AGENDA

CITY OF BENBROOK
PLANNING AND ZONING COMMISSION
THURSDAY, AUGUST 11, 2016

911 WINSCOTT ROAD
WORKSESSION, 7:00 P.M.

CENTRAL CONFERENCE ROOM, OPEN TO PUBLIC
A quorum of the Benbrook City Council may be in attendance at this meeting.

1. **Discuss Items on Agenda**
2. **Staff Briefing on Development Activities (time permitting)**
   - General Development Activities
   - Update on Benbrook Boulevard (US 377) Project

REGULAR MEETING, 7:30 P.M.
CITY COUNCIL CHAMBERS
ITEMS UNDER CONSIDERATION ARE SUBJECT TO FINAL ACTION

I. CALL TO ORDER

II. CONSIDERATION OF MINUTES

Regular Meeting, July 14, 2016

Documents:

1. MINUTES PZ 7.14.2016.PDF

III. REPORTS OF CITY STAFF

A. SUBDIVISION ORDINANCE

S-16-01

Consider a waiver from Chapter 16.28.025, D. 16 and 17 of the Subdivision Ordinance, (Design Requirements, Parking Lots and Fire Lanes); to authorize an alternate pavement design on Lot 1, Block 5, Benbrook Industrial Park (7608 Benbrook Parkway) - **continued from the June 9, 2016 and July 14, 2016 regular meeting of the Planning and Zoning Commission.**

Documents:

S-16-01 PACKET.PDF

IV. ADJOURNMENT

THIS FACILITY IS WHEELCHAIR ACCESSIBLE. FOR ACCOMMODATIONS OR TO INFORM US OF INACCESSIBILITY TO THIS MEETING, PLEASE CONTACT ANDY WAYMAN, CITY MANAGER, AT 817-249-3000. FOR SIGN INTERPRETATIVE SERVICES, PLEASE CALL 48 HOURS IN ADVANCE.

MINUTES
OF THE MEETING OF THE
CITY OF BENBROOK
PLANNING AND ZONING COMMISSION
REGULAR MEETING
THURSDAY, JULY 14, 2016

The regular meeting of the Planning and Zoning Commission of the City of Benbrook was held on Thursday, July 14, 2016, at 7:30 p.m. in the Council Chambers at 911 Winscott Road with the following members present:

Alfredo Valverde
Brandon O'Donald
David Ramsey
John Dawson
Jonathan Russell
Tom Casey
Matthew Wallis

Also present:

Dave Gattis, Deputy City Manager
Ed Gallagher, Planning Director
Sue Clark, Recording Secretary
Athena Seaton, Planning Intern
Tommy Davis, Fire Chief
Jason Tate, Assistant Fire Chief
Ed Brock, RJM Contractors
and one other

I. CALL TO ORDER

Chairman Valverde called the meeting to order at 7:30 p.m.

II. CONSIDERATION OF MINUTES

Regular Meeting, June 9, 2016

Motion by Mr. Dawson to approve the minutes of the June 9, 2016. Second by Mr. Russell. The Chair called the question.

Vote on the motion:

Ayes: Mr. Valverde, Mr. Dawson, and Mr. Russell

Noes: None

Abstain: Mr. Ramsey, Mr. O'Donald, Mr. Casey, and Mr. Wallis

Motion carried: 3 – 0 – 4

III. REPORTS OF CITY STAFF

A. SUBDIVISION ORDINANCE

S-16-01 Consider a waiver from Chapter 16.28.025, D. 16 and 17 of the Subdivision Ordinance, (Design Requirements, Parking Lots and Fire Lanes); to authorize an alternate pavement design on Lot 1, Block 5, Benbrook Industrial Park (7608 Benbrook Parkway) - **Continued from the June 9, 2016 regular meeting of the Planning and Zoning Commission.**

Chairman Valverde introduced the item and asked for a presentation from the applicant.

Ed Brock, 426 Fountain Park, Euless, representing the applicant, R.J. Miller, said that he had revised the plans to reflect staff's recommendations from the June meeting, but did not have time to get the revisions to staff for review before the Planning and Zoning Commission meeting. Mr. Brock requested that the Commission continue the item until the next scheduled Planning and Zoning Commission meeting.

The Chair asked for any comments or questions from the Commission.

Mr. Dawson said it was very cordial of the applicant to ask for a continuance.

Motion by Mr. Wallis for the Planning and Zoning Commission to continue the item until additional information is provided by the applicant. Second by Mr. Ramsey. The chair called the question.

Vote on the motion:

Ayes: Mr. Ramsey, Mr. O'Donald, Mr. Valverde, Mr. Dawson, Mr. Russell, Mr. Casey, and Mr. Wallis

Noes: None

Abstain: None

Motion carried: 7 – 0 – 0

B. Zoning Ordinance

Z-16-01 Consider proposed amendments to the Zoning Ordinance, including the following chapters: Chapter 17.08 Definitions; Chapter 17.20 Districts, District Boundaries and District Uses; Chapter 17.54 – "D" Multiple-Family District; Chapter, 17.74 – "MU" Mixed Use District; Chapter 17.75 – "FBC" Form Based Code District; Chapter 17.84 – Supplementary District Regulations; Chapter 17.92 – Sign Regulations; Chapter 17.96 – Fence Regulations; and Chapter 17.98 - Landscape and Buffer Requirements.

Ed Gallagher said that each year staff reviews the Zoning Ordinance for potential changes and/or amendments. He said that reviews are based on input from citizens, the business community, developers, City Council, the Planning and Zoning Commission, and City Staff. A routine review of, and amendments to the Zoning Ordinance, is beneficial in achieving orderly and productive development. Zoning Ordinance amendments are also worthwhile to address changes in development trends and changes in community needs and community desires. Occasionally existing regulations in the Zoning Ordinance have not addressed a particular issue in the manner that was intended when the regulation was approved, and revisions may be required. The Z-16-01 consideration includes input from the Planning and Zoning Commission following two work sessions on May 12, 2016, and June 9, 2016.

Mr. Gallagher said that in Chapter 17.08, Definitions, four definitions are added for "Fence Repair" and "Fence Replacement (Substantial Improvement)" and both added to provide for better and more consistent regulations addressing work on nonconforming fences. The proposed definitions are widely acceptable definitions from the International Building Code. A definition of "Unified Commercial Development" is added. The term is referenced in the Height and Area Regulations, Side Yard provisions of "E," "F", "HC," and "G" zoning districts and in the proposed amendment to Chapter 17.98, Landscape and Buffer Requirements, and the term needs to be defined. A definition of "Unified Commercial Sign" is proposed and will complement amendments to the Sign Regulations that will be noted later in this report.

Amendments to Chapter 17.20, Districts, District Boundaries and District Uses, include the deletion of Form Based Code District ("FBC") from the Designated listing of districts and the deletion of the "FBC" column in the Summary of Uses table. The Summary of Uses table also includes a more specific summary of uses in the "MU" Mixed Use District column.

Mr. Gallagher said that Chapter 17.54, "D" Multiple-Family District, includes a change in Section 17.54.032A, "Additional Design Requirements", to be consistent with the "Additional Design Requirements", cited in all other residential zoning districts regarding architectural design requirements, including exterior materials and roof pitch standards. The current text, to be deleted, refers to Chapter 17.84.100, Architectural Standards for Nonresidential Buildings indicating standards are applicable to only nonresidential buildings.

With the amendments to the "MU" including elements from the "FBC" District, Chapter 17.75, "FBC" Form Based Code District is to be entirely deleted from the Ordinance.

Mr. Gallagher said that this amendment creates a new Mixed Use zoning district by combining elements from the current "MU" zoning district and the "FBC" zoning district. He said the two existing zoning districts are very similar since they both allow for a mix of uses (residential, commercial uses such as offices, retail, etc.), all comingled in one building, one property, one development, they both encourage walkability, open space where people can gather and socialize; focusing on various new urbanism concepts or neo-traditional developments which includes on building a sense of community. Having two similar zoning districts is not needed and the effort is to combine the best elements or features of both zoning districts into a single mixed use zoning district. Starting with the current "MU" District as the foundation, some elements in "MU" are changed and, some elements from the current "FBC" are retained in the proposed "MU" District.

All zoning districts in Benbrook's Zoning Ordinance begin with a Purpose statement to summarize the goal of the zoning district, linking the rules and regulations to the purpose statement. The continued purpose of the "MU" District is to provide areas with a combination of residential and nonresidential uses. The mix of uses are intended to be comingled in a pedestrian and bicycle-friendly environment, while accommodating automobile and surface parking within designated areas with emphasis on the form of buildings and adequate civic and open space.

Mr. Gallagher said that General Development Principles are added to further establish essential development goals for development in the new "MU" District. Some of these principles came from the purpose of the “FBC” District and others are from new standards established in the new “MU” District. These principles focus on economic development and reinvestment along major corridors and enabling a sustainable tax base; cultivating a development pattern with convenient access offering various types of transportation options; high quality design and building placement standards, and the preservation of natural resources by incorporating these features into the development as an amenity.

Section 17.74.020 establishes that all developments must comply with the ordinance.

Mr. Gallagher said that Section 17.74.022 provides the Permitted Uses in the “MU” District; all residential uses and a list of nonresidential uses that resulted from the two recent Commission work sessions. He said that some permitted uses in regular commercial districts are excluded, including automobile related uses, such as auto repair and agricultural uses such as farms, barns, stables and animal lots. Permitted uses include institutional uses such as schools and churches; commercial uses, such as retail, sit-down restaurants, and the like.

Section 17.74.024 addresses conditional uses which may not be appropriate but may be made appropriate through conditions placed on the use or the development by the Planning and Zoning Commission through a Conditional Use approval to mitigate nuisances. The potential conditional uses include drive-through facilities, artists’ studios, small animal pet grooming and veterinary services wind energy systems that exceed the maximum height in the zoning district, solar photovoltaic systems exceeding 1,000 sq. ft. and Food Trucks.

Section 17.74.026 addresses Special Exceptions uses authorized by the Zoning Board of Adjustment (ZBA) and references Chapter 17.16, which provides uses which can be considered by the ZBA as a Special Exception.

Mr. Gallagher said that although the current “MU” and “FBC” zoning districts were very similar, there are differences that should be noted. Typical “FBC”s don’t necessary regulate uses as in conventional zoning districts. “FBC”s place an emphasis on regulating the physical form of buildings and the public realm (how buildings relate to the public realm), including streets, blocks and building frontage, differing from conventional zoning which place an emphasis on separation of uses, including mixed use zoning districts which evolved from historic single use districts, but still limit or prohibit certain uses, focusing on use base standards, bulk and height regulations. The new “MU” District is a hybrid zoning district, combining traditional regulations with “FBC” design principles. A statement is included that if there is a conflict between the “MU” District building form regulations and the International Building Code regulations that the IBC regulations would prevail.

The design standards are from the “FBC” District, with minor tweaks and amendments. The new “MU” zoning district is anticipated to raise the level of quality for mixed use developments within a regulatory structure, while offering flexibility and options, and not necessarily strict requirements, but also understanding the importance of a set of minimum regulations or site design standards and recognizing that all developments should be subject to minimum standards.

Mr. Gallagher said that Development Standards address the physical form and placement of buildings. The five major components of the District Design Standards are:

1. Building Form and in relation to various street types,

2. Building Design Standards, which addresses building orientation, and massing and scale,

3. Streetscape Standards, which address the natural and built fabric of the street and its visual effect,

4. Civic Space and Open Space Standards, which address recreational areas and the preservation of natural resources, and

5. Neighborhood Transition Standards, which address compatibility between new and existing single family developments.

Mr. Gallagher said that the goal of the Building Form and Development Standards is to build structures that can be utilized for a variety of uses, which extends the building's economic viability. He said the standards are based on street designations established by the Comprehensive Plan and these street designations shall be established for all streets within the "MU" District, which include Arterial Streets, Collector Streets, Local Streets, and Alleys.

The District Design Standards are Building Form and Development Standards that include regulations for building placement, including building frontage required, and the build-to-zone (BTZ), which is defined as the area between the minimum and maximum setbacks within which the principal building's front façade is to be built. The BTZ requirement is intended to help create vibrant and pedestrian friendly developments by bringing buildings closer to the street. This section also addresses side and rear yard setbacks, as well as block standards, which give a minimum and maximum block length, perimeter length; and building height and parking locations.

Mr. Gallagher said that in addition to Design Standards for buildings, the Design Standards in the new "MU" District also include:

- Streetscape Standards
- Civic Space and Open Space Standards
- Building and Screening Standards
- Neighborhood Transition Standards

Mr. Gallagher said the ordinance calls for a Development Site Plan to be presented to the Planning and Zoning Commission for approval after a public hearing. The Site Development Plan will actually be a "package" that includes extensive site plan information, addresses typical engineering and drainage considerations and Traffic Impact Analysis considerations. The package will include, or be accompanied by all of the normal subdivision plat submittal information required by the Subdivision Ordinance.

This is an overview of the proposed new "MU" District. The new "MU" District regulations reflect considerable input and direction from the Commission resulting from two recent lengthy Commission work sessions.

Mr. Gallagher said that changes in Chapter 17.84, Supplemental District Regulations, are the deletion of "D" District from the applicable districts in the Architectural Standards for Nonresidential Buildings and the correction of spelling error changing "track" to "truck" in 17.84.150 Food Truck Parks.

Amendments in Chapter 17.92, Sign Regulations, include the correction of inconsistencies between Table 17.92.050-A Permitted Signs by Type and Zoning District and Table

17.92.050-B Number, Dimensions, and Location of Individual Signs by Zoning District. Table "B" correctly limits building signs in "D" District to 60 square feet but Table "A" incorrectly shows the signs as "Not allowed". The correction is to the information in Table "A" to note "Allowed only with sign permit". In both tables, Form Based Code "FBC" is deleted from the Zoning District columns.

Mr. Gallagher said that additional amendments to Chapter 17.92, Sign Regulations, include provisions for "Unified Commercial Signs", as a new sign category. The Unified Commercial Signs are anticipated to fill a void by enhancing business identifications and reducing sign clutter. Current sign regulations prohibit off-premise advertising of businesses, products or services (17.92.090, G). The prohibition was established in the late 1970's and most particularly affected billboard signs. At the time, most businesses had buildings with frontage on Benbrook Boulevard, Camp Bowie West or Vickery Boulevard; and on-site signs provided acceptable visibility for business identifications. More recently developments have business sites that are visually separated from major roadways, by other businesses or secondary roadways; and on-site signs provide limited or no business identification from major roadways.

Mr. Gallagher said that the amendment to add Unified Commercial Signs provides for limited off-premise signs in a consolidated and controlled manner. He said that the proposed ordinance amendment includes the addition of Unified Commercial Sign in the Definitions Chapter as previously noted and provisions for the regulation and approval of the signs in the Sign Regulations Chapter (17.92) of the Zoning Ordinance. The Prohibited Signs section also includes reference to the exception for Unified Commercial Signs in the prohibition listing of off-premises signs.

In Chapter 17.96, Fence Regulations, the amendments include a revision to correct a reference to circumstances requiring a Fence Permit from the Inspection Department. The amendments also include the requirement of metal posts in concrete to provide a more sustainable fence and a better communication process for the Inspection Department in the fence inspection procedure.

Athena Seaton said that the goal of the landscape and buffer ordinance is to create visually appealing landscapes and initiate sustainable practices throughout the city; therefore, the staff proposes the following changes and corrections to Section 17.98.

The staff proposes adding an additional purpose that states the importance of protecting and enhancing environmental, economic and aesthetic qualities to development.

Ms. Seaton said that tables A-B-C-D for bufferyard requirements were corrected to reference accurately the different district zones and remove districts Mixed Use and Form Based Code, if approved this evening.

Text was revised to accurately describe the illustrations for screening.

Ms. Seaton said that for visual appeal, and to eliminate the "sea of cars" in parking lots, the parking lot landscaping requirements were modified from 10 parking spaces to 8 parking spaces with diamond shaped planter islands. She said illustrations are recommended to illustrate the visual appearance and measurement requirements to protect the trees and plants within the planters.

Plantings (tree canopies, shrubs and foliage) were reviewed for all districts and tables were modified for visual appeal and the health of plants.

To reduce the confusion of artificial lot lines and landscaping obligations for a developer, the planning director must approve before the issuance of a building permit.

The website reference for the Texas Smartscape is updated.

Ms. Seaton said that under maintenance of the landscaping, staff recommends that the owner is responsible for replacement of all plant materials with no time period restrictions for the repair of the irrigation system.

Mr. Gallagher said that staff recommends that after a public hearing, the Planning and Zoning Commission recommend that the City Council adopt the proposed amendments to the Zoning Ordinance.

The Chair asked for any comments or questions from the Commission. There being none, the Chair opened the public hearing at 8:03 p.m. and asked if anyone wished to speak for or against the item. There being none, the Chair closed the public hearing at 8:04 p.m. and asked the Commission for any comments, questions or a motion.

Motion was made by Mr. O'Donald to recommend that the City Council approve the proposed amendments to the Zoning Ordinance, second by Mr. Dawson. The Chair called the question.

Vote on the motion:

Ayes: Mr. Ramsey, Mr. O'Donald, Mr. Valverde, Mr. Dawson, Mr. Russell, Mr. Casey, and Mr. Wallis

Noes: None

Abstain: None

Motion carried: 7 – 0 – 0

VIII. ADJOURNMENT

There being no further business on the agenda, the Chair adjourned the meeting at 8:15 p.m.

APPROVED _____________,2016

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Chair

City of Benbrook
Planning and Zoning Commission

DATE: June 9, 2016 July 14, 2016 August 11, 2016	REFERENCE NUMBER: S-16-01	SUBJECT: Waiver to authorize alternate pavement material for parking areas and fire lanes	PAGE: 1 of 8

REQUEST: A request for a waiver from Chapter 16.28.025. D, Design Requirements, 16. Parking Lots; and 17. Fire Lanes of the subdivision ordinance to authorize an alternate pavement design for parking areas and the fire lane.

SUBJECT PROPERTY: Lot 1, Block 5, Benbrook Industrial Park
(7608 Benbrook Parkway)

ZONING DISTRICT CLASSIFICATION: "H," Industrial District

PROPERTY OWNER: Ronald J. Miller
Fort Worth, TX

APPLICANT: RJM Contractors
Fort Worth, TX

BACKGROUND INFORMATION

The subject property includes approximately 1.6 acres of land and is currently vacant. The property was platted as Lot 1, Block 5, Benbrook Industrial Park, on August 9, 1982. A permit was issued on January 15, 2016 to allow for the construction of two, one-story office/warehouse buildings and associated parking spaces, drive aisles, fire lanes, etc. Building "A" will include approximately 7,995 square feet and building "B" will include 6,346 square feet. The plans submitted for permitting conformed to all applicable codes and ordinances, including the International Building Code, International Fire Code, Zoning Ordinance, Subdivision Ordinance and floodplain regulations.

