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November 18, 2019
Project No. 19-200-M

Bellecci & Associates
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Concord, CA

SUBJECT: **Pavement Rehabilitation Options**
Fremont Avenue- Grant Street to Stevens Creek
Los Altos, California

This technical memorandum is prepared by Butano Geotechnical Engineering with input from Bellecci & Associates to provide options for a pavement rehabilitation strategy on the Fremont Avenue Pavement Rehabilitation Project. Pros and cons for each treatment method have been outlined as well as a recommendation for the most effective strategy based on life cycle cost analysis.

1.0 Background

The project alignment is along Fremont Avenue within the paved roadway between Grant Road and Stevens Creek and is approximately 4,200 linear feet. The City of Los Altos intends to repair and resurface the asphalt roadway, this will include designing new grades with conforming cross slopes to provide positive drainage, and restriping within the limits of work. For our review and recommendation, we have received the following:

1. Pavement Rehabilitation/ Digouts Plan (Exhibit A) from Bellecci & Associates field pavement review conducted between August 14, 2019 and October 3, 2019.
2. Life-cycle Cost Analysis (Exhibit B) prepared by Bellecci & Associates
3. Coring Data (Exhibit C) collected by Butano Geotechnical Engineering on October 15, 2019
4. R-Value Testing Results collected by Butano Geotechnical Engineering on October 9, 2019, and tested by Cooper Testing Laboratories

2.0 Pavement Rehabilitation/ Digouts Plan

A field engineering/pavement evaluation was performed on August 14, 2019 with a follow up site visit on November 15, 2019.

The total pavement rehabilitation area is approximately 218,200 square feet. Road pavement conditions were examined and locations with severe cracks have been identified. A total area of 35,455 square feet is severely distressed and requires removing all or a portion of the pavement section and replacing with hot mix asphalt pavement, commonly called digouts. This is approximately 16.3% of the total pavement rehabilitation area. Projects with areas exceeding 15% digouts are candidates for Cold In-place Recycling (CIR) per CIR industry representatives. CIR eliminates the need for digouts.

The major pavement failure types observed in the field were block cracking (Figure 1), transverse cracking (Figure 2) and raveling (Figure 3). These types of failure are typically caused by shrinkage of the asphalt concrete which indicates the asphalt binder has hardened over time. Based on our review they do not appear to be load related.

Figure 1. Block Cracking

Figure 2. Transverse Cracking

Figure 3. Raveling

The selected options are treatments and treatment combinations that are commonly used for pavement rehabilitation and maintenance. The list of treatments was determined based on types of distress that exist in the pavement and experience from past projects.

3.0 Treatments

Digouts (Rehabilitation)

Pavement sections with severe cracks are to be removed or partially removed and replaced with new asphalt concrete.

- Pros: Provides a new pavement section with a 20-year design live. Allows for new grades to be set. May be used to increase the structural pavement section to a higher traffic index.
- Cons: Requires off-haul causing wear and tear on the adjacent streets. Has a high environmental impact by using all new material with no recycling. Has a long construction time. Expensive.

Overlay (Maintenance)

Pavement with less severe cracks can be simply fixed by overlaying another layer of hot mix asphalt on top.

- Pros: Relatively inexpensive. Has the look and feel of a new road in a maintenance option. Short construction time.
- Cons: Raises grades possibly causing grading and drainage issues. Reflective cracking may transfer to the surface over time so not suitable for areas with severe distress.

Cape seal (Maintenance)

Cape seal contains chip seal with slurry seal placed on top. This method provides a hard-wearing surface and seals the underlying existing pavement. It lasts longer than slurry seal.

- Pros: Inexpensive. Good for maintaining pavement in fair to good condition. Short construction time.
- Cons: Short life.

Slurry Seal (Maintenance)

Slurry seal is a cost-effective treatment method for roadways that are in good or fair condition. It is a seal coat which protects the pavement surface against traffic loading and water intrusion.

- Pros: Least expensive. Short construction time.
- Cons: Short life.

Cold In-place Recycling-CIR (Rehabilitation)

The method involves scarifying the existing pavement surface, mixing and reusing it in place. It is suitable to correct medium to high severity cracking of all types. In terms of constructability, the paving process is performed under one operation. Vehicle traffic may be allowed on treated areas within three hours of compaction of the recycled material depending on site conditions. Shoulder backing may be needed during treatment process.

- Pros: Lowest long-term cost. Re-uses the existing pavement reducing off-haul and import of material. May be used to increase the structural pavement section to a higher traffic index. May be used to mitigate distress in the asphalt layer. Quicker construction time than digouts.
- Cons: May not be used to mitigate subgrade failures. Expensive initial cost. Has limited ability to increase the structural pavement section to a higher traffic index. Longer construction time than the maintenance options.

