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PREDICTIVE VISUAL QUALITY ASSESSMENT IN
AGGREGATE MINE RECLAMATION

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Peter S. Keefe

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PREDICTIVE VISUAL QUALITY ASSESSMENT IN AGGREGATE MINE RECLAMATION

By

Peter S. Keefe

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ABSTRACT

PREDICTIVE VISUAL QUALITY ASSESSMENT IN AGGREGATE MINE RECLAMATION

By

Peter S. Keefe

The study of landscape aesthetics has recently been brought into the forefront of research through the passage of various federal legislative acts which mandate the consideration of the quality of surroundings as a natural resource.

I applied models that have been developed to meet these national program requirements to a local land use, aggregate mining. I evaluated if current reclamation procedures improve the visual quality of aggregate mines. Using a perception-based, predictive visual quality formula on two surface mine sites, I determined the effect of applying four different reclamation treatments: open water, natural revegetation, agriculture and housing development in comparison to the operating site.

The visual quality model predicted with a 95% confidence level that reclaiming the mine sites using open water or natural revegetation does significantly increase the visual quality of mine sites. Conversely, reclaiming by using housing development or agriculture had no significant effect on the visual quality of the mine sites.

DEDICATION

To Veda, who gracefully accepted the burdens of my schooling with support, loving and a smile.

ACKNOWLEDGMENTS

To Anthony Bauer whose enthusiasm for landscape architecture first encouraged my interest in land reclamation. To Jon Burley who taught me a variety of ways to view landscape architecture and to Terry Brown who unselfishly added to my thesis.

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INTRODUCTION

Only recently has the aesthetic quality of a space has become a "mainstream" concern. With a series of legislative actions the federal government brought the topic of environmental scenic quality to the forefront. Laws such as the Wilderness Act of 1964, National Wild and Scenic Rivers Act of 1968, the National Trails Act of 1968, the National Environmental Protection Act (NEPA) of 1970, and the Coastal Zone Management Act of 1972 all contain articles that pertain to aesthetic quality (Ruddell, Gramann, Ruddis and Westphal, 1989, Leopold, 1982, Brown and Daniel, 1991, Latimer, Hogo and Daniel, 1981, Arthur, 1977). The NEPA states "it is the responsibility of the federal government to use all practical means ... (to) assure for all Americans ... aesthetically and culturally pleasing surroundings" (NEPA, sec. 101 (b)).

The passage of NEPA marked the turning point in acknowledging the landscape as a visual resource (Brown, 1994). Many government agencies needed to adopt this new attitude which led to new goal setting policies. The Forest Service now has in it's mission statement to treat the visual landscape "as a basic resource, to be treated as an essential part of and receive equal consideration with other basic resources of the land" (USDA Forest Service,

1977) and "one of the management goals for New England's forests is the consideration of aesthetics" (USDA Forest Service, 1973).

With the need to preserve scenic values, the scenic quality of an area now had to be defined, measured and manipulated in order to preserve these qualities. New management models have, and still are, emerging to aid in the assessment of the visual landscape.

The purpose of this study is to apply these techniques used in federal projects and apply them to local and private projects. These methods of predicting visual impact could be used as design and management tools on the local level to mitigate the effects of high impact development. I have chosen to utilize these methodologies in aggregate mining.

Aggregate mining is a local land use that is widely distributed across the country. Aggregate is a basic construction commodity that accounts for 43% of all mineral commodities produced in the United States (Dietrich, 1986). Michigan has an estimated 5, 000 total mine sites (Wyckoff, 1992) with 357 operating mines in 1994 (US Department of Interior, Bureau of Mines, 1995). On average this accounts for an average of 60 total mine sites, with 4.3 being active, in every county across the state.

LITREATURE REVIEW

The first step in being able to analyze landscape quality is the ability to define it. Landscape quality has been defined by the features that make up the landscape, the characteristic elements and attributes, and then the degree of excellence which that landscape possesses (Daniel and Vinning, 1983).

Questions pertaining to landscape definition and landscape assessment have led to differing forms of landscape assessment models. In their review of various landscape models, Daniel and Vinning (Daniel and Vinning, 1983) categorized all landscape quality models into five classes. Within these classes some apply directly to landscape visual assessment while other models do not. Looking at the full range of classes is helpful in understanding the theoretical nature of the work.

Landscape Quality Models

Ecological Model

The ecological models are typified by McHarg's model that defines the landscape in terms of its biology. It places a high value on natural functions such as diversity and biomass production, while placing a low value on cultural values such as appropriateness and visual human impact (Daniel and Vinning,

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Formal Aesthetic Model

The formal aesthetic model is the most commonly utilized landscape visual assessment model as it is used by the Forest Service (USDA Forest Service, 1984) and the Canadian Ministry of Forests (Ministry of Forests, 1981). This model relies on the design principles to guide the designer to find the most appropriate solution. The appeal of this approach is that it allows agencies to utilize existing personnel, skills and often existing data to implement the model (Brown, 1994) making it cost effective (Leopold, 1982).

The formal aesthetic model has severe limitations in that it is capable of rating and comparing various landscape development alternatives only in a very rudimentary way. This model is a set of principles used to guide the designer.

Psychophysical Model

The psychophysical model creates a quantitative relationship between physical environmental stimuli and perceptual responses (Hull, Buhyoff and Cordell, 1987). This approach selects individual stimuli in the landscape and then develops mathematical models in order to explain the human response to the stimuli. Many of these models are oriented toward measuring the effect of a single-factor stimulus such as waterflow quantity (Brown and Daniel, 1991), atmospheric optical quality (Landphair, 1979) or forest visual quality (Ruddell et al., 1989). Other models have expanded this concept in order to determine the visual quality of entire landscapes (Shafer, 1969, Burley, 1995).

The strength of the psychophysical approach lies in it's ability to relate change in manageable site characteristics to resulting impacts on visual quality (Ruddell et. al., 1989). This model has direct applications to the field of visual quality management due to it's ability to identify the portions of the landscape that elicit positive or negative responses and gauge the magnitude of change, allowing various landscape alternatives to be compared.

Psychological Model

The psychological models attempt to determine the users response to the landscape in terms of their feelings and perceptions. This model rates landscapes on informational variables, such as how space organization is interpreted and if the user understands this organization (Kaplan and Kaplan, 1989). The most notable psychological models have been developed by the Kaplans (Kaplan, 1979) and Appleton (Appleton, 1984).

This model incorporate the feelings that the landscape evokes within the viewer, expressing the landscape in terms of security, relaxation, warmth, freedom happiness, stress fear, insecurity gloom, constraint, prospect and refuge.

Although the psychological model is strong theoretically, it's use of conceptual variables makes it difficult to apply in predicting scenic quality.

Phenomenological Model

The phenomenological model places the greatest emphasis on individual feelings, expectations and interactions between the user and the landscape. The model typically elicits responses from the participant in the form of a questionnaire. The model then assesses the person-landscape-context interaction. This results in assessments that are extremely complex and too variable for this model to be used as a landscape management tool (Daniel and Vinning, 1983).

Visual Quality Applications

In order for any model to be useful in assessing landscape visual quality, it must be possible to use it as a development tool which guides the designer to find visually pleasing solutions. As a development tool the model must be predictive in nature, allowing the designer or manager to determine the visual quality before the landscape is altered (Arthur, 1977). Scenic resources should be evaluated in an objective and quantitative fashion (Carlson, 1977). The only models that have the qualities for determining landscape visual quality are the psychophysical and the formal aesthetic models.

Model Comparisons

Validity

Although the formal aesthetic model is the most widely used form of visual quality modeling, it does present serious drawbacks. The model presents serious reliability concems as this model is the most dependent on expert judgment (Carlson, 1977) and it does not present a standard methodology for testing results. The results of applying the formal aesthetic model are not reproducible, so the outcome of applying the model cannot be duplicated to test it's validity. Therefore, the validity of this model is solely dependent on the expertise of the designer.

The psychophysical model overcomes the validity problem associated with formal aesthetic model, the application is more objective, being less dependent on the skills of the designer, and utilizes a mathematical model to determine the magnitude of the visual quality. This model allows different landscape altematives to be quantified and tested against each other. This testing of alternatives removes the subjectivity from the process that that is inherent in the formal aesthetic model (Miller, 1984).

Quantification

Both the psychophysical and the formal aesthetic models are predictive landscape visual quality models, that is, they both forecast the net result of landscape alterations on visual quality before the changes occur. However, the formal aesthetic model can predict only what the net effect should be, not the magnitude of the change; it can only suggest that the resulting view will improve or degrade visual quality.

The psychophysical model can also predict the direction of change as well as quantify the significance of the change. This allows the designer or manager to make informed decisions on the relative visual quality of the proposed changes.

Public versus Expert Opinion

The models split with regards as to whose interpretation of a landscape is the more appropriate to use. Though, the expert may have the greater understanding of the landscape, the local public probably has the greater attachment to the land. The formal aesthetic model is clearly dependent on expert opinion, but the psychophysical model, such as Shafer's, is based on public opinion and public interpretation of the landscape.

The research surrounding public versus expert opinion is confusing and often contradictory. A summary of 11 different studies that compared results of surveys of both professional and public opinion found that one third of the time they strongly agreed, one third of the time they strongly disagreed and one third of the time they were in moderate agreement, suggesting that there is no correlation between the two groups. This study did determine that the public tends to decide on perceived naturalism while professionals tended to be biased according to their own professional perspectives (Palmer, 1984).

