APPENDIX 6.4.4-A

Teco Natural Resources Report

Visualizations of Shore Gold's Star and Orion South Kimberlite Developments – Excavation, Overburden, and Processed Ore
Methodology Report

Submitted by:

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1. INTRODUCTION

1.1 PROJECT OBJECTIVES AND OVERVIEW

The objective of this project was to provide Shore Gold with graphic representations of the post-development reclaimed landscape resulting from the development of the Star and Orion South Kimberlite deposits. The size, shape, and location of the open pits, of the excavated and piled overburden material, and of processed and piled ore were incorporated into the existing digital elevation models. Spatially explicit representations of existing vegetation, roads, and surface hydrography were draped over a digital elevation model to produce perspective views representing the post-development landscape. Fixed point perspective views were generated from an observation point near Smeaton, from an observation point in the vicinity of James Smith Cree Nation, and from the hillside at the top of the lifts at Wapiti Valley Ski and Board Resort.

A separate visibility analysis was run to determine if an observer at several elevations above ground level in Prince Albert would be able to see the development at Star and Orion South. Elevated observation points extended to 100 meters above ground level in the vicinity of the Marquis Towers.

In order to provide the best possible understanding of what the pit / pile complex will look like, a fly by of the reclaimed post-development landscape was constructed. This fly by is presented as a computer animation which is probably best described as a helicopter tour of the complex taking place after the pit has been excavated and the overburden and processed ore has been piled. The benefit of this approach is that it provides the best possible illustration of the composition of the pit / pile complex. The disadvantage of this approach is that you are illustrating something that very few people will ever see. Ground based observation views more accurately model visual impacts to surface observers.

To accurately determine all points that the pit / pile complex could potentially be visible from, several visibility analyses were run. In a visibility analysis, the modelled end-state landscape is analyzed, and all areas from which a ground observer can see the pit / pile complex are identified. If the objective of the project is to determine locations from which the piles can be seen, this analysis should be performed first – as a way of identifying visual impacts, and as an effective means of determining what ground based observation points should be used to illustrate what can be seen. Visibility analyses were run without tree screening for the preliminary viewpoint location exercise and to determine whether the development was visible from Prince Albert. Visibility analyses from the selected final viewpoints were run with tree screening heights added to the base DEM.

Mapping, geographic data and visibility analysis was done with ArcGIS version 9.3.1. The 3D perspective views were generated with World Construction Set version 4.6.1. Photo image manipulation was performed with Jasc Paint Shop Pro and Photoshop.

2. PROJECT METHODOLOGY

2.1 BASEMAP DATA ASSEMBLY

a. Determine and delineate project boundaries

The project boundary delineation defines the area for which project data will need to be compiled. The project area was originally defined by a box bounded by Prince Albert in the west, Highway 6 in the east, Smeaton in the north, and Highway 3 in the south. The area was expanded by 15 km in all directions to include a broader extent of positive results from the visibility analysis.

Delivered dataset: project_boundary/aoiplus15.shp

b. Compile Hydrographic Data

The best available Hydrographic data for the complete project area is contained within the Canadian National Hydro Network (NHN) datasets. This 1:50,000 and better data is organized by drainage basin and is available for download free of charge from geobase.ca. Six separate drainage basin datasets were downloaded and combined into a single dataset to support this project. The combined dataset was not be clipped to the project area outline and extends to the full extent of the drainage basins.

Delivered Dataset: hydro/Shore_NHN.gdb

c. Compile Roads Data

The provincial Canadian National Roads Network (NRN) dataset was compiled and clipped to the project boundary.

Delivered dataset: roads/ NRN_SK_3_0_ROADSEG_Clip.shp

d. Compile Vegetation Data

Ground based perspective views provide representations of vegetation based on summaries of forest and ecological inventories. Critical attributes include tree species, stand density, and tree height. For this project area, vegetation inventories at that level of detail are available only for areas within the Provincial Forest. The Saskatchewan Forest Vegetation Inventory (SFVI) was obtained for the Fort a la Corne and Steep Creek Provincial Forests. An algorithm was applied to extract the Provincial Forest Type Classes from the SFVI dataset and to weight attributes in multilayer stands to derive stand height and density statistics. Non forest elements such as agricultural land, hayfields, marshes, fens, water bodies etc were also identified.

