (i.e., there may be some biases in a judgment-only system that might be mitigated by a criteria-based system), as well as by comparisons with undisturbed areas (analogues) and the expected variability in natural systems.

Workshop Comment

Time since reclamation determines expectations (as does the type of reclamation)

Stand age sets expectations about species, diversity and ecological processes

Approval conditions and reclamation/closure plans set expectations – therefore it is critical that criteria and indicators take into account approval conditions and standard plans (and vice versa)

A person's experience with the site history determines level of confidence, how does the trajectory look?

Compare with natural stands and processes and with other reclamation sites, general stand assessment, stand dynamics

Review Comment

As a site ages, we would expect the effect of slightly off-target conditions to become more obvious. So, the amount of emergent vegetation would start to decrease over time if the marsh was not quite holding on to its water long enough. Similarly, we may see an increase in hydrocarbon or salt tolerant species over time if there were slightly elevated levels of oil or salt in the site. If however, you follow a site for 20 years, and over that entire time it responds to changing conditions in the same manner as reference sites, you would be quite confident that it functions in much the same way as the reference sites and is therefore 'healthy'.

The groups identified a variety of parameters they look for. Several groups noted that they distinguish between evidence of *things* (e.g., wildlife signs) and *processes* (e.g., invasion of native species).

Appendix 2 provides the detailed workshop notes from this session.

3 SESSION TWO – FIVE SENSES PLUS EQUIPMENT

Session Two: Next, when you go onto the site you can bring one piece of equipment or one tool.

- What would you bring?
- What additional information will it provide for your assessment of the site?
- How much extra time (and time consuming logistics) would it add to your assessment of the site?
- Now how confident are you (%) in your assessment decisions (mean and range)?

The tool or piece of equipment selected most often reflected a desire to examine what can't be determined with the five senses alone – e.g., chemistry, subsurface features, and landscape-level interactions. One group noted that the tool or piece of equipment could be used to help clarify the type and degree of risk.

In general the level of confidence in decisions increases with the additional support of sampling data gathered with the assistance of a tool or piece of equipment. Qualifiers regarding factors affecting the level of confidence were provided.

Workshop Comment

Confidence – increased, especially for older sites and habitat type

Confidence – increase 22% without drill rig and 62% with drill rig

Confidence – increase 25% for lakes and streams; increase 10% for wetlands

Confidence increase from 30% to 80% (note 100% if shovel and data)

Confidence – increases on older sites

The additional time taken to use the tool or piece of equipment and synthesize the data varied from half a day to two years (some groups reported percent increases from the Session One exercise rather than a specific time period). One group noted that extra time will also be required by the regulator to review the data. Another noted that the additional work will increase costs.

Workshop Comment

Time – double time if doing the whole area but if you focus on problem areas then less (maybe even quit when a significant problem is found)

Also noted will take same level of effort for regulators to review as for an approval application

Don't discount the need for cheap, plentiful and knowledgeable labour (e.g., summer students)

The types of tool or piece of equipment varied amongst the subject matter experts, ranging from a simple shovel to a drill rig and included cameras, nets, multimeter/smart devices, and remote sensing images or helicopter over flights. One group suggested that the reclamation certificate application was their tool or piece of equipment of choice. Interestingly, another group flagged the desire to have an Aboriginal Elder accompany them to provide context.

Workshop Comment

Ideal tool would integrate water balance at various scales, shallow subsurface information including ecosystem processes, soil cover and substrate

Helicopter for overview (especially important given the expected large size of certificate application areas – 500 to 1,000+ hectares)

Appendix 3 provides the detailed workshop notes from this session.

4 SESSION THREE – FIVE SENSES, EQUIPMENT PLUS REPORT

Session Three: Next, in addition to your senses, experience, and the additional equipment you brought, you can ask for a report (s) regarding the site before the field assessment.

- What information would you want to see in the report/documents?
- Now, how confident are you (%) in your decision (mean and range)?

Confidence in decisions increases significantly with the combination of the five senses, field sampling and a report –for some groups up to 80% to 100%. The quality of the report is a key factor in determining the increase in confidence from the Session Two results. One group noted that a report and combined with older reclamation creates more confidence, but confidence varies by site type (Figure 3).

Figure 3. Interaction between Confidence, Age of Reclamation and Site Type

Workshop Comment

Confidence – increases if multiple years with a positive outcome

Confidence

- Optimistic approach would be 100%
- Pessimist – bad reclamation = 100% fail; good reclamation and report – 50%; good reclamation but bad report – low (20%)
- Pessimist may never be satisfied even with best report and reclamation

Confidence – 50% to 90% depending on report quality

A wide variety of content was requested by the groups, in most cases reflecting their particular areas of expertise, but there were several themes mentioned by at least two groups:

- Multiple years of data showing trends/change/trajectory over time
- Comparisons to reference condition sites
- Consistency with goals, plans and approval conditions
- Integration of features across site and lease boundaries
- A detailed site history/biography
- Visual aids (maps, air photos, GIS, LiDAR, DEM, etc.)

This suggests that it would be valuable to develop a *Guide to Reclamation Certification Application Content.*

Workshop Comment

It is interesting – people are not able to think outside the box – they are asking for what is available rather than identifying what they really need

Review Comment

I'm not sure this is really fair. Knowing 'what you need' presumes that you already know what the problem is. You can never be 100% sure what the problem is. Even if there are tar-balls washing up on shore, you can't be sure that the only problem affecting the site is excess hydrocarbon. There could be other issues as well. Moreover, knowing what the problem is presumes that you completely understand what normal is. Any ecosystem is going to be far too complex to understand completely. We know some of the big, obvious things (analogous to knowing that without gasoline the car won't run), but we may never understand the finer points (analogous to knowing the maximum machining tolerance between the piston and the cylinder before the engine loses compression).

Some groups offered additional observations related to the approach to, and process of, certification.

Workshop Comment
Comparisons to reference condition sites (assumes there is comparable long term monitoring of reference sites)
Site history and why we should believe it
Data and history must be archived and available – it is the responsibility of industry to do this.
[Reclamation certification is about] certainty of future performance not just what we see at the inquiry
[There is a logical] progression from objectives -> reclamation -> monitoring -> application -> certificate [but we do not have] discussion about what is meant by "monitoring"(structure, function, composition)
Professional(s) sign-off adds integrity to the process
A lot depends on how one approaches the project, and if you have a positive or negative view, how full is your cup? Pessimist may never be satisfied even with best report and reclamation.
One could conclude that it is possible, functional, and realistic to have a common set of criteria for the reclamation of Alberta surface mines. These could be described in a "field guide" to assist evaluators that may not have the history on the mine's reclamation history. The Oil Sands section may have differences because of ecoregion and reclamation (land use) objectives.

Appendix 4 provides the detailed workshop notes from this session.