After the permit was issued, staff had several meetings with the applicant, at his request, to discuss alternate designs. On April 21, 2016, the applicant submitted application for a waiver to authorize an alternate pavement material for parking areas and the fire lane.

APPLICATION SUMMARY

The applicant is seeking a waiver from the minimum design standards of Chapter 16.28.025. D.16 (Parking Lots); and 16.28.025.D.17 (Fire Lanes), of the Subdivision Ordinance to authorize an alternate pavement material for parking areas and the fire lane.

The Subdivision Ordinance requires parking lots to be designed with concrete with a minimum pavement thickness of five inches (5") of 5-sack concrete with a minimum compressive strength of three thousand pounds (3,000 lbs.) per square inch, reinforced with number 3 bars on twenty-four inch centers (24” o.c.) in both directions over fill, sand, lime, or cement stabilized subgrade or equivalent.

The Subdivision Ordinance requires fire lanes to be constructed of all-weather pavement designed and maintained to support a twelve thousand five hundred pound (12,500 lb.) wheel loading. Unless approved by the City Engineer, such pavement shall consist of five-inch (5”) thick concrete pavement in light traffic areas and six-inch (6”) thick concrete pavement in areas expected to receive heavy traffic, such as service drives and dumpster areas. The approved plans submitted for permitting included the required Pavement Design Plan, which specified the required thickness of concrete sections.

The applicant has presented three proposals for alternate pavement design of parking areas, drives and fire lanes on the site:

Option 1: TXDOT-approved road base only in the rear parking area, which includes the fire lane and drive areas; and asphalt for parking spaces in front of the buildings, which includes the fire lane.

Option 2: Asphalt for all parking areas, including parking in the front and rear of the building, and all drive areas, including the fire lanes.

Option 3: Concrete fire lanes in the rear of the buildings, including drive areas in the rear of the building; and asphalt parking areas in the rear and front of the buildings, inclusive of drive areas and the fire lane in front of the buildings.

Pursuant to Chapter 16.24.020 (Deferral or Waiver of Required Improvements), the Planning and Zoning Commission may defer, reduce, or waive at the time of plat approval, subject to appropriate conditions, the provision of any or all design requirements or improvements as, in its judgement, are not necessarily in the interest of the public health, safety and general welfare.

STAFF EVALUATION

Concrete is a rigid-type pavement section which can ‘bridge’ in instances where the subgrade may fail. An asphalt pavement is a flexible-type section which heavily relies on the stability and strength of the subgrade under it. Typically an asphalt section is thicker than a concrete section. A road-base-type section, or sometimes called Flex Base type materials, are very flexible and rely heavily on the subgrade and lower base materials and strength. Contractors normally find the required subgrade density for a flexible base road section difficult to achieve because it also has to meet specific moisture content. This type section is not an all-weather surface. Dust and tracking is normally an associated nuisance with this type section. Staff is not aware of an instance where this type section has been used as a permanent roadway or pavement in an urban-type environment in Benbrook unless constructed many years ago. No engineered information has been provided by the applicant for the asphalt or road base type sections with this request. This would need to be provided by a geotechnical engineer for the site's specific conditions.

The three options presented by the applicant do not indicate the removal of the bulb portion of pavement or portions of the pavement along the east property line, as the currently approved plans do. The neighboring lot uses this area for access. To reduce negative impacts to the neighboring properties, the runoff from the rear of the site (north portion of the property) is currently designed to flow east, and then south along the site's east property line toward Benbrook Parkway; and to an onsite curb inlet, which is required to be installed with this development. Hence, the grades are at an acceptable minimum slope. The removal of the bulb and a portion of the existing pavement along the east property line, per the current plans, is necessary to convey the runoff from this portion of the subject property.

Staff offers the following evaluation for each of the three options:

Option 1: TXDOT approved road base in the rear parking area, which includes the fire lane and drive areas; and asphalt for parking spaces in front of the buildings, which is inclusive of the fire lane.

- The dumpster pad is proposed to be constructed with a concrete pad; however, not only should the dumpster pad be heavily reinforced, but also where the truck sits to empty the container due to vibrations and loads from the truck tires. If this option is approved, staff recommends that more area is concreted.
- The front parking area has an invert down the middle of this section. Asphalt tends to deteriorate much quicker when flow continuously drains over it due to rainfall, irrigation systems, etc. For this reason, asphalt streets typically have concrete valleys and curb and gutter sections to convey the daily flows and to create a border of the asphalt which eliminates deterioration of the asphalt edge.
- As previously mentioned, if tracking from the road base material occurs it will negatively affect the neighbor's pavement surface since it will be is used for access to the rear of the subject property.
- This type section normally requires continued maintenance, and once a specific type section is installed, the maintenance is not a priority to the owner.
- A curb would need to be installed along the north property line to convey the flow east and south as mentioned above.

Option 2: Asphalt for all parking areas, including parking in the front and rear of the building, and all drive areas, which is inclusive of the fire lanes; and

Option 3: Concrete fire lanes in the rear of the buildings, including drive areas in the rear of the building; and asphalt parking areas in the rear and front of the buildings, inclusive of drive areas and the fire lane in front of the buildings.

- As mentioned above, the dumpster pad is proposed to be constructed of concrete. However, where the truck sits to empty the container should also be reinforced, due to vibrations and loads from the truck tires.
- The asphalt valley is also a concern with options 2 and 3.
- A curb and gutter section would need to be installed on the border of all asphalt sections. Curb and gutter sections will also be needed to help convey flow along the north property line.

RECOMMENDATION

Staff has no objections to asphalt pavement meeting engineering design approval in parking and other areas exclusive of required fire lanes. Staff recommends that the Planning and Zoning Commission deny a pavement design waiver for any pavement in any required fire lane.

ATTACHMENTS

1. Aerial Map
2. Applicant Submittal
3. Geotechnical Report and Supporting Documents (Provided August 1, 2016)
4. Proposed Pavement Design (Provided August 1, 2016)

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July 14, 2016

This item was continued by the Commission at the June 9, 2016 regular meeting to allow the applicant time to provide additional information. The applicant had not submitted the additional information at the time the packet was completed. The additional information from the applicant will be forwarded to the Commission when available or distributed at the work session prior to the regular meeting.

August 11, 2016

This item was continued by the Commission at the July 14, 2016 regular meeting to allow staff time to review documents the applicant had available, but did not provide to staff prior to the meeting. On August 1, 2016, the applicant provided staff with a Geotechnical report, drainage analysis and supporting documents in response to items requested by the Commission regarding the proposed alternate paving design. The Geotechnical report and drainage information was previously submitted to and reviewed by staff during the permitting process for the proposed development. No new information was submitted.

The below includes the six items requested by the Commission at the June 9, 2016 meeting and how the items were addressed based on documents provided by the applicant:

1. Provide a geotechnical report indicating recommendations for pavement types and subgrades.

   The geotechnical report (by Alpha Testing, Inc., dated August 6, 2014) provided specifications for pavement types and subgrade preparation. The geotechnical report states that concrete versus asphalt pavements are not considered equal in performance. Asphalt generally has a shorter life expectancy and higher maintenance costs than does concrete.

   The report states the following pavement sections are considered a minimum:

   Concrete Pavement

   - 6 inches of lime stabilized subgrade for drive lanes, fire lanes, and pavement subject to dumpster truck traffic;
   - Subgrade treatment not required for parking lot if using concrete pavement;
   - 5 inches of concrete for parking lot;
   - 6 inches of concrete for drive lanes, fire lanes and light truck traffic; and
   - 7 inches of concrete for dumpster truck traffic.

   OR

   - If lime stabilization is not used, then increase concrete thickness to 7 inches for drive lanes, fire lanes and dumpster traffic.

   Asphalt Pavement

   - 6 inches of lime stabilized subgrade in all cases below:
   - 5 inches of asphalt for parking lot;
   - 6 inches of asphalt for drive lanes, fire lanes, and bus lanes; and
   - There were no specifications to use asphalt pavement for dumpster traffic.

   The applicant also provided a copy of parts of the Asphalt Paving Design from Minnesota Asphalt Pavement Association. It is not clear why the applicant included this information, but if this manual is used for the design of the parking lot and drive lanes, then:

   - Soil is classified as very poor due to the high clay content;
   - 7 inches of asphalt for parking lot; and
   - 9 inches of asphalt for drive lanes.

   Page 3-11 of Asphalt Paving Design Guide (Minnesota)

   "Subgrade Stabilization
   Very poor soils can be stabilized with granular material, a geotextile, or additives such as lime, fly-ash, asphalt cement,

> Portland cement, and combinations of cement stabilizers to improve subgrade support characteristics. The selection of a stabilizing agent, the amount to use, and the application procedure depend on the soil classification and the subgrade-support value desired."

Staff Response: The geotechnical report made the above recommendations without regard to the City's Subdivision Ordinance. The report states that, in some cases, City minimum standards may exceed these criteria (see top of Page 9 in geotechncial report). The geotechnical report provides options for paving, but does not recommend one over the other.

2. Provide details on how proposed, alternative pavement types will affect drainage in the area.

   Staff Response: Neither the geotechnical report nor the Drainage Analysis Report (by AGT Civil LLC, dated February 2015) addressed this question directly. Typically, drainage is not affected by the choice of pavement types. The Subdivision Ordinance/iSWM specifies a runoff coefficient for all hard surfaces, and does not differentiate between asphalt and concrete.

   The applicant also mentioned the significant cost associated with drainage on the project. The owner of the property pursued a Letter of Map Revision (LOMR) through the Federal Emergency Management Agency (FEMA), which provided more detailed information regarding this location and allowed the site reduce the fill in lieu of meeting the current map elevations. This reduced the amount of fill from six feet (6') to approximately three feet (3'). In addition, the current owner decided to show that the drainage on Benbrook Parkway had sufficient capacity to accept the site's flow rather than providing detention to meet the City's Ordinance.

3. Provide information on both the current sheet flow conditions; and based on current climate conditions, what is to be expected for a catch basin or collection point.

   Staff Response: According to the applicant's engineer, there is no difference or ill effect on drainage or sheet flow if the design slope, elevations and collection points are maintained. The site is designed to drain to a proposed new onsite inlet and the drainage system in Benbrook Parkway.

4. Provide the life cycle costing requirement of proposed alternative pavement types.

According to the applicant's engineer, the average life cycle cost of asphalt versus concrete is somewhat subjective because of methodology and preparation but a general average is:

- Concrete 20 years.
- Asphalt 5-10 years: Asphalt requires maintenance but if done correctly can have an equal life expectancy.

Staff Response: Life cycle costs for asphalt are typically higher because of their shorter life expectancy. Based on the applicant's submittal, asphalt lasts approximately 5-10 years and concrete lasts 20 years. Unit costs for asphalt provided by the applicant are $5.85/sq.ft. and for concrete are $5.00-$5.75/sq. ft., exclusive of subbase preparations (Note that you must add the 2" and 4" asphalt costs to equal the 5" concrete costs). Based on the applicant's data, the initial asphalt and concrete construction costs are almost identical but because the lifespan of asphalt is less than half of the concrete, the life cycle cost of asphalt may be double that of concrete. For this reason, the City constructs new roads using concrete and not asphalt.

Asphalt requires more routine maintenance than is typically performed on commercial properties. There are many older commercial sites in Benbrook built before the current concrete requirement where the asphalt parking lots are in need of repair and maintenance. The applicant referenced the City Hall parking lot (built in 1976) as an asphalt parking lot that is in good shape, but this is because of regular and continued maintenance. The parking lot is overlaid with fresh asphalt every few years. The applicant may be able to maintain asphalt parking lots, but as properties are sold, new owners may not be as diligent.

5. Provided details on heavy equipment to be used on site.

According to the applicant, the buildings will not be built to dock height and are not intended for any vehicles heavier than pickup trucks.

Staff Response: Although the buildings will not be dock high, the buildings may receive shipments from delivery services and their trucks could range from standard vans to 18 wheelers. The Fire Department is concerned that the asphalt fire lanes will not be properly maintained over time which could create problems during an emergency when using larger equipment such as the ladder truck or pumper. The Fire Department's recommendation on the waiver remains that concrete should be used in all areas, as per the Subdivision Ordinance. High temperatures soften the asphalt binder, allowing heavy loads to deform the pavement. The giving/shifting of placement under the outriggers of the ladder truck can cause a catastrophic failure of the ladder without warning. This alone can compromise the safety of firefighters during emergency operations.

6. Provide the appraised value of the property based on engineering estimate of the various pavement materials proposed.

   The applicant stated that in their commercial real estate broker's opinion, the valuation would not change based on the property having an asphalt or concrete parking lot.

   Staff Response: Staff has no evidence that either type of parking lot pavement results in a higher property value, but the staff has not engaged a property appraiser to make a study of the differences.

OPTIONS FOR THE COMMISSION:

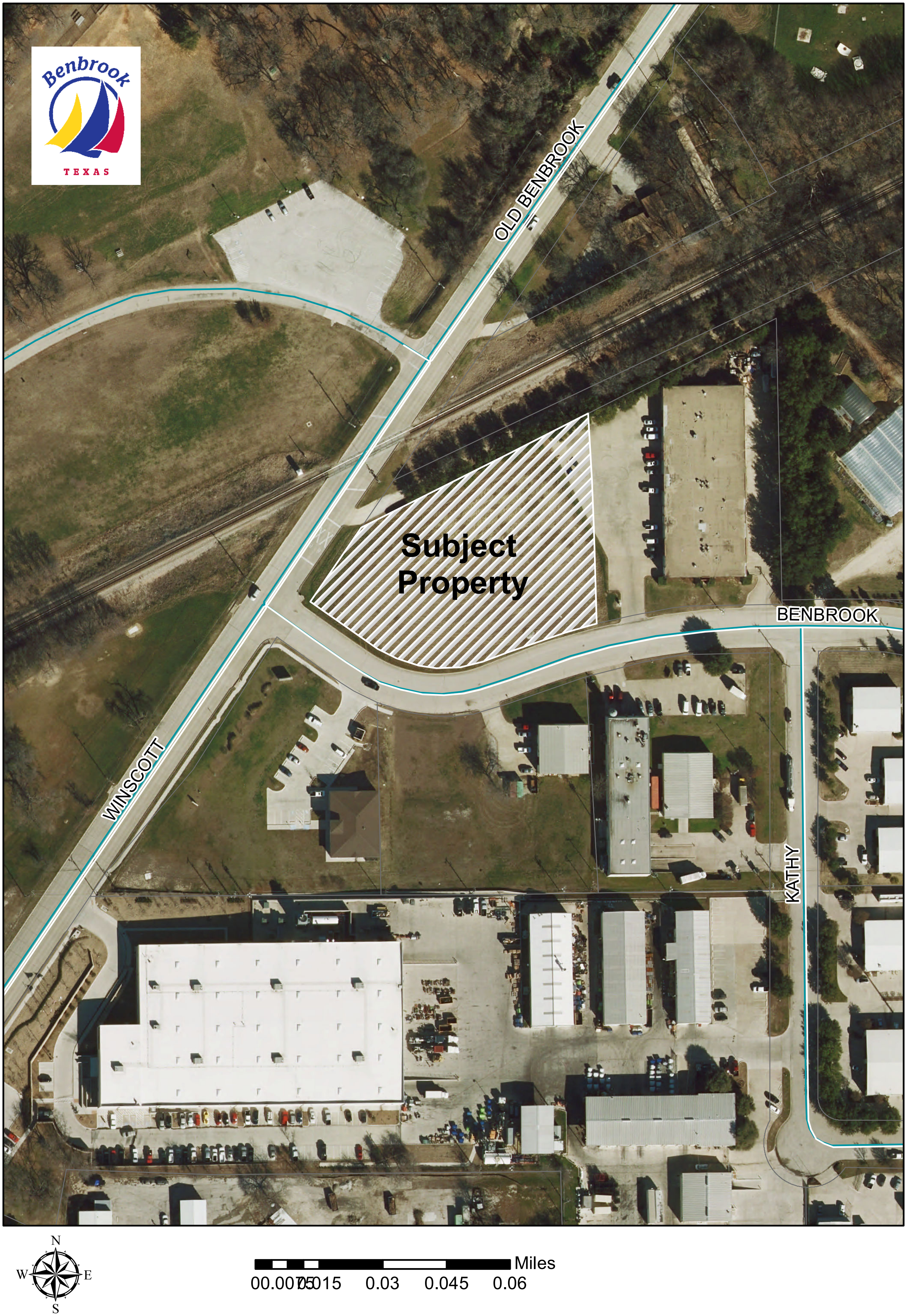
To reiterate, the Commission has the following options:

1. Approve the waiver request to allow asphalt paving in lieu of concrete throughout the site,

2. Deny the waiver and require that the parking lot be built with concrete in accordance with the City's Subdivision Ordinance, or

3. Approve a modified waiver to allow 6-inch asphalt paving in the parking stalls, bordered by a concrete curb, but maintain the concrete paving for the fire lanes, drive lanes, dumpster pad and dumpster approach.

Aerial Map


Benbrook
TEXAS
OLD BENBROOK
Subject Property
BENBROOK
WINSCOTT
KATHY
N
W
E
S
Miles
00.0075 0.015 0.03 0.045 0.06

GEOTECHNICAL REPORT
and
SUPPORTING DOCUMENTS

RJM Contractors

3629 Lovell Ave.

Ft. Worth, TX 76107

Presentation for:

Benbrook Industrial Park

7608 Benbrook Parkway

Request for Waiver to Ordinance

16.28.025.D16

Ed Brock

RJM Contractors

1. Response to City Information Request
2. Geotech Report
3. Drainage Analysis
4. Pictures and Support
5. Attachments

RJM
Contractors

3629 Lovell Ave.

Fort Worth, Texas 76107

Phone 817.377.0971

Fax 817.377.0973

July 30, 2016

Johnna Matthews
City Planner
City of Benbrook
911 Winscott Rd.
Benbrook, TX 76126
RE: Benbrook Industrial Park

Dear Johnna,

Here are some additional things to take into consideration when the Board is making their decision.

1 Most experts agree that preparation to the subsoil is as important as the material above it. Our plan is to follow those guidelines and meet or exceed those requirements. If the compaction and densities are correct you can expect the material on top to perform as designed.

2 This is considered a low traffic building. It's not a retail type facility. We have approximately 9 full time office employees and very few daily visitors. We are a General Contracting Company and don't get any "walk up" type traffic.

