RESOURCE INVENTORY AND SENSITIVITY ANALYSIS

Greater Bragg Creek Area

Alberta

Prepared for

Municipal District of Rocky View No. 44

911 - 32nd Avenue NE
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ALPINE ENVIRONMENTAL

EXECUTIVE SUMMARY

The following is the Resource Inventory and Sensitivity Analysis (RISA) of the Greater Bragg Creek area completed by Alpine Environmental Ltd. (Alpine) for the Municipal District of Rocky View No. 44 (MD). The RISA was completed for the entire area of Greater Bragg Creek that is part of the MD's jurisdiction. The Greater Bragg Creek area is currently undergoing an Area Structure Plan (ASP). The ASP terms of reference requires completion of a baseline inventory of the environmental resources within the area. This RISA was designed to provide assistance to the ASP committee in developing policy-based recommendations. The RISA consisted of acquisition and inventory of existing data from the Calgary Regional Partnership (CRP) and the MD's own geospatial data.

A RISA technical committee was formed to evaluate the environmental resources and sensitivity of the policy area based on the information provided. A resource inventory was completed as part of this study. It revealed data gaps primarily with respect to groundwater resources, specifically quality and quantity. It is the view of the technical committee that groundwater resources represent the most significant concern with respect to development in the area.

The need for adequate riparian planning and habitat connectivity was addressed in a riparian policy. The RISA technical committee agrees that the proposed setback of 50 m along the Elbow River and 30 m adjacent to all other surface water bodies, including wetlands, can serve the dual purpose of: a) improving and maintaining high quality water recharge to surface water bodies and b) providing wildlife corridors.

A sensitivity analysis revealed that approximately 26% of lands in the policy area are excluded from potential development based on an existing MD Planning policy. As a result of challenges pertaining to the provision of access and servicing, subdivision and development on slopes greater than or equal to 15% is generally not permitted. The largest proportion of lands (43%) within the policy area correspond to areas of low slope (0 - 4%).

An analysis of current forest composition in the area shows that much of the Greater Bragg Creek area is forested with hardwood and softwood tree species. The largest single forest cover class (34%) is pure hardwood. Non-forested areas make up the second largest single class covering approximately 26% of the policy area.

A modelling exercise to determine the range of natural variability of the area, given an imposed disturbance like wildfire, revealed that the natural proportion of forest types range from 0.5 to 2.0 times the current composition. The technical committee suggests that a directive by the MD should include a schedule to ensure the forest composition range of natural variability is maintained.

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1. INTRODUCTION & BACKGROUND INFORMATION

Alpine Environmental Ltd.'s (Alpine) services were retained by the Municipal District of Rocky View No. 44 (MD) in June 2004 to conduct a resource inventory and sensitivity analysis (RISA) for the Greater Bragg Creek area (Bragg Creek). The goal of the RISA was to provide a baseline inventory of environmental resources in the area and to assist the Area Structure Plan (ASP) Steering Committee in developing policy-based recommendations for the area. Data were provided both directly from MD data resources and, via the MD, from the Calgary Regional Partnership (CRP). The information gathered during the RISA process was compiled and placed into an interactive cartographic Geographic Information System (GIS).

The MD covers an area that borders the City of Calgary to the north, east and west. The total area of the MD is approximately 4,000 km2 (Municipal District of Rocky View, 2003). The Greater Bragg Creek policy area (Figure 1) covers approximately 47.9 km2, or approximately 1% of the total MD lands. Bragg Creek is situated in the foothills of the Front Ranges of the Rocky Mountains and is often referred to as the "Gateway to Kananaskis Country", which is a Provincial multi-use recreational area that borders Bragg Creek to the west. The area supports tourist and recreational opportunities along with farm land, residential and commercial development.

Generally, the attitude of and about Bragg Creek is one of environmental sensitivity. Recreational users and residents alike have a strong appreciation for the natural serenity of water and woodland provided in the area. A generally wooded area, forests of varying abundance of Trembling Aspen, Alpine Fir, Douglas Fir, Alpine Larch, Lodgepole Pine, Balsam Poplar, Black Spruce, Engelmann Spruce and White Spruce cover much of Bragg Creek. In addition, large non-forested areas comprise approximately 25% of the total landscape of Bragg Creek. A portion of the non-forested component are surface water bodies including one river, the Elbow, and its tributary, Bragg Creek, which have their confluence in the central portion the Bragg Creek area.

There is a sense that preserving the environmental integrity of the area is a common objective. In meeting the objectives of the RISA, it was recognized that an awareness of the broader ecosystem, of which Bragg Creek is a part, and the need to harmonize development and preservation were fundamental to the success of the study.

The information presented herein is a compilation of results coming from the RISA project directed by Ms. Gail Sokolan, and a RISA technical committee comprised of:

- Mr. Ken Venner, Municipal Planner, MD of Rocky View; and,
- Mr. Tim Dietzler*, Agricultural Fieldman, MD of Rocky View.

and resident experts:

- Dr. Roy Crowther*, Ecologist, Alpine (water, fish, wetlands, GIS);
- Dr. Brad Stelfox, Forem Technologies, Landscape Ecologist (ecology, GIS);
- Dr. Mary Reid, Ecologist, University of Calgary (insects);
- Mr. Bill Hoyne, Systems Administrator, University of Calgary (groundwater); and,
- Mr. Eric Lloyd, local resident (social engineer);

* co-chair of RISA technical committee.

Several meetings were convened with the RISA technical committee to discuss and review the data inventory and the results of spatial analyses. Due to conflicting schedules, it became necessary to convene partially-attended technical committee meetings. As the project progressed Alpine convened a total of twelve technical committee meetings; however, no meeting was attended by the entire team. To ensure the committee was kept apprised of project developments, relevant information relating to the material covered at each meeting was circulated to the entire committee via e-mail.

This assessment was based on information provided by the MD and, by way of the MD, data were also provided through the Calgary Regional Partnership (CRP).

The objectives of and terms of reference attached to this RISA were as follows:

To collect and compile an inventory of relevant spatial data with a focus on data already existing in the region. Of particular importance were the following:

- Soils;
- Topography;
- Surface water including lakes, rivers, streams, wetlands, peatlands;
- Groundwater;
- Land use designations;
- Riparian areas;
- Vegetative cover;
- Resource extraction including mining, forestry, oil & gas;
- Surface disturbance;
- Wildlife;

- Provincial and Federally designated areas;
- Identification of data gaps;
- Identification of sensitivities revealed through the RISA process; and,
- Provision of recommendations to address these sensitivities.

Based on this information and an interpretation of the RISA data, determine levels of sensitivity and risk to future development options or plans.

2. GLOSSARY

Crown Closure - the percent canopy closure for each tree species observed by a person on the ground using a mirrored instrument divided into a grid.

Datum - the spheroid that defines the surface of the earth (e.g. NAD83).

Development - any of the following associated with or resulting from local government regulation or approval for residential, commercial or industrial activities or ancillary activities to the extent that they are subject to local government powers i.e. the Municipal Governance Act:

a) removal, alteration, disruption or destruction of vegetation;
b) disturbance of soils;
c) construction or erection of buildings and structures;
d) creation of non-structural impervious or semi-impervious surfaces;
e) flood protection works;
f) construction of roads, trails, docks and bridges;
g) provision and maintenance of sewer and water services; and,
h) development of utility corridors and / or subdivisions as defined by the MD.

Digital elevation model - is also known by the common abbreviation “DEM”. A DEM consists of an array of evenly spaced grid cells which hold elevation values and have horizontal reference to a consistent projection and coordinate system.

Geomatics - is a field of study that incorporates and systematically manages all information related to the acquisition and use of spatially referenced data.

Metadata - is data about data. It provides information about the development, use, currency, relevance and spatial referencing of data.

Orthophoto - is a completely spatially referenced photograph that has been corrected for all variations due to relief, scale and other displacements.

Pixel - is the contraction for picture element. In an image, it is the area on the ground represented by each digital number. Each pixel holds a corresponding digital number. The digital number can represent any input unit, such as slope, tree species or elevation. The digital number for a pixel represents the average true value for the area covered by the extent of a single pixel.

Riparian area - a streamside protection and enhancement area.

Remotely sensed images - images acquired by airborne or satellite platforms

Stream - includes any of the following that provide fish habitat:

a) a watercourse, whether it usually contains water or not;

b) a pond lake, river, creek or brook; and,

c) a ditch, spring or wetland that is connected by surface water flow to something referred to in a) or b).

Triangulated irregular network - also known by the common abbreviation “TIN”, is a contiguous surface on non-overlapping triangles which represent the surface of a plane. When the input data for a TIN represent elevation, the resulting TIN provides a visual approximation of the sloped surface.

Wetland - land that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal conditions does support, vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, fens, and similar areas that are not part of the active flood plain.

3. METHODS

The area was assessed using a combination of aerial photographs, spatial data and local knowledge contributed by the technical committee. All data were provided by the MD with the exception of provincially and federally designated sites (Parks) as discussed in section 3.1 below.

3.1 RESOURCE INVENTORY

All vector data provided by the MD and CRP were presented in or converted to ESRI shapefile format (*.shp). Data provided by the CRP were converted to the coordinate system and datum used by the MD Geomatics department (NAD83, 3TM, -114CM). A summary of existing data was compiled and circulated to the committee to assess the utility and project-specific relevance of the datasets. Data gaps were identified throughout the project and were filled, where possible, given the confines of budgetary restraints.

No spatial data related to provincially and federally designated sites were provided by the MD or CRP. Free spatial data are provided by the Government of Canada through Natural Resources Canada (NRCan). National and provincial park boundary data were acquired through the NRCan Geogratis resource.

Each data layer was examined for completeness of spatial extent, attribute data and metadata. Where deficiencies in one or more of these areas were found, it was brought forward to technical committee to discuss the utility of the data for the purposes of this project.

3.2 SENSITIVITY ANALYSIS

3.2.1 Riparian Policy

A riparian policy was developed as part of this study. It is based on the review of current and historic literature and is appended (Appendix I).