5 SESSION FOUR – FOCUS QUESTIONS

The original Session Four questions were intended to get the subject matter expert groups to identify if their answers or issues would be different if they were thinking in terms of being a part of an integrated team as opposed to just working in isolation in their area of expertise. However the first three sessions clearly showed they were already thinking in these terms so the questions were modified to draw out opinions on a variety of subjects related to the CEMA Criteria and Indicators project and the reclamation certification process in general.

Invited Participant Comment

Interdisciplinary work – it is essential. The geotechnical assessment cannot be properly done without the information / assessment from hydrology, hydrogeology, hydraulic engineering. Vegetation can help manage erosion and slope stability thus also relevant to have an interaction with geotechnical. Geotechnical prediction of seepage areas, groundwater levels, water quality (geochemistry) is also relevant for vegetation specialists if there is an interaction between these waters and plant roots.

I would bring a complete team of technical/ecological specialists to obtain the required data, samples, and observations needed to properly assess reclamation success.

Each group was assigned a question to answer.

5.1 Question 1. What do we need to know about contamination and remediation?

The group indicated that the overall goal for any remediation should be that there is no ongoing management required by the Crown.

Salinity and hydrocarbons were identified as areas of potential concern; salinity because it affects so many different ecosystem components and hydrocarbons because there is uncertainty about the applicable criteria.

The group noted that soil capping depths are currently used as "remediation" – deeper soils required as buffer over poor quality natural (saline Clearwater clays) and anthropogenic materials (plant site).

5.2 Question 2. What advice can you give CEMA on criteria and the certification process?

This question gave rise to a discussion of Type 1 errors and Type 2 errors, who bears the consequences of the error and how that affects the approach we take in criteria development and in issuing certificates. The group felt that this was fundamental to the whole certification process.

Review Comment

The problem is, how many investigations (vegetation, hydrology, chemical, etc.) are enough? The answer to 'how many is enough' is determined in part scientifically (science tells you what you can and cannot prove) but also socially (society tells you how much risk of being wrong is acceptable).

The group recommended that criteria which are integrative (represent multiple sub-indicators) should be chosen over multiple related criteria. They also suggested that at least 30 years of performance monitoring data be collected before certification to provide confidence in the certification decision.

5.3 Question 3. Do expectations and process needs change depending on the reclamation goal(s)?

In general the group felt that both expectations and process should change. They acknowledged that the overarching goal is a functional boreal forest, but that sub-goals of wildlife habitat, traditional use, recreational areas, and/or commercial forestry may be superimposed. In this case, reclamation criteria targeted to each specific goal would be required.

The group flagged the potential concern of trying to fit site-specific goals into regional goals and the need to ensure plans and success measures considered such things as integration and connectivity across lease boundaries (lease to undisturbed and lease to lease).

5.4 Question 4. Do expectations and process needs change depending on when the site was reclaimed (i.e., older sites, currently reclaimed sites, sites reclaimed in the future)?

There are definitely different expectations for sites reclaimed in the past compared to today (and there are likely to be changed expectations for future sites).

The group recommended using standards of the day at the time of certification (but somehow need to recognize standards at the time the site was built and reclaimed). This led to considerable discussion with the primary focus being the negative effects on progressive reclamation efforts (none would be done to avoid having to redo work later) and the fact that once soils are salvaged the range of reclamation options is immediately restricted by the amount and type of materials available (i.e., standards of the day at construction really determine outcome). The discussion ended with the suggestion that the more realistic approach is to use standards at the time the reclamation work was done (promotes certainty, progressive reclamation and adaptive management).

Review Comment

Caution: It is necessary to recognize approval timelines/approval requirements when setting certification requirements as that is what dictated what was done/to be done (soil salvage and replacement, contouring, revegetation, etc.). These requirements changed over the years and went into new approvals thus setting a new timeline for the next area of development. These new requirements/timelines cannot be imposed retroactively to older areas and expect old approvals to expire.

5.5 Question 5. How long do we monitor for before applying for a reclamation certificate?

The group noted that the timing depends on when you start the clock (i.e., when is time zero). They also noted that a given large landform may likely have a range of development and reclamation ages (e.g., top of a dump has 10 years of tree growth but bottom has 30 years) so elapsed time since reclamation would be longer for the early portions and shortest for the area last reclaimed.

The group provided a range of suggested monitoring timelines, from 10 years to 30 years.

Review Comment

There should be multiple points along the reclamation trajectory where monitoring occurs. If sites are not checked until certification at 10 – 30 years, it will be very difficult to correct problems that resulted in the failure to certify the site. We need more information on the early part of reclamation trajectories so we can course-correct earlier in the process, when it is easier to manipulate a site.

5.6 Question 6. Do expectations and process needs change based on landform type (e.g., dump, tailings pond, dedicated disposal area, plant site)?

The group indicated the certification process should not change but the application content may change with different focal areas for different landform types and related reclamation. The monitoring period to show success may also vary.

5.7 Question 7. What disciplines are missing from the discussion today?

A wide variety of organizations and interests were identified who would have an interest in the certification process and results but there was no indication on how these groups would be able to participate:

- Aboriginal groups, municipal groups, operational employees (cat skinner), trappers/outfitters/recreational users
- NGOs (e.g., Alberta Wilderness Association)
- Federal agency staff (e.g., DFO)
- Socioeconomic and legal interests

Appendix 5 provides the detailed workshop notes from this session.

6 OBSERVATIONS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Additional Observations

One workshop participant drew an interesting parallel between the criteria and indicators and reclamation certification process and the practice of medicine[1].

Review Comment

This is pretty much identical to the situation faced by a physician who is trying to diagnose a case.

If all he has is his hands and eyes and ears, then only the most primitive assessment can be made. If he happens to see jaundice or hears crackles or wheezes in the lungs or can feel a fever, he can make some interpretations at a basic level. This is analogous to the 5-senses posed to the group.

If he can speak to the patient and get a history, then that can help quite a bit in diagnosis – this is analogous to the background information on the site.

If he can get some lab tests done, then that helps even more – this is analogous to the equipment question posed.

If he can get a report from specialists, that gives him even more confidence. This is analogous to the analytical reports question posed to the group.

One workshop participant noted that one of the issues affecting confidence is that we don't know what a healthy site is (i.e., we can't yet define success). This also helps explain why we tend to look for failures, because they **are** obvious.

Review Comment

We all know that natural systems are not totally understood. So, we wind up making judgments on the basis of consistency. "Is what I am seeing here consistent with reference site(s) which I assume to be healthy?" We know that what we can sense directly is only a small portion of what is happening in a site (for example, we cannot directly sense the rate of nitrogen fixation in the soil, we cannot directly sense water retention and transit rates, we cannot directly sense small mammal occupancy). So we can't tell if the reclaimed site is really consistent with the reference site. Hence, we don't trust what we can sense

[1] One could say this simply reinforces the earlier comments since doctors are predisposed to look for illness (failure). They do look for health (success), but primarily as a means to reduce the number of potential failure modes.

because it shows us so little of the picture. This also partially explains the 'easier to determine failure than success phenomenon' – if you can see cattails growing in what should be upland, you know for sure that there is a problem with water retention. If you don't see cattails, that doesn't necessarily mean that there is no problem with water retention (absence of proof is not proof of absence).