3 I have also enclosed pictures of other buildings with much higher traffic volume that have asphalt parking areas including your own City Hall. They don't seem to be any worse for wear. The definition is to provide for the health and safety of the occupants. Employees and visitors in our building would be no less safe than in City Hall.

4 There was a comment made from a single neighboring property owner concerned that somehow our $4,000,000 project would cause his property to depreciate if we had asphalt paving. His concern should be how much the appraised value for his property will increase. These two buildings were designed to have architectural elements that will bring a timeless sophistication and appeal for many years to come. The buildings were designed to achieve a particular look and not value engineered like other properties in the area. The money is in the engineered drainage and building design.

RJM
Contractors

5 Drainage concerns have all been pre-engineered prior to permitting. We have spent an exorbitant amount of money with our engineering firm to satisfy the City and FEMA. All of the storm water is directed to the front of the property and directed to inlets which capture the water and then filter it before it continues to the storm drain. We feel we have gone above and beyond to accommodate all State and local requirements in order to turn a pasture into a viable, tax generating facility that will be a welcome asset to the City of Benbrook.

In conclusion, I wanted to thank the City staff and the Board for their time and sincere consideration to our request. We want to provide a complex that both RJM and the City will be proud of and seen as a genuine asset Benbrook.

Many Thanks,

Ed Brock
RJM Contractors.

3629 Lovell Ave.

Fort Worth, Texas 76107

Phone 817.377.0971

Fax 817.377.0973

RJM
Contractors

3629 Lovell Ave.

Fort Worth, Texas 76107

Phone 817.377.0971

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July 30, 2016

Johnna Matthews
City Planner
City of Benbrook
911 Winscott Rd.
Benbrook, TX 76126
RE: Benbrook Industrial Park Paving

Dear Johnna,

The following information is provided in response to your letter from June 10, 2016 regarding the request for information about alternate paving design at our new office buildings.

A. I have enclosed a copy of the geotechnical report indicating design and construction recommendations and options. The report does not make any recommendation as to specific material preference; it does however indicate regardless if you use concrete or asphalt, the proper sub-grade preparations to implement in order to maximize the stability and longevity of the pavement area. See pages 9-10.
B. Cost estimates for concrete vs asphalt. Again, the subsoil preparation is key in the equation. The following pricing is exclusive of soil preparation cost.
C.

Concrete	5"	$5.00 sq ft
	7"	$5.75 sq ft
Asphalt	2"	$2.75 sq ft
	4"	$3.10 sq ft

Initial savings calculated at $35,000.
Also, please see the attached letter from Mark Wood at Howe/Wood and Associates. He has been a commercial real-estate broker for more than 30 yrs. There is no significant difference between concrete and asphalt with relation to value to a property. It's more related to the condition not the

RJM
Contractors

material. Concrete can crack and fracture if not installed properly.

D. According to our Engineer for this project, Tom Davis, if we maintain the designed slope, elevations and collection points, there is no difference or ill effect on drainage or sheet flow.
E. The average life cycle of asphalt vs concrete is somewhat subjective due to methodology and preparation but a general average is:
Concrete 20yrs. Asphalt 5-10 yrs. Asphalt does require some maintenance but if done correctly can have an equal life expectancy.
F. These are not dock height buildings and are not intended for any vehicles heavier than pickup trucks.

Hopefully these bullet points will answer the majority of your concerns. I appreciate your time and thoughtful consideration for this request.

Sincerely,

Ed Brock
RJM Contractors

3629 Lovell Ave.

Fort Worth, Texas 76107

Phone 817.377.0971

Fax 817.377.0973

RJM

GEOTECHNICAL EXPLORATION

on

RJM OFFICE / WAREHOUSE
Off Benbrook Parkway
Benbrook, Texas
ALPHA Report No. W141332

Prepared for:

RJM CONTRACTORS, INC.
3629 Lovell Avenue
Fort Worth, Texas 76107
Attention: Ms. Cynthia Turner
August 6, 2014

Prepared By:

ALPHA TESTING, INC.
5058 Brush Creek Road
Fort Worth, Texas 76119

ALPHA TESTING
WHERE IT ALL BEGINS

Geotechnical
Construction Materials
Environmental
TBPE Firm No. 813

5058 Brush Creek Road
Fort Worth, Texas 76119

Tel: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

August 6, 2014

RJM Contractors, Inc.
3629 Lovell Avenue
Fort Worth, Texas 76107
Attention: Ms. Cynthia Turner

Re: Geotechnical Exploration
RJM Office / Warehouse
Off Benbrook Parkway
Benbrook, Texas
ALPHA Report No. W141332

Attached is the report of the geotechnical exploration performed for the project referenced above. This study was authorized by Ms. Cynthia Turner on July 11, 2014 and performed in accordance with ALPHA Proposal No. 37654 dated August 19, 2013.

This report contains results of field explorations and laboratory testing and an engineering interpretation of these with respect to available project characteristics. The results and analyses were used to develop recommendations to aid design and construction of foundations and pavement.

ALPHA TESTING, INC. appreciates the opportunity to be of service on this project. If we can be of further assistance, such as providing materials testing services during construction, please contact our office.

Sincerely,

ALPHA TESTING, INC.

STATE OF TEXAS
BRIAN J. HOYT
115748
LICENSED
PROFESSIONAL ENGINEER
August 6, 2014

Brian J. Hoyt, P.E.
Geotechnical Department Manager

Mark L. McKay, P.E.
Senior Geotechnical Engineer

BJH/MLM/jck
Copies: (1 - PDF) Client

TABLE OF CONTENTS

On

ALPHA REPORT NO. W141332

1.0 PURPOSE AND SCOPE

The purpose of this geotechnical exploration is for ALPHA TESTING, INC. ("ALPHA") to evaluate for the "Client" some of the physical and engineering properties of subsurface materials at selected locations on the subject site with respect to formulation of appropriate geotechnical design parameters for the proposed construction. The field exploration was accomplished by securing subsurface samples from widely spaced test borings performed across the expanse of the site. Engineering analyses were performed from results of the field exploration and results of laboratory tests performed on representative samples.

Also included are general comments pertaining to reasonably anticipated construction problems and recommendations concerning earthwork and quality control testing during construction. This information can be used to evaluate subsurface conditions and to aid in ascertaining construction meets project specifications.

Recommendations provided in this report were developed from information obtained in test borings depicting subsurface conditions only at the specific boring locations and at the particular time designated on the logs. Subsurface conditions at other locations may differ from those observed at the boring locations, and subsurface conditions at boring locations may vary at different times of the year. The scope of work may not fully define the variability of subsurface materials and conditions that are present on the site.

The nature and extent of variations between borings may not become evident until construction. If significant variations then appear evident, our office should be contacted to re-evaluate our recommendations after performing on-site observations and possibly other tests.

2.0 PROJECT CHARACTERISTICS

It is proposed to construct two (2) new office and warehouse buildings located generally east of the intersection of Winscott Road and Benbrook Parkway in Benbrook, Texas. We understand the plan areas for the two (2) buildings are about 8,094 and 6,854 sq ft. A drawing illustrating the general outline of the property is provided as Figure 1, the Boring Location Plan, in the Appendix of this report.

At the time the field exploration was performed, the site was a cleared field with grassy vegetation. Review of topographical maps available at www.dfwmaps.com indicates the site slopes generally downward from west to east about 4 ft (Elev: 630 to Elev: 626).

We understand the buildings will be lightly loaded and will be supported with drilled pier foundations. Grading plans were not available for this study. However, based on conversations with the Client, we understand fills of up to about 6 ft will be required to raise the grade in the building pad area.

3.0 FIELD EXPLORATION

Subsurface conditions on the site were explored by drilling a total of five (5) test borings. Three (3) test borings (Borings 1 through 3) were drilled for the buildings to a depth of about 25 ft each and two (2) test borings (Borings 4 and 5) were drilled for the pavement to a depth of about 5 ft each. All test borings were performed in general accordance with ASTM D 420 using standard rotary drilling equipment. The approximate location of each boring is shown on the Boring Location Plan, Figure 1, enclosed in the Appendix of this report. Details of drilling and sampling operations are briefly summarized in Methods of Field Exploration, Section A-1 of the Appendix.

Subsurface types encountered during the field exploration are presented on the Log of Boring sheets (boring logs) included in the Appendix of this report. The boring logs contain our Field Technician's and Engineer's interpretation of conditions believed to exist between actual samples retrieved. Therefore, the boring logs contain both factual and interpretive information. Lines delineating subsurface strata on the boring logs are approximate and the actual transition between strata may be gradual.

4.0 LABORATORY TESTS

Selected samples of the subsurface materials were tested in the laboratory to evaluate their engineering properties as a basis in providing recommendations for foundation design and earthwork construction. A brief description of testing procedures used in the laboratory can be found in Methods of Laboratory Testing, Section B-1 of the Appendix. Individual test results are presented on the Log of Boring sheets or summary data sheets enclosed in the Appendix.

5.0 GENERAL SUBSURFACE CONDITIONS

Based on geological atlas maps available from the Bureau of Economic Geology, published by The University of Texas at Austin, this site lies within Alluvium Deposits underlain by the Goodland Limestone and Walnut Clay formations mapped as undivided. Alluvium Deposits generally consist of clays, sand and gravels. The Goodland Limestone Formation generally consists of limestone with clay beds. The clay soils encountered in this formation are generally characterized with low to high shrink-swell potential.

Subsurface conditions encountered in the borings generally consisted of clay soils extending to the termination depths of the borings (about 25 ft in Borings 1, 2 and 3 and about 5 ft in Borings 4 and 5). A layer of limestone was encountered within the clay soils in Boring 1 at a depth of about 8 ft extending to about 12 ft below the ground surface. More detailed stratigraphic information is presented on the Log of Boring sheets attached to this report.

The clay and limestone materials encountered in the borings are considered relatively impermeable and are expected to have a relatively slow response to water movement. Therefore, several days of observation would be required to evaluate actual groundwater levels within the depths explored. Also, the groundwater level at the site is anticipated to fluctuate seasonally depending on the amount of rainfall, prevailing weather conditions and subsurface drainage characteristics.

Groundwater was encountered during drilling at depths of about 22 ft to 23 ft below the ground surface in Borings 1, 2 and 3 and at a depth of about 21 ft in the open boreholes immediately upon completion of drilling. It is common to encounter seasonal groundwater from natural fractures within the clayey matrix and at the soil rock (limestone) interface and from fractures in the rock, particularly during or after periods of precipitation. If more detailed groundwater information is required, monitoring wells or piezometers can be installed.

Further details concerning subsurface materials and conditions encountered can be obtained from the boring logs provided in the Appendix of this report.

6.0 DESIGN RECOMMENDATIONS

The following design recommendations were developed on the basis of the previously described Project Characteristics (Section 2.0) and General Subsurface Conditions (Section 5.0). If project criteria should change, including the building locations on the site our office should conduct a review to determine if modifications to the recommendations are required. Further, it is recommended our office be provided with a copy of the final plans and specifications for review prior to construction.

The following design criteria given in this report were developed assuming the floor slabs are constructed about 6 ft above the existing grade. Filling on the site beyond that assumed can alter the recommended foundation design parameters. Therefore, it is recommended our office be contacted once detailed site grading plans are available to verify appropriate design parameters are utilized for final foundation design.

6.1 Drilled and Underreamed Piers

The structural frame and walls for the proposed buildings could be supported using a system of drilled and underreamed piers. We recommend these piers bear in clay at a depth of about 17 ft below finished grade after filling. Some field adjustments in the depth of the piers may be required in some areas to maintain the bottom of the piers above any possible groundwater seepage encountered near the bearing depth. Adjustments in the depths of the piers should be observed in the field by ALPHA personnel.

Limestone was encountered at a depth about 8 ft below the existing ground surface in Boring 1. After fills of about 6 ft to achieve final grade in the building pad area (discussed in Section 2.0), this limestone will situated at a depth of about 14 ft below final grade. Based on the boring logs, the depth/presence of limestone is variable across the site. Where limestone is encountered at a depth of at least 13 ft below the final ground surface, the underream can bear on the surface of the limestone. ALPHA should be retained to monitor pier construction and verify the pier bearing depths during construction.

Piers can be dimensioned using a net allowable end bearing pressure of 3 kips per sq ft and no skin friction component of resistance. The above bearing capacity contains a factor of safety of at least three (3) considering a general bearing capacity failure. Normal elastic settlement of piers under loading is estimated to be less than about 1 inch.

Each pier should be designed with full length reinforcing steel to resist the uplift pressure (soil-to-pier adhesion) due to potential soil swell along the shaft from post construction heave and other uplift forces applied by structural loadings. The magnitude of uplift adhesion due to soil swell along the pier shaft cannot be defined accurately and can vary according to the actual in-place moisture content of the soils during construction. It is estimated this uplift adhesion will not exceed about 1.5 kips per sq ft. This soil adhesion is approximated to act uniformly over the upper 12 ft of the pier shaft in contact with clayey soils. Uplift adhesion due to soil heave can be neglected over the portion of the pier shaft in contact with any non-expansive material.

The uplift force due to swelling of active clays should be resisted by the underreamed portion of the pier. The underreamed portion should be at least two (2) and not exceeding three (3) times the diameter of the shaft. The minimum clear spacing between edges of adjacent piers should be at least one (1) underream diameter, based on the larger underream.

All grade beams connecting piers should be formed and not cast in earthen trenches. Grade beams should be formed with a nominal 8-inch void at the bottom. Commercially available cardboard box forms (cartons) are made for this purpose. The cardboard cartons should extend the full length and width of the grade beams. Prior to concrete placement, the cartons should be inspected to verify they are firm, properly placed, and capable of supporting wet concrete. Some type of permanent soil retainer, such as pre-cast concrete panels, must be provided to prevent soils adjacent to grade beams from sloughing into the void space at the bottom of the grade beams. Additionally, backfill soils placed adjacent to grade beams must be compacted as outlined in Section 7.3 of this report.

6.2 Floor Slabs and Subgrade Improvement

Potential seasonal movements at this site will be highly dependent on the type of fill materials used to raise site grades within the building pads. Floor slabs constructed over fills of about 6 ft above existing grade, as described in Section 2.0, using on site or similar soils (with a PI of 30 or less) could experience soil-related potential seasonal movements of about 3 inches. Potential seasonal movements could exceed 3 inches if clay soils with a plasticity index greater than 30 are used to raise the grade. Alternately, if non-expansive fill is used to raise the grade 6 ft, potential seasonal movements would be about 1 inch or less. Non-expansive fill is described in Section 7.3 of this report.

The above potential seasonal movements were estimated in general accordance with methods outlined by Texas Department of Transportation (TxDOT) Test Method Tex-124-E, from results of absorption swell tests and engineering judgment and experience. Estimated movements were calculated assuming the moisture content of the in-situ soil within the normal zone of seasonal moisture content change varies between a "dry" condition and a "wet" condition as defined by Tex-124-E. Also, it was assumed a 1 psi surcharge load from the floor slab acts on the subgrade soils. Movements exceeding those predicted above could occur if positive drainage of surface water is not maintained or if soils are subject to an outside water source, such as leakage from a utility line or subsurface moisture migration from off-site locations.

The most positive floor system for the buildings supported on piers is a slab suspended completely above the existing expansive soils. At least 12 inches of void space should be provided between the bottom of the lowest hanging beam or utility and top surface of the underlying expansive clays. A ventilated and drained crawl space is preferred. Provisions should be made for adequate drainage of the under-floor space and differential movement of utility lines.

If clay fill is used to raise the grade, installation of 8 ft of moisture conditioned soil in conjunction with 2 ft of non-expansive fill could reduce floor slab movements to about 1 inch. Based on fills of 6 ft to raise the grade, the existing onsite clay soils would require over-excavation to a depth of 4 ft to provide the required 8 ft depth of moisture conditioned soil and 2 ft non-expansive fill cap below the floor slab. Likewise, 10 ft of water pressure injection in conjunction with 2 ft of non-expansive fill should also reduce floor slab movements to about 1 inch. Subgrade improvement methods are discussed in more detail in Sections 6.2.1 and 6.2.2. Non-expansive fill is described in Section 7.3 of this report, below. ~~In choosing these methods of floor slab movement reduction, the~~ Owner is accepting some post construction seasonal movement of the floor slab (1 inch).

If a soil-supported floor slab is utilized for the planned building, a "floating" (fully ground supported, and not structurally connected to walls or foundations) floor slab is preferred. This reduces the risk of cracking and displacement of the floor slab due to differential movements between the slab and foundations. A floor slab doweled into perimeter grade beams can develop a plastic hinge (crack) parallel to and approximately 5 to 10 ft inside the building perimeter. The structural engineer should determine the need for connections between the slab and structural elements and determine if control joints to limit cracking are needed. A properly designed and constructed moisture barrier should be placed between the slab and subgrade soils to retard moisture migration through the slab.

6.2.1 Subgrade Improvement Utilizing Moisture-Conditioned Soil

Movement of the floor slab could be reduced to about 1 inch by placing a minimum 2-ft cap of non-expansive material between the bottom of the floor slab and the top surface of 8 ft of moisture-conditioned soil. Non-expansive fill could consist of select fill or flexible base material as described in Section 7.3 below.

Moisture-conditioning consists of processing and compacting the specified minimum thickness of on-site soil at a "target" moisture content approximated to be at least 5 percentage points above the material's optimum moisture content as determined by the standard Proctor method (ASTM D 698). The moisture-conditioned soil should be compacted to a dry density of 93 to 97 percent of standard Proctor maximum dry density. Moisture conditioning of the on-site soil should extend throughout the entire building pad area and at least 5 ft beyond the perimeter of the building. At building entrances and outward swinging doors, moisture conditioning should extend at least 10 ft beyond the building perimeter. However, non-expansive material should not extend beyond the building limits. If flatwork or paving is not planned adjacent to the structure (i.e. above the moisture-conditioned soils), a moisture barrier consisting of a minimum of 10 mil plastic sheeting with 8 to 12 inches of soil cover should be provided above the moisture conditioned soils. Moisture-conditioned soils should be maintained in a moist condition prior to placement of the required thickness of non-expansive material or flatwork.

The resulting estimated potential seasonal movements (about 1 inch) were calculated assuming the moisture content of the moisture-conditioned soil varies between the "target" moisture content and the "wet" condition while the deeper undisturbed in-situ soil within the normal zone of seasonal moisture content change varies between the "dry" condition and the "wet" condition as defined by methods outlined in TxDOT Test Method Tex-124-E.

