EXECUTIVE SUMMARY

The purpose of this study was to evaluate the concentrations of Total Phosphorus in the Park City Formation within the Upper East Canyon Creek Watershed. Soil samples collected throughout the Park City Formation were used to characterize the nature of total phosphorus occurring in the Park City Formation. Samples were collected between July 17, 2007 and October 4, 2007. In order to illustrate the Total Phosphorus concentration within the confines of the study area, an interpolation method was employed to estimate area-wide concentrations from discrete soil samples with measured values. For the purposes of this study, the simplest interpolation tool, Inverse Distance Weighted (IDW) was utilized. All soil samples collected within the Park City Formation were utilized in the concentration mapping. The results of the IDW mapping are as follows:

- The northern region of the study area (843 acres) had peak Total Phosphorus concentrations ranging between \(5,000 - 10,000\) mg/Kg;
- The southern region of the study area (289 acres) had peak Total Phosphorus concentrations ranging between \(15,000 – 20,000\) mg/Kg;
- Background samples reported a Total Phosphorus concentration range of \(110 – 890\) mg/Kg;
- Based on a RUSLE analysis, the average annual total phosphorus available from those sub-basins that intersect the Park City Formation is \(10,365\) lb/year.

The data compiled for this report indicates that the Park City Formation has significantly higher concentrations of Total Phosphorus than background levels. This higher phosphorus concentration soil could potentially be a source of Total Phosphorus to surface water drainages, tributary to East Canyon Creek. Based on the results of this study, Stantec recommends the following for future studies:

- Due to the limited number of soil samples collected for this study, it is recommended that additional soil samples be collected within the study area.
- In-stream sampling within the Park City Formation, as well as stormwater and snowmelt runoff, and dry weather sampling should be conducted to more fully determine the impact of these soils on the water quality of the East Canyon Creek watershed.
- Development within the Park City Formation should continue to implement effective soil control methods to prevent the migration of soil off-site.
1.0 INTRODUCTION AND PURPOSE OF INVESTIGATION

The East Canyon Creek is listed on Utah’s 303(d) list of impaired water bodies for total phosphorus and dissolved oxygen [UDEQ, 2000]. The Division of Water Quality (DWQ) believes that the dissolved oxygen problem is caused by excessive nutrients, principally phosphorus, in the water column [UDEQ, 2000]. The excess phosphorus may be a result of point source impacts and nonpoint source impacts (from agriculture, forestry, development activities, urban runoff, and so forth). According to the Environmental Protection Agency (EPA), phosphorus is primarily transported in surface runoff with eroded sediments because of the tendency of phosphorus to sorb to soil particles and organic matter [EPA, 1999]. Rocks and natural phosphate deposits are the main sources of natural phosphorus and the release occurs through weathering, leaching, erosion and mining. Based on water quality monitoring results by BIO/WEST Inc. in 2000, the largest anthropogenic nonpoint sources of phosphorus and sediment pollution are Ski Areas, Agriculture/Grazing, Residential Areas, and Active Construction [BIO/WEST, 2000].

Stantec Consulting Inc. (Stantec) was retained to evaluate the concentration of Total Phosphorus in the Park City Formation based on soil samples collected in the Park City Formation within the upper East Canyon Creek watershed. This was accomplished through the collection of 50 soil samples collected in areas where the Park City Formation is exposed at the surface within the boundaries of the East Canyon Creek Watershed (Watershed). The soil samples were analyzed for Total Phosphorus utilizing EPA method 6010. Figure 1 illustrates an overall site map of the area of interest within the Watershed.

The following sections describe the study area in more detail and conditions in the study region pertinent to the soil samples collected. In addition, subsequent sections will present the procedures and sampling parameters for the soil samples that were collected and the final results.

2.0 STUDY AREA

The soil samples were collected in areas where the Park City Formation is exposed at the surface within the boundaries of the Watershed. The study area is composed of approximately 1,110 acres. Figure 2 illustrates the study area, which corresponds with the location where the Park City Formation outcrops within the Watershed.

