2008 FRUITLAND OUTCROP MONITORING REPORT

LA PLATA COUNTY COLORADO

MARCH 2009

Prepared for:

THE GROUP
Durango, Colorado

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Prepared for:

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EXECUTIVE SUMMARY

Since 1997, LT Environmental, Inc. (LTE) has conducted methane seep monitoring on the Fruitland Formation (Kf) outcrop north of the Southern Ute Indian Tribe (SUIT) Reservation boundary in La Plata County, Colorado. The study area is located along the northern rim of the San Juan Basin. The objective of the monitoring program is to observe and document the relative change in methane seepage from the Kf outcrop over time and space. In total, the scope of work provides an efficient and accurate means to characterize subsurface gas seepage, if any, in the project area by inspecting those areas with the greatest potential for seeps based on geological characteristics.

The field methods of the monitoring program include detailed methane seep mapping in known seep areas; regional reconnaissance along the entire outcrop using infrared imagery (IR) and field verification (pedestrian survey) once every three years; and a yearly survey of natural springs along the Kf outcrop.

During the 2008 monitoring event, LTE used a West Systems, LLC portable flux meter capable of detecting the presence of methane, carbon dioxide, and hydrogen sulfide at very low levels. This is the second time that the flux meter was used to conduct detailed mapping on the Kf outcrop. The area surveyed using the flux meter in 2008 was greatly increased over the previous year to include the Horse Gulch area between Carbon Junction and Florida River at the request of the Colorado Oil and Gas Conservation Commission (COGCC). Regional reconnaissance using the IR imagery, two natural spring sampling events, and an abandoned production well soil gas survey were also included as part of the 2008 monitoring event.

DETAILED FLUX MAPPING

The 2008 detailed flux mapping was performed during the period from June 2, 2008 through September 25, 2008. The 1,951 acres mapped in 2008, was substantially greater than the 554 acres mapped in 2007. The increase in mapping area was established to address observed increases in gas pressure at several COGCC monitoring wells near the Horse Gulch area of the Kf outcrop and recent requests for infill drilling directly down-dip of the Horse Gulch area.

Results of the detailed mapping activities indicate that methane continues to seep in the same areas along the Kf outcrop in La Plata County north of the SUIT boundary.

The highest individual methane mass flux value was recorded in the South Fork Texas Creek (SFTC) area. The Pine River area exhibited the highest total volumetric flux. The total estimated volumetric flux for the 1,951 acres of the Kf outcrop mapped in 2008 was approximately 5,355 thousand cubic feet per day (MCFD).

Measurable carbon dioxide flux values were recorded at 95 percent (%) of the sample locations during 2008. It is reasonable to assume that carbon dioxide seepage exists within all portions of the project area, including areas where methane seepage does not exist. Data also indicate that carbon dioxide flux values are higher in areas of measured methane seepage.

Measurable hydrogen sulfide flux values detected within the project area were very low and are not considered to be a threat to human health.

In 2007, LTE estimated the total methane flux over the entire Kf outcrop in La Plata County north of the SUIT Reservation boundary at 7,125 MCFD. This value was based on actual measurements as well as extrapolating measured fluxes to inaccessible areas due to private landowner access issues. Without the extrapolation of data, the total methane flux was estimated to be 6,120 MCFD. LTE now believes that, due to the variable nature of the methane seepage within the known seep areas, extrapolating values obtained within measured areas into areas where access was not granted is not appropriate. The uncertainty involved in this estimation method is too great and can generally provide misleading results.

In 2008, LTE increased the detailed mapped area to 1,951 acres (more than 3.5 times the previous mapping area) covering nearly all of the known active methane seepage areas in La Plata County. Therefore, with the exception of the private lands that were inaccessible, particularly in prominent active seep areas including SFTC and Pine River, substantially most of the expected flux area was deemed to be included in 2008. The total estimated volumetric methane flux for the mapped areas is 5,355 MCFD.

REGIONAL RECONNAISSANCE

Regional reconnaissance of suspect areas identified in the IR imagery was performed following the completion of detailed mapping activities in October 2008. The number of suspect areas identified during the 2008 regional reconnaissance decreased as compared to the 2005 regional reconnaissance event. This is mainly due to the incorporation of the upland area north of Basin Creek, the upland area west of Florida River, the upland areas near Vosburg Pike, the Horse Gulch areas, into the detailed flux mapping effort. In addition, LTE's ability to discern suspect areas on the IR imagery and the findings of the previous regional reconnaissance surveys have also decreased the number of suspect areas that require field verification.

Thirty-one suspect areas were identified in the 2008 IR imagery. Of the 16 suspect areas that were accessible and field-verified, none had a measureable concentration of subsurface methane. Four inspected suspect areas were co-located with 2005 suspect areas. All four of these suspect areas showed no indication of subsurface methane in 2005 and 2008. Most 2008 field observations of suspect areas indicate that stressed vegetation may be due largely to poorly developed soil conditions on the Kf outcrop.

During the course of the 2008 monitoring program, LTE was introduced to Airborne Natural Gas Emission Lidar (ANGEL) data by ITT Corporation (ITT) as a means to conduct the regional reconnaissance of the Kf outcrop for methane seepage. During the evaluation of this technology, it was determined that LTE's field methods of detailed mapping and the regional reconnaissance efforts were highly reliable and consistent with the findings of the ANGEL data.

From our assessment, it is clear that the ANGEL technology is superior to the current regional reconnaissance technology and can identify areas with the potential to exhibit methane seepage with greater ease and accuracy. But, the ANGEL technology is not without it's limitations and

has been shown to identify false positives and false negatives, is highly influenced by wind and moisture, still requires field verification, and cannot quantify the methane seepage flux rate.

ANGEL data from the entire outcrop in La Plata County have been acquired by the SUIT and may be obtained for a fee for use in confirming LTE's historic monitoring results. However, based on our observations of a portion of the ANGEL data obtained by Chevron for the western portion of the mapping area, LTE has concluded that the findings in other areas of the outcrop would likely be similar to those demonstrated over the past 10 years. It is our understanding that the ANGEL technology costs are significantly higher than those incurred using the current regional reconnaissance IR imagery method. Therefore, LTE questions the viability and usefulness of the ANGEL data to The Group.

NATURAL SPRINGS MONITORING

Six natural springs were accessible for sampling in 2008. At the request of the COGCC, the springs were sampled in both the Spring and Fall of 2008 to observe any seasonal changes in water quality that may be present. Five natural springs were sampled in June 2008, while six were sampled in October 2008. The dissolved methane concentration in each of the water samples was below the laboratory method detection limit of 0.02 milligrams per liter (mg/L). Past results of methane concentrations also indicated low or no methane in natural springs waters.

General water chemistry analyses were performed for the first time in 2008. Major ion concentrations indicate that all natural spring waters exhibit a calcium bicarbonate character.

Natural springs discharge rates were measured at the time of sampling. Discharge rates were generally low, within ranges of past measurements and without an apparent seasonal trend. One measured discharge rate was anomalously high, and may reflect an error in measurement.

During the October 2008 sampling event, subsurface soil gas was measured at three natural springs. Methane was not detected.

ABANDONED PRODUCTION WELL SOIL GAS SURVEYS

At the recommendation of the COGCC, the areas surrounding three abandoned production wells were inspected for subsurface methane. No methane was detected at any of the abandoned production wells.

RECOMMENDATIONS

Based on the results of the 2008 Kf outcrop monitoring event, LTE recommends the following:

- Conduct detailed methane seep mapping and flux estimation using the portable flux meter in June 2009. LTE will return to the sample locations visited during the 2008 field activities with the exception of the Horse Gulch mapping area. With no methane detected in additional suspect areas, the extent of flux mapping will be similar to the 2007 effort;

- Conduct natural springs sampling during Spring 2009 to continue to build the database and assess any changes in the number of springs, the flow rates, and/or the chemistry of natural springs;
- Conduct the next regional reconnaissance IR aerial survey in 2011; and
- Continue to evaluate the viability of the ANGEL technology including a cost-benefit analysis.

SECTION 1.0

INTRODUCTION

Since 1997, LTE Environmental, Inc. (LTE) has conducted methane seep monitoring on the Fruitland Formation (Kf) outcrop in La Plata County, Colorado (Figures 1A and 1B). The study area is located along the north rim of the San Juan Basin, north of the Southern Ute Indian Tribe (SUIT) Reservation boundary.

This monitoring program is being conducted on behalf of Chevron Corporation (Chevron), BP, Inc. (BP), XTO Energy, Inc. (XTO), the Colorado Oil and Gas Conservation Commission (COGCC), the Bureau of Land Management (BLM), and La Plata County. These organizations are collectively referred to as "The Group".

1.1 OBJECTIVE

The objective of the monitoring program is to observe and document the relative change in methane seepage from the Kf outcrop over time and space. In total, the scope of work provides an efficient and accurate means to characterize subsurface gas seepage, if any, in the project area by inspecting those areas with the greatest potential for seeps based on geological characteristics.

1.2 PROJECT AREA

The project area consists of approximately 23 miles of the Kf outcrop extending from the northern boundary of the SUIT Reservation near Basin Creek (southwest of Durango), northeastward to the boundary between La Plata and Archuleta Counties (Figure 1B).