Please note; it is the intent of the moisture-conditioning process described above to reduce the free swell potential of the moisture-conditioned soil to 1 percent or less. Additional laboratory tests (i.e., standard Proctors, absorption swell tests, etc.) should be conducted during construction to verify the "target" moisture content for moisture-conditioning (estimated at 5 percentage points above the material's optimum moisture content as defined by ASTM D 698) is sufficient to reduce the free swell potential of the processed soil to 1 percent or less. In addition, it is recommended samples of the moisture-conditioned material be routinely obtained during construction to verify the free swell of the improved material is 1 percent or less.

Moisture conditioning should be monitored and tested on a full-time basis by ALPHA TESTING to verify materials tested are placed with the proper degree of moisture and compaction as presented in this report. Field density tests should be performed for each lift of fill placed in each building pad area.

6.2.2 Subgrade Improvement Utilizing Water Pressure Injection (WPI)

As an alternative, installation of 10 ft of water pressure injection (WPI) in conjunction with a 2-ft cap of non-expansive fill could reduce potential slab movements to about 1 inch.

Improvement Procedures:

1. Following removal of the necessary thickness of on-site expansive soils to allow for placement of at least 2 ft of non-expansive fill, the exposed subgrade of the building pad should be water pressure injected (WPI) to a depth of 10 ft below the bottom of the non-expansive fill. The water pressure injection should extend throughout the entire building pad area and at least 5 ft beyond the perimeter of the building. At building entrances and outward swinging doors, WPI should extend at least 10 ft beyond the building perimeter. However, the non-expansive fill should not extend beyond the building limits. Recommended specifications for WPI are attached to this report in the appendix.

2. If flatwork or paving is not planned adjacent to the structure (i.e. above the injected soils), a moisture barrier consisting of a minimum of 10 mil plastic sheeting with 8 to 12 inches of soil cover should be provided above the moisture injected soils. Injected soils should be maintained in a moist condition prior to placement of the required thickness of select, non-expansive material or flatwork.

Performance of post-injection swell testing and moisture content determinations should be employed as final acceptance criteria in engineering analysis to examine accomplishment of intended objectives of the injection treatment. Maximum benefit of these movement reduction procedures can be achieved by employing ALPHA TESTING, INC. to observe, monitor and test the entire process. Construction specifications for the water pressure injection process are provided in the Appendix of this report.

The purpose of the above procedure is to pre-swell the existing soils. Satisfactory completion of the injection process is achieved when the desired moisture content and abatement of swell in the injected subgrade clay soils are reached. Acceptance criteria for water pressure injection should be based upon obtaining an average free swell of 1 percent or less in the injected zone. Performance of post-injection swell testing and moisture content determinations should be employed as final acceptance criteria in engineering analysis to examine accomplishment of intended objectives of the injection treatment.

The resulting estimated potential seasonal movements (about 1 inch) were calculated assuming the average free swell of the injected soils does not exceed 1 percent. Further, it is assumed the moisture content of the soil below the injected zone and within the normal zone of seasonal moisture content change varies between a "dry" condition and a "wet" condition as defined by TxDOT Test Method Tex-124-E.

6.3 Exterior Flatwork

Flatwork, pavement and any other soil-supported structural elements will be subjected to the same level of movement as discussed in Section 6.2 (about 3 inches if using on-site or similar soils with a PI of 30 or less to raise site grades). If this level of movement is not acceptable, flatwork could be structurally supported on drilled pier foundations as described in Section 6.2 above. As an alternative, subgrade improvements as recommended in Section 6.2 could be considered for reduction in soil movements in any areas where post-construction movements would be critical.

6.4 Seismic Considerations

The Site Class for seismic design is based on several factors that include soil profile (soil or rock), shear wave velocity, and strength, averaged over a depth of 100 ft. Since our borings did not extend to 100-foot depths, we based our determinations on the assumption that the subsurface materials below the bottom of the borings were similar to those encountered at the termination depth. Based on Section 1613.3.2 of the 2012 International Building Code and Table 20.3-1 in the 2010 ASCE-7, we recommend using Site Class D (stiff soil profile) for seismic design at this site.

6.5 Pavement

To permit correlation between information from test borings and actual subgrade conditions exposed during construction, a qualified Geotechnical Engineer should be retained to provide subgrade monitoring and testing during construction. If there is any change in project criteria, the recommendations contained in this report should be reviewed by our office.

Calculations used to determine the required pavement thickness are based only on the physical and engineering properties of the materials used and conventional thickness determination procedures. Pavement joining buildings should be constructed with a curb and the joint between the building and curb should be sealed. Related civil design factors such as subgrade drainage, shoulder support, cross-sectional configurations, surface elevations, reinforcing steel, joint design and environmental factors will significantly affect the service life and must be included in preparation of the construction drawings and specifications, but all were not included in the scope of this study. Normal periodic maintenance will be required for all pavement to achieve the design life of the pavement system.

Recommendations for Portland cement concrete (PCC) and asphalt concrete (AC) pavement are provided below. These types of pavement are not considered equal in performance. Asphalt concrete pavement should be expected to have a shorter life and higher maintenance costs. Also, pavement in dumpster areas and areas receiving heavy truck traffic should consist of PCC.

Please note, the recommended pavement sections provided below are considered the minimum necessary to provide satisfactory performance based on the expected traffic loading. In some cases, City minimum standards for pavement section construction may exceed those provided below.

6.5.1 Pavement Subgrade Preparation

In areas where clay soils are exposed after final subgrade elevation is achieved, the exposed surface of the pavement subgrade soil should be scarified to a depth of 6 inches and mixed with a minimum 7 percent hydrated lime (by dry soil weight) in conformance with TxDOT Standard Specification Item 260. Assuming an in-place unit weight of 100 pcf for the pavement subgrade soils, this percentage of lime equates to about 32 lbs of lime per sq yard of treated subgrade. The actual amount of lime required should be confirmed by additional laboratory tests (ASTM C 977 Appendix XI) prior to construction. The soil-lime mixture should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 0 to 4 percentage points above the mixture's optimum moisture content. In all areas where hydrated lime is used to stabilize subgrade soil, routine Atterberg-limit tests should be performed to verify the resulting plasticity index of the soil-lime mixture is at/or below 15.

It is recommended lime stabilization procedures extend at least 1 ft beyond the edge of the pavement to reduce effects of seasonal shrinking and swelling upon the extreme edges of pavement.

Lime stabilization of the pavement subgrade soil will not prevent normal seasonal movement of the underlying untreated materials. Pavement and other flatwork will have the same potential for movement as slabs constructed directly on the existing undisturbed soils. Therefore, good perimeter surface drainage with a minimum slope of 2 percent away from the pavement is recommended. The use of sand as a leveling course below pavement supported on expansive clays should be avoided. Normal maintenance of pavement should be expected over the life of the structures.

6.5.2 Portland-Cement Concrete Pavement

Lime treatment of the clay pavement subgrade as described in Section 6.5.1 above is recommended for drive lanes, fire lanes, and pavement subject to truck and dumpster traffic. Lime treatment of the pavement subgrade is not necessary for PCC pavements subjected *exclusively* to passenger vehicle traffic, although lime treatment in these areas would be generally beneficial to the long-term performance of the pavement. Prior to construction of pavement on untreated clay subgrade soil, the exposed subgrade should be scarified to a depth of at least 6 inches and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 0 to 4 percentage points above the material's optimum moisture content.

Pavement in areas subjected exclusively to passenger vehicle traffic can consist of 5 inches of adequately reinforced PCC. A minimum of 6 inches PCC is recommended in drive lanes, fire lanes and areas subject to light volume truck traffic. A minimum of 7 inches of PCC is recommended for dumpster traffic areas or pavement subject to moderate volume truck traffic. Portland-cement concrete should have a minimum compressive strength of 3,000 lbs per sq inch (psi) at 28 days in light-duty traffic areas and 3,500 psi in moderate-duty and truck traffic areas. Concrete should be designed with 5 $\pm$ 1 percent entrained air. Joints in concrete paving should not exceed 15 ft. Reinforcing steel should consist of No. 3 bars placed at 18 inches on-center in two directions.

Alternately, lime-stabilization of the clay pavement subgrade could be eliminated by increasing the corresponding PCC thickness presented in the pavement sections above for drive lanes, fire lanes, and pavement subjected to truck and dumpster traffic by 1 inch. Prior to construction of pavement on untreated clay subgrade soil, the exposed subgrade should be scarified to a depth of at least 6 inches and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 0 to 4 percentage points above the material's optimum moisture content.

6.5.3 Asphalt Concrete Pavement

Subgrade preparation as described in Section 6.5.1 above is required for asphalt concrete pavement.

1. In light-duty traffic areas (passenger vehicle parking and areas up to about 100,000 18-kip equivalent axle load repetitions), the pavement section can consist of at least 5 inches of asphalt concrete. This section could be composed of 2 inches of surface course (TxDOT Standard Specification Item 340 – Type D Surface Course) over 3 inches of asphalt concrete base course (TxDOT Standard Specification Item 340 – Type A or B Base Course) and overlying a subgrade prepared as recommended in Section 6.5.1.

2. In moderate-duty traffic areas (drive lanes, bus lanes, and areas up to about 300,000 18-kip equivalent axle load repetitions), the pavement section can consist of at least 6 inches of asphalt concrete. This section could be composed of 2 inches of surface course (TxDOT Standard Specification Item 340 – Type D Surface Course) over 4 inches of asphalt concrete base course (TxDOT Standard Specification Item 340 – Type A or B Base Course) and overlying a subgrade prepared as recommended in Section 6.5.1.

3. The coarse aggregate in the surface course should be composed of angular crushed limestone rather than smooth gravel.

6.6 Drainage and Other Considerations

Adequate drainage should be provided to reduce seasonal variations in the moisture content of foundation soils. All pavement and sidewalks within 5 ft of the structures should be sloped away from the buildings to prevent ponding of water around the buildings. Final grades within 5 ft of the structures should be adjusted to slope away from the structures at a minimum slope of 2 percent. **Maintaining positive surface drainage throughout the life of the structures is essential.**

In areas with pavement or sidewalks adjacent to the new structures, a positive seal must be maintained between the structure and the pavement or sidewalk to minimize seepage of water into the underlying supporting soils. Post-construction movement of pavement and flatwork is common. Normal maintenance should include examination of all joints in paving and sidewalks, etc. as well as resealing where necessary.

Several factors relate to civil and architectural design and/or maintenance, which can significantly affect future movements of the foundation and floor slab system:

1. Preferably, a complete system of gutters and downspouts should carry runoff water a minimum of 5 feet from the completed structures.

2. Large trees and shrubs should not be allowed closer to the foundations than a horizontal distance equal to roughly one-half of their mature height due to their significant moisture demand upon maturing.

3. Moisture conditions should be maintained "constant" around the edge of the slab. Ponding of water in planters, in unpaved areas, and around joints in paving and sidewalks can cause slab movements beyond those predicted in this report.

4. Planter box structures placed adjacent to the buildings should be provided with a means to assure concentrations of water are not available to the subsoil stratigraphy.

Trench backfill for utilities should be properly placed and compacted as outlined in Section 7.3 of this report and in accordance with requirements of local City standards. Since granular bedding backfill is used for most utility lines, the backfilled trench should not become a conduit and allow access for surface or subsurface water to travel toward the new structures. Concrete cut-off collars or clay plugs should be provided where utility lines cross building lines to prevent water from traveling in the trench backfill and entering beneath the structures.

7.0 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

Variations in subsurface conditions could be encountered during construction. To permit correlation between test boring data and actual subsurface conditions encountered during construction, it is recommended a registered Professional Engineering firm be retained to observe construction procedures and materials.

Some construction problems, particularly degree or magnitude, cannot be anticipated until the course of construction. The recommendations offered in the following paragraphs are intended not to limit or preclude other conceivable solutions, but rather to provide our observations based on our experience and understanding of the project characteristics and subsurface conditions encountered in the boring.

7.1 Site Preparation and Grading

All areas supporting floor slabs, flatwork, pavement and areas to receive new fill should be properly prepared.

After completion of the necessary stripping, clearing, and excavating, and prior to placing any required fill, the exposed soil subgrade should be carefully evaluated by probing and testing. Any undesirable material (organic material, wet, soft, or loose soil) still in place should be removed.

The exposed soil subgrade should be further evaluated by proof-rolling with a heavy pneumatic tired roller, loaded dump truck or similar equipment weighing approximately 20 tons to check for pockets of soft or loose material hidden beneath a thin crust of possibly better soil. Proof-rolling procedures should be observed routinely by a Professional Engineer or his designated representative. Any undesirable material (organic material, wet, soft, or loose soil) exposed from the proof-roll should be removed and replaced with well-compacted material as outlined in Section 7.3.

Prior to placement of any fill, the exposed soil subgrade should then be scarified to a minimum depth of 6 inches and recompacted as outlined in Section 7.3.

If fill is to be placed on existing slopes (natural or constructed) steeper than six horizontal to one vertical (6:1), the fill materials should be benched into the existing slopes in such a manner as to provide a minimum bench width of five (5) feet. This should provide a good contact between the existing soils and new fill materials, reduce potential sliding planes and allow relatively horizontal lift placements.

Slope stability analysis of embankments (natural or constructed) and global stability analysis for retaining walls was not within the scope of this study.

The contractor is responsible for designing any excavation slopes, temporary sheeting or shoring. Design of these structures should include any imposed surface surcharges.

Construction site safety is the sole responsibility of the contractor, who shall also be solely responsible for the means, methods and sequencing of construction operations. The contractor should also be aware that slope height, slope inclination or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state and/or federal safety regulations, such as OSHA Health and Safety Standard for Excavations, 29 CFR Part 1926, or successor regulations. Stockpiles should be placed well away from the edge of the excavation and their heights should be controlled so they do not surcharge the sides of the excavation. Surface drainage should be carefully controlled to prevent flow of water over the slopes and/or into the excavations. Construction slopes should be closely observed for signs of mass movement, including tension cracks near the crest or bulging at the toe. If potential stability problems are observed, a geotechnical engineer should be contacted immediately. Shoring, bracing or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Texas.

Due to the nature of the clay soils found near the surface at the borings, traffic of heavy equipment (including heavy compaction equipment) may create pumping and general deterioration of shallow soils. Therefore, some construction difficulties should be anticipated during periods when these soils are saturated.

7.2 Foundation Excavations

All foundation excavations should be monitored to verify foundations bear on suitable material. The bearing stratum exposed in the base of all foundation excavations should be protected against any detrimental change in conditions. Surface runoff water should be drained away from excavations and not allowed to collect. All concrete for foundations should be placed as soon as practical after the excavation is made. Piers should be excavated and concrete placed the same day.

Prolonged exposure of the bearing surface to air or water will result in changes in strength and compressibility of the bearing stratum. Therefore, if delays occur, pier excavations should be slightly deepened and cleaned, in order to provide a fresh bearing surface.

All pier shafts should be at least 1.5-ft in diameter to facilitate clean-out of the base and proper monitoring. Concrete placed in pier holes should be directed through a tremie, hopper, or equivalent. Placement of concrete should be vertical through the center of the shaft without hitting the sides of the pier or reinforcement to reduce the possibility of segregation of aggregates. Concrete placed in piers should have a minimum slump of 5 inches (but not greater than 7 inches) to avoid potential honey-combing.

Observations during pier drilling should include, but not necessarily be limited to, the following items:

Verification of proper bearing strata and consistency of subsurface stratification with regard to boring logs,

Confirmation the minimum required penetration into the bearing strata is achieved,

Complete removal of cuttings from bottom of pier holes,

Proper handling of any observed water seepage and sloughing of subsurface materials,

No more than 2 inches of standing water should be permitted in the bottom of pier holes prior to placing concrete, and

Verification of pier diameter, underream size, and steel reinforcement.

Groundwater was encountered at depths of about 21 ft to 23 ft below the ground surface in Borings 1, 2 and 3. Groundwater seepage could be encountered during pier installation. The risk of encountering this seepage is increased during or after periods of precipitation. Some field adjustments in the depth of the piers may be required in some areas to maintain the bottom of the piers above groundwater seepage. Adjustments in the depths of the piers should be observed in the field by ALPHA personnel. Also, the clay soils encountered at the boring locations are prone to collapse during construction of the underreamed portion of the pier foundation. Immediate placement of concrete after constructing the underream and/or the use of submersible pumps may be adequate to control underream collapse and/or seepage. Temporary casing may be useful for controlling groundwater seepage that could occur in the clay soils. As casing is extracted, care should be taken to maintain a positive head of plastic concrete and minimize the potential for intrusion of water seepage. It is recommended a separate bid item be provided for casing on the contractors' bid schedule.

ALPHA should be contacted for further review and evaluation if groundwater seepage and/or underream collapse occurs during pier installation.

7.3 Fill Compaction

Materials used as select, non-expansive material should have a liquid limit less than 35, a plasticity index (PI) not less than about 4 nor greater than 15 and contain no more than 0.5 percent fibrous organic materials, by weight. All select material should contain no deleterious material and should be compacted to a dry density of at least 95 percent standard Proctor maximum dry density (ASTM D 698) and within the range of 1 percentage point below to 3 percentage points above the material's optimum moisture content. (Note: The plasticity index and liquid limit of material used as select, non-expansive material should be routinely verified during placement using laboratory tests. Visual observation and classification should not be relied upon to confirm the material to be used as select, non-expansive material satisfies the above plasticity index and liquid limit criteria.)

Flexible base used as non-expansive fill in the building pad should consist of material meeting the requirements of TxDOT Standard Specifications Item 247, Type A, B, C, or D, Grade 1, 2 or 3. The flexible base should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 2 percentage points below to 2 percentage points above the material's optimum moisture content.

The recommendations below pertain to fill placement for general site grading outside the building pad areas. All fill placed in the building pads should conform to the requirements in Section 6.2 of this report, above.

Clay soils with a plasticity index equal to or greater than 25 should be compacted to a dry density between 93 and 98 percent of standard Proctor maximum dry density (ASTM D 698). The compacted moisture content of the clays during placement should be within the range of 2 to 6 percentage points above optimum.

Clay soils with a plasticity index below 25 should be compacted to a dry density of at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 1 percentage point below to 3 percentage points above the material's optimum moisture content.

Clay fill should be processed such that the largest particle or clod is less than 6 inches prior to compaction.

In cases where either mass fills or utility lines are more than 10 ft deep, the fill/backfill below 10 ft should be compacted to at least 100 percent of standard Proctor maximum dry density (ASTM D-698) and within 2 percentage points of the material's optimum moisture content. The portion of the fill/backfill shallower than 10 ft should be compacted as outlined above.

Compaction should be accomplished by placing fill in about 8-inch thick loose lifts and compacting each lift to at least the specified minimum dry density. Field density and moisture content tests should be performed on each lift.

