For Ty Civil
1923 W Fairview
Spokane, WA 99205
Cell: 509-209-7455
email: 4TyCivil@gmail.com

STORMWATER DESIGN REPORT

FOR

Liberty Lake Retail

Liberty Lake, WASHINGTON

Prepared: September, 2016

By: Danny Patterson, P.E.

Appendix 1

Appendix II

Appendix III

Appendix IV

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Basis of Design of Stormwater System

1.0 Introduction

The intent of this design report is to summarize the storm drainage design for the new Liberty Lake Retail building at 21801 E Country Vista Dr., in the city of Liberty Lake. The entire project site is approximately 1.29 acres in area. The proposed building will be facing north and has access from the Home Depot parking lot. The site lies within the city of Liberty Lake, in Spokane County, Washington. See Appendix I for a Project Location Map.

The existing site is generally sloped from North to South. It is currently empty. See Appendix II for the pre-development site map. The storm water report has identified the 10-year event for the development area. The handling of the run-off associated with this event will be divided into 3-parts. Part 3 will be the frontage and public side walk along Country Vista that resides in the easement. It will continue to be treated stored and disposed of in the road side swales. Part 2 will be the Roof of the proposed building. The roof drainage will be captured and piped directly to an onsite drywell. Finally part 1 will be captured and directed with catch basins, pipes and grading to the offsite swale (Swale "C")to the west which has been designed for this development. The report has identified potential post-development runoff based on anticipated lot coverage of buildings, parking and landscape.

Storm drainage system (i.e. type "A and B" drywells and grassed percolation areas (GPA) or "208" swales) will be installed to accommodate the stormwater runoff generated by the proposed improvements.

2.0 Design Concept

The proposed long-range stormwater management concept for this project is to direct onsite flows to the master grassed percolation areas (GPA) which will accept, hold and treat stormwater runoff that is produced by the new PGIS's (the parking lot and associated walkways and landscaping). The roof area will be directly piped to a drywell as it is not a pollution generating surface. The intent here is to fully treat the developed area.

The master GPA(Swale "C") was designed to treat the first 1/2" of runoff in a storm event and have the storage volume to contain the runoff for a 10 year event as prescribed in the Spokane Regional Stormwater Manual. The drainage pond was sized and shaped based on the development and the assumed uses for each lot.

The roof of the building is a nonpolluting/nonasphaltic roof and will be piped directly to the drywell.

3.0 Drainage Area Summary

The project area all drains to 2 systems. The existing master swale accepts the drainage for the parking lot and associated landscaping. The onsite drywell accepts drainage for the roof. Swale "C" swale and drywells are adequately sized based on post development conditions of the commercial site. The slope generally ranges from approximately 1% to 4% in the area of construction. See Appendix III for the drainage basin map.

The proposed site includes a 12,482sq. ft. building, a 22,815sq.ft. Parking and drive area and associated landscaping.

For the purposes of this design, geotechnical information was obtained from the Geotechnical report dated June 21, 2005 by Kleinfelder. A copy of the report is included in Appendix IV.

4.0 Summary of Stormwater Calculations

Attached are worksheets, which determine the peak stormwater runoff for post-development conditions for the drainage basins. The drainage areas, which are less than 10 acres in size, were analyzed using the rational method (Q=CIA) to determine the peak stormwater runoff based on a 10 YR design frequency. The time of concentration (Tc) is determined using the method outlined in the Spokane Regional Stormwater Manual.

The Intensity-Duration Curve for the Spokane Area was used to determine the corresponding intensity (I) for the time of concentration. A weighted runoff coefficient (C) is calculated for the post-development conditions, using the surfaces, types and area on site.

The existing master Swale (GPA) will be used for stormwater treatment and detention. Type "B" drywells will aid in extreme runoff. For the roof runoff, the storm water will be piped directly to a type “A” drywell.

The capacities of each type “B” drywell is 1.0 cfs and 0.3 cfs for the type “A” as outlined in the Geotechnical Report.

The Master Swale is detailed in the Taylor Engineering Report Dated April 29, 2005. It accounts for our site to have a total area of 45,265 sq.ft. This is accurate if you take the Country Vista Dr. Easement that has its own storm water swales and drywells and also remove the existing swale area at the corner of the lot shown on Appendix III. Of this 45,265sq.ft., the report accounts for 30,050 sq.ft. of ACP (pollution generating, impervious surface) and 4,527 sq ft. of landscaping. This leaves a building roof area of 10,688sq.ft. that they assume will be piped directly to a drywell. We are proposing 22,815sq.ft. of ACP (7,285 less), 9,968sq.ft. of landscaping (5,441sq.ft. more) and 12,482sq.ft. roof top area which will not be entering the Master swale (or Swale “C” as described in the report).

In comparing the volumes that this proposed site generates we compare it to what is provided to ensure that there is adequate volume for treatment and storage. There are 4 double barrel (type “B”) in the existing swale that are shared among the 3 areas, including our site, listed in the report. See Appendix V for the calculation spreadsheets.

Table 4.01 below is a summary of the calculations and analysis.

4.01 Tabular Summary of Stormwater Analysis

Drainage Area, DA	Time of Concentration, Tc (min.)	Rainfall Intensity, I (in/hr)	Weighted Coefficient, C	Total Area, A (acres)	Peak Runoff Q10YR (cfs)
Basin 1	5	2.62	0.90	0.29	0.68
Basin 2	5	2.62	0.70	0.75	1.38

5.0 Erosion Control Considerations

The erosion or sediment control plans are included as part of this project.

The Contractor is responsible for insuring the use of proper erosion control and shall maintain such measures throughout construction, until all pertinent landscaping and permanent erosion control measures (i.e. grassed areas, paved surfaces) have been established. Maintenance shall include daily inspections and repair of the erosion control measures. The Contractor will also inspect all erosion control measures following each stormwater event during construction or until the permanent measures are established.

Specific temporary measures, which will be used during construction, include filter fabric on grate inlets, silt fences and construction entrances.

Periodically, the temporary erosion control measures must be cleaned of debris and siltation. The contractor shall dispose of the materials so as not to damage any reclaimed areas or create other erosion problem areas. Upon direction by city of Spokane, Owner or Engineer, the Contractor may also be required to clean the roadway of siltation or other debris, which may occur along or at the construction entrance.

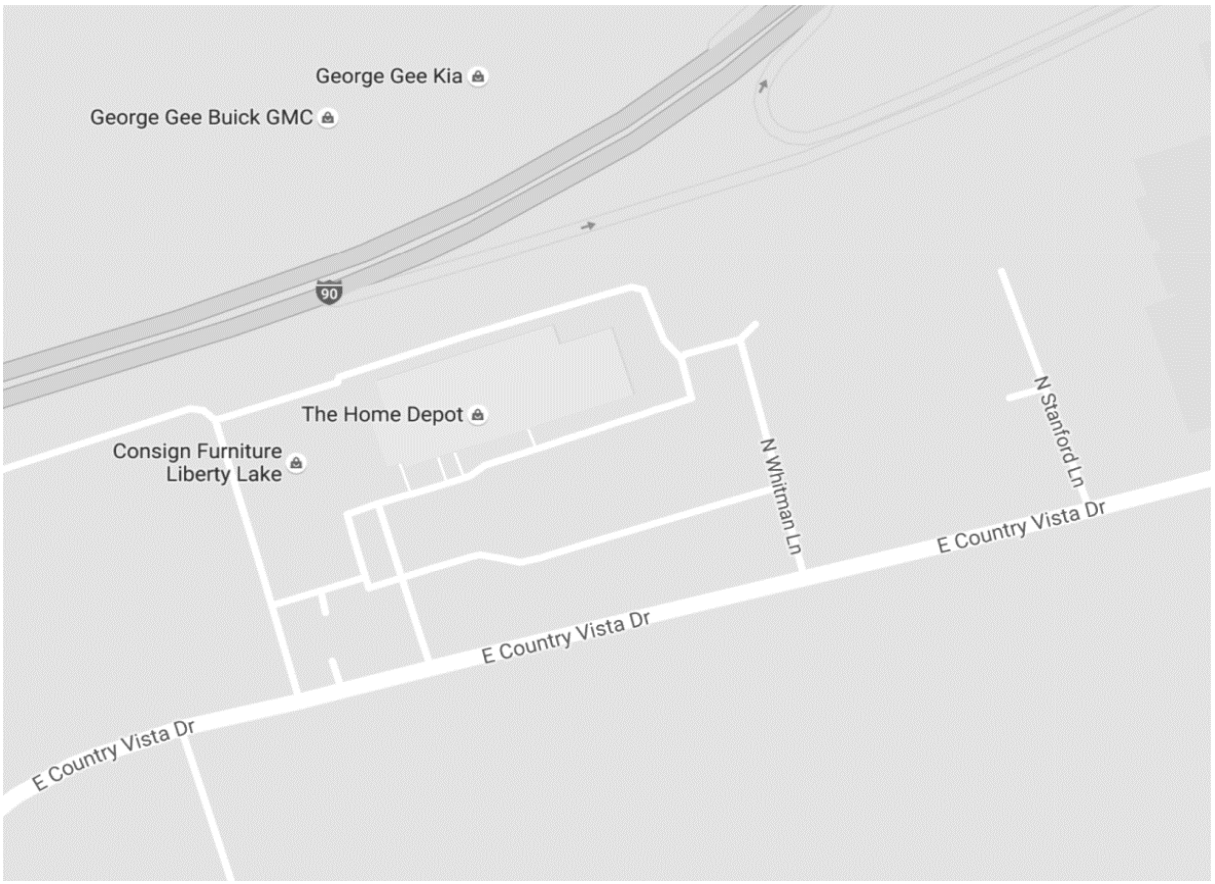
6.0 Summary/Conclusions

By comparing the ACP provided for and what we are proposing. And givien the fact that we are now using a smaller inch/hour storm to determine storm water, we have more than required volumes for this site.