This problem becomes more involved with the question of which public to use, tourist or resident? Rachel Kaplan (Kaplan, 1979) compared the results of testing residents versus tourists on visual quality. She found tourists were more interested in preserving the regional characteristics and the residents were interested in that create regional flavor.

The questions of who the arbiter of landscape visual quality should be is confusing. No definitive study has been conducted to determine this. It could well be that the determining group could be dependent on the location, the type, and intent of the landscape modification.

Landscape Representation

The model that has required the most validation for the techniques it uses is the psychophysical model. While many other models may use photography and computer generated depictions, the psychophysical model is dependent on them.

The validity of using landscape representations in place of the actual landscape has been an area of active research. The spectator of the natural environment is in that environment in a way which the spectator of a photograph is not in the photograph (Carlson, 1977). In early work Shafer even states that “complete understanding of the perceptual process requires the inclusion of experience and of its lasting traces in the memory (Shafer, 1969). A wide variety of studies have determined that black and white photographs and color slides are accurate representations of a landscape and participants react to the images in the same way they would react to the landscape itself (Stamps, 1992, Waztek and Ellsworth, 1994).

Using photographs in modeling has advantages and disadvantages. The use of photographs allows for techniques such as photomontage and photomanipulation so that accurate representations of the proposed changes can be constructed. The most important term here is “accurate”. The models are a valid representation if the respondent cannot detect that the photo has been altered (Orland, 1994) and if representational deviations are less than 6% (Waztek and Ellsworth, 1994).

Other landscape representational techniques such as hand rendering or computer generated images, such as from CAD programs, do not elicit equal responses as the actual landscape and therefor are not valid substitutes for the landscape (Zube, 1984).

Model Considerations

Shafer's equation in the psychophysical model includes three primary implementation concerns. First, Shafer makes the assumption that aesthetic quality is correlated with a preference for that landscape. In fact, Shafer seems to use these terms almost interchangeably (Carlson, 1977). A preference for a landscape might, or might not, be directly related to the perceived beauty of a landscape.

A second concern of this model is that it lacks any theoretical basis. This psychophysical approach has received criticism as these models are developed without any theoretical basis (Weinstein, 1976). Although these criticism are valid, I do not believe that this invalidates the results, as statistical relationships are considered strong enough to validate an equation in other fields (Burley, 1995).

The third concern is the inherent negative attributes of this form of equation. When one considers the wide range of elements that occur in landscapes, it becomes clear that an equation in this form could never account for them all. To attempt to accomplish this would mean an infinite number of variables that could be added to the equation to account for all possible situations. But without testing for all of these variables it is impossible to know their effect on visual quality. Using this logic it may be possible to predict the primary influences in visual quality, but it becomes inherently impossible to account for all of the factors that may play a role.

Future Model Development

Landscape quality models seem to be moving in two clear directions. First is the theoretical basis. These researchers tend to discount current models for any long-term use as they fail to have any theoretical basis (Bourussa, 1991, Weinstein, 1976, Carlson, 1977). The models that do have strong theoretical bases are developing into biological models. They attempt to explain man's interpretation of his surroundings in terms of inbred biological responses. Appleton (1984) has attempted to create a holistic approach to explain human aesthetic responses by inbred biological needs. This model there has two basic forms. First is the prospect is an environment that allowed primitive man to hunt by viewing his prey without being spotted. Conversely, the refuge is a landscape where primitive man was able to find shelter and refuge from the environment and other predators (Appleton, 1984). Modern man interprets these as spaces that may elicit feels of security or exploration.

The Kaplans have conducted research in a similar direction. They tested for similar inbred traits from our ancestry to determine if responses to landscapes

landscapes are influenced by man's ability to understand the landscape, to comprehend the surroundings, and to gather information (Zube, 1984). A second direction is being called for in model development.

> "Much of the validity testing has been done; predicting for limited subjects, testing the validity of simulations, biases in research methods etc. What is needed is a more elaborate and theoretical model that predicts scenic beauty magnitude and estimates the change in value resulting from landscape modification. Planners need to ask how much better... . Landscape quality models need to become landscape utility models that are equations that clearly show cause and effect relationships in landscape alterations ... (Hamilton, et. al., 1979).

In this article the authors call for further development of the psychophysical models. The existing predictive equations were a first step but they now believe that it is time to move past these models. Researchers believe that these models could be used to move toward finding a theoretical basis for visual quality (Hull et. al., 1987).

Within the limits of the existing models, the psychophysical appears to be the most capable of estimating the magnitude of visual quality changes. This is the only model that is capable of directly comparing landscapes or landscape alternatives, to determine their relative visual quality. This allows the landscape manager to determine the significance in visual quality that alterations on the landscape will have.

Intent

Purpose of Research

The purpose of this study is to determine the visual qualitative effects that reclamation may have on aggregate mine sites. People commonly assume that a mine site will have a detrimental visual quality impact on the surrounding community. They also assume that reclamation, in any form, will improve this. Until recently this has been demonstrated only through heuristic judgments by the community, regulators, miners and designers. I utilized a format in which these assumptions could be either proven or dispelled in a more objective format using scientific methodology.

The Existing Problem

When a new aggregate operation is proposed within a community, the opposition that it faces can be severe. The local citizens are concerned about the negative impacts that the mine could have on the community. Some of these impacts, such as groundwater contamination, noise pollution, and increased truck traffic, are relatively easy to predict and monitor. Other impacts, such as visual degradation, have been difficult to monitor and measure. Impacts that are ambiguous and ill defined can result in arguments that are highly emotional, which tend to lead away from an objective decision making process.

Visual Quality Modeling as a Decision Making Tool

Until recently, techniques for determining and measuring visual quality have not existed, and they are still developing. Although they may not have reached a high degree of sophistication they do provide a reliable yardstick against which proposed changes to the landscape can be measured. These models offer a methodology that takes visual quality out of the heuristic and personal judgment stages and places them in a form that can be quantified, analyzed, and compared to determine their quality within the setting.

This approach allows all of the parties involved to make more rational decisions, decisions that are based on sound principles. It also allows them to determine if their existing assumptions regarding visual quality of mine sites and reclaimed sites are correct or how sites could be altered to improve their visual quality.

METHODOLOGY

Approach

The approach employed in this experiment determined measurable visual quality differences between various landscape reclamation treatments and the existing mining conditions. To accomplish this research, photographs of the mine sites were altered to simulate various proposed post-mining conditions. The visual quality of the existing and post-mining views were then determined by applying Burley's visual quality equation and statistically analyzed using Friedman's two-way analysis.

Geology of Michigan

Michigan is primarily divided into two areas geographically, the northern and southern peninsulas. To a considerable degree these two areas are geologically separate and distinct (Heinrich, 1976). Although the geology is not absolutely divided along these geographic parts, a gradient of change occurs through the state. The northern peninsula is generally underlain by rock from the Precambrian Age while the southern peninsula is underlain by much younger Ordovician or Pennsylvanian materials.

Throughout the southern peninsula much of this bedrock is covered by the surficial geology that is composed of glaciofluvial deposits. These sediments are typically tills, gravels, sands silts, and clays. These high quality deposits are the class of deposits that are needed to obtain a quality source of sand and gravel (Michigan Limestone Corp., 1987).

The Sites

For this study, I selected two operating aggregate mine sites that would demonstrate the widest possible diversity in conditions that occur at aggregate mines within Michigan. The first site is a sand and gravel operation located in Brighton Michigan. This mine is located within a growing suburban area located 36 miles west of Detroit (Figure 1). This relatively small operation encompasses approximately 250 acres and is used primarily by a single contractor as a source for construction base materials (Hayes, 1995). The site is also used as a deposit site for cut soils that are generated from these same construction sites.

The second site is the world's largest operating limestone quarry, where the open pit is approximately five miles by two miles. The limestone quarried here is used primarily in glass and cement production (Michigan Limestone Corp., 1987). This quarry is located in Rogers City Michigan, 210 miles north of Detroit, in a rural community of 4,000 on the shore of Lake Huron.

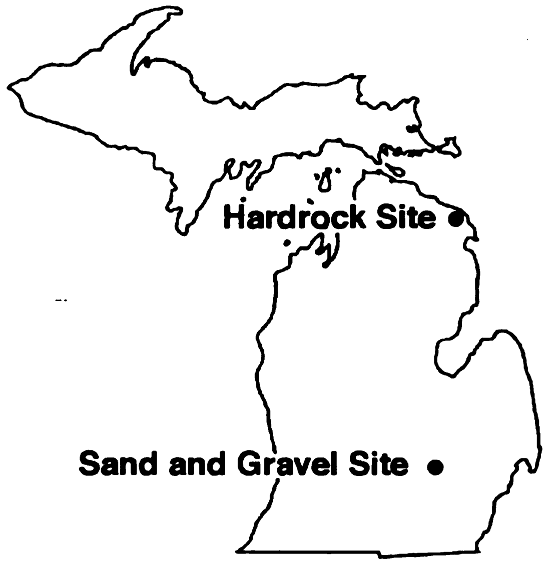


Figure 1 Mine Site Locations

These two sites demonstrate the wide range of conditions that aggregate operations can present: the material being mined, the scale of the operation, the setting of the operation, the equipment used for mining, and the conditions within and surrounding the mines.

