West Dowling Road

Design Study Report

April 2009

bluefox UNIVERSAL

DESIGN STUDY REPORT

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS

AADT .... annual average daily traffic
AASHTO .... American Association of State Highway and Transportation Officials
ADA .... Americans with Disabilities Act
ADEC .... State of Alaska Department of Environmental Conservation
ADF&G .... State of Alaska Department of Fish and Game
ADOT .... State of Alaska Department of Transportation and Public Facilities
AWWU .... Anchorage Water and Wastewater Utility
CEA .... Chugach Electric Association, Inc.
DCM .... Design Criteria Manual
DSR .... Design Study Report
EA .... Environmental Assessment
H&H .... Hydrologic and Hydraulic
LOS .... level-of-service
MEV .... million entering vehicles
MOA .... Municipality of Anchorage
mph .... miles per hour
OHMP .... Office of Habitat Management and Permitting
OSHP .... Official Streets and Highway Plan
ROW .... right-of-way
USACE .... United States Army Corps of Engineers
WDR .... West Dowling Road

1.0 INTRODUCTION

1.1 Project Need

This project was proposed to increase capacity and create a more direct east-west connection between Old Seward Highway and C Street. This project in combination with other current ADOT and MOA projects will relieve congestion on other east-west arterial roads within the MOA. The useful life of the facilities within the project corridor has declined and does not meet current standards. The pavement is rutted and failing, the pedestrian facilities are sporadic and the Campbell Creek Bridge has settled significantly. The existing roadway is shown in Figure 1.

1.2 Objectives

The principal purpose for this project is to upgrade the existing facilities in order to provide better east west travel from the Old Seward Highway to C Street on West Dowling Road. The major improvements include expanding the roadway from two lanes to four lanes, adding pedestrian facilities and creating a more direct route from the Old Seward to C Street. The project design will consider cost, design standards, and the needs of the traveling public. The objective of this report is to document the design decisions made for the project.

2.0 EXISTING CONDITIONS

2.1 Roadway Facilities

The current roadway can be seen below in Figure 1.

Figure 1 Existing West Dowling Corridor

2.1.1 Existing Segment – Potter Drive to Old Seward Highway

This section of Dowling road is designated as a Minor Arterial in the ADOT Central Region Annual Traffic Report and as a Class III Major Arterial in the Official Streets and Highways Plan (OSHP). Starting at the Old Seward Highway and working west to Potter Drive, this segment of roadway consists of two 12-foot-wide paved lanes. At the intersection of the Old Seward Highway and WDR heading eastbound, WDR widens to allow for a dedicated left turn lane and two through lanes with the through lane on the south side doubling as a right turn lane. Heading west on WDR, pedestrian facilities consist of a 5-foot wide sidewalk on the north side and a separated trail along the south side of WDR ending on the east side of the Campbell Creek Bridge. East of the Campbell Creek bridge the Campbell Creek Trail crosses WDR at grade. As Dowling Road approaches Potter Drive the road once again widens to accommodate a dedicated through lane onto Potter Drive and a left turn lane onto WDR Limited curb and gutter exists on this segment of the road. Curb and gutter exists at the intersection of WDR and the Old Seward Highway extending on the north side of WDR to the east side of the Campbell Creek Bridge and at the intersection of Potter Drive and WDR. The rest of the roadway consists of grass swales.

2.1.2 Existing Segment – Potter Drive to B Street

This section of WDR is designated as a Minor Arterial in the ADOT Central Region Annual Traffic Report and as a Class III Major Arterial in the OSHP. This section of WDR consists of a 24-foot-wide paved section of road with no shoulder or pedestrian facilities. At the intersection of Potter Drive and WDR heading east, there exists a stop sign for the WDR movements onto Potter Drive.

2.1.3 Undeveloped Segment – B Street to C Street

This section of WDR is designated as a Class III Major Arterial in the OSHP and is not currently classified by the ADOT since this section of the road is not currently developed. Figure 2 illustrates the current conditions of the undeveloped section.

Figure 2 Undeveloped Segment between B Street and C Street

3.0 CAPACITY AND SAFETY ANALYSIS

3.1 Capacity Analysis

3.1.1 Signal Warrant Analysis

Further research and data will be necessary to determine warrants. Based on recommendations and existing conditions a signalization plan was created. The warrants to verify these assumed signalized areas will require further investigation prior to construction.

3.1.2 Intersection Level of Service

The LOS required for the design year must meet minimum requirements set by the ADOT. The minimum LOS is a D for the design year of 2030 based on the ADOT requirements. This will allow for an acceptable amount of delay during PHV at the design year. The data compiled and calculated from the AADT and intersection geometry was inputted into the Highway Capacity Software 2000 (HCS2000) to determine the LOS based on the variables encountered and projected in the field.

3.1.2.1 West Dowling Road and Old Seward Intersection

At this intersection the geometry is a major concern due to the limited amount of ROW available. The intersection geometry and phasing for each of the alternatives can been found in Appendix C-2. Table 1 below summarizes the results of each alternative.

Table 1 LOS for Dowling Road and Old Seward Highway

Alternative	Delay (sec/veh)	Cycle Length (sec)	LOS
1	85	171.7	F
2	53.9	69	D
3	33.9	63	C

After analyzing the three different alternatives, Alternative 3 was the chosen. Alternative 3 was similar in geometry to Alternatives 1 and 2 except for the addition of a second left exclusive northbound lane. Currently there is an enlarged median at this approach, so adding an extra lane will only require reconstructing the median. Due to this fact, no extra ROW will need to be acquired on the approach. In addition, by adding the extra lane both the northbound and southbound approaches will have similar geometry, which is recommended by our mentor, Professor Osama Abaza. Since Alternative 3 will not require extra ROW on either side of the roadway, decreases delay and improve LOS, this was chosen as the Preferred Alternative. The intersection geometry can be seen below in Figure 3.

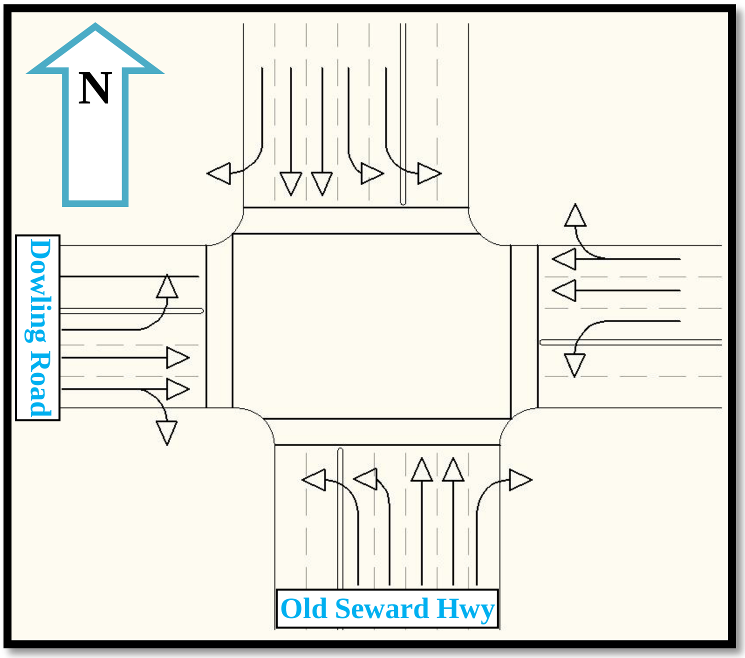


Figure 3 Selected Alternative geometry at Dowling Road and Old Seward Highway

3.1.2.2 West Dowling Road and Potter Drive Intersection

At this intersection projected through traffic using Potter Drive will diminish due to access of C Street through the WDR extension. Based on the projected traffic volumes and available ROW, there will be modifications done to the intersection. One modification will be to realign Potter Drive to intersect WDR at an approximate right angle. By creating a right angle intersection traffic visibility and right turn speeds will increase. In addition, Potter Drive will be stop sign controlled entering WDR. The main reason this intersection can be stop sign controlled is that traffic turning onto WDR from Potter Drive will not have left turn access. The reason for the restriction is that many small side streets and driveways connect to WDR throughout the corridor. If all these streets were allowed left turn access into a shared lane, the safety of the drivers would be at a much higher risk. To avoid this safety issue the median running through the corridor will have limited access points. Although vehicles will not be able to turn left onto WDR, one of the access points will allow drivers to turn left off of WDR onto Potter via a turn pocket in the median.

3.1.2.3 West Dowling Road and C Street Intersection

For this intersection two different alternatives were analyzed in order to determine which geometry and phasing would best suit the traffic patterns. One major concern with this intersection was the large number of through traffic. The intersection geometry and phasing for each of the alternatives can been found in appendix C-2. Table 2 on the following page summarizes the results of each of the alternatives.

Table 2 LOS for Dowling Road and C Street

Alternative	Delay (sec/veh)	Cycle Length (sec)	LOS
1	79.6	67	E
2	34.3	57	C

Since the two alternatives required the same ROW and Alternative 2 resulted in much higher LOS and less delay, it was chosen without hesitation. The main difference between the two alternatives is the assignment of the lanes. For Alternative 1 there are exclusive right turn lanes and only one left turn lane, while Alternative 2 uses shared right turn lanes and two left turn lanes. This change significantly decreases delay and results in a higher LOS. Figure 4 shows the intersection geometry for the selected Alternative. One issue that will need to be considered is reconstruction of C Street to accommodate for the new intersection. The paths and current median may need to be altered to expand the roadway for the new geometry. Since the ROW at this area is not a limiting factor the purposed geometry should not encounter any constraint issues.

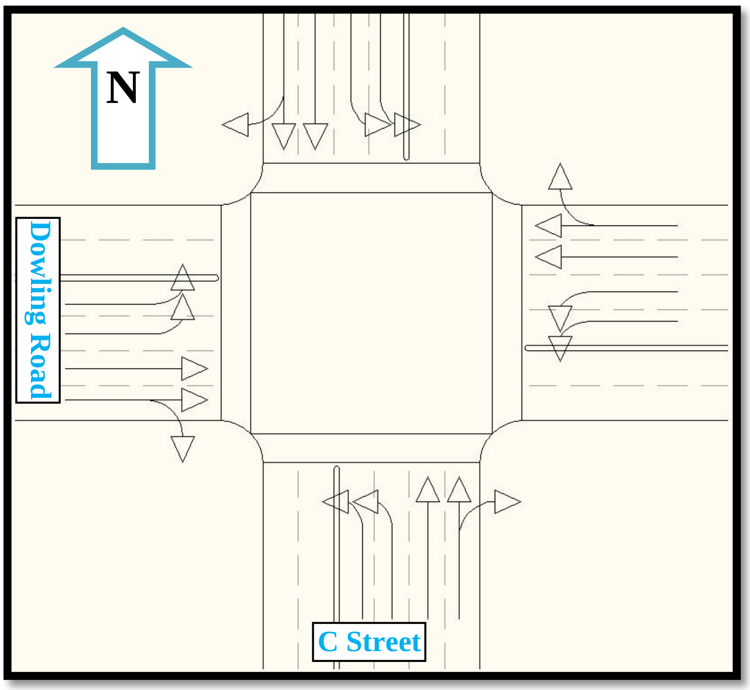


Figure 4 Selected Alternative Geometry at Dowling Road and C Street

3.1.2.4 Potter Drive and C Street Intersection

At this intersection it is recommended that the light remain in place for future use. If 54th Ave was to be extended and connect to Old Seward Highway at the east and merged with Potter at the west, then Potter Drive could become another east-west corridor between C Street and Old Seward Highway, as shown in Figure 5. The signal light must be semi-actuated to allow for the primary flow of traffic on C Street to have priority at this intersection. The future traffic increases also suggest that the light remain in place for coordination purposes. A major issue faced in the future will be creating a coordination plan for the heavy through traffic on C Street and this light may help at the intersection.

Figure 5 Proposed future 54th Avenue Extension

3.1.3 Other Capacity Considerations

The following recommendations are made based on the realignment of the WDR corridor, the proposed median throughout the project length and the projected traffic volumes.

3.1.3.1 Potter Drive and C Street Intersection

At this intersection a similar approach will be taken to that of the Potter Drive and WDR intersection. Austin Street will be stop sign controlled entering WDR Austin Street is already aligned at a right angle with WDR so the next revision will be restricting left turn access. This will be done similarly to Potter Drive with the use of the median and signage. In addition, a turn pocket will allow the WDR traffic to make left turns onto Austin Street. Figure 6 below shows the traffic control arrangement at Austin Street.

Figure 6 Access plan at Austin Street

3.1.3.2 Franklin Drive

Once Potter Drive is realigned with respect to WDR, the Franklin Drive intersection with Potter Drive is recommended to be removed in order to minimize conflicts at the Potter Driver and WDR intersection. At the existing intersection Franklin Drive will need to be terminated from Potter Drive and reconstructed as a cul-de-sac. Closing Franklin Drive should be appealing to current residents since through traffic will be eliminated, creating a safer neighborhood for pedestrians. The threat from theft will also be reduced since easy access in and out of the neighborhood will be significantly reduced.

3.1.3.3 C Street Progression Analysis

Based on the projected AADT for 2030 traffic flowing north and south on C Street was projected to be of substantial volume. Due to this large volume, an analysis of the progress of traffic flowing north and south must be considered. To maintain an even flow progression, signalization must be optimized and coordinated through each intersection in order to carry the traffic flow as one platoon through the C Street corridor.

3.2 Safety Analysis

Crash data was compiled for a ten year period starting in 1997 and ending in 2006. The compiled data takes into account all reported accidents on Potter Drive and WDR between their intersections with C Street and the Old Seward Highway. The data was broken down and a safety analysis was completed for any possible design problems of the old road that could be taken into account when designing the new. Results can be seen in Table 3 below and are summarized as follows:

- Six bicycle crashes and no pedestrian crashes were reported during the study period.
- One fatal crash occurred in this corridor during the study period but was caused by unsafe driving.
- One moose and one other animal crash occurred during the study period.

Table 3 Fatal Bicycle and Wildlife Crashes

Year	Fatal	Bicycle	Moose	Animal	Total For Year
1997	-	1	1	-	2
1998	-	1	-	1	2
1999	-	-	-	-	0
2000	-	2	-	-	2
2001	-	-	-	-	0
2002	-	-	-	-	0
2003	1	-	-	-	1
2004	-	2	-	-	2
2005	-	-	-	-	0
2006	-	-	-	-	0

3.2.1 Intersection Crash Analysis

Ten years of crash data was compiled for all of the main intersections on WDR and Potter Drive between the Old Seward Highway and C Street. The data was compiled into specific categories to see if any particular area of concern could be seen on the excising road. A large percent of crashes that occurred at every main intersection was related to left hand turns. The remaining crashes consisted of rear end collisions of which most where caused during icy conditions. The Intersection Crash Data table can be found in Appendix C-4, Table 1.

The average crash rate per million entering vehicles (MEV) was calculated for the two main intersections at Old Seward Highway and WDR and C Street and Potter Drive. The average crash rate per MEV for the Old Seward Highway and C Street was found to be 0.975 and 1.055, respectively. These two values were well below the average crash rate per MEV for the State of Alaska with a value of 1.86 for similar intersections. The Intersection Crash Rate data can be found in Appendix C-4, Table 2.

3.2.2 Segment Crash Analysis

The amount of crashes on each segment was split between rear-end collisions and angled collisions. Most rear end collisions were due to either icy conditions or driver error, while most angled collisions were due to left turns. Angled crashes will hopefully be mitigated by the placement of a center raised divider which will only allow for right-hand turns. Other pedestrian/bicycle accidents will also hoped to be mitigated by the construction of new sidewalks and an underpass at the Campbell Creek Bridge, which will also provide a crossing for moose and other animals in the greenbelt. Accidents caused by rear-end collisions will be reduced by adding the left-hand turn-pockets and an extra thru-lane. Accidents caused by rain, snow, or bad lighting will be reduced by improved roadway drainage, increased snow storage facilities, and improved lighting, respectively. The Road Segment Crash data can be found in Appendix C-4, Table 3.

3.2.3 Crash Analysis Conclusions

Overall the amount of crashes on Potter and WDR between C Street and Old Seward Highway are below the average crash rate for the State of Alaska on similar roadways and intersections. The new design of WDR with curb and gutter, raised medians, higher access control, and additional pedestrian bike trails may help lower future collisions.

4.0 DESIGN CRITERIA

4.1 Sources

Several agencies publish design standards for criteria-based design of roadways. The principal sources of design criteria used on West Dowling Road are the AASHTO (American Society of State Highway and Transportation Officials) *Policy on Geometric Design of Highways and Streets* and the ADOT (Alaska Department of Transportation and Public Facilities) *Preconstruction Manual*.

4.2 Criteria

Criteria for design were obtained from the above standards agencies and documents. West Dowling is an urban minor arterial according to the ADOT. The design speed for the West-Dowling Extension was set to 45 mph based on AASHTO recommendations for road classification and surrounding roads with similar classifications. Together with the super-elevation grade, AASHTO defines a minimum radius for horizontal curves based on the design speed. The super-elevation selected for this project is six percent. The minimum radius for these criteria is 660 feet. Limiting criteria for the vertical curve based on design speed are as follows:

- Six-percent maximum grade (0.5% minimum grade for drainage)
- 360 foot stopping sight distance for vertical curves
- K-value of 61 for crest curves, 79 for sag curves

4.3 Horizontal and Vertical Alignment

The horizontal and vertical alignments for the Preferred Alternative were designed with the following goals in mind:

- Raise level of service & follow appropriate design criteria
- Minimize ROW acquisition & costs
- Minimize utility relocation
- Minimize wetlands impact
- Compatibility with existing intersections
- Minimize materials cost & cut and fill quantities

Noteworthy utility conflicts on West Dowling Road (WDR) include overhead electric (OE) transmission line towers alongside the existing roadway and a four-foot diameter sewer line in the Campbell Creek area. All alignments were drawn to meet design criteria. For the horizontal alignment, every curve was drawn with a radius equal to or greater than the minimum as specified by AASHTO and ADOT. For the vertical alignment, grades were maintained in the acceptable range and parabolic curves were designed at or above required lengths.

4.3.1 Horizontal Alignment

The horizontal alignment was designed first since the vertical profile of the alignment changes with the horizontal positioning of the road. Several alternatives were considered for the horizontal alignment.

4.3.1.1 Rejected Alternatives

Alternative 1 (Figure 7) essentially follows the existing centerline; however, it curves in the western side of the project to intersect C Street at a right angle. This alignment is advantageous in that it lines up well with existing intersections. Since Alignment 1 follows the existing centerline, there is minimal right of way acquisition required. It does not avoid the transmission towers, which are costly to relocate. Since it does not make extra ROW provisions for the OE it is likely that additional ROW would have to be purchased.

Figure 7 Alternative horizontal alignment 1

Alternative 2 (Figure 8) aims to avoid the overhead electric transmission line towers on the south side of the existing road. This alignment also curves to intersect C Street at a right angle. The centerline of the road re-aligns with the existing centerline at Old Seward Highway through a reverse curve. Alternative 2 avoids many of the OE towers but requires substantial ROW since it will be acquired from just one side. Additionally, the reverse curve can be dangerous and confusing for drivers; not to mention more expense to plan and construct.

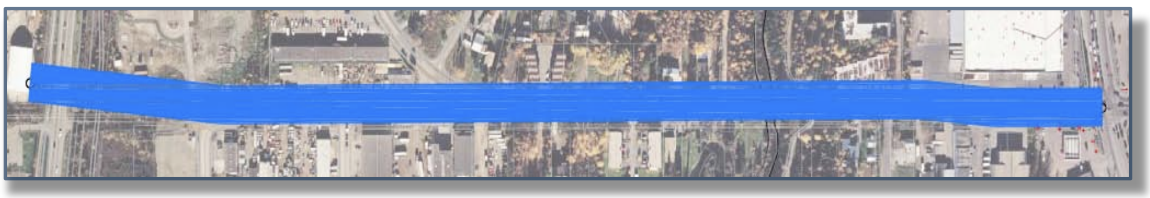


Figure 8 Alternative Horizontal Alignment 2

The third alternative (Figure 9) removes the potentially dangerous reverse curve and shifts the entire alignment to the north, as to avoid placing the bridge foundation overtop the four-foot diameter sewer line in that area.

4.3.1.2 Preferred Alternative

The Preferred Alternative for the project (Alternative 4) builds off of Alternative 3. It takes the narrower corridor across the bridge into consideration. As a result, the centerline from Alternative 3 was shifted south and still avoids the four-foot sewer line with a buffer of 10-feet.

Figure 9 Preferred horizontal alignment

The preferred alignment was selected for the following reasons:

- Partial avoidance of OE towers
- Complete avoidance of four-foot diameter sewer line
- Minimal curves (no reverse curves)
- Partial wetlands avoidance
- Minimal ROW acquisition

Potter Road will intersect West Dowling Road at ninety-degrees with a restricted left hand turn. Geometries at the other intersections have been designed in accordance with analysis based on projected and saturated traffic volumes.

4.3.2 Vertical Alignment

The vertical alignment was drawn as an iterative process after the preferred horizontal alignment was selected. Design of the vertical alignment was a compromise between meeting design requirements and matching the existing ground. This is the least costly alternative because it minimizes the amount of cut and fill. The road must meet vertical alignment requirements as well such as grade and length of parabolic curve.

4.4 Typical Sections

4.4.1 Typical Cross Section

The typical section specified in the project scope of work will run the length of the corridor excluding the bridge. The median was narrowed slightly for space considerations and to allow for inside shoulders. This urban-arterial section is comprised of two, 12-foot travel lanes in each direction and a 16-foot raised median with left-turn pockets as appropriate. Two-foot shoulders are required. Curb and gutter will be used for drainage, as it minimizes the footprint of the road. Wherever possible, buffers of seven-feet from the top-of-curb provide improved safety and snow storage. A 12-foot multi-use pathway to the north and a six-foot sidewalk to the south are included in the cross section, space permitting. Please refer to B Sheets for the Typical Cross-Sections.

4.4.2 Bridge Cross Section

The cross section on the single span bridge across Campbell Creek will be composed of four 12-foot travel lanes, a four-foot raised median, 4.5-foot outside shoulders, two-foot inside shoulders and six-foot sidewalks on both sides. Please refer to D Sheets for the Bridge cross-section.

4.5 Design Speed

The design speed is the maximum safe speed of travel associated with the design features of a road segment. Traditionally, the posted speed is determined by the speed at which 85% of vehicles are traveling at or below. The road, with the proposed modifications, is not yet in existence so the 85th percentile speed is not determinable. The existing road is posted at 35 mph. The design speed is based on the road classification. West Dowling is an Urban Minor Arterial according to the ADOT. The design speed for the West-Dowling Extension was set to 45 mph based on the AASHTO recommendations for road classification and surrounding roads with similar classifications.

5.0 INTELLIGENT TRANSPORTATION SYSTEMS

Since traffic congestion dramatically reduces efficiency of transportation infrastructure and increases travel time, air pollution, and fuel consumption, intelligent transportation systems (ITS) will be implemented along the WDR corridor. To reduce congestion and increase safety on the WDR corridor, ITS will be utilized by adding variable message signs, utilizing cellular phones as anonymous traffic probes, and cameras for automatic license-plate and speed recognition. ITS can also play a helpful role in the rapid mass-evacuation of people after catastrophic events such as a large earthquake.

5.1 Variable Message Signs

Variable message signs (VMS) will be placed on the signal masts above each turning approach entering WDR at Old Seward Highway and C Street intersections for a total of 6 locations. VMS will serve two common functions: to automatically display warnings conveying traffic congestion levels on WDR and display emergency messages during scenarios involving evacuations or traffic accidents. For an example of typical VMS placement per intersection see Figure 10.

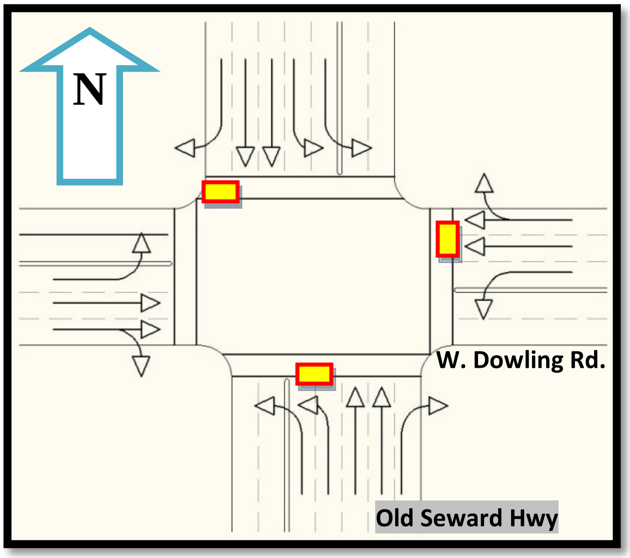


Figure 10 Example of Variable Message Sign Locations (Dowling and Old Seward Intersection)

In the case of high congestion levels on WDR, the VMS will receive wireless communications and display the appropriate messages to reroute users to a predetermined location with historically lower levels of congestion than WDR In the case of a traffic accident, the VMS will be updated from the municipal central control room and display a message rerouting users to a predetermined alternative route. If a catastrophe has occurred in the area, the VMS can be updated to display messages instructing users towards safety zones or helpful destinations/phone numbers to receive assistance. Examples of a catastrophe could include an earthquake, uncontained fire sweeping through the area, a chemical spill, etc.

5.2 Video Vehicle Detection

Video cameras will be installed to automatically track traffic flow measurements and detect traffic incidents at the signalized intersections on WDR The video detection system will record data regarding lane-by-lane vehicle speeds, counts, and lane occupancy readings. These readings will wirelessly trigger the appropriate messages to be displayed on the variable message signs, rerouting potential users. Video vehicle detection is an attractive ITS option because it is a "non-intrusive" method of traffic detection and does not involve installing any components directly into the road surface or roadbed

The proposed video detection systems use automatic number plate recognition to identify vehicles and will provide traffic enforcement to identify vehicles disobeying the posted speed limit. The system will automatically ticket offenders based on their license plate number, resulting in a traffic ticket sent by mail to the offender’s mailing address. The video detection cameras will be mounted on the signal masts at Old Seward Highway and C Street per approach, for a total of 8 cameras.

5.3 Floating Cellular Data

Since the majority of vehicles in the Anchorage traffic network contain one or more mobile phones, vehicle locations and corridor volumes can be easily tracked, while minimizing cost and impact on the WDR traffic operations. Even when no voice connection is established by the user, the locations of vehicles can be tracked as anonymous traffic probes. Using an anonymous format, these locations can be triangulated and converted to traffic flow information used by the variable message signs. As congestion increases, the quantity of phones increases, thus creating more probes for use in future data analysis.

This method of data collection requires no additional infrastructure and uses solely the mobile phone network to collect data and send it to the municipal traffic control headquarters and variable message signs. Floating cellular data will be used to collect data along the entire corridor, as opposed to the limitation of intersections as provided by video detection systems. Costs and traffic disturbances are also minimized by avoiding installation and maintenance of detectors along the corridor. Floating cellular data is never affected by heavy rain and works in all weather conditions.

6.0 PEDESTRIAN AND PUBLIC TRANSPORTATION FACILITIES

6.1 Pedestrian and Bicycle

The current pedestrian and bicycle facilities along WDR are very limited. A 5-foot sidewalk exists on the North and an 8-foot multi-use path with curb ramps and detectable warning tiles exists to the South. Both facilities span from the Campbell Creek Greenbelt to the existing facilities on Old Seward Highway, leaving no pedestrian or bicycle facilities on WDR west of Campbell Creek. The sidewalk to the north is protected from the west-bound (WB) vehicular traffic only by the depth of the curb itself, as no shoulder is present. The current pedestrian and bicycle facilities create an unsafe environment for pedestrians living west of Campbell Creek and for anyone traveling along the north side of WDR.

The typical cross-section designed for the WDR Phase I project includes a 12-foot multi-use pathway and a 6-foot wide sidewalk, each protected by a 7-foot "buffer-zone" between the pedestrian facilities and the shoulder of the vehicular traveled way except along the span of the bridge, where the "buffer-zone" will be removed to reduce bridge width. East of the bridge the sidewalk and path will branch off and intercept the Campbell Creek Greenbelt path traveling perpendicular to the WDR centerline under the bridge and along the East side of Campbell Creek designed with a 12-foot width. The sidewalk and path will both be reduced to 6-feet widths on the north and south sides of the bridge. All pedestrian facilities will be designed in accordance with Americans with Disabilities Act (ADA) standards, including detectable warning tiles and push-button crossing detectors at the proposed signalized WDR/C Street intersection.

6.2 Public Transportation

No public bus routes are currently operating on WDR People Mover currently has no plans in the near future to add any routes to this corridor, as major routes already exist along the lengths of Old Seward Highway and C Street. The demand for public transportation on WDR is assumed to be very minimal since the entire west half is non-residential zoning and it is assumed that the homes on the east end will use the route available on Old Seward Highway. However, with the traffic growth due to the future WRD Phase 2 project, a bus stop will most likely be needed during the life of the WDR project. It is recommended that the most effective location for a bus stop would be on the north side of WDR just east of Potter Drive This is the most suitable location since it is primarily residential east of Potter Drive and there should be adequate ROW since the existing apartment building at that location will be removed. See Figure 11 for a map showing the aforementioned proposed bus stop location. The proposed bus stop will be designed and built in accordance with People Mover standards.

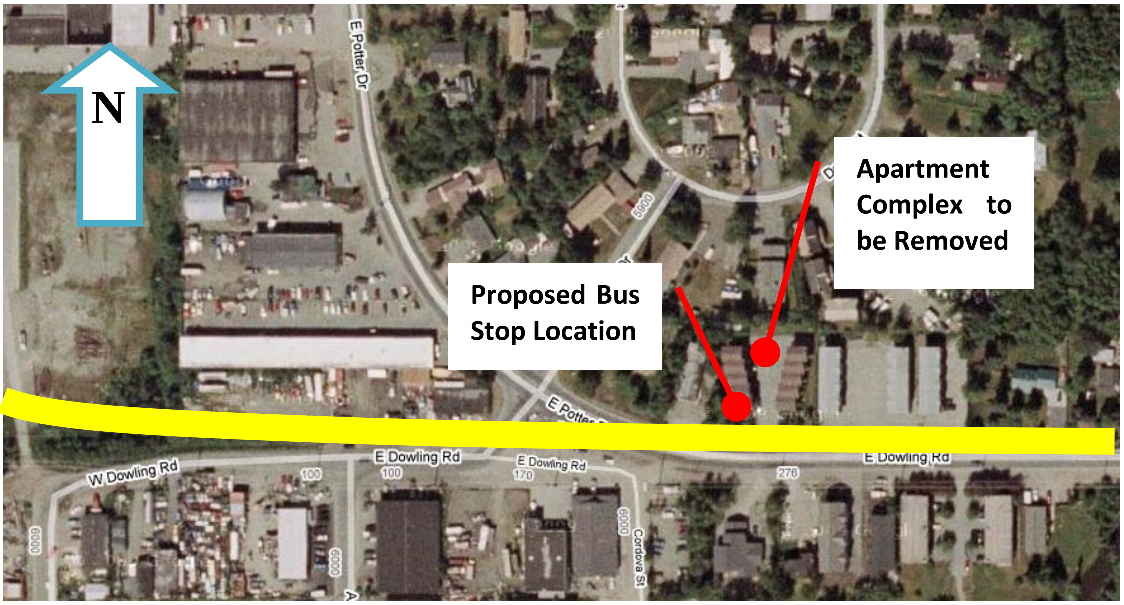


Figure 11 Proposed Bus Stop Location

7.0 CAMPBELL CREEK BRIDGE

7.1 Background

The current bridge on WDR over Campbell Creek is in dire need of repair or replacement. The west side of the bridge has sagged more than 18-inches, creating a large dip in the roadway because of an inadequate foundation. The east side has seen less significant sagging effects. In addition, the existing bridge causes some mild backwater issues as it leaves very little room for flood level creek flows to go under. Therefore, the design of a new bridge is proposed. In addition, pedestrians using the Campbell Creek trail need to cross W. Dowling Road just to the east of the bridge and it is desirable that they, along with moose and other wildlife, are able to pass underneath the bridge structure.

7.2 Objectives

The main criteria for the new bridge are as follows: it must accommodate four lanes of traffic plus sidewalks on either side, as part of the larger WDR expansion project; it must, according to ADF&G and DNR-OHMP, allow for ten to fourteen feet of overhead space above a twelve-foot pathway running parallel to Campbell Creek, which itself must be at least at the elevation of a five-year flood event of the creek; and it must not create backwater problems or be susceptible to significant amounts of scour in one hundred-year flood events or cause serious upstream ice jamming problems.