The workshop and review comments lead to an intriguing possibility. If it is true that:

- It is difficult to define success for a complex ecological goal such as the return of a *self-sustaining, locally common boreal forest ecosystem* and therefore more difficult to explain why you are saying a site has passed;
- Some of the desired outcomes are soft and not directly amenable to numeric description (e.g., landform is natural in appearance);
- It is human nature, and easier, to look for failures than success and therefore we have greater confidence in making failure decisions; and,
- Other professions focus on identifying failures and use evidence of success to rule out potential failure modes (e.g., medicine, new home construction problems checklist, auto mechanics)

Then perhaps the Criteria and Indicators Framework could focus on confirming *no failures* rather than trying to confirm *success*. However, even if we keep the existing approach, it may be useful to test each indicator and criterion by asking *what does failure look like* as well as asking *what does success look like*. At the very least, the gap between the two answers may help us better define our level of tolerance for each indicator and the areas where professional judgment/experience could be used to explain and justify the results.

The groups provided some suggestions about changes to the post-certification process that might improve comfort with issuing certificates and help get Aboriginal buy-in to the process.

Workshop Comment

Note Mikisew Cree First Nation said "land is not reclaimed until we have access to it"; therefore maybe not the best approach to wait until we are 100% certain and instead allow access to areas before certification

Since liability seems to be a driver of confidence perhaps it is time to reconsider immediate reversion of liability to the Crown on issuance of the certificate

6.2 Conclusions

The original intent of the workshop was to supplement the science-based reclamation certification criteria and indicators being developed by the Reclamation Working Group of the Cumulative Environmental Management Association with the knowledge and experience used by people with significant field experience. Although valuable suggestions about criteria were received, the discussions seemed to focus more on the information needs and process for assessing certification suggesting the need for a *Guide to the Reclamation Certification Process*. In particular many observations were made about the impact of the approach or attitude towards certification suggesting there is a need to establish a set of principles to guide the process.

Workshop Comment

"Conservative approach" rather than a "skeptical approach" [would be preferred]

Easy to see bad work, harder to see good work

Look for negatives (what isn't right) as this is easier to do; then move to find what is right

The workshop also sought to determine how the confidence in decision making is affected by the use of field equipment/tools, and the value of background data and reports in increasing confidence. Given the extensive experience of the workshop participants, it was surprising to see how little confidence they had in using only their knowledge and experience to make reclamation certification decisions, although this likely reflects:

- The increasing complexity of oil sands reclamation
- The difficulty in describing and measuring what *success* is
- The diversity of reclamation substrates, especially the uncertainty surrounding tailings (both in terrestrial and pit lake settings)
- The wide range of regulator and stakeholder performance expectations
- Concerns that judgment will vary too much among people and over time to be a reliable method for such an important decision
- The liability that is attached to the decision

Invited Participant Comment

25 years ago I would have been quite confident; now I find the more I learn the less I know

The questions, as posed, suggest that reclamation certification is returning to the dark ages, where a field "officer" relies on gut instinct to determine reclamation success

Participant's confidence in making decisions increased somewhat if they were able to bring a piece of equipment into the field with them to gather data. If they were able to review a high quality report and supporting data from the site's historical file prior to going into the field their confidence increased substantially. This confirms the need for the CEMA RWG Criteria and Indicators work and suggests the need for a *Guide to Reclamation Certification Application Content*.

Review Comment

The absence of these criteria has been a significant barrier to reclamation, in that those reclaiming do not know what to target and those certifying do not know what to measure against

... collective understanding that without criteria that are scientifically-grounded AND socially-acceptable, there will be no reclamation regardless of the experiences of the reclamation certification inspector

Invited Participant Comment

The elephant in the room is the absence of reclamation criteria. While criteria are generally based on scientific principles, there is a strong requirement for social input to guide criteria, in short, "what is expected of reclamation (social), and how do we measure that the expectation has been met (scientific)?" This is where the effort should be invested, not in simplifying the process to "gut feel".

The following table summarizes the factors that workshop participants identified that would help to increase their confidence in reclamation certification decisions. These factors can be used to develop the two Guides noted above.

Table 1. Factors Affecting Confidence in Reclamation Certification Decisions

Factor	**Trend**	**Rationale**	**Implications**
Time since reclamation	Confidence increases with time since reclamation	The longer the site has been reclaimed the more likely a stable state has developed Or, alternatively The longer the site has been reclaimed the more likely low-intensity but long-term deviations from the reference state will become obvious	Suggestion that a reasonable time to monitor the site before application was 10 to 30 years Time could be shorter if there were more data and past site visits
Exposure to variability in ecological stressors	Confidence increases with broader exposure to ecological stressors	It is easier to predict future performance if past performance has been shown against a range of expected stressors NOTE – this is related to the *Time since reclamation* factor	Document ecological stressors that occurred over the post-reclamation period and the responses to those stressors
Site size	Confidence increases for smaller sites	The larger the site: the greater the complexity of landforms the more likely there were different reclamation methods applied the more likely there were more substrates (e.g., overburden, tailings) the more likely there were different regulatory requirements	Give consideration to applications for multiple small sites and/or sites with common features
Site visits	Confidence increases with the number of site visits	The greater the familiarity with the site the more comfortable a person will feel (it is no longer a single-day decision but a decision based on cumulative exposure)	Increase the number of site visits/inspections by regulators

Factor	Trend	Rationale	Implications
Inspector and reviewer experience	Confidence increases with level of experience	Decisions are easier when the inspector or reviewer has experience: issuing certificates, especially with larger disturbances (and ideally oil sands) reviewing reclamation certificate applications with oil sands mines NOTE – related to the *Site visits* factor	Continuity of staff (both regulators and industry) over the life of the project (ideal) or at least the life of the reclamation certification process will improve the certification process
Multidisciplinary team	Confidence increases with the breadth and qualifications of the application team, review team and field inquiry team	Documenting, reviewing and assessing oil sands reclamation requires a multidisciplinary team	Identify the range of disciplines required to develop an acceptable application Consider identifying the expected level of professional experience and education required for team members Industry and regulators need to ensure all required disciplines are represented on the teams
Professional signoff	Confidence increases with professional signoff of the application	Signoff provides some assurance that an appropriate level of expertise (education and experience) has been applied to preparing the application Signoff ensures the signatory (signatories) can be held accountable through their professional organization	Identify the range of professional input required to develop an acceptable application Consider requiring professional signoff of the application and/or the individual discipline components of the application

Factor	Trend	Rationale	Implications
Reclamation certificate application	Confidence increases with the quality of the reclamation certificate application	Human nature to place greater trust in actual performance if the documentation is all present, accurate and consistent with expectations and experience	Develop an understanding of what a "good" application should contain and look like
Visual aids	Confidence increases with maps, digital elevation models, air photos, remote sensing imagery	Given the likely large areal extent of land for reclamation certification and the mosaic of landform types likely to be encountered, visual aids help put the site and data in perspective	Identify list of common visual aids that will enhance applications. Consider specifying format, scale, legend requirements to standardize applications.
Quality of reclamation	Confidence increases when quality is very poor or very good	Suggestion by one group that you might be able to rank sites into bottom 25% (obvious fail), top 25% (likely pass) and the rest (25% to 75%) for which there is considerable uncertainty It is much easier to identify things that are "wrong" and they are often visually evident	There is a tendency to focus on things that are wrong (prove failure) instead of trying to confirm success People are more willing to overlook flaws if the site looks really good

6.3 Recommendations

The following recommendations are made based on the workshop feedback:

1. Develop a *Guide to the Reclamation Certification Process* that addresses the issues around approach (attitude) to certification.
2. Develop a *Guide to Reclamation Certification Application Content* that identifies the preferred content and format of materials to be submitted in the application.