7.4 Groundwater

Groundwater was encountered at depths of about 21 ft to 23 ft below the ground surface in Borings 1, 2 and 3. From our experience groundwater seepage could be encountered in excavations for foundations, utilities and other general excavations at this site. The risk of seepage increases with depth of excavation and during or after periods of precipitation. Standard sump pits and pumping may be adequate to control seepage on a local basis.

In any areas where cuts are made to establish final grades, attention should be given to possible seasonal water seepage that could occur through natural cracks and fissures in the newly exposed stratigraphy. In these areas, subsurface drains may be required to intercept seasonal groundwater seepage. The need for these or other de-watering devices should be carefully addressed during construction. Our office could be contacted to visually observe the final grades to evaluate the need for such drains.

8.0 LIMITATIONS

Professional services provided in this geotechnical exploration were performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. The scope of services provided herein does not include an environmental assessment of the site or investigation for the presence or absence of hazardous materials in the soil, surface water or groundwater. ALPHA, upon written request, can be retained to provide same.

ALPHA TESTING, INC. is not responsible for conclusions, opinions or recommendations made by others based on this data. Information contained in this report is intended for the exclusive use of the Client (and their designated design representatives), and is related solely to design of the specific structures outlined in Section 2.0. No party other than the Client (and their designated design representatives) shall use or rely upon this report in any manner whatsoever unless such party shall have obtained ALPHA's written acceptance of such intended use. Any such third party using this report after obtaining ALPHA's written acceptance shall be bound by the limitations and limitations of liability contained herein, including ALPHA's liability being limited to the fee paid to it for this report. Recommendations presented in this report should not be used for design of any other structures except those specifically described in this report. In all areas of this report in which ALPHA may provide additional services if requested to do so in writing, it is presumed that such requests have not been made if not evidenced by a written document accepted by ALPHA. Further, subsurface conditions can change with passage of time. Recommendations contained herein are not considered applicable for an extended period of time after the completion date of this report. It is recommended our office be contacted for a review of the contents of this report for construction commencing more than one (1) year after completion of this report. Non-compliance with any of these requirements by the Client or anyone else shall release ALPHA from any liability resulting from the use of, or reliance upon, this report.

Recommendations provided in this report are based on our understanding of information provided by the Client about characteristics of the project. If the Client notes any deviation from the facts about project characteristics, our office should be contacted immediately since this may materially alter the recommendations. Further, ALPHA TESTING, INC. is not responsible for damages resulting from workmanship of designers or contractors and it is recommended the Owner retain qualified personnel, such as a Geotechnical Engineering firm, to verify construction is performed in accordance with plans and specifications.

APPENDIX

SOIL MODIFICATION
WATER PRESSURE INJECTION (WPI)
GUIDELINE SPECIFICATIONS

Purpose

The purpose of this specification is to provide a procedural basis for using water pressure injection as a method to obtain a relatively uniform, moist, pre-swelled zone of soil beneath the floor slab. Specifically, the intent of this procedure is to reduce the average free swell potential of soils within the injected zone to 1 percent or less.

Material

1. Only potable water shall be used during the entire injection process.

2. A non-ionic surfactant (wetting agent) will be added to the water according to manufacturer's recommendations, but, in no case will proportions be less than one part (undiluted) per 3,500 gallons of water.

Application

1. The water pressure injection work shall be accomplished after the site has been brought to near final subgrade elevation and prior to installation of any plumbing, trenches and utilities.

2. The injection vehicle will have a minimum gross weight of 5 tons and shall be capable of making straight vertical penetrations to minimize pressure loss around the injector rods to at least 10 ft.

3. Injections will be continued to "REFUSAL" (until the maximum reasonable quantity of water has been injected into the soil and water is flowing freely at the surface, either out of previous injection holes or from areas where the surface soils have fractured. The amount of water flowing from the areas described above will be approximately equivalent to the volume of water being pumped into the soil. As a minimum, injections should be at least 30 seconds at each injection interval unless altered by the Geotechnical Engineer).

   Note: Loss of water or blow-back around injector pipes does not constitute refusal. Continued loss of water in this manner may indicate inadequate injection equipment or techniques, or in some instances, surficial soils that will not form an adequate seal to contain the water. In either instance, the owner's representative should be contacted and an on-site observation made to determine appropriate steps to achieve adequate injection.

After completion of water injection, the injection contractor will submit records which reflect the total quantity of water used. The injection contractor will be totally responsible for determining the means and methods of injecting the on-site soils such that the average free swell of soils within the injected zone does not exceed 1 percent.

4. Injection pipe(s) will penetrate the soil in approximately 12 to 18-inch intervals, injecting to refusal at each interval for a total depth of 10 ft or impenetrable material, whichever occurs first. If a seemingly impenetrable layer is encountered, ALPHA TESTING, INC. must be contacted to evaluate the significance of the lack of penetration with the injector tubes or provide alternate recommendations. A minimum of seven (7) injection intervals will be provided for the 10-ft injection depth. The lower portion of the injection pipe will consist of a hole pattern that will uniformly disperse water throughout the entire depth.

5. Spacing for the injections will not exceed 5 feet on-center each way. Subsequent injections will be offset laterally at one-half the distance in both directions between the original injection centers.

6. Injection pressures should be adjusted to inject the greatest quantity of water possible within a pressure range of 50 - 200 psi pump pressure.

7. After a minimum curing time of 48 hours, the water injected pad shall be tested for moisture content and swell abatement to determine if additional injections with water are necessary. Subsequent water injections will be 5 feet on-center each way and spaced 2 ½ feet offset in two orthogonal directions from the initial injection.

8. Upon completion of the final water pressure injection, the top surface of the injected pad should be scarified to a depth of at least 6 inches and re-compacted to between 93 and 98 percent of the optimum density, at a moisture content between 2 and 4 percentage points above the optimum values, as defined by ASTM D-698. Compaction tests should be performed at a frequency of 1 test per 5,000 sq ft with a minimum of three (3) tests per pad.

9. The moisture content of the injected soils will be maintained until the floor slab is placed. Loss of moisture from the surface or sides of the building pad must be prevented by watering or use of a membrane. Any open trenches should be sealed or kept wet to prevent loss of moisture. All trenches should be backfilled with the excavated material. The moisture content of the backfill should be maintained in the range of 2 to 4 percentage points above optimum.

Special Considerations

Several water injections may be required to achieve the desired final moisture content and corresponding soil swell abatement. A minimum 24 hour waiting period should be implemented between water injection passes. Due to variations in the subsurface soils, the number of injection passes required to reduce the swell potential of the injected soils to 1 percent or less is unknown. Hence, the Client should allow for extra construction time on the site considering the time frame required to achieve the desired reduction in swell potential is unknown. Further, the contract with the Injection Contractor should address the situation where more injection passes than predicted are required to achieve the desired result.

Between the time the subgrade is water pressure injected and either the select fill material or plastic sheeting is placed, the upper surface of the injected soil should not be allowed to dry. To allow for adequate pre-swelling of the soils from the injection procedure, concrete for slabs should not be placed above injected areas until at least two (2) weeks following the final water injection. During this two-week period, the surface of the injected soil must be kept moist or covered with plastic sheeting to prevent moisture loss. About 2 to 3 inches of heave can be expected in building pads during and shortly after completion of the injection process.

Additionally, experience indicates injection adjacent to existing structures (such as, but not limited to, buildings, pavements, grade slabs, and buried utility conduits) can result in swelling of soil in the injected zone as well as those beneath existing nearby structures. Swelling of soil supporting existing structures can result in distress (movement) to existing structures. Therefore, if an existing structure or property line is located within 30 ft of the proposed water injection area, it is recommended a temporary vertical moisture barrier be installed longitudinally between the existing structure and the injected pad to prevent injected water from entering the subgrade of the existing structure. The moisture barrier could consist of a 12-ft deep trench (about 1 ft wide) backfilled with lean concrete or other suitable relatively impermeable material.

Monitoring

A full-time ALPHA TESTING, INC. technician should be retained and present throughout the injection operations. Moisture content and free swell samples should be taken at 1-foot intervals to the total depth injected from a minimum of one test boring per each 4,000 sq feet of injected area (minimum two borings per injected area). The moisture content and shear strength (using a pocket-penetrometer) will be determined for each sample. One-dimension free swell tests (ASTM D 4546-85 Method B) will be performed on selected samples at a frequency of at least three (3) free swell tests per test boring. The free swell tests will be performed with a surcharge equal to the overburden pressure anticipated upon completion of the new structure. Based upon the test results, the current swell potential of the injected soils should be determined by the project Geotechnical Engineer. Acceptance criteria for water pressure injection will be based upon achieving the potential movements indicated in the Geotechnical Exploration. As a guide, an average free swell of 1 percent or less in the injected zone could be used for planning. However, due to variations in the soils across the site, an average free swell of more than 1 percent may be allowable in some areas. Acceptance of soils with average free swells of more than 1 percent should be evaluated by ALPHA TESTING, INC. Depending upon the moisture content and the potential swell remaining in the existing injected soils, additional injections with water containing surfactant may be required until these requirements are met.

Wet and soft surface conditions resulting from the water injection procedures will require the contractor to provide access to drilling equipment used to obtain the soil samples which verify the injection process. Special track equipment may be required to provide the required access. The contractor will be responsible for providing and operating suitable equipment to permit sampling of the injected soils (test borings) with a standard truck-mounted drilling rig.

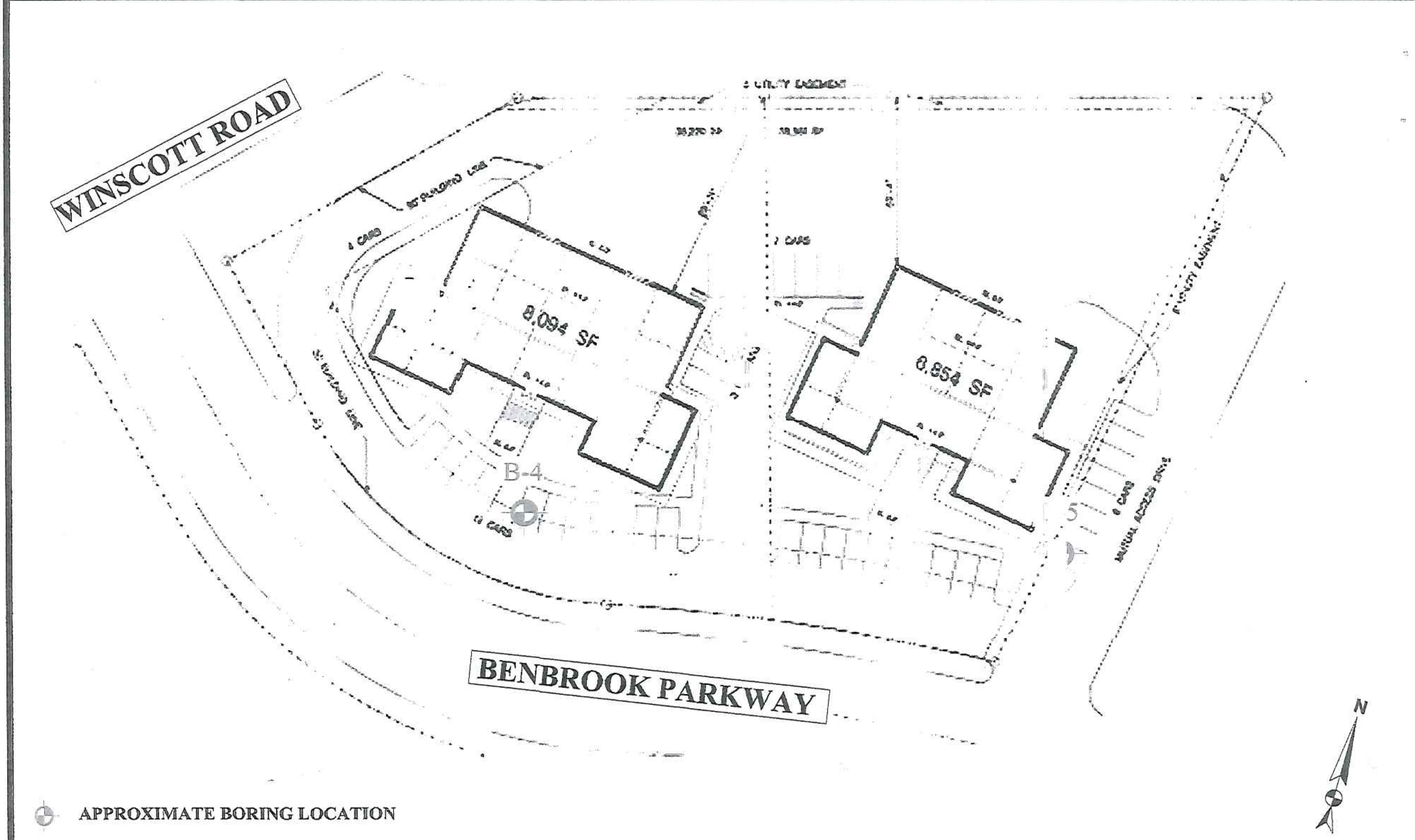
A-1 METHODS OF FIELD EXPLORATION

Using standard rotary drilling equipment, a total of five (5) test borings were performed for this geotechnical exploration at the approximate locations shown on the Boring Location Plan, Figure 1. The test boring locations were staked by ALPHA either pacing or taping and estimating right angles from landmarks which could be identified in the field and as shown on the site plan provided during this study. The location of test borings shown on the Boring Location Plan is considered accurate only to the degree implied by the methods used to define them.

Relatively undisturbed samples of the cohesive subsurface materials were obtained by hydraulically pressing 3-inch O.D. thin-wall sampling tubes into the underlying soils at selected depths (ASTM D 1587). These samples were removed from the sampling tubes in the field and examined visually. One representative portion of each sample was sealed in a plastic bag for use in future visual examinations and possible testing in the laboratory.

A modified version of the Texas Cone Penetration (TCP) test was completed in the field to determine the apparent in-place strength characteristics of the rock type materials. A 3-inch diameter steel cone driven by a 170-pound hammer dropped 24 inches is the basis for TxDOT strength correlations. In this case, ALPHA TESTING, INC. has modified the procedure by using a 140-pound hammer dropping 30-inches for completion of the field test. Depending on the resistance (strength) of the materials, either the number of blows of the hammer required to provide 12 inches of penetration, or the inches of penetration of the cone due to 100 blows of the hammer are recorded on the field log and are shown on the Log of Boring sheets as "TX Cone" (reference TxDOT Test Method TEX 132-E, as modified).

Logs of the borings are included in the Appendix of this report. The logs show a visual description of subsurface strata encountered in the borings using the Unified Soil Classification System. Sampling information, pertinent field data, and field observations are also included. The subsurface samples will be retained in the laboratory for at least 14 days and then discarded unless the Client requests otherwise.



GEOTECHNICAL EXPLORATION
RJM OFFICE / WAREHOUSE
OFF BENBROOK PARKWAY
BENBROOK, TEXAS
ALPHA PROJECT NO. W141332
AUGUST 6, 2014

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WHERE IT ALL BEGINS

BORING LOCATION PLAN

FIGURE 1

B-1 METHODS OF LABORATORY TESTING

Representative samples were evaluated and classified by a qualified member of the Geotechnical Division and the boring logs were edited as necessary. To aid in classifying the subsurface materials and to determine the general engineering characteristics, natural moisture content tests (ASTM D 2216), Atterberg-limit tests (ASTM D 4318), and dry unit weight determinations were performed on selected samples. In addition, unconfined compressive strength tests (ASTM D 2166) and pocket-penetrometer tests are conducted on selected soil samples to evaluate the soil shear strength. Results of all laboratory tests described above are provided on either the accompanying Log of Boring or summary data sheets as noted.

In addition to the Atterberg-limit tests, the expansive properties of the clay soils encountered were further analyzed by absorption swell tests. The swell test is performed by placing a selected sample in a consolidation machine and applying either the approximate current or expected overburden pressure and then allowing the sample to absorb water. When the sample exhibits very little tendency for further expansion, the height increase is recorded and the percent free swell and total moisture gain calculated. Results of the absorption swell test are provided on the Swell Test Data sheet, Figure 2 included in this appendix.

SWELL TEST DATA

Boring No.	Sample Depth	Vertical Pressure, psf	Liquid Limit	Plastic Limit	Plasticity Index	Initial Moisture	Final Moisture	Free Swell
1	5	625	47	20	27	11%		0.7%
2	7	875	43	17	26	15%	18%	0.0%
3	9	1125	45	18	27	10%		0.9%
4	3	375	42	17	25	13%	19%	2.5%

FIGURE 2 SWELL DATA SHEET
GEOTECHNICAL EXPLORATION
RJM OFFICE / WAREHOUSE
OFF BENBROOK PARKWAY
BENBROOK, TEXAS
ALPHA REPORT NO. W141332
AUGUST 6, 2014

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LOG OF BORING NO.: 1

Sheet 1 of 1

PROJECT NO.: W141332

Client: RJM Contractors, Inc.
Project: RJM Office / Warehous
Start Date: 7/23/2014 End Date: 7/23/2014
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Benbrook, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 140 / 30

GROUND WATER OBSERVATIONS
On Rods (ft): 22
After Drilling (ft): 21
After ___ Hours (ft):

Depth, feet	MATERIAL DESCRIPTION	TX Cone or Std. Pen. (blows/ft,in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0 – 8.0	Brown CLAY		4.5+				13			
			4.5+	14.2		118	11			
			4.5+				12	47	20	27
			4.5+				14			
8.0 – 12.0	Tan LIMESTONE with clay seams and layers	100/ 4.75"								
12.0 – 25.0	Light Brown CLAY with some gravel		3.75				11			
			0.5	0.7		109	17			
			0.5				15			
25.0	TEST BORING TERMINATED AT 25 FT									

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LOG OF BORING NO.: 2

Sheet 1 of 1

PROJECT NO.: W141332

Client: RJM Contractors, Inc.
Project: RJM Office / Warehous
Start Date: 7/23/2014 End Date: 7/23/2014
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Benbrook, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 140 / 30

GROUND WATER OBSERVATIONS
▽ On Rods (ft): 23
▼ After Drilling (ft): 21
▼ After ___ Hours (ft):

Depth, feet	MATERIAL DESCRIPTION	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0–2.0	Dark Brown CLAY	4.5+				17			
2.0–10.0	Brown CLAY	4.5+				14			
		4.5+				14			
		4.5+		80		15	43	17	26
		4.5+				15			
10.0–25.0	Light Brown CLAY with some gravel	4.5+	2.4		121	13			
		0.5				16			
						22			
25.0	TEST BORING TERMINATED AT 25 FT								

Other columns: Graphic Log, Sample Type, Recovery % RQD, TX Cone or Std. Pen. (blows/ft,in) — no values recorded. Water levels: ▼ at 21 ft, ▽ at 23 ft.