The soil samples were located based on several factors including geology, soil properties within the study area, topography and access. Six soil samples were collected outside of the Park City Formation to provide background levels of Total Phosphorus in the soil for comparison with
FIGURE 2
STUDY AREA
PARK CITY, UTAH
those soils sampled within the Park City Formation. The background soil samples were collected on soils not formed on the Park City Formation.

3.0 GEOLOGY

The Permian Phosphoria Formation contains the major phosphate deposits in the western United States [Cheney, 1957]. In Utah the Phosphoria Formation intertongues with the carbonate rocks of the Park City Formation. The Park City Formation, in the region of the study area, consists of a lower and upper Franson Member, which is separated by the Meade Peak phosphatic shale tongue of the Phosphoria Formation.

The Meade Peak Phosphatic Shale Member is composed mainly of dark colored phosphate rock, mudstone, carbonate rock and intermixtures of these types. The member is characteristically soft, thin-bedded, and brown to black. The Meade Peak Phosphatic Shale Member may also be light-colored indicating that the rock has been highly weathered. The phosphorites of the Meade Peak member are marine sedimentary deposits. The phosphate in the Meade Peak Phosphatic Shale Member is in the mineral carbonate-fluorapatite [Cheney, 1957]. Generally the Meade Peak is unexposed and characteristically forms a covered slope or saddle [Cheney, 1957]. Due to this, it proved impractical to delineate this unit on the basis of field mapping or aerial photo interpretation. Therefore, the soil samples collected in the field were utilized to characterize the concentration of total phosphorus in the Park City Formation.

The Park City Formation is overlain by the Triassic Woodside Formation, and underlain by the Weber Quartzite. The electronic geologic map data were obtained from Bryant’s 30’ x 60’ Salt Lake City Quadrangle [Bryant, 1990]. The 30’ x 60’ scale data were utilized rather than 1:24,000 scale mapping because the extent of the Park City Formation is the same at both scales. Figure 3 is a geologic map of the study area. Appendix A contains a description of the map units illustrated in Figure 3 (For more detailed map unit descriptions, please refer to Bryant, 1990).

4.0 SOILS

The soils located in the study area include the Agassiz-Rock outcrop complex, Crandall-Lucky Star-Starley complex, the Dromedary-Rock outcrop, the Horrocks-Agassiz very cobbly loams, the Manila-Henefer complex, the Parkcity-Dromedary gravely loams, and the Yeates Hollow-Henefer complex as identified by the United States Department of Agriculture (USDA). Figure 4 illustrates the location of these soils within the study area. A brief description identifying salient features of each type is illustrated in Table 1. Appendix B contains more detailed descriptions of each of these soil types provided by the USDA Soil Data Mart.
Figure 3: Geology Map of the Salt Lake City 30' x 60' Quadrangle, North-Central Utah, and Uinta County, Wyoming. Bruce Bryant, 1990.
<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Elevation (feet)</th>
<th>Mean Annual Precipitation (inches)</th>
<th>Landforms</th>
<th>Parent Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agassiz-Rock outcrop complex, 30 to 70 percent slopes</td>
<td>5,200 to 8,200</td>
<td>16 to 22</td>
<td>Mountain Slopes</td>
<td>Colluvium derived from limestone</td>
</tr>
<tr>
<td>Crandall-Lucky Star-Starley family complex, 30 to 70 percent slopes</td>
<td>7,300 to 10,800</td>
<td>22 to 35</td>
<td>Mountain Slopes</td>
<td>Colluvium derived from sandstone and limestone</td>
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<td>Dromedary-Rock outcrop complex, 30 to 70 percent slopes</td>
<td>5,800 to 10,200</td>
<td>22 to 35</td>
<td>Mountain Slopes</td>
<td>Colluvium and till derived from sandstone, shale and conglomerate</td>
</tr>
<tr>
<td>Fewkes-Yeates Hollow complex, 15 to 30 percent slopes</td>
<td>6,600 to 7,700</td>
<td>16 to 22</td>
<td>Mountain Slopes</td>
<td>Slope alluvium and colluvium derived from sandstone, quartzite and shale</td>
</tr>
<tr>
<td>Horrocks-Agassiz very cobbly loams, 30 to 70 percent slopes</td>
<td>5,600 to 8,200</td>
<td>16 to 22</td>
<td>Mountain Slopes</td>
<td>Colluvium derived from sandstone, conglomerate and andesite</td>
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<tr>
<td>Lucky Star gravelly loam, 30 to 60 percent slopes</td>
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<tr>
<td>Parkcity-Dromedary gravelly loams, 15 to 30 percent slopes</td>
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<td>Mountain Slopes</td>
<td>Slope alluvium and colluvium derived from sandstone, limestone and quartzite</td>
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<tr>
<td>Parkcity-Dromedary gravelly loams, 30 to 70 percent slopes</td>
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</tr>
<tr>
<td>Yeates Hollow-Henefer complex, 30 to 60 percent slopes</td>
<td>5,600 to 8,400</td>
<td>16 to 22</td>
<td>Mountain Slopes</td>
<td>Colluvium derived from conglomerate, sandstone and quartzite</td>
</tr>
</tbody>
</table>
FIGURE 4
SOILS MAP
PARK CITY, UTAH
5.0 TOPOGRAPHY AND SLOPE