1.3 BACKGROUND INFORMATION

There have been a number of previous and continuing studies, which support the overall methane seepage evaluation. Some of these studies include:

- Detailed mapping, methane seepage data collection, and mitigation in the Pine River Area by BP between 1994 and 2004;
- A reconnaissance survey by Stonebrooke in 1995, on behalf of several oil and gas operators and with assistance of the BLM. The survey consisted of over 1,100 surface and subsurface methane sample points. This survey identified four additional primary methane gas seepage areas besides Pine River, including Basin Creek, Carbon Junction, Florida River, and South Fork Texas Creek (SFTC);
- Installation of 162 permanent soil gas monitoring probes by LTE in 1997, with additional probes installed at various locations since that time, and ongoing monitoring of the points by the BLM. The probes are sampled by the BLM approximately six times per year;
- Installation and monitoring of six flux chambers in the primary seep areas from 1998 to 2005. The gas flux chamber measured gas flow on 10-minute intervals;

- Annual pedestrian reconnaissance surveys of the outcrop by LTE from 1998 through 2001;

- Flux chamber system modifications, detailed seep mapping, and infrared imagery (IR) pilot study performed in August 2002. The pilot study demonstrated that IR imagery is useful in identifying suspect areas based on vegetation impacts, which can be subsequently field verified for the presence or absence of methane;

- Detailed seep mapping in the known seep areas in October 2002, May 2003, May 2004, June 2005, May 2006, and September 2007;

- Regional reconnaissance of the 23-mile section of Kf outcrop in the project area in July 2003 and September 2005. The regional reconnaissance included the collection of infrared imagery, identification of suspect areas, and field verification;

- Natural spring survey of the 23-mile outcrop in La Plata County, north of the SUIT Reservation boundary, in September 2005, May 2006, and October 2007; and

- Private Airborne Natural Gas Emission Lidar (ANGEL) data acquisition by ITT Corporation (ITT) during the Summer 2008.

1.4 SCOPE OF WORK

The investigation scope of work included the following tasks: 1) obtaining permission to access private properties; 2) detailed seep mapping at eight key areas of interest; 3) identifying areas of distressed vegetation by aerial IR reconnaissance and field-verifying conditions in those areas; 4) monitoring natural springs in both Spring and Fall conditions; 5) measuring subsurface soil gas at three abandoned gas wells; and 6) preparing this report.

1.5 ORGANIZATION OF THE REPORT

This report is organized into eight sections, including this introduction, which presents the objectives of the study and discusses background information related to the project. The field methods and equipment are described in Section 2.0. Section 3.0 summarizes the results of the detailed flux mapping. Section 4.0 describes the results of the regional reconnaissance task The natural springs monitoring results are presented in Section 5.0. Section 6.0 presents the results of the abandoned wells soil methane monitoring. Section 7.0 presents the conclusions of this survey and recommendations. Section 8.0 lists the report references. Tables, figures and appendices follow the text in separate sections.

SECTION 2.0

DATA COLLECTION METHODS

2.1 DETAILED MAPPING

2.1.1 Flux Measurements

The flux of soil gases moving across the soil surface to the atmosphere was measured using a West Systems, LLC (West Systems) portable gas flux meter. The flux meter has been used to measure soil gas seepage on the Kf outcrop since 2007. The flux meter measures methane, hydrogen sulfide, and carbon dioxide by employing individual gas-specific sensors. The flux meter records the increases, if any, of gas concentrations over time for a given surface area. These increases are proportional to the flux of each gas. The result for each gas is reported as the mass flux in units of moles per square meter per day (moles/m^2·day). Conversion to a volumetric flux can be calculated based on the molecular weight and density of the gas. Information on the West Systems portable gas flux meter is provided in Appendix A.

The flux meter components include an accumulation chamber connected by circulation tubes to the gas detector unit. At each sampling point, the accumulation chamber was placed on the ground surface to capture gas seeping from the ground. To ensure a proper seal between the ground surface and the chamber, LTE personnel chose relatively flat surfaces where possible and placed soil around the base of the chamber to reduce the potential for gas to seep out the base of the chamber. LTE attempted to minimize ground disturbance during the measurement process in order to maintain the natural seep conditions. A fan in the chamber continuously mixes the gases in the chamber during the measurement process.

A pump moves gases in the accumulation chamber to the detector unit. After passing through the detector unit, gases are returned to the chamber. This closed loop process allows soil gases discharging to the chamber to increase over time. Any increases in concentrations are measured and recorded automatically. No gas is allowed to escape the system. A vacuum is not created during the process. This enables measurement of natural seep conditions, if present.

Flux measurement accuracy can be limited by surface conditions. One of the most important factors is the quality of the seal between the accumulation chamber base and the ground surface. In areas with heterogeneous surfaces, the seal was sometimes difficult to achieve. This scenario was evident at locations with poorly developed soil or the soil surface is obscured by decayed organic matter on the forest floor.

The methane sensor within the flux meter unit has a full-scale range of 50,000 parts per million (ppm), with a detection limit of 60 ppm. The flux meter methane measurement range is 0.2 to 300 moles/m^2·day. Methane fluxes below 0.2 moles/m^2·day are detectable and reported, although with decreased accuracy.

The carbon dioxide sensor has a full-scale range of 20,000 parts per million (ppm) by volume (ppmV) and flux measurement range of zero to 600 moles/m^2·day at an accuracy of ±25%.

The hydrogen sulfide detector has a full-scale range of 20 ppm and a flux measurement range of 0.0025 to 0.5 moles/m^2·day at an accuracy of ±25%. The sensor is an electrochemical cell that measures hydrogen sulfide through a chemical oxidation process. The sensing process consumes a small amount of the hydrogen sulfide, which is not returned to the West System's accumulation chamber. Therefore, the flux meter can underestimate hydrogen sulfide flux by as much as 10%.

During the measurement process, gas concentrations are recorded at one-second intervals and directly downloaded via Bluetooth® connection to either an Acer® 300 portable digital assistant (PDA) or a PDA integrated into the Trimble GeoXT® global positioning system (GPS) unit (described below). Other measurements recorded include barometric pressure, temperature, date, and time.

Integrated West Systems Flux Manager® software on the GPS unit recorded the gas measurement data. The software plots the curve of gas concentration versus time for each measurement collected. LTE selected the best-fit line for the curve generated. The slope of the best-fit line is proportional to the flux at the measurement point.

The flux meter was used for the detailed mapping portion of this project at eight Kf outcrop locations in La Plata County comprising 1,951 acres of land area: Basin Creek, Carbon Junction, Horse Gulch, Florida River, Vosburg Pike, Texas Creek, BP Highlands, and Pine River.

2.1.2 Subsurface Soil Gas Measurements

Traditional mapping methods using a slide-hammer, GPS, and four-gas meter were utilized during the regional reconnaissance, natural spring sampling, and abandoned well investigation phases of the project.

LTE used a Mine Safety Appliances (MSA) GasPort® multi-gas meter to measure the concentrations of methane, carbon monoxide, hydrogen sulfide, and oxygen in subsurface soil gas. The MSA GasPort® is capable of detecting methane in concentrations from 0 to 100%. Oxygen concentrations are measureable from 0 to 25%, and carbon monoxide from 0 to 1,000 ppm. Hydrogen sulfide concentrations are detectable from 0 to 100 ppm. Specifications for the meter are included in Appendix A.

Subsurface soil gas measurements were collected by using a hand-driven slide hammer to drive a ½-inch diameter steel rod into the ground to depths ranging from 1 foot below ground surface (bgs) to 3 feet bgs. Occasionally, advancement of boreholes in consolidated outcrop materials was limited. Where probe refusal occurred, measurements were taken at the depth bored.

The rod was removed from the ground and ¼-inch diameter polyethylene tubing was inserted into the borehole. The tubing was perforated at the bottom 6-inches to allow soil gas to enter the tubing. Once the temporary tubing was in place and the borehole was sealed with native soil, LTE attached the MSA GasPort® to the tubing. The meter's internal pump pulled gas from the soil, through the tubing, and into the meter's gas sensors.

LTE recorded the maximum concentrations of methane, carbon monoxide, and hydrogen sulfide; and the minimum concentration of oxygen at each sampling location. Data were recorded in the Trimble GeoXT® GPS equipment.

2.2 GLOBAL POSITIONING SYSTEM DATA MANAGEMENT

LTE used a grid mapping system to conduct the detailed seep mapping during the 2008 monitoring event. The grid mapping system has proven to be systematic, consistent, and successful in delineating the areal extent of seepage.

Mapping grids were created in ArcView® and covered all portions of the Kf outcrop in the known seepage areas. Grids for detailed mapping areas consisted of varying numbers of squares, ranging in area from 2,500 square feet (ft^2) to 40,000 ft^2. The smaller grid spacing was used to map known methane seep areas of relatively small extent.

LTE collected a flux measurement at the corner of each grid square. When methane was detected along the outer edges of the grid, additional grid points were developed and measured to determine the extent of methane seepage.

Each sample location was recorded using a GPS unit. Specifications of the GPS unit are included in Appendix A. Soil gas sampling grids were pre-loaded into the GPS unit so field personnel could quickly and accurately position detection equipment. Soil gas measurements and other relevant field data were then stored as attributes in the GPS unit along with the associated location data. The data stored in the GPS unit were later downloaded for processing and reporting.