3.2.2 Slope

Generally, the MD's planning policies discourage subdivision and development on slopes greater than 15%. Initial attempts to use the DEM provided by the CRP revealed that the resolution of the DEM is too coarse for the purposes of this study. An elevation point file was created from vertices of an edited contour (line) layer comprised of data from both the MD and the CRP. A TIN was constructed from the elevation point file containing x, y and z values. The TIN was generated using the ESRI extension 3DAnalyst. In this instance, the surface is a representation of elevation.

Using the TIN as the input data, an algorithm provided in the ESRI extension Spatial Analyst was used to derive slope. The result is a raster data layer comprised of square cells called picture elements (pixels). The slope derivation resulted in thousands of 32.39519235 m pixels. The value of each pixel represents the average of input values over the area, in this instance, 32 m by 32 m. The slope algorithm does not support smaller pixel sizes in this case, as the default value is constrained by the resolution of the input data (TIN). The resulting slope values were calculated in units of percent slope.

3.2.3 Forest Composition

Current forest composition is provided by the Alberta Vegetation Inventory (AVI). Data provided by the CRP included a layer of AVI polygons that delineate areas of homogeneous forest composition. Primary and sub-dominant tree species and their current abundance (%) are assessed by Alberta Forestry using audited aerial photo interpretation (1:20,000 orthophotos) and ground truthing. Metadata indicate the dataset provided was current to September 2001.

3.3 GEOGRAPHIC INFORMATION SYSTEM

The work presented herein has been incorporated into a GIS. This system allows all information from the sensitivity analysis to be easily accessible and useable in the existing GIS currently in use by the MD. All data layers created by Alpine have been annotated with metadata documenting the purpose, spatial referencing and analytical methods used to derive the layer.

4. RESOURCE INVENTORY

The RISA committee examined the available data and discussed the merits and limitations of each dataset.

4.1 DATA INVENTORY

The MD provided several layers of spatial data currently held in their Geomatics database. A large portion of the resource inventory involved assessing the quality of the data, assembling the data to a consistent geographic coordinate system and datum and identifying gaps within the dataset.

4.1.1 Data provided from the Municipal District data holdings

The following data layers were provided by the MD:

- Hydrobdy;
- PolicyAreas;
- 10 m_contours_GBC;
- LegalFabric; and,
- LandUseByTaxCode.

The following data layers were provided by the MD but are sourced from the Prairie Farm Rehabilitation Administration (PFRA):

- Braggcreekfloodrisk;
- Braggcreekfloodriskareas; and,
- GBC_WWELLS.

4.1.2 Data provided from the Calgary Regional Partnership data holdings

The following data layers were provided by the CRP:

- WW_WATER_QUAL_STN;
- WEATHER_STNS;
- WATER_WELLS;
- WATER_QUALITY;
- WATER_QUANTITY;

- WATER_GAUGING_STN;
- WATER_AUTH;
- OIL_GAS_WELLS;
- BUILDINGS;
- CONTOURS;
- RIVERS_STREAMS;
- POND_RESERVOIR;
- WETLANDS;
- TRAILS;
- SPOT_HGT;
- ROADS;
- CUTLINES;
- CITY_BNDRY;
- BRIDGES;
- AIRSTRIPS;
- AVI;
- AVI_CC;
- GRADIENT;
- GROUNDWATER_YIELD;
- SURFICIAL_GEOL;
- SURFACE_TEXTURE;
- SURFACE_MORPHOLOGY;
- RELIEF;
- SOIL_CLASS;
- QUATERNARY_GEOL;
- LANDUSE;
- LANDSCAPE;

- LAKES;
- ELBOW_WATERSHED;
- ELBOW_SUB_BASIN; and,
- ELBOW_BUFFER.

4.1.3 Alpine generated data

Slope_nov2204_32mfromtin:

- Slope model created from TIN clipped to Policy Areas, pixel size = 32 m.

Aspect_Nov2204_32mfromtin:

- Aspect model created from TIN clipped to Policy Areas, pixel size = 32 m. Methodology to create this layer is the same as that for slope, using a different ESRI algorithm. These data, while not directly used in the sensitivity analysis portion of this project, are provided for the future use of the MD.

AVI_Relief_Slope_Nov2204:

- Union of AVI, Relief (with AGRASID soil composition data) and Slope, clipped to Policy Areas.

ContoursClip:

- Completed contour layer clipped to Policy Areas.

DissolvePolicyAreas:

- Policy Area layer from MD dissolved on PolicyArea attribute to remove sliver polygons that existed in root dataset.

SurfaceWater:

- ElbowRiver digitized to capture active flood plain (estimated from airphoto) and all other surface water features provided in datasets from the MD and CRP.

SurfaceWaterBuffer:

- Buffer of SurfaceWater to 50 m (Elbow River) and 30 m (all other waterbodies) in accordance with proposed Riparian Policy (Appendix I).

ClipProtectedAreasOCSITES:

- Bragg Creek Provincial Park.

ClipCrownReservations:

- Bragg Creek Natural Area.

4.2 RESOURCE ASSESSMENT

4.2.1 Utility of data provided - MD

Hydrobdy:

- This layer outlines hydrologic features within the policy area. It is not considered complete.

PolicyAreas:

- This layer outlines the four policy areas within Greater Bragg Creek.

10m_contours_GBC:

- This layer provides elevation contour information and covers the entire policy area. This layer does not contain elevation attribute data as it was provided as a DXF file and corrections have been made to the file upon merging with CRP provided elevation contour information. Only a small portion of this dataset, not covered by the CRP data, was used in the project.

LegalFabric:

- This layer outlines parcels within the policy area.

LandUseByTaxCode:

- This layer outlines parcels within the policy area and provides attribute information with respect to land use of each parcel.

Braggcreekfloodrisk:

- This layer, provided to the MD from the PFRA, appears to provide cross section locations along a flood risk area within the Hamlet. No metadata was provided with this layer and the utility of the data is not known.

Braggcreekfloodriskareas:

- This layer, provided to the MD from the PFRA, appears to delineate flood risk areas within the Hamlet. No metadata was provided with this layer and the utility of the data is not known.

GBC_WWELLS:

- This layer, provided to the MD from the PFRA, provides location and attributes information for water wells within, and to approximately 6 km beyond, the policy area. No metadata was provided with this layer and the utility of the data is not known. Data appear to be consistent with that which was collected by Alberta Environment at the time of drilling. Some water chemistry data is provided. No metadata accompanied these data and the currency of the data is not known.

4.2.2 Utility of data provided - CRP

The data provided by the CRP represents a compilation of spatial data from various, disparate sources. The City of Calgary, Geomatics department has, where possible, provided metadata to accompany their files. It was found that the metadata provided varied in completeness which resulted in limitations in the utility of the data.

WW_WATER_QUAL_STN:

- Two data points exist located on Bragg Creek approximately 450 m apart near the Hamlet of Bragg Creek. Water quality data can be linked using a related table (WW_QUALITY_DATA.dbf). Greater spatial distribution of sample locations and analysis of a consistent suite of parameters would create utility in this data and allow analysis of spatial and temporal trends in surface water quality. Given the limited distribution of sample locations, this dataset was not considered useable for this project.

WEATHER_STNS:

- No weather stations exist within the Bragg Creek policy areas. Furthermore, this database does not contain any weather information.

WATER_WELLS:

- From this dataset it is shown that 489 water wells are located within the policy area. Upon inspection of the data, it was determined, through local knowledge, that the currency and completeness of these data is suspect.

WATER_QUALITY:

- Seven data points exist within the policy area: two surface water, one (1) groundwater, three rivers or stream and one (1) unknown type. No water quality data are provided.

WATER_QUANTITY:

- One data point exists within the policy area. This point is located on the Elbow River at Bragg Creek. No water quantity data are provided.

WATER_GAUGING_STN:

- Three hydrometric gauging station data points exist within the policy area. Watershed and basin information is provided, along with gross and effective drainage area of the same. The view of the technical committee is that given the very limited hydrologic and hydrogeologic data available, this layer alone does not represent an important data source for the purposes of this project.

WATER_AUTH:

- Forty-seven data points exist within the policy area. This layer endeavours to provide water abstraction data; however, the metadata is not complete. No units of measurement are provided, making numeric values of abstraction useless, and the metadata in fact appears to be “one off”. For example, given three attribute fields, A, B and C, the metadata

reference provided in A actually appears to refer to B, and the reference provided for B actually appears to refer to C. Inconsistent and incomplete metadata leads to uncertainty in the quality of the entire data layer.

OIL_GAS_WELLS:

- Two data points exist within the policy area. One is described as an abandoned well and the other, a farm water well. These data were not considered particularly relevant to the sensitivity analysis portion of the project.

BUILDINGS:

- 534 buildings, all described as a house, are represented by data points within the policy area. These data are notably incomplete as no development is represented in the north part of West Bragg Creek, within the Hamlet itself or in the community near Wintergreen.

CONTOURS:

- Contour line data representing elevation was complete for the policy area with the exception of a small area (approximately one and a half sections) in the northwest portion of West Bragg Creek. These data were used in this project.

RIVERS_STREAMS:

- Rivers and streams are believed to be correctly represented in this data layer. These data were used in this project.

POND_RESERVOIR:

- Ponds and reservoirs are believed to be correctly represented in this data layer. These data were used in this project.

WETLANDS:

- No wetlands are represented within the policy area. Based on local knowledge, this is known to be incorrect.

TRAILS:

- Six trails are represented within North Bragg Creek. The total approximate length of these trails is 5.3 km. These data were not considered relevant to the sensitivity analysis portion of the project.

SPOT_HGT:

- Forty-two data points representing point elevation exist within the policy area. These data appear correct and were used in confirming the consistency and accuracy of the contour data.

ROADS:

- This layer represents various private, collector, major, gravel, dirt, and paved / chip sealed roads along with a secondary highway. The layer is not considered complete, as evidenced when compared with the legal fabric provided by the MD.

CUTLINES:

- Approximately 40 km of cutlines are represented within the policy area. These data were not considered relevant to the sensitivity analysis portion of the project.

CITY_BNDRY:

- This layer represents the City of Calgary boundary, approximately 30 km east of the policy area and is not relevant to this project.