Grind and Inlay (Rehabilitation/Maintenance)

This method takes out and replaces a thin layer on top of the existing pavement surface for areas with less severe cracks. It’s considered more favorable than overlay because it can be used to fix severe surface defects while maintaining the existing pavement elevation.

- Pros: Relatively inexpensive. Moderate construction time. May be used to mitigate minor pavement distress.
- Cons: Moderate off-haul. Moderate life span. Moderate construction time.

4.0 Pavement Rehabilitation Options

The selected 8 preliminary pavement rehabilitation options are listed below. Each option is a common strategy for pavement rehabilitation/maintenance using combinations of the above treatments.

1. Digouts and 1.5” Overlay
2. Digouts and Cape Seal
3. Digouts and Slurry Seal
4. Digouts and 2” Inlay
5. 4” CIR with 2” HMA Overlay
6. 3” CIR with 1.5” Thin HMA Overlay
7. 4” Grind and Inlay
8. 2” Grind and Inlay

5.0 Life-cycle cost analysis

A life cycle cost analysis (LCCA) has been conducted for the preliminary pavement rehabilitation options (Exhibit B).The purpose of the analysis is to evaluate the overall long-term costs associated with the selected options and to facilitate proper decision-making by taking recurring cost into consideration. It assumes an inflation rate of 3.5%, and only considers pavement rehabilitation and striping costs for each option. The analysis sets a period of 60 years as design life for the roadway. It assumes that pavement repaired by each option satisfies the performance objective over their respective life cycles and the same option will be applied at the beginning of every life cycle within the 60 years.

LCCA results indicate that Option 6 – 3’’ CIR with 1.5’’ Thin HMA Overlay has the lowest cost (net present value) for the 60-year design life. In the short run, Option 3 - Digouts and Slurry Seal has the lowest initial cost.

6.0 Coring Data

Butano Geotechnical Engineering conducted 10 pavement cores on October 15, 2019 (Exhibit C). Per the coring data, the existing pavement section consists of 8¾ - 14 inches of asphalt concrete with no aggregate base.

7.0 R-Value and Design Analysis

Laboratory testing performed by Cooper Testing Laboratories indicates that a design R-value of 14 should be used for the project. Traffic index is 8. Based on the two inputs the full depth Hot Mixed Asphalt (HMA) should be 11½ inches thick (0.95 feet) this is consistent with the cores advanced in the field.