Readings collected with the GPS unit can be located with one-meter accuracy. However, the terrain along the Kf outcrop can adversely impact GPS unit accuracy. North-facing slopes and heavily wooded areas can distort or block satellite signals. When satellite signals are limited, positioning accuracy decreases. In locations where the GPS unit could not obtain a signal, LTE field personnel noted measurement data on their field reference maps.

The GPS unit location data were collected in the World Geodetic System 1984 (WGS 84) and projected in Universal Transverse Mercator (UTM) Zone 13 North, North American Datum 1983 (NAD 83) for use in an ArcView® project file. On average, 25 GPS log points were collected for each point feature in order to obtain more accurate positioning.

2.3 REGIONAL RECONNAISSANCE

IR imagery was used to assist in the regional reconnaissance monitoring of the Kf outcrop to identify potential locations of methane seepage in between detailed mapping areas. While the imagery cannot identify specific seeps, it can be useful in identifying areas of dead and/or stressed vegetation that may or may not be attributable to subsurface soil methane.

Suspect areas are defined as areas observed within the IR image that appear anomalous when compared to the surrounding areas. For example, a light gray area surrounded by bright red areas would be considered a suspect area. The natural features that often produce such suspect areas

include areas of dead vegetation, shadows, rock outcrops, exposed surface soil, water bodies, and patches of stressed vegetation.

2.3.1 Aerial Infrared Photography

Imagery acquisition by Agro Engineering (Agro) of Alamosa, Colorado, was selected based on image quality, availability, logistical considerations, and cost. Agro conducted the image flights on June 10 and June 16, 2008**.** This time of year was selected to provide the greatest potential for healthy vegetation conditions with minimal influence from drought and/or senescence. Agro was able to accurately and completely follow the GPS flight path supplied by LTE.

The photo-mission traversed the Kf outcrop from the boundary of the SUIT Reservation in Archuleta County, through La Plata County and the SUIT Reservation, to the New Mexico state line. There were two flights at two different elevations and two different resolutions. On June 10, 2008, 144 IR images were acquired at the flight elevation of 14,500 feet above mean sea level (amsl), with an approximate resolution of 1.5 meters. Ninety-eight of these images were provided for La Plata and Archuleta Counties, and 47 images for the SUIT Reservation. On June 16, 2008, 433 IR images were acquired at the elevation of 11,000 feet asml with an approximate resolution of 0.75 meters. La Plata and Archuleta Counties were covered in 303 images, and 132 images for the SUIT Reservation.

The flight elevations were over rugged terrain with surface elevations ranging between 6,400 to 8,400 feet amsl. The interpretation and analysis for the entire outcrop was performed using the 1.5 meter resolution images since they were determined to be useful for identifying suspect areas and also required fewer images to rectify and evaluate across the entire outcrop area. Agro geo-referenced the 1.5 meter resolution photos for La Plata County and Archuleta County by creating mosaics forming two large format images.

The accuracy of a geo-rectified base map is proportional to the number of control points available and the time and effort exerted during the rectification process. Digital Ortho Quarter Quads (DOQQs) were used as the reference map and the IR image was rectified to the DOQQ. Therefore, the accuracy of the IR base map image is limited but still provides a frame of reference for the field mapping data. In some cases the IR image is accurate to within one meter of the actual location because a control point is available nearby. In certain portions of the same image, accuracy can be skewed as much as 15 meters due to lack of a control point. When viewing the data presented in this report, note that GPS data are accurate to within one meter and the actual position of the feature mapped should be trusted over the position of the features (i.e. trees, buildings, landmarks) observed within the IR image. Ultimately, this approach allows LTE to provide the required accuracy to perform the field verification while controlling project costs.

2.3.2 Imagery Review

The images acquired within the study area were evaluated by LTE using visual observations. Based on professional experience in evaluating IR imagery and knowledge gained during previous regional reconnaissance surveys in La Plata and Archuleta Counties, LTE identified suspect areas along the 23-mile Kf outcrop that appeared to contain dead or stressed vegetation. Suspect areas were delineated as polygons and uploaded to the GPS unit for field verification.

2.3.3 Field Verification

Upon completion of the imagery review activities, LTE initiated field verification of suspect areas with the goal of identifying the presence or absence of methane in subsurface soil gas. A majority of the land intersecting the Kf outcrop in La Plata County is federal land but significant portions of the outcrop and many of the key methane seepage areas are located on private lands. Due to private property considerations, not all areas of the outcrop could be inspected because landowners did not grant access to or across their properties. The 2008 status of access is summarized in Table 1.

The field verification was conducted from October 16 through October 22, 2008. The LTE field crews were equipped with the aerial photographs, topographic maps, a digital camera, boring equipment (slide-hammer), the GPS, and the MSA GasPort® unit. LTE visited each of the accessible suspect areas, and collected subsurface soil gas measurements. LTE also photographed the suspect areas and described the features observed.

2.4 NATURAL SPRINGS MONITORING

In 2005 and 2006, LTE identified eight natural springs on the Kf outcrop with the assistance of personnel from the BLM, United States Forest Service (USFS), Colorado Division of Wildlife (CDOW), and the Office of the State Engineer (SEO). A ninth spring was identified by LTE during this 2008 survey.

In 2008, LTE accessed six of the nine natural springs, collected spring water samples, and monitored for subsurface soil gases near the springs using the MSA GasPort® meter. At each natural spring, LTE located the position and elevation using the GPS. A discharge rate was measured using a graduated cylinder and stop-watch. Water quality measurements, including pH, total dissolved solids (TDS), electrical conductivity (EC), oxidation-reduction potential (ORP), and temperature were collected using a Myron L 6P Ultrameter II (Myron L). The Myron L specifications are included in Appendix A.

Water samples were collected at natural springs in sample bottles prepared by the subcontracted analytical laboratories. Each sample bottle was labeled, indicating the project and sample identification, and the date and time of sample collection. Samples were delivered directly or shipped to the laboratories under chain-of-custody controls.

SECTION 3.0

DETAILED MAPPING RESULTS

This section describes the results of the detailed flux mapping conducted from June 2, 2008 through September 25, 2008 in the eight key mapping areas. Previous soil gas mapping events were conducted in October 2002, May 2003, May 2004, June 2005, May/June 2006, and September 2007. Events through 2006 were conducted exclusively using the MSA GasPort® multi-gas meter. Beginning in 2007, the West Systems portable flux meter was used to conduct detailed soil gas mapping.

LTE conducted detailed flux mapping at eight locations of interest along the Kf outcrop in La Plata County (Figure 1B):

- Basin Creek (subdivided into Basin Creek and Basin Creek North);
- Carbon Junction;
- Horse Gulch (subdivided into Horse Gulch South, Horse Gulch Central, and Horse Gulch North);
- Florida River (subdivided into Florida River West and Florida River East);
- Vosburg Pike;
- South Fork Texas Creek (subdivided into Texas Creek, Texas Creek Central, Texas Creek East, and Texas Creek West);
- BP Highlands; and
- Pine River.

Based on a request by the COGCC, the detailed flux mapping area was expanded from the previous year to include the entire outcrop from Basin Creek to Florida River (Figure 1A). This expansion resulted in an increase in the Basin Creek North mapping area and the development of a new area labeled Horse Gulch and increased the scope of the mapping project by more than 3.5 times the area mapped in 2007.

The addition of these areas to the monitoring program was intended to confirm the presence or absence of methane seepage within areas not fully investigated during previous monitoring events. Primarily, the rationale to conduct the detailed mapping in the expanded areas was based on observations in COGCC monitoring wells located near the Horse Gulch area that show increases in gas pressures over time and a recent request by Chevron to conduct infill drilling directly down-dip of the Horse Gulch area.

LTE has reported flux measurements in this document as mass flux with the units of moles/m^2·day. Conversion to a volumetric flux in units of thousands of cubic feet per day

(MCFD) has been provided as a reference for the natural gas production industry, which typically uses volumetric flow rates. The conversion of mass flux units to volumetric flux is discussed in Section 3.9, with calculation details provided in Appendix C. Methane, carbon dioxide, and hydrogen sulfide flux measurements are summarized by Kf outcrop areas of interest in Table 2. Methane and carbon dioxide measurements are presented on Figures 2 through 29. Flux data are included as Appendix B.

Full color spectrum aerial photographs used as base maps in the figures for this report are dated 2005 and 2007 and do not necessarily indicate present surface conditions. The geologic contacts depicted on the aerial photographic maps were derived from geologic maps prepared by the Colorado Geological Survey (CGS) and digitized at a scale of 1:25,000. Accuracy of the formation contact is reduced when aerial photographs are viewed at a smaller scale.

A total of 1,836 flux measurements were collected at the eight detailed mapping areas. Methane flux was recorded at 1,178 of the 1,836 sample locations. Carbon dioxide flux was detected at 1,741 sample locations, and hydrogen sulfide flux (though barely above sensor detection limits) was recorded at 1,722 sample locations.