Elevations in the study area range between 6,920 feet and 9,000 feet above mean sea level (MSL). The majority of the study area is composed of northwest facing slopes with smaller portions composed of north facing, east facing and northeast facing slopes. The percent slope in the study area ranges from 0 percent to 46%. The majority of the study area is at a 12-26% slope with the remainder of the study area primarily at a 26% to 46% slope. Figure 5 illustrates the slope in the study region and within the Watershed.

6.0 SAMPLING PROCEDURES

6.1 SAMPLING LOCATIONS

Samples were collected between July 17, 2007 and October 4, 2007. Originally, 50 soil samples were to be collected with forty samples to be collected within the Park City Formation, six (6) background samples to be collected outside the Park City formation, and four (4) samples to be reserved for duplicate samples as part of the quality assurance/control procedures.

Upon completion of field operations, a total of 52 soil samples were collected for analysis. Forty-one (41) samples were collected from the Park City Formation. Sample #35 collected on July 17, 2007 was not numbered correctly and was not utilized in the analysis, because its field location did not appear to correspond to the numbered location. A new sample #35 was collected on July 27, 2007 to ensure that the sample location was accurately field mapped. Sample #29 was also not utilized in the analysis because after plotting its field location it was found that the sample did not lie within the Park City Formation.

Seven (7) background soil samples were collected. Upon completion of field operations, it was determined that “Back 2” was not collected from the Nugget Sandstone Formation and was therefore not utilized in the analysis. A new background sample (New Back) was collected in an exposed outcrop of the Nugget Sandstone on July 27, 2007. Four (4) samples were reserved for duplicate samples.

The background samples were collected from soils not formed on the Park City Formation. Two of the three background soil samples at PCMR were located within the Thaynes Limestone and one was located within the Woodside Formation. Two of the three background soil samples at the Canyons were located within the Nugget Sandstone and one was located within the Upper member of the Ankareh Formation.
FIGURE 5
SLOPE MAP
PARK CITY, UTAH
Rather than selecting soil sample locations based on a systematic sample scheme where samples are taken at regularly spaced intervals in all directions, sample locations were selected based on soil type, slope, aspect and ultimately access issues. Based on the conditions encountered during field work operations, some soil sample locations were altered due to site access issues. All final soil sample locations were surveyed in the field using a handheld consumer grade GPS receiver. The final location of the soil samples and background samples are illustrated on Figures 6 and 7.