7.3 Bridge Design

For each facet of the design of the WDR Bridge, multiple alternatives were explored. These alternatives are explained in depth in Appendix D – Bridge Design.

7.3.1 <u>Bridge Span</u>

Several design alternatives were developed. A two span bridge was considered to lower cost of material and the possibility of leaving the existing bridge open during the construction of the new bridge. This alternative was disregarded because, due to the centerline of the new four lane roadway, this design would place the south span directly above an existing 48” sewer line that cannot be moved. Therefore, the southern span will be moved up against the northern span with a concrete barrier between the lanes instead of an eighteen foot median. The simultaneous vertical rise and horizontal curve of the east-bound lanes is, according to the roadway geometry and layout technical teams, less than ideal, but this alternative avoids the sewer line and lowers the cost of material.

Originally, based on initial analysis and research, the use of retaining walls at the bridge abutments was considered. However, retaining walls are undesirable, as both the initial cost and costs of repair are very expensive, as shown in Section 4.4 of Appendix D. Without the use of retaining walls the embankment ratio must be 2:1, which along with the desired twelve feet of overhead space above the pathway was thought to result in a required bridge span of 137 feet. However, after further HEC-RAS analysis of the streambed, a required length of 105 feet was found to allow for the hundred-year flood event to pass safely underneath the span.

Various materials were considered for the construction of the bridge. Timber was briefly considered but consequently disregarded because of the shorter expected lifespan of wood in comparison to other building materials in the exposed environment. A steel girder design was also researched, but also rejected because of a large initial cost to build and the potential of quickly-acting corrosive elements in the Anchorage region causing the need for frequent maintenance and repair work. A bulb-t precast concrete girder design was settled on. In addition to being standard to the area, this design is very cost-effective, requires low amounts of maintenance work, and has a long design life.

After structural analysis of the bridge it was found that a standard 54" depth bulb-t girder will be sufficient to handle the bridge loads for a 105' span, and that twelve girders are necessary for the width of the roadway. The top flange of each girder will be 80" which results in an 80-foot width, including a three foot barrier, two six-foot sidewalks, and two two-lane, twenty-four foot widths for traffic, with four foot shoulders in between the traffic lanes and the pedestrian sidewalks. This cross-section is illustrated in Section 6 of Appendix D in the construction drawings. A more in depth discussion of the process of determining the bridge span dimensions can be found in section 4.2 of Appendix D.

Because the five year flood level was found to be at 96.1 ft MSL, the roadway elevation will be at 113.1 ft MSL, accounting for the twelve feet of overhead space, the 54" girder depth, and a 5" roadway slab depth.

7.3.2 Foundations

Foundation design of a bridge spanning water requires deep foundations. Several options have been considered including H-piles, pipe-piles, and drilled shafts. The H-pile is the most economical type of deep foundation for a single span bridge and is the recommended alternative. Table 4 shows the deep foundation alternatives for the bridge.

Table 4 Foundation Cost Estimate

Pay Item	Pay Unit	H piles	Drilled Shafts	Pipe Piles
Concrete	Cubic Yard	0	$$$	$12000
Reinforcing Steel	Pound	0	$$$	$3920
Piles	Linear Foot	$128700		$204600
Drive Piles	Each	$120000		$168000
Equipment Rental	Lump Sum		$1000000	
Total		$248700	$1000000+	$388520
	Preferred Alternative	**H-Piles**		

7.3.3 Approaches

The proposed bridge elevation is 113.1 ft MSL, the current road elevation is 103.0 ft MSL. The optimal choice is a 1:10 grade increase over 100 ft on both sides of the bridge. This option has the lowest grade possible without interfering with existing side streets. Two other alternatives are discussed in Appendix D, along with the rationale behind the decisions made.

8.0 BRIDGE HYDRAULICS

The bridge hydrology engineers have performed an in-depth hydraulic analysis of the proposed bridge design. The hydraulic analysis investigated flooding potential upstream of the proposed bridge. The hydraulic analysis also addressed potential scouring of the proposed bridge abutments and led to recommendations for scour mitigation. The potential for ice jamming with the proposed bridge design was also evaluated.

8.1.1 Backwater

The hydraulic conditions of the proposed West Dowling Road Bridge were analyzed using the US Army Corps of Engineers program, HEC-RAS. Two conditions were modeled in HEC-RAS. The first hydraulic analysis was run with the existing bridge and stream bed topography. The second hydraulic analysis replaced the creek cross sections under the bridge with cross sections designed for the proposed bridge and trail. The design cross sections included the 2:1 slopped abutments and the 12 ft wide trail at an elevation of 96.1 ft. The two hydraulic analyses were compared to evaluate backwater conditions for the proposed bridge design. The HEC-RAS results indicate that a trail at this elevation will be submerged with flood events larger than the 5 year flood event. The proposed trail and sloped abutments result in a cut of bank material. As expected, this opens the channel under the bridge for larger flood events thus decreasing the elevation of the backwater at larger flood events upstream from the bridge. Table 5 lists the hydrologic data used in the HEC-RAS analysis. The HEC-RAS cross sections and analysis are further addressed in Appendix G.

Table 5 Campbell Creek Hydrologic Data in HEC-RAS

Recurrence Interval	Q_2	Q_5	Q_{10}	Q_{100}	Q_{500}
Exceedance probability	50%	20%	10%	1.00%	0.2%
Drainage Area	46 sq. mi.	46 sq. mi.	46 sq. mi.	46 sq. mi.	46 sq. mi.
Design discharge	340 cfs	550 cfs	700 cfs	1250 cfs	1700 cfs

8.1.2 Scour Mitigation

The new bridge span is designed to minimize or eliminate the potential for scour damage during flooding events. In the current design, two to three feet of the toe of the west 2:1 embankment slope will be submerged under any flood event larger than a ten year flood.

The bridge hydraulics team is recommending leaving existing riprap below the trail elevation and below the high waterline to provide stability to the new trail. Leaving existing riprap will help eliminate impact to the stream by minimizing construction activity in the creek. This will also be more cost efficient then replacing the riprap below the waterline. A previous analysis found that the existing riprap is adequate for the area that it covers. The width of the new bridge span will be significantly larger than the existing bridge therefore the riprap cover, in the form of 0.25 ft. D50 rocks, will likely need to be extended slightly south and a significant amount north of where it is currently installed.

The bridge hydraulics team is also recommending the installation of riprap to protect the bridge abutment embankment. Riprap sized at 6 in. D50 with a mat thickness of at least 9 in. will be sufficient to protect the new bridge abutments from a 100 year flood event or smaller. The riprap apron will wrap around the entire bridge abutment and will extend 4 ft. from the toe of the abutment to a vertical height of 4 ft up the abutment from an elevation of 96.1 ft (trail height) on both sides to 100.1 ft as shown in Figure 12 and Figure 13.

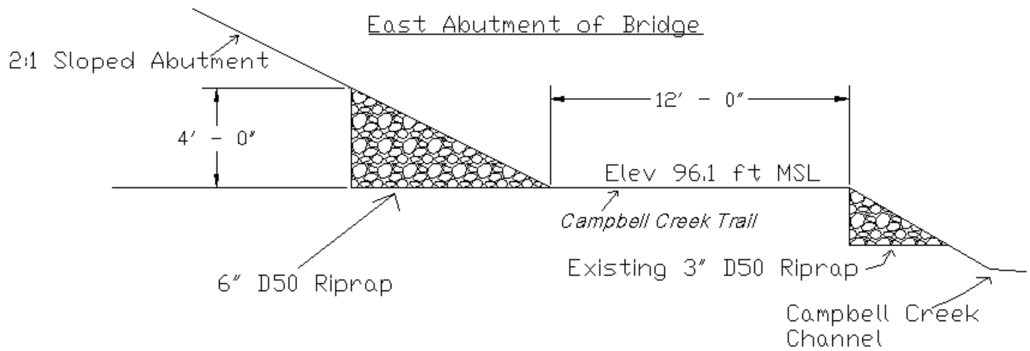


Figure 12 Typical Cross-Section of Bridge Riprap (East Side)

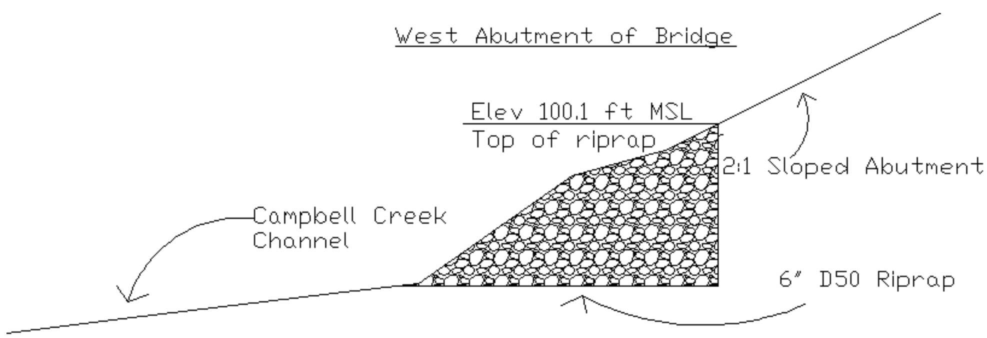


Figure 13 Typical Cross-Section of Bridge Riprap (West Side)

Appendix G details the alternatives considered in providing scour mitigation for the proposed bridge.

8.1.3 Ice Jamming

Extensive icing of Campbell Creek at W. Dowling was observed during the 2004-05 winter and is documented in the HDR Hydrology and Hydraulics Report. The icing occurred during a mid-winter rain event. Ice elevations were surveyed during the event and are shown in Table 6.

Table 6 Campbell Creek Ice Elevations on 1/28/05 (HDR Inc, Alaska)

Cross Section #	Location	Ice Elevation
1	Furthest Downstream	93.57
2		93.75
3		94.04
4		94.29
5		94.64
6	South Edge of Existing Dowling Road Bridge	94.75
7	North Edge of Existing Dowling Road Bridge	94.75
8		95.17
9		95.2
10		95.21
11		95.46
12	Furthest Upstream	95.71

The bridge design will respond to these icing events to reduce icing and ice jamming issues in the future by reducing the channel constriction under the bridge at larger flood events.

9.0 RIGHT OF WAY

9.1 Summary of Findings

The ROW decisions for the West Dowling Road Project were guided by various factors. Some of these factors included: presence of contaminated sites, cost of ROW acquisition, impacts of ROW acquisition on local businesses and community residents and impact on relocation of utilities.

The preferred ROW alternative for the project corresponds to the Roadway Alignment 4. Alternative 4 places the proposed centerline of the project north of the existing centerline. The alignment of the road is angled at C Street to intersect at 90 degrees (Figure 17, Figure 18). The estimated cost for ROW acquisition along this alignment is $11.3 M (See 9.5). The advantages of this alternative are that ROW along the south side of West Dowling Road is minimized. The disadvantages of this alternative are that overhead electric lines on the north side of the project will be necessary.

9.2 Current ROW and Land Use Conditions

The current ROW in the project corridor was determined by examining lot lines for all properties in the project corridor. The current ROW conditions were given to the Road Geometry team to aid their analysis of alignment alternatives.

9.3 Right of Way

The existing right-of-way (ROW) from Old Seward Highway to C Street varies from 55 to 90 feet. The current ROW widths are summarized in Figure 14; the ROW is owned and maintained by Alaska Department of Transportation. ROW acquisition efforts are in progress to obtain a ROW corridor that has a minimum width of 106 feet.

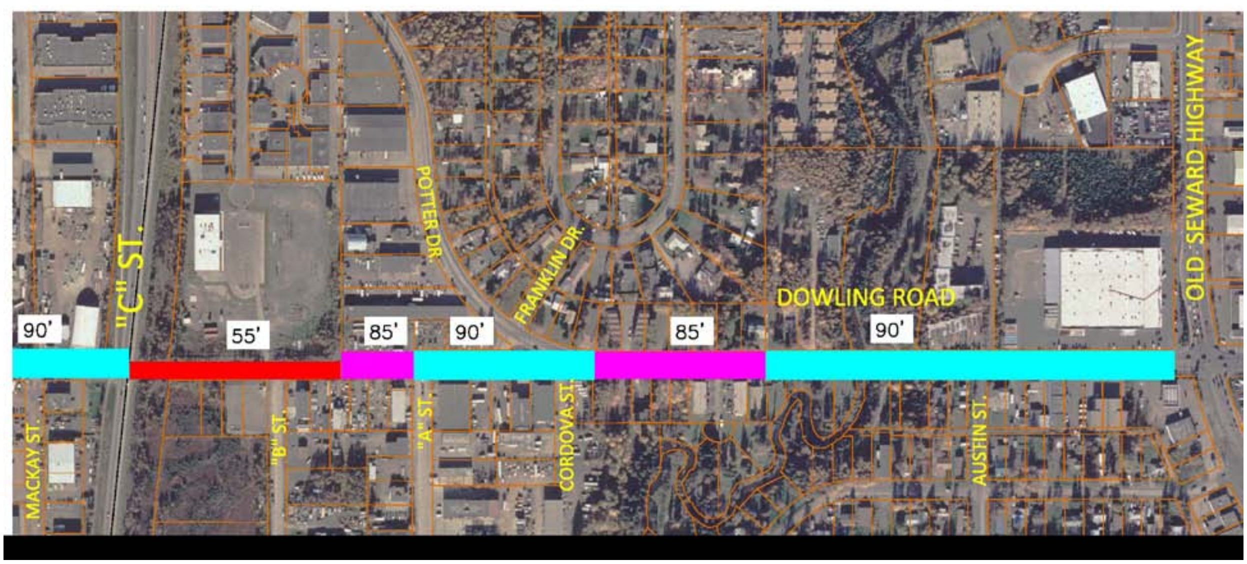


Figure 14 Existing ROW Widths

9.4 Estimated ROW Impacts of Project

The impact of ROW was estimated by coordinating with the Roadway Geometry team and using two different road alignments to estimate cost of ROW acquisition. Roadway geometry came up with four different alternative alignments. However, only two of these alignments differed significantly in the ROW impact. Therefore only Alternative 1 and 4 were analyzed with regard to ROW impacts

9.4.1 Alternative 1

Alternative 1 uses the existing road centerline for the centerline of the proposed road alignment. The alignment of the road is angled at C Street to intersect at 90 degrees (Figure 15, Figure 16). The estimated cost for ROW acquisition along this alignment is $12.0 M. The advantages of this alternative are that it minimizes ROW acquisition of the Sears Warehouse on the NW corner of Old Seward and West Dowling Road. In addition, this alternative minimizes ROW acquisition on the north side of West Dowling Road. The disadvantages of this alignment are that utility relocations of overhead electric lines on both the north and south sides of the road will be necessary.

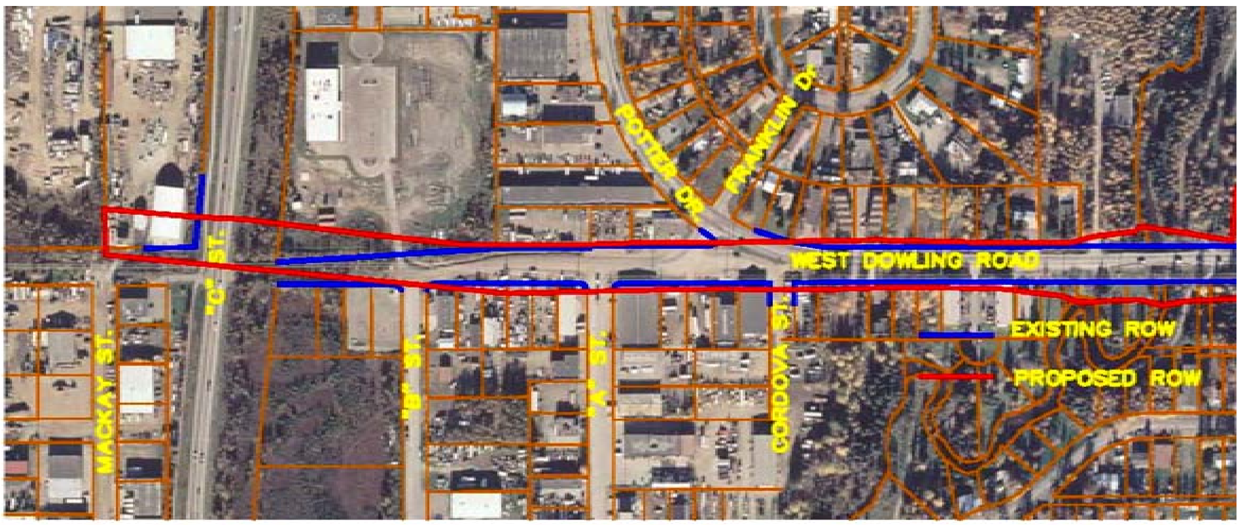


Figure 15 Proposed Alternative 1 (West)

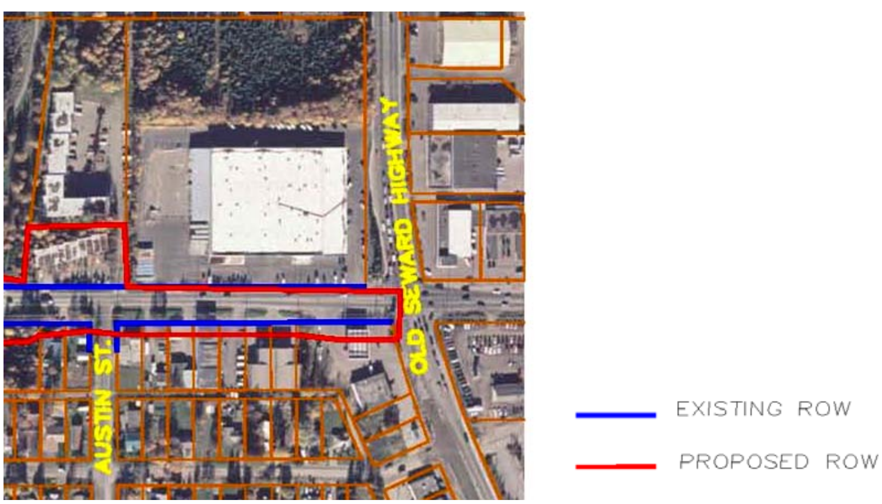


Figure 16 Proposed Alternative 1 (East)

9.4.2 Alternative 4

Alternative 4 places the proposed centerline of the project north of the existing centerline. The alignment of the road is angled at C Street to intersect at 90 degrees (Figure 17, Figure 18). The estimated cost for ROW acquisition along this alignment is $11.3 M. The advantages of this alternative are that ROW along the south side of West Dowling Road is minimized. The disadvantages of this alternative are that overhead electric lines on the north side of the project will be necessary.

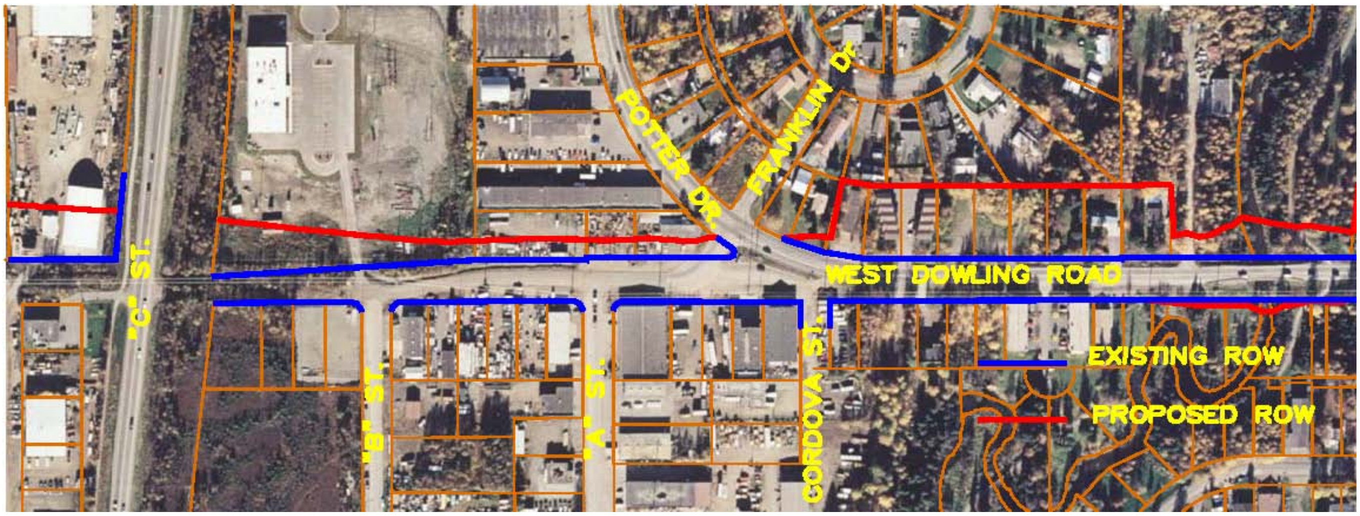


Figure 17 Proposed ROW, Alternative 4 (West)

Figure 18 Proposed ROW - Alternative 4 (East)

9.4.3 Preferred Alternative

The preferred alternative is Alternative 4. The right of way costs for both alternatives are approximately equal. The deciding factor was ultimately the relocation of overhead electric lines. Alternative 4 would not require relocation the overhead electric lines on the south of the road.

9.4.3.1 Old Seward Highway to Campbell Creek

From Old Seward Highway to Austin Street the width of the road is expanded to accommodate more lanes. ROW will be acquired from the Tesoro Service Station and from the Sears Warehouse lots (Figure 18) ROW will be acquired from the Campbell Creek Greenbelt Apartments to accommodate for realignment of Austin Street on the north side of Dowling Road along with placement of a parking lot for access to the Campbell Creek trail.

9.4.3.2 Campbell Creek to Potter Drive

This section of road has also been expanded to accommodate for extra lanes. Area around Campbell Creek on both the north and south sides of Dowling Road will be acquired to accommodate for the new bridge structure (Figure 17). Entire portions of condos, apartments and a house on the north side of Dowling Road between Campbell Creek and Potter Drive will be acquired. While the entire portion of these lots is not required to accommodate the road corridor, the condos and apartments are interconnected and it is not possible to demolish only a portion of the complexes.

9.4.3.3 Potter Drive to C Street

This section of road has also been expanded to accommodate for extra lanes. In addition, Dowling Road will be connected to C Street. Portions of lots on the north side of Dowling Road will be acquired, including a portion of the IBEW training facility and several businesses.

9.4.3.4 Beyond C Street

Dowling Road will be extended beyond C Street approximately 100’ – 200’ to accommodate for Phase II of the project which will connect Dowling Road to Minnesota Drive ROW will be acquired on the north side of the proposed road alignment. Only a portion of this commercially zoned lot will be acquired.

9.5 ROW Acquisitions Costs

The MOA parcel viewer (MOA, 2009) was used to compile a list of current property values. If a value was not available on the MOA parcel view, the information was acquired from the Environmental Assessment. The information compiled is presented in appendix A. The cost of ROW acquisition for Alternative 1 is $12.0 M. The cost of ROW acquisition for Alternative 4 is $11.3M.

10.0 SOIL CONDITIONS

The following summarizes the key points of the preliminary log of test holes completed for the West Dowling corridor.

10.1 Bridge Foundation

The test hole completed within proximity of the bridge location indicates that a pile foundation would be best suited for the in-situ materials encountered. The clay layer deep within the soil would need to be removed if any other footing is to be used. A pile foundation would also minimize the environmental impacts met with removing the underlying materials.

10.2 Organics/Surcharge

Test holes near the west end of the project indicated several layers of peat material. The material will need to either be removed or overlain in order to support the embankment construction. Leaving the peat in place may result in long term settlement, increased maintenance and pavement failure. The location of the peat is near the proposed intersection of West Dowling and C Street, which will encounter large traffic loads and may cause greater settlement if the material is left in place. Removal of the peat will have a higher initial cost, but will remove the issues related with leaving the material in place.

Further geotechnical investigation will need to be conducted in order to provide cost comparisons with the different possible options regarding the peat material.

10.3 Groundwater

The groundwater table ranges from 4-12 feet based on the test holes conducted throughout the project location. To prevent frost heave a geotextile fabric can be placed in between the subgrade and subbase material. Raising the roadway in some areas may be necessary to prevent further frost action.

The highest encountered water table was found in the areas with peat material near the west end of the project. The low elevation and high water table suggest that the roadway be raised at this area and geotextile material be placed in order to allow drainage for the embankment.

10.4 Reuse of Materials

Further investigation will be needed in order to determine the characteristics of the material that will be removed for reuse purposes. Excavated material will need to be tested to verify that it meets the necessary requirements before it may be reused.

10.5 Dewatering

Dewatering will be required along the alignment due to the high water table. The dewatering process will be the responsibility of the contractor based on the construction methods. The west portion of the project near C Street will require well points in order to drain the high water table.

11.0 PAVEMENT DESIGN

The following pavement design is based on recommendations found in the geotechnical report, calculated and projected traffic data and environmental conditions encountered in the corridor. The structural section will provide a 20-year life with no seasonal restrictions. The design was performed using both the Alaska Flexible Pavement Design and the AASHTO standards. Minimum layer thicknesses were met during the design.

11.1 Current Conditions

Throughout the project corridor the many different types of fatigue cracking and settlement issues are apparent in the pavement surface as can be seen in Figure 19. After researching each specific failure and understanding the symptoms, it is obvious that frost action and subsurface saturation play a major role in the condition of the pavement surface.

Figure 19 Settlement failure due to subsurface saturation and frost action.

The visual inspection is also supported with the evidence from the geotechnical data collected. The groundwater table throughout the corridor is significantly high with respect to the embankment structure. Along with the high water table, many portions of the corridor are positioned over frost susceptible soils. These two conditions allow for the winter climate to cause major frost action effects to the pavement structure.

11.2 Cold Regions Issues

When designing a mix design and pavement structure, consideration must be given to the climate in the area. A pavement that works well in a dry, warm climate will not function well in a wet, cold climate. Pavement is very sensitive to variations in temperature due to the viscous nature of asphaltic cement. The moisture in the environment is another important consideration because it can cause the pavement structure to fail. Alaska also has unique issues such as snow tires and the freeze-thaw cycle. These climate-related issues present themselves in a variety of failure patterns and can be remedied with appropriate consideration.

Temperature affects the viscosity of the asphaltic binder. Warmer temperatures will cause the binder to be soft and flow more readily while colder temperatures will cause the binder to be thicker and stiffer. When the pavement is too stiff, it is brittle and easy to fracture. In Alaska, this problem presents itself as thermal cracking. Thermal cracks are long cracks in the pavement, perpendicular to centerline, caused by expansion and contraction of the asphalt from variations in temperature (Dore et al., 2009). The asphalt was too brittle to allow for elastic response to the change in volume. A soft pavement is too ductile and results in permanent deformation of the pavement. This problem presents itself as rutting of the pavement. Depressions are made in the wheel path as a result of traffic load. This can make lateral maneuvering difficult and create a risk of hydroplaning as water collects in the depressions. Studded tires can also contribute to rutting though chipping of the pavement aggregate by the metal studs (Dore et al., 2009).

Moisture penetration is another common problem with pavement in cold regions. Fatigue cracking results when the asphalt layers experience high strain because the base layers have been weakened by excess moisture (Dore et al., 2009). It is a fatigue failure in that many small loads are applied. In cold regions this problem is intensified by the existence of frozen ground. Ice lenses can weaken the ground when melted. Differential frost heaving is another issue associated with pavement on frozen ground (Dore et al., 2009). In order for frost action to be present there are three conditions that must be satisfied, 1) there must be freezing temperatures, 2) there must be moisture and 3) there must be frost susceptible soil.

11.3 Drainage Design

To avoid pavement distress in the future, saturation of all layers of the pavement structure must be designed in order to drain properly. The layers must be analyzed with respect to each other for filtration possibilities. For example, the subbase course must be analyzed to make sure filtration criteria are met with respect to the base course. This will help ensure that clogging and permeability issues are kept to a minimum. In some areas of the project site thick layers of peat material exist. This peat layer is associated with one of the highest groundwater tables in the corridor. Due to these facts the underlying peat will be removed and an additional geotextile separation fabric will be placed prior to backfill with the subbase material. The geotextile material will help reduce the amount of fines that are carried upward into the pavement structure and allow for higher levels of drainage.

Another area that required geotextile fabric is near the bridge structure. The major concern is the subgrade materials. Under the bridge the geotechnical data indicates thick layers of silty sands and clay material. These layers are very frost susceptible and have high capillary effects. Since this area is near the creek the soil around the embankment area will be fully saturated. The geotextile fabric will allow for separation between the fill materials and the underlying soils. A major excavation would normally be necessary, but since there are existing water and sewage systems that cannot be disturbed, this will not be an option.

11.4 Traffic Data

After all the preliminary investigations of the area were complete, traffic data needed to be analyzed in order to determine the future demands that the pavement structure would experience. To relate the demands to the pavement structure the ESAL was determined. This value took into account growth rates, the amount of trucks on the road, design life and the lane distributions. The calculated values can be found in Appendix E Section 1.0.

The ESAL was then used in two different methods in order to calculate the cross section thicknesses. The excess fines pavement design from the flexible pavement manual and the AASHTO method were used. Both resulted in different asphalt, base and subbase values.

11.5 Excess Fines Method

The first method that was used in order to determine the pavement thickness was the excess fines method found in the Alaska Flexible Pavement manual. This method relates the percent material that is less than .075 micrometers to deflection. The excess fines method states that the more fines within the materials, the larger the deflection that will occur. The calculations done for this method can be found in Appendix E Section 2.0 along with the methodology behind the values chosen. The results for this method can be seen in Table 7.

Table 7 Excess Fines Results for Pavement Cross-section

Excess Fines Method	
	Thickness (inches)
Asphalt	5
Base Course	4
Subbase Course	14

11.6 AASHTO Design Method

The second method that was used was the AASHTO design method. The values calculated with this method are base on the specific factors encountered at the project site. For example the traffic patterns, roadbed soils, environment and materials used for construction are factors that are used for the analysis and they will be found specifically for the Dowling corridor. The calculations along with the methodology and chosen values can be seen in Appendix E Section 3.0. Two separate alternatives were found by using different assumed values in the analysis. The results and comparisons of the alternatives for the AASHTO design method can be seen in Table 8.

Table 8 AASHTO Design Method for Pavement Cross-sections

AASHTO Design method Layer thickness (inches)		
	Alternative 1	**Alternative 2**
Asphalt	4	4
Base Course	6	8
Subbase Course	7	5

11.7 Preferred Alternative

Based on the alternatives calculated and the recommendations from our peers the following pavement structure was designed.

11.7.1 <u>Fog Seal Coat</u>

In design of the pavement on West Dowling Road, cold regions issues have been taken into consideration and the pavement design team has taken several steps to combat the causes of pavement failure. A fog seal will be overlaid on the wear coarse. A fog seal is a thin layer of slow-curing emulsified asphalt used to prevent moisture penetration (Garber et al., 2009). This will help prevent the problem of fatigue cracking.

11.7.2 Two inches Type V-R Asphalt

The type V-R asphalt is a wear coarse material with recycled crumb rubber as an additive. The edition of a plastic material like rubber helps the pavement resist permanent deformation such as rutting (Dore et al., 2009). Rutting can also be minimized by adequate drainage on the facility. The crumb rubber will result in a slightly higher initial cost, but will reduce surface wear, roughness and cracking. By reducing these factors lower maintenance will be required throughout the design life of the pavement structure.

11.7.3 Tack Coat

This thin bonding layer will be of the standard requirements used currently by the ADOT. The bonding agent will simply adhere the two separate layers of the pavement structure into one unit.

11.7.4 Three inches of Type-II Class B Asphalt Concrete

The bonding course will supply an interface between base course and the wear surface. The material will meet DOT standards in order to provide adequate support to the pavement structure and resist fatigue.

11.7.5 Four Inches of 1:1 Recycled Asphalt Pavement and Crushed Aggregate

The options for the base course are 4 inches, developed from the excess fines method, 6 inches, developed from Alternative 1 of the AASHTO design method, and 8 inches, developed from Alternative 2 of the AASHTO design method. All three options are safe and within standards, therefore a base course of 4 inches was selected because of the savings due to a lesser volume.