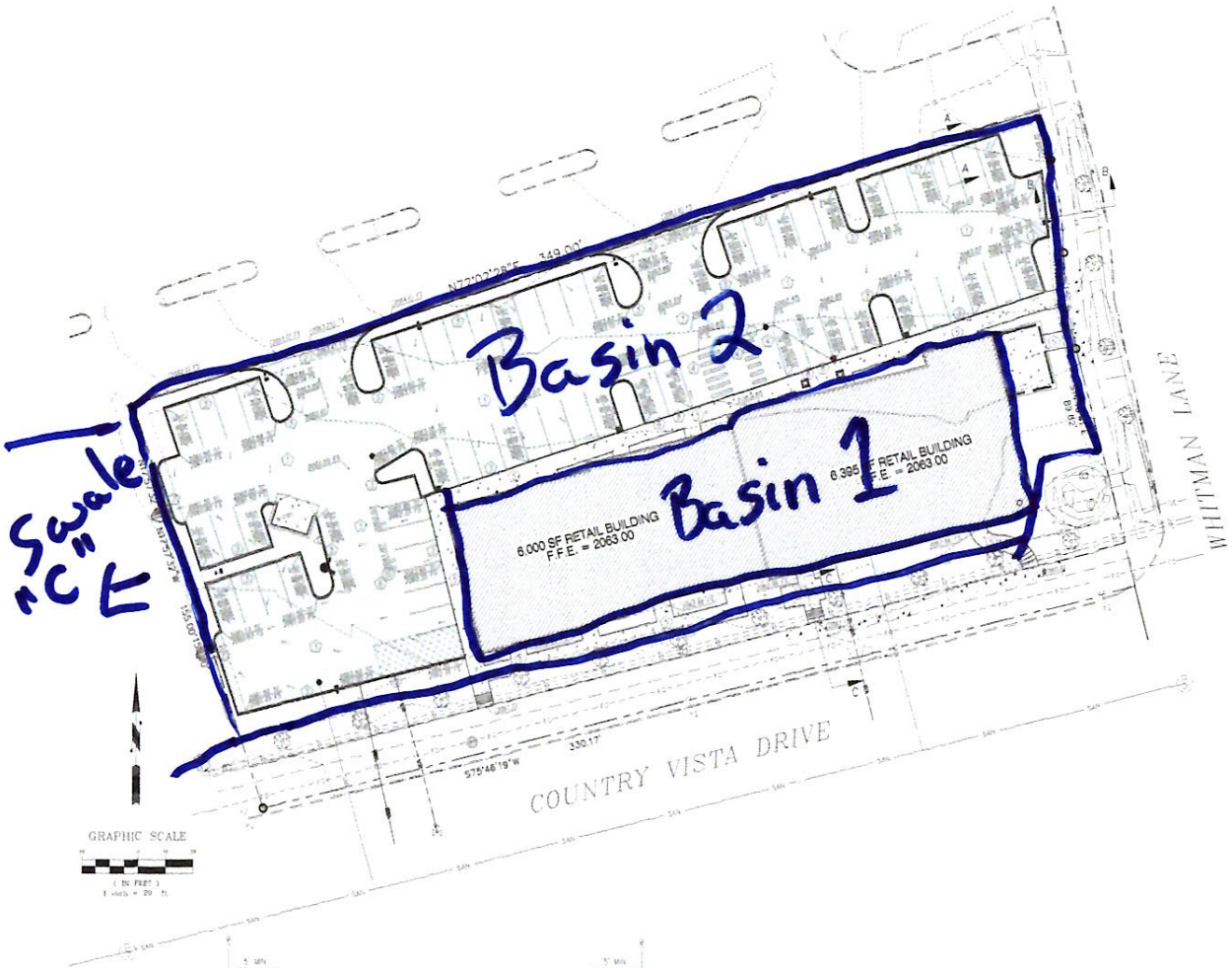
Included in the Claculations is a full Swale "C" calculation that uses the same areas for the other areas but our proposed surface areas and shows that the treatment and storage volumes are more than adequate (8,769 cu.ft. required vs. 10,550cu.ft. provided)

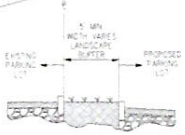
The stormwater runoff generated by post-development conditions of the site will discharge directly into the subsurface native soils. The GPA (or "208" swale) will function as stormwater detention pond, as well as provide treatment (for pollution generating surfaces) prior to discharge into the drywell.

The Contractor(s) will be responsible for the proper installation and maintenance of all temporary erosion control measures necessary to protect down gradient areas from siltation. The Contractor shall also protect against siltation of the drywells and GPA (or "208" swale) throughout construction. The drywells and GPA installed for this Project are based solely on post-development conditions of this site. No offsite development conditions are considered.



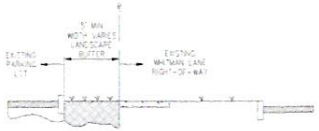
Project Location Map





SITE X-SECTION A-A

SCALE N.T.S

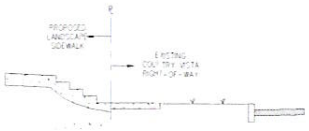


SITE X-SECTION B-B

SCALE N.T.S

REFERENCE NOTES:

1. CONTRACTOR TO INSTALL NEW ASPHALT PAVEMENT. SEE DETAIL 4/C6.0
2. CONTRACTOR TO INSTALL NEW 24' DRIVEWAY PER SPOKANE COUNTY STD. PLAN NO B-16A AND TYPE 1 CROSS GUTTER
3. CONTRACTOR TO INSTALL NEW 6" VERTICAL CONCRETE CURB. SEE DETAIL 5/C6.0
4. ADA SIGNING AND STRIPING. SEE ARCHITECTURAL PLANS
5. CONTRACTOR TO INSTALL NEW ONSITE 6' WIDE CONCRETE SIDEWALK. SEE DETAIL 3/C6.0
6. CONTRACTOR TO INSTALL TYPE A DRYWELL PER COUNTY STD. PLAN B-1
7. CONTRACTOR TO INSTALL 30' WIDE CURB CUT WITH 18' TRANSITION ON EACH SIDE PER COUNTY STD. PLAN B-8. CONTRACTOR TO EXTEND APRON TO BOTTOM OF EXISTING SWALE
8. CONTRACTOR TO INSTALL TYPICAL CONCRETE WHEEL STOP PER DETAIL 7/C6.0



SITE X-SECTION C-C

SCALE N.T.S

CONTRACTOR NOTE:

ALL EXISTING UTILITIES SHOWN ON PLANS ARE TO BE VERIFIED HORIZONTALLY AND VERTICALLY PRIOR TO ANY CONSTRUCTION. ALL EXISTING FEATURES, INCLUDING BURIED UTILITIES ARE SHOWN AS INDICATED ON RECORD MAPS AND SURVEY, FURNISHED BY OWNERS. WE ASSUME NO LIABILITY FOR THE ACCURACY OF THOSE RECORDS AND SURVEYS. CONTACT THE UTILITY OWNER AGENCY FOR THE FINAL LOCATION OF EXISTING UTILITIES IN AREAS CRITICAL TO CONSTRUCTION.

UNDERGROUND SERVICE ALERT
ONE-CALL NUMBER
(800)424-5555
CALL TWO BUSINESS DAYS BEFORE YOU DIG

4T Civil Engineering
Danny Peterson, P.E
1903 W Fairview
Spokane, WA 99205
C: 509.209.7455
Email: 4TYCivil@gmail.com

REVISIONS

#	DESCRIPTION	DATE

PERMIT DRAWINGS
LIBERTY LAKE RETAIL

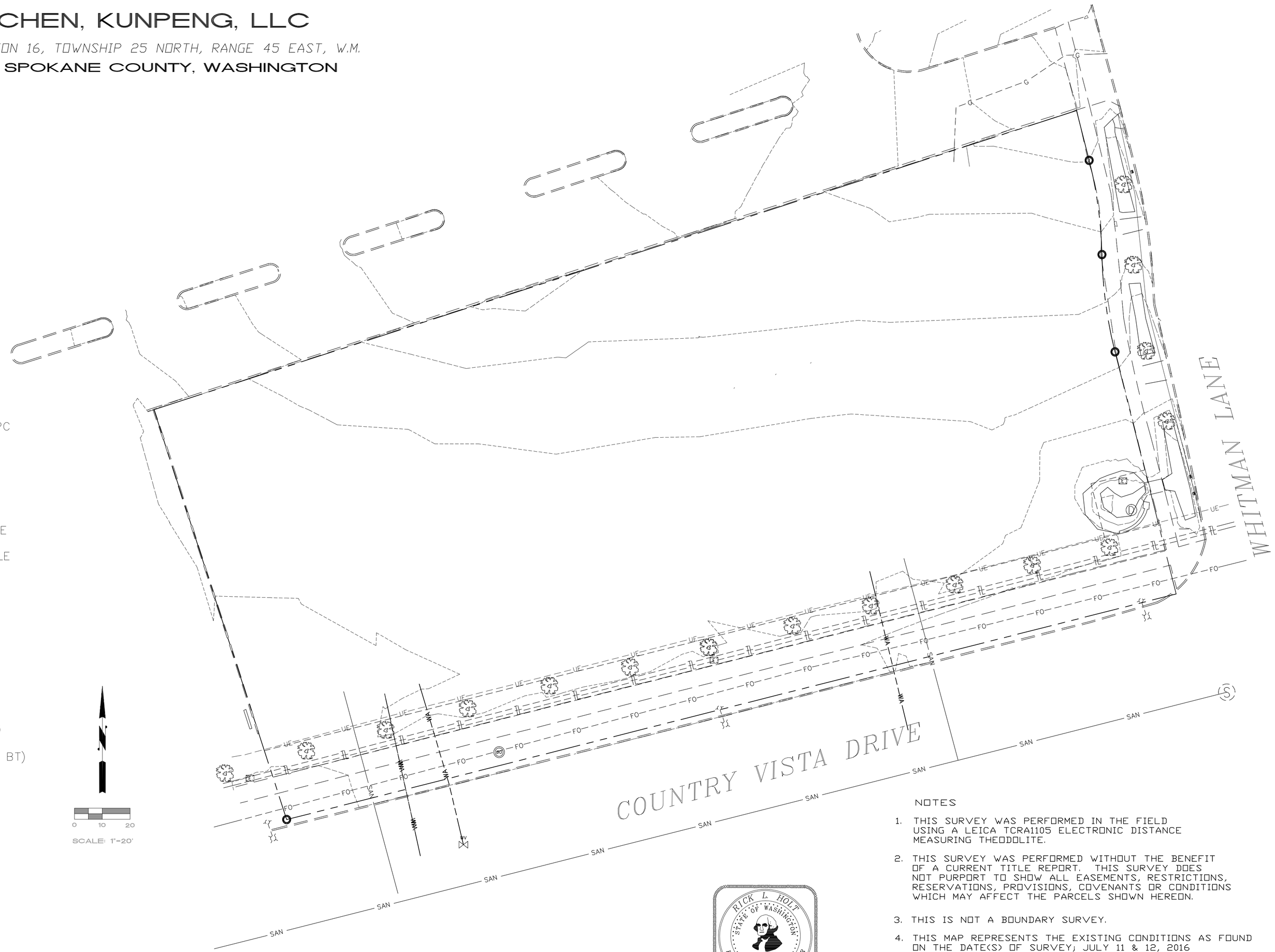
21801 E COUNTRY VISTA DR
LIBERTY LAKE WA

GRADING PLAN

C3.0

4TYND | 1/22 | DRAWN: DLP
DATE | 3-8-19 | REVIEWED: DLP

TOPOGRAPHIC SURVEY
FOR
PETER CHEN, KUNPENG, LLC
A PORTION OF SECTION 16, TOWNSHIP 25 NORTH, RANGE 45 EAST, W.M.
LIBERTY LAKE, SPOKANE COUNTY, WASHINGTON



LEGEND

EXISTING FEATURES

- CURB
- FOUND 5/8" REBAR W/YPC
- DRYWELL
- LIGHT POLE
- WATER VALVE
- SANITARY SEWER MANHOLE
- WATER BLOW OFF MANHOLE
- IRRIGATION BOX
- ELECTRICAL BOX
- TREE (DECIDUOUS OR CONIFEROUS)
- WATER LINE
- SANITARY SEWER LINE
- POWER LINE (OHP OR BP)
- TELEPHONE LINE (OHT OR BT)
- GAS LINE
- CONTOURS
- FIBER OPTIC LINE

NOTES

1. THIS SURVEY WAS PERFORMED IN THE FIELD USING A LEICA TCRA1105 ELECTRONIC DISTANCE MEASURING THEODOLITE.
2. THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A CURRENT TITLE REPORT. THIS SURVEY DOES NOT PURPORT TO SHOW ALL EASEMENTS, RESTRICTIONS, RESERVATIONS, PROVISIONS, COVENANTS OR CONDITIONS WHICH MAY AFFECT THE PARCELS SHOWN HEREON.
3. THIS IS NOT A BOUNDARY SURVEY.
4. THIS MAP REPRESENTS THE EXISTING CONDITIONS AS FOUND ON THE DATE(S) OF SURVEY; JULY 11 & 12, 2016
5. UNDERGROUND UTILITY LOCATIONS SHOWN HEREON ARE BASED UPON SURFACE INDICATORS AND THE 1-800 LOCATE SERVICE. PRIOR TO CONSTRUCTION USER SHOULD CALL THE UTILITY LOCATE SERVICE 48 HOURSBEFORE CONSTRUCTION.
6. CONTOURS AND SURFACE FEATURES AS REPRESENTED HEREON ARE IN CONFORMANCE WITH ACCEPTED INDUSTRY PRACTICE. CONTOUR INTERVAL: 1 FEET.