6.2 FIELD SCREENING AND SAMPLING PROCEDURES

The following procedures were conducted during sampling events:

- Prior to and between soil sample collections, a shovel or other digging device used to collect the soil samples was cleaned with de-ionized water.

- The soil samples were collected in native soils at a depth of approximately six inches below the ground surface.

- The soil was collected by scooping sufficient quantities into zip-lock baggies with disposable plastic spoons. The samples were appropriately labeled with location, date, time, and sampler name prior to collection.

- The soil samples were transported under chain-of-custody documentation to ChemTech Ford Laboratories.

Field Data Sheets were maintained for each sample collected. Copies of the data sheets are provided in Appendix C.

6.3 QUALITY CONTROL/QUALITY ASSURANCE

As stated previously, a duplicate sample was analyzed from four soil samples as part of the quality assurance/quality control (QA/QC) procedures. The duplicate samples were obtained from the original grab samples and were stored, transported and analyzed in the same manner as the original samples.

7.0 RESULTS

7.1 ANALYTICAL LABORATORY RESULTS

The analytical laboratory results of the soil samples are presented in Table 2. Figures 6 and 7 illustrate the final locations of the 40 soil samples and the 6 background samples and the total phosphorus concentrations. Copies of the analytical laboratory results and chain of custody documentation are attached in Appendix D.
Ankareh 614 ppm
Nugget 2 110 ppm
Nugget 1 226 ppm
Back 2 4550 ppm

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Salt Lake City, Utah
84107-2540
Tel. 801.261.0090
Fax 801.266.1671
www.stantec.com

Legend

Streams
Soil Samples
Background Soil Samples
Background, Outlier
Study Area
East Canyon Watershed
County Boundary

MOUNTAINLAND ASSOCIATION
OF GOVERNMENTS
PHOSPHATE DEPOSIT MAPPING

FIGURE 6
SAMPLE LOCATIONS
NORTHERN STUDY AREA

1 inch equals 2,000 feet
FIGURE 7
SAMPLE LOCATIONS
SOUTHERN STUDY AREA
TABLE 2
TOTAL PHOSPHORUS ANALYTICAL LABORATORY DATA

<table>
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<tr>
<th>Sample ID</th>
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<th>Easting (feet)</th>
<th>Elevation (feet)</th>
<th>Total Phosphorus (mg/Kg)</th>
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</table>

*Sample 29 was not utilized in subsequent analysis because it was not collected within the Park City Formation.
*Sample 35 collected on July 17, 2007 was incorrectly labeled and not utilized in subsequent analysis.
Datum and Projection: NAD 1983, UTM Zone 12N
Duplicate sample identification numbers are italicized.
A summary of the results of Total Phosphorus in the soil sampled within the Park City Formation is as follows:

- Average concentration - 4,997 mg/Kg
- Minimum concentration - 750 mg/Kg
- Maximum concentration - 17,100 mg/Kg
- Background concentration ranged between 110 mg/Kg - 890 mg/Kg.

The QA/QC duplicate samples collected all had concentrations within 15% of their original grab sample indicating moderately good laboratory accuracy.

7.2 TOTAL PHOSPHORUS SOIL CONCENTRATION MAPPING

The soil samples collected in the field have been utilized to characterize the Total Phosphorus concentration of the Park City Formation in the study area. An isoconcentration layer of Total Phosphorus concentration was generated by interpolation based on a limited set of soil samples that were collected in the field. Isoconcentration contours were generated to illustrate sets of lines of equal total phosphorus concentration within the study area.