BRIDGES:

- No bridges are represented within the policy area. This is known to be erroneous information and, as a result, the completeness of this layer is suspect.

AIRSTRIPS:

- No airstrips are represented within the policy area. This is believed to be correct.

AVI:

- Complete Alberta Vegetation Inventory (AVI) data were provided for the policy area. These data were used in the sensitivity analysis portion of the project.

AVI_CC:

- There are no clear cuts within the AVI data represented within the policy area. This is believed to be correct.

GRADIENT:

- This layer provides complete coverage over the policy area; however, due to incomplete metadata, the unique information provided is not useable in this project. This layer contains the same information provided in the Relief layer with the exception of the “Gradient” attribute. No metadata with respect to units of measurement is provided for the “Gradient” attribute yielding a dataset without utility.

GROUNDWATER_YIELD:

- This layer provides complete coverage over the policy area; however, due to incomplete metadata, the information provided is not useable in this project. No metadata with respect to units of measurement are provided for the “Yield” attribute. In addition, the values provided for “Yield” have a wide range (unique values within field are: 160 - 650, 30 - 160, 5 - 30 and < 5). While the units of yield are not known, the utility of any data that has a range between 160 and 650 units is not expected to be high. If the units of measurement are gallons per minute, the lowest value (5) does not provide enough information to be

useful, as the Alberta Environment limit for groundwater yield required for a domestic water well is 2 gpm.

SURFICIAL_GEOL:

- This layer provides complete coverage over the policy area. The surficial geology of the region is captured and good descriptions provided. The utility of this dataset for the purposes of this project could not be established.

SURFACE_TEXTURE:

- This layer provides complete coverage over the policy area. The texture of surface material of the region is captured and good descriptions provided. The metadata does not indicate what depth interval is considered "surface". The polygons and attributes of this layer are consistent with AGRASID soil polygons. AGRASID data are held in this layer, in duplicity with GRADIENT, RELIEF, SURFACE MORPHOLOGY and LANDSCAPE. The utility of this dataset for the purposes of this project could not be established.

SURFACE_MORPHOLOGY:

- This layer provides complete coverage over the policy area. Two (2) morphology types are present within the policy area: hill and valley. The metadata does not indicate what criteria are used to assign areas to morphologic classes. The polygons and attributes of this layer are consistent with AGRASID soil polygons. AGRASID data are held in this layer, in duplicity with GRADIENT, SURFACE TEXTURE, RELIEF and LANDSCAPE. The utility of this dataset for the purposes of this project could not be established.

RELIEF:

- This layer provides complete coverage over the policy area; however, due to incomplete metadata, the information provided is not useable in this project. No metadata with respect to units of measurement is provided for the "Yield" attribute. In addition, the values provided for "Relief" have a wide range (unique values within field are: 3, 5, 30, and 60). In addition, the highest value of "Relief" (60) corresponds to the Elbow River Valley. The polygons and attributes of this layer are consistent with AGRASID soil polygons. AGRASID data are held in this layer, in duplicity with GRADIENT, SURFACE TEXTURE, SURFACE MORPHOLOGY and LANDSCAPE. While any of the five (5) layers containing AGRASID data would have sufficed, this layer was used as the root source for the AGRASID data compiled for this project. The "Relief" data were not used.

SOIL_CLASS:

- This layer provides complete coverage over the policy area. The polygon attributes are based on the Canadian Land Inventory (CLI) Agriculture class descriptions. Four (4) classes exist within the policy area: class 5 (very severe limitations which restrict their capability to producing perennial forage crops, and improvement practices are feasible), class 6 (capable only of producing perennial forage crops, improvement practices are not feasible), class 7 (no capability for arable culture or permanent pasture) and class O (organic soils, not placed in capability classes). The majority of the policy area is covered by class 5 soils. It was determined that the class descriptions and boundaries presented in

this layer are not sufficiently detailed to provide useful information to this project with respect to development and potential land use.

QUATERNARY_GEOL:

- This layer does not provide complete coverage over the policy area. Four (4) types of quaternary deposits are noted for the area of Bragg Creek that does have coverage. These types are: glacial, bedrock and glacial, fluvial and ice-contacted lacustrine. The utility of this dataset for the purposes of this project could not be established, not only due to the partial coverage of the data.

LANDUSE:

- This layer provides complete coverage over the policy area. There are six (6) land use types over the area: 1 (Cropland), 2 (Forage), 3 (Grassland), 5 (Trees), 7 (Water Bodies), and 8 (Other lands). The majority of the policy area is classified as grassland or trees.

LANDSCAPE:

- This layer provides complete coverage over the policy area. There are six (6) types of landscape described: three (3) variations of a hummocky type plus a level and a terraced class, undulating high relief class and a wide valley class. The large majority of the policy area is classified to one (1) of the three (3) hummocky type landscape classes. The polygons and attributes of this layer are consistent with AGRASID soil polygons. AGRASID data are held in this layer, in duplicity with GRADIENT, SURFACE TEXTURE, RELIEF and SURFACE MORPHOLOGY. The utility of this dataset for the purposes of this project could not be established.

LAKES:

- No lakes are represented within the policy area.

ELBOW_WATERSHED:

- Divided into nine (9) polygons depicting effective drainage areas, the outer boundary of this layer is consistent with that of the ELBOW_SUB_BASIN layer extent. The extent covers the policy area with the exception of a small area (approximately one and a half sections) in the northwest portion of West Bragg Creek.

ELBOW_SUB_BASIN:

- A single polygon that defines the Elbow River sub-basin. The extent covers the policy area with the exception of a small area (approximately one and a half sections) in the northwest portion of West Bragg Creek.

ELBOW_BUFFER:

- 5 km and 10 km buffer from the boundary of the ELBOW_SUB_BASIN.

4.2.3 Utility of data provided - Alpine

The area coverage of the policy area boundaries is 0.21 km2 larger than the coverage of the AVI / AGRASID / Slope data. There are small areas at the northeast and northwest corners of the north edge of the policy area boundary. This discrepancy is rooted in the TIN interpolation procedure that rounds edges where no data exist beyond the edge. These rounded edges contain no slope or aspect data and impact the total size of the area covered by all three (3) layers (AGRASID, AVI and Slope / Aspect).

Policy areas = 47.91 km^2
AVI/AGRASID/Slope area = 47.69 km^2
Difference in aerial extent = 0.21 km^2

Slope_nov2204_32mfromtin:

- This layer provides nearly complete coverage of the policy area, as outlined above. Slope data values are provided that indicate the percent slope angle from horizontal.

Aspect_Nov2204_32mfromtin:

- This layer provides nearly complete coverage of the policy area, as outlined above. Aspect data values are provided that indicate the facing direction of slope in units of azimuth degrees.

AVI_Relief_Slope_Nov2204:

- This layer provides nearly complete coverage of the policy area, as outlined above. This layer is a result of intersection operations of Slope, AVI and Relief data sets. The intersection operation produces polygons with the full extent and attributes of the input layers. The resulting layer enables tabulation of relationships between variables and a single data holding place for these important component layers.

ContoursClip:

- This layer provides complete coverage of the policy area. The contour data from both the MD and CRP were combined to create a seamless coverage for the area of interest. The slope calculation was based on this layer.

DissolvePolicyAreas:

- The policy area layer provided by the MD contained sliver polygons. Sliver polygons are erroneous and the dissolved layer contains only four (4) polygons, each corresponding with one (1) of the four (4) areas within the Bragg Creek policy area.

SurfaceWater:

- This layer is a result of merging all hydrologic data provided by the MD and CRP. Now a single data source for hydrologic information, the root layers of each component are still held as attributes within the database. This provides single-source coverage of hydrologic features in the policy area.

SurfaceWaterBuffer:

- As outlined in the Riparian Policy (see 4.1, below), a buffer of 50 m beyond the banks of the Elbow River and 30 m beyond all other surface water bodies has been delineated as riparian area.

ClipProtectedAreasOCSITES:

- The extent of Bragg Creek Provincial Park is provided as part of the RISA terms of reference.

ClipCrownReservations:

- The extent of Bragg Creek Natural Area is provided as part of the RISA terms of reference.

4.2.4 Data gaps

One aim of the RISA process was to identify data gaps. Based on the terms of reference outlined in Section One (1), the RISA has revealed several areas of weak or absent data. The resource inventory portion of the project was not able to satisfy all terms of reference for this project due to data resolution and reliability.

At the initiation of the RISA project Alpine was informed that Husky Energy Inc. (Husky) and Shell Canada Ltd. (Shell) had acquired spatial data, particularly of indicator wildlife species, for the area and was in agreement to partner with the MD to provide these data for the purposes of the RISA, as outlined in the terms of reference. The MD advised Alpine that further investigation into these data sources revealed that Golder Associates Ltd. (Golder) was the holder of these data and, as such, the MD requested relevant copies to be provided to the RISA project. Alpine was notified that following a search for these data, Golder had advised the MD that they were not available due to data storage system instability leading to their ultimate loss.

Other data sources were identified at the beginning of the project, including the Spray Lakes Sawmills and the T'suu Tina Nation; however, no auxiliary data, beyond that outlined in section 4.1, were provided.

Soils and surficial geology data were provided to this project at a ground resolution that does not allow the RISA technical committee to provide clear guidance with respect to development, particularly in terms of assessing areas with characteristics likely to be problematic for septic disposal using a tank and tile system. Given that users in the area, including but not limited to

the downstream users of the City of Calgary, place a high value on clean surface water bodies and given the proximity of residents using septic field systems to surface water bodies, the lack of monitoring of septic field efficacy is considered an important data gap.

Resource extraction data with respect to mining were not provided. Freely available data with respect to mining were investigated and show no such resources in the area; however, given the data resources available, confirmation of this result is not considered complete.

Wildlife data were not provided and, in the opinion of the RISA technical committee, accurate and complete sources of these data are not known to exist. In lieu of this, the RISA technical committee has decided that the use of forest cover composition (AVI) is an adequate surrogate for wildlife data, based on the premise that preservation of connected habitat will allow and encourage the local population of wildlife to use the area.