RICK L. HOLT
STATE OF WASHINGTON
37549
REGISTERED
PROFESSIONAL LAND SURVEYOR

LEGAL DESCRIPTION:

PARCEL A-22, EIGHTH AMENDMENT TO BINDING SITE PLAT BY SURVEY LIBERTY LAKE CORPORATION PART (BSP 50-96), ACCORDING TO THE PLAT THEREOF RECORDED IN VOLUME 1 OF PLATS, PAGE 91H, UNDER AUDITOR'S FILE NO. 5234572, RECORDS OF SPOKANE COUNTY, WASHINGTON.

SITUATE IN THE CITY OF LIBERTY LAKE, COUNTY OF SPOKANE, STATE OF WASHINGTON.

HOLT SURVEYING AND MAPPING, INC.
PROFESSIONAL LAND SURVEY SERVICES
PO BOX 271, CHENEY, WA 99004
Tel: 509-222-0468
rickholtsurveying@gmail.com

PROJECT	SCALE: 1"=20'	SHEET DESCRIPTION	JOB NO.
TOPOGRAPHIC SURVEY FOR PETER CHEN, KUNPENG, LLC — A PORTION OF SECTION 16, TOWNSHIP 25 NORTH, RANGE 45 EAST, W.M. — LIBERTY LAKE, SPOKANE COUNTY, WASHINGTON	DRAWN BY: R. HOLT CHECKED BY: R. HOLT FIELD BOOK: XX DATE: JULY 13, 2016	EXISTING CONDITIONS 21801 EAST COUNTRY VISTA DRIVE, LIBERTY LAKE, WA JULY, 2016	16-021 DRAWING NO. 16-021 CALC.DWG SHEET 1 OF 1

4 TY
Danny Paterson, P.E.
1923 W Fairview
Spokane, WA 99205
C: 509.209.7455
Email: 4TyCivil@gmail.com
Civil Engineering

REVISIONS

#	DESCRIPTION	DATE

PROJECT #: XXXXXX

PERMIT DRAWINGS
LIBERTY LAKE RETAIL

21801 E. COUNTRY VISTA DR.
LIBERTY LAKE, WA

EXISTING SITE SURVEY

C1.0

4 TY NO.	1602	DRAWN	DLP
DATE	9-8-16	REVIEWED	DLP

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED LIBERTY LAKE
COMMERCIAL DEVELOPMENT
PARCELS A-20, A-21, AND A-22
COUNTRY VISTA DRIVE AND WHITMAN LANE
LIBERTY LAKE, WASHINGTON

For:
Rawson, Blum & Leon
456 Montgomery Street, Suite 1000
San Francisco, CA 94104

Attention: Mr. Jeffrey S. Leon

By:
Kleinfelder, Inc.
15320 E. Marietta, Suite #2
Spokane, Washington 99216

Kleinfelder Project No: 58019

June 21, 2005

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Prepared for:

Rawson, Blum & Leon
456 Montgomery Street, Suite 1000
San Francisco, CA 94104

Attention: Mr. Jeffrey S. Leon

Kleinfelder Project No.: 58019

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED LIBERTY LAKE COMMERCIAL DEVELOPMENT
PARCELS A-20, A-21, AND A-22
COUNTRY VISTA DRIVE AND WHITMAN LANE
LIBERTY LAKE, WASHINGTON

Prepared by:

Scott R. Ward, P.E. (Washington)
Senior Geotechnical Engineer

G. Alexander Rush, P.E. (Idaho)
Senior Geotechnical Engineering

SCOTT R. WARD
STATE OF WASHINGTON
31698
REGISTERED
PROFESSIONAL ENGINEER

6-21-05

EXPIRES: 11-25-05

Kleinfelder, Inc.
15320 E. Marietta, Suite #2
Spokane, Washington 99216
(509) 926-9994

June 21, 2005

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF WORK

This report presents the results of our geotechnical investigation performed for the proposed Commercial Development to be located at the northwest corner of the intersection of Country Vista Drive and Whitman Lane in Liberty Lake, Washington. The general location of the project is indicated on the Vicinity Map, Figure 1 (Appendix A). In general, the purposes of this investigation were to evaluate the characteristics and engineering properties of the subsurface soils, and to provide recommendations for general site grading and for design and construction of foundations and pavements. The investigation included subsurface exploration, representative soil sampling, field and laboratory testing, engineering analyses, and preparation of this report.

Written authorization to perform this geotechnical investigation was provided by Rawson, Blum & Leon dated June 2, 2005. The geotechnical investigation was conducted in accordance with the scope of services outlined in our proposal dated May 22, 2005.

1.2 PROJECT DESCRIPTION

The project site consists primarily of three discontinuous parcels of undeveloped land located north of Country Vista Drive west of Whitman Lane in Liberty Lake, Washington. The size of parcels A-20, A-21, and A-22 are approximately 1.03, 0.95, and 1.29 acres, respectively. The parcels are located immediately south of a proposed Home Depot development (Parcel A-19). It is our understanding that the three parcels will be developed with commercial and retail structures, with associated parking and access drives, and that stormwater disposal for the development will be incorporated into the proposed Home Depot stormwater features. Details regarding the proposed building layouts, size, and structural loads were not available to Kleinfelder at the time this report was prepared. It is anticipated site grading will include fills on the order of 4 to 5 feet in height.

1.3 REFERENCES

Kleinfelder reviewed the following information in the course of our site investigation. This information serves as the basis of our understanding of the project type and scope.

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- "Eighth Amendment to Binding Site Plan by Survey of Liberty Lake Corporate Park (BSP-50-96)" by Taylor Engineering, Inc. dated May 12, 2005.
- "Final Geotechnical Evaluation Report, Proposed Home Depot, NWC Country Vista Drive and Whitman Lane, Liberty Lake, Washington", by Kleinfelder, dated February 9, 2005.

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2.0 METHODS OF STUDY

2.1 FIELD INVESTIGATION

The subsurface soil conditions at the proposed site were explored by excavating a total of three test pits using a conventional rubber-tired backhoe. Kleinfelder performed the field investigation in general accordance with the American Society of Testing and Materials (ASTM) Standard D 5434. The field investigation was conducted on June 2, 2005. The approximate locations of the test pits are shown on Figure 2 (Appendix A). The test pits were advanced to depths of approximately 8 to 10 feet below the existing ground surface. Samples of the subsurface soils were obtained at selected depths from within the test pits or from the backhoe bucket. Subsurface conditions, as encountered in the test pits, were recorded at the time of excavation by our field personnel and are presented on the test pit logs (Appendix B). Test pits were backfilled with spoil obtained during excavation. We performed general cleanup at the test pit locations, but site restoration was not included in our scope of services.

2.2 LABORATORY INVESTIGATION

Representative samples were tested in our laboratory to evaluate the pertinent engineering properties of the soils. The following test methods and procedures were utilized:

- ASTM D 1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D 2488 – Classification of Soils for Engineering Purposes.

The results of laboratory tests are presented on the test pit logs and in Appendix C.

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3.0 GENERAL SITE CONDITIONS

3.1 SURFACE CONDITIONS

As shown on Figure 2, the site consists of three rectangular-shaped parcels fronting the north side of Country Vista Drive. The site is bounded by the proposed Home Depot site (Parcel A-19, presently vacant) to the north, an existing office building to the east, Country Vista Drive to the south, and undeveloped property to the west. Existing site vegetation consists of grasses and weeds. Landscaped grass buffer and sidewalks have been constructed along Country Vista Drive and at the intersection of Country Vista and Whitman Lane. Site topography slopes gently downward towards the southwest. Vertical relief from east to west across the site is estimated at 6 feet.

3.2 SUBSURFACE CONDITIONS

3.2.1 Soils

A generalized subsurface profile (Table 1) has been developed for this project to provide a basis for discussion of soil conditions underlying the proposed facilities. This profile is based upon the field test data and exploration logs, and the laboratory testing program conducted by Kleinfelder.

TABLE 1
GENERALIZED SUBSURFACE PROFILE*

Stratum	Generalized Description
I	Dark Brown, loose to medium dense Silty Gravel with Sand (GM), Brown loose Poorly Graded Gravel (GP), and Brown medium stiff Silt with Sand and Gravel (ML). This stratum was encountered to depths ranging from about 2.5 to 4 feet below existing ground surface, and contained significant organics within the upper six inches. Based on field observations this stratum was interpreted as fill.
II	Gray, moist, Poorly Graded Gravel with Sand and Cobbles (GP). The soils of this stratum were found to be loose to medium dense. This stratum underlies Stratum I and extends to the maximum depth explored (about 10 feet bgs). Based on field observations this stratum was interpreted as alluvium.

*See the logs of exploration (Appendix B) for detailed subsurface information.

3.2.2 Groundwater

Groundwater was not encountered during the field exploration at depths of approximately 10 feet below the existing ground surface in the test pits excavated for this study. It should be noted that

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groundwater levels typically fluctuate, and may change in response to season, precipitation patterns, irrigation practices, off-site construction activities, site utilization, or other factors.

3.3 GENERAL SEISMIC SETTING

Based on the soil characteristics encountered during our exploration program, the Site Class is designated "C", in accordance with the 2003 International Building Code (IBC). In addition to the Site Class, the spectral response acceleration parameters have been selected in general accordance with the maps and guidelines presented in the IBC 2003, as follows:

S_S = 35 percent of g [from Figure 1615(1)]
S_1 = 9.5 percent of g [from Figure 1615(2)]

The design spectral response acceleration should be computed by the structural engineer in accordance with Section 1615.1.4, using the fundamental period (T) of the proposed building.

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4.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

4.1 GENERAL

Based on the results of our field and laboratory evaluations, it is our opinion that the site is suitable for the proposed commercial development provided that the recommendations contained in this report are incorporated into the design and construction.

The soils of Stratum I consist of loose and variable man-made fill to depths of 2.5 to 4 feet below existing grade. These materials (in their existing condition) are not considered suitable for uniform support of foundations or concrete slabs. In general, the structure may be supported by conventional continuous or spread type foundations established on Stratum II materials, or on properly placed and compacted structural fill, which extends to these soils. The surficial soil with vegetation and roots to a depth of approximately six inches should be removed from within the building pad and parking areas prior to placement of any structural fill.

The following sections of this report address these issues and present recommendations regarding foundation design and construction, floor slab and pavement design and construction, soil corrosion and construction observation and testing. If any revisions in the nature, design, or location of the proposed building or other structures occur at a later date which significantly alters the present definition of the project, the recommendations within the following sections shall be subject to review by Kleinfelder, and may be modified as deemed necessary.

4.2 EARTHWORK

Based on the subsurface conditions encountered at the project site, we recommend that the following operations be performed as part of the site preparation.

4.2.1 General Site Preparation and Grading

Clearing and Stripping: Prior to commencing site-grading operations, the building and pavement areas should be stripped of all vegetation, fill and organic soils. We estimate the depth of stripping required to remove organic-laden topsoils will be approximately six inches across the site. Areas of heavier vegetation may require stripping of 12 inches or more. Following the stripping operation, the upper 12 inches of the exposed surface should be

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scarified, moisture conditioned and compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557.

A representative of Kleinfelder should be present during the stripping operations to help identify the extent of the organic-laden soils, and again during the scarifying and compaction process to verify proper compaction of the native soil. The excavated topsoils are not suitable for use as structural fill, and will need to be wasted or stockpiled for landscaping use. Existing utilities (asphalt pipe and drain lines) should be completely removed as part of the clearing and stripping operations.