In order to generate a layer illustrating the total phosphorus concentration within the confines of the study area, an interpolation method had to be employed. For the purposes of this study, the simplest interpolation tool, Inverse Distance Weighted (IDW) was utilized. The IDW interpolation estimates values for each cell using the value and distance of nearby points. The interpolated values for the IDW layer are a weighted average of the values of a set of nearby points, weighted so the influence of nearby points is greater than that of distant points. IDW interpolation explicitly assumes that sampling points that are close to one another are more alike than those that are farther apart.
It is important to note that the best results from IDW are obtained when sampling is sufficiently dense with regard to local variation. If the sampling points are sparse, the results may not sufficiently represent the desired layer. Therefore, the layer generated for this study is based on the samples collected, but the actual concentrations of total phosphorus may vary in ways that are not represented by the mapped results. It would be extremely valuable to collect additional soil samples within the study area to further refine the layer illustrating the concentration of total phosphorus in the soil. The IDW method was employed within a Geographic Information System (GIS). The Spatial Analyst extension was utilized within ESRI’s ArcGIS software to interpolate a layer based on the soil samples collected.

A second family of interpolation methods consists of geostatistical methods such as kriging, which include autocorrelation. Kriging was not utilized in this analysis because it assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the layer, which did not prove to be the case when the data were explored within a geostatistical framework. Although kriging is often used in soil science and in geology, the sample points were not dependent or spatially autocorrelated, indicating that a prediction layer using kriging was not appropriate for this analysis. If additional samples are collected in the future, the use of geostatistical methods may be more appropriate than deterministic interpolation methods.

All soil samples collected within the Park City Formation were utilized in the concentration mapping. Figures 8 and 9 illustrate the layer generated by the IDW interpolation and the resulting isoconcentration contours illustrating total phosphorus concentration (mg/Kg).

### 7.3 REVISED SOIL LOSS EQUATION

The Revised Soil Loss Equation (RUSLE) was utilized to estimate the average annual erosion expected within each of the study areas and to ultimately estimate the annual loading of Total Phosphorus from the Park City Formation at each resort. This formula includes a soil loss factor based upon vegetated coverage. Only those areas within the Park City Formation were estimated.

The erosion rate for a given site results from the combination of many variables [USDA, NRCS, 1998]. The RUSLE computes the average annual erosion expected on a slope as:

\[
A = R \times K \times LS \times C \times P
\]
Legend
- Study Area
- East Canyon Watershed
- Soil Sample Locations
- Background Soil Samples

IDW Surface of Total Phosphorus Concentration (mg/Kg)
- 0 - 1,000
- 1,000 - 5,000
- 5,000 - 10,000

Geologic Units
- Mahogany Member of Ankareh Formation
- Nugget Sandstone
- Park City Formation and related rocks
- Thaynes Limestone
- Till of Pinedale age
- Twin Creek Limestone
- Upper member of Ankareh Formation
- Woodside Formation

NORTHERN STUDY AREA

Client/Project
MOUNTAINLAND ASSOCIATION OF GOVERNMENTS
PHOSPHATE DEPOSIT MAPPING

Figure No. 8

IDW LAYER OF TOTAL PHOSPHORUS
NORTHERN STUDY AREA

1 inch equals 800 feet
Title

MOUNTAINLAND ASSOCIATION OF GOVERNMENTS

PHOSPHATE DEPOSIT MAPPING

Figure No.

IDW LAYER OF TOTAL PHOSPHORUS SOUTHERN STUDY AREA

Legend

- Resort Boundaries
- Study Area
- East Canyon Watershed
- Streams
- Soil Sample Locations
- Background Soil Samples

IDW Surface of Total Phosphorus Concentration (mg/Kg)

- 0 - 1,000
- 1,000 - 5,000
- 5,000 - 10,000
- 10,000 - 15,000
- 15,000 - 20,000

Geologic Units

UNITNAME

- Artificial fill
- Outwash deposits of Pinedale age
- Park City Formation and related rocks
- Thaynes Limestone
- Weber Sandstone
- Woodside Formation