These Guides could be stand-alone documents or could form Appendices to the Criteria and Indicators Framework and/or Alberta Environment and Sustainable Resource Development's upcoming reclamation certification process guide.

3. The Reclamation Working Group should focus on Criteria and Indicators that are integrative of a number of individual sub-criteria and/or sub-indicators. Effort should be made to ensure there is a clear understanding of the potential linkages between criteria and between indicators so that compliance with one does not conflict with or hinder another.

4. Alberta Environment and Sustainable Resource Development should discuss with industry the potential value to the certification process in changing the post-certification liability period. Workshop discussions indicated that risk aversion, related in part to immediate acceptance of liability, is one of the issues leading to a lack of confidence in issuing reclamation certificates. Changing the liability period for the oil sands mine may remove this particular concern (note, the operator is accountable for reclamation issues that arise on the plant site for 25 years following certification – the "liability period"). Such a change would require an amendment to the *Conservation and Reclamation Regulation* (Government of Alberta 1993).

7 REFERENCES

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7.1 Additional Reading

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8 ACRONYMS

ABMI	Alberta Biodiversity Monitoring Institute
ASPB	Alberta Society of Professional Biologists
CEMA	Cumulative Environmental Management Association

DEM	Digital Elevation Model
DFO	Department of Fisheries and Oceans
EM	Electromagnetic (survey)
EPL	End Pit Lake
GIS	Geographic Information Systems
LiDAR	Light Detection and Ranging
NGO	Non-government Organization
OSRIN	Oil Sands Research and Information Network
RWG	Reclamation Working Group (of CEMA)
SEE	School of Energy and the Environment (U of Alberta)
TEK	Traditional Ecological Knowledge

APPENDIX 1: Workshop Attendees

Participants	Heather Jones
Al Malcolm	Jay Woosaree
Amanda Sanregret	Jim Davies
Ann Smreciu	John Begg
Anne Naeth	John Railton
Bonnie Drozdowski	Kale Bromley
Brad Pinno	Kathryn Bessie
Brett Purdy	Kevin Ball
Brian Eaton	Kevin Devito
Bruce Anderson	Larry Brocke
Bruce Patterson	Leon Marciak
Bryan Ebbers	Marie Keys
Carol Jones	Markus Thormann
Chris Hale	Marsha Trites-Russell
Clayton Dubyk	Martin Jalkotzy
Clive Welham	Murray Anderson
Corey de la Mare	Rebecca Rooney
Dane McCoy	Rob Wirtz
Dani Walker	Ryan Puhlmann
Derek Ebner	Steve Tuttle
Don Watson	Tanya Richens
Don Weleschuk	Theo Charette
Dustin Shauer	
Elisa Scordo	**Observers**
Ellen Macdonald	Chris Powter
Ernst Kerkhoven	Kyle Harrietha
Gillian Donald	Mike Poscente
Gord McKenna	Roger Creasey

APPENDIX 2: Session 1 Discussions

Session One: You are going to visit a reclaimed oil sands mine site and decide if a reclamation certificate should be issued.

- What positive and negative features do you look for?
- How confident (%) would you be that your decision is correct i.e. mean and range?

Wildlife and Habitat Group

- Noticing species and habitat all at the same time (no definite priorities or sequence)
- Habitat is what you see
    - Vegetation structure, layers, species distribution (common vs. rare species), coarse woody debris
    - Native vs. non-native species
    - Look for heterogeneity (a desired feature)
    - Forage and prey availability (insects, microtines)
    - Microsites for various species at different points in life cycle
    - Spatial structure of habitat is important
- Missing items are negative; present items positive
- Wetland habitat quality – littoral zones
- Stream habitats – characteristics such as sinuosity, riffles/runs, coarse woody debris size
- Expectations set based on time since reclamation, type of reclamation, type of site (ecosite phase)
- Wildlife species – presence, sign (browse, pellets, tracks, nests/burrows/cavities/dens), diversity, abundance, productivity, survivorship, common vs. rare
- Don't expect to see lots of animals during a site visit, as some are nocturnal, elusive, don't occur at high density, etc.
- Ecological processes – molds and fungus are must haves
- Connectivity with adjacent (undisturbed, native) lands important but not discussed
- Diversity, abundance, productivity, survivorship all important aspects
- Confidence – 0%

Invited Participant Comment

I look for habitat structure. Is the habitat complex, comprising a diversity of species at each strata (ground cover, low shrub, tall shrub, sub-dominant trees, dominant trees)? Is the habitat "dense" or is it "loose"? I would expect that a complex, diverse, highly structured, and dense vegetated habitat would reflect a decent level of soil fertility and a functional water regime, and hence, a good level of habitat quality for target species.

Confidence – I would want to see the data, groundwater, surface water, soil, vegetation, wildlife, etc. It would violate the ASPB ethics criteria for me to make any decision or recommendation on reclamation success/certification without doing due diligence, which for me, is an evaluation of all the data relevant to the created habitat.

Geotechnical and Hydrology Group

- Important to define the boundaries for investigation
- Need a good map and aerial overview and topography
- Too late at reclamation certificate time to change many of the reclaimed site features, familiarity with program history would be important
- Where in the precipitation cycle (wet or dry) are we at the time of certification, when in the season and climate cycle
    - Spring melt – streams
    - Late summer (not too dry)
    - Late fall
    - Some parameters benefit from multiple years of observation
- Distinguish natural processes from unnatural ones
- Geotechnical – slumps, slides, settlement, cracks, sinkholes, piping, solifluction, soft ground, ponding, erosion, deposition,
- Morphology – swale and ridge, floodplain, microtopography, micro-sites
- Hydrology – erosion, deposition, channel (size, armour, outlet, morphology, blockage, flow), ponding, gully
- Soil moisture – spatial variability, vegetation indicators
- Groundwater – seeps (especially if expected to be poor quality water), salt rings
- Surface water – levels, salts, seeps, turbidity, high water mark, shoreline erosion/retreat, gassing/bubbling

- Wetlands – variability (type), wet/dry cycle
- Wildlife – watch for beaver activity impacts
- Vegetation provides clues (bare spots)
- Soils – texture and organic material
- Need subsurface information to be comfortable (thus more confident in decision)
- Confidence – extremely high when very bad; much lower if no obvious issues (easier to fail than pass), especially if the landscape has not been "tested" by a range of events, could benefit from subsurface info and history of ongoing monitoring

Invited Participant Comment

A seasoned geotechnical engineer with significant experience in field reconnaissance and assessment of sites in the oil sands region of Alberta could determine that a reclaimed site is not acceptable if there are indications of excessive deformation and/or unacceptable seepage in critical locations. However, the opposite is not true because no visible indication of problems does not necessarily mean the reclaimed site is acceptable. A "desk study" would be required to do an initial assessment. Design criteria, design parameters, selected configuration, as-build condition, monitoring data, etc. would be required to assess geotechnical performance, critical for a decision-making process.