Overexcavation – Building Area: Stratum I fill soils consist of loose and variable man-made fill to depths of 2.5 to 4 feet below existing grade. These materials (in their existing condition) are not considered suitable for uniform support of foundations or concrete slabs because these soils vary in terms of compressibility and bearing capacity.

To provide relatively uniform support of the building foundations and floor slabs, we recommend that the Stratum I soil be removed below all building envelopes and replaced with compacted structural fill.

The compacted structural fill placed below foundations and slabs should conform to the material guidelines, and be placed in accordance with Section 4.2.2 of this report. Prior to fill placement, the overexcavation subgrade should be prepared in accordance with the *Subgrade Preparation* section presented below.

Overexcavation - Limits: The overexcavation limits within the building area should be wide enough to contain a 1H:1V (Horizontal:Vertical) slope extending from one foot outside each edge of the footing downward to the bottom of the Overexcavation.

Subgrade Preparation: We recommend that the subgrade for foundation, cast-on-grade slabs, pavement, and overexcavation areas, and for those areas receiving any additional fill be scarified, moisture-conditioned, and compacted to a depth of at least 12 inches. These areas should be moisture-conditioned to at least optimum moisture, but not greater than 2 percent over optimum moisture content, and compacted to at least 95 percent of the maximum laboratory dry density as determined by the ASTM D-1557 (Modified Proctor). All areas to receive fill should be observed by the Geotechnical Engineer prior to fill placement. If loose or soft pockets are detected that cannot be effectively compacted by repeated passes of the

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compactor, those areas should be overexcavated and backfilled with properly compacted structural fill material. Care should be taken during seasonally wet construction periods so that compaction operations do not excessively disturb the subgrade.

Observation and Testing: We recommend that all earthwork activities (i.e., clearing, overexcavation of Stratum I, site preparation, fill placement, etc.) performed for the proposed development be observed and tested by Kleinfelder. Qualified geotechnical personnel should be present during site preparation operations to observe stripping and grubbing depths, overexcavation depths, and to observe the compaction operations. Prior to placing fill, the overexcavation areas and subgrade surfaces to receive fill should be observed, tested, and approved by Kleinfelder.

4.2.2 Structural Fill, Site Fill and Compaction

All fill material used to replace the overexcavated site soils below the building area (supporting foundations and cast-on-grade slabs), and below paved areas should consist of compacted structural fill. The structural fill may consist of the Stratum I soils removed during the overexcavation process, excluding the surficial soil with vegetation and roots.

Imported structural fill should conform to the requirements outlined in Table 2.

TABLE 2
RECOMMENDED REQUIREMENTS FOR IMPORTED STRUCTURAL FILL

Sieve Size	Percent Passing
4-inch	100
No. 4	30-60
No. 200	Less than 10
Liquid Limit less than 30 percent Plasticity Index less than 10 percent	

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Materials that are frozen, contaminated, contain organic matter (such as strippings or roots), trash, debris, stones larger than four inches, excess moisture, or that are classified as CH, CL, MH, PT, OL, and OH (in accordance with ASTM D-2487) will not be suitable for use as structural fill. Structural fill, including all utility trench backfill, should be placed in horizontal lifts no greater than eight inches in thickness, and compacted to at least 95 percent of the maximum dry density as determined by ASTM D-1557. Soil moisture content during compaction should be maintained within two percent of the optimum condition (ASTM D-1557). Prior to any fill placement, the exposed soils should be uniformly scarified to a minimum depth of 12 inches, moisture-conditioned as necessary, and compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D-1557 (see Section 4.2.1 of this report). Before fill material placement, the excavations should be observed by the Geotechnical Engineer to document that all unsuitable materials have been removed and that the exposed soils are in a firm, unyielding condition.

Any structural fill required to raise the site to design grade should be placed before foundation elements are constructed. This will facilitate more uniform placement and compaction of the fill, and also reduce the potential for differential settlement of shallow spread foundations. Structural fill should extend at least 12 inches beyond the edges of foundations, slabs, or pavements in all directions for each foot of fill below these elements. Final lines and grades at the project site should be planned so that drainage is directed at least 15 feet away from all building foundations and pavement edges.

4.2.3 Excavation Stability and Excavatability

Stability of construction excavations is the contractor's responsibility. If stability of an excavation becomes questionable, the excavation should be evaluated promptly by a representative of Kleinfelder. The soil classifications and strength properties presented in this report may be used for the planning of excavations and excavation slopes in accordance with OSHA requirements or for the design of shoring and/or the use of trench boxes. Construction personnel should be aware that soil conditions might change rapidly if soil moisture conditions change or if soils which have been disturbed by previous excavations are encountered. If sloughing or free water is encountered, it may be necessary to reduce slopes beyond OSHA requirements or provide shoring. All excavations should comply with current OSHA safety requirements.

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Based on observations made during our field exploration, the site soils appear to be excavatable with conventional, heavy construction equipment. We anticipate that standard wheel and/or track-mounted excavation equipment will be able to operate on the site. However, the contractor should satisfy himself as to the difficulty involved and the type of equipment needed.

4.2.4 Wet Weather Construction

The Stratum I Silty Gravel (GM) and Silt with Sand and Gravel (ML) contain appreciable fines and will be moisture sensitive. If the site construction is performed during wet periods of the year, the surficial soils will be susceptible to pumping or rutting when subjected to heavy construction loads, such as from rubber-tired construction equipment or other vehicles that exert a heavy point load.

Wet weather earthwork should be performed by low-pressure, track-mounted equipment. All soft, disturbed areas should be excavated to undisturbed soil and backfill with structural fill as recommended in Sections 4.2.1 and 4.2.2 of this report.

If soft, undisturbed areas are encountered, we recommend that Kleinfelder be notified to evaluate the nature and extent of the soft subgrade and provide additional recommendations for placement of structural fill to improve earthwork efficiency and to achieve a stable subgrade.

4.2.5 Permanent Slopes

We recommend that permanent cut and fill slopes be maintained at an inclination no steeper than 3H:1V (Horizontal:Vertical). This recommendation is based on the assumption that slope heights will be less than five feet, and that loads will not be imposed above the slope within one half of the slope height from the slope face. The site soils are expected to be erodible, and slopes should be vegetated or covered with riprap to reduce erosion. Surface runoff should be directed away from slope faces to swales, drainage ways, or ditches to lessen the erosional effects on cut and fill slopes.

4.3 FOUNDATIONS

Based on the results of the subsurface exploration, conventional spread footings may be proportioned for a maximum net allowable bearing pressure of 3,000 pounds per square foot (psf) provided that:

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- Stratum I soils are removed and replaced with structural fill below all footings.
- All footings are founded on compacted structural fill as defined in Sections 4.2.1 and 4.2.2;
- Continuous wall footings are at least 24 inches wide or consistent with the current requirements of the International Building Code (IBC);
- Isolated column pad areas are at least 36 inches square or consistent with the current requirements of the IBC;
- Exterior footings are placed 24 inches below the lowest adjacent final grade for frost protection;
- The base of the foundation excavations are observed and probed in the field by Kleinfelder prior to placement of any formwork, reinforcement steel, or concrete; and any soft or loose soil pockets encountered at the base of the footing excavations are removed and replaced with lean concrete or properly compacted fill.

Spread footings designed in accordance with these criteria would be expected to experience post construction settlement of 1 inch or less, with differential settlements of ½ inch or less over 50 feet. A one-third increase of the net allowable bearing pressure may be used for transient wind or seismic loads.

Horizontal loads acting on foundations formed in open excavations will be resisted by friction acting at the base of foundations and by passive earth pressures. If design makes use of passive earth pressures, it is important that backfill is placed and compacted properly. Therefore we recommend that Kleinfelder be present during any footing backfill placement.

The friction acting along the base (bottom) of footings founded on properly compacted native soil or structural fill may be computed by using a coefficient of friction of 0.40 with the normal dead load.

4.4 LATERAL EARTH PRESSURES

Ultimate lateral earth pressures acting against below-grade and earth-retaining structures may be computed from the equivalent fluid densities presented in Table 3.

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TABLE 3 RECOMMENDED LATERAL EARTH PRESSURES		
Condition	**Lateral Pressure Coefficient**	**Equivalent Fluid Density (pcf)**
Active	0.36	35
At-rest	0.60	55
Passive	2.8	350

The coefficients and densities presented assume level backfill behind walls and that no buildup of excess hydrostatic pressure will develop. Lateral pressures from surcharge loads may be computed by multiplying the surcharge load by the appropriate lateral pressure coefficient. Retaining walls that are allowed to rotate slightly should use the active coefficient. Buried structures, or retaining walls that are not allowed to rotate should use the at-rest coefficient.

Overcompaction of wall backfill should be avoided, as increased compactive effort will result in lateral pressures greater than those presented above. Heavy compaction equipment or other construction loads should not be allowed within 30 inches of retaining walls, unless planned for in the structural design. Walk-behind or lightweight compaction equipment, such as a vibrating plate for granular soils, should be utilized to compact material within 30 inches of retaining walls.

Where the potential for water accumulation behind walls exists, we recommend retaining walls be properly drained to prevent development of hydrostatic pressures. This may be accomplished by placing free-draining gravel against the wall, with a geotextile filter fabric placed around the gravel to prevent the infiltration of fines into the gravel. The free-draining material should comply with the requirements presented in Table 4.

TABLE 4 RECOMMENDED GRADATION FOR FREE-DRAINING GRANULAR MATERIAL	
Sieve Size	**Percent Passing**
3-inch	100
No. 4	30-70
No. 200	0-5
Non-plastic (NP) Plastic Index	

As an alternative to free-draining gravel, a geocomposite drainage fabric, such as manufactured by Enkadrain, Miradrain, C-drain, or equivalent, may be placed against the wall.

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The layer of granular material should be placed against the full height of the wall, to within 18 inches of the final ground surface behind the wall. In addition, the granular drainage material should extend at least 12 inches beyond the back of the wall. The upper 18 inches of the compacted retaining wall backfill should consist of fine-grained soils, or a pavement structure should be provided, to reduce infiltration of surface water into the backfill and drainage materials. Sloping of the ground surface and other surface drainage control features should be planned so that surface water is directed at least 15 feet away from below grade walls and retaining walls. Any water collected at the base of the wall should be removed by means of weep holes or collection pipes that discharge to suitable drainage structures.

4.5 INTERIOR CONCRETE SLAB-ON-GRADE CONSTRUCTION

Direct support for interior concrete floor slabs may be provided by a minimum six-inch layer of ¾-inch crushed aggregate (less than 40 percent passing No. 4 sieve and less than 5 percent passing No. 200 sieve). Prior to placement of the aggregate layer, the native soils or structural fill should have been prepared as recommended in Sections 4.2.1 and 4.2.2 of this report. As a basis for designing concrete slab thickness a subgrade modulus of 300 pounds per cubic inch (pci) may be used. The actual floor slab thickness and reinforcement design should be provided by the Structural Engineer.

If moisture sensitive floor coverings are used, an impermeable membrane (minimum 10-mil polyethylene sheeting) should be placed under the aggregate layer.

A coefficient of friction of 0.35 may be used for concrete slabs placed over the ¾-inch crushed aggregate. A coefficient of friction of 0.20 may be used for concrete slabs over a plastic barrier. The recommended friction coefficients may be increased by one-third for transient wind or seismic loads.

Special precautions must be taken during the placement and curing of all concrete slabs. Excessive slump (high water-cement ratio) of the concrete and/or improper curing procedures used during either hot or cold weather conditions could lead to excessive shrinkage, cracking or curling in the slabs. We recommend that all concrete placement and curing operations be performed in accordance with the American Concrete Institute (ACI) Manual.