Additionally, there is an option to use Reclaimed Asphalt Pavement (RAP) in the base course. RAP is most commonly added at 10 to 30 percent by weight although additions as high as 80 percent by weight have been used (FHWA, 2001). A considerable amount of construction cost can be saved with the use of RAP; the majority of savings develop from transportation cost. Also, a base course including RAP drains better and is stronger than crushed aggregate alone. With the use of 50% RAP and 50% Crushed Aggregate a 4 inch thickness was chosen because of the increase in strength from using RAP, choosing either 6 or 8 inches of RAP base course would overdesign the pavement structure and raise costs considerably. It is standard in Alaska to use 50% RAP with an oil content of 2.5%.

11.7.6 40-inches (minimum) of Select Material, Type A

The process for calculating the subbase material deals with relationships between underlying materials, traffic loads and climate characteristics. Using the excess fines and AASHTO design methods resulted in subbase layers of 14 and 10 inches, respectively. For the corridor area these values would not allow for adequate resistance to frost penetration. Recommendations given by Mitch Miller, from the DOT Central Regions Material Laboratory suggested that the subbase always be a minimum of 36 inches if the subgrade material is of typical quality. In some situations where the subgrade is a thick gravel layer that meets subbase and drainage standards, a subbase layer is not need. On the other hand, if the existing material is very soft the subbase layer could be up to 60 inches thick. After analyzing the gathered data and alternatives a thickness of 40 inches minimum of Type A select material was chosen for the corridor. The area in which underlying peat materials will need to be removed and replaced will require a thicker subbase.

Figure 20 shows the thicknesses and the resulting pavement cross-section required for West Dowling Road.

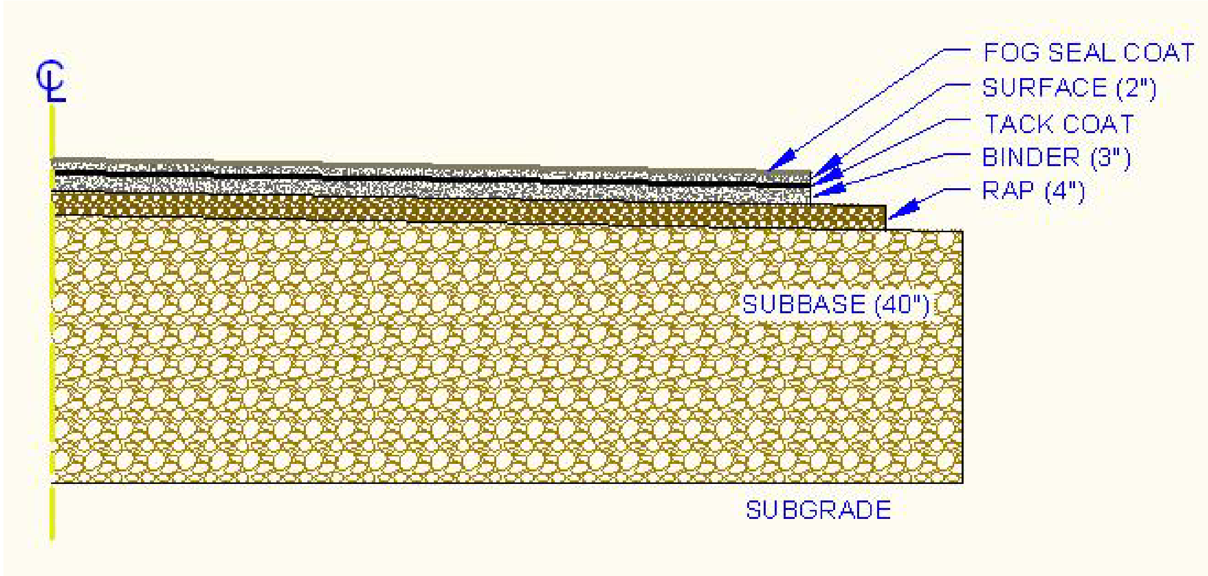


Figure 20 Pavement Structure Cross Section

11.8 Maintenance

Pavement maintenance is crucial to the durability and life of pavement. A successful pavement preservation program incorporates many maintenance strategies and treatments. The three types of pavement maintenance are listed below.

11.8.1 Preventive Maintenance:

Planned strategy of cost-effective treatments to an existing roadway system that preserves the system, delays future deterioration, and maintains or improves the condition of the system. Preventive maintenance does not add any structural capacity. Surface treatments that are less than two inches in thickness are not considered as adding structural capacity.

11.8.2 Corrective Maintenance

Corrective Maintenance is completed after a deficiency occurs in the pavement, such as moderate to severe rutting, raveling or extensive cracking. This may also be referred to as “reactive” maintenance.

11.8.3 Emergency Maintenance

Emergency Maintenance is completed during an emergency situation, such as severe potholes that needs repair immediately. This could also include temporary treatments that hold the surface together until a more permanent treatment can be performed.

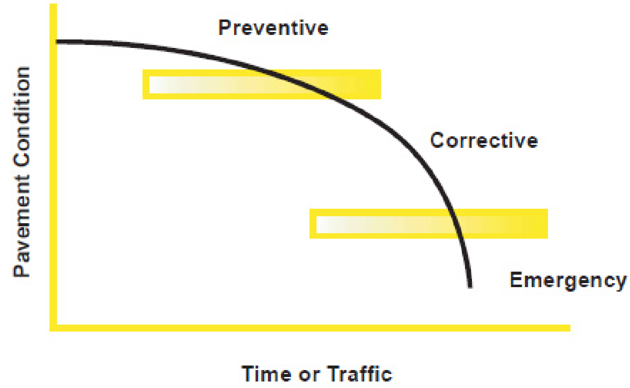


Figure 21 Categories of pavement maintenance

If preventative maintenance is incorporated the cost of maintenance can be 6 to 10 times less than corrective or emergency repairs. In Figure 22 it can be seen that the overall quality of the road remains high. Preventive maintenance treatments include: dowel bar retrofitting, crack sealing, armor coating, chip sealing, fog sealing, broom or scrub seals, rut filling, and thin overlays.

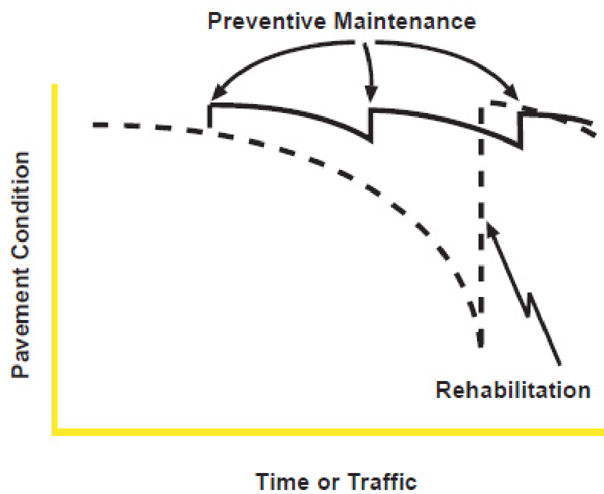


Figure 22 Preventive and corrective maintenance

Seal coating was chosen because it is the most effective and affordable preventative maintenance measure. Fog sealing is incorporated into the initial pavement design and is suggested to be reapplied every 4 years.

12.0 UTILITY RELOCATION AND COORDINATION

The Utility Conflict Report is included in Appendix C. The utilities relocation decisions for the West Dowling Road Project were guided by various factors. The most important factor considered was the proposed roadway alignment and design.

Proposed Roadway Alignment Alternative 4 was used to determine future location of the utilities and possible utility conflicts. With Alternative 4 the proposed centerline of the project is situated north of the existing centerline. Therefore, the relocation or replacement of utilities along the south side of the road is minimal.

The existing utilities and primary conflicts that require coordination are summarized below.

12.1 Existing Utilities

The following is a list of the primary utilities and their major segments that are located within the project corridor:

12.1.1 Water

- A 16-inch water transmission line runs on the south side of West Dowling Road from C Street to 50 feet west of A Street where it crosses to the north side of West Dowling Road. The 16 inch line is located to the north of West Dowling Road in the vicinity of the bridge crossing Campbell Creek. The 16 water line located in the middle of West Dowling Road as approaches Old Seward Highway.

12.1.2 Sewer

- A 48-inch sewer main line runs along West Dowling Road between C Street and Old Seward Highway. The sewer main runs along the south side of the existing bridge over Campbell Creek.
- AWWU wastewater line runs from C street to Campbell Creek

12.1.3 Natural Gas Lines (ENSTAR)

- Enstar has transmission, main and service lines in the project area.

12.1.4 Communications (GCI and ACS)

- Underground telephone lines are present along the north side of West Dowling Road from Station 17+90 to 18+70
- Underground telephone lines are present along the south side of West Dowling Road from Station 18+80 to 35+50.
- Underground telephone lines are present along the north side of West Dowling Road and Potter Street from West Dowling Road crossing at Station 25+35.
- Underground telephone lines are present along the north side of West Dowling Road from Station 35+50 to telephone vault at Station 41+80.

12.1.5 Electrical (CEA)

- CEA overhead transmission lines consisting of a 138 kilovolt (kV), two 34.5 kV and a single 277/480 volt (V) line run along the Dowling Road section line on the south side.
- CEA 120/240 V and 120/280 V aerial lines run along the north side of the Dowling project corridor.
- Lines cross Dowling Road at the following locations:
- Station 21+80
- Station 25+00
- Station 27+75
- Station 28+60
  Station 37+15

The electrical distribution lines located to the north of West Dowling Road from C Street to Old Seward Highway are in the proposed project area and will have to be relocated. The service drops to customers will also need to be relocated.

Street luminaries will need to be replaced along the project corridor.

12.2 Utility Conflicts

The most significant impacts are summarized below.

12.2.1 Utility Conflict Summary

- Existing water, sewer, electrical, and cable utilities that are associated with residences will need to be removed and/or rerouted onto private property.
- Existing water, sewer, electrical, and cable crossings will be evaluated for removal and replacement, or temporary shoring during construction.
- Existing storm drain and sewer manholes will need to be adjusted to final grade and/or reconstructed.
- Relocation of several CEA poles on the 120/240 V and 120/280 V line.
- Relocation of several service drops during construction.
- Several main transmission line poles may need relocation along new road alignment.

12.3 Illumination

12.3.1 Existing Conditions and Design Criteria

Dowling Road is classified as a Class III Major Arterial in the OSHP. An average illumination level of 1.3 foot candles with an average to minimum uniformity ratio of 3:1 for medium pedestrian conflict areas is recommended according to Table 5-1 of the MOA DCM. Continuous lighting is recommended to reduce potential collisions between moose and vehicles.

Pedestrian facilities are required to meet the recommended values of Table 5-4 in the MOA DCM when continuous roadway lighting will be provided. Medium pedestrian conflict area average illumination levels identified in the table are 0.5 foot candle (horizontal), 0.2 foot candles (vertical), with a 4.1 average to minimum uniformity ratio.

Recommended road and pathway illumination levels will be achieved by mounting single luminaire electroliers along each side of the road at on-center pole spacing of 150 feet with approximately 29 pole locations along each side of WDR Matching existing lighting is recommended as current LED technology does not provide recommended lighting values with regards to light output.

12.4 Utility Cost Estimation

Bid examples from the ADOT were used to compile the preliminary cost estimate for each utility. A total of $4,044,000 was estimated for the West Dowling Road project (See Appendix F). These figures are an estimate for the project based on the information available at the time of submittal.

13.0 STORM WATER

13.1 Methodology

All drainage systems for Dowling Road upgrades have been preliminarily sized to meet the design criteria for this project. Table 1 presents both routing and treatment design criteria. The criteria used to design routing systems were found in the Alaska Department of Transportation (ADOT) “Preconstruction Manual.”

The criteria used to design sedimentation basins are based on the following publications produced by MOA (Municipality of Anchorage): Project Management and Engineering Design Criteria Manual (DCM) (PM&E, 2007) and ADOT Drainage Design Guidelines (ADOT, 1995). Sedimentation basins are to be sized to treat flow from the 2-year, 6-hour rainfall event. The basin must facilitate settlement of sediment that has a 20-micron diameter or greater. The cross-sectional area of the basin must be great enough to sustain a peak horizontal velocity less than or equal to 0.04 feet per second (fps). All basins would be designed to bypass flows greater than the treatment design storm. Table 1 lists the design storms proposed for design of bypass structures.

All proposed storm drains were assumed to be placed at a 0.3% slope and are to be constructed of corrugated metal unless otherwise noted. Pipe diameters could be reduced if slopes are increased or a pipe with less roughness used. (PM&E, 2007)

Topographic maps along with drainage basins from the previous Dowling Road Hydraulic Report were used to determine drainage basins in the project area. A field reconnaissance visit of the entire project corridor from Old Seward Highway to C Street was made in spring 2009. MOA maps were also analyzed to determine existing storm drainage system.

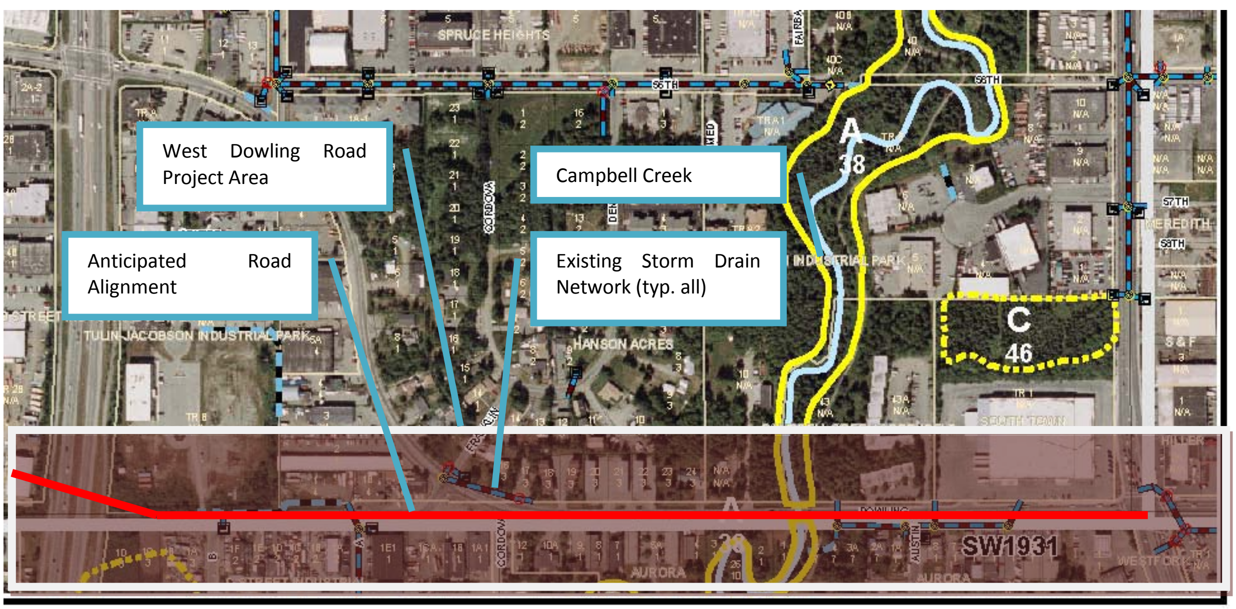


Figure 23 MOA Storm Water System and Wetlands (Site Area)

13.2 Rational Method

The rational method was used to calculate flow rates for each of the basins in the project area (Equation 1). Where Q is the flow rate (cfs), C is the rational constant, i is the rainfall intensity (in/hr) and A is the area of the drainage area (acres).

$$Q = CiA$$

Equation 1 Rational Method

After the information regarding proposed roadway profile became available, the drainage basins were revised to reflect the new road geometry and a max flow rate for any inlet along the system was calculated (Table 9).

Table 9 Revised Max System Flowrates

	Maximum Inlet Drainage Area
Road length	1200
Road width/2	53
Area (SF)	63,600.00
Area (acres)	1.46
i (in/hr)	0.28
C	0.96
Q (CFS)	0.4

13.3 Hydraulic Analysis

13.3.1 Existing Drainage Basins

The existing drainage basins for the project were analyzed using topographic maps of the area, the previous report (HDR, 1995) and two site visits during spring 2009. The existing drainage basins are shown in Figure 24.

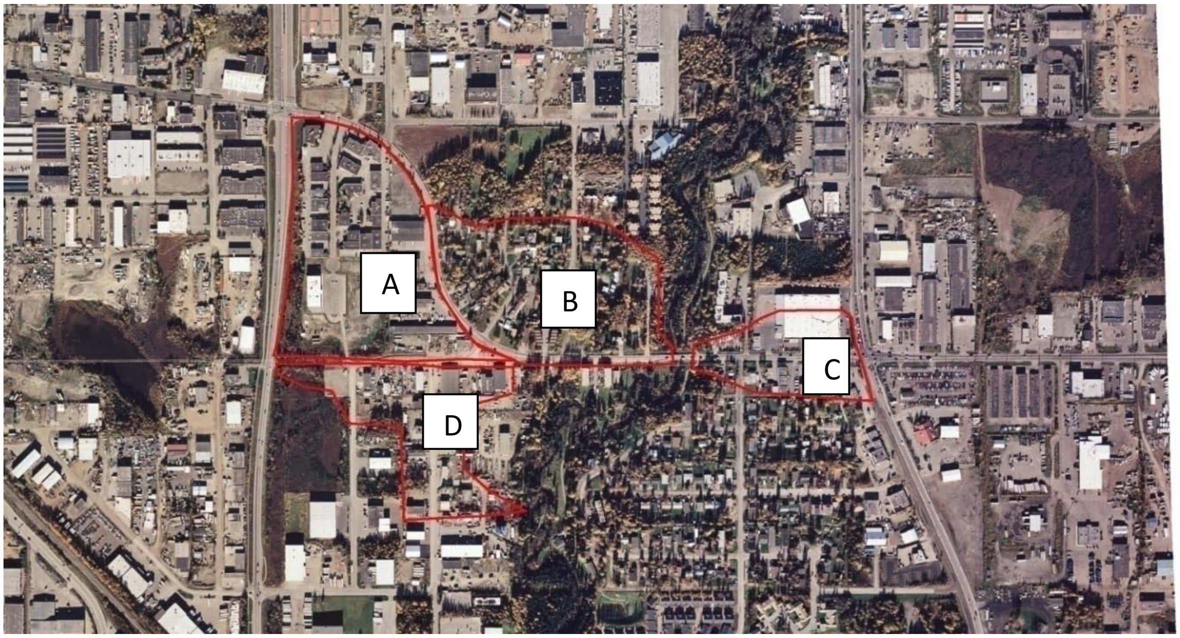


Figure 24 Project Area Drainage Basins (Alternative 1)

The existing drainage in the area consists of limited storm drains in isolated areas. The majority of the flow from basins A, B, C and D is routed through drainage ditches along either side of Dowling Road which flow into Campbell Creek.

The existing drainage in the area is deemed inadequate and will be replaced by a system encompassing basins A, B and D which will outfall into Campbell Creek (Figure 23).

13.3.2 Basin A

Basin A, as shown in Figure 24, drains from north to south and extends from C Street to Potter Drive and is bounded by on the south side by the proposed alignment for West Dowling Road. The roads are crowned and as such define the extents of the drainage area.

The majority of this basin is zoned for commercial and industrial land use. The south west corner of the basin contains undeveloped land with wetland features, although it actually lies north of the area designated wetland on the MOA map (Figure 23).

The area surrounding the IBEW training facility ditches on the north east corner and the south edge of the IBEW training facility has one culvert along the north side of the road along with storm water pipe which connects into the system serving areas south of West Dowling road. The rest of the drainage area has no storm water system.

13.3.3 Basin B

Basin B, as shown in Figure 24, drains from north to south and extends from Potter Drive to the area west of Campbell Creek and is bounded on the south side by Dowling Road. The northern portion of the basin is bounded by a high point in the neighborhood which bounds the drainage.

The majority of the basin is zoned for residential land use. The eastern edge of the basin includes undeveloped area around Campbell Creek.

13.3.4 Basin C

Basin C, as shown in Figure 24, drains from north to south and extends from the area east of Campbell Creek to the east side of Old Seward Highway and south of Dowling Road. This basin is bounded by Old Seward Highway on the east which has C&G system.

The area contains both residential and commercially zoned lands. The area also includes undeveloped land around Campbell Creek.

13.3.5 Basin D

Basin D, as shown in Figure 4, drains from south to north and extends from the south side of the proposed West Dowling Road alignment to the industrial areas south of the road.

The majority of the basin is zoned for industrial land use. The area does contain undeveloped land that has been designated wetland area (Figure 23).

13.4 Water Quality Treatment

13.4.1 Structural Treatment

There are several alternatives available for treatment of the storm water collected along the proposed West Dowling Road. (PM&E, 2007). These alternatives are discussed in depth in Appendix H. The Preferred Alternative is discussed below.

13.4.1.1 Preferred Alternative – Oil and Grit (O&G) Separators

Oil and grit separators provide a means of removing not only sediment from the storm water stream, but also diesel range organics such as oil. In addition, oil and grit separators have a relatively small footprint and can be buried underground. One of the disadvantages is the large capital cost of purchasing and installing O&G separators. Because of the ROW restrictions on the project and the improved treatment qualities of O&G separators, they were chosen as the Preferred Alternative.

Oil and grit separators will be installed on either side of Campbell Creek to treat storm water before entering Campbell Creek (Figure 25**Error! Reference source not found.**). The software provided by Stormceptor was used to size the oil and grit separator. The software incorporates over 35 years of rainfall data from Anchorage International Airport along with drainage basin characteristics in order model rainfall events. The recommended size for oil and grit separators on either side of Campbell Creek was the STC 900 model. This model will provide for the following percent removals of TSS for a fine (organics, silts and sand) particle size distribution (Details of the particle distribution are provided in the Stormceptor reports found in the appendix):

13.4.2 Bioswale Treatment

In addition to treating the storm water collected along the proposed West Dowling Road, treatment will also be required for the proposed parking lot the will be constructed east of Campbell Creek on the north side of West Dowling Road. Bioswales will be placed to the east of Campbell Creek on the north side of Dowling Road, adjacent to the proposed Campbell Creek parking lot (Figure 25).

13.5 Recommendations

13.5.1 Basin 1

13.5.1.1 Alternative 1

Basin 1 will be connected into the storm drain system that discharges to the O&G separator west of Campbell Creek (Figure 25). This is the Preferred Alternative, since it will not add excess water to the existing storm drain network south of the project. Furthermore, treatment in the new O&G separator will probably be superior to the existing treatment regime.

Figure 25 Proposed Storm Drain System – Alternative 1

13.5.1.2 Alternative 2

Alternatively, this basin may be connected into the existing storm drain system south of Dowling Road along A Street (Figure 26). This is not the Preferred Alternative

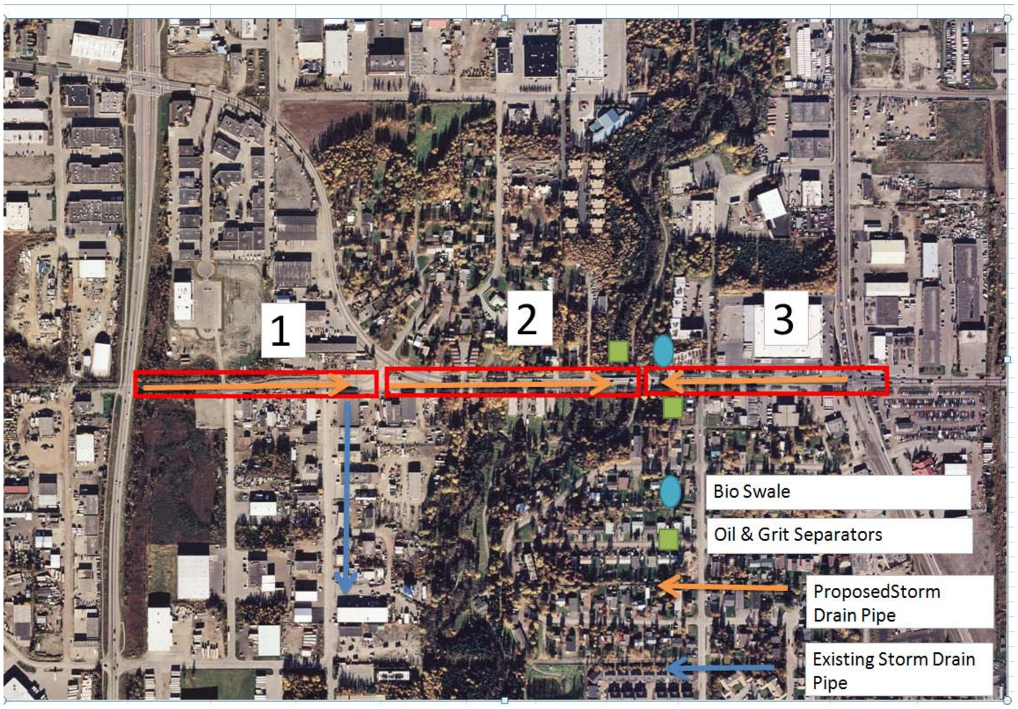


Figure 26 Proposed Storm Drain System - Alternative 2

13.5.2 Basin 2

Basin B will be connected into the system that discharges to the O&G separator west of Campbell Creek.

13.5.3 Basin 3

Basin C will be connected into the storm drain system that discharges to the east of Campbell Creek.

13.5.4 System Layout

The anticipated system layout is as described above in each basin description. With regard to an exact alignment, three alternatives were analyzed and are discussed in Appendix H. The Preferred Alternative is discussed below.

13.5.4.1 Preferred Alternative – North Side of West Dowling Road

This Alternative would place the primary storm drain pipes on the north side of West Dowling Road. Lateral connections to the catch basins on the south side of the road would connect to the primary storm drain pipes on the north side.

Placing the storm drain alignment along the centerline is not preferable for two reasons:

1. Maintenance will be more difficult than if the line was placed along the side of the road.
2. Manhole placement in the travel lanes in not ideal from a traffic perspective.

The utilities along the proposed road corridor, both to the west of Campbell Creek and to the east of Campbell Creek find that both the north and the south sides of the road have current utilities including overhead electric lines, fiber optic lines, sanitary sewer lines, water lines, gas lines and telephone lines (Figure 27). The south side of the road appears to have a higher number of utilities and placement of the storm drain line would be easier on the north side of the road.

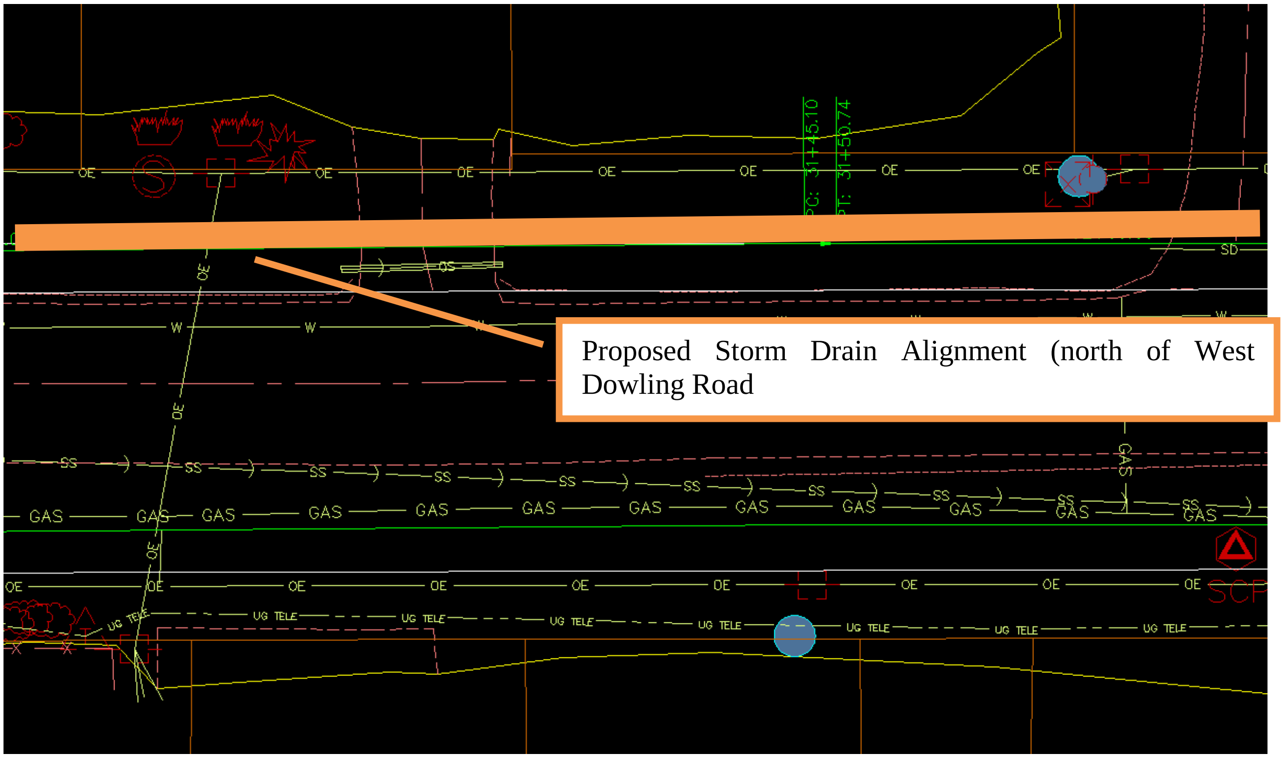


Figure 27 Sample Section of West Dowling Road between Campbell Creek and Potter

13.5.5 Storm Drain and Pipe Material

All pipe will be 24-inch Type S Precoated Corrugated Metal Pipe (PCMP) or Type S Corrugated Polyethylene Pipe (CPEP) unless otherwise noted (PM&E, 2007).

13.6 Conclusion

The existing drainage system in the West Dowling Road corridor is deemed inadequate. The system improvements made during construction of the proposed West Dowling Road will provide sufficient treatment of storm water runoff before discharge to Campbell Creek. Drainage ditches along the north and south sides of West Dowling Road will transport water from drainage basins adjacent to the project area to Campbell Creek. Storm water collected along West Dowling Road will be collected in a storm drain system, transported to oil and grit separators, treated and discharged to Campbell Creek. Storm water along the entire project corridor will be treated at oil and grit separators on either side of Campbell Creek (Figure 25). Alternatively, a the storm water collected between Potter and C Street may be routed to the existing storm drain system south of Dowling Road along A Street (Figure 26). The existing conditions of this system must be analyzed in order to determine if the additional inflow of storm water can be handled by the system.

14.0 ENVIRONMENTAL AND PERMITTING

The environmental technical group for Blue Fox Universal is responsible for all environmental processes and alternatives for the West Dowling Extension project. This DSR section is a summary of the Environmental and Permitting Appendix. The Environmental Appendix is Appendix I and contains all of the work that the technical group has completed throughout the project. Included in this DSR report is the technical group's methodologies for completing the project, environmental draft permits and environmental design alternatives. All references for the completion of the group's work are documented in the references section at the end of the report.

14.1 Methodology

The general methodology of the environmental technical group began by looking at the tasks that must be completed by the group. Once these tasks were determined a plan was developed to complete these tasks while following the main mission of the group: to reduce the impact of the project on the community and environment. Using this mission the tasks were able to be properly completed.

The tasks that must be completed can be summarized into three major groups: (1) Environmental Commitment Communication, (2) Environmental Draft Permits and (3) Environmental Design Alternatives. Each of these groups will be discussed in detail in this report. These tasks were completed sequentially in the order listed above because of their natural order and efficiency that it gave the group.

In summary, the environmental commitment communication task involved a major analysis of the EA and a summary of all pertinent design information for the increased quality of all of Blue Fox Universal's technical groups. This document had to be written at the beginning of the project so that all technical teams could be consistent and reach a design that addressed all of the environmental issues.

The environmental draft permits task was completed next with the contribution of information from the group's mentor and the EA document. In a real project, the environmental permitting process involves an ongoing dynamic process of review and design evolution between the project team and the appropriate government and municipal agencies, due to the NEPA process. The West Dowling Project completed by Blue Fox Universal has a scope that does not include the review and evolution part of the NEPA process. Regardless, the environmental technical group collected and filled out the permits to its best abilities. This is the reason the permits are considered "draft permits." An important sub-section of this task involved the determination of the amount of wetlands affected by the project. The wetland credit/debit method was also researched.

Finally, the environmental design alternatives task was completed. This task involves the determination of important design alternatives in the environmental realm. The design alternatives looked at include alternatives for noise reduction barriers for the affected real estate, sustainable landscaping design and trail and recreation design. These three areas have significant impact on the final project and are important undertakings for the environmental group to succeed in its mission.