Detected methane flux values ranged from 0.0002 moles/m^2·day to a high of 302.7 moles/m^2·day. Carbon dioxide flux values ranged from 0.0007 moles/m^2·day at BP Highlands to a maximum 21.55 moles/m^2·day at Basin Creek. Minimum, maximum, and average flux measurements at each location of interest are summarized in Table 2. Appendix B contains the flux measurement results for each sample location.

Health and safety concerns over hydrogen sulfide have been present with regard to the seepage activity along the Kf outcrop. Elevated levels of hydrogen sulfide have been identified in the Carbon Junction and SFTC areas since the inception of the monitoring program but concentrations in the atmosphere above the ground surface have not been detected at levels that pose a risk to human health. Elevated hydrogen sulfide concentrations have been detected in the shallow subsurface soil but were found to dissipate quickly to below detectable limits above the ground surface. The source of the hydrogen sulfide detected along the Kf outcrop is believed to be from local, near surface, anaerobic microbial activity as hydrogen sulfide is not present within the coalbed methane production gas developed within the northern San Juan Basin.

The West Systems flux meter is a highly sensitive field meter capable of detecting very low flux rates of hydrogen sulfide. Thus, it is not surprising that hydrogen sulfide flux was detected at a large number (1,722) of the sampling points during the 2008 detailed mapping event. However, the majority of the flux rates measured were only slightly above the detection limit of the unit of 0.0002 moles/m^2·day. Given an accuracy of ±25%, the majority of these measured values are not considered to pose a threat to human health. Hydrogen sulfide flux values ranged from a low of 0.0002 moles/m^2·day to a high of 0.0253 moles/m^2·day. The highest hydrogen sulfide flux values, though still relatively low, were measured at SFTC.

Due to the very low values of hydrogen sulfide measured during the 2008 detailed mapping program, maps of hydrogen sulfide measurements were not deemed useful and therefore, not prepared.

3.1 BASIN CREEK

The detailed flux mapping of the Basin Creek area was conducted between August 15, 2008 and September 25, 2008. The mapping area was centered on Basin Creek just east of the recently constructed Animas-La Plata Project's Basin Ridges dam. The mapping area consisted of approximately 5.8 miles along the Kf outcrop. Figures 2 through 5 illustrate the results of the detailed mapping in the Basin Creek area. A summary of the 371 flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B.

A key finding during the 2008 monitoring event, and as a result of the expanded mapping program, was the larger extent of methane seepage in the upland area north of Basin Creek than previously identified. However, this larger extent should not be interpreted as an increase in methane seepage in comparison with the previous studies. It is likely that the seepage has been present in prior years, and possibly since the inception of the monitoring program, it has simply not been identified to the extent until now. This area has not been identified as a suspect area during the regional reconnaissance in 2005 because seepage conditions have not affected vegetation to a significant degree.

Limited seepage in this area has been detected by LTE in prior years, just not to the extent identified during the 2008 detailed mapping event because the area had not been sampled at the scale of the grid conducted in 2008. Figure 4 illustrates the location of the methane seepage in this area north of Basin Creek.

3.2 CARBON JUNCTION

The mapping area at Carbon Junction is centered on the Animas River near the Wal-Mart shopping center on Highway 160 and extended approximately 1.1 miles along the Kf outcrop. The Carbon Junction mapping area is illustrated on Figures 6 and 7.

The Carbon Junction area was mapped in several separate mapping events between June 2, 2008 and September 17, 2008. A total of 149 flux sample points were measured. A summary of the flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B.

3.3 HORSE GULCH

The Horse Gulch mapping area (the portion of Kf outcrop located between Carbon Junction and Florida River) measured approximately 3.8 miles along the Kf outcrop. This area has been added to the 2008 detailed mapping program at the request of the COGCC in response to an increased concern over the potential for seepage to be present in this large area. The Horse Gulch mapping area is shown on Figures 8 through 13.

The area was mapped between June 24, 2008 and September 23, 2008. A total of 475 flux sample points were measured. A summary of the flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B.

While methane flux was detected at 265 of the 475 measurement locations, values reported were very low. Relative to active seep areas like Carbon Junction, Florida River, SFTC, and others, Horse Gulch is not considered to exhibit methane seepage and has not exhibited methane seepage during previous regional reconnaissance and pedestrian survey monitoring events conducted since 1997.

3.4 FLORIDA RIVER

The mapping area at Florida River extended approximately 1.5 miles along the Kf outcrop. The Florida River mapping occurred between August 5, 2008 and August 14, 2008. Figures 14 through 17 illustrate the results of the flux mapping. A total of 196 flux sample points were measured. A summary of the flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B.

3.5 VOSBURG PIKE

The mapping area at Vosburg Pike is an upland portion of the Kf outcrop, located approximately half-way between the Florida River and SFTC mapping areas. The Vosburg Pike mapping area covered approximately 1.3 miles along the Kf outcrop (Figure 1). Flux mapping occurred on September 15 and 16, 2008. Figures 18 and 19 illustrate the results of the flux mapping. A summary of the flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B.

3.6 SOUTH FORK TEXAS CREEK

The mapping area at SFTC is located where the creek transects the Kf outcrop. A large alluvial grass-covered valley parallels the strike of the outcrop but eventually turns northward and transects the contact between the Kf and Kpc. The entire mapping area extended approximately 2.4 miles along the Kf outcrop (Figures 20 through 25). The main seep area within SFTC and the Ward and Kurtz properties has been designated SFTC Central (Figures 22 and 23). The seep area located approximately 0.25 miles east of the creek has been labeled SFTC East (Figures 24 and 25). The most recent flux mapping at SFTC occurred between June 27, 2008 and September 17, 2008.

A total of 406 flux sample points were measured. A summary of the flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B. A significant decrease in estimated flux was noted during the 2008 monitoring event. A detailed review of the data points indicates that this decrease is attributed to large decreases in measured flux rates at only a few measurement locations.

The seep at SFTC is considered to be one of the most active and prolific methane seeps within the project area and is currently undergoing a pilot study funded by the COGCC to evaluate mitigation technologies for the methane seepage.

3.7 BP HIGHLANDS

The mapping area at BP Highlands was added to the monitoring program following the completion of the IR regional reconnaissance mapping in 2003. The BP Highlands is an upland area west of Pine River. Over the last several years, the previous property owner had noted an increase in areas of dead vegetation and had also complained about methane in their water supply wells, which are completed in the Kf. The BP Highlands mapping area covered approximately 0.9 miles along the Kf outcrop (Figures 26 and 27). Flux mapping was performed between July 7, 2008 and July 14, 2008.

A total of 59 flux sample points were measured. A summary of the flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B.

3.8 PINE RIVER

The mapping area at Pine River is located where the Pine River transects the Kf outcrop. The mapping area covers approximately 1.1 miles along the Kf outcrop. The 2008 mapping event occurred between June 30, 2008 and July 18, 2008. Figures 28 and 29 illustrate the results of the flux mapping performed at Pine River.

A total of 122 flux sample points were measured. A summary of the flux measurements is presented in Table 2. Specific results for each sample point are tabulated in Appendix B.

The seep at Pine River is also currently undergoing a pilot study funded by the COGCC to evaluate mitigation technologies for the methane seepage.

3.9 TOTAL FLUX VOLUME ESTIMATIONS

LTE estimated the total volumetric flux of methane and carbon dioxide by combining generally contiguous areas of interest of the Kf outcrop in La Plata County. Flux data were interpolated and gridded, then contoured and processed to estimate total volumetric flux.

The results were converted to volumetric flux rates common to the natural gas production industry in units of MCFD. A discussion of the methods and calculations used to determine total methane flux is presented in Appendix C. Methane flux contour maps of areas of interest are presented in Figures 30 through 43. Carbon dioxide flux contour maps are presented in Figures 44 through 57.

The total estimated methane flux volume for the Kf outcrop in La Plata County is 5,355 MCFD. The total estimated carbon dioxide flux volume for the Kf outcrop in La Plata County is 2,313 MCFD.

3.10 HISTORICAL FLUX DATA COMPARISON

From 2007 to 2008, LTE expanded the area of detailed mapping from 554 acres to 1,951 acres, roughly 3.5 times the area of the previous survey. The increase in mapping area was due largely to the addition of the Horse Gulch area of interest. However, very little seepage was measured in

the Horse Gulch area and is therefore not considered an active seep area. The increase in mapping area in 2008 should not be construed as an increase in methane seepage area.

To assess changes in methane and carbon dioxide volumetric flux from 2007 to 2008, LTE considered only those areas of interest common to the two years: Basin Creek, Basin Creek North, Carbon Junction West & East, Florida River West & East, Vosburg Pike, SFTC Central and West, SFTC Main Seep Area, Texas Creek East, BP Highlands, and Pine River. Table 3 summarizes the changes in the seepage extent and the volumetric methane flux from 2007 to 2008.

Decreases in methane flux from 2007 to 2008 were noted in Basin Creek, Carbon Junction West, Florida River West, Florida River East, SFTC, and Texas Creek East. Increases in methane flux from 2007 to 2008 were noted in Basin Creek North, Carbon Junction East, Vosburg Pike, BP Highlands, and Pine River. As shown in Table 3, the measured flux in 2007 was 6,120 MCFD and the measured flux in 2008 over the same common areas was 4,092 MCFD. The net change for the common detailed mapping areas from 2007 to 2008 is a decrease of 2,028 MCFD or 33.1%.