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4.6 CONCRETE PAVEMENT AND EXTERIOR FLATWORK

All concrete pavement and exterior concrete flatwork exposed to heavy traffic loads should have a minimum thickness of five inches and be supported on a minimum of six inches of compacted crushed ¾-inch aggregate base material, as described in Section 4.7 of this report. Prior to constructing the concrete pavement, exterior slabs or placement of structural fill, all unsuitable soils should be removed and the subgrade prepared as recommended in Section 4.2.1.

4.7 PAVEMENT SECTIONS

Support for the asphalt pavement sections may be provided by properly prepared subgrade. Prior to placing pavement subbase and base course materials, the subgrade should be prepared as recommended in Section 4.2.1 of this report. Any structural fill required to raise the grade of paved areas, following clearing and stripping operations, should be compacted as outlined in Section 4.2.2.

The pavement design provided in the following section is based on the results of a resistance R-value test performed on the adjacent Home Depot project (Parcel A-19) immediately north of the site. The test indicated a resistance value of 67 for Silty Gravel (GM) soil. For design purposes, the R-value of 67 was used to estimate a resilient modulus of 16,500 psi, which was used in the pavement section design. Project traffic data for use in design of the pavement areas was assumed equivalent to the Home Depot criteria and based on a 20-year design life. The following pavement section designs provided in Table 5 are based on the following:

- A resilient modulus of 16,500;
- A 20-year design life with 100,000 ESALs for the standard-duty section and 440,000 ESALs for the heavy-duty section.

Table 5
Recommended Flexible Pavement Sections

20-Year Design Life		
Material	**Standard Duty Thickness (inches)**	**Heavy Duty Thickness (inches)**
Asphalt Concrete	3.0	3.5
Crushed Aggregate Base (3/4-inch minus)	4.0	5.0
Subbase (Pit-Run)	---	---

*Subgrade shall be prepared in accordance with Section 4.2.1 prior to placement of any pavement base course materials.

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The above 20-year pavement sections have been developed using the Gravel Equivalence (GE) Method.

Asphalt, aggregate base, and subbase material should conform to Washington State Department of Transportation 2004 Standard Specifications Sections 5-04 Hot Mix Asphalt, 9-03.8 Aggregates for Hot Mix Asphalt, 9-03.9(3) Top Course for aggregate base, and 9-03.10 for Aggregate for Gravel Base (subbase). All subbase and base material should be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D-1557. The asphalt-paving contractor shall submit a copy of the proposed asphalt mix design to be used for the project to the geotechnical engineer for approval, prior to the start of paving operations. Only one mix design shall be approved for use on the project. Asphalt concrete should be compacted to within a range of 92 to 95 percent of the Theoretical Maximum Specific Gravity in accordance with AASHTO T-166, Method A and T-209, or compacted to a minimum of 95 percent of the Marshall (50 blow) maximum density in accordance with ASTM D-1559. Field and laboratory testing should be performed to evaluate conformance with these requirements.

Pavement life will be increased if efforts are made to reduce the accumulation of excess moisture in the subgrade soils. Parking areas should be sloped and drainage gradients maintained to carry all surface water runoff away from building and pavement areas.

4.8 CORROSION POTENTIAL

The following information is based on tests conducted for the Home Depot (Parcel A-19) project immediately north of the project site. Based on the results of two laboratory tests, the nearby soil pH ranged from 7.0 to 8.5, and the minimum soil resistivity varied from 7,000 to 8,000 ohm-centimeters. Using these results as a basis, the site soils present a low to moderate potential for corrosion of steel. Two selected specimens of the Parcel A-19 site soil were tested for soluble sulfate concentration. The soluble sulfate concentration measured in the laboratory was 5 to 7 parts per million (ppm). Based on this test result, the site soils present a negligible relative potential for sulfate attack of concrete. Accordingly, concrete with Type I/II Portland cement is recommended for construction of structural elements in contact with the site soils.

4.9 MOISTURE PROTECTION AND SURFACE DRAINAGE

Precautions should be taken during and after construction to reduce the potential for saturation of soils beneath foundations and pavements. Positive drainage should be established away from the

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structure and pavements. Landscape watering adjacent to structures should be avoided. All utility trenches leading into the structure should be backfilled with compacted structural fill. Special care should be taken during installation of subfloor sewer and water lines to reduce the possibility of future subsurface saturation.

4.10 SUBSURFACE INFILTRATION FOR BIOSWALE DRYWELLS

It is understood that surface runoff from the site will be directed to one of three bioswales planned as part of the adjacent Home Depot development (Parcel A-19). The soils at the site are mapped by the Natural Resource Conservation Service (NRCS) as Garrison Gravelly Loam. Based on the field and laboratory testing performed by Kleinfelder (for this site and Parcel A-19) the on-site soils appear to be consistent with the NRCS soil mapping. The Garrison series is approved by Spokane County for the use of either Standard Type A or B drywells with allowable infiltration rates of 0.3 and 1.0 cubic feet per second (cfs), respectively.

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5.0 CLOSURE

5.1 LIMITATIONS

Recommendations contained in this report are based on our field explorations, laboratory tests, and our understanding of the proposed construction. The study was performed using a mutually agreed upon scope of work. It is our opinion that this study was a cost-effective method to evaluate the subject site and evaluate some of the potential geotechnical concerns. More detailed, focused, and/or thorough investigations can be conducted. Further studies will tend to increase the level of assurance, however, such efforts will result in increased costs. If Rawson, Blum & Leon wishes to reduce the uncertainties beyond the level associated with this study, Kleinfelder should be contacted for additional consultation.

The soils data used in the preparation of this report were obtained from the field explorations made for this investigation. It is possible that variations in soils exist between the points explored. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at this site which are different from those described in this report, our firm should be immediately notified so that we may make any necessary revisions to our recommendations. In addition, if the scope of the proposed project, locations of structures, or building loads change from the description given in this report, our firm should be notified.

The recommendations made in this report are based on the assumption that an adequate program of tests, observation, and engineering consultation will be made during construction to verify compliance with the report findings and recommendations. This should include, but not necessarily be limited to, the following:

- Observations and testing during site preparation and earthwork.
- Observation of footing and trench excavations.
- Observation and testing of construction materials.
- Engineering consultation as may be required during construction.

These items are critical with regards to the conclusions and recommendations provided in this report. If these items are not adequately performed during construction, then Rawson, Blum &

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Leon agrees to assume Kleinfelder's responsibility for any potential claims that may arise during or after construction.

The report has been prepared for specific application to this project in accordance with the generally accepted standards of practice at the time the report was written. No warranty, express or implied, is made.

This report may be used only by Rawson, Blum & Leon and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on- and off-site), or other factors including advances in man's understanding of applied science may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 36 months from its issue. Kleinfelder should be notified if the project is delayed by more than 24 months from the date of this report so that a review of site conditions can be made, and recommendations revised, if appropriate.

It is Rawson, Blum & Leon's responsibility to see that all parties to the project including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk. Any party other than Rawson, Blum & Leon who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by Rawson, Blum & Leon or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

5.2 PROJECT BID DOCUMENTS

It has been our experience during the bidding process, that contractors often contact us to discuss the geotechnical aspects of the project. Informal contacts between Kleinfelder and an individual contractor could result in incorrect or incomplete information being provided to the contractor. Therefore, we recommend a pre-bid meeting be held to answer any questions about the report prior to submittal of bids. If this is not possible, questions or clarifications regarding this report should be directed to the project Owner or his designated representative. After consultation with Kleinfelder, the project Owner (or his representative) should provide clarifications or additional information to all contractors bidding the job.

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We also recommend that project plans and specifications be reviewed by us to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

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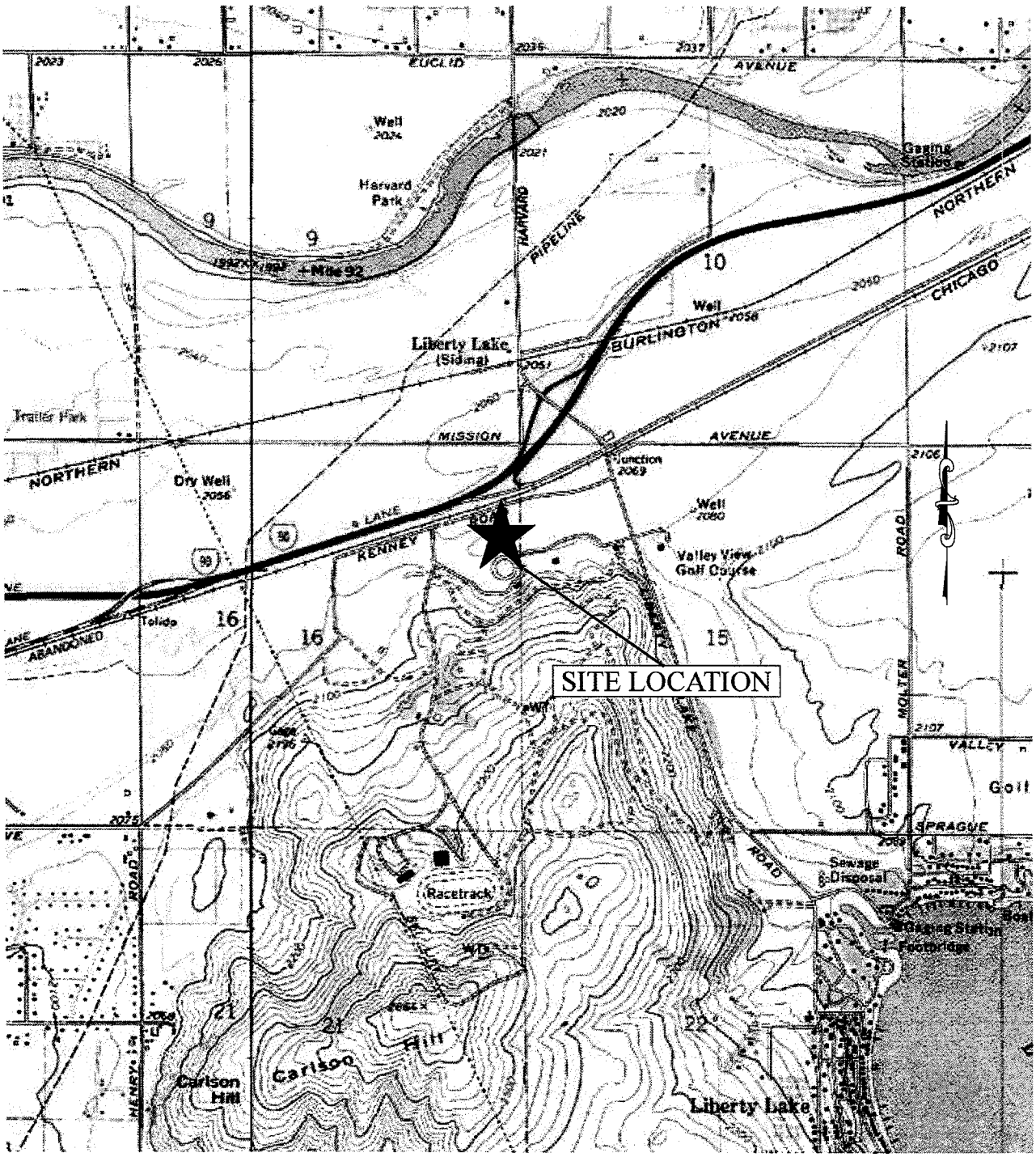
APPENDIX A