Wetlands and Water Bodies Group

- Lakes
  - Look for heterogeneous habitats as an indication of success
  - Nursery
  - Thermocline
  - Sandy shores (based on vegetation)
  - Sediment/substrate
  - Variable slopes (gentle for plants)
  - Shape/sinuosity
  - Shoreline heterogeneity
  - Coarse woody debris
  - Vegetation – cover and amount, diversity, zonation, health

- Salt crusts
- Oil on water
- Smell in littoral zone
- Water colour and transparency
- Small fauna
- Macrofauna

- Wetlands
  - Sediment/substrate
  - Gentle slopes, less than or equal to 5%
  - Vegetation – cover, amount and species, diversity, zonation, health
  - Salt crusts
  - Oil sheen on water
  - Smell – H_2S, NH_3, organic acids
  - Water colour/transparency
  - Small fauna
  - Macrofauna
- Fens and bogs
  - Depth of peat
  - Stratigraphy of peat
  - Water saturation
  - Continuous moss cover
  - Open water
  - White spruce and tamarack
  - Hummocks and hollows
- Beaver activity (context)
- Streams
  - Consider floodplain, not just channel
  - Sinuosity
  - Erosion
- Key criteria would be (1) heterogeneity/zonation of the vegetation given the physical profile, and (2) obvious “red flags”

- Confidence:
  - 25th percentile – 80% confidence
  - > 25th percentile – less confidence
  - >75 percentile – 25% to 50% confidence

Soils Group

- Vegetation as an expression of soil conditions – plant species composition relative to landscape position
- Soil placement at micro/meso/macro scales
- Positive indicators are leaf litter, soil colour, soil organic matter, woody debris, vegetation vigour, tilth, surface water
- Negative indicators are salt crusts, no cover (why?), erosion, stoniness, compaction (hardness, crusting)
- More likely to be accepting of concerns if you approach certification with a positive attitude (prove success rather than failure)
- Confidence
  - higher at both ends of spectrum (top and bottom 25% of sites), much less in the middle 50% of sites
  - Maybe 30% to 40% for skeptics and 40% to 60% for optimists
  - Confidence increases with the number of positive observations but also the confidence in rejection increases with the number of negative observations.

Vegetation Group

- Noted vegetation identified as an indicator by other disciplines
- Need to look first at the forest and then at the trees (scale and perception), site history and succession status
- Evidence of processes vs. evidence of species composition
- Discussed two approaches – start at the landscape/landform scale and work down or vice versa, structured assessment of canopy and understory, litter accumulation
- Compare with natural stands and processes and with other reclamation sites – how old should site be?

- General stand assessment
  - Site history
  - Succession status
  - Stand dynamics – leader growth, leaf area index, submergent vs. emergent species, zonation
  - Overstory – bark health (note different information gained from deciduous (integrate one year) vs. coniferous (integrate multiple years)), foliar health
  - Understory – age correlation, diversity, nitrogen fixers
  - Litter accumulation
  - Distance to undisturbed area
- Positive indicators
  - Appropriate leaf area index
  - Good needle retention
  - Appropriate understory diversity
  - Evidence of successional processes
  - Elements of naturalness
  - Non-vascular species
- Negative indicators
  - Poor reproduction
  - Too many ruderal species
  - Invasive species
  - Large gaps in vegetation
  - Poor foliar health
  - Bare ground
- Stand age sets expectations about species, diversity and ecological processes
- Confidence – greater with increasing site age; marsh > upland >> bog/fen

Integration Group One

- Based on an understanding of the regulatory requirements for the site including approved plans and end land use
- Landform contours stable (subsidence, erosion), micro- and macro-topography

- Integrated drainage patterns
- Vegetation
    - Cover
    - Presence/absence
    - Healthy and thriving
    - Appropriate species (boreal forest, approved plans)
    - Weeds
    - Indications of stress (water, contamination, disease, insects); e.g., foxtail barley and salt
    - Succession (second generation growth)
    - Growth is good enough you can't tell if the substrate is problematic (e.g., overburden or tailings)
- Soils – look for profile development (kick the dirt) and presence of salts or hydrocarbons
- Drainage – sustainable, stable, functioning, wet or dry as expected, when was last major rainfall event and did site behave as expected
- Wetlands – waterfowl, frogs
- Wildlife present and evidence of use (tracks, nests, dens)
- No extreme erosion
- No obvious contamination (salts, oil sheen); impacts vegetation and water quality
- Look for negatives (what isn't right) as this is easier to do; then move to find what is right
- Look for small problems that may grow in future – erosion, water flowing in different location than planned (new channel)
- Consider size and nature of the "problem" and place in context of overall application area
    - e.g., remnants of a stockpile but if vegetation is growing is it OK?
    - e.g., how big is an erosion or bare area
- Visual problems indicate lack of success and therefore 100% certain of failure; however, no visual problems means dig deeper and get data

- Confidence
    - high with sites where lots is wrong; otherwise range from 10% to 75%, the latter especially if there have been lots of previous site visits
    - confidence increases with site age
    - confidence decreases with site size

Integration Group Two

- Hearing holistic language being used by other groups
- Drainage, contours, vegetation, species composition, microsites, variability, ponding
- 5 senses can tell us something – lots of judgment is possible without data
- Sustainability/successional trajectory
- Milestones (trajectory)
- Presence of engineered features in water bodies is bad
- Visual – straight lines are bad (nature abhors a straight line)
- Reclamation certification decisions are made on the present day but are based on forward projections of performance
- Look for site to be emulating a natural analogue
- Important to know the end land use
- A person's experience with the site history determines level of confidence – how does the trajectory look?
- A person's experience with sites of similar size, land use and reclamation objectives increases confidence
- Still need to see data
- Confidence – 60% to 80%; increases if you have visited the site previously and if milestone events have been confirmed

APPENDIX 3. Session 2 Discussions

Session Two: Next, when you go onto the site you can bring one piece of equipment or one tool.