The vegetation for the non forested areas was derived from National Topographic Database Land Cover datasets. This dataset proved very useful in identifying the location of tree patches outside of the Provincial Forest datasets. The data simply indicated presence or absence of treed vegetation patches and these patches were assigned appropriate default tree heights and species compositions and custom

attributes where they affected the sight lines based on either neighbouring provincial forest attributes, local knowledge, or photographic evidence.

The two inventories were merged and dissolved on the stand height attribute. The resulting tree height distribution layer was converted to a raster which was then 'added' to the base raster producing a surface used to produce the screened visibility products. Stands with a crown density of less than 10% were assigned a zero height as were areas under the mine development features.

The merged inventory was also used as the base for the vegetation input layer to World Construction Set.
Delivered datasets: NTDB_veg.shp ; SVFI_stands.shp

e. Compile Elevation Data

The base digital elevation data for the complete project area was assembled from the publicly available 1:50,000 scale Canadian Digital Elevation Data point data set. A total of 32 point DEM files were down loaded, converted to points, appended, projected to the North American 1983 CSRS UTM zone 13 projection, and interpolated to a surface raster using an inverse distance weighted technique. A grid size of 25 m was chosen based on the size of the area to be analyzed, the minimum viewing distances and the scale of the development components.

Shore Gold supplied LIDAR based Digital Elevation Models (DEMs) of the final development including surface contours, overburden and processed ore piles , pits and a reservoir. The individual components were extracted and converted to TINs (Triangular Irregular Networks), surface rasters and convex hulls (outlines).

The component surface rasters were blended with the base DEM to create the final surface for all subsequent non-screened analyses. This surface was also used as the base for the data input into World Construction Set, the 3D visualisation software used to generate the perspective views.

The TINS and surface rasters were incorporated into the final maps and the animation. The outlines were used to erase vegetation polygons overlaying the development components and to set tree heights to zero for the generation of the screening tree height layer.

An analysis surface for screened viewsheds was constructed by adding heights from the vegetation datasets to the base analysis surface. (See section 2.1 d.)
Delivered datasets:DEMs/ArcGrids/base; DEMs/ArcGrids/baseplusth; DEMs/ArcGrids/treehtgrid – also the same datasets in Ascii format in the Ascii folder; NTS_dem_data raw DEM datasets.

2.2 VISIBILITY ANALYSIS

The base visibility analysis shows line of sight visibility from a group of viewpoint systematically situated on the proposed pit and pile models. This unscreened analysis shows the visibility outwards from the tops of the piles and was used to confirm the possibility that the development may be visible from the various candidate viewpoints.
Delivered map: map/noscreen_vis2.pdf

A visibility analysis looking from Prince Albert towards the site was run using viewpoints stacked at 10 meter intervals from ground level to 100 meters above ground level at the site of the Marquis Towers. This is also an unscreened analysis.
Delivered map: maps/basevis_pa2.pdf

The visibility analysis from the final viewpoints towards the proposed development was run with tree screening included. This analysis best represents the real world situation and closely matches the results from the World Construction Set generated perspective views. The viewpoint observer heights were set at 2 meters for this analysis.
Delivered map: maps/vpvis2a.pdf

Earth curvature and refraction corrections were made for all visibility analyses. The formula used for the correction is:

$$Z_{actual} = Z_{surface} - \frac{Dist^2}{Diam_{Earth}} + R_{refr} * \frac{Dist^2}{Diam_{Earth}}$$

where:
- *Dist* is the planimetric distance between the observation feature and the observed location.
- *Diam* is the diameter of the earth.
- R_{refr} is refractivity coeeficient of light.