FIGURES



1 0.5 0 0.5 1

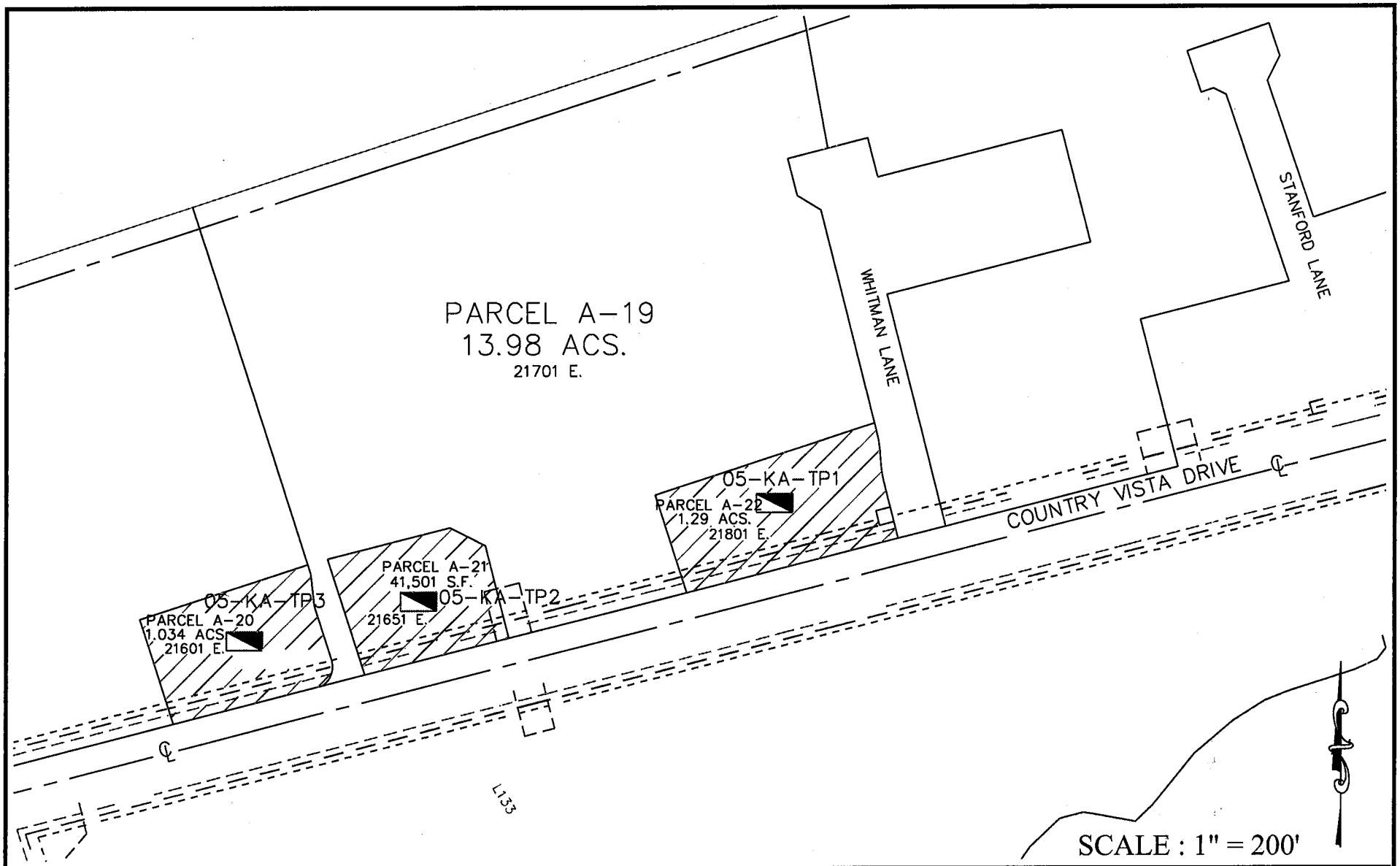
APPROXIMATE SCALE IN MILES (1:24,000)

VICINITY MAP
Proposed Commercial Development
NWC Country Vista Drive and Whitman Lane
Liberty Lake, Washington

KA Project No. 58019 Date: June 2005

FIGURE 1

KLEINFELDER
15320 E. Marietta, Suite #2
Spokane, Washington 99216



05-KA-TP3
Approximate Test Pit Location

SITE MAP
Proposed Commercial Development
Liberty Lake, WA

KA No. 58019-001 Date: June 2005

FIGURE 2

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APPENDIX B

LOGS OF EXPLORATION

General Legend and Notes for Logs of Exploration

SYMBOL	DESCRIPTION
BG	Small volume bag sample
BK	Large volume bulk sample
SS	Standard split-spoon sample (reference ASTM D 1586)
OSS	Over-sized spilt-spoon sample with an outside diameter of 3-inches. Blow counts are not corrected to N-Values unless noted separately on the logs
ST	Thin-walled (Shelby) tube sample with an inside diameter of 2.88-inches unless otherwise noted on the logs (reference ASTM D 1587)
PT	Piston tube sample with an inside tube diameter of 2.88-inches unless otherwise noted on the logs (reference ASTM D 1587)
RS	Ring sample with an inside diameter of 2.42-inches unless otherwise noted on the logs (reference ASTM D 3550)
CR	Core barrel sample (reference ASTM D 2113)
ω	Water content
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
▽	Indicates the measured groundwater level

Note:

1. Soil samples recovered were identified, described, and classified in the field using ASTM D 2488 (Unified Soil Classification System) as a guide.

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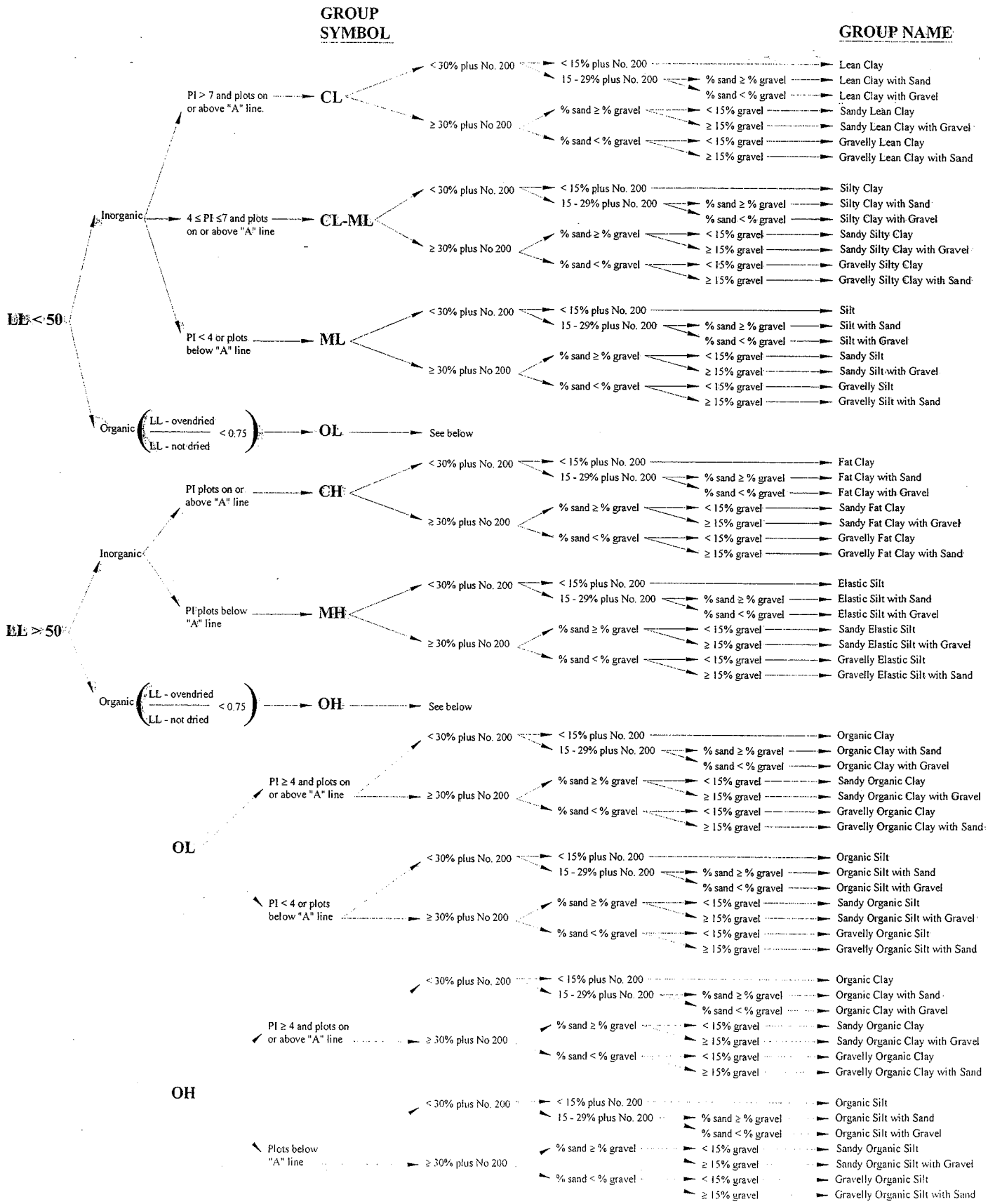
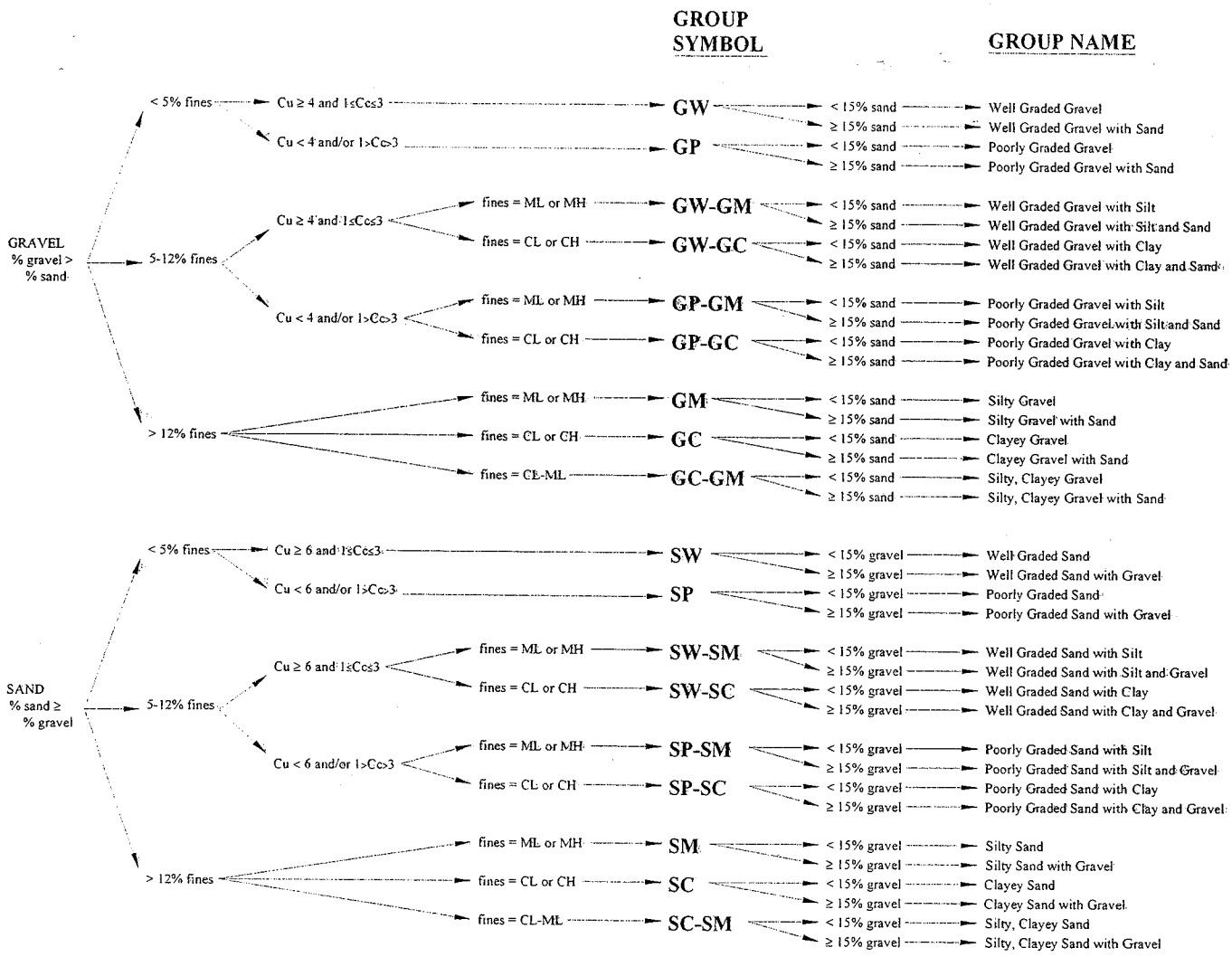
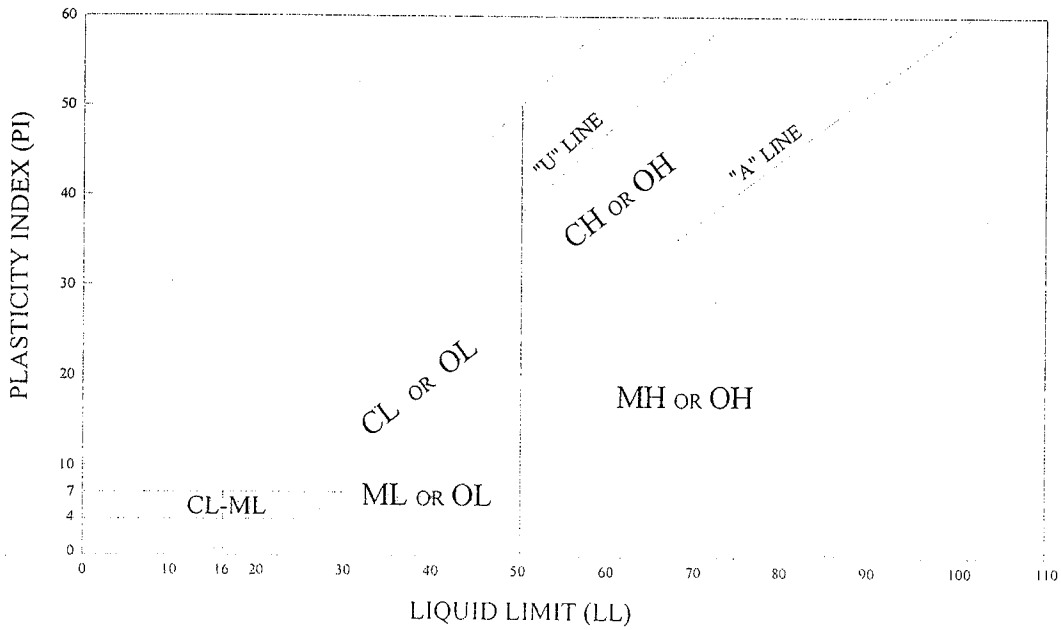
ASTM D2487 Soils Classification Chart