Significant decreases in methane flux rates were noted in Carbon Junction West, Florida River East, and SFTC. Significant increases in methane flux rates were noted in Carbon Junction East and Pine River. A review of the data from these seep areas revealed that only a small number of the data points within the sampling grid account for the significant changes in estimated methane flux. For example, in Pine River, order of magnitude increases of mass flux at three measurement points are responsible for the four-fold increase in estimated flux from the area. The effect that these elevated values measured in Pine River have on the contoured surface and resulting flux estimate can be readily observed on Figure 43.

In 2007, LTE estimated the total methane flux over the entire Kf outcrop in La Plata County north of the SUIT boundary at 7,125 MCFD. This value was based on actual measurements as well as extrapolating measured fluxes to inaccessible areas due to private landowner access issues. After further consideration and evaluation of multiple data sets, LTE believes that extrapolating values obtained within measured areas into areas where access was not granted is not appropriate. The uncertainty involved in this estimation method is too great and can generally provide misleading results. This conclusion is supported by the significant changes in total flux estimations in areas like SFTC and Pine River where only a few measurement points accounted for the majority of the change in measured flux.

In 2008, LTE increased the mapped area to 1,951 acres covering nearly all of the known active methane seepage areas in La Plata County. Therefore, substantially most of the expected flux area was deemed to be included in 2008, with a total estimated volumetric methane flux of 5,355 MCFD. While access limitations remain in this project, particularly in prominent active seep areas including SFTC and Pine River, LTE hesitates to estimate the seepage in areas without measurements due to the high degree of uncertainty.

SECTION 4.0

REGIONAL RECONNAISSANCE RESULTS

The regional reconnaissance of the Kf outcrop has evolved since it was introduced 11 years ago. Initially, the regional reconnaissance was a pedestrian survey with the collection of surface methane concentration and qualitative observations of vegetative condition. The qualitative nature of the pedestrian survey and the subjective bias by the varying field crews over the years warranted the development of an alternative approach to monitor the far reaching extents of the Kf outcrop area, particularly those areas not exhibiting active methane seepage. The pedestrian survey program required extensive effort in areas where methane seepage was generally not occurring.

The 2005 regional reconnaissance effort included IR aerial photography and imagery review for stressed vegetation, followed by field verification with the collection of subsurface methane measurements in identified suspect areas. The 2008 regional reconnaissance included similar IR imagery review and field verification tasks as conducted in 2005. However, since 2005, the number of identified suspect areas has decreased from 105 to 31 in 2008. The number of field-verified suspect areas also decreased from 95 in 2005 to 16 in 2008. This decrease is, in part, due to an increased coverage of detailed flux mapping from 2007 to 2008. In 2008, imagery review and field verification were generally focused on areas between Florida River East and Vosburg Pike, Vosburg Pike and Texas Creek West, and east of Pine River.

This section describes the results of the 2008 aerial IR imagery reconnaissance, imagery review, and field verification activities conducted in La Plata County along the Kf outcrop. Aerial photography was conducted on June 10 and 16, 2008. Field verification of suspect areas was performed between October 17 and 22, 2008.

A key map of the aerial images is presented in Figure 58. Locations of suspect areas identified on the aerial photographs, and subsurface soil methane concentration measurements are illustrated on Figures 59 through 68.

4.1 FIELD VERIFICATION ACTIVITIES

From October 17, 2008 to October 22, 2008, LTE conducted the field verification of 16 of the 31 suspect areas. Fifteen locations that were not inspected were inaccessible due to property access issues.

Field inspection observations, including vegetation type, health and coverage, degree of slope, ground conditions, and general observations are summarized in Table 4. Photographs of many of the suspect areas taken during field verification activities are presented in Appendix D. Subsurface soil gas measurement data are presented in Appendix E.

LTE collected 69 subsurface gas concentration measurements in 15 suspect areas using the MSA GasPort® meter. Suspect area 26 could not be measured due to the impermeable rock surface.

Methane was not detected in any of the suspect areas measured. Oxygen values ranged from 19.1% to 21.0%. Hydrogen sulfide was also not detected in any of the suspect areas measured.

LTE generally observed that poor vegetation health in suspect areas was a function of surface physical conditions, such as poor soil development on coal and rock outcrops and/or steep slopes. Vegetation mortality has also been attributed to pine beetle infestation, drought, and/or normal die-back of scrub oak in past field verification events.

4.2 COMPARISON TO PREVIOUS FIELD VERIFICATION SURVEYS

Of the 16 accessible 2008 suspect areas, only 4 were coincident with the 105 suspect areas indentified on 2005 aerial IR images. With the exception of the Vosburg Pike and BP Highlands seep areas identified in the 2005 regional reconnaissance, both events did not identify methane seepage in the suspect areas.

4.2.1 Edgemont Ranch

Suspect areas 7 and 8 are located in the Edgemont Ranch area (Figure 60). Suspect area 7 is noted as a coal bed outcrop (Table 4). No methane was detected in either area in 2008. Both suspect areas were also identified and field verified in 2005. No methane was detected in 2005 at either area.

4.2.2 Texas Creek

Suspect area 16 was identified in the western portion of the Texas Creek area (Figure 62). In 2005, the same area was identified and field-verified. No methane was detected. Livestock grazing was identified as the cause of vegetation impacts. In 2008, no methane was detected in suspect area 16. The property owner reported to LTE's field crew that the location was treated with herbicide in 2006, that the herbicide has a four-year residual effect, and that the field had recently been tilled (Table 4).

Suspect area 18 was identified at the extreme eastern margin of the Texas Creek area of interest (Figure 63). Suspect area 18 was also located at the eastern-most reach of a suspect area identified in 2005. No methane was detected at suspect area 18 in either 2005 or 2008. Vegetation in suspect area 18 in 2008 was described as sparse, occurring between coal, shale, and weathered sandstone outcroppings (Table 4).

4.2.3 East of Pine River

Suspect area 30 was identified east of the Pine River area of interest, near the boundary between La Plata and Archuleta Counties (Figure 68). Suspect area 30 includes a small portion of a larger suspect area identified in 2005. No methane was detected in 2005 or 2008 in these suspect areas. During the 2008 field verification event, the area was noted as a talus pile consisting of coal bed and other debris from a nearby abandoned mine.

4.3 ALTERNATIVE REGIONAL RECONNAISSANCE TECHNOLOGY

During the course of the 2008 monitoring program, LTE was introduced to an alternative remote sensing technology called ANGEL developed by ITT. The SUIT have contracted ITT to test this technology on the northern rim of the San Juan Basin. Chevron purchased the rights to a portion of this data covering the Basin Creek, Carbon Junction, and Horse Gulch areas early in 2009 and used the remote sensing data, in conjunction with LTE's detailed mapping data, as part of Chevron's infill drilling application.

During the evaluation of this technology, it was determined that LTE's field methods of detailed mapping and the regional reconnaissance efforts were highly reliable and consistent with the findings of the ANGEL data. The evaluation indicated that the ANGEL data have some limitations as it is strongly influenced by wind conditions, moisture, has been shown to report false positives and false negatives on occasion, and cannot quantify a flux rate.

Nonetheless, the ANGEL technology provides tangible seepage screening results for surveying large areas of the Kf outcrop and identifying those areas where methane may be present and where more detailed mapping and investigation are warranted. From our assessment, it is clear that the ANGEL technology is superior to the current regional reconnaissance IR imagery technology because it can identify areas of potential methane seepage with greater ease and accuracy than the current IR imagery method.

It is our understanding that ANGEL data from the entire outcrop in La Plata County have been acquired and may be obtained from the SUIT for a fee. If the remaining ANGEL data were obtained for use in the ongoing monitoring program, it may be useful to confirm LTE's findings over the past 10 years and possibly identify small seep areas not already noted from historic monitoring results. However, LTE has concluded, based on our review of the ANGEL data provided by Chevron, that the findings in other areas of the outcrop would likely be similar to those demonstrated over the past 10 years, with only a few exceptions.

More importantly, it is our understanding that the ANGEL technology costs are significantly higher than those incurred using the current regional reconnaissance IR imagery method. So much so that LTE asserts that a detailed mapping grid on a 200-foot spacing over the entire outcrop could be performed in a more cost effective manner than using the ANGEL technology. In addition, potential seep areas identified with the ANGEL technology would still require field verification. Assuming that there is not significant gain (i.e. the identification of new seep areas) by utilizing this technology, LTE questions the viability and usefulness of the ANGEL data to The Group.

SECTION 5.0

NATURAL SPRINGS MONITORING

Nine natural springs have been previously identified on the Kf outcrop in La Plata County north of the SUIT boundary. Five of the natural springs were located in the vicinity of SFTC, two natural springs were located in the Edgemont Ranch area, one spring was located in the area west of Florida River, and one spring was located on the BP Highlands property, west of Pine River. Due to access restrictions only six natural springs were sampled in 2008.