14.2 Environmental Commitment Communication

The environmental communication task involved the distribution of pertinent design information to the rest of the Blue Fox Universal technical groups to ensure the project design addressed environmental concerns. Methodology for this task began with the analysis of the EA followed by the creation of the Environmental Commitments Document. The EA can be found in the references section under HDR Alaska, 2007. All data was gathered from this source for this specific task.

Once the EA was analyzed the Environmental Commitment Document was written and distributed to the Blue Fox Universal technical groups. The Environmental Commitment Document is shown on the following page.

Senior Design – BLUE FOX | Environmental & Permitting (Bolling, Chung, Ohlfs, Yager) | 2/12/09

Environmental Commitments Document

Environmental commitments stated in the EA for the W. Dowling Extension.
Incorporate the below commitments and mitigation measures in the project design.

Water Quality

- Strom water runoff must be treated

Wetland impacts

- The alignment was shifted to the north in the vicinity of Tina Lake
- Limit Construction staging areas to uplands
- Disturbed areas would be recontoured to approximate original conditions and reseeded with native vegetation to minimize erosion and stabilize stream banks

Vegetation Impacts

- Impact to vegetation can be minimized through proper erosion and sedimentation control, covering fill material stock piles, revegetation of disturbed areas, limit heavy equipment to within the construction footprint, stabilize slopes to Campbell Creek and use contaminant free materials surface construction.

Concern regarding adversely affect EFH and anadromous fish resources.

- No work will be performed below Ordinary High Water
- Campbell Creek supports Chinook and Coho Salmon rearing and spawning habitat

Campbell Creek Bridge

- The replacement is longer and wider than the existing bridge for pedestrian crossings on the bridge and underneath the bridge.
- The bridge abutments will be above ordinary high water.
- No riprap will be placed below ordinary high water. The placement of in-stream riprap in Campbell Creek should be avoided through the use of trench fill revetments. This is because Campbell Creek supports Chinook and Coho Salmon rearing and spawning habitat.
- Disturbed areas would be revegetated to stabilize soils and to minimize further runoff except in areas where vegetation will not grow such as under bridges.
- The bridge will have greater than or equal to 10 feet of clearance.
- Lighting should be provided on the upgraded road to allow pedestrians and motorists to see moose that may get onto bridges.
- The trail will be re-directed to go under the bridge.
- The MINIMUM required bridge dimensions to avoid an impact on the 100-year flood is an **89 ft opening**.
- Work within the 100-year floodplain has been minimized to comply with Executive Order 11988

Green Belt and Trails

- MOA Parks and Recreation supports the project and grade separated trail crossing
- By grade-separating the trail, users of the greenbelt would not affected by visual and/or noise impacts associate with the road.
- Pedestrian detours would be established during construction
- Make project enhance the Campbell Creek Trail Greenbelt

Railroad Crossings

- A grade-separated rail crossing.
- The existing at-grade crossing of the Alaska Railroad by Arctic Boulevard will remain.

14.3 Draft Permits

The environmental draft permits task was completed with information contributions from the group's mentor and the EA document. As stated earlier, in a real project, the environmental permitting process is an ongoing process of review and design evolution between the project team and the appropriate agencies, due to the NEPA process. Although the West Dowling Project completed by Blue Fox Universal has a scope that does not include the review and evolution part of the NEPA process, the environmental technical group collected and filled out the permits to its best abilities. This is the reason the permits are considered "draft permits." An important sub-section of this task involved the determination of the amount of wetlands affected by the project. The wetland credit/debit method was also researched.

The Environmental Appendix contains all information for obtaining the appropriate environmental permits. The list below summaries all environmental permits required for the West Dowling Project.

- **US Army Corps of Engineers (USACE) -** Section 404 wetlands permit
- **Alaska Department of Environmental Conservation (ADEC) -** Section 401 Certificate of Reasonable Assurance
- **Alaska Department of Fish and Game (ADF&G) -** Fish Habitat (Title 16) Permit
- **Municipality of Anchorage (MOA) -** Flood Hazard Permit, Municipal Noise Permit, hydrologic analysis and Municipal Separate Strom Sewer System (MS4) permit
- **Department of Natural Resources Department of Coastal and Ocean Management (DCOM) -** Coastal Consistence Determination
- **Environmental Protection Agency (EPA) –** National Pollutant Discharge Elimination System Permit and "Notice of Intent" for NPDES Storm Water Discharges from Construction Activities

The Anchorage Debit-Credit Methodology was also researched. It is a set of procedures designed to apply a uniformed and formatted approach to quantify wetlands disturbance and compensatory measures within the Municipality of Anchorage. The Methodology works in conjunction with the Anchorage Wetlands Management Plan (AWWP), and provides a means to measure impacts from a proposed development project on wetlands and waterways in terms of direct impacts (the actual footprint of fill or disturbance), indirect impacts (the areas near the direct fill or disturbance that may be slightly affected due to proximity), and temporary impacts, such as those due to construction.

14.4 Environmental Design Alternatives

The environmental design alternatives task involved the determination of important design alternatives in the environmental realm. The design alternatives looked at include alternatives for noise reduction barriers for the affected real estate, sustainable landscaping design and trail and recreation design. These three areas have significant impact on the final project and are important undertakings for the environmental group to succeed in its mission.

14.5 Noise Barriers

In the Environmental Appendix, existing noise level conditions, expected traffic noise levels, and basic noise calculations were completed along with recommendations for dealing with noise. Various noise mitigation techniques were looked into and their applicability to the West Dowling Project were reviewed. Final conclusions and recommendations were made.

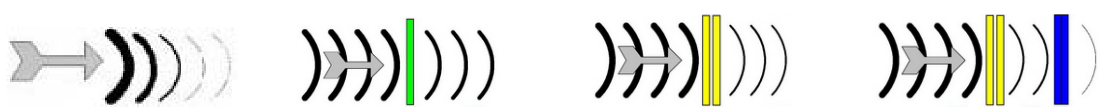
14.5.1 Potential Noise Mitigation Techniques

- Fencing – Due to the numerous openings required directly from the right of way for access, fencing would be a poor noise mitigation technique in this area. Fencing could have a positive psychological impact, however, and also contribute to a sense of privacy and security. See Figure 28 for an example.

Figure 28 Example of Noise Barrier Facing in New Road Construction

- Vegetation barriers – Vegetation barriers are also a poor noise mitigation technique for the same reason as fencing. These barriers can also have a positive psychological impact, however and can greatly add to the ambiance of the area.
- Window Noise Insulation - Double pane noise reducing window panes and insulation can greatly affect the amount of interior noise and is feasible. See Figure 29 and Figure 30.

Figure 29 Example of a double pane window



Sound intensity | Single Pane window STC Rating 26-28 | Double pane window STC Rating 26-33 | Soundproof and double pane window STC Rating 43-49

Figure 30 Comparison of Sound transmission Class (STC) Sound Intensity rating between Single Pane, Double Pane and soundproof windows.

- Rubberized asphalt – In 2003 the Arizona Department of Transportation adopted a Quiet Pavements Program to overlay most of the Regional Freeway System with rubberized asphalt. The mixture of 80% Asphalt Cement (AC) and 20% crumb rubber from recycled tires has resulted in an overall 3 to 5 dB (A) decrease in noise. This is definitely a feasible option for the Dowling Road project.

14.5.2 Recommended mitigation method for north side of road

A combination of rubberized asphalt, wooden fencing, and some shrubs inside the fencing is recommended. Installation of this combination can substantially reduce traffic noise and psychologically isolate the noise receivers. In order to create a psychological ambiance, property owners should plant large shrubs, such as the fast growing and Alaska friendly Siberian Pea along the inner fence line. Property owners should also invest in good quality double pane/soundproof windows with noise insulating attributes. Combined with the other mentioned noise mitigation techniques this can cause a marked improvement.

In designing this noise mitigation plan, the main focus of this proposal is the North side of the road where most residences are occupied. Businesses on the south side of the road will also benefit from the noise reduction gains from rubberized asphalt and window insulation. Fencing is not feasible on the south side of the road because it would restrict business operations. Creating flower vases along the South side road will also add to a friendly atmosphere, but this option requires consultation with a landscape team.

14.6 Landscaping

The use of appropriate landscaping throughout any project can increase water quality, environmental sustainability and add value to the community real-estate. The amount of landscaping done will be related to the amount of money available for such improvements. If the client finds it reasonable, many improvements can be completed.

14.6.1 Vegetation

The design strategy of vegetation should involve two major factors: environmental sensitivity and low operations and maintenance costs. Using these factors the main type of vegetation that should be used are native plants. The use of native plants keeps the surrounding ecosystem robust and lowers the O&M costs because the vegetation is already in its suitable climate. A list of native plants of Alaska can be found at www.fhwa.dot.gov/environment/rdsduse/ak.htm. A knowledgeable landscape architect can also be hired to find the most appropriate native plants for the project. Other design factors must include an understanding of the dimensions of the proposed plants throughout their life time. This will eliminate poor placement of non-appropriate plants, such as large spruce trees under utility lines.

14.6.2 Small-Scale Swales

Due to the narrow project area the Storm water Technical group did not utilize large swales in the project. This is an appropriate decision but there are other ways to incorporate smaller swales into the project. On a small scale, swales can be created by recontouring the topography to create small depressed areas. Storm water flows into these depressions and drain into the soil. Appropriate design of these swales can allow planted vegetation to be irrigated by placing the plants at the bottom of the swale.

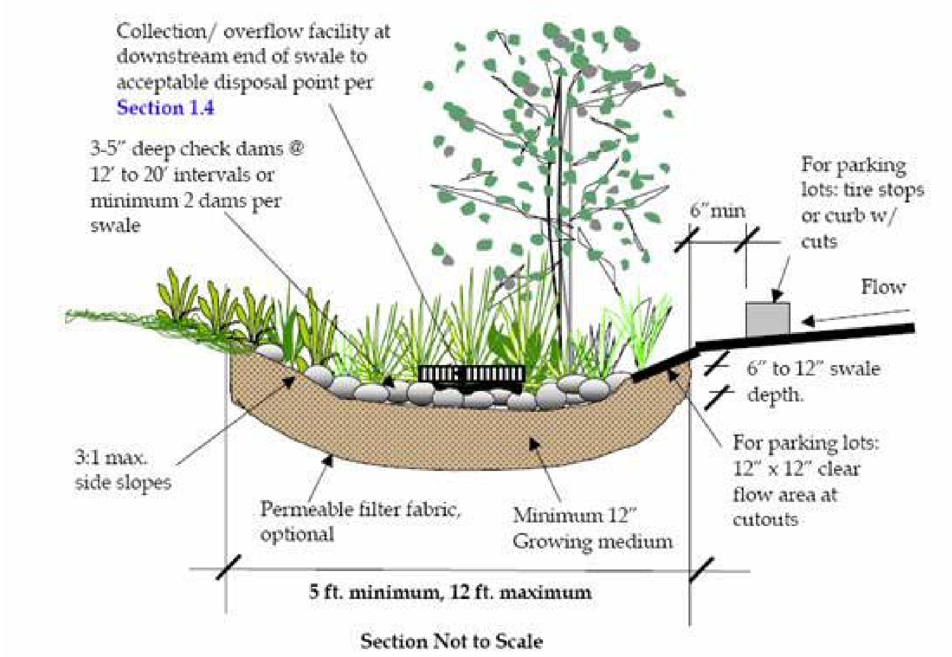


Figure 31 Potential Swale (City of Sandy Website)

Figure 31 shows a possible example, although swales can be used that have smaller cross-sections and no piped overflow. Smaller swales can be staggered so that one overflows into another. Smaller swales allow for plants to be irrigated thus lowering O&M costs and also allow for water quality to be improved.

14.6.3 Landscaping Conclusion

By using appropriate plants and small scale swales, the landscaping of this project will enhance water quality and improve the environment. With the environment around the project enhanced the community will benefit because their surrounding environment will be healthier.

14.7 Trails and Recreation

Design alternatives for the trails and recreation areas surrounding the project were looked at. Specifically, No-Net-Loss of Parkland was considered along with signs and surface materials for trails and parking lots.

14.7.1 Campbell Creek Greenbelt Trail and Parking

Environmental considerations for the design of the Campbell Creek Greenbelt trail through the project area and the parking facility at the trailhead include the surface materials for both parking and trail construction and the placement of signs for trail users. The design decisions for various surface materials and signs are detailed in the following sections.

14.7.2 Surface materials

When considering surface materials for trail construction the following criteria were evaluated.

Initial capital cost – The initial capital cost will include excavation, sub-base preparation, aggregate base placement, and application of the selected trail surface. Areas that have existing trail will most likely have to be resurfaced.

Maintenance and long term durability- Since this will be a trail subjected to high traffic durability is an important consideration. A more durable trail in general will require less maintenance.

Existing soil and environmental conditions – The trail should be built on a solid and permeable base surface. Flooding events should also be anticipated when designing the subsurface.

Anticipate Use/Functionality- Campbell Creek Trail is used for many forms of recreation and transportation. In order to accommodate all the different usages, a surface material that is durable to withstand the heavy impact, smooth for ease of travel and aesthetically pleasing should be selected. Anticipated modes of transportation on the trail include pedestrian traffic, bicycle traffic, large mammal (moose) traffic and occasional vehicular traffic for maintenance.

14.7.3 Alternative 1- Porous pavement for trail surface and parking area

Porous pavement is an attractive technology to implement in the trail surface along Campbell Creek and the new parking facility. Porous pavement will provide a permeable surface so that storm water will infiltrate through the surface and reduce the amount of runoff entering the creek. The porous pavement provides groundwater recharge and helps reduce erosion in stream beds and along river banks (Lake County Forest Preserves, 2003). The general profile of porous pavement is a permeable pavement surface placed over a uniformly sized aggregate base material with approximately 40% void space (Figure 32). A geosynthetic fabric lines the base of the aggregate base material to provide additional filtration of finer particulates. The application of porous pavements in parking facilities and trails often qualifies for LEED (Leadership in Energy and Environment Design) credits. The close proximity of Campbell Creek to the parking facility and the trail system makes this a practical alternative to reduce storm water runoff entering the creek. However, porous asphalt may not be an option in cold climates such as Anchorage. Water infiltrating through the asphalt and subgrade has the potential to freeze causing expansion. This expansion will most likely result in heaving and surface cracking increasing the maintenance costs.

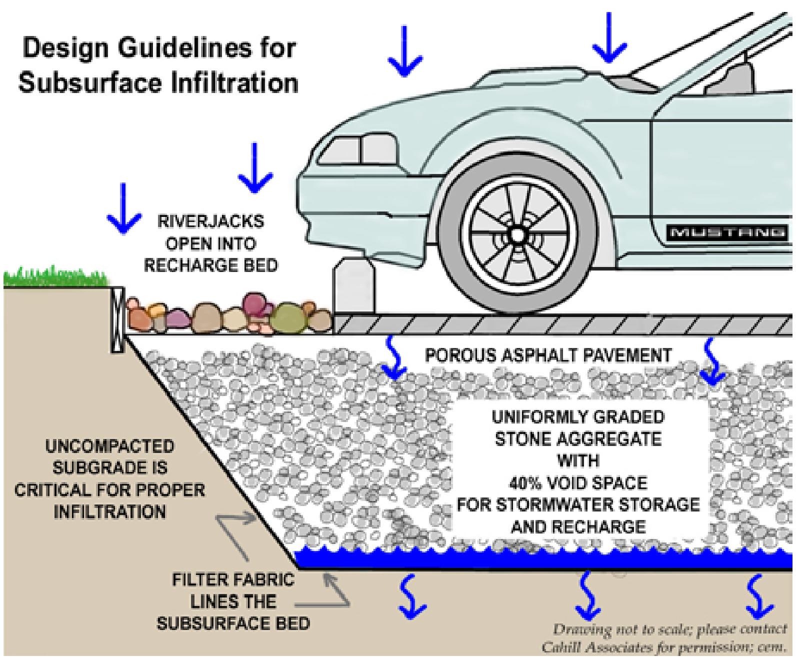


Figure 32 Profile of porous pavement parking facility (Penn. DEP, 2005)

14.7.4 Alternative 2- Porous pavement for parking area and regular asphalt for trail

A second alternative could include the implementation of porous pavement in the parking area, which would otherwise be a large impervious surface subject to large quantities of runoff into Campbell Creek, and pave the trail with regular asphalt. This alternative would most likely be more cost effective than porous pavement on the trail and parking facility. The trail will be subject to fewer pollutants than the parking are, thus the recommendation to pave the trail with regular asphalt and allow the storm water to drain directly into the creek. This will also result in a smooth transition between existing trail on either side of the project area and the newly constructed trail. Again porous asphalt may not be an option in cold climates such as Anchorage.

14.7.5 Alternative 3- Regular asphalt for trail and parking area

A third alternative would include paving the trail and the parking area with regular asphalt. Regular pavement would increase the amount of impervious surface around the creek, resulting in an increase of pollutants entering the creek. This surface water runoff from the parking facility will have to be treated before entering the creek. The implementation of regular asphalt for trail and parking areas will withstand cold climate conditions better than porous pavement requiring less long term maintenance. This option is also a more cost effective solution than the porous pavement.

14.7.6 Signs

Trail signs will conform to the wooden sign convention used throughout Anchorage's greenbelt trails (Figure 33). There will be a sign located at the trail head in the newly constructed parking area. There will also be informative signs about wildlife and the Campbell Creek ecosystem posted in the parking facility.

Sign posts directing trail users to major landmarks, including West Dowling Road, and general trail information will be placed at both north and south trail junctions (Figure 33). Trail regulations and user guidelines will also be posted on the sign posts. A location map will be placed at the trail head referencing users to their location in relation to the Anchorage Greenbelt network.

Figure 33 Anchorage greenbelt trail sign convention and landmark direction sign post examples on the Tony Knowls Coastal Trail (Alaska Bike Rentals, 2007)

14.7.7 Trails and Recreation Conclusion

Upon reviewing the alternatives for surface materials for the parking facility and the portion of the Campbell Creek trail extending through the project area, the environmental review committee has decided that the trail and parking facility should be constructed from regular asphalt. The storm water runoff from the parking facility will contain pollutants and must be included in the storm water treatment design. Storm water from the trail will be relatively free of pollutants and may drain directly into the creek. A “Campbell Creek Greenbelt” sign and locator map will be placed at the trailhead in the parking facility. Sign posts with directions and trail regulations will be placed at the junctions of the Campbell Creek trail and the trails extending off the north and south sides of West Dowling Road.

15.0 COST ESTIMATE, FUNDING AND SCHEDULE

The final cost estimate of WDR can be found in Table 10. The cost is close to the $30 million budget.

Table 10 Final Cost Estimate

Phase	Cost
Tear up and Demolition	$233,000.00
Pavement Design	$8,580,700.00
Bridge Construction	$2,329,490.00
Storm Water	$544,500.00
Utilities	$4,044,000.00
Construction Phasing	$2,675,000.00
Construction Cost (20% Contingent)	$21,861,228.00
Construction Engineering	$3,279,184.20
Right of Way	$11,300,000.00
Environmental	$100,000.00
Subtotal	$36,540,412.20
ICAP	$1,702,783.21
Total	$38,243,195.41

16.0 PUBLIC INVOLVEMENT

Public Involvement is defined as the total effort, both informal and formal, made by the Contractor and the Contracting Agency to keep the public and agencies informed about the project, to ensure that all reasonable alternatives are identified, and that public and agency concerns are considered and addressed.

16.1 Public Meetings

Three Open House Public Meetings will be held during the course of the project. The first meeting will occur prior to the Plans-in-Hand submittal, the second meeting shall occur before beginning Right-of-Way acquisition at the 65% submittal, and the third shall be near the end of the project at the 95% submittal. After each public meeting, a written summary of comments and responses during these meetings shall be submitted.

16.2 Public Involvement Requirement Completion

16.2.1 The following Public Involvement requirements have been completed.

The scoping meetings for stakeholder public comments were held in August 2002, October 2002, and May 2003 and an official West Dowling Road Project website for public information, review, and comment was established. The Environmental Assessment Plan was completed and January 2007, The Environmental Assessment Public Open House was held. In November 2008, the Public Involvement Plan (PIP) was completed and will be updated and revised as needed during the project.

17.0 CONSTRUCTION PHASING

17.1 Objectives

The purpose of phasing the construction of the West Dowling Road Phase 1 State funded project is primarily to provide a safe passageway through the project for the traveling public for the duration of construction. With a construction phasing plan the project has the potential of not only being completed on schedule time but to be completed within budget as well.

The project goals include completing construction within the project time frame while maintaining business and residential access, allowing through traffic, and employing Best Management Practices through the duration of the project.

17.2 Critical Path

17.2.1 Season 1

In preparation of constructing West Dowling Road Phase 1, Right of Way will be purchased and cleared of buildings and other obstacles encountered for the entire project. Advance relocation of Chugach Electric Association's facilities that are in conflict near the C Street Connection will be relocated further south and a surcharge will be added to that area. Please refer to Appendix E "Soil Conditions and Pavement Design" for details in the surcharge loading.

The west bound lanes from the Old Seward Highway to Potter Drive as well as the northernmost span of the bridge will be constructed leaving traffic open on the existing roadway. Utilities will be relocated concurrently with the exception of the above mentioned power lines and a portion of Anchorage Waste Water Utility's water main that is in conflict with the bridge. AWWU's facility will be relocated prior to the construction of the bridge.

17.2.2 Season 2

Construction during the second and final phase of the project will include the southern span of the bridge as well as the east bound traffic from the Old Seward Highway to Potter Drive. It will also include the removal of the surcharge and the construction of all four lanes from the C Street connection to Potter Drive plus the intersection at Potter Drive. The extension to the west of the C Street intersection will be built as well. Finally, the intersections at the Old Seward Highway and C Street will be constructed. Once the intersections are built the entire project can be opened to through traffic.

17.3 Alternatives

17.3.1 Alternative 1

The alternative considered in the construction Phasing plans can be seen in the diagram below. The point of interest in the plans is the construction of the bridge. The options for different options for construction of the bridge are the major differences in the phasing of the project. The alternative considered here were as follows: a temporary bridge installment during construction, seasonal closure of through traffic for bridge construction, and a two season two part bridge installation. The alignment of the roadway lent itself to the two part bridge construction and this allowed traffic to remain in operation through the area during construction with minimal closures.

17.3.2 Preferred Alternative

The Preferred Alternative will be set up to be completed in a two season construction process. The breakdown of the processes in the two season time frame can be seen below in Figure 34 and Figure 35. This alternative allows traffic to continue on the existing roadway during the first construction season. In the second season of construction the traffic can be diverted onto the new north bridge and new traffic corridor. This allows the existing bridge to be removed and disposed of and the new south bridge to be installed. The old road surface can then be removed and re-graded to the final surface elevation. The west end can then be completed over the surcharge that was placed the season prior.

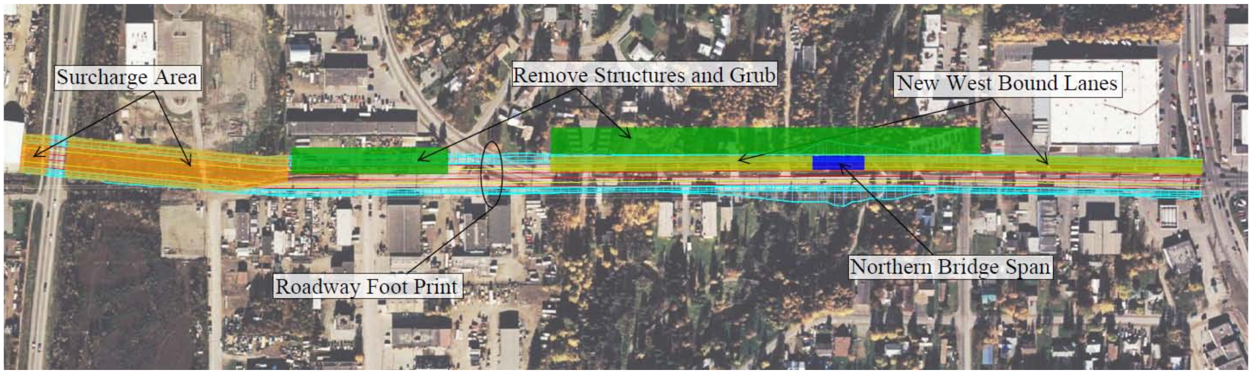


Figure 34 Season 1

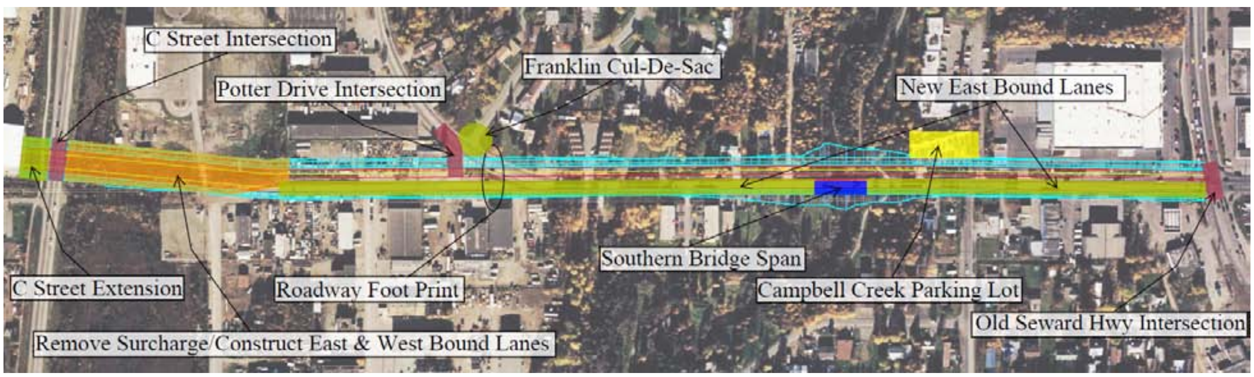


Figure 35 Season 2

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DESIGN STUDY REPORT

APPENDIX A

RIGHT OF WAY

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
Central Region
4111 Aviation Avenue
Anchorage, Alaska 99502

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April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AASHTO ....American Association of State Highway and Transportation Officials
DCM ....Design Criteria Manual
DOT&PF..State of Alaska Department of Transportation and Public Facilities
DSR..Design Study Report
EA ....Environmental Assessment
HPM.. Highway Preconstruction Manual
LRTP.. Long range Transportation Plan
LUST ....leaking underground storage tank
MOA ....Municipality of Anchorage
mph .... miles per hour
PCM .... Preconstruction Manual
ROW .... right-of-way
WDR ....West Dowling Road

1.0 SUMMARY OF FINDINGS

This report has been compiled to support the information provided in the Design Study Report for the West Dowling Road Project.

The ROW decisions for the West Dowling Road Project were guided by various factors. Some of these factors included: presence of contaminated sites, cost of ROW acquisition, impacts of ROW acquisition on local businesses and community residents and impact on relocation of utilities.

The preferred ROW alternative for the project corresponds to the Roadway Alignment #4. Alternative 4 places the proposed centerline of the project north of the existing centerline. The alignment of the road is angled at C Street to intersect at 90 degrees (Figure 6, Figure 7). The estimated cost for ROW acquisition along this alignment is $11.3 M (Figure 8). The advantages of this alternative are that ROW along the south side of West Dowling Road is minimized. The disadvantages of this alternative are that overhead electric lines on the north side of the project will be necessary.

2.0 CURRENT ROW AND LAND USE CONDITIONS

The current ROW in the project corridor was determined by examining lot lines for all properties in the project corridor. The current ROW conditions were given to the Road Geometry team to aid their analysis of alignment alternatives.

2.1 Right of way

The existing right-of-way (ROW) from Old Seward Highway to C Street varies from 55 to 90 feet. The current ROW widths are summarized in Figure 1, the ROW is owned and maintained by Alaska Department of Transportation. ROW acquisition efforts are in progress to obtain a ROW corridor that has a minimum width of 106 feet.

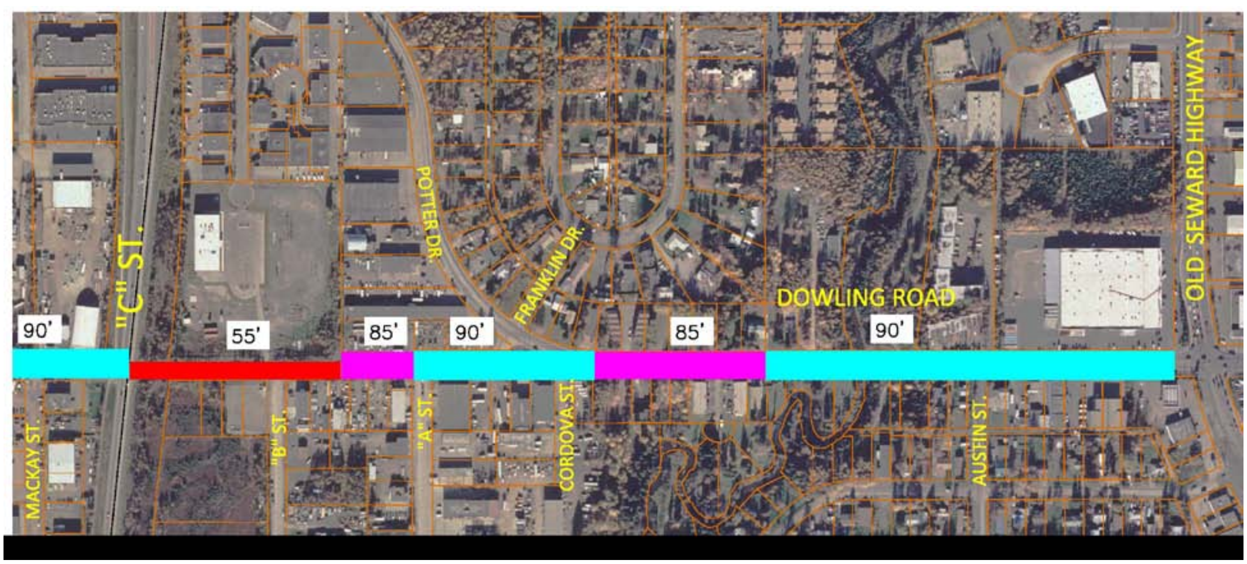

Figure 1 Existing ROW Widths

2.2 Development and land use

Development and land use in the MOA is guided by the Anchorage Bowl Comprehensive Plan, Anchorage 2020, adopted February 2001. The following are the current land use and development in the project corridor (Figure 2):

- Property to the southwest of the Old Seward and Dowling intersection is zoned B-3, General Commercial Uses. Development in this area includes: a gas station, retail business and a motel. The property to the northwest of the Old Seward and Dowling intersection is zoned I-1, Light manufacturing and wholesale. Development in this area includes warehouses. Property south of the area zoned B-3 is zoned R-2M, multi-family residential. Development in this area includes: single and multi family residences.
- Property north of Dowling road on either side of Campbell Creek is zoned R-3, Urban and suburban single-family, two-family and multi-family residential. Development in this area includes condos, single and multi-family residences. Property south of Dowling road on either side of Campbell Creek is zoned R-3 and PLI-p, Public lands and institutions – park. The area includes single and multi-family residences and parkland. The Campbell Creek trail crosses Dowling Road to the east of Campbell Creek.
- Property between Potter and C Street is zoned B-3, General Commercial Uses. Development in this area includes: warehouses, heavy equipment repair shops, training facilities and retail business.