Graphic Scale

1 inch equals 600 feet
Where:

\[
A = \text{computed spatial average soil loss and temporal average soil loss per unit of area (usually tons/acre/year)}
\]

\[
R = \text{rainfall-runoff erosivity factor}
\]

\[
K = \text{soil erodibility factor}
\]

\[
L = \text{slope length factor}
\]

\[
S = \text{slope steepness factor}
\]

\[
C = \text{cover-management factor – the ratio of soil loss from an area with specified cover and management to soil loss from an identical area in tilled continuous fallow}
\]

\[
P = \text{support practice factor}
\]

The study area was subdivided into areas which contributed to the Threemile Canyon, Upper Spring Creek, Willow Draw, and Treasure Hollow sub-basins within the Watershed. The sub-basins were further subdivided into those contributing areas that fell within the Park City Formation and those contributing areas that fell outside the Park City Formation. The sub-basins were divided in this way in order to characterize the percentage of influence that the phosphorus concentration within the Park City Formation has on the overall phosphorus concentration within each of these sub-basins. Figures 10 and 11 illustrate the way the sub-basins were divided. Appendix E contains a spreadsheet illustrating how the values for each of the variables were generated.

The average annual soil loss in lb/acre/year for each contributing area was calculated. An arithmetic average total phosphorus concentration (ppm) for each contributing area was calculated utilizing the soil samples which fell within each area. Because no samples were actually collected within Contributing Area B in Threemile Canyon, an arithmetic average of the background samples collected in the Willow Draw sub-basin were utilized. This was done because the background samples collected in the Willow Draw sub-basin were collected on soils formed on nearly the same formations as those that fall within Contributing Area A of Threemile Canyon. Because no samples were collected within Contributing Area B in Upper Spring Creek, an arithmetic average of the background samples collected in the Willow Draw sub-basin were utilized. This was done because the background samples collected in the Willow Draw sub-basin were collected on soils formed on the same formations as those that fall within Contributing Area B of Upper Spring Creek. No samples were collected within Contributing Area A of the Upper Spring Creek either. An arithmetic average of total phosphorus concentration of the nearest samples within Threemile Canyon was utilized for this sub-basin.

The average phosphorus concentration was converted from ppm to pounds per dry ton of phosphorus. The pounds per dry ton of phosphorus were then multiplied by the average annual soil loss (tons/acre/year) to obtain the average annual phosphorus in lb/acre/year. This was
CONTRIBUTING AREAS FOR RUSLE CALCULATIONS WITHIN THREEMILE, UPPER SPRING CREEK, AND WILLOW DRAW
CONTRIBUTING AREAS
FOR RUSLE CALCULATIONS
WITHIN TREASURE HOLLOW

Legend

Flow Direction
Streams
East Canyon Watershed
Treasure Hollow Sub-basin
Treasure Hollow Sub-basin
Contributing Areas

Graphic Scale
1 inch equals 600 feet

Client/Project
MOUNTAINLAND ASSOCIATION
OF GOVERNMENTS
PHOSPHATE DEPOSIT MAPPING

Figure No.
11

Title
CONTRIBUTING AREAS
FOR RUSLE CALCULATIONS
WITHIN TREASURE HOLLOW
then multiplied by the area of influence (acres) to obtain the average annual total phosphorus in lb/year for each contributing area. Table 3 below illustrates the final results of this analysis.