Bridge data provided by the CRP requires updating to include the existing bridge structures in the Greater Bragg Creek policy area.

Accurate and complete riparian area delineation was not provided to the project leading to the need, identified by the RISA technical committee, to develop a riparian policy. Surface water data provided did not resolve some important features tied to the accurate definition of riparian buffer widths, specifically, the top of bank. To fill this gap, for the purposes of the RISA, Alpine provided airphoto interpretation and adjustment of surface water body margins which provided a better dataset on which to apply the riparian policy. In addition, airphoto information reveals the presence of lentic water bodies (e.g. lakes) which were not captured in the vector data provided. Given the data provided, these gaps in surface water data have been filled to the best of the ability of Alpine and the RISA technical committee; however, in the absence of groundtruthing, this exercise is not considered complete.

Groundwater information was found to be inaccurate in terms of water well locations, and incomplete in terms of the aquifer characteristics of the producing depth of water wells. Aquifer characteristics data, such as groundwater quality and yield are incomplete and, where present, are not at a resolution that can provide guidance to the committee with respect to availability and potential development of water resources.

The RISA study based its hydrogeological information on data provided by the MD. Mr. Bill Hoyne reviewed a report, external to the RISA, which was completed for the M.D. of Rocky View #44 by Hydrogeological Consultants Ltd. (HCL) in March 2002. This study encompassed the entire municipal district, which is an area much larger than the RISA study area. The data and analysis provided in the HCL (March 2002) report is of a type and quality that could prove useful for a preliminary study of hydrogeology of the Greater Bragg Creek area. The findings of that study are not at a scale that provides information specific to the Greater Bragg Creek area; therefore, no further attempts were made to use the data for the purposes of the RISA.

In summary, specific data gaps, with respect to water resources, were identified in the areas of surface water, groundwater and meteoric water (recharge).

Surface water data gaps include:

- Top of bank for surface water bodies;
- Flood risk area delineation;
- Surface water quality;
- Surface water quantity; and,
- Wetland delineation.

Groundwater data gaps include:

- Existing water well location updates;
- Water well aquifer characterization;
- Groundwater quality; and,
- Groundwater quantity.

Meteoric data gaps include:

- Recharge quantity.

5. SENSITIVITY ANALYSIS

Essentially there are two layers that were used to create fields of values for comparison: AVI and Slope. Soil composition (AGRASID) is also included in the database for future use by the MD Geomatics group. The RISA technical committee has identified that cumulative impacts of development on the water and land resources in the area is a significant consideration in planning and proposed new developments. Cumulative impacts are observed as effects that development may have on other environmental parameters. For example, the clearing of forest materials on steep slopes may have manageable site specific impacts; however, the impact of increased erosion, decreased water holding capacity, increased runoff and fragmentation of wildlife habitat may cumulatively pose serious environmental impacts. The RISA technical committee suggests that the MD consider the potential cumulative impacts of all new developments within the policy areas.

5.1 RIPARIAN POLICY

The results of a literature review and the corresponding summary recommendations with respect to riparian areas are appended (Appendix I). The riparian policy demonstrates that a minimum development setback is 30 m from the top of bank on all surface water bodies, with the exception of the Elbow River, which is to have a 50 m setback, supports the preservation of riparian integrity and ecosystem functions. This policy is based on and supported by similar legislation in other municipalities. The riparian policy recommends that no development is to occur within the riparian area defined by the buffer widths described in Appendix I. The aerial extents within the Bragg Creek policy areas proposed to be protected by the riparian policy (Figure 2) are summarized in Table 1. The results show that the aerial extents of riparian buffers cover approximately 7.1 km^2. In addition to surface water bodies, the RISA technical committee considers wetlands to be an important component of a properly functioning ecosystem.

Wetland conservation provides important habitat for wildlife including migratory and resident birds, mammals, invertebrates and amphibians. In addition, wetlands are a natural physical and chemical filter of overland flow. Contaminants and sediments carried in overland flow are intercepted and purified by the vegetation and sediments that characterize wetlands. For the purposes of this report, areas classified by AVI as wet moisture regime are considered wetlands. Given the available data, the delineation of areas of wet moisture regime is provided as a best approximation of the actual wetland areas within the Bragg Creek policy areas. No groundtruthing has been conducted to confirm the extents of these areas and the RISA technical committee proposes that site specific investigations to determine the extent of wetlands should be carried out by a qualified environmental professional for any proposed development that encroaches on an identified wetland (Figure 3). Wetlands are commonly classified using broad terminology such as marsh, swamp, bog and fen.

The assessment of wetlands should consider the following principles:

- Wetlands are periodically flooded and may experience prolonged dry periods
- Wetlands are characterized by plants that require saturated soils and are adapted for wet conditions
- Wetlands are underlain by hydric soils which may be mixed with organic material
- There are seven wetland types recognized by the Canadian Wildlife Service: wet meadow, shallow marsh, emergent deep marsh, transitional open water, shallow open water, open alkali and disturbed wetland (Millar, 1976). The Canadian Wildlife Service published the Wetland classification in western Canada (Millar, 1976) which contains a classification methodology and field form template which may provide a suitable reference for the site specific inspection of proposed developments adjacent to wetland areas. The results of site specific investigations may increase or decrease the extent of the wetlands within the study area. The aerial extents of the mapped wetlands provide an additional 5.5 km^2 of protected areas and are important components of the connectivity of the riparian areas (Figure 3).

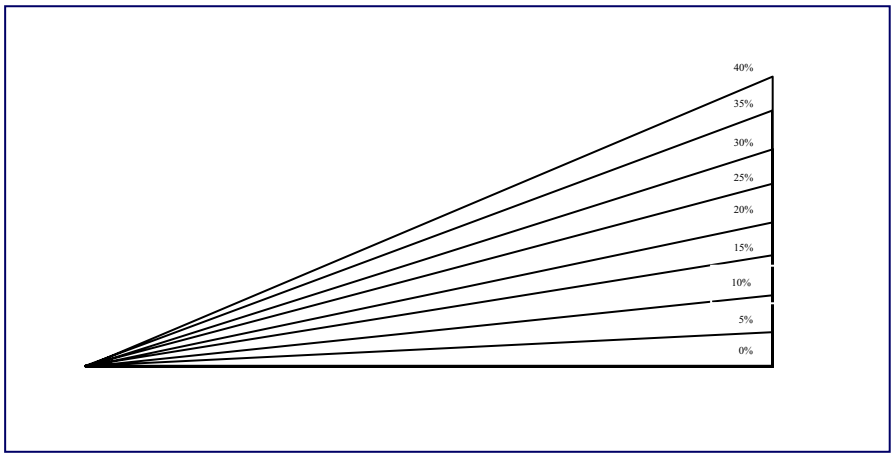
5.2 SLOPE

5.2.1 Basis for classifying "Slope" with regard to Development limitation potential (SlpDevelop)

A TIN generated from elevation data provided by the CRP and the MD was used to create a slope layer (Figure 4). Break points for each class were based the on MD Planning guideline (15% slope cut-off) and even distribution of remaining values.

Class	Description
Excluded	All slopes ≥ 15%
High	Slopes 10 - 14% inclusive
Medium	Slopes 5 - 9% inclusive
Low	Slopes 0 - 4% inclusive

The diagram below provides a conceptual view of slope angles from horizontal.



The results of the slope classification procedure (Table 2, Figure 5) described above show that approximately 26% of the policy area is classified as excluded based on an existing MD planning and development standards (≥ 15% slope). This standard specifies that development plans must show an area of at least one contiguous acre (approximately 4,000 m^2) of developable land (≤ 15% slope) for the provision of an adequate tank and tile septic field. The largest proportion (43%) of the policy area is classified as low slope (0 - 4% inclusive), of which approximately 25% (12.33 km^2) is classified as 0% slope. Of the remaining area, 12% of lands are classified high slope (10 - 14% inclusive) and 18% are classified as medium slope (5 - 9% inclusive). The maximum slope within the policy area is 128% covering an area approximately 0.002% of lands.

5.3 FOREST COMPOSITION

5.3.1 Basis for classifying "AVI" with regard to species composition (Class)

AVI stand composition was used to classify pure and mixed-wood stands. This classification scheme establishes a method for assessing the present (2001) forest stand composition within the policy area.

Class:

1. Pure Spruce (> 80%)
2. Pure Pine (> 80%)
3. Pure Hardwood (> 80%)
4. Mixed - Spruce leading Hardwood
5. Mixed - Pine leading Hardwood
6. Mixed - Hardwood leading Spruce or Pine
7. Non-forested

8. Mixed softwood - Spruce leading Pine
9. Mixed softwood - Pine leading Spruce

The AVI classification system uses a crown closure method for estimating dominant, or leading, and less dominant, or secondary, tree species. The method involves measurement of percent canopy closure for each tree species observed by a person on the ground using a mirrored instrument divided into a grid. The AVI system has developed a supervised, or groundtruthed, classification scheme that now allows them to estimate crown closure through spectral response from remotely sensed images.

There are five leading tree species within the policy areas (Trembling Aspen, White Birch, Balsam Poplar, undifferentiated Pine, and White Spruce) and five secondary tree species (Lodgepole Pine, Trembling Aspen, Balsam Poplar, undifferentiated Pine and White Spruce). It is the view of the RISA technical committee that an adequate assessment of the forest cover is provided by summarizing the various tree species into hardwood and softwood cover types. The hardwood tree species include Trembling Aspen, White Birch, and Balsam Poplar. The softwood tree species include White Spruce, Lodgepole Pine and undifferentiated Pine.

The results of the forest composition analysis (Table 3, Figure 6) described above show that approximately 26% of the policy area is non-forested. Of the remaining 74% of the policy area, the largest proportion (34%) is classified as pure hardwood, based on the classification scheme outlined above. Approximately 4% of the policy area is comprised of pure Pine forest and 13% is considered pure Spruce. The remaining areas are mixed-wood forests with varying dominant species.