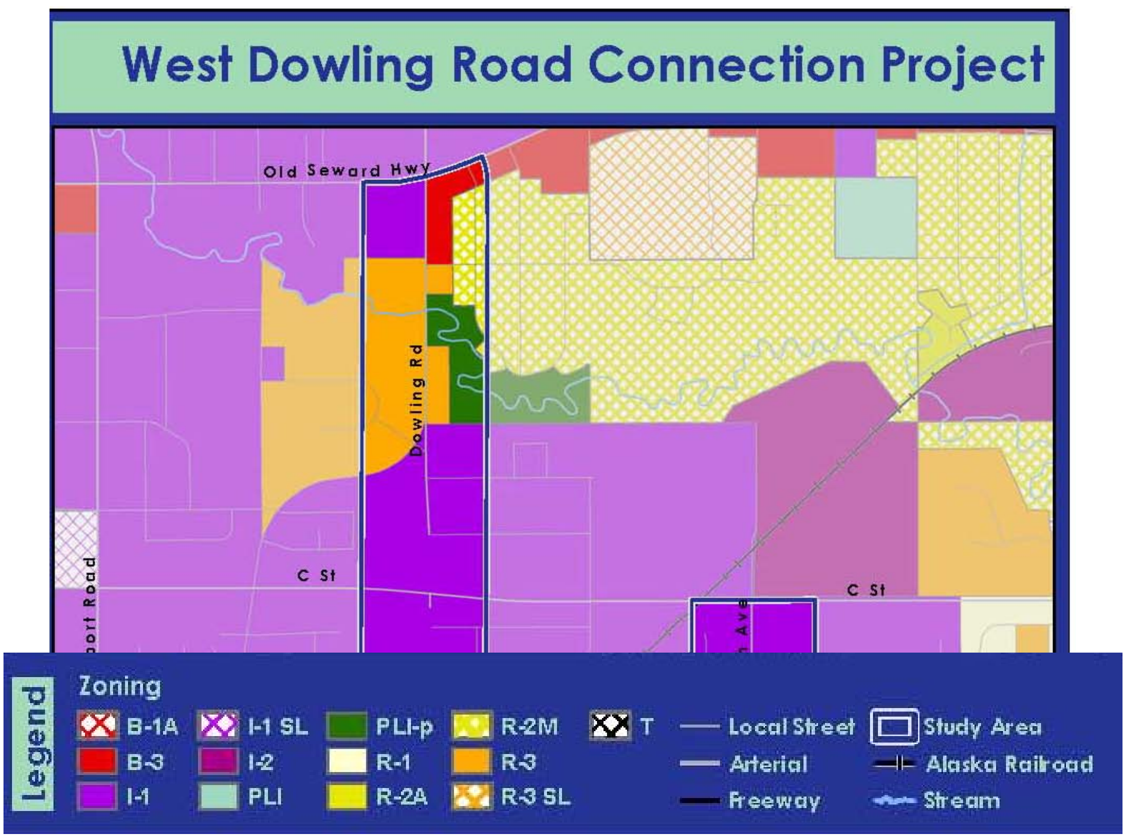

Figure 2 Dowling Road Zoning Areas (HDR, 2007)

Our project area lies within the central subarea of the Anchorage 2020 plan. According to the plan 81% of the land in this subarea is developed (Susan & Fison, 2001).

2.3 Contaminated Sites

Various LUST (leaking underground storage tank) and UST (underground storage tank) sites are within the project area as shown in Figure 3 (Shannon Wilson, LLC, 2004). There are also several sites where contaminated groundwater has been documented (Shannon Wilson, LLC, 2005). The sites investigated include those that pertain to Phase I (Old Seward to C Street) and Phase II (C Street to Minnesota) of the project. Phase I sites include the 6010 Old Seward (Tesoro Station) and 877 Dowling Road. The groundwater contamination at the Tesoro Station is at great depths (17 – 28') and is not considered a concern. The LUST is located at 877 Dowling Road is outside of the current project area, so is not considered a concern. The sites pertaining to Phase II of the project should be taken into account when planning the geometry of the Dowling and C Street Intersection (Shannon Wilson, LLC, October 2005). Contamination had been documented at 6029 Mackay Street and in the Tina Lake area.

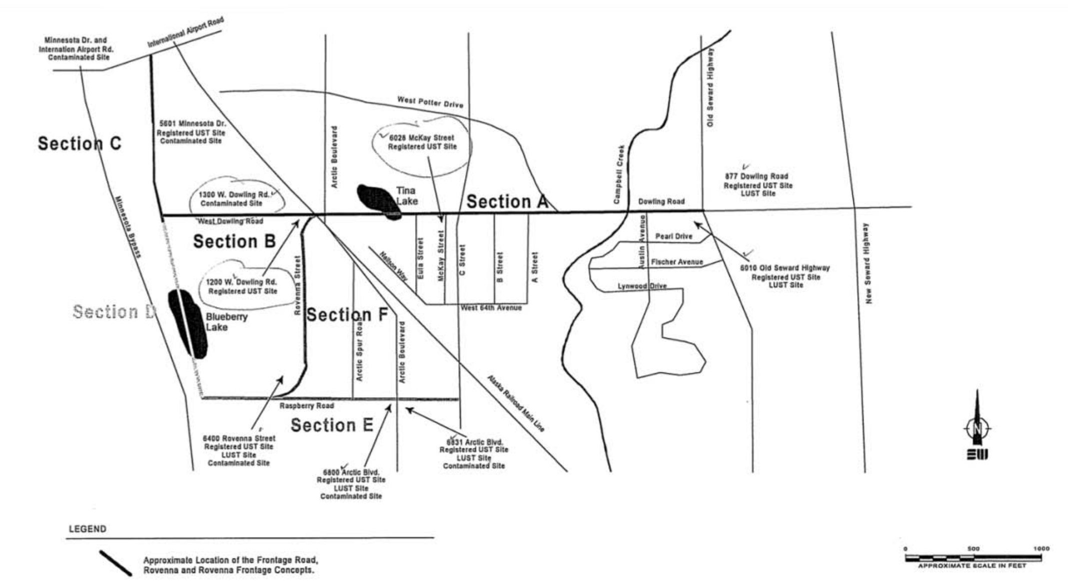

Figure 3 Contaminated Sites in Project Area (Shannon Wilson, LLC, 2004)

3.0 ESTIMATED ROW IMPACTS OF PROJECT

The impact of ROW was estimated by coordinating with the Roadway Geometry team and using two different road alignments to estimate cost of ROW acquisition. Roadway geometry came up with four different alternative alignments. However, only two of these alignments differed significantly in the ROW impact. Therefore only alternative #1 and #4 were analyzed with regard to ROW impacts

3.1 Preliminary ROW Costs

A preliminary investigation of ROW acquisition was conducted. The objective is to inform fellow design teams about ROW concerns and provide them with a VROM (very rough order of magnitude) estimate of ROW acquisition. This information was shared with the Road Geometry Team in order to provide guidance for selection of a preliminary alignment.

ROW acquisition along the project is expected to cost between $20 -$60 per square foot. The cost of acquiring a 20 feet of additional ROW along the West Dowling Road from Old Seward Highway to C Street is $2.7 million. The costs of acquiring 40, 60 and 80 feet are $5.4, $8.2 and $11 million respectively.

The price per square foot values are presented in Table 1. Note that these values are values should only be used as rough estimates to find the possible cost of acquiring particular section of land. The idea was to present the other groups with preliminary information that could aid some of their design decisions.

Table 1 Preliminary ROW Costs

Price Per Square Foot of ROW Acquisition		
MIN	$	8.87
MAX	$	93.87
AVERAGE	$	46.48
MEDIAN	$	39.91
STDEV	$	27.47

In order to help roadway geometry determine what the potential costs were for different roadway cross sections another estimate was prepared (Table 2). This table explains what the estimated cost is for different widths of ROW acquisition. For example, if the project requires an extra 30ft of ROW along the entire project corridor, then the cost of ROW acquisition would be $4.4 M. This information was given to roadway geometry to help them make design decisions about possible roadway cross sections along the project.

Table 2 Preliminary Project Costs for ROW Acquisition

ROW Acquisition			
12	ft	$	1,784,764.91
20	ft	$	2,974,608.19
30	ft	$	4,461,912.28
40	ft	$	5,949,216.38
50	ft	$	7,436,520.47
60	ft	$	8,923,824.56
70	ft	$	10,411,128.66
80	ft	$	11,898,432.75

3.2 Alternative 1

Alternative 1 uses the existing road centerline for the centerline of the proposed road alignment. The alignment of the road is angled at C Street to intersect at 90 degrees (Figure 4, Figure 5). The estimated cost for ROW acquisition along this alignment is $12.0 M. The advantages of this alternative are that it minimizes ROW acquisition of the Sears Warehouse on the NW corner of Old Seward and West Dowling Road. Also, this alternative minimizes ROW acquisition on the north side of West Dowling Road. The disadvantages of this alignment are that utility relocations of overhead electric lines on both the north and south sides of the road will be necessary.

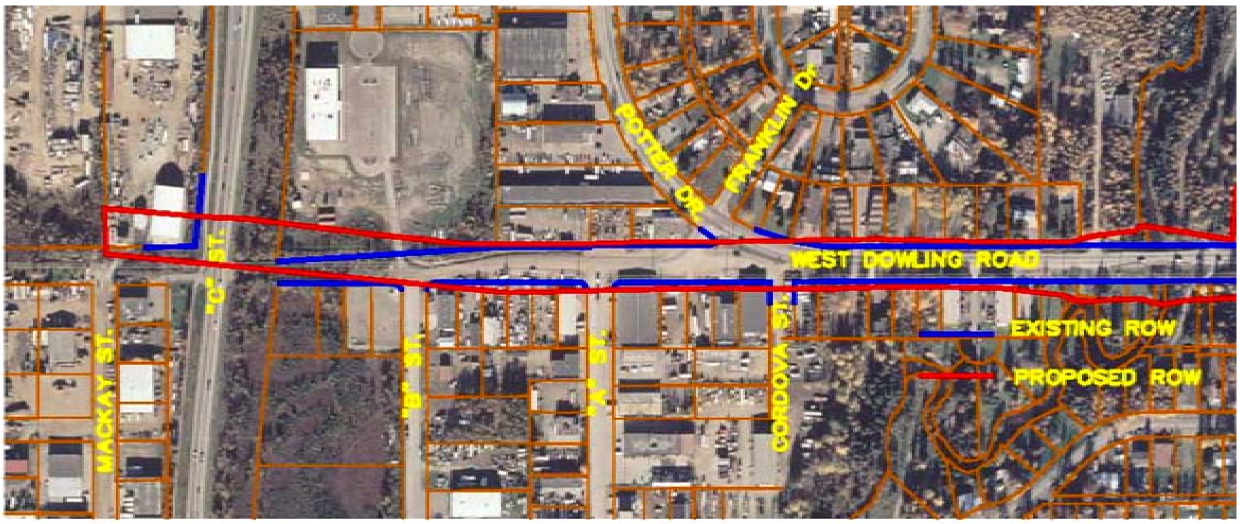

Figure 4 Proposed Alternative 1 (West)

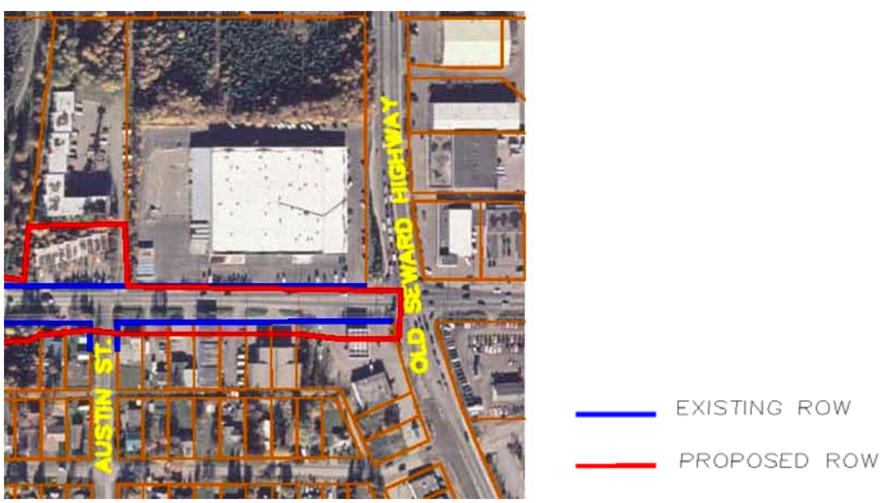

Figure 5 Proposed Alternative 1 (East)

3.3 Alternative 4

Alternative 4 places the proposed centerline of the project north of the existing centerline. The alignment of the road is angled at C Street to intersect at 90 degrees (Figure 6, Figure 7). The estimated cost for ROW acquisition along this alignment is $11.3 M. The advantages of this alternative are that ROW along the south side of West Dowling Road is minimized. The disadvantages of this alternative are that overhead electric lines on the north side of the project will be necessary.

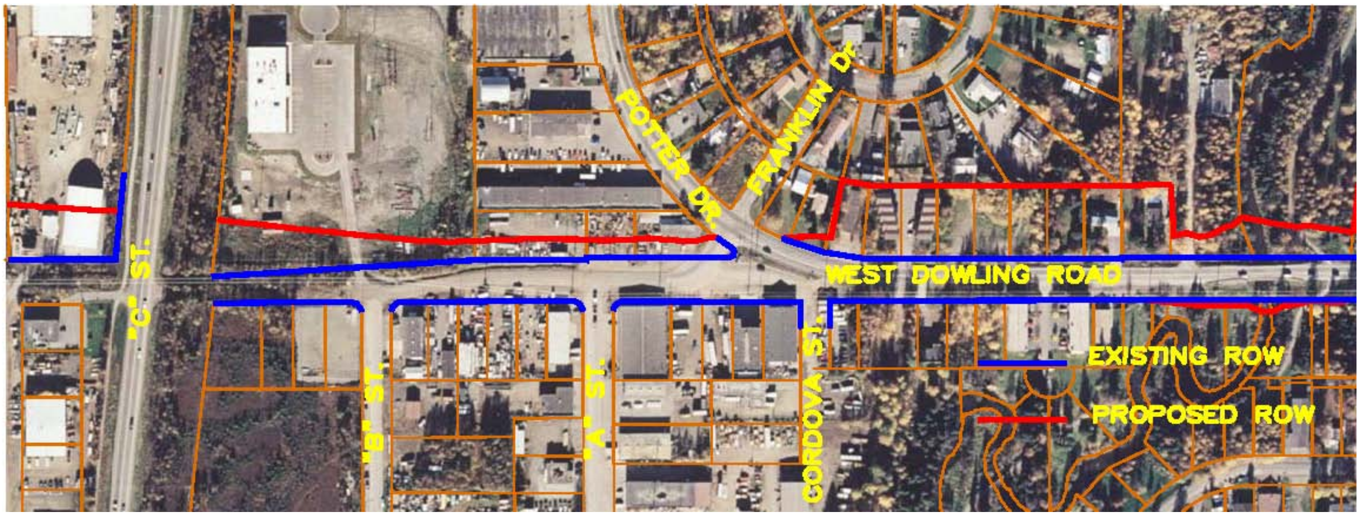

Figure 6 Proposed ROW, Alternative 4 (West)

Figure 7 Proposed ROW - Alternative 4 (East)

3.4 Preferred Alternative

The preferred alternative is alternative 4. The right of way costs for both alternatives are approximately equal. The deciding factor was ultimately the relocation of overhead electric lines. Alternative 4 would not require relocation the overhead electric lines on the south of the road.

3.4.1 <u>Old Seward Highway to Campbell Creek</u>

From Old Seward Highway to Austin Street the width of the road is expanded to accommodate more lanes. ROW will be acquired from the Tesoro Service Station and from the Sears Warehouse lots (Figure

7) ROW will be acquired from the Campbell Creek Greenbelt Apartments to accommodate for realignment of Austin Street on the north side of Dowling Road along with placement of a parking lot for access to the Campbell Creek trail.

3.4.2 Campbell Creek to Potter Drive

This section of road has also been expanded to accommodate for extra lanes. Area around Campbell Creek on both the north and south sides of Dowling Road will be acquired to accommodate for the new bridge structure (Figure 6). Entire portions of condos, apartments and a house on the north side of Dowling Road between Campbell Creek and Potter Drive will be acquired. While the entire portion of these lots is not required to accommodate the road corridor, the condos and apartments are interconnected and it is not possible to demolish only a portion of the complexes.

3.4.3 Potter Dr. to C Street

This section of road has also been expanded to accommodate for extra lanes. Also, Dowling Road will be connected to C Street. Portions of lots on the north side of Dowling Road will be acquired, including a portion of the IBEW training facility and several businesses.

3.4.4 Beyond C Street

Dowling Road will be extended beyond C Street approximately 100' – 200' to accommodate for Phase II of the project which will connect Dowling Road to Minnesota Dr. ROW will be acquired on the north side of the proposed road alignment. Only a portion of this commercially zoned lot will be acquired.

4.0 ROW ACQUISITIONS COSTS

The MOA parcel viewer (MOA, 2009) was used to compile a list of current property values. If a value was not available on the MOA parcel view, the information was acquired from the Environmental Assessment. The information compiled is presented in appendix A. The cost of ROW acquisition for Alternative 1 is $12.0 M. The cost of ROW acquisition for Alternative 4 is $11.3M.

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6.0 APPENDICES

6.1 ROW Log

Description	Owner	Address	Parcel ID	Legal Description	Building Value	Lot Value	Total Value	Area SF	Take	Percent Take	Lot Cost (x1.5)	Building Take?	Total Cost
Sears Warehouse	Sears Roebuck & Co	5900 OLD SEWARD HWY	00929106-000	SOUTH TOWN , TR 1 REM	$ 4,493,600.00	$ 4,286,000.00	$ 8,779,600.00	351,663	17,558	5%	$ 320,990.22	N	$ 320,990.22
East side of Old Seward	GOSNELL NORMA JEAN TRUST	851 Dowling Rd	00928536-000	HILLER , LT 2A PTN			$ 1,156,200.00	25,252		0%			
East side of Old Seward	PHIL HAWS AUTO OUTLET LLC	900 E DOWLING RD	01301502-000	WESTFORK , TR 1 REM			$ 1,783,000.00	109,842		0%			
Tesoro Service Station	MOATS INVESTMENTS LLC	6006 Old Seward Hwy	013-011-31-000	AURORA , BLK 1 LT 1	$ 328,000.00	$ 768,700.00	$ 1,096,700.00	46,200	1,317	3%	$ 32,869.41	N	$ 32,869.41
South Lot	DABELLS LLC	666 Dowling Rd	01301130-000	AURORA , BLK 1 LT 2	$ 417,800.00	$ 158,400.00	$ 576,200.00	9,600		0%	$ -	N	$ -
South Lot	DABELLS LLC		01301129-000	AURORA , BLK 1 LT 3	$ 417,800.00	$ 158,400.00	$ 576,200.00	9,600		0%	$ -	N	$ -
South Lot	PB INVESTMENTS LLC	654 E Dowling Rd	01301128-000	AURORA , BLK 1 LT 4	$ -	$ 158,400.00	$ 158,400.00	9,600		0%	$ -	N	$ -
South Lot	PB INVESTMENTS LLC	648 Dowling Rd	01301127-000	AURORA , BLK 1 LT 5	$ 387,500.00	$ 158,400.00	$ 545,900.00	9,600		0%	$ -	N	$ -
South Lot	CAREY DORIS M/TRUSTEE	646 E Dowling Rd	01301126-000	AURORA , BLK 1 LT 6	$ 108,000.00	$ 158,400.00	$ 266,400.00	9,600		0%	$ -	N	$ -
South Lot	CAREY DORIS M/TRUSTEE	614 Dowling Rd	01301125-000	AURORA , BLK 1 LT 7	$ 19,500.00	$ 158,400.00	$ 177,900.00	9,600		0%	$ -	N	$ -
South Lot	SMITH VICTOR C	6017 Austin St	01301124-000	AURORA , BLK 1 LT 8	$ 186,000.00	$ 171,600.00	$ 357,600.00	9,600		0%	$ -	N	$ -
Campbell Creek Greenbelt Apartments	WILSON BRADLEY J REVOC TRUST	573 E Dowling Rd	00929121-000	CAMPBELL CREEK GREENBELT #04 , LT 43A	$ 3,260,800.00	$ 686,600.00	$ 3,947,400.00	129,269	33,793	26%	$ 269,232.46	Y	$ 1,547,870.97
CAMPBELL CREEK GREENBELT #04 , LT 43		654 Dowling Rd	00929120-000	CAMPBELL CREEK GREENBELT #04 , LT 43				133,064	14,026	11%	$ -	N	$ -
	KORPI MARTHA HILDA &	433 E Dowling Rd	00929104-000	T13N R3W SEC 31 , W2SW4SE4SE4 PTN	$ 174,300.00	$ 762,300.00	$ 936,600.00	158,400	8,547	5%	$ 61,698.66	N	$ 61,698.66
	KORPI JAMES L	415 E Dowling Rd	00929103-000	T13N R3W SEC 31 , SW4SW4SE4SE4 PTN , PARCEL 13B	$ 95,000.00	$ 122,000.00	$ 217,000.00	15,000					
CONDO	GRIMM RUSSELL S & JOD	361 Dowling Rd	00929201-000	HANSON ACRES #1 , BLK 3 LT 24	$ 70,000.00	$ 133,200.00	$ 203,200.00	11,205	11,205	100%	$ 304,800.00	Y	$ 304,800.00
CONDO			00929202-000	HANSON ACRES #1 , BLK 3 LT 23	$ 82,500.00	$ -	$ 82,500.00	11,250	11,250	100%	$ 123,750.00	Y	$ 123,750.00
CONDO			00929203-000	HANSON ACRES #1 , BLK 3 LT 22 , DOWLING AT THE PARK	$ -	$ 604,600.00	$ 604,600.00	11,250	11,250	100%	$ 906,900.00	Y	$ 906,900.00
CONDO			00929204-000	HANSON ACRES #1 , BLK 3 LT 21 , DOWLING AT THE PARK	$ -	$ 704,000.00	$ 704,000.00	11,250	11,250	100%	$ 1,056,000.00	Y	$ 1,056,000.00
CONDO			00929205-000	HANSON ACRES #1 , BLK 3 LT 20 , DOWLING AT THE PARK	$ -	$ 604,600.00	$ 604,600.00	11,250	11,250	100%	$ 906,900.00	Y	$ 906,900.00
CONDO			00929206-000	HANSON ACRES , BLK 3 LT 19 , CANBERRA	$ -	$ 592,100.00	$ 592,100.00	11,250	11,250	100%	$ 888,150.00	Y	$ 888,150.00
CONDO			00929207-000	HANSON ACRES , BLK 3 LT 18 , CANBERRA	$ -	$ 592,100.00	$ 592,100.00	15,000	15,000	100%	$ 888,150.00	Y	$ 888,150.00
CONDO			00929208-000	HANSON ACRES #1 , BLK 3 LT 17	$ 75,700.00	$ 303,000.00	$ 378,700.00	10,000	10,000	100%	$ 568,050.00	Y	$ 568,050.00
CONDO			00929209-000	HANSON ACRES #1 , BLK 3 LT 16			$ 64,514.92	10,359	1,480	14%		N	$ 13,825.96
RESIDENTIAL			00929411-000	HANSON ACRES #1 , BLK 1 LT 13	$ 207,000.00	$ 97,400.00	$ 304,400.00	9,500	0	0%	$ -	N	$ -
RESIDENTIAL			00929514-000	HANSON ACRES #1 , BLK 4 LT 1A	$ 153,000.00	$ 175,100.00	$ 328,100.00	12,333	0	0%	$ -	N	$ -
RESIDENTIAL			00929513-000	HANSON ACRES #1 , BLK 4 LT 1B			$ 113,400.00	9,500	0	0%	$ -	N	$ -
RESIDENTIAL			00929505-000	HANSON ACRES #1 , BLK 4 LT 1 W230'			$ 249,000.00	23,000	0	0%	$ -	N	$ -
RESIDENTIAL	MOA			AURORA #2 , BLK 1 LT 1				10,650	0	0%	$ -	N	$ -
RESIDENTIAL	MOA			AURORA #2 , BLK 1 LT 2				13,575	0	0%	$ -	N	$ -
RESIDENTIAL	MOA			AURORA #2 , BLK 1 LT 2A				2,150	0	0%	$ -	N	$ -
RESIDENTIAL	MOA			AURORA #2 , BLK 1 LT 3				7,775	0	0%	$ -	N	$ -
RESIDENTIAL	WHITE ANGELA M	342 E Dowling Rd	01301114-000	AURORA #2 , BLK 1 LT 4	$ 104,400.00	$ 251,400.00	$ 355,800.00	8,400	0	0%	$ -	N	$ -
RESIDENTIAL			01301144-000	AURORA #2 , BLK 1 LT 5A , PARKSIDE TERRACE				25,294	0	0%	$ -	N	$ -
RESIDENTIAL			01301107-000	AURORA #2 , BLK 1 LT 7 , CAMPBELL CREEK TERRACE				8,400	0	0%	$ -	N	$ -
RESIDENTIAL			01301106-000	AURORA #2 , BLK 1 LT 8 , STONESTHROW TOWNHOME				8,400	0	0%	$ -	N	$ -
RESIDENTIAL			01301105-000	AURORA #2 , BLK 1 LT 9	$ 191,100.00	$ 104,400.00	$ 295,500.00	8,400	0	0%	$ -	N	$ -
RESIDENTIAL			01301143-000	AURORA #2 , BLK 1 LT 10A	$ 417,500.00	$ 158,600.00	$ 576,100.00	16,802	0	0%	$ -	N	$ -
RESIDENTIAL			01301102-000	AURORA #2 , BLK 1 LT 12		$ 90,200.00	$ 90,200.00	8,400	0	0%	$ -	N	$ -
COMMERCIAL			01201429-000	C STREET INDUSTRIAL , BLK 1 LT 1A1	$ 406,000.00	$ 163,300.00	$ 569,300.00	12,011	12,011	100%		Y	$ 853,950.00
COMMERCIAL			01201428-000	C STREET INDUSTRIAL , BLK 1 LT 1B	$ 452,900.00	$ 134,700.00	$ 587,600.00	9,769	9,769	100%		Y	$ 881,400.00
COMMERCIAL									0	0%	$ -	N	$ -
COMMERCIAL	JOHNSON DAVID C & JANE C	6016 Austin Ave	01301148-000	AURORA , BLK 7 LT 1A	$ -	$ 93,700.00	$ 93,700.00	8,938	0	0%	$ -	N	$ -
COMMERCIAL	JOHNSON DAVID C & JANE C	528 E Dowling Rd	01301149-000	AURORA , BLK 7 LT 2A	$ 149,900.00	$ 102,600.00	$ 252,500.00	10,291	0	0%	$ -	N	$ -
COMMERCIAL	STATE OF ALASKA		01301145-000	AURORA , BLK 7 LT 3A			$ -	14,410	0	0%	$ -	N	$ -
COMMERCIAL	MOA	352 E Dowling Rd	01301152-000	AURORA , BLK 7 LT 5			$ -	15,280	0	0%	$ -	N	$ -
COMMERCIAL			01301152-000	AURORA , BLK 7 LT 5				15,280	0	0%	$ -	N	$ -
COMMERCIAL									0	0%	$ -	N	$ -
COMMERCIAL			01201323-000	C STREET INDUSTRIAL , BLK 2 LT 1A			$ 489,200.00	11,927	0	0%	$ -	N	$ -
COMMERCIAL									0	0%	$ -	N	$ -
COMMERCIAL									0	0%	$ -	N	$ -
IBEW Training Facility			00930121-000				$ 2,066,157.89	290,053	38,553	13%			$ 411,941.53
	GRATRIX KRIS E & SHARON K	101 W Dowling Rd	00929505-000	HANSON ACRES #1 , BLK 4 LT 1 W230'			$ 249,000.00	23,000	9,565	42%			$ 155,327.28
AK DIESEL SERVICE	MADDOCKS ROY & JEANNE	240 E POtter Dr	00929514-000	HANSON ACRES #1 , BLK 4 LT 1A			$ 328,100.00	12,333	12,333	100%			$ 492,150.00
	THOMAS RAYMOND G	120 E Dowling Rd	01201437-000	C STREET INDUSTRIAL , BLK 1 LT 1CA			$ 271,400.00	19,511	0	0%	$ -	N	$ -
				SILVERADO , TR 2B	$ 1,212,400.00	$ 1,714,800.00	$ 2,927,200.00	165,528	23215	14%			$ 960,884.36
													$ 11,375,608.39

Figure 8 ROW Log of Each Parcel in the Project Corridor

DESIGN STUDY REPORT

APPENDIX B

ROADWAY GEOMETRY

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
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Prepared by:

Blue Fox Universal
University of Anchorage Alaska

Matt Majoros
Galen Jones

April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AASHTO ....American Association of State Highway and Transportation Officials
ADOT ....State of Alaska Department of Transportation and Public Facilities
DSR..........Design Study Report
HPM.......... Highway Preconstruction Manual
LOS.......... level-of-service
MOA..........Municipality of Anchorage
mph .... miles per hour
PCM..........Preconstruction Manual
PDO .... Property Damage Only
ROW.......... right-of-way
WDR..........West Dowling Road

1.0 DESIGN CRITERIA

1.1 Sources

Alaska Department of Transportation and Public Facilities. (2006) *Alaska Highway Precosntruction Manual.*

American Association of State Highway and Transportation Officals. (2004). *A Policy on Geometric Design of Highways and Streets.*

United States Department of Transportation, Federal Highway Adminstration. (2003). *Manual on Uniform Traffic Control Devices.*

Engineering is a practical field. Engineering theory is based in math and science but the most important test of success if whether the engineering facility performs is function in the real world. Because of this, much engineering work can be performed using standards that have worked in the past. There are a variety of entities responsible for producing and publishing design criteria and manuals. These manuals allow for design to be performed based on empirical and theoretical means without much of the tedious computations that would otherwise be required. The principal sources of design criteria used on West Dowling Road are the ASASHTO (American Society of State Highway and Transportation Officials) *Policy on Geometric Design of Highways and Streets* and the AADOT (Alaska Department of Transportation and Public Facilities) *Preconstruction Manual*.

1.2 Criteria

The principal starting point for highway design is defining a functional classification of the proposed roadway. There are five commonly accepted classes of highways based on the service they provide:

1. Principle Arterials
2. Minor Arterials
3. Major Collectors
4. Minor Collectors
5. Local Roads and Streets

The classes are listed in decreasing order of mobility and increasing order of accessibility. In other words, principle arterials or freeways are the best type of road for traveling long distances quickly but do not allow direct access to as many locations as a local road with driveways. Roads are also classified as rural or urban based on the land use of the surrounding area. (Garber et al., 2009) The AADOT define the proposed West Dowling Road as an urban minor arterial based on existing use and the purpose they want the new road to fulfill.

The design speed is the maximum safe speed of travel associated with the design features of a road segment. Traditionally, the posted speed is determined by the speed at which 85% of vehicles are traveling at or below. The road, with the proposed modifications, is not yet in existence so the 85th percentile speed is not determinable. The existing road is posted at 35 mph. The design speed is based on the road classification, volume and terrain. West Dowling is an Urban Minor Arterial; as a minor arterial the road should provide more mobility, indicating higher speeds than the more accessible classifications. A large volume indicates a higher speed is necessary while rugged terrain can make high speeds dangerous and difficult to maintain. The design speed for the West-Dowling Extension was set to 45 mph based on AASHTO recommendations for road classification and surrounding roads with similar classifications.

The design speed for the new road is 45 mph. Together with the super-elevation grade, AASHTO define a minimum radius for horizontal curves based on the design speed. The maximum super-elevation selected for this project is six percent. The minimum radius for these criteria can be read from the following table and is 660 feet.

Table 1 Horizontal Curve, Grade and Sight Distance Criteria Summary (ADOT PCM, 2006)

HORIZONTAL CURVE, GRADE AND SIGHT DISTANCE CRITERIA SUMMARY

Design Speed (mph)	SIGHT DISTANCE (2)		HORIZONTAL CURVES					MAXIMUM GRADES % (1)								
	MINIMUM	MINIMUM	DESIRABLE		MINIMUM*	MAXIMUM	MINIMUM**	FUNCTION and TERRAIN								
	STOPPING (feet)	PASSING (feet)	RADIUS (feet) (4)	DEGREE OF CURVE (4)	RADIUS (feet) (4)	DEGREE OF CURVE (4)	LENGTH (feet) (4)	ARTERIAL			COLLECTOR			LOCAL		
								L	R	M	L	R	M	L	R	M
20	115	710	155	36.75	115	49.25	(3)				7	10	12	8	11	16
25	155	900	235	24.25	185	30.75	(3)				7	10	11	7	11	15
30	200	1090	350	16.25	275	20.75	450				7	9	10	7	10	14
35	250	1280	550	10.25	380	15.00	525				7	9	10	7	10	13
40	305	1470	750	7.50	510	11.00	600	5	6	8	7	8	10	7	10	13
45	360	1625	1250	4.50	660	8.50	675	5	6	7	7	8	10	7	9	12
50	425	1835	1725	3.25	835	6.75	750	4	5	7	6	7	9	6	8	10
55	495	1985	2500	2.25	1065	5.25	825	4	5	6	6	7	9	6	7	10
60	570	2135	3500	1.50	1340	4.25	900	3	4	6	5	6	8	5	6	
65	645	2285	5000	1.00	1660	3.25	975	3	4	5						

Limiting criteria for the vertical curve based on design speed are as follows:

- Six-percent maximum grade (0.5% minimum grade for drainage)
- 360 foot stopping sight distance for vertical curves
- K-value of 61 for crest curves, 79 for sag curves

2.0 DESIGN OF THE ALIGNMENT

The alignment of a highway generally outlines the position of the centerline in the project corridor. The alignment is three-dimensional; in design, the alignment can be modeled with a vertical and a horizontal component. The horizontal alignment uses circular curves while the vertical alignment uses parabolic curves. Connecting the curves are straight segments or tangents (also called grades in the vertical alignment). The horizontal and vertical alignments for the Preferred Alternative were designed with the following goals in mind:

- Raise level of service/follow appropriate design criteria
- Minimize ROW acquisition & costs
- Minimize utility relocation
- Minimize wetlands impact
- Compatibility with existing intersections
- Minimize materials cost/cut and fill quantities

There were several considerations pertinent to the positioning of the centerline including roadway geometry, utility conflicts, ROW acquisition, and coordination with the vertical alignment and wetlands encroachment. The alignment should correspond to desired geometry including positioning at intersections, appropriate radii, and footprint of the lanes. In this project specifically there are overhead electric (OE) towers that would be costly to relocate. The corridor generated by the new road will encroach into the existing Right of Way. Additional ROW will have to be acquired. This will likely take up a large portion of the project's total budget and spending in this area should be minimized. It is general practice to check the horizontal alignment against the vertical alignment and select the one the "takes the form of the natural topography" (Garber and Hoel, 2009). This is the least costly alternative because it minimizes the amount of cut and fill. The road must meet vertical alignment requirements as well such as grade and length of parabolic curve.