### Table 3
**RUSLE Results**

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Contributing Area&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Land Area (acres)</th>
<th>Average Annual Total Phosphorus (lb/yr)</th>
<th>Average Annual Total Phosphorus per Subbasin (lb/yr)</th>
<th>Percentage of Phosphorus Load attributable to the Park City Formation Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willow Draw</td>
<td>A</td>
<td>137</td>
<td>1634.07</td>
<td>3724.91</td>
<td>75%</td>
</tr>
<tr>
<td>Willow Draw</td>
<td>B</td>
<td>137</td>
<td>1162.75</td>
<td>1162.75</td>
<td></td>
</tr>
<tr>
<td>Willow Draw</td>
<td>C</td>
<td>1,380</td>
<td>928.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three Mile</td>
<td>A</td>
<td>501</td>
<td>2268.74</td>
<td>4494.54</td>
<td>50%</td>
</tr>
<tr>
<td>Three Mile</td>
<td>B</td>
<td>1,673</td>
<td>2225.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Spring Creek</td>
<td>A</td>
<td>63</td>
<td>498.77</td>
<td>641.96</td>
<td>78%</td>
</tr>
<tr>
<td>Upper Spring Creek</td>
<td>B</td>
<td>312</td>
<td>143.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasure Hollow</td>
<td>A</td>
<td>123</td>
<td>458.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasure Hollow</td>
<td>B</td>
<td>34</td>
<td>301.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasure Hollow</td>
<td>C</td>
<td>62</td>
<td>297.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasure Hollow</td>
<td>D</td>
<td>60</td>
<td>197.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasure Hollow</td>
<td>E</td>
<td>201</td>
<td>129.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasure Hollow</td>
<td>F</td>
<td>146</td>
<td>118.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup>The Contributing Areas featured in bold are located within the Park City Formation.

As illustrated in Table 3, the percentage of phosphorus attributable to the Park City Formation in these sub-basins of the Watershed is greater than 50% in all four cases. However, it is important to note that this analysis assumes that all of the phosphorus in the soil is soluble and could be transported to the Watershed in a storm water event. This is likely not the case. Only a portion of the total phosphorus in the soil is soluble and thus available for transport. Therefore, this analysis has been performed to provide a basis for determining the impact that the phosphorus in the Park City Formation has on the total amount of phosphorus available from these sub-basins to the Watershed.
8.0 SUMMARY AND RECOMMENDATIONS

Soil samples collected throughout the Park City Formation were used to characterize the amount of total phosphorus occurring in the Park City Formation. Samples were collected between July 17, 2007 and October 4, 2007. Six background soil samples were collected outside of the study region to provide a background level of total phosphorus. These background samples were collected from soils not formed on the Park City Formation. Another four soil samples were collected for duplicate samples as part of the quality/assurance quality control procedures. The final laboratory analytical results are illustrated in Table 1.

In order to generate a layer illustrating the total phosphorus concentration within the confines of the study area, an interpolation method was employed to create a continuous surface from discrete soil samples with measured values. For the purposes of this study, the simplest interpolation tool, Inverse Distance Weighted (IDW) was utilized. All soil samples collected within the Park City Formation were utilized in the concentration mapping. The results of the IDW mapping are as follows:

- The northern region of the study area had a peak concentration between 5,000 - 10,000 mg/Kg;
- The southern region of the study area had a peak concentration between 15,000 – 20,000 mg/Kg;
- Background samples reported a Total Phosphorus concentration range of 110 – 890 mg/Kg;
- Based on a RUSLE analysis, the average annual total phosphorus available from those sub-basins that intersect the Park City Formation is 10,365 lb/year.

It appears that the Park City Formation has significantly higher concentrations of Total Phosphorus than background levels. This higher phosphorus concentration soil could potentially be a source of Total Phosphorus to surface water drainages, tributary to East Canyon Creek. However, it must be recognized that the study area represents approximately 1% of the entire East Canyon Creek Watershed, and therefore may not be significant. Based on the results of this study, Stantec recommends the following for future studies:

- The layer generated for this study is based on the samples collected, but the actual concentrations of Total Phosphorus may vary in ways that are not represented by the mapped results because of the limited number of sample points. It would be extremely valuable to collect additional soil samples within the study area to further refine the Total Phosphorus concentration within the Park City Formation.

- Water quality samples should be collected throughout sections of streams that flow through the Park City Formation prior to and after storm events to more fully determine the impact of these soils on the water quality of the East Canyon Creek watershed.
Parameters to be measured should include Total Phosphorus, Dissolved Phosphorus, and Total Suspended Solids. Additional monitoring may include dry weather conditions, stormwater runoff and snowmelt runoff.

- Development within the Park City Formation should continue to implement effective soil control methods to prevent the migration of soil off-site.
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