Study Design

I took a series of black and white photographs at each mine site using a SLR camera fitted with a 50 mm lens. This camera configuration was chosen as it best reproduces a view as seen by the human eye (Schaefer, 1992). Black-and-white photography was used because color is not a variable within Burley's visual-quality equation. Also black-and-white images require less memory when entered into a computer (Adobe, 1994).

The mining photos were typically taken from the perimeter of the operations area so that the resulting views are generally oriented into the active pit. The photos depict the conditions that can exist within an active pit including views of crushers, screeners, trucks, cars, cranes, shovels, waste piles, utilities, vegetation, standing water, reclaimed areas, steep eroded banks and sheer rock faces.

I chose thirty photographs to represent the two sites. The sixty photographs demonstrate the wide range of conditions possible between the two sites. I scanned these photographs into a computer using a flat bed scanner at a moderate resolution of 150 lines per inch.

Along with the mining photos, I scanned other landscape images at this time. These other landscape photographs were taken throughout the lower peninsula and were used to create a library of scenes that could be used to construct post-mining treatments representing the reclaimed mine sites.

I scanned all of these images and imported them into Adobe Photoshop. With the mining views in Adobe Photoshop, I could then construct images to represent the four different post-mining treatments. These reclamation treatments include the existing mine site, agriculture, single-family housing, natural revegetation, and open water (Figure 2). All of these post-mining reclamation images assume a 10 to 20 year time lapse from the time of mining cessation.

The 300 images (5 treatments x 60 samples) used in this study (see enclosed CD ROM) were then exported from Photoshop and written to slide film to create a permanent hard copy. I chose the slide format as a cost and time effective method for enlarging the images to the 8" x 10" format that is necessary for applying the visual quality formula.

I projected these slides onto the rear of a translucent screen. The screen had an 8" x 10", 1/4" grid drawn on it for the tabulation of the visual-quality equation. The translucent screen allowed me to work in front of the screen without blocking the projection of the image. From this grid I counted each variable and entered the resulting values into Burley's equation (Equation 1). The variables for this equation were developed by Shafer and Burley (Table 1)

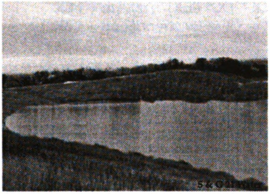
<u>Figure 2</u> Set of Mine Site Images

Sand and Gravel - Existing Condition

Reclaimed for Agriculture

Reclaimed for Housing

Reclaimed by Natural Revegetation



Reclaimed for Open Water

$$
\begin{aligned}
Y = {} & 68.3 - (1.878 * Health) - (0.131 * X1) \\
& - (0.064 * X6) + (0.020 * X9) + (0.036 * X10) \\
& + (0.129 * X15) - (0.129 * X19) - (0.006 * X32) \\
& + (0.00003 * X34) + (0.032 * X52) + (0.0008 * X1 * X1) \\
& + (0.00006 * X6 * X6) - (0.0003 * X15 * X15) \\
& + (0.0002 * X19 * X19) - (0.0009 * X2 * X14) \\
& - (0.00003 * X52 * X52) - (0.0000001 * X52 * X34)
\end{aligned}
$$

Equation 1 Burley's Visual Quality Equation

Table 1 Visual Model Variables

Health = from the environmental quality index
X1 = perimeter of immediate vegetation
X2 = perimeter of intermediate non-vegetation
X3 = perimeter of distant vegetation
X4 = area of intermediate vegetation
X6 = area of distant non-vegetation
X7 = area of pavement
X8 = area of buildings
X9 = area of vehicles
X10 = area of humans
X14 = area of wildflowers in foreground
X15 = area of utilities
X16 = area of boats
X17 = area of dead foreground vegetation
X19 = area of wildlife
X30 = open landscape: X2 + X4 + (2 * (X3 + X6))
X31 = closed landscape: X2 + X4 + (2 * (X1 + X17))
X32 = openness: X30 - X31
X34 = mystery: (X30 * X1 * X7) /1140
X52 = noosphericness: X7 + X8 + X9 + X15 + X16

Within this equation, one variable requires further computation in order to gain a resultant. The environmental quality index is calculated from Table 2.

Table 2 Environmental Quality Index

Purifies air	+1	0	-1
Purifies water	+1	0	-1
Builds soil resources	+1	0	-1
Promotes human cultural diversity	+1	0	-1
Preserves natural resources	+1	0	-1
Limits use of fossil fuels	+1	0	-1
Minimizes radioactive contamination	+1	0	-1
Promotes biological diversity	+1	0	-1
Provides food	+1	0	-1
Ameliorate wind	+1	0	-1
Prevents soil erosion	+1	0	-1
Provides shade	+1	0	-1
Presents pleasant smells	+1	0	-1
Presents pleasant sounds	+1	0	-1
Does not contribute to global warming	+1	0	-1
Contributes to the world economy	+1	0	-1
Accommodates recycling	+1	0	-1
Accommodates multiple use	+1	0	-1
Accommodates low maintenance	+1	0	-1
Visually pleasing	+1	0	-1

Using this formula, I calculated the value for each component by counting the number of squares that each variable occupied on the screen. I calculated the visual quality value by entering these values into the equation.

Analysis

In order to determine the significance of the results from the visual quality formula I utilized the Friedman two-way analysis of variance by ranks test (Daniel, 1978). I organized the raw scores from the visual quality formula into table form, labeling the reclamation treatment as the treatment and the scene as the subject. I then ranked these raw scores with the low score being ranked as

1, to the high being ranked 5, within each subject (Appendix D). I then totaled these rankings according to treatment. I made adjustments to the test statistic to compensate for ties that occurred in the ranking process. From these treatment totals, I calculated the test statistic.

I used the test statistic to determine that the null hypothesis could be rejected, demonstrating that at least one treatment was significantly different from the others. I employed a multi-comparison procedure to determine which treatments were significantly different.

RESULTS

This experiment resulted in visual quality scores for each existing view and for each proposed reclamation treatment (Appendix B, Appendix C and Figure 3). The testing generated raw scores that ranged from a least preferred view score of 82 to a most appealing view score of 28. The mean scores were 63 for the sand and gravel site and 56 for the hardrock site. To place these scores within context, a score of 70 is a neutral score; making the high score of 82 represents a moderately unpleasant view, while the mean scores of 63 and 56 are neutral to pleasant views, and the low score of 28 is an extremely pleasing view.

The application of each reclamation treatment resulted in low rates of variance in the visual quality, when scores were grouped by treatment. The resulting mean and standard deviations, by treatment, are synopsized in Table 3.

In order to determine the net effect of each reclamation treatment, I compared the score for each treatment to the existing score for that site (Table 4). The agriculture and housing development treatments had little effect on the visual quality scores of the existing site, improving the score as little as one point (-1) or degrading the view at most by three points (3). Conversely the natural revegetation and open water had significant impacts on the existing site score, improving the score by as much as 29 points (-29).

Table 3 Visual Quality Score by Reclamation Treatment

Reclamation Treatment	Mean	Standard Deviation.
Existing	74 / 65	2.91 / 7.96
Agriculture	73 / 68	1.48 / 5.60
Housing	76 / 67	1.97 / 6.43
Natural Revegetation	45 / 39	1.37 / 6.10
Open Water	48 / 42	1.74 / 7.26

Key: Sand and Gravel Data / Hard Rock Data

Figure 3 Graph of Visual Quality by Site Treatment

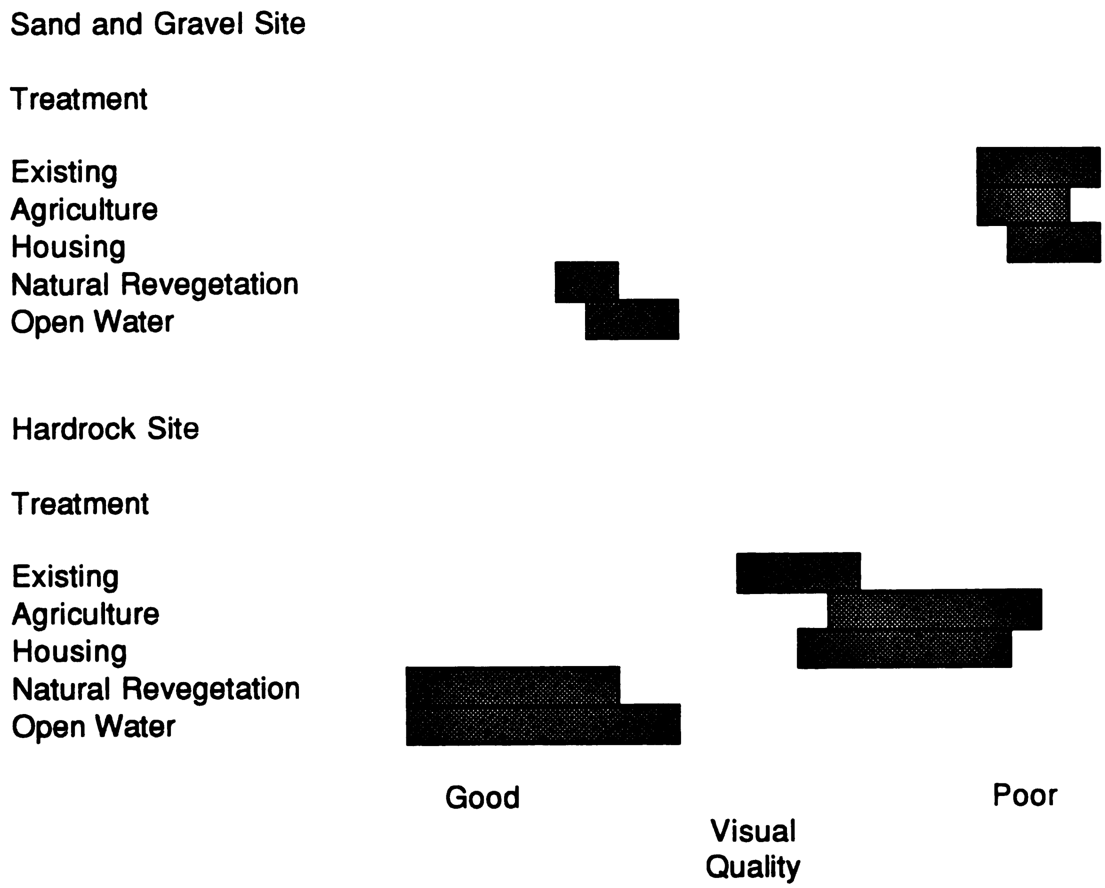


Table 4 Adjustment to Existing Site Score by Treatment

Reclamation Treatment	Mean Change	Standard Deviation
Agriculture	-1 /3	2.58 / 5.48
Housing	2 / 2	2.94 / 4.17
Natural Revegetation	-29 / -26	2.79 / 4.80
Open Water	-26 / -23	2.87 / 4.34