The following natural springs were accessible for sampling in 2008:

- 6/23/08: Darwin Rather Spring #1, Darwin Rather Spring #2, Rancho Durango LTD Spring, Rancho Durango North Spring, and Hoier Spring; and
- 10/15/08: Darwin Rather Spring #1, Darwin Rather Spring #2, Rancho Durango LTD Spring, Rancho Durango East Spring, Rancho Durango North Spring, and Hoier Spring.

Locations of the natural springs are illustrated on Figures 26, 27, 42, 56, 69, and 70.

5.1 FIELD OBSERVATIONS AND MEASUREMENTS

Field observations and measurements of temperature, pH, EC, ORP, and TDS, were collected at most sampled springs. The 2008 field observations and measurements for all natural springs, including historical measurements, are summarized in Table 5. Photographs of several natural springs sampled in 2008 are included in Appendix F.

Discharge rates were measured at five natural springs sampled in June 2008, and at the six natural springs sampled in October 2008. Natural spring discharge rates, including historical data, are presented in Table 5. Rancho Durango East Spring flow was measured in October 2008 for the first time, at a flow rate of 0.19 gallons per minute (gpm). The 2008 flows at Rancho Durango LTD Spring and Rancho Durango North Spring were relatively low, yet within the range of past measurements. Measurements at Hoier Spring, estimated only once at less than 0.25 gpm, were quantified in 2008 at 0.042 and 0.031 gpm. Darwin Rather Spring #2, also only estimated in 2005 and 2006 at less than 0.25 gpm and less than 1.0 gpm, respectively, was calculated in 2008 at 0.63 gpm and 0.25 gpm. The flow measurement at Darwin Rather Spring #1 increased substantially to 9 gpm from a previous high of 1 gpm recorded in 2006 and 2007. We suspect that the high flow rate recorded may not be correct and is the result of a measurement error.

5.2 NATURAL SPRINGS SAMPLING AND ANALYSIS

In 2008, natural spring water samples were collected and submitted to Four Corners Geoscience, Inc. for analysis of dissolved methane. Samples were also submitted to Green Analytical Laboratories for general water chemistry analyses for the first time. Analytical results are presented in Appendix G.

Laboratory analytical results for dissolved methane, including historical results, are summarized in Table 6. In 2008, no methane was detected in any natural spring water samples. Historically, methane had been detected at Rancho Durango LTD Spring, Darwin Rather Spring #2, and Hoier Spring at concentrations below the 2008 methane detection limit of 0.02 milligrams per liter (mg/L).

The COGCC uses 2 mg/L as the threshold limit for methane in domestic water systems. The COGCC holds that water systems containing dissolved methane concentrations above 2 mg/L have an increased risk of desorption from the water and create potentially explosive conditions in confined spaces. Historic detected methane concentrations from La Plata natural springs have been three orders of magnitude below the COGCC 2 mg/L threshold.

Major ion chemistry of the natural springs' samples is summarized in Table 7, and presented graphically as tri-linear diagrams in Figures 71 and 72. Tri-linear diagrams are a useful tool for classifying water by major ionic species. Natural springs' waters sampled in June and October 2008 exhibit a calcium bicarbonate character. The Hoier Spring is noted for a low level of total dissolved solids and absence of sulfate.

5.3 SUBSURFACE SOIL GAS MEASUREMENTS

During the October 2008 natural springs sampling event, one subsurface soil gas measurement was collected Rancho Durango North, Rancho Durango East, Darwin Rather #1, and Darwin Rather #2 springs using the MSA GasPort® meter. Two soil gas measurements were made at the Rancho Durango LTD Spring. No measurement was made at the Hoier Spring due to instrument failure. Methane was not detected in the subsurface soil gas at any measured natural spring.

SECTION 6.0

ABANDONED WELLS SOIL GAS MONITORING RESULTS

LTE conducted subsurface soil methane monitoring using the MSA GasPort® meter at three abandoned gas well sites: Baird #1-25 (API #05-067-06568); Federal #34-1/2-34-1 (API #05-067-07514); and Pole Barn Monitor Well #1 (API #05-067-07969). Monitoring was conducted to determine whether methane seepage exists within the vicinity of the sites at the request of the COGCC.

Seventeen soil gas measurements were collected at Pole Barn Monitor Well #1 and Federal 34-1/2-34-1. Eighteen measurements were collected at Baird 1-25. Methane was not detected at any measurement point. Results are presented in Figures 73 through 75.

SECTION 7.0

CONCLUSIONS AND RECOMMENDATIONS

7.1 DETAILED FLUX MAPPING

The 2008 methane seep mapping was performed during the period from June 2, 2008 through September 25, 2008. This was the second time the portable flux meter has been used to conduct methane seep mapping. Mapping was performed at eight key areas of interest along the Kf outcrop in La Plata County north of the SUIT Reservation boundary. The detailed flux mapping program was expanded by 3.5 times the area mapped in 2007.

LTE calculated methane flux changes from 2007 to 2008 in common areas of interest in order to determine if there is any annual variation. The volumetric flux in the common areas of interest decreased from 2007 to 2008 by 33.1% from 6,120 MCFD to 4,092 MCFD. Significant changes in flux rates occurred at only a few measurement points within several of the mapping areas and account for the majority of the differences observed on a site by site basis. For example, while the volumetric flux increased substantially at Pine River (683 MCFD to 2,764 MDFD), it decreased substantially at SFTC (4,500 MCFD to 671 MCFD).

In 2008, LTE estimated the total methane flux from all of the areas mapped to be 5,355 MCFD. The total methane flux estimate from 2007 included extrapolation of data into areas where access was not granted and was calculated to be 7,125 MCFD. Without the extrapolation of data, the total methane flux was estimated to be 6,120 MCFD. LTE has concluded that given the high variability of measurements across a given seep area and the sensitivity of each measured value to the total flux estimate, extrapolation of data is not an accurate estimation method.

Carbon dioxide seepage exists within all monitored areas of interest, with greater areal extent than methane seepage. Since the focus of the detailed flux mapping program is to delineate the extent of methane seepage, it is reasonable to expect that carbon dioxide seepage may exist in locations where there is no methane seepage along the Kf outcrop. LTE calculated a total volumetric carbon dioxide flux of 2,313 MCFD in 2008.

Hydrogen sulfide flux values along the Kf outcrop were very low and most were reported only slightly above the detection limit of the flux meter. Data indicate that hydrogen sulfide is present in the subsurface at elevated levels in only a few locations. Measured values above the ground surface are very low, if not detected, and are not considered to be a threat to human health. The source of the hydrogen sulfide is believed to be local, near surface, anaerobic microbial activity. LTE did not determine the total volumetric flux of hydrogen sulfide for 2008.

The accuracy of the total flux estimation within the project area is influenced by the ability of the grid spacing system to represent the actual flux on a detailed level relative to the subsurface fracture system, coal quality, and stratigraphy within the Kf. The accuracy of the field meters also influences the flux estimation.

7.2 REGIONAL RECONNAISSANCE

Several suspect areas identified in the 2005 regional reconnaissance (the upland area north of Basin Creek, the upland area west of Florida River, and upland areas near Vosburg Pike) were recommended for, and have been included in, the flux mapping effort. In addition, the 2008 monitoring event included detailed mapping in the Horse Gulch area. As a result, the number and size of suspect areas identified in the 2008 regional reconnaissance decreased. Thirty-one suspect areas were identified in 2008. Of the 16 suspect areas that were accessible and field-verified, none had measureable concentrations of subsurface methane. Four inspected suspect areas were co-located with 2005 suspect areas. All four of these suspect areas showed no indication of subsurface methane in both 2005 and 2008. Most 2008 field observations of suspect areas indicate that stressed vegetation may be due largely to poorly developed soil conditions on the Kf outcrop.

During the course of the 2008 monitoring program, LTE was introduced to ANGEL developed by ITT as a means to conduct the regional reconnaissance of the Kf outcrop for methane seepage. During the evaluation of this technology, it was determined that LTE's field methods of detailed mapping and the regional reconnaissance efforts were highly reliable and consistent with the findings of the ANGEL data.

From our assessment, it is clear that the ANGEL technology is superior to the current regional reconnaissance IR imagery technology and can identify areas with the potential for methane seepage with greater ease and accuracy. However, the ANGEL technology has limitations and has been shown to identify false positives and false negatives, is highly influenced by wind and moisture, still requires field verification, and cannot quantify methane seepage rates.

ANGEL data from the entire outcrop in La Plata County have been acquired by the SUIT. Based on a review of the ANGEL data obtained by Chevron for a portion of the project mapping area, LTE has concluded that the findings in other areas of the outcrop would likely be similar to those demonstrated over the past 10 years. It is our understanding that the ANGEL technology costs are significantly higher than those incurred using the current regional reconnaissance IR imagery method. Therefore, LTE questions the viability and usefulness of the ANGEL data to The Group.

7.3 NATURAL SPRING SURVEY

Five natural springs were sampled in June 2008, followed by the sampling of six natural springs in October 2008. The seasonal difference in sampling times allowed LTE to assess any changes in the number of springs, the flow rates, and/or the chemistry of the natural springs. No significant seasonal differences were noted.

The Rancho Durango East Spring was apparently flowing, locatable, and sampled for the first time in October 2008. The other five natural springs (Rancho Durango North & LTD, Darwin Rather Springs #1 & #2, and Hoier Spring) had been accessible and previously sampled.