ASTM D2487 Soils Classification Chart (cont.)





PROJECT: Proposed Commercial Development
LOCATION: Liberty Lake, Washington
ELEVATION:

EXCAVATION CONTRACTOR:
EXCAVATION EQUIPMENT: John Deere 310SG

LOGGED BY: Scott Ward
DATE OF EXCAVATION: June 2, 2005
WATER LEVEL(S) / DATE(S): None encountered on 6-2-05

TEST PIT LOG NO. 05-KA-TP1
SHEET 1 of 1

KLEINFELDER

KA PROJECT NO. 58019

DEPTH (ft.)	SAMPLE TYPE - NUMBER	SAMPLE GRAPHIC SYMBOL	DESCRIPTION	REMARKS
				Stratification lines on this log are based on sampling observations and represent approximate boundaries between soil and rock. In-situ, the transition between soil types may be gradual.
0	BG		Silty Gravel with Sand (GM): Dark brown; moist; loose to medium dense; abundant roots to 6" (topsoil).	
1	BG		Note: trace of cobbles, medium dense below 1.4 ft.	FILL
2	BG			
			Poorly Graded Gravel with Sand and Cobbles (GP): Gray; moist; loose.	ALLUVIUM
3	BG			
4			Note: increase in cobbles, decrease in sand content below 4.5 ft.	
5				
6				
7				
8				
9	BK			
10			Test pit terminated at 10 ft.	

PROJECT: Proposed Commercial Development
LOCATION: Liberty Lake, Washington
ELEVATION:

EXCAVATION CONTRACTOR:
EXCAVATION EQUIPMENT: John Deere 310SG

LOGGED BY: Scott Ward
DATE OF EXCAVATION: June 5, 2005
WATER LEVEL(S) / DATE(S): None encountered on 6-5-05

TEST PIT LOG NO. 05-KA-TP2
SHEET 1 of 1

KLEINFELDER

KA PROJECT NO. 58019

DEPTH (ft.)	SAMPLE TYPE - NUMBER	SAMPLE GRAPHIC SYMBOL	DESCRIPTION	REMARKS
				Stratification lines on this log are based on sampling observations and represent approximate boundaries between soil and rock. In-situ, the transition between soil types may be gradual.
0	BG		Silty Gravel (GM): Dark brown; moist; loose; trace of snad; abundant roots to 6".	FILL
1	BK		Poorly Graded Gravel (GP): Brown; moist; loose; trace of sand; trace of cobbles.	FILL 8" dia. asphalt pipe on north side of trench.
2				
3	BG		Silty Gravel with Sand and Cobbles (GM): Brown; moist; medium dense; lense of medium to coarse sand.	FILL
4			Poorly Graded Gravel (GP): Gray; moist; loose.	ALLUVIUM
5				
6				
7				
8			Test pit terminated at 8 ft.	
9				
10				

PROJECT: Proposed Commercial Development
LOCATION: Liberty Lake, Washington
ELEVATION:

EXCAVATION CONTRACTOR:
EXCAVATION EQUIPMENT: John Deere 310SG

LOGGED BY: Scott Ward
DATE OF EXCAVATION: June 2, 2005
WATER LEVEL(S) / DATE(S): None encountered on 6-2-05

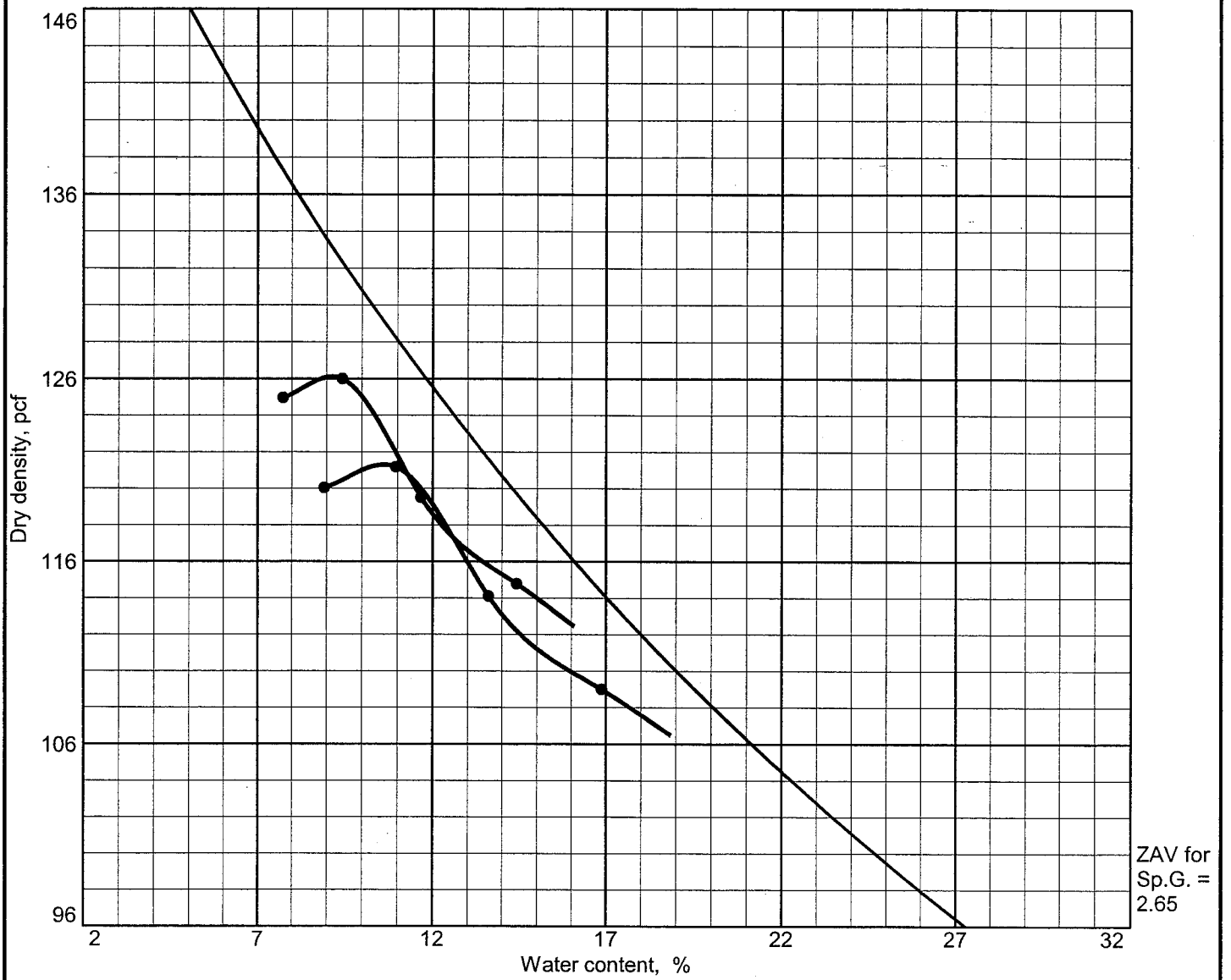
TEST PIT LOG NO. 05-KA-TP3
SHEET 1 of 1

KLEINFELDER

KA PROJECT NO. 58019

DEPTH (ft.)	SAMPLE TYPE - NUMBER	SAMPLE GRAPHIC SYMBOL	DESCRIPTION	REMARKS
				Stratification lines on this log are based on sampling observations and represent approximate boundaries between soil and rock. In-situ, the transition between soil types may be gradual.
0	BK		Silty Gravel with Sand (GM): Brown to dark brown; moist; loose; laminations at 6"; abundant roots to 6".	FILL
1				
2	BK		Silt with Sand and Gravel (ML): Brown; moist; medium stiff; trace of cobbles; upper 2" is dark brown.	FILL
3	BG		Silty Gravel with Sand (GM): Brown; moist; medium dense.	FILL
4			Poorly Graded Gravel with Sand (GP): Gray; moist; loose; 1" minus.	4" dia. corrugated ABS perforated pipe bedded in 2" minus washed drain rock.
5				
6				
7				
8			Test pit terminated at 8 ft.	
9				
10				

COMPACTION TEST REPORT



Test specification: ASTM D 1557-00 Method B Modified
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SC						16.0	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 126.1 pcf	121.3 pcf	Clayey Silt with Gravel
Optimum moisture = 9.1 %	10.6 %	

Project No. 58019.001 **Client:**
Project: Liberty Lakes Developement

● **Source:** **Sample No.:** 56

Remarks:
Sampled By: SW
Tested By: JF/PF

COMPACTION TEST REPORT

KLEINFELDER, INC.