Key Sand and Gravel data / Hardrock data

Statistical Analysis

The Friedman two-way analysis of variance test revealed statistically significant difference between at least two treatments using a confidence level of 99.5% ($p \leq 0.005$). The multiple comparison procedure produced a test statistic of 34.42. By using multiple comparison I was then able to determine which treatments produced significantly different scores from other treatments, using a 95% confidence level ($p \leq 0.05$). These results are outlined in Table 5.

These results confirm what was inferred in Table 3 and Appendix C. The visual quality scores for the existing condition, housing development, and the agriculture treatments are all closely related and are, in fact, not significantly different. The natural revegetation and the open water treatments are also so closely related that they are not statistically different. These two groupings of treatments do vary greatly from each other and are statistically very different.

This trend of two groupings of reclamation treatments is nearly identical at both the hardrock and the sand and gravel sites, with a single exception at the sand and gravel site; the agriculture and the housing treatments were closely related but were statistically different.

Table 5 Multiple Comparison of Reclamation Treatment by Site

Site	Treatment		Treatment	Test Statistic	Result
Sand and Gravel Site					
	Existing	and	Agriculture	16.50	Not significant
	Existing	and	Housing	23.50	Not significant
	Existing	and	Revegetation	88.00	Significant
	Existing	and	Water	58.00	Significant
	Agriculture	and	Housing	40.00	Significant
	Agriculture	and	Revegetation	71.50	Significant
	Agriculture	and	Water	41.50	Significant
	Housing	and	Revegetation	111.50	Significant
	Housing	and	Water	81.50	Significant
	Revegetation	and	Water	30.00	Not significant
Hardrock Site					
	Existing	and	Agriculture	20.00	Not significant
	Existing	and	Housing	15.50	Not significant
	Existing	and	Revegetation	74.00	Significant
	Existing	and	Water	52.00	Significant
	Agriculture	and	Housing	4.50	Not significant
	Agriculture	and	Revegetation	94.00	Significant
	Agriculture	and	Water	72.00	Significant
	Housing	and	Revegetation	89.50	Significant
	Housing	and	Water	67.50	Significant
	Revegetation	and	Water	22.00	Not significant

DISCUSSION

Perhaps the most unanticipated result of this testing were the factors that did not influence visual quality. I presumed that the differences between the two sites would influence the results of performing the reclamation, but this was not the case. The sand and gravel mine is a small site that has been sequentially reclaimed, with many of the pit's banks having established vegetation. The hardrock site is a large open quarry with no vegetation within the pit. I believed that as the hardrock site presents a larger and less vegetated view, it would accentuate the relative magnitude of improvement the reclamation would result.

Without specifically testing for the impact of the views between the sites, it appears that if the differences between the two sites had any influence at all, the influence was minor. At both sites the scores of the existing site were comparable and when the treatments were applied, the visual quality results were similar.

Another surprising feature of the results was that the existing site ranked as the third most preferred view. I believe that prevailing opinion would have rated the existing site as the least preferred, as the perception of mining is being so destructive to the landscape. These existing views depicted mining as it commonly occurs, and include views of buildings, equipment, material stockpiles waste heaps and roadways presumably would make them rate quite low. This was the first indication that not all reclamation improves the visual quality of the mine sites

The results of the experiment demonstrate the relationships that occur between the reclamation treatments (Appendix C). The grouping that received the more preferred scores were the open water and natural revegetation treatments. These two treatments had mean scores that that improved on the existing visual quality score by up to 29 points. The two treatments generated visual quality scores that differed between each other by an average of only three points.

In the second, less preferred, grouping were the existing conditions, agriculture and housing treatments. These two reclamation treatments generated scores that closely related to the score of the existing site, resulting in scores that only varied from the existing score by an average of three points.

Interpretation

Reclamation Improving Visual Quality

These groupings of treatments raise the question, is all reclamation good reclamation in terms of visual quality? If one of the primary goals of reclamation is to improve the appearance of the mine site, then two of these reclamation treatments do not achieve this goal. The results suggest that not all reclamation treatments create views that are significantly better than that of the operating mine site. The results of the analysis demonstrate that when the mine sites were reclaimed using the agriculture and housing reclamation treatments, the resulting views did not have a significantly different visual quality than that of the operating mine site.

A result of these groupings of treatments is that although the intended end use of the mine site may be very different under different reclamation plans, the resulting visual quality of the reclaimed site may not be different. At both mine sites the resulting visual quality from applying the open water and the natural revegetation treatments resulted in views that were not significantly different. This is also the result from applying the housing and the agriculture treatments.

This close relationship of resulting visual quality could allow for reclamation planning that is broader in scope and allow a greater variety of end uses. A case in point would be that if housing development were the approved end use then sequential reclamation of the mine site would be unimportant from a visual quality standpoint. If open water were the end use, then sequential reclamation would be very important as it would significantly increase the visual quality of the site.

These groupings of treatments could be used to accommodate very different uses of the site without impacting the visual quality of the site. This discounts the practice of choosing a particular end use to regulate the visual quality of a mine site. What seems to be more important is to choose a grouping of reclamation treatments that have similar visual quality results and then apply the one that is the most appropriate land use.

Model Variable Groupings

As noted by Burley (Burley, 1995) the visual quality equation (Appendix A) includes three sets of variables. The first set of variables are those that have a positive effect on visual quality. These variables tend to be perceived as those that have naturalistic qualities. The second grouping of variables are those that have a negative effect on the visual quality. These variables can be interpreted as being man's intrusion onto the landscape. The third category contains variables that are considered to be neutral within the equation. While these neutral factors may not be significant in the equation, they do impact the resulting visual quality by limiting the quantity of positive or negative variables within the scene. For example, if a lake were to be constructed, making water (a neutral variable) the dominant feature, it would exclude other elements such as flowers (a positive variable) or pavement (a negative variable).

The result of identifying these variable groupings is that they can then be used as criteria in the design process. If one of the goals of the designer is to manipulate the visual quality to achieve the highest possible level, then the inclusion of positive variables needs to be optimized while the impact of the negative variables needs to be mitigated. Therefore landscape manager do not need to have a full understanding of Burley's equation, they only need to understand the principle of the three variable groupings in order to increase visual quality.

Patterns in Testing Results

Throughout this testing, resulting visual quality scores seem to result in reoccurring patterns. If the scores resulting from the application of a treatment are rated on a scale using the existing score as the baseline, then the magnitude in the change as a result of having applied the treatment appears to be predictable (Table 4). The effect on the existing score will be the existing score +- score adjustment +- standard deviation. For example, when natural revegetation was applied in SG 4, the existing score of 74 was lowered by 30 points to a reclaimed score of 44. This score adjustment of 30 points is within the range of the mean change (29 points) +- standard deviation (2.97). These results demonstrate that when a particular reclamation treatment is applied to an existing view, the direction and the magnitude of the change in visual quality could be forecast within the range of the standard deviation. Since the resulting standard deviations are relatively small, this allows for a fairly accurate prediction of applying a treatment.

If future testing were to yield similar results, it could become unnecessary to test the visual quality results of applying many reclamation treatments. In its place an accurate forecasting model could be constructed that could predict the results of applying treatments, without the need to test each alternative. The visual quality equation could then be applied as a confirmation tool at the end of the design process.

Applications of the Visual Quality Equation

The most direct application of this quantitative visual quality equation is it's use as a design tool. By utilizing the equation and maximizing the variables that have a positive effect while minimizing the negative effect variables, the visual quality of a view can be increased. Therefore it is not important to have a detailed understanding of the model. What is important is to determine what elements will raise visual quality, what elements will lower the visual quality, and then to use these variables to the design's advantage.

In the past these design decisions have generally been relegated to expert opinion. When any aesthetic issue was involved, the site manager deferred those questions to the architect, landscape architect, or the designer. Many have believed that the professionals who have been trained in the design principles have a deeper understanding of their surroundings. With the development of the visual quality equation this no longer needs to be the case. The site manager could use this model to gain insight into design and have a greater ability to work with the designer to find the most appropriate solution.