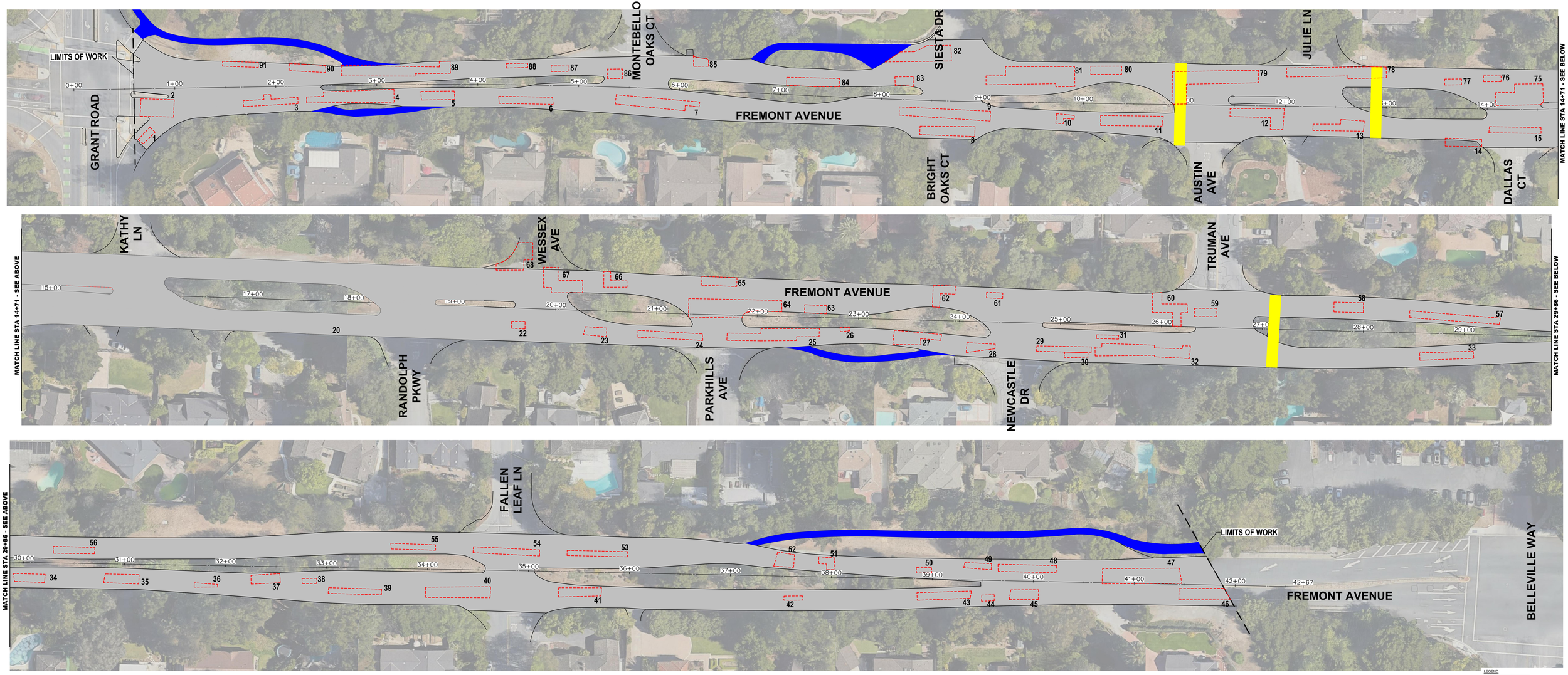
8.0 Recommendation

Based on the existing pavement evaluation, life cycle cost analysis, coring data, and R-value testing result, the recommended pavement rehabilitation strategy is 3'' CIR with a 1.5'' HMA Overlay. This recommendation is based on the following factors:

- Based on the coring data, the asphalt concrete pavement thickness is 8¾" to 14" thick which is conducive to CIR treatment.
- Based on our field observations the major pavement failure types observed in the field are block cracking and transverse cracking. The street does not exhibit base failures. These types of failures will be mitigated by the CIR treatment.
- The coring data collected exhibited that the existing pavement is suitable to be included in the mix for CIR operation.
- CIR treatment is to be performed with a single unit train which allows us to recycle curvy roads, busy intersections and wide-open roads without snarling traffic and creating dust.
- The trees are currently being trimmed prior to construction to allow for CIR equipment working along roadway.
- The City of Los Altos is willing to invest more into a pavement rehabilitation program which is a green design. CIR is a green design because:
    a) In-place aggregates and asphalt are reused and renewed which eliminates asphalt disposal
    b) Lower raw material consumption
    c) There's less construction traffic which leads to less energy consumption and fewer emissions/greenhouse gases
    d) There is less off-haul and import reducing the impact on the neighboring streets

EXHIBIT A

Pavement Rehabilitation/ Digouts Plan



FREMONT AVENUE - CONCEPT PAVEMENT REHABILITATION EXHIBIT

PREPARED BY BELLECCI & ASSOCIATES
OCTOBER, 2019

EXHIBIT B

Life-Cycle Cost Analysis (LCCA)

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION & BIKE LANE PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

Life Cycle Cost Analysis - LCCA (pavement rehabilitation and striping costs only)

Revised October 11, 2019

Inflation:	3.5%
Project length (LF):	4,145
Project pavement area (SF):	218,200
Total years:	60

Option	Description	Recurring Cost	Life Cycle (years)	Net Present Value
1	**Digouts & 1.5" Overlay**	$1,240,000	6-8	**$5,800,000**
2	**Digouts & Cape Seal**	$984,000	5-7	**$5,300,000**
3	**Digouts & Slurry Seal**	$845,000	5-7	**$5,300,000**
4	**Digouts & 2" Inlay**	$1,891,000	8-10	**$7,100,000**
5	**4" Cold In-place Recycling (CIR) and 2" Overlay**	$1,848,000	15-17	**$4,400,000**
6	**3" CIR and 1.5" Thin Overlay**	$1,531,000	12-14	**$4,000,000**
7	**4" Grind and Inlay**	$2,180,000	10-12	**$6,900,000**
8	**2" Grind and Inlay**	$1,388,000	7-9	**$5,800,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 1 - DIGOUTS & 1.5'' OVERLAY

Item #	Description		Item Total
1	Remove & Replace Asphalt Paving & Base at 6" Digouts		$355,000
2	Grinding along Curb / Berm		$4,400
3	Shoulder Backing		$48,000
4	HMA - 1.5'' Overlay		$346,052
5	Restriping		$111,915
6	Pavement Markings		$10,000
7	Traffic control & Mobilization & WPC		$157,566
		Subtotal	$1,032,933
		20% Contingency	$206,587
		Construction Cost	**$1,240,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 2 - DIGOUTS & CAPE SEAL