The dissolved methane concentration in each of the water samples collected during 2008 was below the laboratory method detection limit of 0.02 mg/L. These results were similar to the results of previous sample results.

Natural springs' samples were also analyzed for general water chemistry for the first time in 2008. Results of all samples indicated waters of calcium bicarbonate character.

Generally, the flow rates of the natural springs have been consistently low at 2 gpm or less (many measurements noticeably less), with an anomalously high measurement of 9 gpm noted at Darwin Rather Spring #1 in October 2008.

7.4 ABANDONED WELLS SOIL GAS MONITORING

At the recommendation of the COGCC, the areas surrounding three abandoned production wells were inspected for subsurface methane. No methane was detected at any of the abandoned production wells.

7.5 RECOMMENDATIONS

Based on the results of the 2008 Kf outcrop monitoring event, LTE recommends the following:

- Conduct detailed methane seep mapping and flux estimation using the portable flux meter in June 2009. LTE will return to the sample locations visited during the 2008 field activities with the exception of the Horse Gulch mapping area. Since no methane was detected in additional suspect areas, the extent of flux mapping will be similar to the 2007 effort;

- Conduct natural springs sampling during Spring 2009 to continue to build the database and assess any changes in the number of springs, the flow rates, and/or the chemistry of natural springs;

- Conduct the next regional reconnaissance IR aerial survey in 2011; and

- Continue to evaluate the viability of the ANGEL technology including a cost-benefit analysis.

SECTION 8.0

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TABLES

TABLE 1
PROPERTY ACCESS STATUS
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

Parcel Number	Mapping Area	Property Owner	Access Granted
Undetermined	Undetermined	ACME REALITY - DURANGO LTD	No Response
567508200326	TEXAS CREEK	BRETT CLARK	Returned
566905400806, 566905400032	CARBON JUNCTION	DURANGO CROSSING II LLC, C/O KE ANDREWS & COMPANY	No Response
567509300144, 567508400169	TEXAS CREEK	E WARD PROPERTIES NO 2 LTD, LLP	No Response
566904300003	CARBON JUNCTION	EMERY WILLMETT ETALS	No Response
567514201017	PINE RIVER	WILLIAM EARL GOMER	No Response
567508100265	TEXAS CREEK	VICTORIA ANNE HUYCK & TIMOTHY YALE DEAL	Returned
567508200328	TEXAS CREEK	RONALD L & CHERYL A & JARRETTE IRELAND	No Response
567509200167	TEXAS CREEK	H RICHARD KURTZ	No Response
566905400024	CARBON JUNCTION	LA PLATA COUNTY HUMANE SOCIETY	Returned
567514201001	PINE RIVER	VICKY A MULLINS TRUST	No Response
566733100801	CARBON JUNCTION	OAK RIDGE ENERGY INC	No Response
567514201002	PINE RIVER	CARY ALLEN RAY & MITZIE CORBIN	No Response
567514100002, 567514100015	PINE RIVER	REMMOW LAND CO LIMITED PARTNERSHIP	No Response
567514300009	PINE RIVER	HERMAN SCHUTZ, C/O LA PLATA COUNTY ASSESSORS	No Response
566907100035	BASIN CREEK	STATE OF COLORADO, BENEFIT OF DIV OF WILDLIFE	Yes
566301200139	BASIN CREEK	USA ACTING THROUGH BUREAU OF RECLAMATION	Yes
566905100003	CARBON JUNCTION	STATE OF COLORADO, DEPARTMENT OF TRANSPORTATION	Yes
567509300188, 567509400231	TEXAS CREEK	ROY VARCOE & MICHAEL GORETSKI & MARK MARION	No Response
567508100113, 567508100165	TEXAS CREEK	C GLEN & IVY K WALKER	No Response
566905400805	CARBON JUNCTION	WAL MART STORES INC, #DIVISION-STORE PROP TAX #0555	No Response
567119200267	FLORIDA RIVER	MARSHALL A. & MARY P. BEACH TRUSTEES & ZACHARIAH A. BEACH	No
567514201009, 567514201014	PINE RIVER	JOEL AND CORY LYNNE BRAME	Yes
567508300307	TEXAS CREEK	PHILIP JAMES AND LUCY T BRYSON	Yes
567514201020	PINE RIVER	JOSEPH AND HELEN CALLENDER	Yes
566905100028	CARBON JUNCTION	DONALD L CARLENO AND MARY ELIZABETH VON FELDT	Yes
566905100002	CARBON JUNCTION	CARVON LLC	Yes
566905400803, 566904200021	CARBON JUNCTION	CITY OF DURANGO	Yes
567111300824	VOSBERG PIKE	D&G INVESTMENTS	No
567509200132, 567509200284	TEXAS CREEK	RONALD C. & DARLENE A. FINCHER	Yes
567514201003	PINE RIVER	ALAN R. & GAY W. FRIEDMAN	Yes
567514201018	PINE RIVER	BRYAN F. & JULIE A. GREEN	No
567509100179	TEXAS CREEK	HARRY DILLASHAW LIVING TRUST	Yes
567508200327	TEXAS CREEK	DIANA M WILKENING AND BECKY JO HITCHCOCK	No
567509100178	TEXAS CREEK	KELLY ROBERTS PARTNERSHIP	Yes
567508400192	TEXAS CREEK	LEWIS CHRISTOPHER CHARLSIE AND PAULA LEA NYGUARD	Yes
566524100054	FLORIDA RIVER	WILLIAM AND SHERRY LOEHR	Yes
566524100806, 567118300800	FLORIDA RIVER	MACHO FAMILY TRUST	No
567514300016	PINE RIVER	GERALD D. & AVON D. MAGEE	Yes
567119200266	FLORIDA RIVER	WILLIAM BUSH AND ELIZABETH W. MARSH	No
567508400264	TEXAS CREEK	DENNIS AND DUANE McCOY	No
567110300889	VOSBERG PIKE	BARBARA DILLOW NICHOLS	Yes

TABLE 1 (CONTINUED)
PROPERTY ACCESS STATUS
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

Parcel Number	Mapping Area	Property Owner	Access Granted
567514201015	PINE RIVER	OSCAR D. & BETTY PERRY	Yes
567118400806	FLORIDA RIVER	PALMER RANCH LIMITED II	Yes
567509400065	BP HIGHLANDS	RVM LLC	Yes
567508100168	TEXAS CREEK	GREGORY R. SARAFIN	No
566524400813	FLORIDA RIVER	SUBSURFACE MACHINE & MFG INC	Yes
567508300309, 567508300308	TEXAS CREEK	WILLIAM AND ELIZABETH TULLOCH CO TRUSTEES	Yes
567119200197	FLORIDA RIVER	STEPHAN TURNER AND REGINA TURNER-ANDEREGG	No
567514400008	PINE RIVER	ROBERT H & GWENDOLYN S WILLIAMS TRUSTEES	No
567514201019	PINE RIVER	JENNIFER SUE YOUNG	Yes
567117101001	EDGEMONT RANCH	WILLIAM J. & DONNA M. HERRICK TRUSTEES	Returned
567110300887, 567110300892	VOSBERG PIKE	RISE AND WALK LP	No Response
567513300017	PINE RIVER	YIANNAKIS LINE LLC	No Response
567115200335	VOSBERG PIKE	ROBERT M. & RENEE M JT STRONG LIVING TRUST	No Response
567112100261	TEXAS CREEK	KANE RANCH LLC	No Response
567515100018, 567111200305	PINE RIVER, VOSBERG PIKE	BLM	Yes

TABLE 2
FLUX MEASUREMENTS
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

Mapping Area	Number of Sample Points	Methane Flux				Carbon Dioxide Flux				Hydrogen Sulfide Flux			
		Number of Sample Points w/ Methane	Minumum	Maximum	Average	Number of Sample Points w/ CO_2	Minumum	Maximum	Average	Number of Sample Points w/ H_2S	Minumum	Maximum	Average
Basin Creek													
Basin Creek	178	98	0.0002	18.00	0.7425	169	0.0035	10.27	0.2868	166	0.0002	0.0079	0.0018
Basin Creek North	193	132	0.0002	17.48	0.5505	193	0.0049	21.55	0.4604	191	0.0002	0.0025	0.0025
Subtotal	*371*	*230*				*362*				*357*			
Carbon Junction	149	109	0.0002	78.13	1.155	136	0.0077	7.132	0.2654	138	0.0002	0.0087	0.0018
Horse Gulch													
Horse Gulch South	132	72	0.0002	0.2068	0.0863	113	0.0099	16.60	0.5171	111	0.0002	0.0085	0.0023
Horse Gulch Central	182	114	0.0002	0.2033	0.0652	177	0.0031	1.062	0.1614	181	0.0002	0.0136	0.0026
Horse Gulch North	161	79	0.0002	0.3269	0.0802	141	0.0060	1.133	0.1867	141	0.0002	0.0098	0.0021
Subtotal	*475*	*265*				*431*				*433*			
Florida River													
Florida River West	170	144	0.0009	4.659	0.1430	156	0.0111	4.430	0.3655	151	0.0002	0.0153	0.0029
Florida River East	26	18	0.0234	0.2858	0.1023	19	0.0608	0.5677	0.247	20	0.0005	0.0164	0.0055
Subtotal	*196*	*162*				*175*				*171*			
Vosburg Pike	58	38	0.0002	1.745	0.1598	57	0.0269	2.130	0.2464	57	0.0007	0.0072	0.0028
Texas Creek													
Texas Creek West	261	170	0.0002	302.7	9.246	258	0.0086	7.474	0.5197	256	0.0002	0.0244	0.0038
Texas Creek East	145	93	0.0028	22.82	0.7375	142	0.0112	6.617	0.429	139	0.0002	0.0253	0.0032
Subtotal	*406*	*263*				*400*				*395*			
BP Highlands	59	31	0.0002	32.46	1.129	58	0.0007	1.686	0.3303	52	0.0002	0.0099	0.0028
Pine River	122	80	0.0002	210.4	5.698	122	0.0078	3.183	0.3815	119	0.0002	0.0177	0.0037
Totals	**1,836**	**1,178**				**1,741**				**1,722**			