An example of how the manager and designer could collaborate is in the design process. Many municipalities currently have landscape or aesthetic ordinances that regulate the quantity, density, and specie of plant material that are required. The shortcoming of this approach is that they attempt to apply a standardized solution to situations that vary widely. The resulting landscapes are often inappropriate. Although they may serve the intended purpose, they may also create new conflicts because they cannot account for the variety of site variables.

The alternative is to set quantitative visual quality standards. In place of specifying planting plans the municipality could mandate that the existing visual quality could not be altered by more than a specified range. This would allow the designer to determine the most appropriate and economical method to achieve the standard. The designer would have the freedom to use site characteristics, such as topography to develop creative solutions in order to mitigate the visual quality impact of the mine site. The municipality could be included in the process and have a better understanding of the constraints and tools that the designer used to reach the design solution.

One concern of this approach is that visual quality may not be the primary concern of the municipality. If the objective of the community master plan is economic development, then applying strict visual quality standards could be argued as being inappropriate since there is a predisposition in the equation to favor natural settings.

This should not be interpreted as meaning that the equation would be irrelevant though. The visual quality equation could still be used as a design tool to mitigate the effects of the development. It's principles could be utilized to reduce the blighted appearance that many industrial zones now have. The effect could be one of the industrial campus that many firms are now promoting.

Conclusion

By quantifying visual quality both designers and regulators are now able to predict the visual impact that pit mining and various reclamation treatments will create. This ability to predict and systematically analyze the effect of proposed changes is important because it adds rational and objective decision making to a process that is currently highly subjective and emotional.

The objective of this experiment is to determine whether the most common reclamation practices do in fact increase the visual quality of active mine sites. The results determine that two common reclamation treatments do not yield statistically significant different visual quality than that of the operating mine. Reclaiming for housing development and for agriculture both resulted in visual quality levels that were not statistically different from the existing view. Reclamation that utilizes open water or natural revegetation do significantly increase the visual quality of the mine site however.

Another important finding from this study was that some reclamation treatments yield identical visual quality results. Using heuristic methodology one could assume that all reclamation treatments are unique and, therefore would yield unique visual quality levels. This was shown to be not true. Using these reclamation treatments, both development for housing and reclamation for agriculture were found to have the same visual quality as the existing site. Also, open water and the natural revegetation treatments yielded similar results.

The results of applying various reclamation treatments were surprisingly consistent. When a treatment was applied to a site, the resulting visual quality scores occurred within a small well defined range. This was also true when the same treatment was applied between sites. If this observation were confirmed in future testing, it could potentially lead to a model that could forecast the result of applying a specified treatment. This could negate the need for much of the testing that has been performed in this experiment and streamline the visual quality analysis procedure.

The ability to identify and manipulate variables within the landscape is important in promoting visual quality. By exploiting the variables within the equation that cause positive changes in visual quality and suppressing the variables that cause negative changes in visual quality, the equation can be manipulated as a design tool. During the design process this could be incorporated during the inventory and analysis phases in the mapping of positive and negative visual elements and then designing the proposed landscape to accentuate the positive and mask the negative elements.

This paper demonstrates that visual quality procedures developed for use on public lands can be applied to local land uses through this application using open pit mining. The use of these procedures would benefit all participants in the mining process. The goal of the regulatory process is to ensure that mining will not have significant ill effects on the natural and cultural community surrounding it. This should also be one of the mining industries goals. This methodology is one step in ensuring that mining need not be a burden on a community and, in fact, could be used to improve the visual quality of the area.

APPENDICES

APPENDIX A

Equation Variable Classification

Variables having a negative effect on visual quality

humans
vehicles
utility structures
buildings
pavement
air and water pollution
eroded land

Variables having a positive effect on visual quality

foreground vegetation
distant non-vegetation
wildlife
openness
presence of flowers

Variables having a neutral effect on visual quality

foreground herbaceous vegetation
intermediate vegetation
distant vegetation
sky
clouds
sun
moon
water
ice
snow

APPENDIX B

Condensed Testing Results

Visual Quality Raw Scores for Sand and Gravel Site

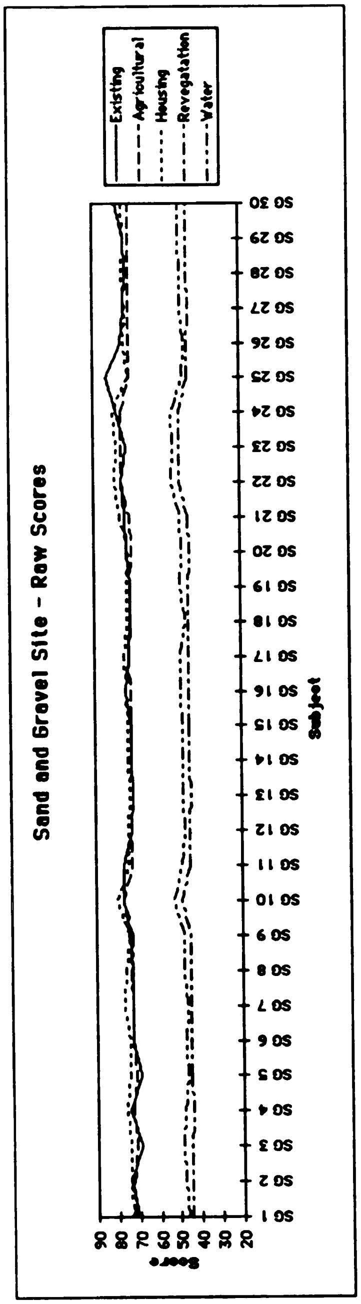
	Existing	Agricultural	Housing	Revegetation	Water
SG 1	71	73	74	45	47
SG 2	75	73	74	45	48
SG 3	69	71	74	45	49
SG 4	74	73	76	44	48
SG 5	69	71	74	45	47
SG 6	73	73	75	45	47
SG 7	73	73	77	45	47
SG 8	73	73	76	45	48
SG 9	74	73	74	45	48
SG 10	77	77	80	49	53
SG 11	77	73	74	45	48
SG 12	73	73	74	45	47
SG 13	72	72	74	44	48
SG 14	73	73	75	45	48
SG 15	73	73	74	45	48
SG 16	75	73	75	45	49
SG 17	73	73	76	45	49
SG 18	73	73	75	45	46
SG 19	73	73	75	45	48
SG 20	74	72	73	44	48
SG 21	75	73	78	45	49
SG 22	77	77	80	49	52
SG 23	75	77	79	49	52
SG 24	79	77	81	49	52
SG 25	83	73	73	45	47
SG 26	77	73	75	45	46
SG 27	75	73	75	44	48
SG 28	75	73	76	45	48
SG 29	75	73	75	45	48
SG 30	79	73	76	45	48

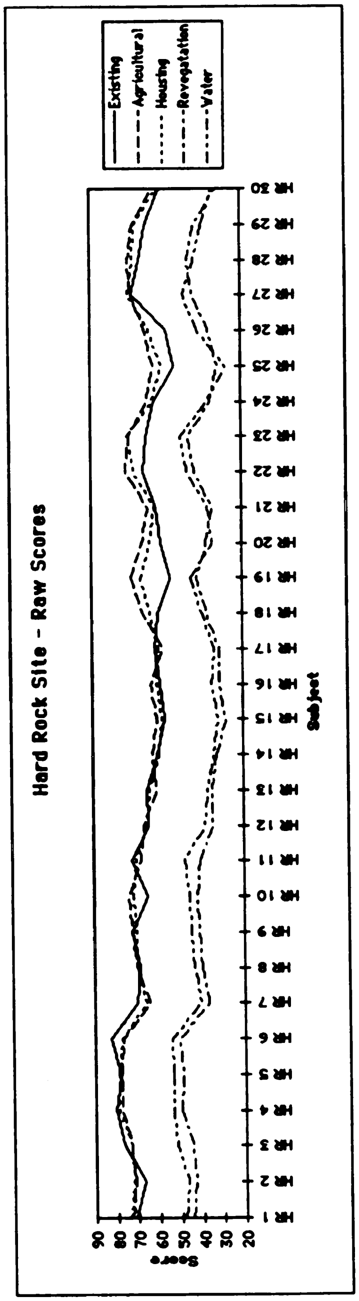
Visual Quality Raw Scores for Hardrock Site

	Existing	Agricultural	Housing	Revegetation	Water
HR 1	72	73	74	45	49
HR 2	68	72	73	43	47
HR 3	77	73	73	45	52
HR 4	80	78	79	50	53
HR 5	78	78	79	49	53
HR 6	82	77	77	50	54
HR 7	70	65	66	37	40
HR 8	69	70	70	40	44
HR 9	73	73	70	41	45
HR 10	65	74	72	42	45
HR 11	72	68	70	40	48
HR 12	65	66	66	34	38
HR 13	65	61	63	35	36
HR 14	60	62	59	32	34
HR 15	57	60	58	28	31
HR 16	58	63	60	31	35
HR 17	61	58	59	31	33
HR 18	60	67	63	37	39
HR 19	54	71	68	41	44
HR 20	58	67	63	37	34
HR 21	60	64	61	34	36
HR 22	66	74	70	42	46
HR 23	65	73	73	44	48
HR 24	61	64	61	34	36
HR 25	51	61	58	31	27
HR 26	55	65	63	35	41
HR 27	71	71	73	43	47
HR 28	67	73	71	45	42
HR 29	65	70	70	42	38
HR 30	58	62	59	32	33