2.1 Horizontal Alignment

Because the vertical profile of the alignment changes with the horizontal positioning of the road, the horizontal alignment was designed first. Several alternatives were considered for the horizontal alignment.

2.1.1 Rejected Alternatives

Alternative 1 essentially follows the existing centerline. However, it curves in the western side of the project to intersect C Street at a right angle. Ninety-degree intersections are preferred according to design recommendations. Curves for the alignment were drawn with a minimum radius of 660 ft in accordance with AASHTO requirements. This alignment is advantageous in that it lines up well with existing intersections. Since Alignment 1 follows the existing centerline, there is minimal Right-of-Way acquisition required. It does not avoid the transmission towers, which are costly to relocate. Since it does not make extra ROW provisions for the OE, however, it is likely that additional ROW would have to be purchased.

Figure 1 Alternative Horizontal Alignment 1

Alternative 2 aims to avoid the overhead electric (OE) transmission line towers on the south side of the existing road. This alignment also curves to intersect C Street at a right angle. The centerline of the road re-aligns with the existing centerline at Old Seward Highway through a reverse curve. Alternative 2 avoids many of the OE towers but requires substantial ROW since it will be acquired from just one side. Additionally, the reverse curve can be dangerous and confusing for drivers; not to mention more expense to plan and construct.

Figure 2 Alternative Horizontal Alignment 2

Alternative 3 removes the potentially dangerous reverse curve and shifts the entire alignment to the north, as to avoid placing the bridge foundation overtop the four-foot diameter sewer line in that area.

2.1.2 Preferred Alternative

The Preferred Alternative for the project (Alternative 4) builds off of Alternative 3. It takes the narrower corridor across the bridge into consideration. As a result, the centerline from Alternative 3 was shifted south and still avoids the four-foot sewer line with a buffer of 10 feet.

Figure 3 Preferred Horizontal Alignment

The Preferred Alternative consists of the following:

- A 5-lane urban section, multi-use pathway and sidewalk.
- A single-span bridge with 4-lane urban section and sidewalks.

Associated improvements include modifications to intersection geometry, lighting, signage and stripping, medians, shoulders, snow-storage buffers, transit accommodations, and necessary utility relocations.

The Preferred Alternative avoids many of the overhead electric transmission line towers and the four-foot diameter sewer pipe at Campbell Creek. This alternative minimizes curves (no reverse curves), and intersects C Street at a right angle; the wetlands in that area are also partially avoided by the curve. The alternative avoids encroachment into Right-of-Way that would be too costly to acquire. Potter Road will intersect West Dowling Road at ninety-degrees with a restricted left hand turn. Geometries at the other intersections will be in accordance with analysis based on projected and saturated traffic volumes.

2.2 Vertical Alignment

Design of the vertical alignment was an iterative process of matching the existing terrain and satisfying design requirements. The design process started with required elevations at the existing intersects and the bridge. Grades on tangents had to be maintained within the acceptable range of 0.5% to 6%. This was not a difficult constraint given the relatively level/rolling terrain. Maximum grades on the finished alignment approached three percent. Grades were rounded off to allow for easier construction. Length of parabolic curve requirements were met by setting the curves to required K-values in the design software (AutoCAD Civil 3D). The minimum length of curve (L) was computed by Equation 1.

$$L = KA$$

Equation 1 Minimum Length of Curve

Where A is the change in grade between the two tangents and K is the length of vertical curve per percent change in A (Garber & Hoel, 2009). Equation 1 is a simplified version of more complicated equation involving sight distance. K values are published in Tables by AASHTO and others. In design, lengths were rounded up for ease in construction.

3.0 TYPICAL SECTIONS

3.1 Typical Cross Section

The typical cross section for our corridor was determined from the project scope, particularly the Memo from the Alaska Department of Transportation, dated November 11^{th}, 2008. In this memo, ADOT outlines the essential elements of the cross section, “The proposed improvements include… widening Dowling Road to five lanes (four 12-foot travel lanes, 16-foot wide center turn lane, and 2-foot shoulders)... A 6-foot sidewalk and a 12-foot separated pathway are included in the project.”

The typical section specified in the project scope of work will run the length of the corridor (excluding the bridge). The median was narrowed slightly for space considerations and to allow for inside shoulders. This urban-arterial section is comprised of two, 12-foot travel lanes in each direction and a 14-foot raised median with left-turn pockets as appropriate. Two-foot shoulders are required. Curb and gutter will be used for drainage, as it minimizes the footprint of the road. Wherever possible, buffers of seven-feet from the top-of-curb provide improved safety and snow storage. A 12-foot multi-use pathway to the north and a six-foot sidewalk to the south are included in the cross section, space permitting.

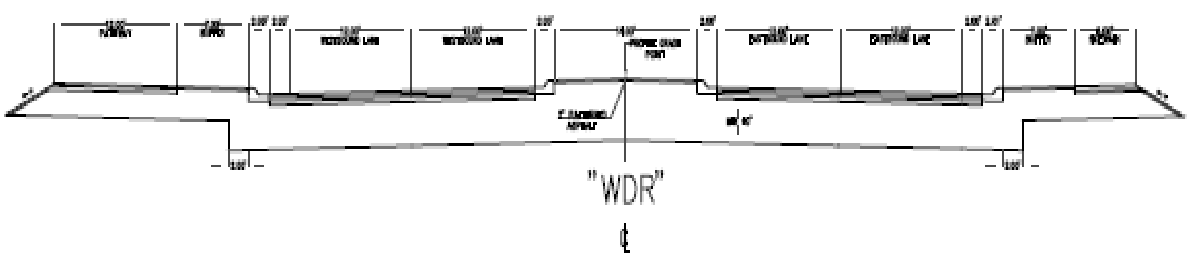

Figure 4 Typical cross section

3.2 Bridge Cross Section

The cross section on the single span bridge across Campbell Creek will be composed of four 12-foot travel lanes, a four-foot raised median, 4.5-foot outside shoulders, two-foot inside shoulders and six-foot sidewalks on both sides.

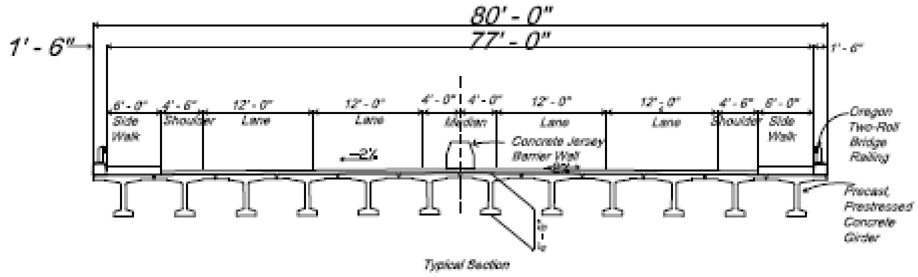

Figure 5 Bridge cross section

4.0 QUANTITIES

Quantities for cut and fill were computed using engineering drawing and modeling software, specifically AutoCAD Civil 3D 2009. The road surface was modeled three dimensionally and compared to the ground surface. Cut and fill volumes were computed from the existing ground to the bottom of the pavement structure. The values are reported in Table 2.

Table 2 Cut and Fill Volumes

	Volume	
	(ft^3)	(yd^3)
Cut	1160612.1	42985.6
Fill	589220.4	21823.0
Net	-571391.7	-21162.7

5.0 BIBLIOGRAPHY

Alaska Department of Transportation and Public Facilities. (2006). *Alaska Highway Preconstruction Manual.*

American Association of State Highway and Transportation Officals. (2004). *A Policy on Geometric Design of Highways and Streets.*

Garber, N. J., & Hoel, L. A. (2009). *Traffic and Highway Engineering.* Cengage Learning.

United States Department of Transportation, Federal Highway Adminstration. (2003). *Manual on Uniform Traffic Control Devices.*

DESIGN STUDY REPORT

APPENDIX C

TRAFFIC ANALYSIS

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
Central Region
4111 Aviation Avenue
Anchorage, Alaska 99502

Prepared by:

Blue Fox Universal
University of Anchorage Alaska

Galen Jones
Mahear Abou'Eid
Joshua Satterfield

April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS

AADT .... Annual Average Daily Traffic
AASHTO .... American Association of State Highway and Transportation Officials
ADA .... Americans with Disabilities Act
ADOT .... State of Alaska Department of Transportation and Public Facilities
DCM .... Design Criteria Manual
DHV .... Design Hourly Volume
DSR .... Design Study Report
HPM .... Highway Preconstruction Manual
HTNA .... Highway Traffic Noise Study
ITS .... Intelligent Transportation Systems
LOS .... Level-of-Service
LRTP .... Long-range Transportation Plan
MEV .... Million Entering Vehicles
MOA .... Municipality of Anchorage
mph .... Miles per Hour
OSHP .... Official Streets and Highway Plan
PCM .... Preconstruction Manual
PER .... Preliminary Engineering Report
PHV .... Peak Hourly Volumes
ROW .... Right-of-Way
VMS .... Variable Message Signs
WB .... West-Bound
WDR .... West Dowling Road

1.0 INTRODUCTION

1.1 Objectives

This traffic operations report will explain the traffic related justifications to implement the West Dowling Road Phase I Project. The traffic operations plan will include, but is not limited to, pedestrian facilities, intersection signalization, accident prevention plans and future expansion Alternatives and recommendations. The West Dowling Road Project is being funded by State of Alaska legislative appropriations and administered by the Alaska department of Transportation & Public Facilities (DOT&PF). The network summary for the traffic operations is summarized in Figure 1.

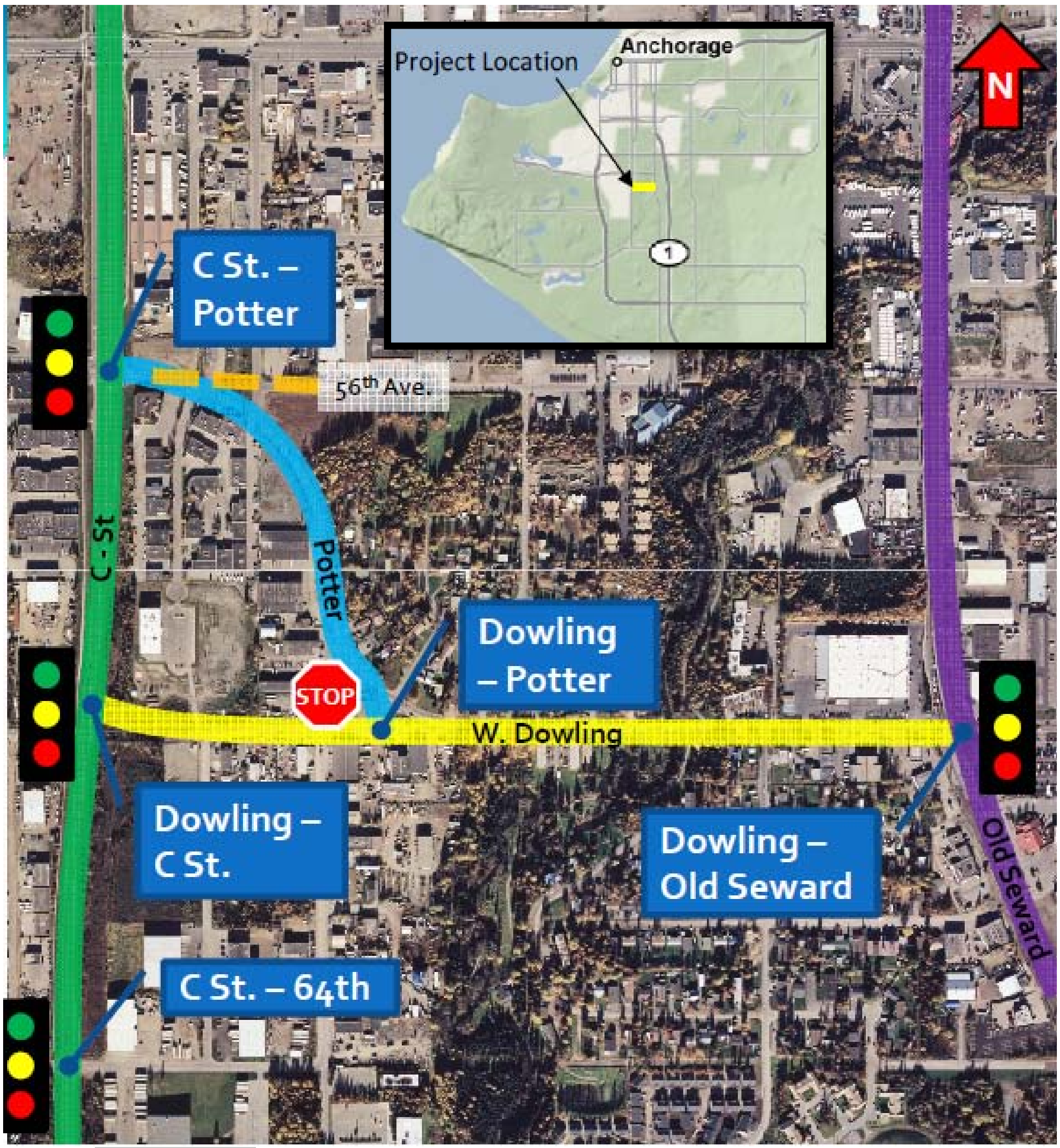

Figure 1 Adjacent Network Summary

1.2 Background

The purpose of the West Dowling Road Extension and Reconstruction project is to relieve east-west congestion on the legs between Old Seward Highway and C Street and provide an additional connection between the arterials running north and south through town. It will also provide pedestrian facilities along the entire corridor, improving safety and capacity for drivers and pedestrians. The traffic operations on the existing West Dowling Road (WDR) will be altered significantly with the Phase I construction of this project. These changes must be met with new traffic plans and sufficient level of service (LOS) for the projected design life of 20 years.

The WDR project will help to expand the Municipality of Anchorage's (MOA) plan to "connect Anchorage", ridding the city-wide network of its growing congestion. This project will compliment the proposed East Dowling Road extension, recent Elmore Road extension, and proposed Martin Luther King Dr. Projects, providing an effective alternative to the congested Tudor Road. The WDR project will effectively facilitate traffic caused primarily by commuters generated from communities North of Anchorage. See Figure 2 for a graphical display of the direct project compliments described above

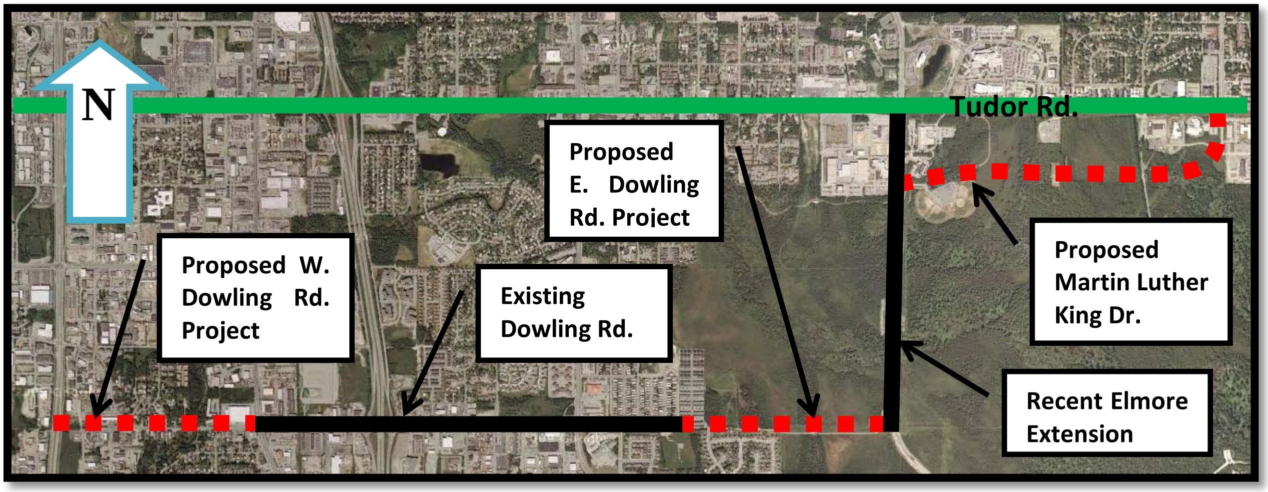

Figure 2 Direct Project Compliments in Anchorage Traffic Network

2.0 EXISTING CONDITIONS

2.1 Facilities

The current roadway can be seen in Figure 3.

Figure 3 Existing West Dowling Corridor

2.1.1 Existing Segment – Potter Drive to Old Seward Highway

This section of Dowling road is designated as a Minor Arterial in the ADOT Central Region Annual Traffic Report and as a Class III Major Arterial in the Official Streets and Highways Plan (OSHP). Starting at the Old Seward Highway and working west to Potter Drive, this segment of roadway consists of two 12-foot-wide paved lanes. At the intersection of the Old Seward Highway and WDR heading eastbound, WDR widens to allow for a dedicated left turn lane and two through lanes with the through lane on the south side doubling as a right turn lane. Heading west on WDR, pedestrian facilities consist of a 5-foot wide sidewalk on the north side and a separated trail along the south side of WDR ending on the east side of the Campbell Creek Bridge. East of the Campbell Creek bridge the Campbell Creek Trail crosses WDR at grade. As Dowling Road approaches Potter Drive the road once again widens to accommodate a dedicated through lane onto Potter Drive and a left turn lane onto WDR. Limited curb and gutter exists on this segment of the road. Curb and gutter exists at the intersection of WDR and the Old Seaward Highway extending on the north side of WDR to the east side of the Campbell Creek Bridge and at the intersection of Potter Drive and WDR. The rest of the roadway consists of grass swales.

2.1.2 Existing Segment – Potter Drive to B Street

This section of WDR is designated as a Minor Arterial in the ADOT Central Region Annual Traffic Report and as a Class III Major Arterial in the OSHP. This section of WDR consists of a 24-foot-wide paved section of road with no shoulder or pedestrian facilities. At the intersection of Potter Drive and WDR heading east, there exists a stop sign for the WDR movements onto Potter Drive.

2.1.3 Undeveloped Segment – B Street to C Street

This section of WDR is designated as a Class III Major Arterial in the OSHP and is not currently classified by the ADOT, because this section of the road is not currently developed.

2.2 Right of way

The existing right-of-way (ROW) from Old Seward Highway to C Street varies from 55 to 90 feet. The current ROW widths are summarized in Figure 4. The ROW adjacent to WDR is owned and maintained by ADOT. ROW acquisition efforts are currently in progress to obtain a ROW corridor providing a minimum width of 106 feet.

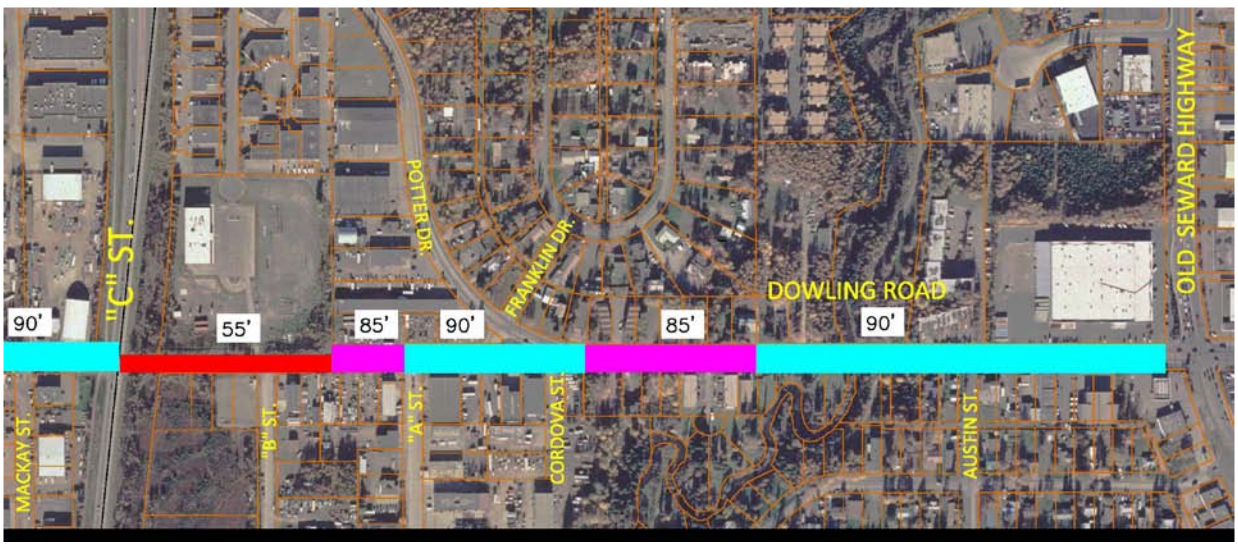

Figure 4 Existing Right-of-Way widths

2.3 Existing Traffic

2.3.1 Annual Average Daily Traffic

The current recorded average annual daily traffic AADT on WDR for Old Seward Highway to Potter Drive was 9,257 vehicles per day. This value was obtained from the design criteria table provided by ADOT and has been provided in Appendix C-1.

2.3.2 Turning Movements

The turning movements onto the project corridor for the existing conditions include one major signalized intersection at WDR and Old Seward Highway in addition to many stop-sign-controlled local roads and private drives. Currently the local roads and private drives have complete access allowing left and right turning movements onto WDR. A large portion of the existing traffic uses Potter Drive as an extension of WDR causing heavy turning movements at the C-Street and Potter Drive intersection.

2.4 Pedestrian Facilities

2.4.1 West Dowling Road

The current pedestrian and bicycle facilities along WDR are very limited. A 5-foot sidewalk exists on the North and an 8-foot multi-use path with curb ramps and detectable warning tiles exists to the South. Both facilities span from the Campbell Creek Greenbelt to the existing facilities on Old Seward Highway, leaving no pedestrian or bicycle facilities on WDR west of Campbell Creek. The sidewalk to the north is protected from the west-bound (WB) vehicular traffic only by the depth of the curb itself, as no shoulder is present. The current pedestrian and bicycle facilities create an unsafe environment for pedestrians living west of Campbell Creek and for anyone traveling along the north side of WDR.

The typical cross-section designed for the WDR Phase I project includes a 12-foot multi-use pathway and a 6-foot wide sidewalk, each protected by a 7-foot “buffer-zone” between the pedestrian facilities and the shoulder of the vehicular traveled way except along the span of the bridge, where the “buffer-zone” will be removed to reduce bridge width. All pedestrian facilities will be designed in accordance with Americans with Disabilities Act (ADA) standards, including detectable warning tiles and push-button crossing detectors at the proposed signalized WDR/C-Street intersection.

No public bus routes are currently operating on WDR. People Mover currently has no plans in the near future to add any routes to this corridor, as major routes already exist along the lengths of Old Seward Highway and C-Street. However, with the traffic growth due to the future WDR Phase 2 project, a bus stop will most likely be needed during the life of the WDR project. The most effective location for a bus stop would be on the north side of WDR just east of Potter Dr. This is the most suitable location since it is primarily residential east of Potter Drive and there should be adequate ROW since the existing apartment building at that location will be removed. See Figure 5 for a map showing the aforementioned proposed bus stop location. The proposed bus stop will be designed and built in accordance with People Mover standards.

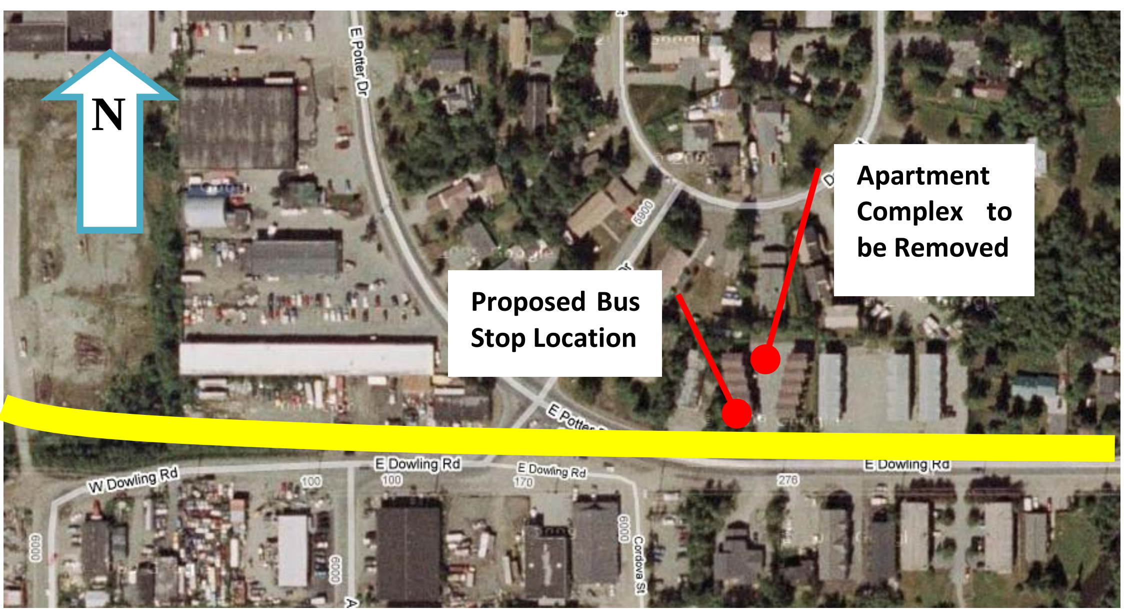

Figure 5 Proposed Bus Stop Location

2.4.2 Campbell Creek Trail Crossing

East of the bridge the sidewalk and path will branch off and intercept the Campbell Creek Greenbelt path traveling perpendicular to the WDR centerline under the bridge and along the east side of Campbell Creek designed with a 12-foot width. The sidewalk and path will both be reduced to 6-feet widths on the north and South sides of the bridge for feasibility and ROW reasons.

3.0 ANALYSIS STANDARDS

3.1 Level of Service Criteria

The level of service (LOS) required for the design year must meet minimum requirements set by the ADOT. The minimum LOS is a D for the design year of 2030 based on the ADOT requirements. This will allow for an acceptable amount of delay during peak hour traffic volumes at the design year. The data compiled and calculated from the AADT and intersection geometry was inputted into the Highway Capacity Software 2000 (HCS2000) in order to determine the LOS based on the variables encountered and projected in the field.

3.2 Design Speed

The design speed is the maximum safe speed of travel associated with the design features of a road segment. Traditionally, the posted speed is determined using the 85^{th} percentile speed, which can be summarized as the speed at which 85% of vehicles are traveling at or below. The road, with the proposed modifications, is not yet in existence, meaning the 85^{th} percentile speed is not determinable. The existing road is posted at 35 mph, which is strictly dictated by current road classification. WDR is an Urban Minor Arterial according to ADOT. The design speed for the WDR Extension was set to 45 mph based on the American Association of State Highway and Transportation Officials (AASHTO) recommendations for road classification based on surrounding roads with similar classifications and the proposed geometry.

4.0 EXISTING TRAFFIC OPERATIONS

4.1 Intersection Level of Service

Current AADT volumes may be obtained from ADOT. The volumes used in the projected 2030 design-year-turning-movement calculations were modified in order to obtain current turning movements. These values were obtained using an exponential growth factor and similar turning percentages as the 2030 data. The current turning movements can be seen in Figure 6.

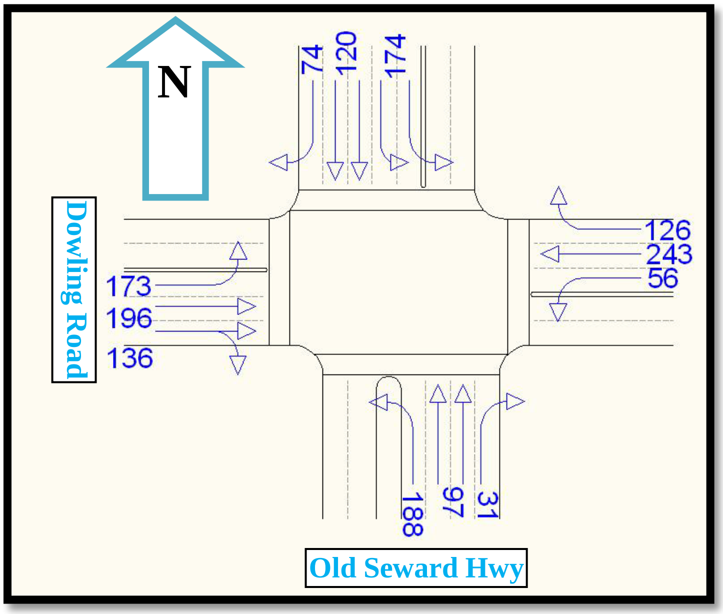

Figure 6 Current Intersection Turning Movements

After calculating the intersection movements the phasing and LOS analysis were completed. The phasing plan that resulted in the most efficient green time can be seen in Appendix C-2 section 1.1. The LOS was completed using HCS2000 and the results are summarized in Table 1.

Table 1 Current LOS

Delay (sec/veh)	Cycle Length (sec)	LOS
19.7	55.5	B

4.2 Pedestrian Travel

The WDR corridor currently provides very limited pedestrian travel due to the inadequate pathways throughout the corridor. Refer to section 2.4.1 for a more detailed description of the existing pedestrian facilities.

5.0 2030 PROJECTED TRAFFIC VOLUMES

5.1 Traffic Volume Development Methodology

The 2030 AADT volumes were obtained from ADOT for the intersections and roadways under consideration. The peak hourly volumes were reported to be approximately 10.5% of the projected AADT. Using the turning percentages given by the ADOT, turning movements were determined for 2030.

5.2 Design Hour Turning Movements

5.2.1 West Dowling Road

The turning movements were determined using supplied data from the ADOT for the intersections under consideration. The 2030 AADT volumes along with the percent through, left and right traffic were used to determine the intersection movements for the design year. These peak hourly volumes (PHV) can be seen in Figure 7 for the Old Seward/WDR and C Street/WDR intersections.