- What would you bring?
- What additional information will it provide for your assessment of the site?
- How much extra time (and time consuming logistics) would it add to your assessment of the site?
- Now how confident are you (%) in your assessment decisions (mean and range)?

Wildlife and Habitat Group

- Net handle with multiple heads
- Stream kick net for benthic invertebrates (ephemeroptera, plecoptera, tricoptera) as indicators of stream health
- Aquatics – invertebrates, amphibians, plants, benthics
- Terrestrial – invertebrates
- Time – add 10% to 20% (depending on distractions)
- Confidence – increased, especially for older sites; depends on habitat type

Invited Participant Comment

With proper site evaluation by qualified persons, my confidence would increase to 80% or more +/-15%), again, depending on the size and complexity of the reclaimed area. Anything less than a full and proper evaluation would reduce my confidence dramatically, quickly returning it to 0%

Geotechnical and Hydrology Group

- Ideal tool would integrate water balance at various scales (local and regional), shallow subsurface information including ecosystem processes, soil cover and substrate
- Drill rig (note needed before vegetation establishment to avoid disturbing successful reclamation; maybe a milestone assessment); if not available then hand drilled well
- Camera/shovel/auger for confirmation, clinometer (to measure slope angles that could be compared to design and/or as-built angles at the time of a "desk study" of the reclaimed site)/inclinometer

- Surface water
    - Survey rod and stopwatch for stream flow measure
    - Water quality sampling
- GPS, surveyor, topographic map, satellite photo, Google Earth (historic images)
- Geiger counter, pH meter
- Don't discount the need for cheap, plentiful and knowledgeable labour (e.g., summer students)
- NOTE: all of this work adds to reclamation cost
- Time – 8 weeks for drill rig work, add 6 to 24 months to gather, analyze and write up data
- Confidence – increase 22% without drill rig and 62% with drill rig

Wetlands and Water Bodies Group

- Multimeter with multiple probes/sensors
    - Electrical conductivity
    - Dissolved oxygen
    - Temperature
    - pH
    - Redox
    - Turbidity
    - Chlorophyll A
    - Depth
- Sediment – conductivity meter, shovel
- Gather more information on lake status, wetlands and streams
- Provides explanation for vegetation observations
- Time – add less than a day
- Confidence – increase 25% for lakes and streams; increase 10% for wetlands

Soils Group

- 5/6 said a shovel (or other excavation device), 1/6 said a camera (document progression of changes)

- Ability to inspect the medium in question
    - Look for variability in quantity and quality
    - Vegetation rooting patterns
- Look for distribution of "extremes" in placement depth and quality
- Help clarify the type and degree of risk – confirmation of suspicions
- Time increase
    - Shovel – 3 to 4 times as long
    - Camera – 10% increase
- Confidence
    - Shovel – Increase from 50% to 80% (note 100% if shovel and data)
    - Camera – Increase from 50% to 60% to 70%

Vegetation Group

- Smart device with camera, GPS plus software
- 5/7 suggested an aboriginal Elder as a resource to help interpret results and a different way to look at the site (i.e., TEK)
- 5/7 suggested a shovel (note must be high quality) to look for soil characteristics and belowground productivity
- 6/7 suggested the use of calibrated high-resolution remote sensed imagery (this is the tool of the future)
- Confidence – increases on older sites (no numerical estimate provided)

Integration Group One

- Shovel
    - Root depth and quantity
    - Topsoil depth
    - Topsoil texture
    - Soil development
    - Compaction
    - Hydrocarbons/tar balls
    - Water table

    - Presence of rocks
    - Depth to impermeable/unsuitable material (e.g., overburden, tailings)
    - Soil moisture at depth
- High-resolution satellite imagery helpful (2nd preferred tool)
- Helicopter over-flight with reclamation application in hand
- Approved closure plan sets expectations and context
- Allows quick identification of failures and ability to focus on problem areas
- Time – double time if doing the whole area but if you focus on problem areas then less (maybe even quit when a significant problem is found)
- Confidence – increases considerably (now 50% to 90%)

Integration Group Two

- Reclamation certificate application
    - History
    - Analytical data (soils, vegetation, water, landscape)
    - Allows comparison of visual attributes of site with application and allows for validation of application
- Helicopter for overview (especially important given the expected large size of certificate application areas – 500 to 1,000+ hectares)
- Need off-site and/or natural analogue information for comparison
- Consistency – i.e., are the data in the application comparable to the field observations?
- Acknowledged that preparation of an application requires big effort by company
- Also noted will take same level of effort for regulators to review as for an approval application
- Confidence – increases (no number specified)

APPENDIX 4. Session 3 Discussions

Session Three: Next, in addition to your senses, experience, and the additional equipment you brought, you can ask for a report(s) regarding the site before the field assessment.

- What information would you want to see in the report/documents?
- Now, how confident are you (%) in your decision (mean and range)?

Wildlife and Habitat Group

- Multiple years of data (species, communities, etc.)
- Metrics, data to describe the trajectory e.g., ABMI intactness
- Maps
- Soil and vegetation performance for habitat quality
- Change over time
- Reclamation goals and plans for land parcels
- Traditional Ecological Knowledge is critical for wildlife
- Integration with neighboring sites (terrestrial, hydrology, connectivity)
- Comparisons to reference condition sites (assumes there is comparable long term monitoring of reference sites)
- Access to regulatory data
- End pit lake characteristics (littoral zone, depth, etc.)
- Confidence – increases if multiple years with a positive outcome

Geotechnical and Hydrology Group

Invited Participant Comment

The exact pieces of information that I would like to see in the report would vary from site to site depending on the details of the site geology and on the design elements that were present during operation and at the time of reclamation

- Understanding of goals and expectations
- Provide a holistic report

- Biography (history) of landform – look at White Book[2] list for potential content
  - Design
  - Construction
  - Stratigraphy
  - Reclamation
  - Groundwater
  - Surface water
  - Geotechnical
  - Soils, vegetation, wildlife
  - As-built
  - Maintenance
  - QA/QC
  - Costs
- Description of planned vs. actual construction and reclamation (as-built), how this landform fits with closure plan and the regional landscape
- Modeling and monitoring data indicating geotechnical performance of all elements and systems during operation, during reclamation activities and post-reclamation activities
  - Tailings consolidation
  - Topography and erosion
  - Temperature
  - Climate
  - Streamflow
  - Water levels
  - Water quality
  - Geotechnical – movement, ground settlement
  - Soil moisture
  - Climate change

[2] Land Conservation and Reclamation Council, 1991. A guide to the preparation of applications and reports for coal and oil sands operations. Alberta Land Conservation and Reclamation Council, Edmonton, Alberta. http://environment.gov.ab.ca/info/library/6849.pdf [Last accessed July 23, 2012].