With respect to balancing habitat conservation objectives and future land development goals, the RISA technical committee is guided by the principle of preserving the abundance of various forest and non-forest cover types within the historic range of natural variability. The RISA technical committee recognizes that appropriate variances in the area and age class composition of the major plant communities in the region provide a useful surrogate in ensuring a full suite of biota (both plant and wildlife species) is maintained. This approach is further supported by the lack of distribution and abundance maps for regional biota. In the absence of wildlife data, maintenance of the area and connectivity of the existing habitat types is the most conservative and appropriate method of protecting wildlife resources. Using stochastic disturbance (fire) models imposed on the current (2001) forest composition the RISA technical committee has developed an approximation of the range of natural variability. The range of natural variability is a measure that the RISA technical committee proposes to guide planners and developers on levels of acceptable deforestation that is within the range of what statistically would be observed if the area were permitted to undergo variation caused by natural disturbance regimes. Assessment of the range of natural variability aims to quantify the aerial range of deforestation that would be observed by natural processes and disturbance mechanisms.

While a range of abundance of habitat is an important numerical quantification of the landscape, the fragmentation of the habitat is equally important but beyond the scope of this investigation. A fragmentation analysis is a spatial quantification of the landscape. Using the GIS data available to the MD and given the boundaries of proposed new developments, it is possible to track through time the connectivity of the landscape. Further investigation into the limits of the landscape metrics for this application would be required.

While the riparian policy provides connected riparian habitat, these areas are not the exclusive habitat of all wildlife in the area. The RISA technical committee acknowledges that further work may be required on a site specific basis to ensure the preservation of connectivity of upland forested areas. The results of the range of natural variability analysis suggest that the abundance of any one cover type should range between a factor of 0.5 and 2.0 times the current conditions. This range amounts to the preservation of no less than half of the current abundance of each forest cover type and suggests that the abundance of any single cover type to more than double the current conditions is beyond the range of natural variability. The methods, principles and results of the ALCES disturbance modelling performed by Dr. Brad Stelfox are appended (Appendix II).

6. RECOMMENDATIONS

6.1 RESOURCE INVENTORY

The data gaps that exist with respect to groundwater and surface water quality and quantity within the Greater Bragg Creek policy area are the most significant concern presented by the RISA technical committee.

Groundwater is an important resource from an environmental perspective, in addition to being an important source for residential and stock water in the area. Precipitation and infiltration causes water to move through the subsurface geology to recharge aquifers, which in turn provide a recharge source for surface water bodies. Following the water cycle, contamination at the precipitation stage and especially through the groundwater stage leads to impact downstream. Without consideration to surface vegetation, contaminated precipitation, such as acid rain, can be effectively filtered through natural mechanisms during flow through appropriate hydrogeologic substrates. Examples of such filtration mechanisms are adsorption to geologic media and biologic digestion by soil organisms. Contamination to groundwater may be effectively filtered before it reaches a surface water or groundwater user, depending on the nature of the contaminant, substrate and the distance between the contaminant source and these outputs. The risk to users of groundwater and surface water increases inversely with the distance from contaminant source.

For the purposes of developing an inventory of available resources in the Bragg Creek policy area, and due to the limited and incomplete data available, it is the opinion of the technical committee that water is the most limiting resource in the area. While the area of the Hamlet is expected to be provisioned with water services, the majority of residents in other policy areas rely on groundwater for domestic and stock use. If the aim of the MD is to continue to permit residential development in the area, water resources and stresses thereof are baseline data that will assist in determining the long term sustainability of such development. While the jurisdiction of groundwater resources lies with Alberta Environment, the limited knowledge of groundwater resources with respect to the ability of the area to support further development is identified as a significant concern. It is well established in the preparation of risk matrices that where there is little known about a contributing factor, the highest risk should be assigned. In this instance, that contributing factor is water.

The committee suggests that the MD, in partnership with Alberta Environment and other local associations undertake a groundwater resource investigation and follow through with a sensitivity analysis based on the results of the investigation. As a first step, the RISA technical committee recommends that a qualified hydrogeological consultant re-examine a subset of the data used by HCL that is specific to the Greater Bragg Creek area to try to determine the groundwater quantity and quality, the different aquifers that are used to produce domestic water and the aerial extent of those

aquifers. This could be done by using the existing Alberta Environment database along with a small sample of groundtruthing.

The RISA technical committee also recommends that the MD establish a database for all future drilling. This database would contain detailed information about the lithology encountered while drilling, producing depth and lithology, analytical water quality and water quantity as demonstrated by flow rates from a proper pump test.

Groundwater is a finite resource which needs to be quantified, especially in areas such as West Bragg Creek which are likely not to be included on a municipal water system.

It is the view of the committee that permitted development within the policy area can be impacted by the availability of good quality water and a long term approach to the water budget within the area is a prudent objective for the MD. This inventory is also critical with respect to maintaining base flow conditions in the Elbow River and Bragg Creek which potentially impacts regional fisheries, important wetland and migratory bird habitat and downstream uses such as Redwood Meadows, Springbank and ultimately the City of Calgary.

6.2 SENSITIVITY ANALYSIS

6.2.1 Riparian Policy

The RISA technical committee recommends that the ultimate riparian buffer width on all surface water bodies and wetlands will not be less than the specified 30 and 50 m in width, as outlined in Appendix I. Riparian buffer adjustments above this standard width will be determined on a site-specific basis. A policy amendment is recommended whereby any proposed development activity, having potential to disturb an existing wetland or riparian areas be subject to a development permit application and review by the Municipal District and Alberta Environment to prevent degradation of existing water bodies.

6.2.2 Slope

The RISA technical committee has no recommendations with respect to slope beyond the existing planning and development standards that the MD has in place that limits development on steep slopes. It is the view of the RISA technical committee that this protocol is sufficient to prevent development on slopes of greater susceptibility to instability and deleterious environmental impacts.

6.2.3 Forest Composition

Range of natural variability

The RISA technical committee recommends the creation of a planning policy for the Bragg Creek policy area whereby the forest composition will be maintained within the range of natural

variability as outlined in Appendix II. A tally of the reduction in forest cover, by type, should be maintained as new development proposals are reviewed to ensure the abundance is within the range outlined by the RISA technical committee. This function requires that the Geomatics department at the MD, or a consultant, maintain updated GIS records of all deforestation activities within the policy area. Updated forest composition analysis will be required as new AVI data are made available by Alberta Forestry and an assessment should be undertaken to determine the maintenance of forest cover within that range over time. A future comparison between the tally maintained within the GIS and that quantified by updated AVI will indicate the success and reliability of this methodology.

7. CONCLUSIONS

The results of the resource inventory show that there are significant limitations in data completeness with respect to water availability and quality, especially in the West Bragg Creek policy area. As all developments will be dependent on good sources of water, and without a prospective servicing arrangement for this policy area, it is prudent that the MD acquire better information about this important resource.

The sensitivity analysis reveals a need for preserving connectivity of undisturbed areas, especially proximal to water bodies, which can serve a dual purpose of improving and maintaining high quality water recharge to surface water bodies and providing wildlife corridors.

The range of natural variability of forest composition has been demonstrated. A conservative approach to landscape management shows there is a need to maintain the forest composition of the policy area within a range of a factor of 0.5 to 2.0 times the current conditions. Updated forest composition data can be obtained from Alberta Forestry as they become available and updated forest composition analyses should be procured.

8. REFERENCES

Millar, J. B. 1976. *Wetland classification in western Canada*. Canadian Wildlife Service Report Series Number 37.

Municipal District of Rocky View. 2003. *Economic Development Strategy.*

Natural Resources Canada. *Geogratis*. Retrieved August 27, 2004 from http://geogratis.cgdi.gc.ca/clf/en

9. CLOSURE

This report has been prepared by Alpine, for the exclusive use of the Municipal District of Rocky View, No. 44, using generally accepted spatial analysis techniques and principles. Information was obtained while conducting an authorized investigation on the Greater Bragg Creek area in southwestern Alberta.

The material contained in this report reflects the RISA technical committees' best judgement in light of the information available at the time of preparation. The RISA technical committee has relied upon the representations or opinions of persons contacted during the preparation of this report. The accuracy of these representations and opinions will affect the accuracy of this report.

Any use which a third party makes of this report or any reliance on, or decisions to be based on this report, are the responsibility of such third parties. The RISA technical committee and Alpine accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

ALPINE ENVIRONMENTAL LTD.

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TABLE 1: AERIAL EXTENTS OF THE RIPARIAN POLICY
MUNICIPAL DISTRICT OF ROCKYVIEW - BRAGG CREEK POLICY AREA

Class	Riparian Buffer Width	Area (km^2)	Percent of total area [a] (%)
Riparian area (wetland buffer)	30 m	2.48	5.20%
Riparian area (surface water buffer)	30 m	3.62	7.59%
Riparian area (Elbow River buffer)	50 m	1.03	2.17%
Wetland area		5.54	11.62%

Notes:

Source - AVI September 2001

[a] - Total area 47.69 km^2

TABLE 2: SLOPE
MUNICIPAL DISTRICT OF ROCKYVIEW - BRAGG CREEK POLICY AREA

Class	Slope Range	Area (km^2)	Percent of total area [a] (%)
Excluded	³ 15%	12.72	26.66%
High	10 - 14% inclusive	5.85	12.27%
Medium	5 - 9% inclusive	8.58	17.99%
Low	0 - 4% inclusive	20.55	43.08%

Notes:

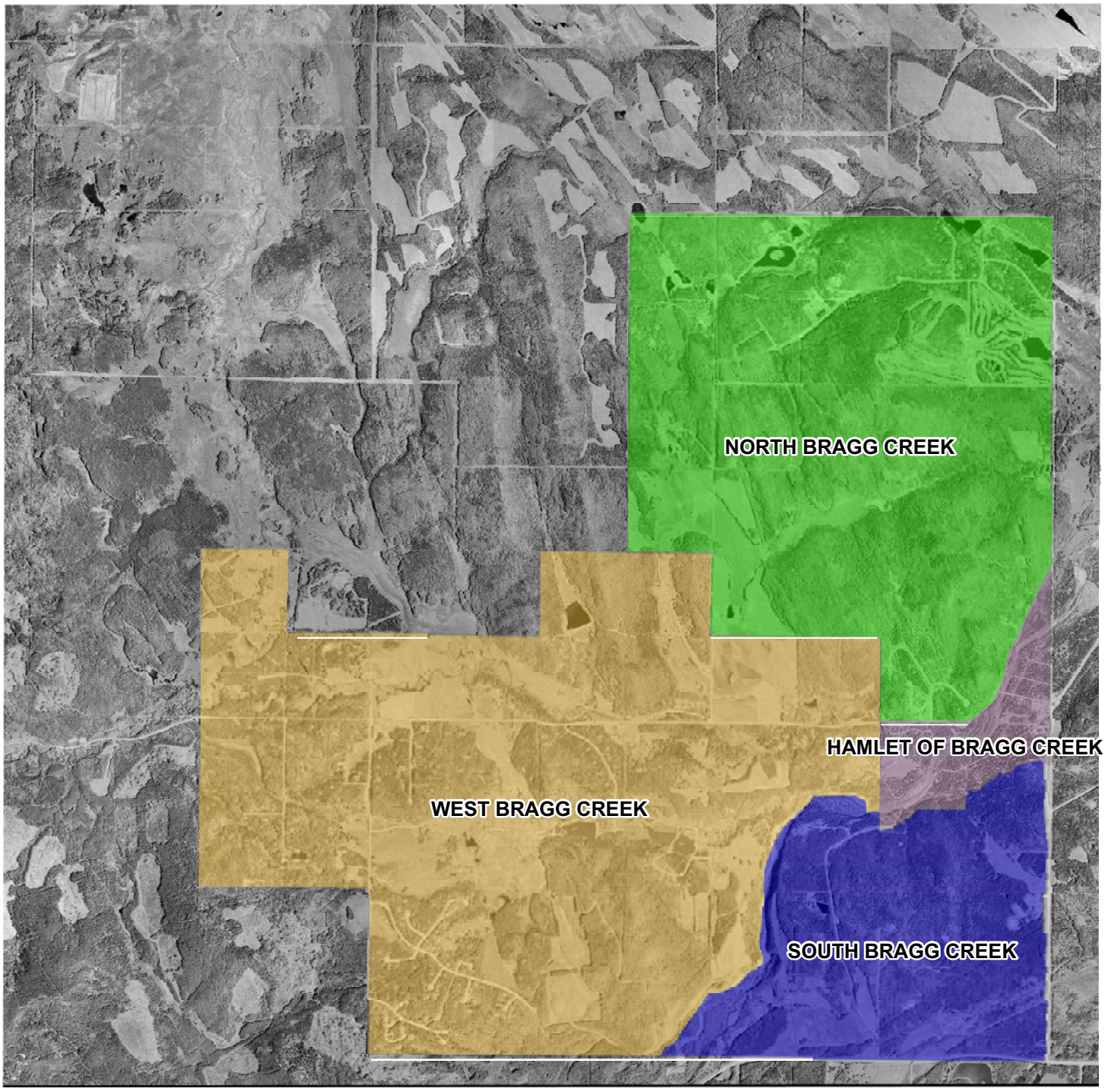
Source - AVI September 2001

[a] - Total area 47.69 km^2

TABLE 3: FOREST COMPOSITION AND PROPOSED RANGE OF NATURAL VARIABILITY LIMITS
MUNICIPAL DISTRICT OF ROCKYVIEW - BRAGG CREEK POLICY AREA

Class	Area (2001) (km^2)	Percent of total area (2001) [a] (%)	Low limit (0.5) total area (km^2)	Low limit (0.5) percent of total area [a] (%)	High limit (2.0) total area (km^2)	High limit (2.0) percent of total area [a] (%)
Pure Hardwood	16.61	34.82%	8.30	17.41%	33.21	69.65%
Pure Pine	1.84	3.87%	0.92	1.93%	3.69	7.74%
Pure Spruce	6.19	12.98%	3.10	6.49%	12.38	25.97%
Mixed - Hardwood leading Spruce or Pine	2.10	4.41%	1.05	2.21%	4.21	8.82%
Mixed - Pine leading Spruce	2.87	6.01%	1.43	3.00%	5.73	12.02%
Mixed - Spruce leading Pine	4.15	8.70%	2.07	4.35%	8.30	17.40%
Mixed - Pine leading hardwood	0.70	1.47%	0.35	0.73%	1.40	2.93%
Mixed - Spruce leading hardwood	0.83	1.74%	0.42	0.87%	1.66	3.48%
Non-forested	12.41	26.01%	6.20	13.01%	24.81	52.03%

Notes:
Source - AVI September 2001
[a] - Total area 47.69 km^2



LEGEND

- HAMLET OF BRAGG CREEK
- NORTH BRAGG CREEK
- SOUTH BRAGG CREEK
- WEST BRAGG CREEK

0 0.25 0.5 1 Kilometers

1:55,000

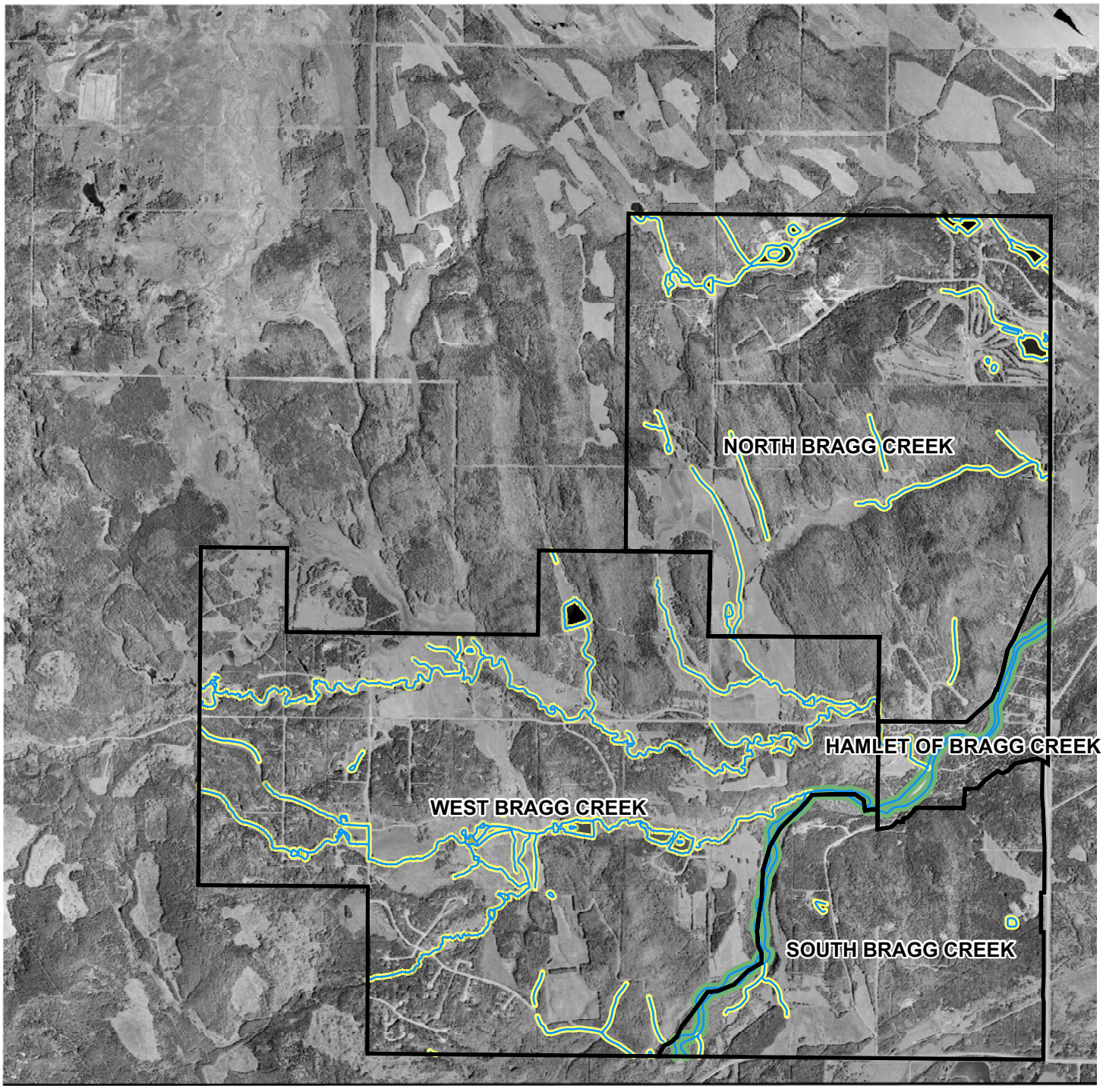
N

BRAGG CREEK POLICY AREA

NAD83 3TM CM -114
December 16, 2004
RDCF

Note: This figure was compiled from information available at the time of preparation. This information is believed to provide a reasonable representation of existing features within the Bragg Creek Policy Area of the Municipal District of Rocky View.