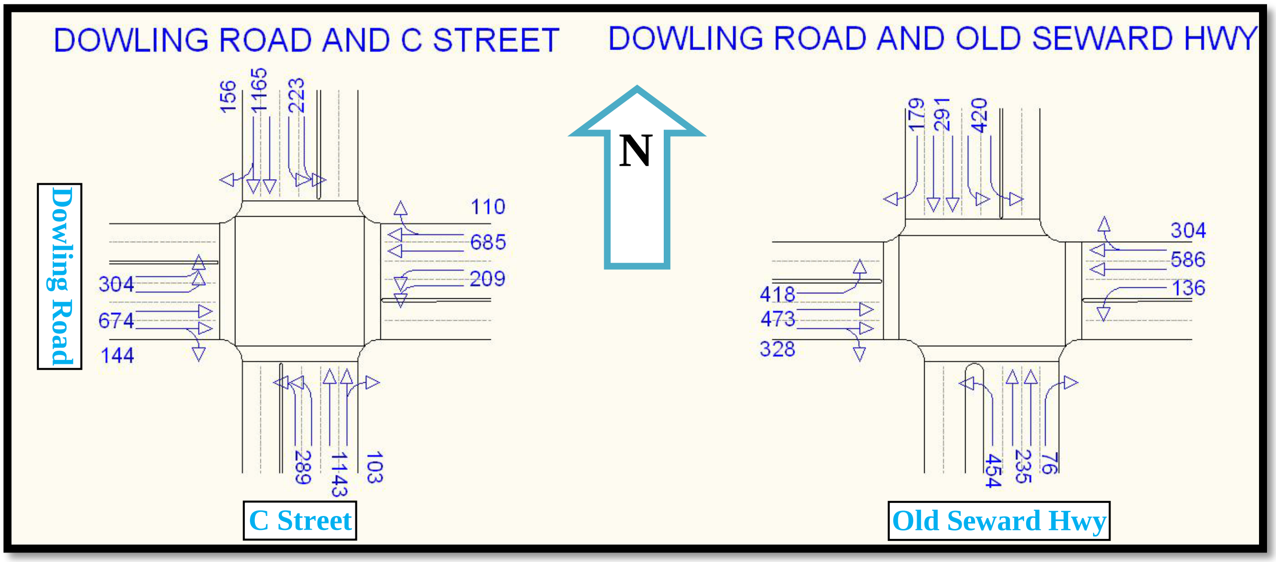

Figure 7 Intersection PHV Turning Movements

The PHV in Figure 4 are shown for the through, left, and right turning movements for the major intersections to be considered in the LOS analysis.

6.0 CAPACITY ANALYSIS

6.1 Signal Warrant Analysis

Further research and data will be necessary to determine warrants. Based on recommendations and existing conditions a signalization plan was created. The warrants to verify these assumed signalized areas will require further investigation prior to construction.

6.2 Intersection Level of Service

The LOS required for the design year must meet minimum requirements set by the ADOT. The minimum LOS is a D for the design year of 2030 based on the ADOT requirements. This will allow for an acceptable amount of delay during PHV at the design year. The data compiled and calculated from the AADT and intersection geometry was inputted into the HCS2000 to determine the LOS based on the variables encountered and projected in the field.

6.2.1 West Dowling Road and Old Seward Intersection

At this intersection the geometry is a major concern due to the limited amount of ROW available. The intersection geometry and phasing for each of the Alternatives can be found in Appendix C-2. Table 2 summarizes the results of each Alternative.

Table 2 LOS for Dowling Road and Old Seward Highway

Design Year: 2030			
Alternative	Delay (sec/veh)	Cycle Length (sec)	LOS
1	85	171.7	F
2	53.9	69	D
3	33.9	63	C

After analyzing the three different choices, Alternative 3 was the chosen. Alternative 3 was similar in geometry to Alternatives 1 and 2 except for the addition of a second left exclusive northbound lane. Currently there is an enlarged median at this approach, so adding an extra lane will only require reconstructing the median. Due to this fact, no extra ROW will need to be acquired on the approach. In addition, by adding the extra lane both the northbound and southbound approaches will have similar geometry, which is recommended by our mentor, Professor Osama Abaza. Since Alternative 3 will not require extra ROW on either side of the roadway, decreases delay and improve LOS, this was chosen as the preferred Alternative. The intersection geometry can be seen in Figure 8.

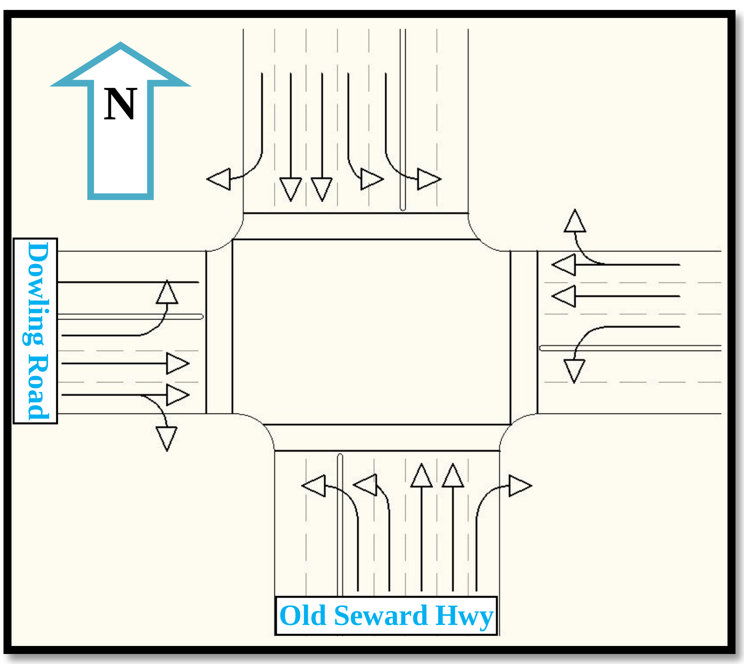

Figure 8 Selected Alternative Geometry at Dowling Road and Old Seward Highway

6.2.2 West Dowling Road and Potter Drive Intersection

At this intersection projected through traffic using Potter Drive will diminish due to access of C Street through the WDR extension. Based on the projected traffic volumes and available ROW, there will be modifications done to the intersection. One modification will be to realign Potter Drive to intersect WDR at an approximate right angle. By creating a right angle intersection traffic visibility and right turn speeds will increase. Also, Potter Drive will be stop sign controlled entering WDR. The main reason this intersection can be stop sign controlled is that traffic turning onto WDR from Potter Drive will not have left turn access. The reason for the restriction is that many small side streets and driveways connect to WDR throughout the corridor. If all these streets were allowed left turn access into a shared lane, the safety of the drivers would be at a much higher risk. To avoid this safety issue the median running through the corridor will have limited access points. Although vehicles will not be able to turn left onto WDR, one of the access points will allow drivers to turn left off of WDR onto Potter via a turn pocket in the median.

6.2.3 West Dowling Road and C Street Intersection

For this intersection, two different Alternatives were analyzed in order to determine which geometry and phasing would best suit the traffic patterns. One major concern with this intersection was the large number of through traffic. The intersection geometry and phasing for each of the Alternatives can be found in appendix C-2. Table 3 summarizes the results of each of the Alternatives.

Table 3 LOS for Dowling Road and C Street

Dowling Road and C Street			
Design Year: 2030			
Alternative	**Delay (sec/veh)**	**Cycle Length (sec)**	**LOS**
1	79.6	67	E
2	34.3	57	C

Since the two Alternatives required the same ROW and Alternative 2 resulted in much higher LOS and less delay, it was chosen without hesitation. The main difference between the two Alternatives is the assignment of the lanes. For Alternative 1 there are exclusive right turn lanes and only one left turn lane, while Alternative 2 uses shared right turn lanes and two left turn lanes. This change significantly decreases delay and results in a higher LOS. Figure 9 shows the intersection geometry for the selected Alternative. One issue that will need to be considered is reconstruction of C-Street to accommodate for the new intersection. The paths and current median may need to be altered to expand the roadway for the new geometry. Since the ROW at this area is not a limiting factor the purposed geometry should not encounter any constraint issues.

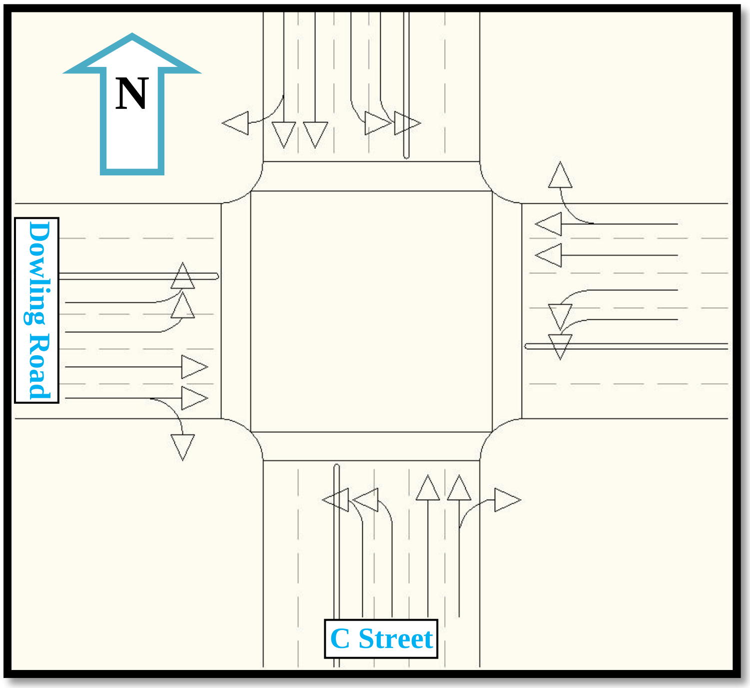

Figure 9 Selected Alternative Geometry at Dowling Road and C-Street

6.2.4 Potter Drive and C-Street Intersection

At this intersection it is recommended that the light remain in place for future use. If 54th Ave was to be extended and connect to Old Seward Highway at the east and merged with Potter at the west, then Potter Drive could become another east-west corridor between C-Street and Old Seward Highway, as shown in Figure 10. The signal light must be semi-actuated to allow for the primary flow of traffic on C-Street to have priority at this intersection. The future traffic increases also suggest that the light remain in place for coordination purposes. A major issue faced in the future will be creating a coordination plan for the heavy through traffic on C-Street and this light may help at the intersection.

Figure 10 Proposed future 54th Avenue Extension

6.3 Other Capacity Considerations

The following recommendations are made based on the realignment of the WDR corridor, the proposed median throughout the project length and the projected traffic volumes.

6.3.1 West Dowling Road and Austin Avenue Intersection

At this intersection a similar approach will be taken to that of the Potter Drive and WDR intersection. Austin Avenue will be stop sign controlled entering WDR. Austin Avenue is already aligned at a right angle with WDR so the next revision will be restricting left turn access. This will be done similarly to Potter Drive with the use of the median and signage. Also a turn pocket will allow the WDR traffic to make left turns onto Austin Avenue. Figure 11 shows the traffic control arrangement at Austin Avenue.

Figure 11 Access plan at Austin Avenue

6.3.2 Franklin Drive

Once Potter Drive is realigned with respect to WDR, the Franklin Drive intersection with Potter Drive is recommended to be removed in order to minimize conflicts at the Potter Driver and WDR intersection. At the existing intersection Franklin Drive will need to be terminated from Potter Drive and reconstructed as a cul-de-sac. Closing Franklin Drive should be appealing to current residents since through traffic will be eliminated, creating a safer neighborhood for pedestrians. The threat from theft will also be reduced since easy access in and out of the neighborhood will be significantly reduced.

6.4 C-Street Progression Analysis

Based on the projected AADT for 2030 traffic flowing north and south on C-Street was projected to be of substantial volume. Due to this large volume, an analysis of the progress of traffic flowing north and south must be considered. To maintain an even flow progression, signalization must be optimized and coordinated through each intersection in order to carry the traffic flow as one platoon through the C-Street corridor.

7.0 INTELLIGENT TRANSPORTATION SYSTEMS

Traffic congestion dramatically reduces efficiency of transportation infrastructure and increases travel time, air pollution, and fuel consumption, intelligent transportation systems (ITS) will be implemented along the WDR corridor. To reduce congestion and increase safety on the WDR corridor, ITS will be utilized by adding variable message signs, utilizing cellular phones as anonymous traffic probes, and cameras for automatic license-plate and speed recognition. ITS can also play a helpful role in the rapid mass-evacuation of people after catastrophic events such as a large earthquake.

7.1 Variable Message Signs

Variable message signs (VMS) will be placed on the signal masts above each turning approach entering WDR at Old Seward Highway and C-Street intersections for a total of 6 locations. VMS will serve two common functions: to automatically display warnings conveying traffic congestion levels on WDR and display emergency messages during scenarios involving evacuations or traffic accidents. For an example of typical VMS placement per intersection, see Figure 12.

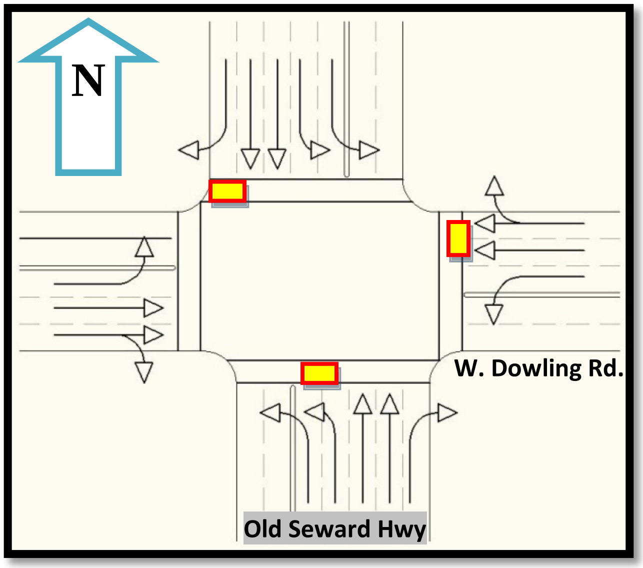

Figure 12 Example of Variable Message Sign Locations (Dowling and Old Seward Intersection)

In the case of high congestion levels on WDR, the VMS will receive wireless communications and display the appropriate messages to reroute users to a predetermined location with historically lower levels of congestion than WDR. In the case of a traffic accident, the VMS will be updated from the municipal central control room and display a message rerouting users to a predetermined Alternative route. If a catastrophe has occurred in the area, the VMS can be updated from the traffic control center to display messages instructing users towards safety zones or helpful destinations/phone numbers to receive assistance. Examples of a catastrophe could include an earthquake, uncontained fire sweeping through the area, a chemical spill, etc.

7.2 Video Vehicle Detection

Video cameras will be installed to automatically track traffic flow measurements and detect traffic incidents at the signalized intersections on WDR. The video detection system will record data regarding lane-by-lane vehicle speeds, counts, and lane occupancy readings. These readings will wirelessly trigger the appropriate messages to be displayed on the variable message signs, rerouting potential users. Video vehicle detection is an attractive ITS option because it is a "non-intrusive" method of traffic detection and does not involve installing any components directly into the road surface or roadbed

Video detection systems use automatic plate number recognition to identify vehicles and will provide these numbers to traffic enforcement to identify vehicles disobeying the posted speed limit. The system will automatically ticket offenders based on their license plate number, resulting in a traffic ticket sent by mail to the offender’s mailing address. The video detection cameras will be mounted on the signal masts at Old Seward Hwy and C-Street per approach, for a total of 8 cameras.

7.3 Floating Cellular Data

Since the majority of vehicles in the Anchorage traffic network contain one or more mobile phones, vehicle locations and corridor volumes can be easily tracked, while minimizing cost and impact on the WDR traffic operations. Even when no voice connection is established by the user, the locations of vehicles can be tracked as anonymous traffic probes. Using an anonymous format, these locations can be triangulated and converted to traffic flow information used by the variable message signs. As congestion increases, the quantity of phones increases, thus creating more probes for use in future data analysis.

This method of data collection requires no additional infrastructure and uses solely the mobile phone network to collect data and send it to the municipal traffic control headquarters and variable message signs. Floating cellular data will be used to collect data along the entire corridor, as opposed to the limitation of intersections as provided by video detection systems. Costs and traffic disturbances are also minimized by avoiding installation and maintenance of detectors along the corridor. Floating cellular data is never affected by heavy rain and works in all weather conditions.

8.0 SAFETY ANALYSIS

Crash data was compiled for a 10-year period starting in 1997 and ending in 2006. The compiled data takes into account all reported accidents on Potter Drive and WDR between their intersections with C-Street and the Old Seward Highway. The data was broken down and a safety analysis was completed for any possible design problems of the old road that could be taken into account when designing the new. Results can be seen in Table 4 and are summarized as follows:

- Six bicycle crashes and no pedestrian crashes were reported during the study period.
- One fatal crash occurred in this corridor during the study period but was caused by unsafe driving.
- One moose and one other animal crash occurred during the study period.

Table 4 Fatal Bicycle and Wildlife Crashes

Year	Fatal	Bicycle	Moose	Animal	Total For Year
1997	-	1	1	-	2
1998	-	1	-	1	2
1999	-	-	-	-	0
2000	-	2	-	-	2
2001	-	-	-	-	0
2002	-	-	-	-	0
2003	1	-	-	-	1
2004	-	2	-	-	2
2005	-	-	-	-	0
2006	-	-	-	-	0

8.1 Intersection Crash Analysis

Ten years of crash data was compiled for all of the main intersections on WDR and Potter Drive between the Old Seward Highway and C-Street. The data was compiled into specific categories to see if any particular area of concern could be seen on the excising road. A large percent of crashes that occurred at every main intersection was related to left hand turns. The remaining crashes consisted of rear end collisions of which most where caused during icy conditions. The Intersection Crash Data table can be found in Appendix C-4, Table 1.

The average crash rate per million entering vehicles (MEV) was calculated for the two main intersections at Old Seward Highway and WDR and C-Street and Potter Drive. The average crash rate per MEV for the Old Seward Highway and C-Street was found to be 0.975 and 1.055, respectively. These two values were well below the average crash rate per MEV for the State of Alaska with a value of 1.86 for similar intersections. The Intersection Crash Rate data can be found in Appendix C-4, Table 2.

8.2 Segment Crash Analysis

The amount of crashes on each segment was split between rear-end collisions and angled collisions. Most rear end collisions were due to either icy conditions or driver error, while most angled collisions were due to left turns. Angled crashes will hopefully be mitigated by the placement of a center raised divider which will only allow for right-hand turns. Other pedestrian/bicycle accidents will also hoped to be mitigated by the construction of new sidewalks and an underpass at the Campbell Creek Bridge. The Road Segment Crash data can be found in Appendix C-4, Table 3.

8.3 Crash Analysis Conclusions

Overall the amount of crashes on Potter and WDR between C-Street and Old Seward Highway are below the average crash rate for the State of Alaska on similar roadways and intersections. The new design of WDR with curb and gutter, raised medians, higher access control, and additional pedestrian bike trails may help lower future collisions.

9.0 SOURCES

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DOT. (2005). *Alaska Highway Preconstruction Manual.* Anchorage: DOT.

Garber, N. J., & Hoel, L. A. (2008). *Traffic & Highway Engineering.* Pacific Grove: CL-Engineering.

United States Department of Transportation, Federal Highway Adminstration. (2003). *Manual on Uniform Traffic Control Devices.*

Monahan, Torin. 2007. "War Rooms" of the Street: Surveillance Practices in Transportation Control Centers. *The Communication Review* 10 (4): 367-389

Appendix C-1

Design Criteria

TABLE OF CONTENTS

LIST OF ACRONYMS

AADT .... annual average daily traffic
AASHTO .... American Association of State Highway and Transportation Officials
ACMP .... Alaska Coastal Management Plan
ADA .... Americans with Disabilities Act
ADF&G .... State of Alaska Department of Fish and Game
AWMP .... Anchorage Wetlands Management Plan Maps
AWWU .... Anchorage Water and Wastewater Utility
CEA .... Chugach Electric Association, Inc.
DCM .... Design Criteria Manual
DEC .... State of Alaska Department of Environmental Conservation
DHV .... design hourly volume
DOT&PF .... State of Alaska Department of Transportation and Public Facilities
DSR .... Design Study Report
EA .... Environmental Assessment
H&H .... Hydrologic and Hydraulic
HLB .... Heritage Land Bank
HPM .... Highway Preconstruction Manual
HTNA .... Highway Traffic Noise Study
LOS .... level-of-service
LRTP .... Long range Transportation Plan
LUST .... leaking underground storage tank
MEV .... million entering vehicles
MOA .... Municipality of Anchorage
mph .... miles per hour
MSE .... mechanically stabilized earth
MVM .... million vehicle miles
N/A .... not applicable
NWI .... National Wetlands Inventory
OSHP .... Official Streets and Highway Plan
PCM .... Preconstruction Manual
PDO .... Property Damage Only
PER .... Preliminary Engineering Report
PIH .... Plans-In-Hand
ROW .... right-of-way
TAG .... Technical Advisory Group
USACE .... United States Army Corps of Engineers
USC .... under separate cover
USFWS .... United States Fish and Wildlife Service
WDR .... West Dowling Road

1.0 DESIGN CRITERIA TABLE

The following table is information and criteria, provided by the DOT. The recommended design solutions must adhere to the criteria specifications.

West Dowling Road Phase I – Old Seward Highway to C Street

ELEMENT	CRITERIA	SOURCE/COMMENTS
Functional Classification	Minor Arterial	2005-2007 Central Region Annual Traffic Report (DOT&PF)
Number of Lanes/Roadways	5	DOT&PF
Terrain	Rolling	AASHTO 2001 (page 235)
Design Year	2030	Design Designations (DOT&PF)
Existing Year AADT (2007) Old Seward Hwy. to Potter Dr.	9,257	Design Designations (DOT&PF)
Construction Year AADT (2010) Old Seward Hwy. to Potter Dr.	15,000	Design Designations (DOT&PF)
Mid-Life Year AADT (2020) Old Seward Hwy. to C St.	19,015	Design Designations (DOT&PF)
Design Year AADT (2030) Old Seward Hwy. to C St.	24,104	Design Designations (DOT&PF)
Design Hourly Volume (DHV) /Directional Split	10.5% of AADT /TBD	Design Designations (DOT&PF)
Trucks (%T)	8.0%	Design Designations (DOT&PF)
30-Year Design ESAL (2040) Old Seward Hwy. to C St.	TBD	DOT&PF
Pavement Design Year	TBD	DOT&PF
Design Vehicle	WB-50	AASHTO
Posted Speed (existing)	35 mph- 45 mph	
Posted Speed (proposed)	45 mph	DOT&PF
Design Speed	45 mph	AASHTO 2001 (page 67)
Stopping Sight Distance	360 feet	HPM, AASHTO 2001 (page 449)
Passing Sight Distance	1,625 feet	HPM, AASHTO 2001 (page 449)
Maximum Grade Minimum Grade	6.0% 0.5%	HPM, AASHTO 2001 (page 450)
Maximum Rate of Super-elevation	6%	HPM, AASHTO 2001 (page 141)
Minimum Radius of Curvature (e = 4) (e = 6)	730 feet 660 feet	HPM, AASHTO 2001 (page 145)
Minimum Length of Curvature ($L_{c\ min}$ = 15V)	675 feet	HPM, AASHTO 2001 (page 233-234)
Desirable Radius of Curvature (normal crown)	6,000 feet	AASHTO 2001 (page 157)
Minimum K-Value for Vertical Curves (crest/sag)	61/79	AASHTO 2001 (page 274 and 280)
Minimum Taper Ratio	15:1	AASHTO 2001 (page 719)
Minimum Left-Turn Lane Storage Length	25 feet per vehicle based on DHV (100' minimum)	HPM (page 1150-2)
Minimum Shoulder Width Old Seward Hwy. to C St.	Urban Section/2 feet	AASHTO 2001 (page 318)
Minimum Lane Width Old Seward Hwy. to C St.	12 feet	HPM, AASHTO 2001 (page 315)
Surfacing, Lanes	AC Pavement	DOT&PF
Side Slope Ratios (min)	4:1 or flatter (fills) 3:1 or flatter (cut)	HPM, AASHTO 2001 (page 331)
Clear Zone	24 feet (fill) 14 feet (cut)	HPM (page 1130-6)
Median Treatment		Assumed

ELEMENT	CRITERIA	SOURCE/COMMENTS
Old Seward Hwy. to C St.	Median/Left turn lane	
Curb and Gutter Old Seward Hwy. to C St.	 Barrier	Assumed
Access Control Old Seward Hwy. to C St.	 No	Assumed
Curb Return Radii -Arterial intersecting an arterial	 40 feet	HPM
Pedestrian Provisions - Sidewalk Width - Multi-use Trail - Maximum Cross Slope - Minimum Vertical Clearance - Minimum Curb Ramp Landing Width	 5.0 feet min. 8.0 feet min. 2% 8.0 feet 5.0 feet	ADAAG
Roadway Cross Slope	2% typical, 1.5% minimum	HPM (page 1130-13), AASHTO 2001 (page 450)
Roadway Vertical Clearance	16.5 feet	HPM (page 1130-5)
Driveways - Minimum Return Radii - Minimum Spacing - Minimum Corner Distance - Minimum Sight Distance - Maximum Landing Slope	 20 feet 75 feet 60 to 70 feet 360 feet +/- 2%	HPM (page 1190-9, 1190-10, 1190-11, 1190-14)

Appendix C-2

Traffic Phasing

TABLE OF CONTENTS

LIST OF FIGURES

1.0 TRAFFIC PHASING

1.1 Dowling Road/Old Seward Highway Current Situation

The traffic phasing for the current intersection was determined based on turning movements. Using a split traffic phase allowed for the most efficient use of time.

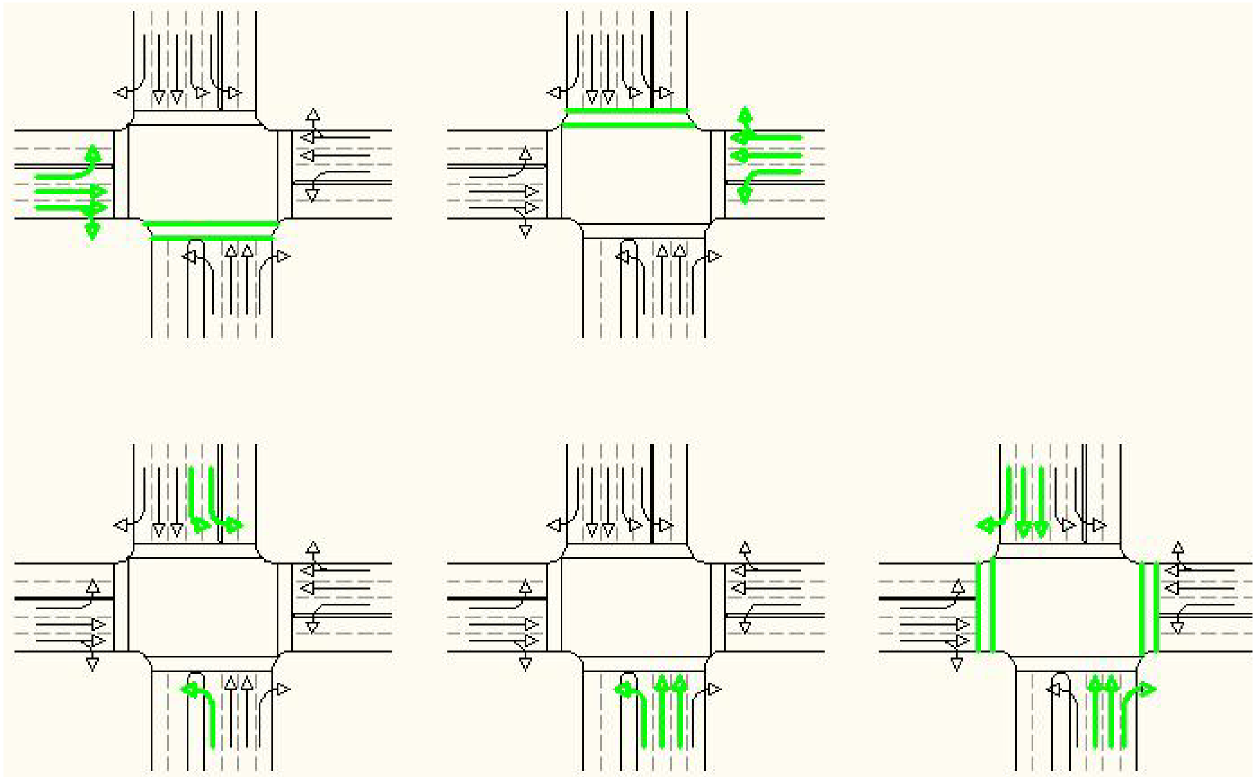


Figure 1 Optimized phasing for Current Dowling Road/Old Seward Highway intersection.

1.2 Dowling Road/Old Seward Highway Alternative 1

Alternative 1 uses split phasing to optimize cycle length. By first allowing the left-turn lanes to move and then allowing the through, right and left lanes to move in the controlling direction, cycle length could be optimized. Figure 2shows the split phasing for alternative 1.

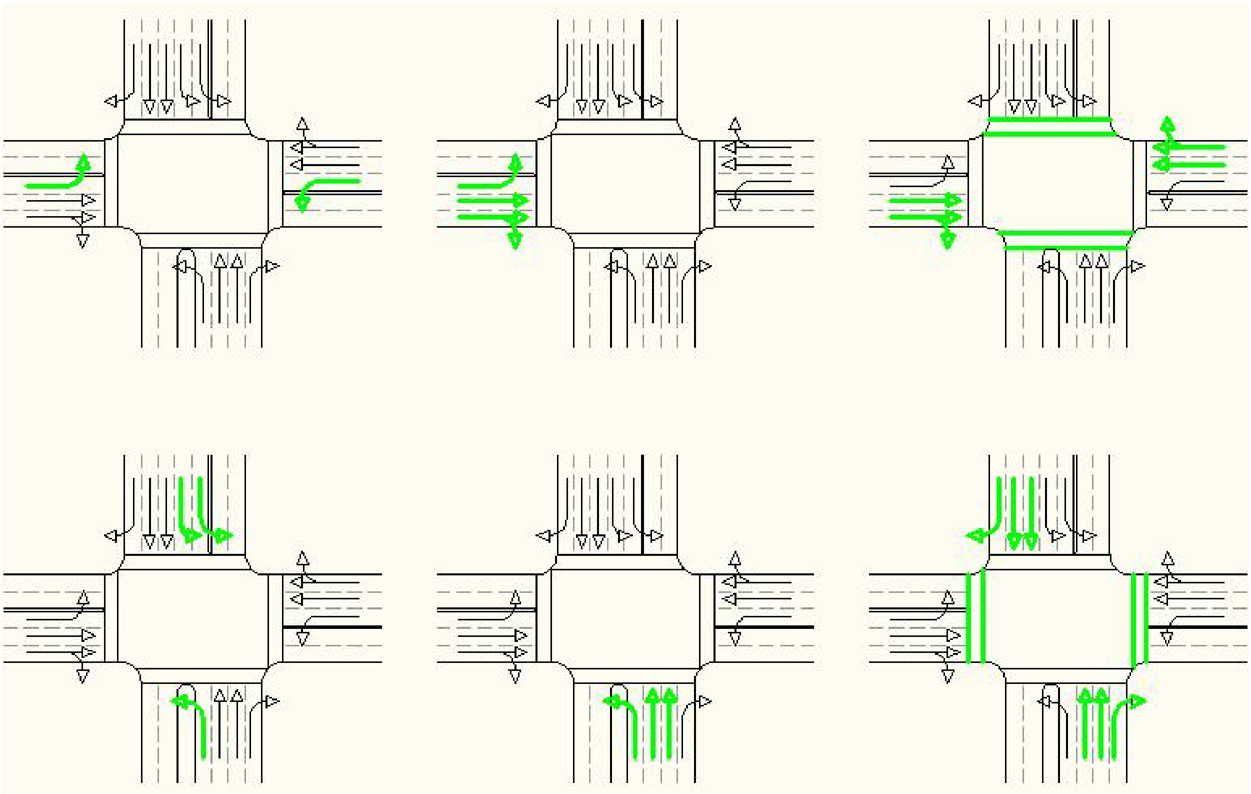


Figure 2 Alternative 1 split phasing for Dowling Road/Old Seward Highway intersection.

1.3 Dowling Road/Old Seward Highway Alternative 2

Alternative 2 uses a combination of normal and split phasing to achieve a more efficient cycle length than alternative 1. By first allowing the through, right and left lanes for the eastbound and westbound traffic to move the cycle length was decreased substantially. Figure 3shows the Dowling Road and Old Seward Highway phasing for alternative 2. Note that the decrease in cycle length was achieved without changing the actual intersection geometry.