APPENDIX C

Graph of Visual Quality Scores





APPENDIX D

Ranked Visual Quality Scores

Ranked Visual Quality Scores at the Sand and Gravel Site

	Existing	Agricultural	Housing	Revegetation	Water
SG 1	3.0	4.0	5.0	1.0	2.0
SG 2	5.0	3.0	4.0	1.0	2.0
SG 3	3.0	4.0	5.0	1.0	2.0
SG 4	4.0	3.0	5.0	1.0	2.0
SG 5	3.0	4.0	5.0	1.0	2.0
SG 6	3.5	3.5	5.0	1.0	2.0
SG 7	3.5	3.5	5.0	1.0	2.0
SG 8	3.5	3.5	5.0	1.0	2.0
SG 9	4.5	3.0	4.5	1.0	2.0
SG 10	3.5	3.5	5.0	1.0	2.0
SG 11	5.0	3.0	4.0	1.0	2.0
SG 12	3.5	3.5	5.0	1.0	2.0
SG 13	3.5	3.5	5.0	1.0	2.0
SG 14	3.5	3.5	5.0	1.0	2.0
SG 15	3.5	3.5	5.0	1.0	2.0
SG 16	4.5	4.0	4.5	1.0	2.0
SG 17	3.5	3.5	5.0	1.0	2.0
SG 18	3.5	3.5	5.0	1.0	2.0
SG 19	3.5	3.5	5.0	1.0	2.0
SG 20	5.0	3.0	4.0	1.0	2.0
SG 21	4.0	3.0	5.0	1.0	2.0
SG 22	3.5	3.5	5.0	1.0	2.0
SG 23	3.0	4.0	5.0	1.0	2.0
SG 24	4.0	3.0	5.0	1.0	2.0
SG 25	5.0	3.5	3.5	1.0	2.0
SG 26	5.0	3.0	4.0	1.0	2.0
SG 27	4.5	3.0	4.5	1.0	2.0
SG 28	4.0	3.0	5.0	1.0	2.0
SG 29	4.5	3.0	4.5	1.0	2.0
SG 30	5.0	3.0	4.0	1.0	2.0

Ranked Visual Quality Scores at the Hardrock Site

	Existing	Agricultural	Housing	Revegetation	Water
HR 1	3.0	4.0	5.0	1.0	2.0
HR 2	3.0	4.0	5.0	1.0	2.0
HR 3	5.0	3.5	3.5	1.0	2.0
HR 4	5.0	3.0	4.0	1.0	2.0
HR 5	3.5	3.5	5.0	1.0	2.0
HR 6	5.0	3.5	3.5	1.0	2.0
HR 7	5.0	3.0	4.0	1.0	2.0
HR 8	3.0	4.5	4.5	1.0	2.0
HR 9	4.5	4.5	3.0	1.0	2.0
HR 10	3.0	5.0	4.0	1.0	2.0
HR 11	5.0	3.0	4.0	1.0	2.0
HR 12	3.0	4.5	4.5	1.0	2.0
HR 13	5.0	3.0	4.0	1.0	2.0
HR 14	4.0	5.0	3.0	1.0	2.0
HR 15	3.0	5.0	4.0	1.0	2.0
HR 16	3.0	5.0	4.0	1.0	2.0
HR 17	5.0	3.0	4.0	1.0	2.0
HR 18	3.0	4.5	4.0	1.0	2.0
HR 19	3.0	5.0	4.0	1.0	2.0
HR 20	3.0	5.0	4.0	2.0	1.0
HR 21	3.0	5.0	4.0	1.0	2.0
HR 22	3.0	5.0	4.0	1.0	2.0
HR 23	3.0	4.5	4.5	1.0	2.0
HR 24	3.5	5.0	3.5	1.0	2.0
HR 25	3.0	5.0	4.0	2.0	1.0
HR 26	3.0	5.0	4.0	1.0	2.0
HR 27	3.5	3.5	5.0	1.0	2.0
HR 28	3.0	5.0	4.0	2.0	1.0
HR 29	3.0	4.5	4.5	2.0	1.0
HR 30	3.0	4.0	5.0	1.0	2.0

APPENDIX E

Visual Quality Testing Results

SG 1

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-4	-5	-5	10	9
X1	50	50	50	50	50
X2	30	0	53	0	19
X3	84	79	79	79	79
X4	221	326	262	326	307
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	41	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	419	484	473	484	484
X31	351	426	415	426	426
X32	68	58	58	58	58
X34	0	0	0	0	0
X52	0	0	41	0	0
Score	71	73	74	45	47

SG 2

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	48	48	48	48	48
X2	99	0	97	0	94
X3	91	91	91	91	91
X4	0	328	272	328	140
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	56	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	281	510	551	510	416
X31	195	424	465	424	330
X32	86	86	86	86	86
X34	0	0	0	0	0
X52	0	0	56	0	0
Score	75	73	74	45	48

SG 3

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-2	-4	-5	10	8
X1	29	54	54	54	54
X2	0	0	47	0	48
X3	50	50	50	50	50
X4	317	317	276	317	227
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	41	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	417	417	423	417	375
X31	375	425	431	425	383
X32	42	-8	-8	-8	-8
X34	0	0	0	0	0
X52	0	0	41	0	0
Score	69	71	74	45	49

SG 4

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-6	10	8
X1	94	52	52	52	52
X2	83	0	91	0	82
X3	93	93	93	93	93
X4	78	330	265	330	175
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	65	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	347	516	542	516	443
X31	349	434	460	434	361
X32	-2	82	82	82	82
X34	0	0	0	0	0
X52	0	0	65	0	0
Score	74	73	76	44	48

SG 5

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-3	-4	-5	10	9
X1	89	48	48	48	48
X2	36	0	37	0	34
X3	66	66	66	66	66
X4	186	180	143	180	161
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	37	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	354	312	312	312	327
X31	400	276	276	276	291
X32	-46	36	36	36	36
X34	0	0	0	0	0
X52	0	0	37	0	0
Score	69	71	74	45	47

SG 6

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	9
X1	42	42	42	42	42
X2	90	0	73	0	28
X3	80	80	73	80	80
X4	146	241	207	241	218
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	50	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	396	401	426	401	406
X31	320	325	364	325	330
X32	76	76	62	76	76
X34	0	0	0	0	0
X52	0	0	50	0	0
Score	73	73	75	45	47

SG 7

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-6	10	9
X1	94	44	44	44	44
X2	85	0	61	0	83
X3	84	84	84	84	84
X4	29	259	204	259	137
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	55	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	282	427	433	427	388
X31	302	347	353	347	308
X32	-20	80	80	80	80
X34	0	0	0	0	0
X52	0	0	55	0	0
Score	73	73	77	45	47

SG 8

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	37	47	47	47	47
X2	82	0	49	0	93
X3	46	46	46	46	46
X4	89	535	431	535	388
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	104	0	0
X9	3	0	0	0	0
X10	0	0	0	0	0
X14	11	11	11	11	11
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	263	627	572	627	573
X31	245	629	574	629	575
X32	18	-2	-2	-2	-2
X34	0	0	0	0	0
X52	3	0	104	0	0
Score	73	73	76	45	48

SG 9

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	83	47	47	47	47
X2	90	0	74	0	97
X3	89	89	89	89	89
X4	50	399	344	399	230
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	55	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	318	577	596	577	505
X31	306	493	512	493	421
X32	12	84	84	84	84
X34	0	0	0	0	0
X52	0	0	55	0	0
Score	74	73	74	45	48

SG 10

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	0	0	0	0	0
X2	86	0	105	0	46
X3	56	56	56	56	56
X4	210	880	793	880	286
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	87	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	408	992	1010	992	444
X31	296	880	898	880	332
X32	112	112	112	112	112
X34	0	0	0	0	0
X52	0	0	87	0	0
Score	77	77	80	49	53

SG 11

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	0	50	50	50	50
X2	107	0	78	0	78
X3	74	74	74	74	74
X4	210	568	518	568	296
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	50	0	0
X9	2	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	465	716	744	716	522
X31	317	668	696	668	474
X32	148	48	48	48	48
X34	0	0	0	0	0
X52	2	0	50	0	0
Score	77	73	74	45	48

SG 12

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	9
X1	42	42	42	42	42
X2	151	0	75	0	85
X3	79	79	79	79	79
X4	84	385	353	385	279
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	32	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	393	543	586	543	522
X31	319	469	512	469	448
X32	74	74	74	74	74
X34	0	0	0	0	0
X52	0	0	32	0	0
Score	73	73	74	45	47

SG 13

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	54	54	54	54	54
X2	89	0	59	0	89
X3	95	95	95	95	95
X4	0	269	199	267	98
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	38	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	279	459	448	457	377
X31	197	377	366	375	295
X32	82	82	82	82	82
X34	0	0	0	0	0
X52	0	0	38	0	0
Score	72	72	74	44	48

SG 14

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	49	49	49	49	49
X2	132	0	47	0	94
X3	82	82	82	82	82
X4	0	365	303	365	172
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	62	0	0
X9	1	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	296	529	514	529	430
X31	230	463	448	463	364
X32	66	66	66	66	66
X34	0	0	0	0	0
X52	1	0	62	0	0
Score	73	73	75	45	48

SG 15

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	47	47	47	47	47
X2	91	0	84	0	93
X3	90	90	90	90	90
X4	0	394	342	394	220
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	52	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	271	574	606	574	493
X31	185	488	520	488	407
X32	86	86	86	86	86
X34	0	0	0	0	0
X52	0	0	52	0	0
Score	73	73	74	45	48