Figure Number
1



LEGEND

Bragg Creek Policy Areas

Surface Water

Riparian Buffer

Elbow River (50 m)

Surface Water (30 m)

0 0.25 0.5 1 Kilometers

1:55,000

N

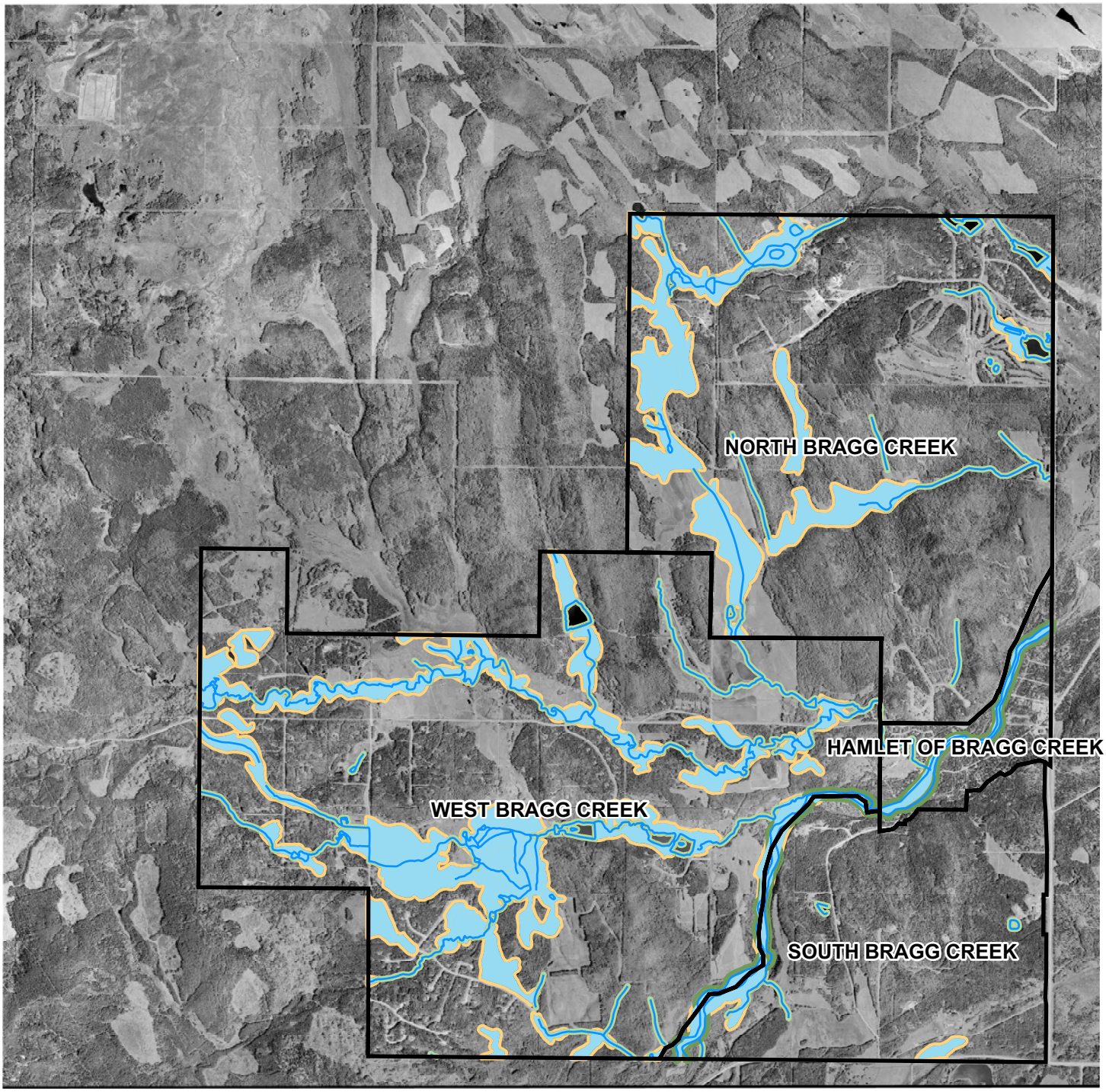
SURFACE WATER BODIES AND RIPARIAN POLICY

NAD83 3TM CM -114
December 16, 2004
RDCF

Note: This figure was compiled from information available at the time of preparation. This information is believed to provide a reasonable representation of existing features within the Bragg Creek Policy Area of the Municipal District of Rocky View.

Figure Number

2



LEGEND

- Bragg Creek Policy Areas
- Surface Water
- Wetlands

Riparian Buffer

- Elbow River (50 m)
- Surface Water (30 m)
- Wetland (30 m)

N

0 0.25 0.5 1 Kilometers

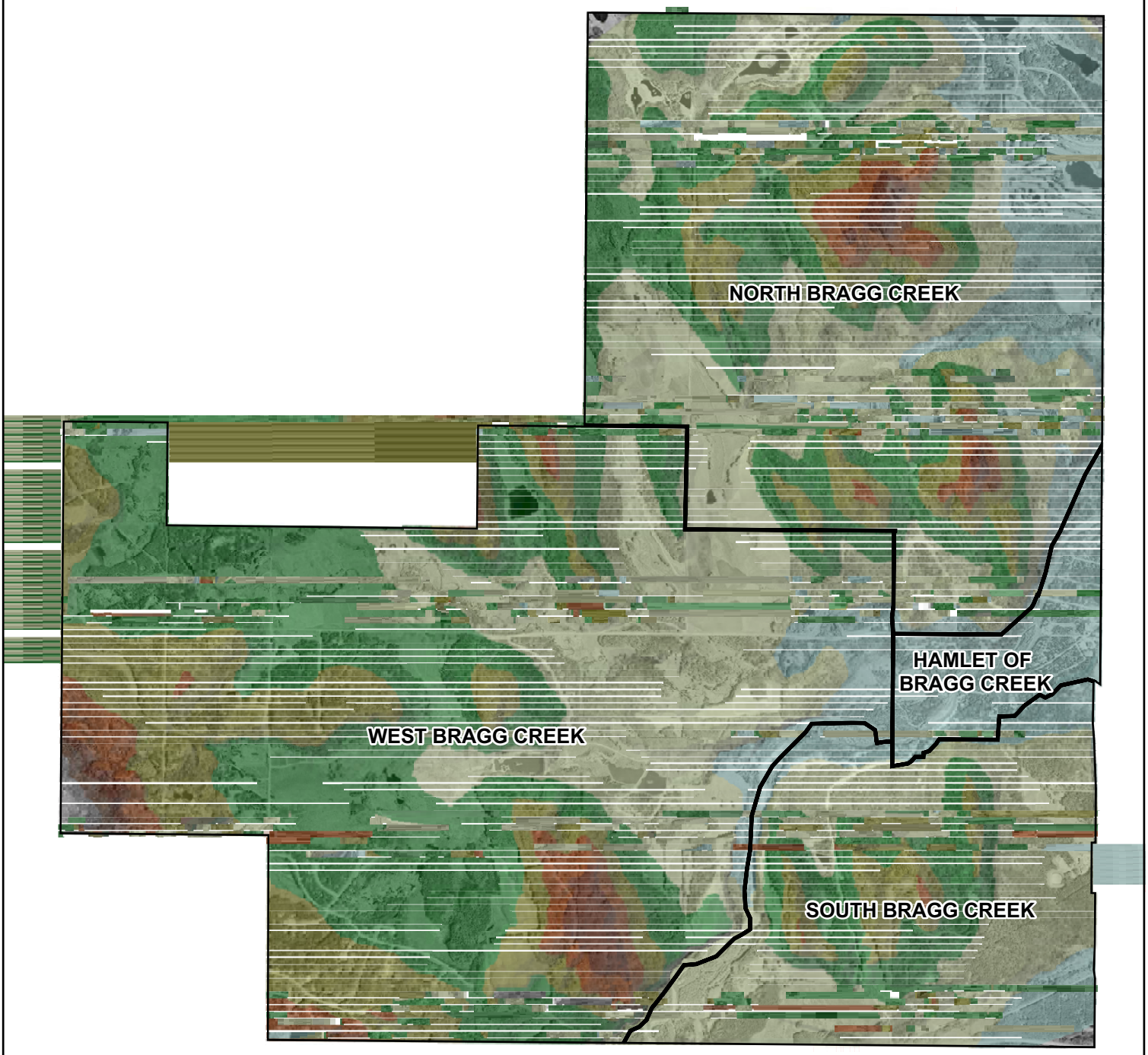
1:55,000

SURFACE WATER BODIES, RIPARIAN POLICY AND AREAS OF WET MOISTURE REGIME

NAD83 3TM CM -114
December 16, 2004
RDCF

Note: This figure was compiled from information available at the time of preparation. This information is believed to provide a reasonable representation of existing features within the Bragg Creek Policy Area of the Municipal District of Rocky View.

Figure Number 3



LEGEND

Bragg Creek Policy Areas

Elevation (m AMSL)

- 1547.778 - 1580
- 1515.556 - 1547.778
- 1483.333 - 1515.556
- 1451.111 - 1483.333
- 1418.889 - 1451.111
- 1386.667 - 1418.889
- 1354.444 - 1386.667
- 1322.222 - 1354.444
- 1290 - 1322.222