Figure

Stormwater Design

Date: 9/26/2016
Owner Name: Peter Chen
Project: LL Retail

Description and Assumptions:
Located at 21801 E Country Vista Dr
Town of Liberty Lake, Washington
***
Land is *** the Aquifer Sensitive Area, and geotechnical analysis was completed
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula
No offsite runoff contributes to the site or any drainage facilities

Sub-Area: Basin A

Total Drainage Area	12482 s.f.	0.29	ac.
Total Impervious Area	12482 s.f.	0.29	ac.

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Asphalt &SIDEWALKS	0	-	0.90	-
FIRE LANE	0	-	0.90	-
Landscaping	0	-	0.25	-
Building Roofs	12482	0.29	0.90	0.258
TOTAL	12482	0.29		0.258

Weighted Runoff Coefficient=(sum CA)/(sumA)= 0.90

2 Determine Rainfall Intensity, I

Duration (in minutes) is based on the Time of Concentration, TC

Reach 1: Overland Flow

Tc=Ct(L*n/s^1/2)^0.6 where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
n=friction factor of the ground surface (See Table 13, Page 6-34)
s=Average slope in ft/ft
Ct=0.15 for overland flow (See Figure 3, Page 6-5)

L (ft)	n	s	Ct
150	0.016	0.02	0.15

Time of Concentration= 0.82 minutes
Use 5 minutes

Reach 2: Gutter Flow

Reach 3: Channel or Pipe Flow

Note: Tc should be calculated for each significantly different slope. Tc for flow in pipes, ditches and gutters should be completed as a function of the velocity as defined by Manning's formula.

$I = m/T_c^n$ where: m and n are 6.98 and 0.609 respectively from table 5-7

I =	2.62	in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	0.68	c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes	
Time of Conc.=	5.00	minutes	
Desired Outflow=	1	cfs	1 Type "A" Drywell
C=	0.90		
A=	0.29	acres	

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	0.68	-	-	-	
1	60	2.62	0.68	54.32	60	(6)	
2	120	2.62	0.68	150	120	30	for t>Tc
5	300	2.62	0.68	272	300	(28)	
10	600	1.72	0.44	311	600	(289)	
15	900	1.34	0.35	346	900	(554)	
20	1200	1.13	0.29	379	1,200	**(821)**	
25	1500	0.98	0.25	405	1,500	(1,095)	
30	1800	0.88	0.23	432	1,800	(1,368)	
35	2100	0.80	0.21	454	2,100	(1,646)	
40	2400	0.74	0.19	477	2,400	(1,923)	
45	2700	0.69	0.18	499	2,700	(2,201)	
50	3000	0.64	0.17	512	3,000	(2,488)	
55	3300	0.61	0.16	535	3,300	(2,765)	
60	3600	0.58	0.15	554	3,600	(3,046)	
65	3900	0.55	0.14	568	3,900	(3,332)	
70	4200	0.53	0.14	588	4,200	(3,612)	
75	4500	0.50	0.13	593	4,500	(3,907)	
80	4800	0.48	0.12	607	4,800	(4,193)	
85	5100	0.47	0.12	631	5,100	(4,469)	
90	5400	0.45	0.12	639	5,400	(4,761)	
95	5700	0.44	0.11	658	5,700	(5,042)	
100	6000	0.42	0.11	661	6,000	(5,339)	

The Bowstring calculations show that the drywell is never at over-capacity during the design storm.
(Type B drywell has about 100 cubic feet of storage in the barrel.)

*Is the Tybe "B" drywell large enough to hold the **Total Required Detention Volum** **OK**

Stormwater Design

Date: 9/26/2016
Owner Name: Peter Chen
Project: LL Retail

Description and Assumptions:
Located at 21801 E Country Vista Dr
Town of Liberty Lake, Washington
***
Land is *** the Aquifer Sensitive Area, and geotechnical analysis was completed
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula
No offsite runoff contributes to the site or any drainage facilities

Sub-Area: Basin2 (Proposed site les the building roof)

Total Drainage Area	32783 s.f.	0.75	ac.
Total Impervious Area	22815 s.f.	0.52	ac.

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Asphalt Pavement	22815	0.52	0.90	0.471
Drives and Walks	0	-	0.90	-
Landscaping	9968	0.23	0.25	0.057
Building Roofs	0	-	0.90	-
TOTAL	32783	0.75		0.529

Weighted Runoff Coefficient=(sum CA)/(sumA)= 0.70

2 Determine Rainfall Intensity, I

Duration (in minutes) is based on the Time of Concentration, TC

Reach 1: Overland Flow

Tc=Ct(L*n/s^1/2)^0.6 where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
n=friction factor of the ground surface (See Table 13, Page 6-34)
s=Average slope in ft/ft
Ct=0.15 for overland flow (See Figure 3, Page 6-5)

L (ft)	n	s	Ct
150	0.016	0.02	0.15

Time of Concentration= 0.82 minutes
Use 5 minutes

Reach 2: Gutter Flow

Reach 3: Channel or Pipe Flow

Note: Tc should be calculated for each significantly different slope. Tc for flow in pipes, ditches and gutters should be completed as a function of the velocity as defined by Manning's formula.

$I = m/T_c^n$ where: m and n are 6.98 and 0.609 respectively from table 5-7

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	1.38 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes	
Time of Conc.=	5.00	minutes	
Desired Outflow=	1	cfs	1 Type "2" Drywell
C=	0.70		
A=	0.75	acres	

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	1.38	-	-	-	
1	60	2.62	1.38	111.35	60	51	
2	120	2.62	1.38	307	120	187	for t>Tc
5	300	2.62	1.38	557	300	257	
10	600	1.72	0.91	638	600	38	
15	900	1.34	0.71	710	900	**(190)**	
20	1200	1.13	0.60	778	1,200	(422)	
25	1500	0.98	0.52	830	1,500	(670)	
30	1800	0.88	0.47	885	1,800	(915)	
35	2100	0.80	0.42	931	2,100	(1,169)	
40	2400	0.74	0.39	979	2,400	(1,421)	
45	2700	0.69	0.36	1,022	2,700	(1,678)	
50	3000	0.64	0.34	1,049	3,000	(1,951)	
55	3300	0.61	0.32	1,097	3,300	(2,203)	
60	3600	0.58	0.31	1,135	3,600	(2,465)	
65	3900	0.55	0.29	1,163	3,900	(2,737)	
70	4200	0.53	0.28	1,205	4,200	(2,995)	
75	4500	0.50	0.26	1,216	4,500	(3,284)	
80	4800	0.48	0.25	1,244	4,800	(3,556)	
85	5100	0.47	0.25	1,292	5,100	(3,808)	
90	5400	0.45	0.24	1,309	5,400	(4,091)	
95	5700	0.44	0.23	1,349	5,700	(4,351)	
100	6000	0.42	0.22	1,355	6,000	(4,645)	

The Bowstring calculations show that the drywell is never at over-capacity during the design storm.
(Type B drywell has about 50 cubic feet of storage in the barrel.)

5 Determine Volume of GPA(swale) (Assume trapezoidal cross-section)

Total PGIS Area= 22,815 sf

** Check First: Make sure that the Required Volume is Less than the Volume Provided.

Required Volume=AsphaltArea*1/2"/12in/ft=	951 cu.ft.
Swale Volume Provided=	10550 cu.ft.

Stormwater Design

Date: 9/26/2016
Owner Name: Peter Chen
Project: LL Retail

Description and Assumptions:
Located at 21801 E Country Vista Dr
Town of Liberty Lake, Washington
***
Land is *** the Aquifer Sensitive Area, and geotechnical analysis was completed
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula
No offsite runoff contributes to the site or any drainage facilities

Sub-Area: Basin for Swale "C"

Total Drainage Area	266575	s.f.	6.12	ac.
Total Impervious Area	22815	s.f.	0.52	ac.

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Asphalt Pavement	210454	4.83	0.90	4.348
Drives and Walks	0	-	0.90	-
Landscaping	54327	1.25	0.20	0.249
Building Roofs	0	-	0.90	-
TOTAL	264781	6.08		4.598

Weighted Runoff Coefficient=(sum CA)/(sumA)= 0.76

2 Determine Rainfall Intensity, I

Duration (in minutes) is based on the Time of Concentration, TC

Reach 1: Overland Flow

Tc=Ct(L*n/s^1/2)^0.6 where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
n=friction factor of the ground surface (See Table 13, Page 6-34)
s=Average slope in ft/ft
Ct=0.15 for overland flow (See Figure 3, Page 6-5)

L (ft)	n	s	Ct
150	0.016	0.02	0.15

Time of Concentration= 0.82 minutes
Use 5 minutes

Reach 2: Gutter Flow

Reach 3: Channel or Pipe Flow

Note: Tc should be calculated for each significantly different slope. Tc for flow in pipes, ditches and gutters should be completed as a function of the velocity as defined by Manning's formula.

$I = m/T_c^n$ where: m and n are 6.98 and 0.609 respectively from table 5-7

I =	2.62	in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	12.13	c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes	
Time of Conc.=	5.00	minutes	
Desired Outflow=	4	cfs	1 Type "2" Drywell
C=	0.76		
A=	6.08	acres	

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	12.05	-	-	-	
1	60	2.62	12.05	968.49	240	728	
2	120	2.62	12.05	2,674	480	2,194	for t>Tc
5	300	2.62	12.05	4,842	1,200	3,642	
10	600	1.72	7.91	5,551	2,400	3,151	
15	900	1.34	6.16	6,173	3,600	**2,573**	
20	1200	1.13	5.20	6,764	4,800	1,964	
25	1500	0.98	4.51	7,218	6,000	1,218	
30	1800	0.88	4.05	7,695	7,200	495	
35	2100	0.80	3.68	8,099	8,400	(301)	
40	2400	0.74	3.40	8,512	9,600	(1,088)	
45	2700	0.69	3.17	8,889	10,800	(1,911)	
50	3000	0.64	2.94	9,128	12,000	(2,872)	
55	3300	0.61	2.80	9,541	13,200	(3,659)	
60	3600	0.58	2.67	9,872	14,400	(4,528)	
65	3900	0.55	2.53	10,120	15,600	(5,480)	
70	4200	0.53	2.44	10,483	16,800	(6,317)	
75	4500	0.50	2.30	10,579	18,000	(7,421)	
80	4800	0.48	2.21	10,818	19,200	(8,382)	
85	5100	0.47	2.16	11,241	20,400	(9,159)	
90	5400	0.45	2.07	11,383	21,600	(10,217)	
95	5700	0.44	2.02	11,737	22,800	(11,063)	
100	6000	0.42	1.93	11,783	24,000	(12,217)	

The Bowstring calculations show that the drywell is never at over-capacity during the design storm.
(Type B drywell has about 50 cubic feet of storage in the barrel.)

5 Determine Volume of GPA(swale) (Assume trapezoidal cross-section)

Total PGIS Area= 210,454 sf

** Check First: Make sure that the Required Volume is Less than the Volume Provided.

Required Volume=AsphaltArea*1/2"/12in/ft=	8769	cu.ft.
Swale Volume Provided=	10550	cu.ft.

6 Determine Minimum Required Height of Detention Basin above "208" Swale
(Assume trapezoidal cross-section)

Required Volume=AsphaltArea*1/2"/12in/ft=	8769	cu.ft.
Required Detention Volume=	3,642	cu.ft.
Total Required Detention Volume=	8769	cu.ft.
Swale Volume Provided=	10550	cu.ft.

*Is the swale large enough to hold the **Total Required Detention Volume?** **OK**