SG 16

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	43	43	43	43	43
X2	91	0	81	0	88
X3	92	92	92	92	92
X4	5	315	257	315	155
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	7	7	65	7	7
X9	6	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	280	499	522	499	427
X31	182	401	424	401	329
X32	98	98	98	98	98
X34	0	0	0	0	0
X52	13	7	65	7	7
Score	75	73	75	45	49

SG 17

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	39	39	39	39	39
X2	92	0	82	0	79
X3	90	90	90	90	90
X4	0	254	173	254	121
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	7	7	88	7	7
X9	1	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	272	434	435	434	380
X31	170	332	333	332	278
X32	102	102	102	102	102
X34	0	0	0	0	0
X52	8	7	88	7	7
Score	73	73	76	45	49

SG 18

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	9
X1	91	91	91	91	91
X2	83	0	78	0	83
X3	81	81	81	81	81
X4	10	335	276	335	151
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	7	7	67	7	7
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	255	497	516	497	396
X31	275	517	536	517	416
X32	-20	-20	-20	-20	-20
X34	0	0	0	0	0
X52	7	7	67	7	7
Score	73	73	75	45	46

SG 19

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	47	47	47	47	47
X2	95	0	91	0	89
X3	81	81	81	81	81
X4	0	391	328	391	211
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	63	0	0
X9	1	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	257	553	581	553	462
X31	189	485	513	485	394
X32	68	68	68	68	68
X34	0	0	0	0	0
X52	1	0	63	0	0
Score	73	73	75	45	48

SG 20

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	60	60	60	60	60
X2	98	0	76	0	73
X3	87	87	87	87	87
X4	0	242	208	242	92
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	34	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	272	416	458	416	339
X31	218	362	404	362	285
X32	54	54	54	54	54
X34	0	0	0	0	0
X52	0	0	34	0	0
Score	74	72	73	44	48

SG 21

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-6	10	8
X1	37	40	40	40	40
X2	92	0	117	0	96
X3	89	89	89	89	89
X4	0	568	481	568	172
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	87	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	270	746	776	746	446
X31	166	648	678	648	348
X32	104	98	98	98	98
X34	0	0	0	0	0
X52	0	0	87	0	0
Score	75	73	78	45	49

SG 22

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	0	0	0	0	0
X2	167	38	98	38	42
X3	82	82	82	82	82
X4	361	832	734	832	272
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	98	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	692	1034	996	1034	478
X31	528	870	832	870	314
X32	164	164	164	164	164
X34	0	0	0	0	0
X52	0	0	98	0	0
Score	77	77	80	49	52

SG 23

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-4	-5	-5	10	8
X1	0	0	0	0	0
X2	47	0	76	0	54
X3	84	84	84	84	84
X4	375	941	862	941	854
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	93	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	590	1109	1106	1109	1076
X31	422	941	938	941	908
X32	168	168	168	168	168
X34	0	0	0	0	0
X52	0	0	93	0	0
Score	75	77	79	49	52

SG 24

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	0	0	0	0	0
X2	89	0	120	0	55
X3	81	81	81	81	81
X4	46	744	625	774	319
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	149	0	0
X9	7	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	297	906	907	936	536
X31	135	744	745	774	374
X32	162	162	162	162	162
X34	0	0	0	0	0
X52	7	0	149	0	0
Score	79	77	81	49	52

SG 25

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	182	45	45	45	45
X2	86	0	80	0	93
X3	82	82	82	82	82
X4	43	251	193	251	123
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	58	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	20	20	20	20
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	293	415	437	415	380
X31	493	341	363	341	306
X32	-200	74	74	74	74
X34	0	0	0	0	0
X52	0	0	58	0	0
Score	83	73	73	45	47

SG 26

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	9
X1	0	48	48	48	48
X2	70	0	66	0	88
X3	87	87	58	87	87
X4	112	219	175	219	150
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	66	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	356	393	357	393	412
X31	182	315	337	315	334
X32	174	78	20	78	78
X34	0	0	0	0	0
X52	0	0	66	0	0
Score	77	73	75	45	46

SG 27

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-4	-5	-5	10	8
X1	0	62	62	62	62
X2	91	0	48	0	44
X3	67	67	67	67	67
X4	165	607	380	448	77
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	68	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	390	741	562	582	255
X31	256	731	552	572	245
X32	134	10	10	10	10
X34	0	0	0	0	0
X52	0	0	68	0	0
Score	75	73	75	44	48

SG 28

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-4	-5	-5	10	8
X1	0	48	48	48	48
X2	40	0	66	0	83
X3	86	86	53	86	86
X4	130	166	99	166	127
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	93	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	342	338	271	338	382
X31	170	262	261	262	306
X32	172	76	10	76	76
X34	0	0	0	0	0
X52	0	0	93	0	0
Score	75	73	76	45	48

SG 29

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	58	58	58	58	58
X2	95	0	73	0	95
X3	52	52	52	52	52
X4	107	463	391	463	156
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	72	0	0
X9	2	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	306	567	568	567	355
X31	318	579	580	579	367
X32	-12	-12	-12	-12	-12
X34	0	0	0	0	0
X52	2	0	72	0	0
Score	75	73	75	45	48

SG 30

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	0	47	47	47	47
X2	100	0	118	0	97
X3	88	88	88	88	88
X4	398	620	513	620	235
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	107	0	0
X9	5	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	674	796	807	796	508
X31	498	714	725	714	426
X32	176	82	82	82	82
X34	0	0	0	0	0
X52	5	0	107	0	0
Score	79	73	76	45	48

HR 1

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	43	43	43	43	43
X2	48	0	36	0	52
X3	71	71	71	71	71
X4	0	708	681	708	708
X6	48	0	0	0	0
X7	0	0	0	0	0
X8	0	0	27	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	286	850	859	850	902
X31	134	794	803	794	846
X32	152	56	56	56	56
X34	0	0	0	0	0
X52	0	0	27	0	0
Score	72	73	74	45	49

HR 2

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-4	-5	-5	10	8
X1	57	57	57	57	57
X2	82	0	35	0	89
X3	67	67	67	67	67
X4	0	550	520	550	145
X6	45	14	14	14	14
X7	0	0	0	0	0
X8	0	0	30	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	306	712	717	712	396
X31	196	664	669	664	348
X32	110	48	48	48	48
X34	0	0	0	0	0
X52	0	0	30	0	0
Score	68	72	73	43	47

HR 3

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	6
X1	166	48	48	48	48
X2	39	0	21	0	49
X3	79	79	79	79	79
X4	54	197	197	186	104
X6	32	0	0	0	0
X7	0	0	0	0	0
X8	0	0	11	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	315	355	376	344	311
X31	425	293	314	282	249
X32	-110	62	62	62	62
X34	0	0	0	0	0
X52	0	0	11	0	0
Score	77	73	73	45	52

HR 4

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	10	8
X1	0	0	0	0	0
X2	51	70	32	70	42
X3	0	41	41	41	41
X4	0	513	482	513	39
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	37	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	4	4	4	4	4
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	51	665	596	665	163
X31	51	583	514	583	81
X32	0	82	82	82	82
X34	0	0	0	0	0
X52	4	4	41	4	4
Score	80	78	79	50	53

HR 5

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	0	0	0	0	0
X2	40	64	100	64	42
X3	0	58	40	58	58
X4	0	499	466	499	0
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	35	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	4	4	4	4	4
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	40	679	646	679	158
X31	40	563	566	563	42
X32	0	116	80	116	116
X34	0	0	0	0	0
X52	4	4	39	4	4
Score	78	78	79	49	53

HR 6

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-6	-5	-5	9	7
X1	0	0	0	0	0
X2	43	98	131	98	43
X3	86	86	86	86	86
X4	0	380	257	380	0
X6	0	0	0	0	0
X7	0	0	0	0	0
X8	0	0	23	0	0
X9	78	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	215	650	560	650	215
X31	43	478	388	478	43
X32	172	172	172	172	172
X34	0	0	0	0	0
X52	78	0	23	0	0
Score	82	77	77	50	54

HR 7

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	0	57	57	57	57
X2	96	32	93	32	92
X3	0	0	0	0	0
X4	0	447	408	447	83
X6	119	127	125	127	127
X7	0	0	0	0	0
X8	0	0	41	0	0
X9	19	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	334	733	751	733	429
X31	96	593	615	593	289
X32	238	140	136	140	140
X34	0	0	0	0	0
X52	19	0	41	0	0
Score	70	65	66	37	40

HR 8

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-6	-5	10	8
X1	0	17	17	17	17
X2	78	0	73	0	59
X3	0	0	0	0	0
X4	0	663	615	663	0
X6	151	113	105	113	113
X7	0	0	0	0	0
X8	0	0	56	0	0
X9	18	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	380	889	898	889	285
X31	78	697	722	697	93
X32	302	192	176	192	192
X34	0	0	0	0	0
X52	18	0	56	0	0
Score	69	70	70	40	44

HR 9

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	10	8
X1	0	43	43	43	43
X2	93	92	127	92	92
X3	0	0	0	0	0
X4	0	248	197	228	0
X6	71	71	71	71	71
X7	0	0	0	0	0
X8	0	0	33	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	235	482	466	462	234
X31	93	426	410	406	178
X32	142	56	56	56	56
X34	0	0	0	0	0
X52	0	0	33	0	0
Score	73	73	70	41	45