ALPHA TESTING

WHERE IT ALL BEGINS

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LOG OF BORING NO.: 3

Sheet 1 of 1

PROJECT NO.: W141332

Client: RJM Contractors, Inc.

Project: RJM Office / Warehous

Start Date: 7/23/2014 End Date: 7/23/2014

Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Benbrook, Texas

Surface Elevation:

West:

North:

Hammer Drop (lbs / in): 140 / 30

GROUND WATER OBSERVATIONS

- On Rods (ft): 23
- After Drilling (ft): 21
- After ____ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft,in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Dark Brown CLAY				4.5+				13			
		2.0											
		Brown CLAY				4.5+				14			
5						4.5+				13			
						4.5+				11			
						4.5+				10	45	18	27
10		10.0											
		Light Brown CLAY											
						4.5+				12	34	14	20
15													
						3.0				12			
20													
		▼ (21 ft, after drilling)											
		▽ (23 ft, on rods)											
										18			
25		25.0											
		TEST BORING TERMINATED AT 25 FT											

ALPHA TESTING

WHERE IT ALL BEGINS

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LOG OF BORING NO.: 4

PROJECT NO.: W141332

Client: RJM Contractors, Inc.
Project: RJM Office / Warehous
Start Date: 7/23/2014 **End Date:** 7/23/2014
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Benbrook, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 140 / 30

GROUND WATER OBSERVATIONS
- ▽ On Rods (ft): NONE
- ▼ After Drilling (ft): DRY
- ▼ After ____ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft,in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Dark Brown CLAY				4.5+				15			
		2.0											
		Brown CLAY				4.5+	11.7		118	13	42	17	25
						4.5+				13			
5		5.0											
		TEST BORING TERMINATED AT 5 FT											
10													
15													
20													
25													

ALPHA TESTING
WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas
76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

LOG OF BORING NO.: 5

Sheet 1 of 1

PROJECT NO.: W141332

Client: RJM Contractors, Inc.
Project: RJM Office / Warehous
Start Date: 7/23/2014 End Date: 7/23/2014
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Benbrook, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 140 / 30

GROUND WATER OBSERVATIONS
- On Rods (ft): NONE
- After Drilling (ft): DRY
- After ___ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft,in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Dark Brown CLAY				4.5+				16	60	25	35
2.0		Brown CLAY				4.5+				12			
						4.5+				12			
5.0		TEST BORING TERMINATED AT 5 FT											

ALPHA TESTING

WHERE IT ALL BEGINS

KEY TO SOIL SYMBOLS AND CLASSIFICATIONS

SOIL & ROCK SYMBOLS

- (CH), High Plasticity CLAY
- (CL), Low Plasticity CLAY
- (SC), CLAYEY SAND
- (SP), Poorly Graded SAND
- (SW), Well Graded SAND
- (SM), SILTY SAND
- (ML), SILT
- (MH), Elastic SILT
- LIMESTONE
- SHALE / MARL
- SANDSTONE
- (GP), Poorly Graded GRAVEL
- (GW), Well Graded GRAVEL
- (GC), CLAYEY GRAVEL
- (GM), SILTY GRAVEL
- (OL), ORGANIC SILT
- (OH), ORGANIC CLAY
- FILL

SAMPLING SYMBOLS

- SHELBY TUBE (3" OD except where noted otherwise)
- SPLIT SPOON (2" OD except where noted otherwise)
- AUGER SAMPLE
- TEXAS CONE PENETRATION
- ROCK CORE (2" ID except where noted otherwise)

RELATIVE DENSITY OF COHESIONLESS SOILS (blows/ft)

VERY LOOSE	0 TO 4
LOOSE	5 TO 10
MEDIUM	11 TO 30
DENSE	31 TO 50
VERY DENSE	OVER 50

SHEAR STRENGTH OF COHESIVE SOILS (tsf)

VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
FIRM	0.50 TO 1.00
STIFF	1.00 TO 2.00
VERY STIFF	2.00 TO 4.00
HARD	OVER 4.00

RELATIVE DEGREE OF PLASTICITY (PI)

LOW	4 TO 15
MEDIUM	16 TO 25
HIGH	26 TO 35
VERY HIGH	OVER 35

RELATIVE PROPORTIONS (%)

TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	36 TO 50

PARTICLE SIZE IDENTIFICATION (DIAMETER)

BOULDERS	8.0" OR LARGER
COBBLES	3.0" TO 8.0"
COARSE GRAVEL	0.75" TO 3.0"
FINE GRAVEL	5.0 mm TO 3.0"
COURSE SAND	2.0 mm TO 5.0 mm
MEDIUM SAND	0.4 mm TO 5.0 mm
FINE SAND	0.07 mm TO 0.4 mm
SILT	0.002 mm TO 0.07 mm
CLAY	LESS THAN 0.002 mm

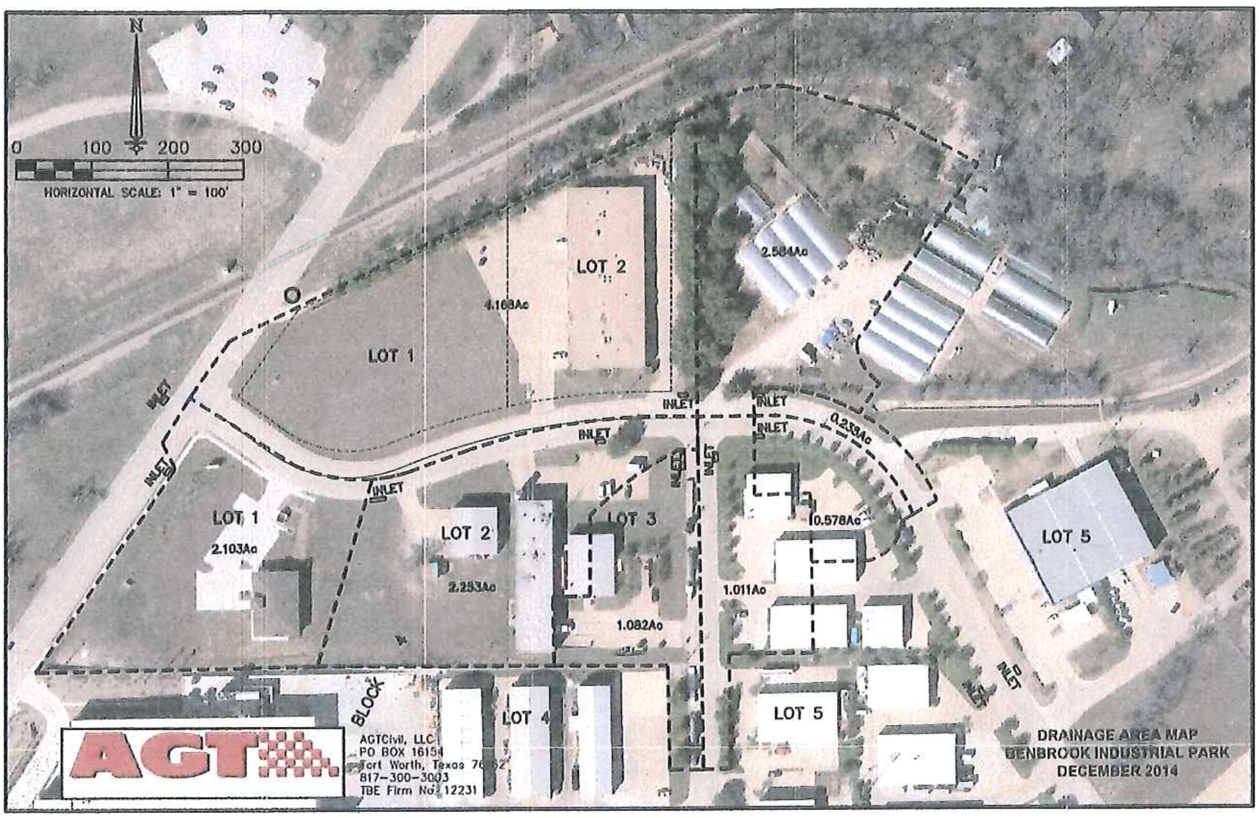
Drainage Analysis for

RJ Miller Construction Office Building Project

7608 Benbrook Parkway

Lot 1 Block 5 Benbrook Industrial Park

Prepared by AGT Civil LLC



STATE OF TEXAS
THOMAS C. DAVIES
70318
REGISTERED
PROFESSIONAL ENGINEER

2/13/15

Drainage Analysis for
RJ Miller Construction Office Building Project
7608 Benbrook Parkway
Lot 1 Block 5 Benbrook Industrial Park

Prepared by AGT Civil LLC

Index of Tables and Drawings

Introduction

Pursuant to the construction of two office buildings to be located on Lot 1 Block 5 of Benbrook Industrial Park at 7608 Benbrook Parkway we have studied the existing storm drainage system and offer the following analysis and conclusion to support the further development of the site.

We have prepared a detailed hydraulic analysis of the capacity and flows expected under design conditions for the storm drain system predominantly located in Benbrook Parkway and culminating in an open concrete lined trapezoidal channel section draining to Mary's Creek. The storm drain system has been analyzed to convey the 5 year design storm using the worst case proposed development flows. We also analyzed the storm drain system using the 100-year design storm for comparison purposes. In most cases the inlets were the restricting flows from getting into the storm drain system.

We have prepared a traditional drainage area calculations spreadsheet with flows based on the hydrological calculations as outlined in the iSWM Technical Manual and additionally to fully analyze the concrete channel we prepared a hydraulic model of the entire system to ensure that the concrete channel was also safely below capacity.

We have also prepared a detailed traditional calculations spreadsheet table of the storm drain system complete with inlet leads and main storm drain analysis.

Executive Summary

The storm drain pipe and channel network was analyzed to carry the 5 year return period event. Using a conservative time of concentration of 10 minutes on all drainage areas yielded a rainfall event of 5.74 inches. We performed and detailed drainage area delineation exercise and determined from field observations and aerial photography what the pervious and impervious coverages were. The C Factor Calculations sheet shows the calculations for each area. In every case we erred on the side of conservative assumptions. The drainage area, with the exception of Lot 1 is totally built-out.

In summary the areas contributing to each inlet are currently substantially less than originally designed. This is mostly due to the development of the Gardner Denver facility with the large north retaining wall that intercepted a large percentage of the original drainage areas and diverted them to the concrete channel south of this project area via the concrete lined flume at the rear of Lots 1-3 of Block 4 and away from this subject drainage area. Subsequently there is a surplus of drainage system capacity in the existing system In Benbrook Parkway. Our study will show this in detail. We have prepared a hydraulic grade line profile sheet showing the entire Benbrook Parkway storm drain and concrete lined channel. Flows for the worst case, 100-year and storm drain pipe 5-year event show.

Our first exhibit is a detailed drainage area map showing the individual drainage areas for each inlet in the system. For each drainage area we determined the percent pervious and percent impervious. Following that is a series of tables that show detailed calculations for the inlets, the runoff from the individual inlet catchments and the bypassing and flows that the storm drain system will experience.

Please find attached Figures showing the Table 1, showing the site C Factor and general site specific runoff calculations for the 1,5,10 and 100 year return period events. We have shown it for 3 scenarios, first is existing, with the site largely a grass field, second is with runoff calculated for the site using the original design criteria of 0.70 runoff C factor., and thirdly we have calculated the runoff for the site as it is proposed from a detailed site inventory of pervious and impervious coverages.

Table 2 shows the detailed runoff calculations for the entire drainage area and all inlets in the affected downstream system we are analyzing. This data is used to load the computer hydraulic model and the inlet bypass routing analysis.

Table 3, is a detailed calculation of the inlets capacity to accept flows based on the latest iSWM calculations. Table 4 is the detailed analysis of these same inlets showing the bypass versus intake and determines how much flow would actually make it into the storm drain system versus bypass an on-grade inlet and flowing downstream to the next inlet available.

Table 5 is a detailed hydraulic grade line, system capacity table of calculations showing the hydraulic grade line (HGL) of the entire system.

We have summarized our findings in a detailed HGL profile for the entire system, including the open channel sections, using the five year storm as the starting water surface elevation.

Conclusion

Flows calculated, with Lot 1 fully built-out, would be less than originally planned and designed for. We have proposed to add a private inlet on Lot 1, collected 100 percent of stormwater runoff from the site. This collects the entire flows from the site and treats it in the inlet using filter baskets as shown on the plans. This also resolves a long standing issue on the north side of Benbrook Parkway with a lack of inlets and ponding at the low point inlet 6 down the street. Flows which previously would pond at this inlet potentially will no longer be relying on the gutter for conveyance.

Due to an actual lower C factor than originally planned and designed for and the fact that the drainage areas are significantly smaller than originally designed for, makes this storm drain system operate with the new additional inlet with less flooding in the street and still well within capacity for the pipe.

The inlet with utilize either ADS Flex Storm or Suntree Technologies inlet filter basket system or approved equal. We are filtering 100% of the 5 year design storm flows which exceeds the requirements of the iSWM Water Quality manual. We have provided for the potential of 6 inches of ponding over the inlet so that the maximum volume of runoff can be filtered over time without bypassing and ponding in the street.

Conclusion

As you can see in the attached spreadsheets and profile using the worst case design conditions we will not have a significant impact on the existing storm drain which will remain considerably underutilized. The overall flows decrease from the original design due to the greatly reduced drainage areas resulting from the Gardner Denver facility to the south.

Addti9naly we have relived the overloaded north side of Benbrook Parkway gutters and sump inlet no 6 with the addition of our private inlet on Lot 1. Flows from Lot 1 now directly flow into the storm drain system rather than flowing down the street.

The existing storm drain line has sufficient capacity to carry the flows from Lot 1 without significant impacts or surcharging. In every case the HGL is well below the threshold of the curb inlets along Benbrook Parkway and even below the crown of the existing pipe system.

Table 1

Runoff and C Factor Calcs Lot 1

Benbrook Industrial Park
Lot 1 Drainage Analysis
RJ Miller Construction, Inc.
Prepared by AGT Civil LLC

Initial calculations on Benbrook Industrial Park

		% Total	C	Weighted
Total Area	1.624			
Impervious	0.991	61%	0.90	0.55
Pervious	0.633	39%	0.30	0.12
				0.67

Proposed

DA	tc Mins	Area Acres	C	I1 in/hr	i5 in/hr	I10 in/hr	I100 in/hr	Q1 CFS	Q5 CFS	Q10 CFS	Q100 CFS
	10	1.624	0.67	4.06	5.74	6.51	9.24	4.391	6.208	7.041	9.994

Existing

DA	tc Mins	Area Acres	C	I1 in/hr	i5 in/hr	I10 in/hr	I100 in/hr	Q1 CFS	Q5 CFS	Q10 CFS	Q100 CFS
	10	1.624	0.30	4.06	5.74	6.51	9.24	1.978	2.797	3.172	4.502
							Added Q	2.413	3.412	3.869	5.492

As Designed Originally

DA	tc Mins	Area Acres	C	I1 in/hr	i5 in/hr	I10 in/hr	I100 in/hr	Q1 CFS	Q5 CFS	Q10 CFS	Q100 CFS
	10	1.624	0.70	4.06	5.74	6.51	9.24	4.615	6.525	7.401	10.504

System Design vs Proposed

	Q1	Q5	Q10	Q100
Reduction	-0.224	-0.317	-0.359	-0.510

Table 3

Inlet Capacity Calculations - 5 Year Event

RJ Miller Office Building Project

Benbrook Industrial Park Lot 1

RJ Miller

Prepared by AGT Civil LLC

Inlet	DA	Length feet	Inlet Capacity cfs	Q5	s st slope	HA-25 Fig 1.8 Lt ft.	L/Lt	HA-26 Fig 1.9 E Efficiency	Inlet Capacity Qi cfs
1	A	20	4.56	5.71	0.004	34	0.59	0.80	4.56
1A	C-1		7.00	6.21	sump	NA	NA	NA	7.00
2	B	10	2.92	7.21	0.004	40	0.25	0.40	2.92
3	C-2	10	4.01	11.91	0.004	49	0.20	0.34	4.01
4	D-1	20	3.40	3.67	0.004	26	0.77	0.93	3.40
5	D-2	10	2.56	4.39	0.004	26	0.38	0.58	2.56
6	F-1	5	5.20	1.20	sump				
7	F-2	10	10.33	2.30	sump				

Notes:

Inlets 6 and 7 are sump inlets and capacity calculated using orifice control for sump inlets

Inlet 1A is a proposed grated inlet rated at 7.02 cfs with 3 in head. Unit installed in 6 inch curb depression.

Inlet Calcs by NCTCOG iSWM Technical Manual - Hydrualics as noted above.

Table 4

Inlet Intake vs Carryover Bypass Calculations - 5 year Event

RJ Miller Office Building Project

Benbrook Industrial Park Lot 1

RJ Miller

Prepared by AGT Civil LLC

Showing Results of Added Private Inlet - No Carryover or Ponding at Sump Inlets

			5 year	Flow		Flow	Flow	Incr	
DA	Inlet	Carry Over US	Runoff	Gutter Q	Inlet Cap	Inlet Lead	Main	Bypass	
A	1		5.71	5.71	4.56	4.56	4.56	1.16	South side of street
C-1	2	1.16	7.21	8.37	2.92	2.92	18.24	5.45	South side of street
D-1	4	[redacted]	3.67	3.67	3.40	3.40	[redacted]	0.26	South side of street
D-2	5	[redacted]	4.39	4.39	2.56	2.56	28.21	1.83	South side of street
F-2	7	7.55	2.30	9.85	10.33	9.85	43.26	sump	South side of street
C-1	1A		6.21	6.21	10.00	6.21	10.77		Added inlet at Lot 1 Private
C-2	3		11.91	11.91	4.01	4.01	22.25	7.90	North side of street
F-1	6	7.90	1.20	9.10	5.20	5.20	33.41	sump	North side of street

Notes:

Inlet calculations done in accordance with NCTCOG iSWM Technical Manaul for Hydrualics.

Added Private Lot 1 Inlet provides relief to Inlet 3 and 6.