Notes:

Flux measurements are in units of moles/square meter • day ($mol/m^2 \cdot day$)

CO_2 - Carbon dioxide

H_2S - Hydrogen sulfide

TABLE 3
COMPARISON OF 2007 AND 2008 METHANE FLUX
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

Mapping Area Name	2007		2008	
	Seepage Area (acres)	Volumetric Flux (MCFD)	Seepage Area (acres)	Volumetric Flux (MCFD)
Basin Creek	17	88	21	54
Basin Creek North	3	6	5	8
Carbon Junction West	32	493	52	93
Carbon Junction East	42	67	64	295
Florida River West	8	25	21	7
Florida River East	22	110	29	37
Vosburg Pike	14	6	16	15
SFTC Central & West	44	2,068	41	174
SFTC Main	6	2,082	4	310
Texas Creek East	19	347	16	187
BP Highlands	13	145	10	148
Pine River	80	683	75	2,764
TOTAL	300	6,120	354	4,092

Note:
MCFD - thousand cubic feet per day

TABLE 4
SUSPECT AREAS OBSERVATIONS
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

Suspect Area No.	Date Inspected	Vegetation Coverage (%)	Vegetation Comments	General Comments	Subsurface Soil Gas Measure-ments	Subsurface Soil Methane Dectected
1-7	No access to property(ies).					
7	10/20/08	40	Scrub oak and grass, healthy.	Methane sampling difficult due to hard coal beds.	5	No
8	10/20/08	15	Scrub oak, healthy.	None.	5	No
9	Not recorded				5	No
10-11	No access to property(ies).					
12	10/20/08	90	Scrub oak and grass, healthy.	None.	5	No
13-15	No access to property(ies).					
16	10/19/08	50	Weeds and grass. Property owner reports that herbicide was applied to area 2 years ago. Herbicide has a 4 year residual affect. Recently tilled	Farmer's field.	3	No
17	No access to property.					
18	10/22/08	Not noted.	Sparse vegetation between coal and shale beds.	Coal and shale bed outcrop with weathered santstone blocks. Competant beds make soil gas sampling difficult.	4	No
19	10/22/08	30	Grass and scrub oak.	Weathered sandstone with poorly developed soil, to two inches deep. Difficult to penetrate for sampling.	5	No
20	10/22/08	30	Grass and scrub oak.	Weathered sandstone with poorly developed soil, to two inches deep. Difficult to penetrate for sampling.	5	No
21-22	No access to property.					
23	10/22/08	90	Mostly grass, with scrub oak and few pines, healthy.	None	4	No
24	10/22/08	0	No vegetation within area. Surrounding area vegetation is healthy.	Coal tailings and shale beds.	3	No
25	10/21/08	50	Mostly scrub oak with new growth, healthy.	None	3	No
26	10/21/08	Not noted.		Sandstone outcrop and shale/coal beds. Could not sample competant rock.	0	not sampled/ impermeable rock
27	10/21/08	30	Type not noted, healthy.	Coal seam outcrop and shale beds.	5	No
28	No access to property					
29	10/19/08	70	Short grasses and scrub oak. No vegetation on coal, but abundant in surrounding soil.	Coal tailings.	5	No
30	10/17/08	60	Healthy vegetation.	Area is a talus pile consisting of coal bed debris and debris from a former mine.	4	No
31	10/19/08	80	Mostly grass with some scrub oak. Vegetation looks healthy, new growth on scrub oak.	None.	5	No

Notes:
% - percent
ppm - parts per million

TABLE 5
NATURAL SPRINGS SAMPLING FIELD MEASUREMENTS
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

Natural Spring Name	Date	Temperature (degrees C)	pH	Electrical Conductivity (µS/cm)	TDS (mg/L)	ORP (mV)	Flow (GPM)
Rancho Durango North Spring	5/24/2006	13.4	7.67	533.2	360.7	87	2.0
	10/8/2007	19.2	7.28	514.8	263.9	43	<0.5
	6/23/2008	19	6.93	728	510.8	51	0.38
	10/15/2008	11.4	6.9	617	401	112.8	1.5
Rancho Durango East Spring	10/15/2008	7.8	6.5	510	0.334	87.2	0.19
Rancho Durango LTD Spring	9/14/2005	14.6	8.05	494.1	338.0	66	>1
	5/24/2006	19.3	7.38	524.5	345.9	77	1.5
	10/8/2007	19.0	7.29	499.7	245.8	529	<0.25
	6/23/2008	12.4	8.02	526	376	20	0.48
	10/15/2008	12.4	7.4	561	365	126.9	1.5
Darwin Rather Spring #1	9/17/2005	10.6	7.20	479.9	329.2	59	0.50
	5/24/2006	12.3	7.76	425.9	288.4	52	1.0
	10/8/2007	15.2	8.05	399.5	210.6	55	1.0
	6/23/2008	12.6	7.34	432.0	308.9	81	Not Measured
	10/15/2008	Not Measured					9
Darwin Rather Spring #2	9/17/2005	14.4	7.50	271.4	178.3	45	<0.25
	5/24/2006	13.0	7.69	344	222.9	-62	<1.0
	10/8/2007	Not Measured					
	6/26/2008	18	7.31	261.4	180.5	76	0.63
	10/15/2008	10.9	6.9	289	188	3	0.25
Hoier Spring	5/24/2006	17.5	7.24	670.5	453.9	35	Not Measured
	10/8/2007	21.0	8.23	221.6	111.9	20	<0.25
	6/23/2008	20.8	8.2	257.0	173.0	52.0	0.042
	10/15/2008	12.33	7.78	254	165	90.4	0.031

Notes:
C - Celcius
µS/cm - microSiemens per centimeter
mg/L - milligrams per liter
mV - millivolts
GPM - gallons per minute
TDS - total dissolved solids
ORP - oxidation reduction potential
< - less than

TABLE 6
NATURAL SPRINGS SAMPLING LABORATORY METHANE CONCENTRATIONS
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

NATURAL SPRING NAME	METHANE (mg/L)				
	2005	2006	2007	2008	
	September	May	October	June	October
Rancho Durango North Spring	Not Sampled	<0.0010	<0.02	<0.02	<0.02
Rancho Durango East Spring	Not Sampled				<0.02
Rancho Durango LTD Spring	<0.0005	0.0016	<0.02	<0.02	<0.02
Darwin Rather Spring #1	<0.0005	<0.0010	<0.02	<0.02	<0.02
Darwin Rather Spring #2	0.002	0.0017	Not Sampled	<0.02	<0.02
Hoier Spring	Not Sampled	0.0017	<0.02	<0.02	<0.02

Notes:
mg/L - milligrams per liter
< - less than the stated laboratory method detection limit

TABLE 7
NATURAL SPRINGS MAJOR IONS CONCENTRATIONS
2008 FRUITLAND OUTCROP MONITORING
LA PLATA COUNTY, COLORADO

THE GROUP

Natural Spring Name	Sample Date	Cations				Anions				TDS (mg/L)
		Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Carbonate (mg/L)	Bicarbonate (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	
Darwin Rather Spring #1	6/23/2008	65.0	21.4	9.0	1.3	<10	212	39	<10	230
	10/15/2008	56.7	18.6	7.5	0.9	<10	208	34	11	230
Darwin Rather Spring #2	6/23/2008	39.3	6.1	13.6	<0.5	<10	138	19	<10	130
	10/15/2008	33.7	6.6	10.9	0.5	<10	133	16	<10	170
Rancho Durango LTD Spring	6/23/2008	79.5	20.1	16.7	0.9	<10	252	69	<10	305
	10/15/2008	69.7	17.5	14.9	1.0	<10	252	71	<10	300
Rancho Durango North Spring	6/23/2008	108	31.9	14.5	2.0	<10	332	122	<10	460
	10/15/2008	77.1	22.0	13.7	1.1	<10	276	79	<10	355
Rancho Durango East Spring	10/15/2008	60.5	12.9	14.8	0.7	<10	206	42	<10	250
Hoier Spring	6/23/2008	25.8	12.4	13.9	1.3	<10	144	<10	<10	105
	10/15/2008	23.7	11.8	13.7	1.4	<10	138	<10	<10	135

Notes:
mg/L - milligrams per liter
TDS - total dissolved solids