- Design, construction, stratigraphy, groundwater, geotechnical parameters of all relevant materials

Invited Participant Comment

- *Site geology and hydrogeology data*
- *Site hydrology and water management approach before and after reclamation.*
- *Operational conditions of the site – presence, materials, nature, operations and performance of dams, dumps, cut slopes, etc.*
- *Reclamation design elements – changes to all design elements that existed during operations + all new design elements, constructed landforms, material removal, drainage, etc.*

- Inspections, agreements, annual reports, deviations (deficiencies encountered and mitigation)
- Photos over time (land, satellite)
- Assessment/Trajectory
  - Comparison of model vs. actual (trends, performance history)
  - Comparison of actual vs. goals/approval
  - Comparison to natural analogues
- Confidence
  - Optimistic approach would be 100%
  - Pessimist – bad reclamation = 100% fail; good reclamation and report – 50%; good reclamation but bad report – low (20%)
  - Pessimist may never be satisfied even with best report and reclamation
- Issues affecting decision (more delays, bogging down)
  - Climate change
  - Really big storm
  - Defects
  - Outside pressure
  - Second guessing

Wetlands and Water Bodies Group

- Map of surrounding land cover(s)
- Site closure and reclamation plan and integration programs
- Reference conditions; pre-disturbance assessment
- LiDAR and digital elevation model at 5 years
- Site reclamation standards
- Evaluate over time (period not specified)
    - Regional hydrology (flows to and from site) and loading rates
    - Water and sediment quality – toxicity/chemistry over 20 years
- Lake thermodynamics
- Consolidation rate – settling
- Sediment quality/chemistry and re-suspension
- Water release
- Biology report
    - Biodiversity
    - Index of Biotic Integrity (IBI) scores
    - Wildlife
    - Species at Risk
    - Traditional knowledge
- Confidence – 50% to 90% depending on report quality

Soils Group

- Map, mine plan, application requirements, as-builts, timelines
- History – reclamation methods, materials (type and volume), equipment, timelines, vegetation information, topography, hydrology (seeps, streams), lab data, reports, off-site or baseline data
- Site inspection post-reclamation
    - physical characteristics – material type to depth, texture, colour, structure (compaction), % effervescence, roots, mottles
    - Soil organic matter – von Post, humic type

    - Lab data – salinity, total organic carbon, soil organic matter, C:N ratio, nutrients, particle size analysis
    - Biological – micro and meso soil fauna
- Evidence of soil ecosystem functions – e.g., cycling of nutrients and soil organic matter
- Evidence of soil development processes and functions (supported by several of the previously noted measures)
- Evidence of hydraulic functions – e.g., connectivity
- Site history and why we should believe it
- Certainty of future performance not just what we see at the inquiry

Review Comment

Not sure ertainty" is achievable. Potentially, given enough time and experience in the area, one could develop a sense of how often certain types of sites achieve their targeted end use, but that will be far in the future as those data do not exist for the oil sands at present.

- Soil health
- Confidence 100%

Vegetation Group

- Progressions from objectives -> reclamation -> monitoring -> application -> certificate
- Report describes:
    - Regulatory requirements
    - Site history – landforms, soils, vegetation
    - Approved closure plan
    - Management intervention
- Reference condition as the comparison
- No discussion about what is meant by "monitoring"(structure, function, composition)
- Measures done over time and at different scales (e.g., stand vs. landform) – structure, composition, function

- What to monitor
    - Comparison to reference
    - Structure – canopy height/closure/layering, imagery, landscape structure/connectivity
    - Composition – plant species abundance, planting history, ingress
    - Function – mortality/reproduction, growth rates (aboveground biomass), foliar nutrition/PRS probes, leaf area index, rooting patterns, mycorrhizae
- Trends over time for many parameters – 10 to 20 to 30 years
- Confidence in certification decision increases with access to a relevant report

Integration Group One

- Focus on content not form
- Site inspection history by reclamation Inspector
- Site history
- Topographic maps and as-built
- Application area boundaries – appropriate, confirmation of what is in and out of the application (e.g., perimeter ditch around a dump, roads)
- Photography showing progression in site development and reclamation
- Approval conditions (note, there may be multiple versions of approval conditions for different blocks of land due to age of site) and commitments
- Suite of biophysical parameters
    - Soil survey/assessment (depth, quality)
    - Vegetation assessment
    - Aquatic assessments
    - Surface water and groundwater assessments - water quality, runoff, seepage
    - Surface drainage (plans, as-built, function, sustainability) and hydrology
    - Stability
    - Biodiversity and wildlife habitat (link to vegetation) – not sure how to assess success though
- Manmade structures and maintenance requirements and who is responsible for maintenance

- Contamination history; Phase 1 for any unusual contaminants and areas of risk (e.g., plant site)
- Integration of features across site and lease boundaries
- Professional(s) sign-off adds integrity to the process
- Interdisciplinary review before site inquiry
- Confidence – increases substantially with interdisciplinary review and inquiry (80%+); increases with smaller site size; increases with age of reclamation

Integration Group Two

- Site history
  - Includes annual reports and inspections)
  - Air photos, LiDAR, GIS
  - Cross sectional maps and site diagrams
  - Water quality and quantity for both surface water and groundwater
- Site closure plans – integration or tie-in with rest of mine and adjacent lands
- Landscape – topographic maps., cross-sections, site diagram
- Geotechnical – geo assessments
- Remediation – salts, hydrocarbons, metals, water quality
- Regeneration standards
- Soils – depth, texture, salinity, Land Capability Classification System rating(s), Best Management Practices
- Vegetation – wetland assessment, Alternative regeneration Standards, Revegetation manual
- Wetlands/water bodies/end pit lakes
- Wildlife information – not sure of specific metrics though
- Not sure how to assess alternative land uses such as recreation (same for TEK and traditional use) – perhaps these get set at the approval stage?
- Confidence – 90%

APPENDIX 5. Session 4 Discussions

Session Four: For the final session in the workshop, the groups were asked to provide their comments on one of seven questions:

1. What do we need to know about contamination and remediation?
2. What advice can you give CEMA on criteria and the certification process?
3. Do expectations and process needs change depending on the reclamation goal(s)?
4. Do expectations and process needs change depending when the site was reclaimed (i.e., older sites, currently reclaimed sites, sites reclaimed in the future)?
5. How long do we monitor for before applying for a reclamation certificate?
6. Do expectations and process needs change based on landform type (e.g., dump, tailings pond, Dedicated Disposal Area, plant site)?
7. What disciplines are missing from the discussion today?

What do we need to know about contamination and remediation?

- Does it matter on an oil sands post-mining landscape? Yes, if causing an adverse effect to receptors/values
- Remediation definition – cleanup and/or cutoff pathways to receptors
- Hydrocarbons (unrefined and refined) and salinity are key issues
- There are no unrefined hydrocarbon numbers available – needed but perhaps difficult to do especially given that it is, by definition, a hydrocarbon-rich environment
- Refined hydrocarbons should be cleaned up to Tier 1[3]
- Salinity
    - Impacts vegetation health, wetlands, aquatic species
    - Use a risk-based approach based on impacts to specific biota (site-specific guidelines)
- Soil capping depths are used as "remediation" – deeper soils required as buffer over poor quality natural (saline Clearwater clays) and anthropogenic materials (plant site)
- Groundwater discharge may need to be addressed

[3] Alberta Environment, 2010. Alberta tier 1 soil and groundwater remediation guidelines. Alberta Environment, Edmonton, Alberta. 204 pp. http://environment.gov.ab.ca/info/library/7751.pdf [Last accessed July 23, 2012].