Inlet 1A is a grated sump inlet with 5 inch surcharge possible to catch 100% of runoff rated at 18x60 in, rated at 7 cfs at 3 in head

5YR
ADDED INLET

```
*************************************
Water Surface Profile Gradient (WSPG)
XP WSPG
Engine Version 1.3          06/09/2010
XP Software         www.xpsoftware.com
*************************************

INPUT FILE
*************************************
C:\Users\tdavies\Documents\AGT\RJ Miller\Benbrook Parkway Office\iSWM\bip concrete ditch2 5year - added inlet 1A.wsx
Computed  02/16/15  14:16:36

TITLE INFORMATION
*************************************

WARNING SUMMARY
*************************************
 WARNING 47: Junction Node4 has a different channel than its direct downstream element.
 WARNING 47: Junction Node6 has a different channel than its direct downstream element.
 WARNING 47: Junction Node8 has a different channel than its direct downstream element.
 WARNING 36: D/S processing stopped in junction Node3 because critical momentum is greater than maximum momentum.
 WARNING 36: D/S processing stopped in junction Node5 because critical momentum is greater than maximum momentum.
 WARNING 36: D/S processing stopped in junction Node7 because critical momentum is greater than maximum momentum.
 WARNING 36: D/S processing stopped in junction Node9 because critical momentum is greater than maximum momentum.
 WARNING 36: D/S processing stopped in junction Node11 because critical momentum is greater than maximum momentum.
 WARNING 36: D/S processing stopped in junction Node12 because critical momentum is greater than maximum momentum.
 WARNING 50: Upstream processing: Water depth exceeds maximum open channel width for element Link13. Vertical walls used
for processing.

RESULTS
*************************************


==============================================================
   Main Line
==============================================================

 Composite Profile:

ELEMENT    TYPE       STATION    INVERT   GROUND   W.S.      DEPTH    Q        VELOC.  VELOC. ENERGY     SUPER
CRITICAL FROUDE   SLOPE    NORMAL   CROSS
NAME                                 ELEV     ELEV     ELEV                                HEAD   GRADE LN   ELEV     DEPTH
 NUMBER              DEPTH    SECTION
---------- ---------- ---------- -------- -------- --------  -------- -------- ------- ------ ---------- ------
-------- ------ ------- ------  ---------
###
"Node14"   Outlet     100.00     612.69   620.00   617.000   4.310    38.71    1.12    0.02   617.02     0.000    1.201
 0.000   0.00000 0.000   Trapez.open
```

```
"Link13"   Reach      693.00    613.88   624.00   617.008   3.128   38.71   1.65   0.04   617.05   0.000   1.201
 0.000   0.00201  1.343   Trapez.open
"Node13"   WallExt    693.00    613.88   622.00   617.008   3.128   38.71   3.67   0.21   617.22   0.000   1.855
 0.000   0.00000  0.000     Pipe
"Link12"   Reach      812.00    614.33   623.00   617.048   2.718   38.71   4.26   0.28   617.33   0.000   1.855
 0.481   0.00378  1.853     Pipe
"Node12"   Junction   813.00    614.33   621.95   617.178   2.848   28.86   3.02   0.14   617.32   0.000   1.592
 0.000   0.00000  0.000     Pipe
"Link11"   Reach      828.00    614.39   621.50   617.180   2.790   28.86   3.08   0.15   617.33   0.000   1.592
 0.340   0.00400  1.549     Pipe
"Node11"   Junction   829.00    614.39   621.95   617.246   2.856   23.66   2.47   0.09   617.34   0.000   1.435
 0.000   0.00000  0.000     Pipe
"Link10"   Reach      874.00    614.57   622.50   617.249   2.679   23.66   2.64   0.11   617.36   0.000   1.435
 0.302   0.00400  1.393     Pipe
"Node10"   Junction   875.00    614.57   622.00   617.250   2.680   23.66   2.64   0.11   617.36   0.000   1.435
 0.000   0.00000  0.000     Pipe
"Link9"    Reach      901.00    614.70   622.50   617.249   2.549   23.66   2.80   0.12   617.37   0.000   1.435
 0.333   0.00500  1.313     Pipe
"Node9"    Junction   927.00    614.70   622.00   617.370   2.670   17.70   1.99   0.06   617.43   0.000   1.235
 0.000   0.00000  0.000     Pipe
"Link8"    Reach      932.00    614.72   623.00   617.370   2.650   17.70   2.00   0.06   617.43   0.000   1.235
 0.231   0.00400  1.197     Pipe
"Node8"    Junction   933.00    614.72   623.00   617.319   2.599   17.70   2.72   0.11   617.43   0.000   1.346
 0.000   0.00000  0.000     Pipe
 HYDRAULIC JUMP  at  952.93  of length  0.04
"Link7"    Reach      966.00    615.85   623.10   617.195   1.345   17.70   5.76   0.52   617.71   0.000   1.346
 1.001   0.03424  0.768     Pipe
"Node7"    Junction   967.00    615.85   623.10   617.651   1.801   13.69   3.09   0.15   617.80   0.000   1.177
 0.000   0.00000  0.000     Pipe
"Link6"    Reach      972.00    615.87   623.10   617.652   1.782   13.69   3.13   0.15   617.80   0.000   1.177
 0.453   0.00400  1.176     Pipe
"Node6"    Junction   973.00    615.87   623.00   617.623   1.753   13.69   3.43   0.18   617.80   0.000   1.209
 0.000   0.00000  0.000     Pipe
 HYDRAULIC JUMP  at 1020.25  of length  0.01
"Link5"    Reach     1059.00    616.46   623.07   617.668   1.208   13.69   5.45   0.46   618.13   0.000   1.209
 1.002   0.00686  1.056     Pipe
"Node5"    Junction  1060.00    616.46   623.00   618.072   1.612   10.77   2.98   0.14   618.21   0.000   1.067
 0.000   0.00000  0.000     Pipe
"Link4"    Reach     1065.00    616.48   623.00   618.074   1.594   10.77   3.02   0.14   618.21   0.000   1.067
 0.464   0.00400  1.073     Pipe
"Node4"    Junction  1066.00    616.48   623.00   617.995   1.515   10.77   3.78   0.22   618.22   0.000   1.134
 0.000   0.00000  0.000     Pipe
"Link3"    Reach     1269.00    617.15   623.00   618.423   1.273   10.77   4.64   0.33   618.76   0.000   1.134
 0.802   0.00330  1.263     Pipe
"Node3"    Junction  1270.00    617.15   624.00   618.906   1.756    4.56   1.37   0.03   618.93   0.000   0.725
 0.000   0.00000  0.000     Pipe
"Link2"    Reach     1326.00    617.35   624.00   618.913   1.563    4.56   1.55   0.04   618.95   0.000   0.725
 0.229   0.00357  0.761     Pipe
```

```
"Node2"    Junction   1327.00    617.35   624.00   618.913  1.563    4.56     1.55    0.04   618.95     0.000    0.725
 0.000   0.00000  0.000     Pipe
 HYDRAULIC JUMP  at 1340.24  of length  0.03
"Link1"    Reach      1386.00    619.20   624.31   619.924  0.724    4.56     4.13    0.26   620.19     0.000    0.725
 1.003   0.03136  0.439     Pipe
"Node1"    Headwrk    1386.00    619.20   624.31   619.925  0.725    4.56     4.12    0.26   620.19     0.000    0.725
 0.000   0.00000  0.000     Pipe
```

*) in the W.S.ELEV column indicates flooding, it is set whenever W.S.ELEV > GROUND ELEV
   i.p. = intermediate point processing results for reaches

Overview

The automobile has become an integral part of modern civilization. As we increasingly rely on personal transportation, we find that the demand for adequate parking also becomes an issue. Nearly all building structures will incorporate some parking features to accommodate their workers, customers, and deliveries. Office buildings and retail stores across America are opening their doors and trying to attract new customers. First impressions are critical and the parking lot serves as a crucial gateway to what that first impression might be.

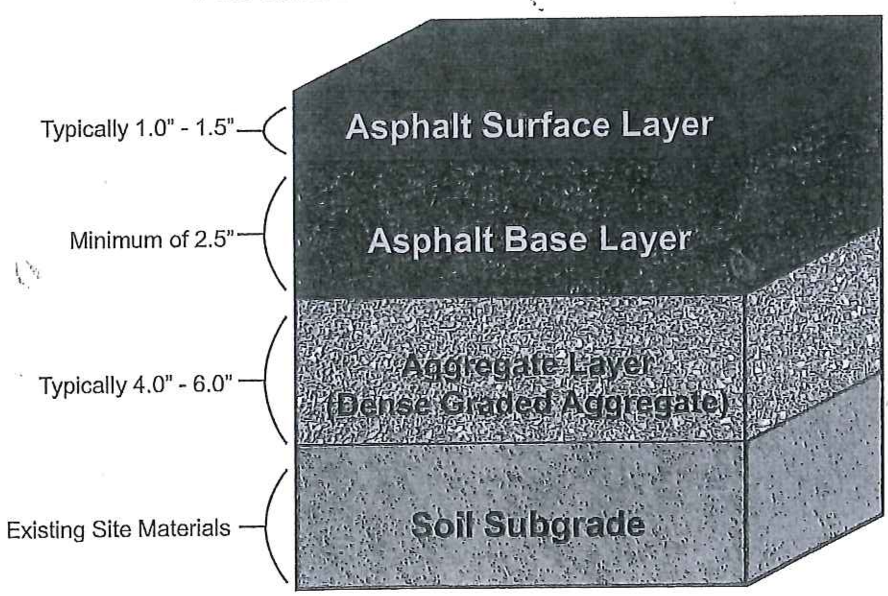
Today's parking lots are engineered with the latest advances in road science to meet the needs of motorists as well as the demands of traffic. As a result, the industry utilizes the technology and advancements to improve the quality of the pavement continuously. Ultimately, the goal is to provide a finished product that remains durable, smooth, safe, and sustainable for a long period of time.

This publication provides owners, architects and engineers guidance on the design and construction of parking lot pavements that serve the user and last for generations.

Pavement Thickness Design

From our busiest distribution centers to the remote parking lot frequented only at the height of holiday shopping, asphalt pavements must account for a multitude of variables requiring that individual projects are uniquely engineered. This section will address the structural design – or thickness – of an asphalt pavement. In its simplest form, the thickness of an asphalt pavement is determined by the quality and strength of the subgrade materials and the volume and composition of the traffic that is expected to travel on the pavement.

Pavement Thickness Schematic



Asphalt pavements are typically characterized as a layered system where different materials are utilized and each layer contributes to the overall strength and function of the pavement structure. Most parking lots in Kentucky are built on a foundation of native subgrade soils and an aggregate layer (typically dense graded aggregate) is utilized to provide load-carrying structure and to improve the working platform for the asphalt paving materials. Following the placement and compaction of the soil and aggregate layers, two or more layers of asphalt pavement are added to complete the pavement structure. The most common approach is to utilize a base asphalt mixture over the aggregate layer and then to utilize a surface mixture as the final riding course.

Pavement Thickness Tables

The pavement thickness for parking lots should be in accordance with the following tables, which have been developed by MAPA for use when designing small parking lots and driveways. Thicknesses shown were determined using the MnDOT Design procedures after estimates of soil condition and traffic loadings were made. The procedures outlined by MnDOT (as described in Chapter 3) should be used for unusual soil conditions or traffic loadings.

Heavily-Loaded Areas

The pavement for entrances, frontage roads, trash dumpster sites, and delivery truck parking, as well as the approach areas to these spaces, must be increased in thickness to prevent pavement failure caused by the weight and dynamic loading of vehicles. These areas should be constructed with a thickness that will support this special type of loading. Failure to provide this strengthening can result in severe pavement failure.

Table 4-3: Design Chart for Full-Depth Asphalt Pavements (AP) Thickness Required – Inches

SUBGRADE SOIL	TRAFFIC LOADING								
	CAR LOTS & DRIVEWAYS			SMALL TRUCK LOTS (1)			LARGE TRUCK LOTS (2)		
	AP WEAR	AP BASE	TOTAL	AP WEAR	AP BASE	TOTAL	AP WEAR	AP BASE	TOTAL
GOOD (R>50)	2″	2.5″	4.5″	2″	2.5″	4.5″	2″	4″	6″
MODERATE (R= 15 to 50)	2″	3.5″	5.5″	2″	4″	6″	2″	6″	8″
POOR (R<15)	2″	5″	7″	2″	7″	9″	2″	9″	11″

(1) Less than 100 Trucks per Day.
(2) More than 100 Trucks per Day.

Table 4-4: Design Chart for Asphalt Pavements (AP) with Aggregate Base Thickness Required – Inches

SUBGRADE SOIL	TRAFFIC LOADING											
	CAR LOTS & DRIVEWAYS				SMALL TRUCK LOTS (1)				LARGE TRUCK LOTS (2)			
	AP WEAR	AP BINDER/ BASE	AGGREGATE BASE	TOTAL GE	AP WEAR	AP BINDER/ BASE	AGGREGATE BASE	TOTAL GE	AP WEAR	AP BINDER/ BASE	AGGREGATE BASE	TOTAL GE
GOOD (R>50)	2″	2	3″	11.5″	2″	2″	4.5″	13″	2″	2″	6″	14.5″
MODERATE (R=15 to 50)	2″	2″	6″	14.5″	2″	2.5″	6″	15.5″	2″	3″	8″	18.5″
POOR (R<15)	2″	3″	6″	16.5″	2″	3″	9″	19.5″	2″	4″	11″	23.5″

(1) Less than 100 Trucks per Day.
(2) More than 100 Trucks per Day.

The Design Thickness required for a particular soil type and traffic loading will vary depending on whether Table 4-3 or Table 4-4 is used. Table 4-3 is based on MnDOT's Full-Depth design, while Table 4-4 is based on MnDOT's Bituminous Pavement Design Chart (Aggregate Base).

PAIKY Pavement Design Table (AASHTO 1993)
Light Duty Traffic Applications

Traffic Characteristics	Primarily Passenger Vehicles (98%) with a few Single Unit Trucks (2%)				
Estimate ESALs	**7,000**	**15,000**	**30,000**	**60,000**	**120,000**
Average Daily Traffic	**< 100**	**< 200**	**< 400**	**< 700**	**< 15,000**
	CBR Value = 1.0 (Soil Stabilization Recommended)				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	3.00	3.50	4.00	4.50	5.50
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00
	CBR Value = 2.0 (Soil Stabilization Recommended)				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	3.00	3.25	3.50	4.00	4.50
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00
	CBR Value = 3.0				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	2.75	3.00	3.25	3.50	4.00
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00
	CBR Value = 4.0				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	2.50	2.75	3.00	3.25	3.50
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00
	CBR Value = 5.0				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	2.50	2.50	2.75	3.00	3.25
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00
	CBR Value = 6.0				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	2.50	2.50	2.50	2.75	3.00
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00
	CBR Value = 7.0				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	2.50	2.50	2.50	2.50	2.75
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00
	CBR Value = 8.0 or above				
Asphalt Surface Thickness (in)	1.50	1.50	1.50	1.50	1.50
Asphalt Base Thickness (in)	2.50	2.50	2.50	2.50	2.50
Aggregate Thickness (in)	6.00	6.00	6.00	6.00	6.00


ICE

HOWE/WOOD
& COMPANY

June 22, 2016

Mr. Ed Brock
RJM Contractors
3629 Lovell Ave.
Fort Worth, TX 76107

Re: Opinion of Value, Concrete vs. Asphalt Parking Lots

Dear Mr. Brock:

As a follow-up to our discussion, I wanted to address your question regarding any possible difference in the value of a property relative to having either a concrete or asphalt parking lot.

Howe/Wood & Company is a commercial brokerage and development company. We have been in business in Tarrant County since 1988. Our business includes representing buyers and sellers of all types of commercial properties, as well as land for all different types of developments. We represent our clients throughout the planning, engineering and design phases, as well as throughout the zoning and platting of the properties. We also work with lenders in order to help facilitate needed financing.

In determining value, a commercial appraisal typically analyzes and compares three different appraisal methods, and concludes by taking an average of the three if they are appropriate to a particular property. Those methods include the Income approach, the Cost approach and the Comparison approach. The Income approach capitalizes the net income of a property based on a capitalization rate used for similar properties in the market. The Cost approach looks strictly at the actual or estimated cost to construct or develop a project. The Comparison approach looks at "comps", or the sales prices of similar or comparable properties that have recently sold in the market.

In my opinion, neither the Income or the Comparison approach valuation would be changed based on a property having either a concrete or asphalt parking lot. Rents would not be any different for a building with one versus the other. In using the Cost approach, the cost of a concrete lot may be higher today than an asphalt lot, but once the three methods are averaged together, very little difference would be made in the overall value. As long as the design standards and required criteria for either product are adhered to, the functionality will be looked at as the main issue when determining value.

I hope this helps in your determination. Please feel free to contact me with any questions.