The default value for the diameter of the earth ($Diam_{earth}$) is defined as 12,740,000 metres and the default value for the refractivity coefficient (R_{refr}) is 0.13.

Delivered datasets: viewshed rasters in IMAGINE image format in the /visibility folder

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2.3 SELECT GROUND BASED OBSERVATION POINTS AND SITE PHOTOGRAPHY

Preliminary ground based observation points for perspective view generation were assigned to locations in Smeaton, in or near the James Smith First Nation, and at an elevated location in Prince Albert. In light of the results of the visibility analysis the final selected ground observation points and corresponding photo numbers were.

1. James Smith Cree Nation - Photo Point 10
2. Top of the Lifts at Wapiti Valley Ski and Board Resort - Photo Point 4A
3. 4 Miles South of Smeaton - Photo Point 1

Thomas Porter Photographics was contracted to take panoramic site photography from the selected viewpoints. View directions and view angles were carefully recorded to be matched to the perspective views generated in World Construction Set. Photo point locations were recorded using a GPS.

2.4 GENERATE PERSPECTIVE VIEWS FOR THREE GROUND BASED OBSERVATION POINTS

Perspective views of the pit / pile complex were generated using 3-D Nature's World Construction Set (WCS) software. This software produces the most technically accurate simulations of landscapes and landscape features, limited of course by the accuracy of the input datasets.

Input data was derived from the same data used to generate the visibility analyses. The non screened base DEM including the development components was exported in to WCS and rebuilt to a 22 m grid. The forested stands from the vegetation dataset were reclassified into ecosystem components links based on height, species composition and crown closure. The non-forested portions were assigned appropriate descriptive attributes. WCS ecosystem components were then constructed to match the input vegetation data. WCS uses 2D images of trees shrubs and other vegetation components which are accurately scaled to the height ranges defined for each ecosystem and thus produces perspective views that properly model real world vegetation screening.

The WCS 'camera' was positioned at the same point as the field photography camera and horizontal view arcs and view directions were set to match the field photos. As with the field camera, several images were taken with a view arc matching a 50mm camera lens and were then stitched together.

The site panoramic photos were then cut into the foregrounds of the generated perspective views. All of the generated screening components between the observation point and the development components were retained.

Inspection and comparison of the perspective views with the screened visibility mapping shows a close correlation as to the visible sections of the components from each of the viewpoints. This confirms that the internal algorithms used to model earth curvature, refraction etc are similar between AcrGIS and World Construction Set.

Delivered maps:maps/stack.pdf; maps/stackb4aft.pdf
Delivered datasets:forest/ STANDS_Merge_wcsinput.shp
STANDS_Merge_wcsinput

2.5 GENERATE FLY BY ANIMATION

A DEM of the area around the mine was updated using the pit and pile models provided. This updated model was then used to drape the orthophoto over, creating a 3D surface of the area. In order to provide context and show the surrounding area, Landsat imagery was used. This imagery was draped over a coarser, provincial DEM as it is only visible from a distance and not critical to the project.

The imagery was updated to better reflect the new pits and piles, and this was done in Photoshop. A simple dirt brown colour was used to show the piles and a gradient of brown to greenish/grey was used for the pits.

Working with Shore Gold staff, a flight path was then created over the 3D surface navigating the model and showing the area of interest. Initially the goal was to create a fifteen to thirty seconds long video of the flight, but that proved too short and the length of the flight was increased to forty five seconds.

After an initial flyby of the surface showing the pits and piles of a working mine, it was then updated in order to show what the area will look like after the mine is closed. The pits were filled with water to roughly 80% and the piles were updated with vegetation. The flight then resumed over this area.

The main issue with the 3d flyby was the lack building sites. The initial goal was to incorporate the building models into the flyby by placing them on the surface, but we could not georeference the buildings into their proper locations. After some back and forth with the Shore Gold staff and the project deadline approaching, the idea of incorporating the buildings was abandoned.

Delivered datasets: Input components, animation .avi file and frame stills in 'animation' folder