- Overall goal should be that there is no ongoing management required by the Crown after certification

What advice can you give CEMA on criteria and the certification process?

- Discussion about Type 1 (false positive) and Type 2 (false negative) errors and which one we are more concerned with (this is fundamental to the whole criteria and certification process)
- The approach to certification should be to confirm success (null hypothesis – site does meet criteria)
- Important in terms of who pays for the "error" – Type 1 site is certified when it should not have been – society and the environment "pay"; Type 2 – site was denied when it should have been certified – industry pays
- The null hypothesis also determines how to structure the process and how to measure success
- Criteria that are integrative (represent multiple sub-indicators) should be chosen over multiple related criteria
- Suggest at least 30 years of performance data to provide confidence in decision

Discussion

- Need to recognize that "company pays" is not entirely accurate as government and society bear some costs even when the "company pays" (e.g., taxes, royalties, stock values)

Do expectations and process needs change depending on the reclamation goal(s)?

- Yes both expectations and process should change
- Overarching goal is functional boreal forest
    - Sub-goals could be: wildlife habitat, traditional use, recreational areas, commercial forestry (acknowledge that specific uses may be imposed on reclaimed boreal forest)
- What do you measure against? Need to identify a suitable reference condition for the goal (e.g., boreal forest is overall goal but if moose habitat deemed important then target reclamation and assessment/measurement to moose-friendly needs such as moose/ha and/or more moose habitat).

- There is a question around the implications of targeting specific goals for a site in terms of the regional goals and issues such as habitat connectivity. There is also a question around how to fit specific goals into the regulatory process.

Discussion

- Until we get an alternate use proposed there isn't much need to spend time on developing criteria and a separate process
- Could one company agree with another to trade off goals (e.g., I do moose you do bears) rather than both being responsible to meet all goals?
- Would it be the goal that changes or just the measurements to show success?
- It was noted that we've already accepted change as there will be fewer wetlands in the reclaimed landscape than in pre-disturbance landscape; what is missing is a method to "calculate" acceptability of change; there is currently no "right" answer; perhaps need to get stakeholders to confirm goal?

Do expectations and process needs change depending on when the site was reclaimed (i.e., older sites, currently reclaimed sites, sites reclaimed in the future)?

- Definitely different expectations for historical sites
- Older site = less ability to influence outcome (when do you re-reclaim?)
- Apply the guidelines contemporaneous with the date of the reclamation certificate application (i.e., use "standards of the day" but somehow need to recognize standards at the time the site was built and reclaimed)

Discussion

- Using standards of the day as suggested will result in no progressive reclamation since there would be uncertainty about final requirements
- Agree that practices and standards should evolve over time (re-assess on a regular basis) but that goal posts should be set for a specific piece of land and stay the same
- Could go with standards at time of approval since that is what the project economics were based on; more realistic approach is standards at the time the reclamation work was done (promotes certainty, progressive reclamation and adaptive management)
- Practices should change as soon as they are shown to be "absolute no-no's"
- Need to recognize that soil salvage requirements in place at the time the site is developed effectively dictate the final reclamation scheme

- Need some balance to support adaptive management while recognizing there are real constraints
- Agree it makes no sense to go back after an inquiry and redo reclamation; the best time to make adjustments is at milestones – landform contouring, soil placement, revegetation)

How long do we monitor for before applying for a reclamation certificate?

- Important to identify when time zero is to start the clock
- A given large landform will likely have multiple ages of development and reclamation (e.g., top of a dump has 10 years of tree growth but bottom has 30 years)
- Suggest 10 to 30 years is appropriate monitoring period (perhaps less time – 6 or 7 years – for a "routine landform" that has been previously successfully reclaimed)
- When is time zero?
    - Start early, e.g., at vegetation planting
    - Can place some reliance on similar reclaimed sites?
    - Vegetation (trees) greater than or equal to 15 years from first trees, and 2 years from last reclamation.
- Geotechnical items, zeros after re-vegetating slopes, 3 to 5 years for settlement
- Surface water
    - 10 to 15 years of tree growth
    - What about similar sites?
    - Trends – e.g., 10 to 15 years erosion
- Groundwater
    - Start at wet up
    - Less than or equal to 30 years steady
    - Greater than or equal to 5 years trend
- Wetland – Marsh, Fen
- Soils
- Vegetation
- Wildlife

- Note Mikisew Cree First Nation said “land is not reclaimed until we have access to it”; therefore maybe not the best approach to wait until we are 100% certain and instead allow access to areas before certification

Discussion

- Since liability seems to be a driver of confidence perhaps it is time to reconsider immediate reversion of liability to the Crown on issuance of the certificate

Review Comment

The workshop seemed to focus a bit on the idea that for the oil sands mines, the "inquiry" would hold the same weight as it used to for particularly upstream oil and gas. I'm not sure however we have determined this is a good model for oil sands mines. A better model may incorporate checks throughout the life cycle of the mine and provide for the collection and analysis of appropriate data to show the site is on the correct trajectory. This type of system would rely on the evaluation of the site and data overtime and may make the inquiry process and the "authority of the inspector" a bit of a formality.

Do expectations and process needs change based on landform type (e.g., dump, tailings pond, Dedicated Disposal Area, plant site)?

- Process should not change
- Expectations don’t change because they are defined in approvals and approved plans but the approved plans will
- Content of application may change with different focal areas for different landform types and related reclamation
- Monitoring period may vary to demonstrate success and may increase depending on risk – e.g., for plant site, end pit lake
- Administrative process should not change, but content of applications may change depending on the needs of the area (i.e., tailings vs. wetlands vs. terrestrial), level of effort to assess stability may change depending on landform type
- Legislation already recognizes the risk for plant sites is higher as shown by the increased liability period

Discussion

- The amendment and renewals process is in place to adopt changes over time

- Have to recognize change is only possible within context of landform and available salvaged soil constraints
- New rules should apply on a go forward basis
- One alternative could be that each block of land has a set of rules and is shepherded by a team of industry/government/stakeholders from Day 1 to certification

What disciplines are missing from the discussion today?

- Traditional Ecological Knowledge, aboriginal input
- Local government goals (they may want other uses such as recreation)
- Operational reclamation staff who build the site
- Trappers/outfitters/recreational users
- Non-Governmental Organizations
- Federal government (Department of Fisheries and Oceans, Environment Canada)
- Socioeconomic issues (acknowledge that these are addressed at the front end more than during the reclamation certification process)
- Legal/risk (process seems to be increasingly liability driven)

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