Sincerely,

Mark S. Wood

PROPOSED PAVEMENT DESIGN
and
SUPPORTING INFORMATION

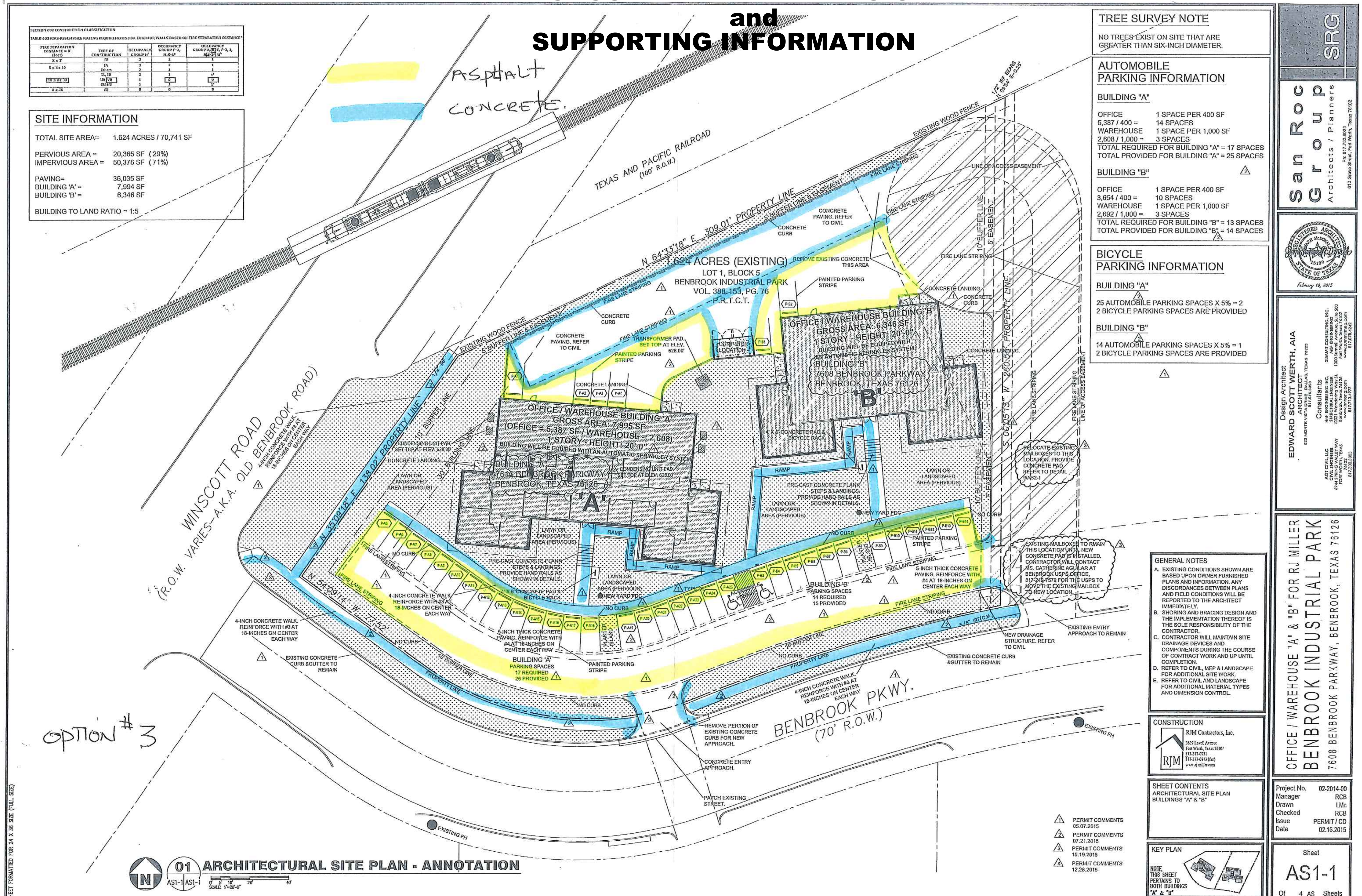


Table 5

Storm Drain Hydraulic Calculations

Benbrook Industrial Park
Lot 1 Drainage Analysis
RJ Miller Construction, Inc.
Prepared by AGT Civil LLC

5 Year Storm Analysis of Proposed Added Inlet to Storm Drain with Proposed Flows

STORM DRAIN HYDRAULIC CALCULATIONS TABLE

FROM (station backwards)	TO	Pipe Length feet	Drainage Area Incremental No.	Drainage Area Incremental Area	Drainage Area Total Area	Runoff "c" cum	Incr. cA	Total cA cum	Time of Concentration Inlet min.	Time of Concentration Travel min.	Time of Concentration Total min.	5-year Intensity in/hr.	100-year Intensity in/hr.	Q5 Runoff cfs	Q100 Runoff cfs	Inlet bypass cfs	Q pipe cfs	Pipe Size in.	n	Sf ft/ft	HGL D/S Elev.	HGL U/S Elev.	V1 (in) ft/sec	V2 (out) ft/sec	$V1^2/2G$ ft.	$V2^2/2G$ ft.	Kj	$KjV1^2/2G$ ft.	Hk ft.	Design HGL Elev.	Invert Elev. FROM ft.	Invert Elev. TO ft.	T/C ELEV. ft.	COMMENTS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
Main Line A																																		
3+14	2+55	59	1	2.103	2.103	0.47	1.00	1.00	10.00	0.00	10.00	5.74	9.24	5.71	9.20	1.15	4.56	27	0.013	0.0002	619.53	619.54	1.15	1.15	0.02	0.02	1.25	0.03	0.10	619.64	617.35	619.20	624.31	
3+70	3+14	56			2.103	0.47	0.00	1.00	10.00	0.00	10.00	5.74	9.24	5.71	9.20	1.15	4.56	27	0.013	0.0002	619.41	619.43	1.15	1.15	0.02	0.02	0.10	0.00	0.10	619.53	617.15	617.35		
4+50	3+70	80			2.103	0.47	0.00	1.00	10.00	0.00	10.00	5.74	9.24	5.71	9.20	1.15	4.56	27	0.013	0.0002	619.07	619.09	1.15	1.15	0.02	0.02	1.10	0.02	0.10	619.19	617.34	617.15		
5+73	4+50	203	1A	2.609	4.712	0.56	1.45	2.63	10.00	0.00	10.00	5.74	9.24	15.07	24.27	4.31	10.77	27	0.013	0.0012	619.07	619.31	1.15	2.71	0.02	0.11	0.10	0.00	0.10	619.41	616.48	617.34		
5+78	5+73	5			4.712	0.56	0.00	2.63	10.00	0.00	10.00	5.74	9.24	15.07	24.27	4.31	10.77	33	0.013	0.0004	618.97	618.97	2.71	1.81	0.11	0.05	0.10	0.01	0.10	619.07	616.46	616.48		
6+64	5+78	86	2	2.253	6.965	0.56	1.26	3.88	10.00	0.00	10.00	5.74	9.24	22.29	35.88	4.05	18.24	33	0.013	0.0012	618.77	618.87	1.81	3.07	0.05	0.15	0.25	0.01	0.10	618.97	616.13	616.46		
6+69	6+64	5			6.965	0.56	0.00	3.88	10.00	0.00	10.00	5.74	9.24	22.29	35.88	4.05	18.24	36	0.013	0.0007	618.66	618.67	3.07	2.58	0.15	0.10	0.10	0.01	0.10	618.77	615.85	615.87		
7+02	6+69	33	3B	2.002	8.967	0.60	1.21	5.41	10.00	0.00	10.00	5.74	9.24	31.05	49.98	8.80	22.25	36	0.013	0.0011	618.52	618.56	2.58	3.15	0.10	0.15	0.25	0.03	0.10	618.66	615.72	615.85		
7+07	7+02	5			8.967	0.60	0.00	5.41	10.00	0.00	10.00	5.74	9.24	31.05	49.98	8.80	22.25	48	0.013	0.0002	618.42	618.42	3.15	1.77	0.15	0.05	0.10	0.02	0.10	618.52	614.70	614.72		
7+33	7+07	26	4 & 5	2.093	11.060	0.62	1.29	6.81	10.00	0.00	10.00	5.74	9.24	39.10	62.95	10.89	28.21	48	0.013	0.0004	618.31	618.32	1.77	2.25	0.05	0.08	0.25	0.01	0.10	618.42	614.57	614.70		
7+78	7+33	45			11.060	0.62	0.00	6.84	10.00	0.00	10.00	5.74	9.24	39.25	63.19	11.04	28.21	48	0.013	0.0004	618.20	618.21	2.25	2.25	0.08	0.08	0.10	0.01	0.10	618.31	614.39	614.57		
7+93	7+78	15	6	0.235	11.295	0.62	0.15	6.98	10.00	0.00	10.00	5.74	9.24	40.09	64.53	6.67	33.41	48	0.013	0.0005	618.09	618.10	2.25	2.66	0.08	0.11	0.25	0.02	0.10	618.20	614.33	614.39		
9+12	7+93	119	7	0.578	11.638	0.62	0.36	7.24	10.00	0.00	10.00	5.74	9.24	41.55	66.88		43.26	48	0.013	0.0009	617.88	617.99	2.25	3.44	0.08	0.18	0.25	0.02	0.10	618.09	613.88	614.33		starting WSL=crown of outlet pipe at headwall
Inlet Leads																																		
Inlet 1A - Private Inlet Added - LOT 1																																		
4+50	Inlet 1A	23	3A	2.609	2.609	0.67	1.74	1.74	10.00		10.00	5.74	9.24	9.97	16.06		9.97	18	0.013	0.0090	619.19	619.40	0.00	5.64	0.00	0.49	1.25	0.00	0.62	620.01	617.34	618.05	622.75	
Inlet 2																																		
5+78	Inlet 2	45	2	2.103	2.103	0.56	1.17	1.17	10.00		10.00	5.74	9.24	6.73	10.84		6.73	21	0.013	0.0018	618.97	619.05	0.00	2.80	0.00	0.12	1.25	0.00	0.15	619.20	615.40	618.57	623.07	
Inlet 3																																		
6+69	Inlet 3	50	3B	2.002	2.002	0.69	1.39	1.39	10.00		10.00	5.74	9.24	7.98	12.85		7.98	21	0.013	0.0025	618.66	618.79	0.00	3.32	0.00	0.17	1.25	0.00	0.21	619.00	615.85	618.12	622.63	
Inlets 4 and 5																																		
	Inlet 4	55	4	1.082	1.082	0.59	0.64	0.64	10.00		10.00	5.74	9.24	3.67	5.90		3.67	21	0.013	0.0005	619.29	619.32	0.00	1.52	0.00	0.04	1.25	0.00	0.05	619.36	616.96	618.22	622.72	
	Inlet 5	20	5	1.011	1.011	0.76	0.77	0.77	10.00		10.00	5.74	9.24	4.39	7.07		4.39	27	0.013	0.0002	619.32	619.32	0.00	1.10	0.00	0.02	1.25	0.00	0.02	619.35	617.17	618.24	622.24	
7+07	Kathy Main	47			2.093	0.76	0.00	1.58	10.00		10.00	5.74	9.24	9.09	14.64		9.09	18	0.013	0.0075	618.42	618.78	1.10	5.14	0.02	0.41	1.25	0.02	0.51	619.29	614.68	617.17		
Inlet 6																																		
7+78	Inlet 6	12	6	0.296	0.296	0.71	0.21	0.21	10.00		10.00	5.74	9.24	1.20	1.93		1.20	21	0.013	0.0001	618.20	618.20	0.00	0.50	0.00	0.00	1.25	0.00	0.00	618.20	614.39	617.45	621.95	
Inlet 7																																		
7+93	Inlet 7	53	7	0.578	0.578	0.69	0.40	0.40	10.00		10.00	5.74	9.24	2.30	3.70	0.00	2.30	21	0.013	0.0002	618.09	618.10	0.00	0.96	0.00	0.01	1.25	0.00	0.02	618.12	614.33	617.45	621.95	

Notes:
1 Inlet capacities calculated from iSWM technical manual see attached table.
2 Drainage areas determined from current topographic surveys of the project area.
3 Lot 1 proposed development was assumed at worst case zoning runoff rates.
4 Paved impervious areas assumed at 0.90 C Factor.
5 Q in pipe is calculated from flows from inlet and inlet capacties calculated by iSWM Tech Manual page HA-25 Figure 1.8 and Efficiecy from Figure 1.9 HA-26
6 All pipes are below capacity based on HGL levels for 5 year return period as designed. Draiange areas are significantly smaller than original design allowed for.
7 Starting HGL is equal to top of pipe at outlet head works.

Table 2

C Factor Calculations For Proposed Conditions with Added Private Inlet

RJ Miller Office Building Project

Benbrook Industrial Park Lot 1

RJ Miller

Prepared by AGT Civil LLC

	Inlet	DA	Pervious Acres	Impervious Acres	TOTAL Acres	C Pervious	C Impervious	CA Pervious	CA Impervious	CA Total	C Avg.	Lot 1 RJM
	1	A	1.495	0.608	2.103	0.30	0.90	0.449	0.547	0.996	0.47	
Lot 1	1A	C-1#	0.633	0.991	1.624	0.30	0.90	0.190	0.892	1.082	0.67	X
	2	B	1.285	0.968	2.253	0.30	0.90	0.386	0.871	1.256	0.56	
Lot 2	3	C-2#	1.022	1.966	2.987	0.30	0.90	0.306	1.769	2.075	0.69	
	4	D1	0.559	0.523	1.082	0.30	0.90	0.168	0.471	0.639	0.59	
	5	D2	0.241	0.770	1.011	0.30	0.90	0.072	0.693	0.765	0.76	
	6	F1	0.096	0.200	0.296	0.30	0.90	0.029	0.180	0.209	0.71	
	7	F2	0.199	0.379	0.578	0.30	0.90	0.060	0.341	0.401	0.69	
	Ditch	G	3.248	0.541	3.789	0.30	0.90	0.975	0.486	1.461	0.39	

Inlet	CA Cum	Area Cum	C Cum	5 Year	100 Year	incr Q5	cum Q5	incr Q100	Q5 incr	Q5 Cum
1	0.996	2.103	0.47	5.74	9.24	5.714	5.714	9.199	5.714	5.714
1A	2.077	3.727	0.56	5.74	9.24	6.208	11.923	9.994	6.208	11.923
2	3.334	5.980	0.56	5.74	9.24	7.212	19.135	11.610	7.212	19.135
3	5.409	8.967	0.60	5.74	9.24	11.913	31.048	19.177	11.913	31.048
4	6.048	10.049	0.60	5.74	9.24	3.665	34.713	5.900	3.665	34.713
5	6.813	11.060	0.62	5.74	9.24	4.392	39.104	7.069	4.392	39.104
6	7.021	11.356	0.62	5.74	9.24	1.198	40.303	1.929	1.198	40.303
7	7.422	11.934	0.62	5.74	9.24	2.299	42.602	3.701	2.299	42.602
Ditch	8.883	15.723	0.56	5.74	9.24	8.386	50.988	13.500	8.386	50.988

Notes:

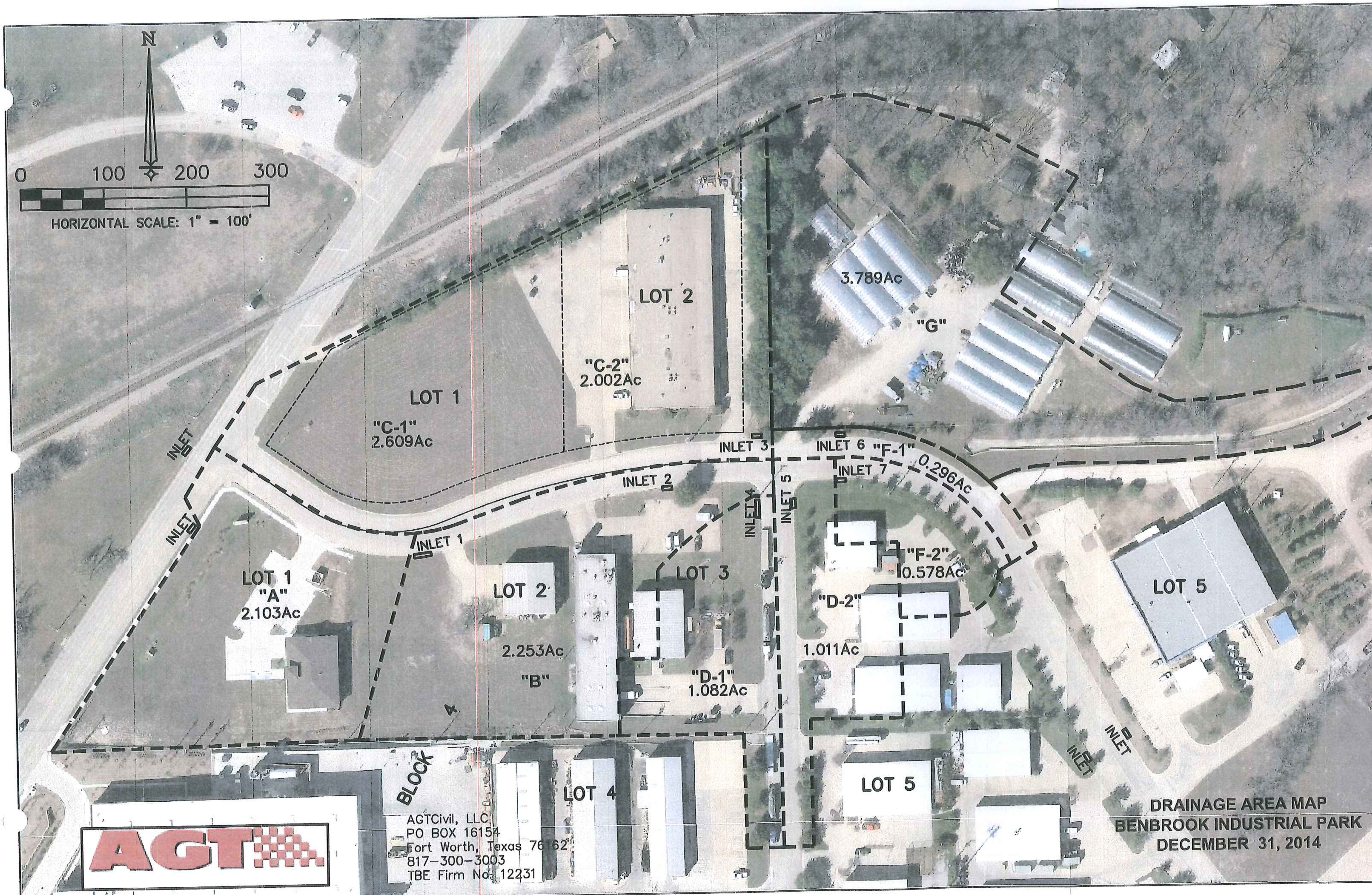
0.30 used for pervious surfaces and 0.90 used for impervious surfaces.
Drainage areas based on current topographic mapping and field observations.
Proposed conditions are shown for C factor using COG rates for pervious and impervious.

DA C Breakdown Proposed Conditions

	Imp Ac	Perv Ac	Area Tot	C Imp	C Perv	CA Imp	CA Perv	CA Total	C Avg
Lot 1 DA	0.991	0.633	1.624	0.90	0.30	0.89	0.19	1.08	0.67
Lot 2 DA	1.966	1.022	2.987	0.90	0.30	1.77	0.31	2.08	0.69
C Total	**2.956**	**1.655**	**4.611**			**2.66**	**0.50**	**3.16**	**0.68**

Notes:

DA C consist of Lot 1, the RJ Miller Property and Lot 2 the existing warehouse building by others.
Lot 1 values are the result of of a detailed pervious and impervious calculation made from the site plan.
Lot 1 values are the drainage area for the actual grated inlet 1A, the Lot 1 ROW and street drainage still drains to Inlet 2 and is shown as part of Lot 2 DA
Lot 1 and Lot 2 DA include street and ROW areas inclusive of actual Lots 1 and 2 so totals are greater than actual area of lots only.


N
0
100
200
300
HORIZONTAL SCALE: 1" = 100'
LOT 2
3.789Ac
"G"
"C-2"
2.002Ac
LOT 1
"C-1"
2.609Ac
INLET
INLET 3
INLET 6
"F-1"
0.296Ac
INLET 7
INLET 2
INLET 5
INLET 4
INLET
INLET 1
LOT 1
"A"
2.103Ac
LOT 2
2.253Ac
"B"
LOT 3
"D-1"
1.082Ac
"F-2"
0.578Ac
"D-2"
1.011Ac
LOT 5
INLET
INLET
BLOCK 4
LOT 4
LOT 5
AGT
AGTCivil, LLC
PO BOX 16154
Fort Worth, Texas 76162
817-300-3003
TBE Firm No. 12231
DRAINAGE AREA MAP
BENBROOK INDUSTRIAL PARK
DECEMBER 31, 2014