Item #	Description		Item Total
1	Remove & Replace Asphalt Paving & Base at 6" Digouts		$355,000
2	Cape Seal		$218,200
3	Restriping		$111,915
4	Pavement Markings		$10,000
5	Traffic control & Mobilization & WPC		$125,121
		Subtotal	$820,236
		20% Contingency	$164,047
		Construction Cost	**$984,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 3 - DIGOUTS & SLURRY SEAL

Item #	Description		Item Total
1	Remove & Replace Asphalt Paving & Base at 6" Digouts		$355,000
2	Slurry Seal		$120,010
3	Restriping		$111,915
4	Pavement Markings		$10,000
5	Traffic control & Mobilization & WPC		$107,447
		Subtotal	$704,372
		20% Contingency	$140,874
		Construction Cost	**$845,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 4 - DIGOUTS & 2'' INLAY

Item #	Description		Item Total
1	Remove & Replace Asphalt Paving & Base at 6" Digouts		$355,000
2	Tree Trimming		$15,000
3	2" Grind		$381,850
4	HMA - 2" Inlay		$461,402
5	Restriping		$111,915
6	Pavement Markings		$10,000
7	Traffic control & Mobilization & WPC		$240,330
		Subtotal	$1,575,497
		20% Contingency	$315,099
		Construction Cost	**$1,891,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 5 - 4'' CIR with 2'' Overlay

Item #	Description		Item Total
1	4" CIR		$654,600
2	Tree Trimming		$15,000
3	Grinding along Curb / Berm		$4,400
4	Shoulder Backing		$48,000
5	HMA - 2" Overlay		$461,402
6	Restriping		$111,915
7	Pavement Markings		$10,000
8	Traffic control & Mobilization & WPC		$234,957
		Subtotal	$1,540,274
		20% Contengency	$308,055
		Construction Cost	**$1,848,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 6 - 3"CIR with 1.5" Thin Overlay

Item #	Description		Item Total
1	3" CIR		$545,500
2	Tree Trimming		$15,000
3	Grinding along Curb / Berm		$4,400
4	HMA - 1.5" Overlay		$346,052
5	Shoulder Backing		$48,000
6	Restriping		$111,915
7	Pavement Markings		$10,000
8	Traffic control & Mobilization & WPC		$194,556
		Subtotal	$1,275,423
		20% Contengency	$255,085
		Construction Cost	**$1,531,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 7 - 4" GRIND &INLAY

Item #	Description		Item Total
1	4" Grind		$480,040
2	Tree Trimming		$15,000
3	HMA		$922,804
4	Restriping		$111,915
5	Pavement Markings		$10,000
6	Traffic control & Mobilization & WPC		$277,157
		Subtotal	$1,816,916
		20% Contingency	$363,383
		Construction Cost	**$2,180,000**

CITY OF LOS ALTOS - FREMONT AVENUE PAVEMENT REHABILITATION PROJECT

Preliminary Engineering - Pavement Rehabilitation Options

OPTION 8 - 2" GRIND &INLAY

Item #	Description		Item Total
1	2" Grind		$381,850
2	Tree Trimming		$15,000
3	HMA		$461,402
4	Restriping		$111,915
5	Pavement Markings		$10,000
6	Traffic control & Mobilization & WPC		$176,430
		Subtotal	$1,156,597
		20% Contingency	$231,319
		Construction Cost	**$1,388,000**

EXHIBIT C

Coring Data

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October 15, 2019
Project No. 19-200-M

Bellecci & Associates
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Concord, CA

SUBJECT: **Coring Data**
Fremont Avenue- Grant Street to Stevens Creek
Los Altos, California

Core #	Intersection	Location	Direction	Section
1	Fremont/ Bright Oaks	9 ½ feet W, 9 ½ feet S of storm drain manhole	EB	8 ¾ inches AC, no AB
2	Fremont/ Kathy	22 feet W, 9 feet S of tip of median	EB	13 inches AC, no AB
3	Fremont/ Wessex	34 feet W, 9 feet S of tip of median	EB	14 inches AC, no AB
4	Fremont/ Truman	34 feet W, 7 feet S of tip of median	EB	12 inches AC, no AB
5	Fremont/ Fallen Leaf	44 feet W, 11 feet S of tip of median	EB	13 inches AC, no AB
6	Fremont/ Fallen Leaf	40 feet E, 12 feet N of tip of median	WB	14 inches AC, no AB
7	Fremont/ Newcastle	48 feet E, 8 feet N of tip of median	WB	12 ½ inches AC, no AB
8	Fremont/ Parkhills	53 feet E, 14 feet N of storm drain manhole	WB	12 inches AC, no AB
9	Fremont/ Randolph Parkway	39 feet E, 9 feet N of tip of median	WB	10 inches AC, no AB
10	Fremont/ Dallas Court	34 feet E, 8 feet N of tip of median	WB	12 inches AC, no AB