0 0.25 0.5 1 Kilometers

1:45,000

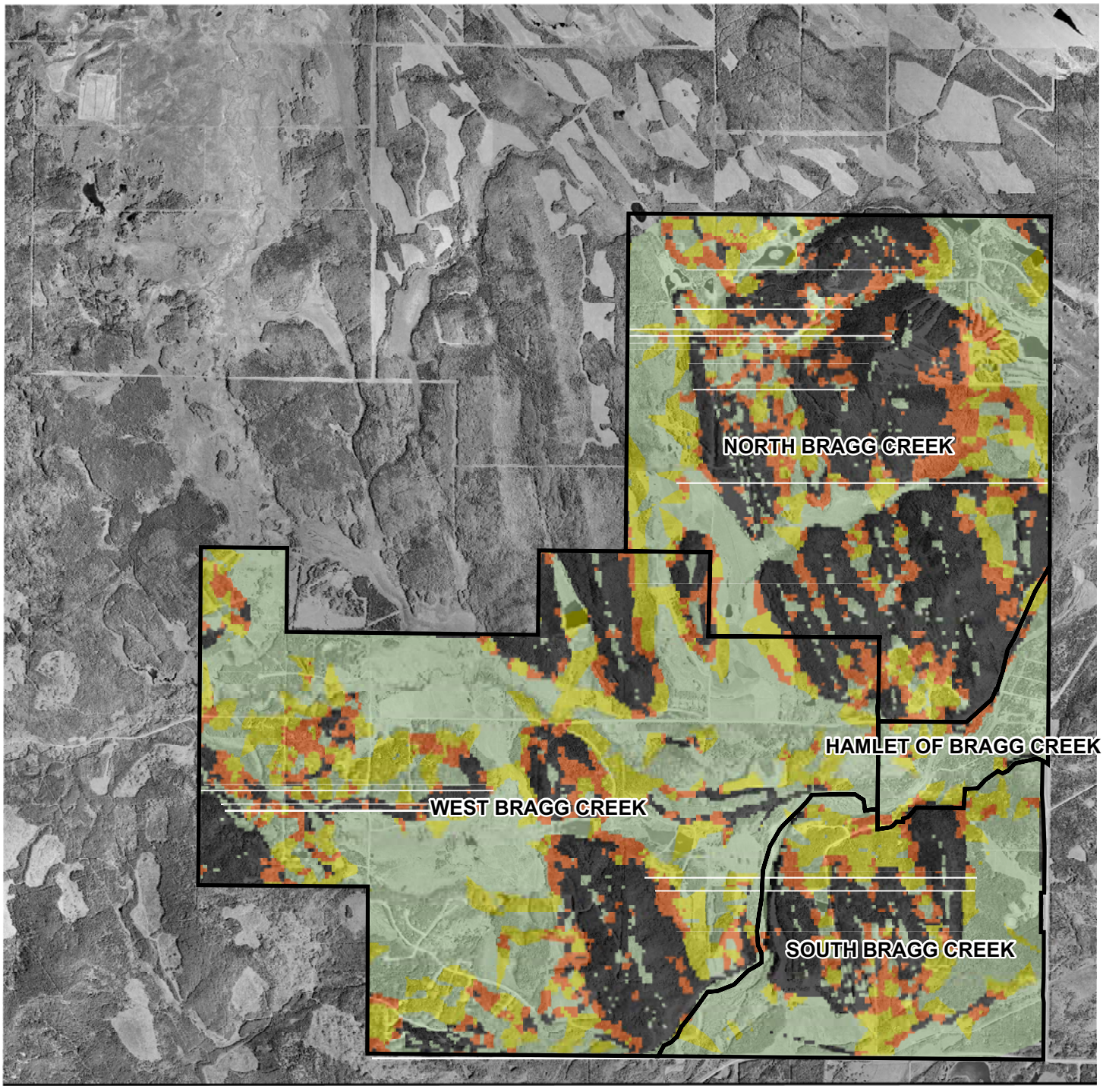
N

ELEVATION DEPICTED BY
TRIANGULATED IRREGULAR NETWORK

NAD83 3TM CM -114
December 16, 2004
RDCF

Note: This figure was compiled from information available at the time of preparation. This information is believed to provide a reasonable representation of existing features within the Bragg Creek Policy Area of the Municipal District of Rocky View.

Figure Number
4



LEGEND

Bragg Creek Policy Areas

Slope Classification

- Excluded (>/= 15%)
- High (10-14%)
- Medium (5-9%)
- Low (0-4%)

0 0.25 0.5 1 Kilometers

1:55,000

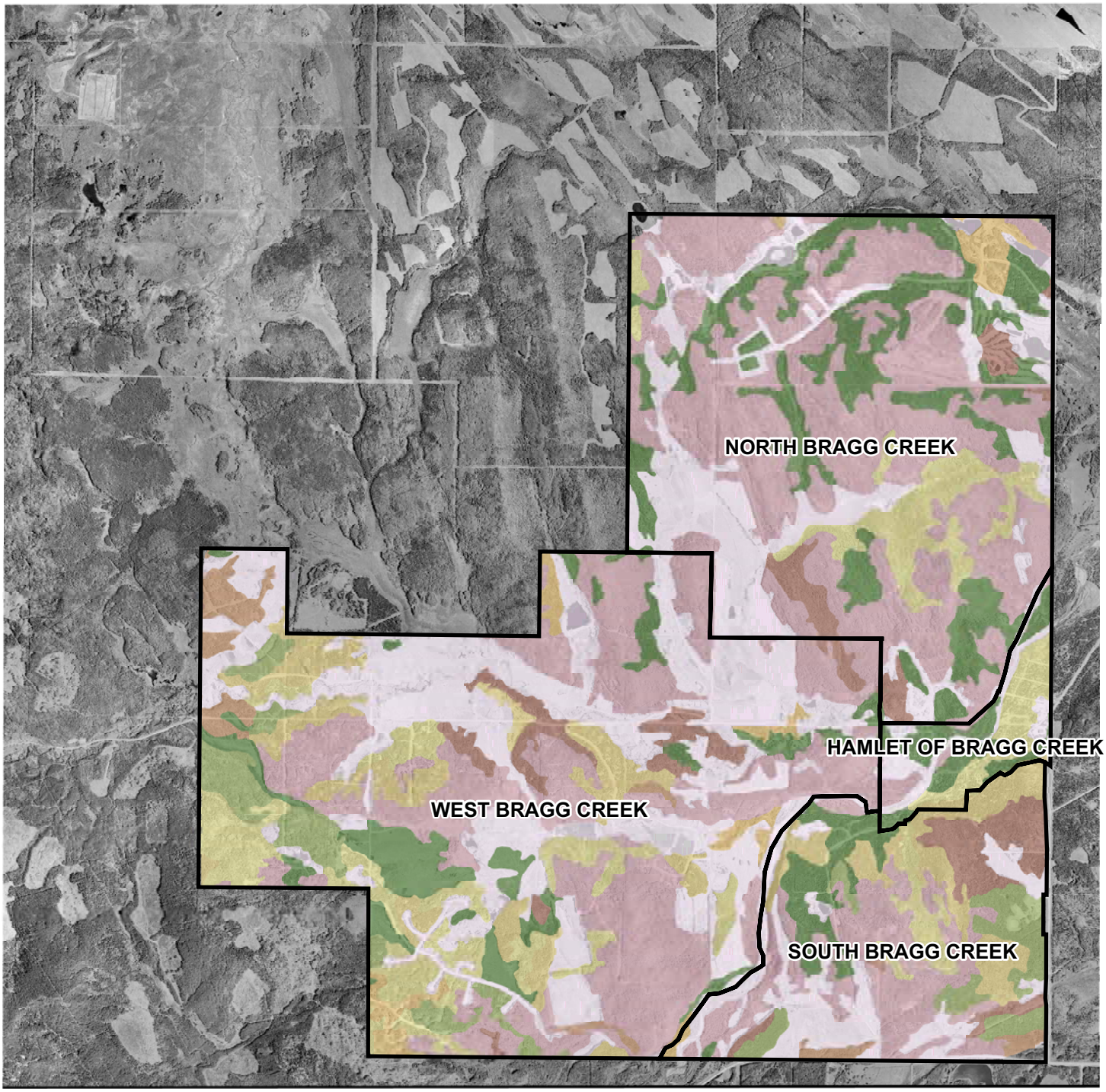
N

SLOPE CLASSIFICATION

NAD83 3TM CM -114
December 16, 2004
RDCF

Note: This figure was compiled from information available at the time of preparation. This information is believed to provide a reasonable representation of existing features within the Bragg Creek Policy Area of the Municipal District of Rocky View.

Figure Number 5



LEGEND

Bragg Creek Policy Areas

Forest Composition (AVI)*

- Pure Spruce (>80%)
- Pure Pine (>80%)
- Mixed - Spruce leading Pine
- Mixed - Pine leading Spruce
- Mixed - Spruce leading Hardwood
- Mixed - Pine leading Hardwood
- Mixed - Hardwood leading Spruce or Pine
- Pure Hardwood (>80%)
- Non-Forested

* Represents distribution based on September, 2001 Alberta Vegetation Inventory (AVI) data

0 0.25 0.5 1 Kilometers

1:55,000

N

FOREST COMPOSITION

NAD83 3TM CM -114
December 16, 2004
RDCF

Note: This figure was compiled from information available at the time of preparation. This information is believed to provide a reasonable representation of existing features within the Bragg Creek Policy Area of the Municipal District of Rocky View.

Figure Number 6

Report Conditions

GENERAL CONDITIONS

The material contained in this report reflects Alpine's best judgement in light of the information available at the time of assessment and report preparation. Alpine may have also relied on information provided by third parties for the preparation of this report. The accuracy of this report is affected by the accuracy of this information.

The reported information is believed to provide a reasonable representation of the general environmental conditions in the areas assessed. The data presented was collected at specific locations and the conditions may be different in other locations where specific information was not collected. Findings outlined in this report cannot and should not be extrapolated to areas of the site or other sites that were not specifically investigated. In addition, only those parameters specifically addressed in this report have been evaluated.

The assessment, conclusions and recommendations provided in this report are intended for the sole use of Alpine's client. Alpine is prepared to provide a one time project specific use "Letter of Reliance" to a third party at the written request of Alpine's client. When the information in this report is used or relied upon by any party other than Alpine's client, Alpine does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report, unless otherwise authorized in writing by Alpine. Any unauthorized use of this report is at the sole risk of the user.

LIMITATIONS OF REPORT

This report pertains to a specific scope of work and to a specific site, developments and adjacent land use as outlined in the report. The conclusions and recommendations set out in this report are based on specific observations, assessments and testing completed on the site.

The report is applicable for developments and land uses present during the assessment of the site. Any variation from the identified site conditions or developments and land use could necessitate additional investigation and assessment.

It should be recognized that conditions may vary across the site and with changes in seasons and these variations could affect the conclusions and recommendations made in this report. The findings, conclusions and recommendations contained in this report are time sensitive.

Alpine is not qualified to make and it is not making any recommendations with respect to the purchase, sale, investment or development of the property. These decisions are the sole responsibility of the client.

THIRD PARTY INFORMATION

During the performance of the work and the preparation of this report, Alpine may have relied on information provided by persons other than the client. While Alpine endeavours to verify the accuracy of such information when instructed to do so by the client, Alpine accepts no responsibility for the accuracy or the reliability of such information which may affect the conclusion reached in the report.

STANDARD OF CARE

Services performed by Alpine for this project have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Technical judgement has been applied in developing the conclusions and/or recommendations provided in this report. No other warranty or guarantee, expressed or implied, is made concerning the test results, conclusions, recommendations, or any other portion of this report.

ELECTRONIC REPORT FORMAT

Where Alpine submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables, the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by Alpine shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions.

The electronic reports and documents shall be used only and exactly as submitted by Alpine. Any corruption and change to the content and quality of the electronic reports and documents as a result of subsequent electronic re-transmission will be the sole responsibility of the party completing the re-transmission.

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