HR 10

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	10	8
X1	0	0	0	0	0
X2	71	41	74	41	42
X3	0	86	103	86	86
X4	0	553	509	553	0
X6	208	97	97	97	97
X7	0	0	0	0	0
X8	0	0	62	0	0
X9	12	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	487	960	983	960	408
X31	71	594	583	594	42
X32	416	366	400	366	366
X34	0	0	0	0	0
X52	12	0	62	0	0
Score	65	74	72	42	45

HR 11

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	0	50	52	50	0
X2	60	109	128	109	60
X3	0	0	0	0	0
X4	0	151	44	151	0
X6	75	75	75	75	75
X7	0	0	0	0	0
X8	0	0	59	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	210	410	322	410	210
X31	60	360	276	360	60
X32	150	50	46	50	150
X34	0	0	0	0	0
X52	0	0	59	0	0
Score	72	68	70	40	48

HR 12

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	10	8
X1	0	53	53	53	53
X2	93	0	86	0	96
X3	15	15	15	15	15
X4	0	511	434	511	0
X6	201	164	156	164	164
X7	0	0	0	0	0
X8	0	0	85	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	525	869	862	869	454
X31	93	617	626	617	202
X32	432	252	236	252	252
X34	0	0	0	0	0
X52	0	0	85	0	0
Score	65	66	66	34	38

HR 13

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	9	8
X1	0	51	51	51	51
X2	88	0	72	0	90
X3	0	0	0	0	0
X4	0	279	227	279	0
X6	200	200	183	200	200
X7	0	0	0	0	0
X8	0	0	52	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	488	679	665	679	490
X31	88	381	401	381	192
X32	400	298	264	298	298
X34	0	0	0	0	0
X52	0	0	52	0	0
Score	65	61	63	35	36

HR 14

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	121	53	53	53	53
X2	101	96	57	0	99
X3	0	0	0	0	0
X4	0	385	355	385	0
X6	250	250	250	250	250
X7	0	0	0	0	0
X8	0	0	30	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	601	981	912	885	599
X31	343	587	518	491	205
X32	258	394	394	394	394
X34	0	0	0	0	0
X52	0	0	30	0	0
Score	60	62	59	32	34

HR 15

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	10	8
X1	42	50	50	50	50
X2	98	96	193	96	90
X3	0	0	0	0	0
X4	0	520	481	520	208
X6	298	298	298	298	313
X7	0	0	0	0	0
X8	0	0	39	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	694	1212	1270	1212	924
X31	182	716	774	716	398
X32	512	496	496	496	526
X34	0	0	0	0	0
X52	0	0	39	0	0
Score	57	60	58	28	31

HR 16

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	10	8
X1	45	31	31	31	31
X2	93	0	89	0	85
X3	0	0	0	0	0
X4	0	524	495	524	0
X6	257	257	257	257	257
X7	0	0	0	0	0
X8	0	0	29	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	607	1038	1098	1038	599
X31	183	586	646	586	147
X32	424	452	452	452	452
X34	0	0	0	0	0
X52	0	0	29	0	0
Score	58	63	60	31	35

HR 17

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	9	8
X1	0	42	42	42	42
X2	86	0	95	0	96
X3	0	0	0	0	0
X4	0	696	636	696	0
X6	280	280	278	280	280
X7	0	0	0	0	0
X8	0	0	60	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	646	1256	1287	1256	656
X31	86	780	815	780	180
X32	560	476	472	476	476
X34	0	0	0	0	0
X52	0	0	60	0	0
Score	61	58	59	31	33

HR 18

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	69	69	69	69	69
X2	0	0	0	0	0
X3	0	31	43	31	0
X4	0	0	0	0	0
X6	218	149	149	149	149
X7	0	0	0	0	0
X8	0	0	10	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	436	360	384	360	298
X31	138	138	138	138	138
X32	298	222	246	222	160
X34	0	0	0	0	0
X52	0	0	10	0	0
Score	60	67	63	37	39

HR 19

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	0	0	0	0	0
X2	0	0	0	0	0
X3	0	77	169	77	23
X4	0	0	0	0	0
X6	694	134	134	134	134
X7	0	0	0	0	0
X8	0	0	32	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	1388	422	606	422	314
X31	0	0	0	0	0
X32	1388	422	606	422	314
X34	0	0	0	0	0
X52	0	0	32	0	0
Score	54	71	68	41	44

HR 20

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	50	50	50	50	50
X2	0	0	0	0	0
X3	0	57	77	57	0
X4	0	0	0	0	0
X6	258	152	152	152	258
X7	0	0	0	0	0
X8	0	0	11	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	516	418	458	418	516
X31	100	100	100	100	100
X32	416	318	358	318	416
X34	0	0	0	0	0
X52	0	0	11	0	0
Score	58	67	63	37	34

HR 21

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	76	76	76	76	76
X2	118	0	88	32	124
X3	0	88	88	88	88
X4	159	410	378	410	0
X6	207	186	186	186	186
X7	0	0	0	0	0
X8	0	0	32	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	691	958	1014	990	672
X31	429	562	618	594	276
X32	262	396	396	396	396
X34	0	0	0	0	0
X52	0	0	32	0	0
Score	60	64	61	34	36

HR 22

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	10	8
X1	52	49	49	49	49
X2	87	0	46	0	93
X3	0	0	0	0	0
X4	0	255	239	285	0
X6	111	50	50	50	50
X7	0	0	0	0	0
X8	0	0	11	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	309	355	385	385	193
X31	191	353	383	383	191
X32	118	2	2	2	2
X34	0	0	0	0	0
X52	0	0	11	0	0
Score	66	74	70	42	46

HR 23

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	51	50	50	50	50
X2	98	0	74	0	98
X3	0	92	94	92	92
X4	217	162	146	162	0
X6	134	0	0	0	0
X7	0	0	0	0	0
X8	0	0	22	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	583	346	408	346	282
X31	417	262	320	262	198
X32	166	84	88	84	84
X34	0	0	0	0	0
X52	0	0	22	0	0
Score	65	73	73	44	48

HR 24

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	58	58	58	58	58
X2	93	0	82	38	106
X3	0	0	0	0	0
X4	0	422	389	422	0
X6	200	200	200	200	200
X7	0	0	0	0	0
X8	0	0	22	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	493	822	871	860	506
X31	209	538	587	576	222
X32	284	284	284	284	284
X34	0	0	0	0	0
X52	0	0	22	0	0
Score	61	64	61	34	36

HR 25

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	50	50	50	50	50
X2	0	0	0	0	0
X3	0	136	171	136	61
X4	0	0	0	0	0
X6	470	240	240	240	428
X7	0	0	0	0	0
X8	0	0	19	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	940	752	822	752	978
X31	100	100	100	100	100
X32	840	652	722	652	878
X34	0	0	0	0	0
X52	0	0	19	0	0
Score	51	61	58	31	27

HR 26

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	92	40	40	40	0
X2	43	0	63	0	41
X3	17	17	17	17	17
X4	0	178	134	178	0
X6	333	194	194	194	194
X7	0	0	0	0	0
X8	0	0	44	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	743	600	619	600	463
X31	227	258	277	258	41
X32	516	342	342	342	422
X34	0	0	0	0	0
X52	0	0	44	0	0
Score	55	65	63	35	41

HR 27

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	51	51	51	51	51
X2	86	82	150	82	93
X3	0	0	0	0	0
X4	12	373	327	373	177
X6	36	36	36	36	36
X7	0	0	0	0	0
X8	0	0	52	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	170	527	549	527	342
X31	200	557	579	557	372
X32	-30	-30	-30	-30	-30
X34	0	0	0	0	0
X52	0	0	52	0	0
Score	71	71	73	43	47

HR 28

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	0	0	0	0	0
X2	54	61	61	61	54
X3	0	77	120	77	0
X4	0	317	291	317	0
X6	173	56	94	56	173
X7	0	0	0	0	0
X8	0	0	32	0	0
X9	15	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	400	644	780	644	400
X31	54	378	352	378	54
X32	346	266	428	266	346
X34	0	0	0	0	0
X52	15	0	32	0	0
Score	67	73	71	45	42

HR 29

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-5	-5	10	8
X1	38	38	38	38	38
X2	82	90	126	90	82
X3	88	83	113	83	83
X4	19	308	284	308	0
X6	128	40	61	40	164
X7	0	0	0	0	0
X8	0	0	40	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	533	644	758	644	576
X31	177	474	486	474	158
X32	356	170	272	170	418
X34	0	0	0	0	0
X52	0	0	40	0	0
Score	65	70	70	42	38

HR 30

Variable	Existing	Agriculture	Housing	Natural Revegetation	Open Water
health	-5	-7	-5	9	8
X1	77	55	55	55	55
X2	96	88	164	88	99
X3	0	0	0	0	0
X4	0	542	508	542	138
X6	260	260	260	260	260
X7	0	0	0	0	0
X8	0	0	34	0	0
X9	0	0	0	0	0
X10	0	0	0	0	0
X14	0	0	0	0	0
X15	0	0	0	0	0
X16	0	0	0	0	0
X17	0	0	0	0	0
X19	0	0	0	0	0
X30	616	1150	1192	1150	757
X31	250	740	782	740	347
X32	366	410	410	410	410
X34	0	0	0	0	0
X52	0	0	34	0	0
Score	58	62	59	32	33

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