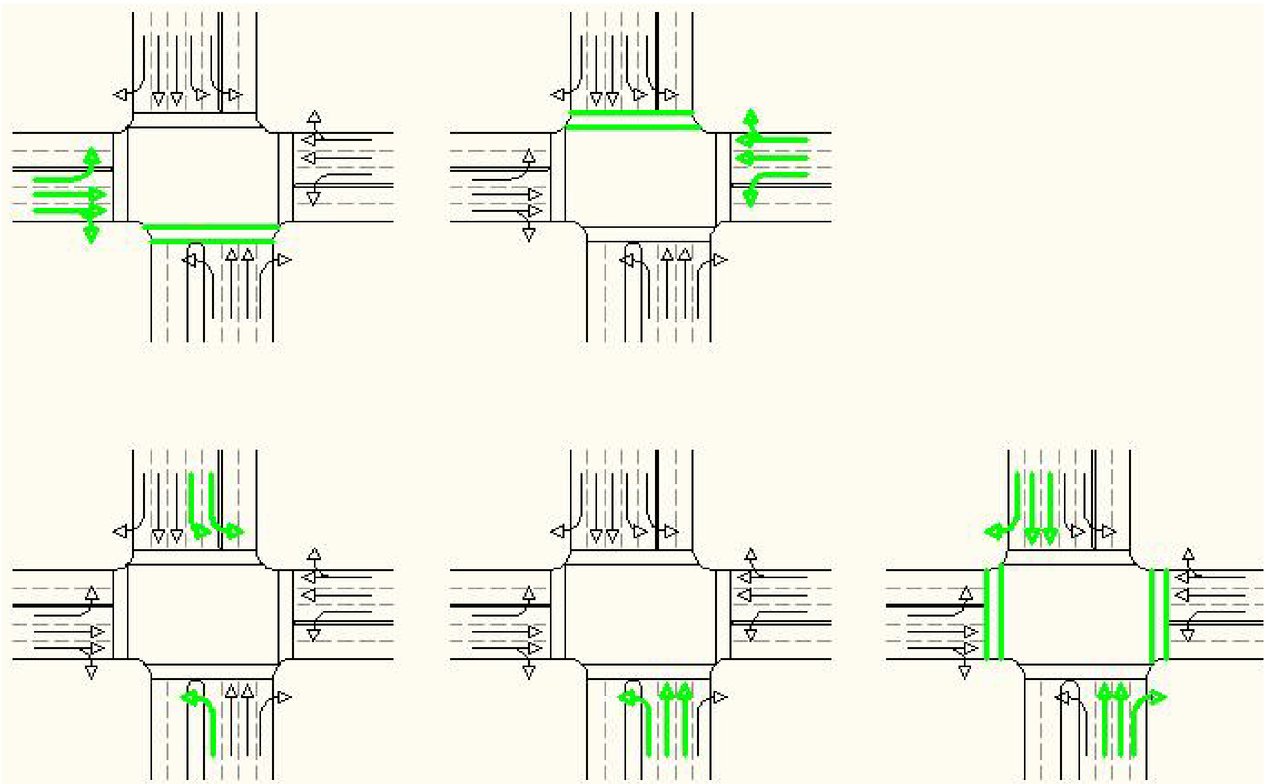


Figure 3 Alternative 2 phasing for Dowling Road/Old Seward Highway intersection.

1.4 Dowling Road/Old Seward Highway Alternative 3

The geometry for this alternative is altered slightly from that of the other alternatives. An addition of a northbound left-turn lane is done in order to relieve congestion. This alters the green time demanded for the turning movements and results in a much shorter and more efficient cycle length. In addition, the added turn lane allows for a more even flow of traffic which results in fewer phases for the cycle.

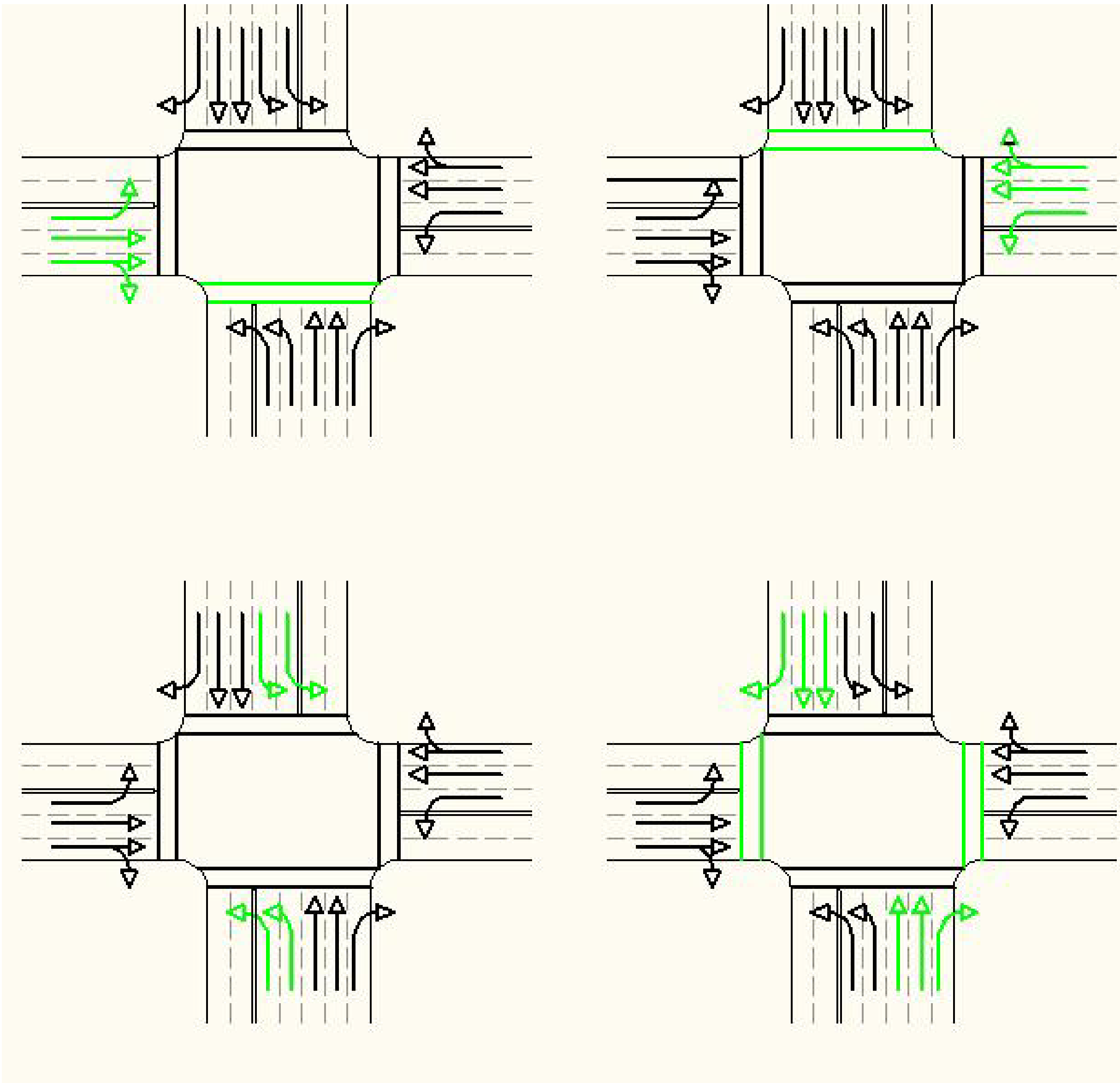


Figure 4 Alternative 3 phasing for Dowling Road/Old Seward Highway intersection.

1.5 Dowling Road/C Street Alternative 1

Currently there is no intersection for C Street and Dowling road, which makes the projected values for the design year theoretical compared to those at an existing intersection. These volumes, in all probability, will have a higher chance of error than volumes based on existing intersections.

Alternative 1 uses split phasing to achieve an acceptable cycle length. By first allowing the left-turn lanes to move and then allowing the through, right and left lanes to move in the controlling direction, cycle length could be optimized. Figure 3 shows the split phasing for alternative 1.

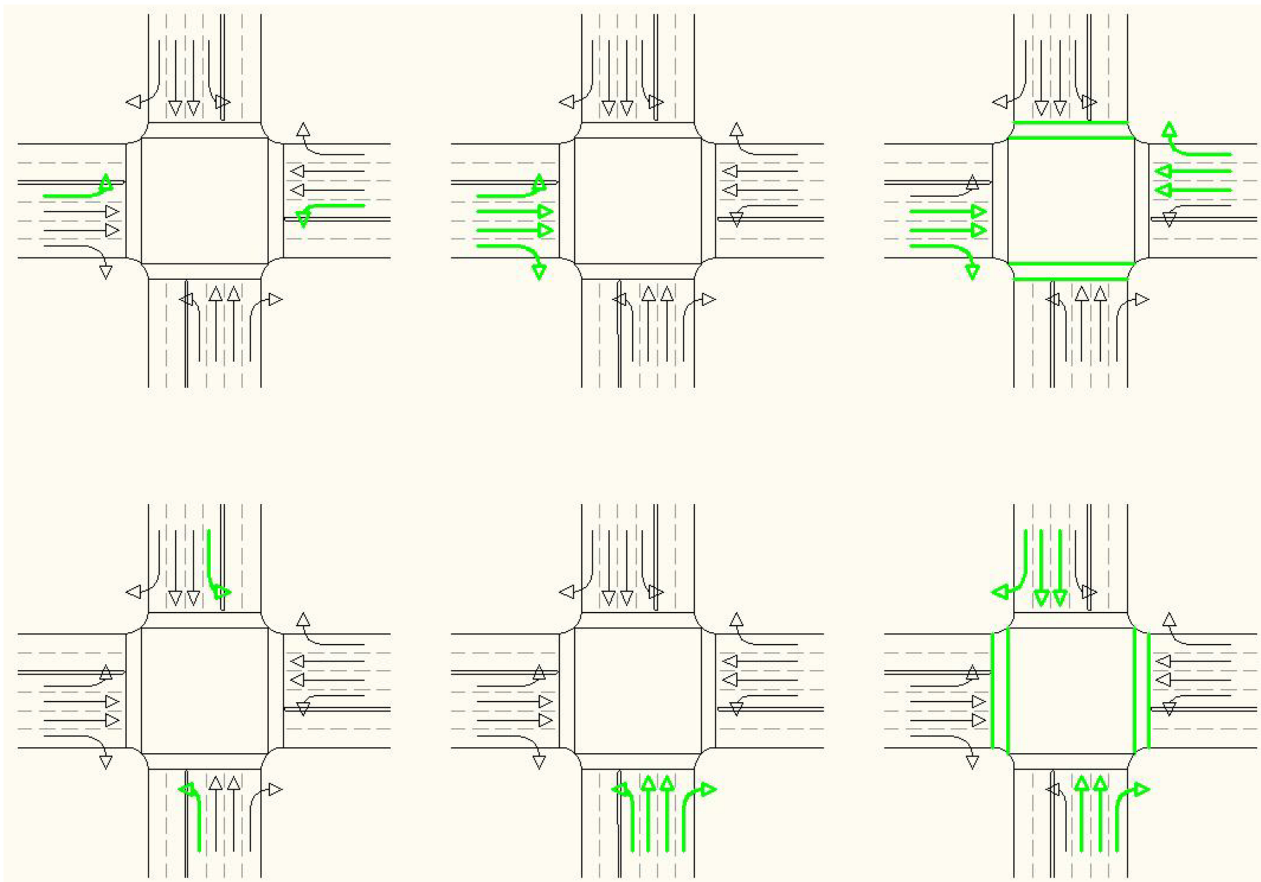


Figure 5 Alternative 1 phasing for Dowling Road/C Street intersection.

1.6 Dowling Road/C Street Alternative 2

Alternative 2 uses split phasing to identical to alternative 1. By first allowing the left-turn lanes to move and then allowing the through, right and left lanes to move in the controlling direction, cycle length could be optimized. The difference in the two options is the lane geometry. Alternative 1 has an exclusive right lane and only one left turn lane in all directions. Alternative 2, on the other hand, has a shared right lane and two left-turn lanes in all directions. This change allows for a more efficient distribution of cycle time and allow for the overall cycle length to be considerable smaller. Note that even though the lane uses are different, both alternatives require four lanes in each direction. Figure 4 shows the split phasing for alternative 2.

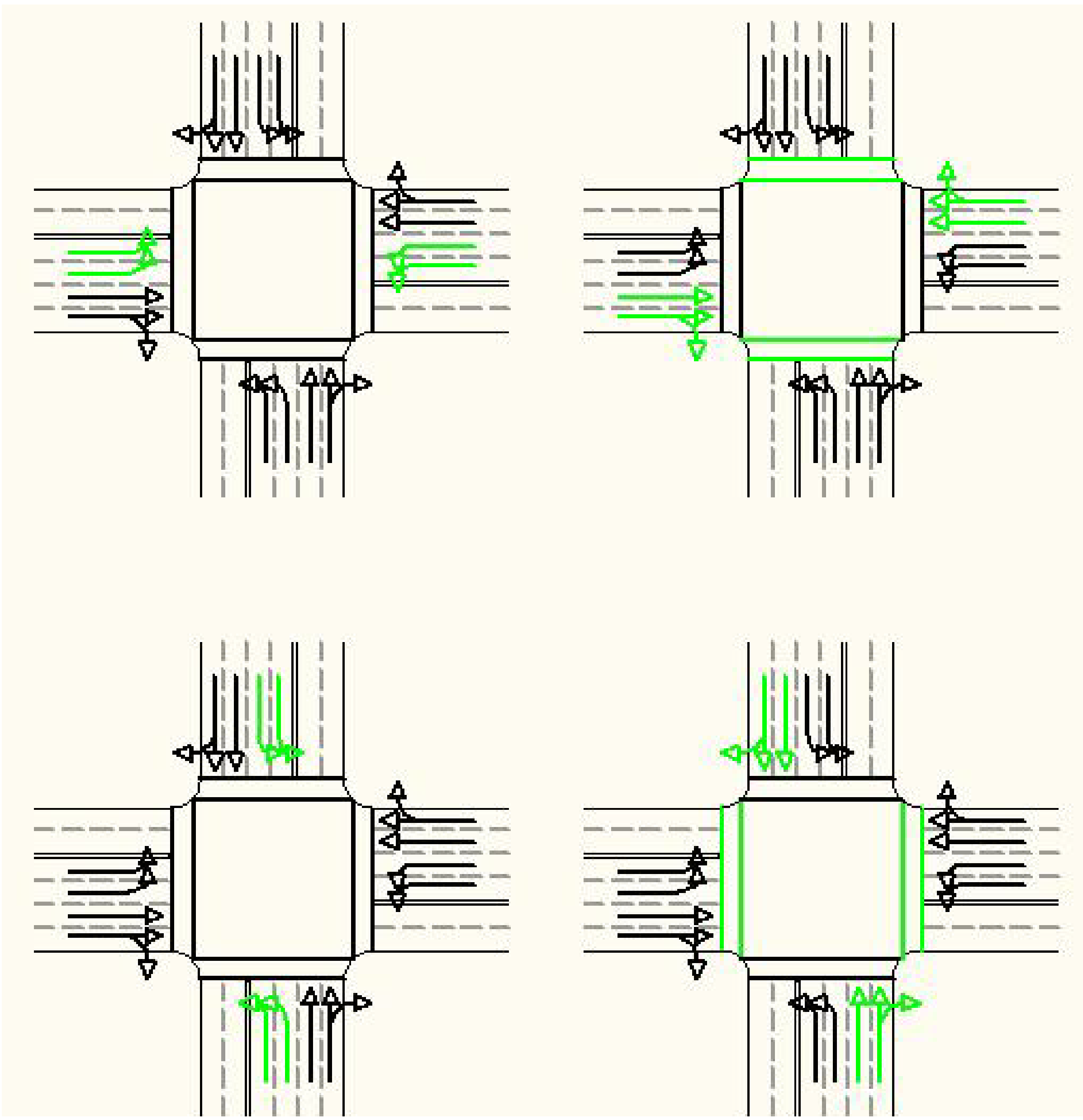


Figure 6 Alternative 2 phasing for Dowling Road/C Street intersection.

Appendix C-3

Level of Service

TABLE OF CONTENTS

1.0 LEVEL OF SERVICE ANALYSIS

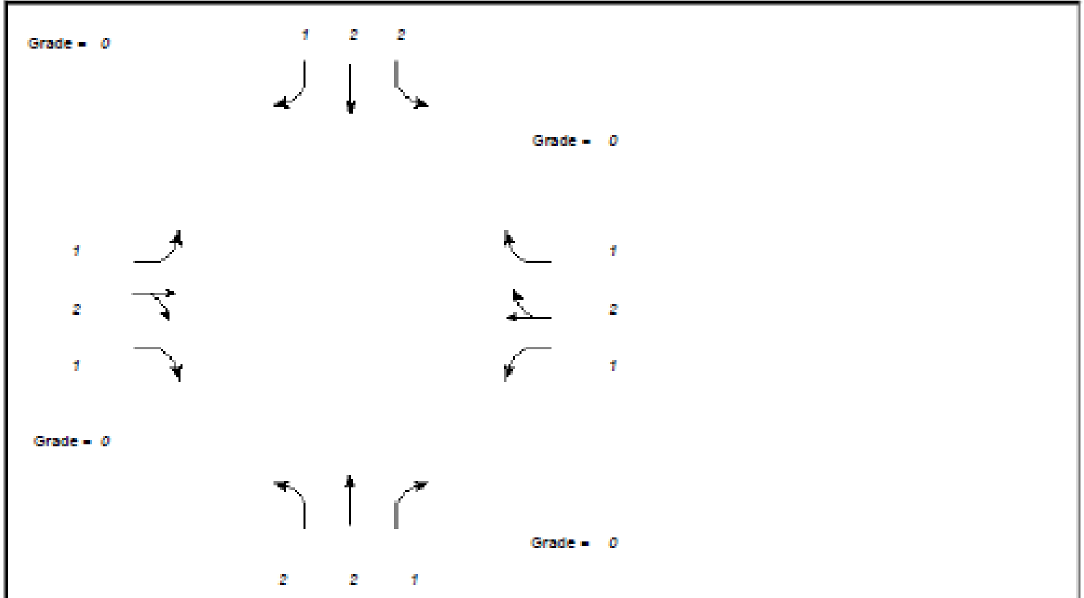
The data compiled and calculated from the AADT and intersection geometry was inputted to the High Capacity Software 2000 (HCS2000) in order to determine the LOS based on the variables encountered and projected in the field. For each alternative, a graphic and tabular representation of the data was produced from the HCS2000 program.

1.1 Dowling Road/Old Seward Highway Current

INPUT WORKSHEET

General Information		Site Information	
Analyst	*Mahear Abou Eid*	Intersection	*Dowling Road and Old Seward Hw*
Agency or Co.		Area Type	*All other areas*
Date Performed	*3/10/2009*	Jurisdiction	
Time Period		Analysis Year	

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*418*	*473*	*328*	*136*	*586*	*304*	*454*	*235*	*76*	*420*	*291*	*179*
% Heavy veh	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*
PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Actuated (P/A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*
Startup lost time	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*
Ext. eff. green	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*
Arrival type	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Ped volume		*0*			*0*			*0*			*0*	
Bicycle volume		*0*			*0*			*0*			*0*	
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Ped timing		*0.0*			*0.0*			*3.0*			*0.0*	

	EB Only	WB Only	03	04	Excl. Left	Thru & RT	07	08
Timing	G = *18.5*	G = *16.0*	G =	G =	G = *12.0*	G = *9.5*	G =	G =
	Y = *1.0*	Y = *1.0*	Y =	Y =	Y = *1.0*	Y = *1.0*	Y =	Y =
Duration of Analysis (hrs) = *0.25*					Cycle Length C = *63.0*			

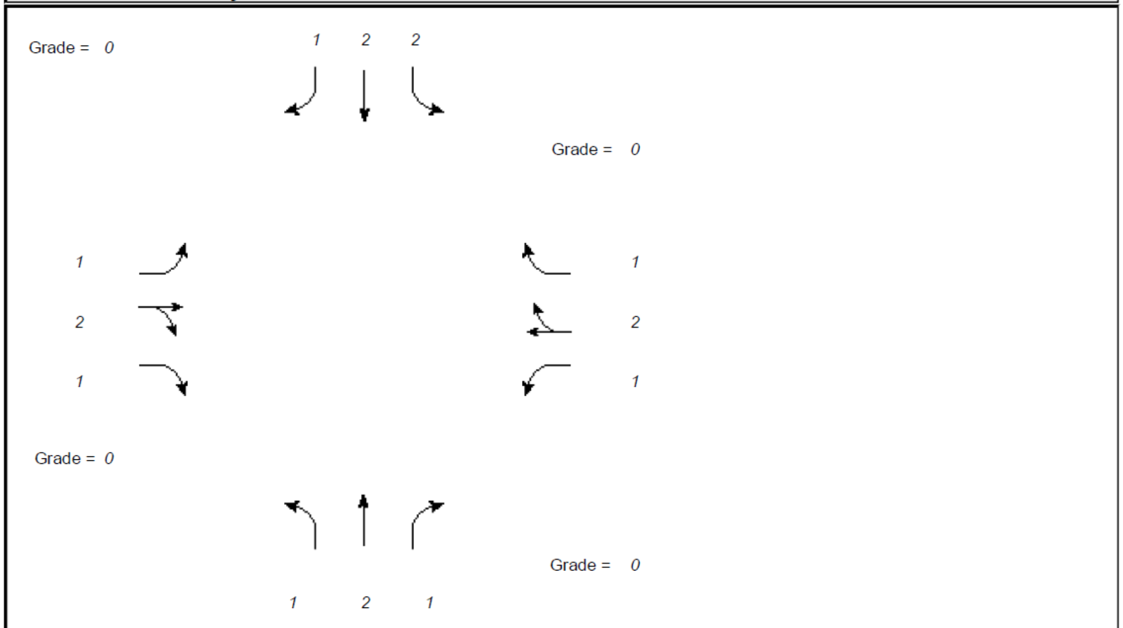
```
               HCS2000: Signalized Intersections Release 4.1

Analyst: Mahear Abou Eid                Inter.: Dowling Road and Old Seward Hw
Agency:                                 Area Type: All other areas
Date:    3/10/2009                      Jurisd:
Period:                                 Year   :
Project ID: Alternative 3 (STANDARD-SPLIT PHASE)
E/W St: Dowling Road                    N/S St: Old Seward Hwy

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound     |   Westbound     |   Northbound    |   Southbound    |
           |  L    T    R   |  L    T    R    |  L    T    R    |  L    T    R    |
           |                |                 |                 |                 |
No. Lanes  |   1    2    1  |   1    2    1   |   2    2    1   |   2    2    1   |
LGConfig   |   L   TR    R  |   L   TR    R   |   L    T    R   |   L    T    R   |
Volume     |418  473  328   |136  586  304    |454  235  76     |420  291  179    |
Lane Width |12.0 12.0 12.0  |12.0 12.0 12.0   |12.0 12.0 12.0   |12.0 12.0 12.0   |
RTOR Vol   |           66   |           61    |           36    |           15    |

_______________________________________________________________________________
Duration     0.25       Area Type: All other areas
____________________________________Signal Operations__________________________
Phase Combination 1     2     3     4 |        5     6     7     8
EB  Left          P                   | NB  Left   P
    Thru          P                   |     Thru         P
    Right         P                   |     Right        P
    Peds          X                   |     Peds         X
WB  Left                P             | SB  Left   P
    Thru                P             |     Thru         P
    Right               P             |     Right        P
    Peds                X             |     Peds         X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            18.5  16.0                       12.0  9.5
Yellow           1.0   1.0                        1.0   1.0
All Red          1.0   1.0                        0.0   1.0
                                                   Cycle Length: 63.0     secs
____________________Intersection Performance Summary___________________________
Appr/   Lane        Adj Sat     Ratios        Lane Group    Approach
Lane    Group       Flow Rate   __________    __________    __________
Grp     Capacity      (s)       v/c    g/C    Delay LOS     Delay LOS
_______________________________________________________________________________
Eastbound
L        491        1671        0.95   0.29   50.8   D
TR       958        3263        0.65   0.29   22.9   C      32.7   C
R        439        1495        0.44   0.29   21.2   C
Westbound
L        424        1671        0.36   0.25   21.6   C
TR       830        3270        0.92   0.25   39.6   D      34.6   C
R        380        1495        0.42   0.25   23.0   C
Northbound
L        618        3242        0.82   0.19   35.8   D
T        504        3343        0.52   0.15   28.4   C      32.8   C
R        225        1495        0.20   0.15   25.3   C
Southbound
L        618        3242        0.76   0.19   32.5   C
T        504        3343        0.64   0.15   31.3   C      35.7   D
R        225        1495        0.81   0.15   51.9   D
         Intersection Delay = 33.9   (sec/veh)   Intersection LOS = C
_______________________________________________________________________________
```

1.2 Dowling Road/Old Seward Highway Alternative 1

INPUT WORKSHEET

General Information		Site Information	
Analyst	*Mahear Abou Eid*	Intersection	*Dowling Road and Old Seward Hw*
Agency or Co.		Area Type	*All other areas*
Date Performed	*3/10/2009*	Jurisdiction	
Time Period		Analysis Year	

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	418	473	328	136	586	304	454	235	76	420	291	179
% Heavy veh	8	8	8	8	8	8	8	8	8	8	8	8
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	P	P	P	P	P	P	P	P	P	P	P	P
Startup lost time	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext. eff. green	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Arrival type	3	3	3	3	3	3	3	3	3	3	3	3
Ped volume	0			0			0			0		
Bicycle volume	0			0			0			0		
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/hr												
Bus stops/hr	0	0	0	0	0	0	0	0	0	0	0	0
Ped timing	0.0			0.0			3.0			0.0		

	Excl. Left	EB Only	Thru & RT	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 14.0	G = 30.0	G = 50.0	G =	G = 23.7	G = 25.0	G = 21.0	G =
	Y = 1.0	Y = 1.0	Y = 1.0	Y =	Y = 1.0	Y = 1.0	Y = 1.0	Y =

Duration of Analysis (hrs) = 0.25 | Cycle Length C = 171.7

HCS2000™ Version 4.1

HCS2000: Signalized Intersections Release 4.1

Analyst: Mahear Abou Eid
Agency:
Date: 3/10/2009
Period:
Project ID: Alternative 1 (SPLIT PHASE)
E/W St: Dowling Road

Inter.: Dowling Road and Old Seward Hw
Area Type: All other areas
Jurisd:
Year :
N/S St: Old Seward Hwy

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	2	1	1	2	1	1	2	1	2	2	1
LGConfig	L	TR	R	L	TR	R	L	T	R	L	T	R
Volume	418	473	328	136	586	304	454	235	76	420	291	179
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
RTOR Vol			66			61			36			15

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	P	P			NB	Left	P	P		
	Thru		P	P			Thru		P	P	
	Right		P	P			Right		P	P	
	Peds			X			Peds			X	
WB	Left	P				SB	Left	P			
	Thru			P			Thru			P	
	Right			P			Right			P	
	Peds			X			Peds			X	
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		14.0	30.0	50.0				23.7	25.0	21.0	
Yellow		1.0	1.0	1.0				1.0	1.0	1.0	
All Red		0.0	0.0	1.0				0.0	0.0	1.0	

Cycle Length: 171.7 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	438	1671	1.06	0.26	122.9	F		
TR	1533	3250	0.42	0.47	30.7	C	63.8	E
R	705	1495	0.24	0.47	27.9	C		
Westbound								
L	136	1671	1.11	0.08	188.7	F		
TR	955	3281	0.78	0.29	62.0	E	78.1	E
R	435	1495	0.41	0.29	51.8	D		
Northbound								
L	484	1671	1.04	0.29	113.1	F		
T	915	3343	0.29	0.27	49.9	D	89.1	F
R	409	1495	0.11	0.27	47.2	D		
Southbound								
L	447	3242	1.04	0.14	128.7	F		
T	409	3343	0.79	0.12	87.6	F	117.2	F
R	183	1495	0.99	0.12	140.4	F		

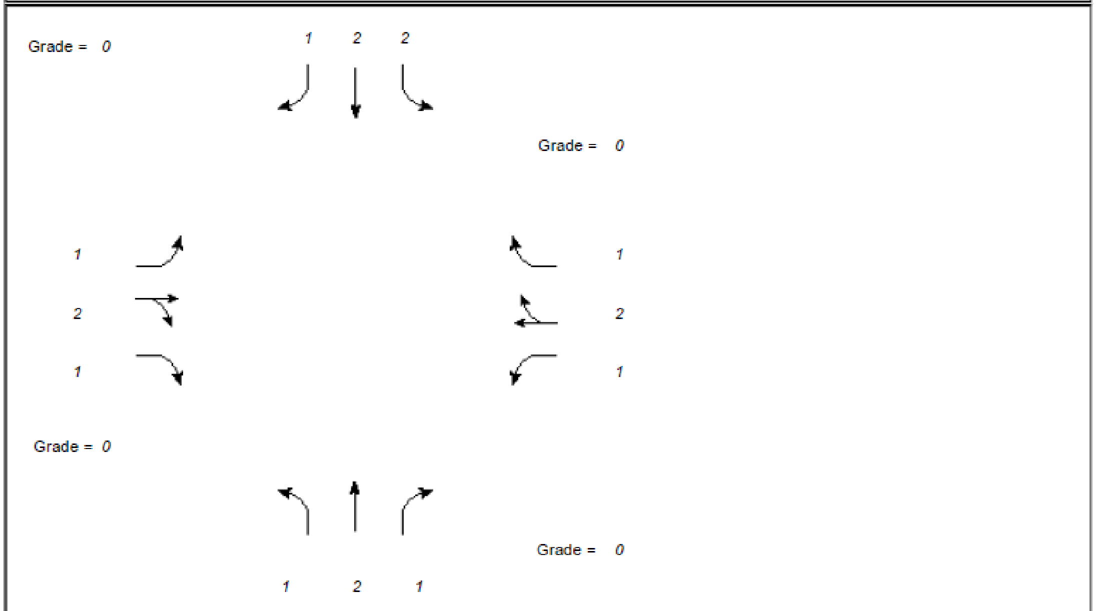
Intersection Delay = 85.0 (sec/veh) Intersection LOS = F

1.3 Dowling Road/Old Seward Highway Alternative 2

INPUT WORKSHEET

General Information		Site Information	
Analyst	*Mahear Abou Eid*	Intersection	*Dowling Road and Old Seward Hw*
Agency or Co.		Area Type	*All other areas*
Date Performed	*3/10/2009*	Jurisdiction	
Time Period		Analysis Year	

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	418	473	328	136	586	304	454	235	76	420	291	179
% Heavy veh	8	8	8	8	8	8	8	8	8	8	8	8
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	P	P	P	P	P	P	P	P	P	P	P	P
Startup lost time	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext. eff. green	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Arrival type	3	3	3	3	3	3	3	3	3	3	3	3
Ped volume		0			0			0			0	
Bicycle volume		0			0			0			0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/hr												
Bus stops/hr	0	0	0	0	0	0	0	0	0	0	0	0
Ped timing		0.0			0.0			3.0			0.0	

	EB Only	WB Only	03	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 17.5	G = 16.0	G =	G =	G = 11.0	G = 8.0	G = 8.5	G =
	Y = 1.0	Y = 1.0	Y =	Y =	Y = 1.0	Y = 1.0	Y = 1.0	Y =
Duration of Analysis (hrs) = 0.25					Cycle Length C = 69.0			

HCS2000™ Version 4.1

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               HCS2000: Signalized Intersections Release 4.1

Analyst: Mahear Abou Eid                Inter.: Dowling Road and Old Seward Hw
Agency:                                 Area Type: All other areas
Date:    3/10/2009                      Jurisd:
Period:                                 Year  :
Project ID: Alternative 2 (STANDARD-SPLIT PHASE)
E/W St: Dowling Road                    N/S St: Old Seward Hwy

                       SIGNALIZED INTERSECTION SUMMARY
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           |  L    T    R   |  L    T    R   |  L    T    R   |  L    T    R   |
           |                |                |                |                |
No. Lanes  |  1    2    1   |  1    2    1   |  1    2    1   |  2    2    1   |
LGConfig   |  L    TR   R   |  L    TR   R   |  L    T    R   |  L    T    R   |
Volume     |418  473  328   |136  586  304   |454  235  76    |420  291  179   |
Lane Width |12.0 12.0 12.0  |12.0 12.0 12.0  |12.0 12.0 12.0  |12.0 12.0 12.0  |
RTOR Vol   |          66    |          61    |          36    |          15    |

Duration     0.25       Area Type: All other areas
                              Signal Operations
Phase Combination 1     2     3     4    |          5     6     7     8
EB  Left          P                      | NB  Left P     P
    Thru          P                      |     Thru       P     P
    Right         P                      |     Right      P     P
    Peds          X                      |     Peds             X
WB  Left                P                | SB  Left P
    Thru                P                |     Thru             P
    Right               P                |     Right            P
    Peds                X                |     Peds             X
NB  Right                                | EB  Right
SB  Right                                | WB  Right
Green            17.5  16.0                          11.0  8.0   8.5
Yellow           1.0   1.0                           1.0   1.0   1.0
All Red          1.0   1.0                           0.0   0.0   1.0
                                                       Cycle Length: 69.0    secs
                          Intersection Performance Summary
Appr/   Lane          Adj Sat     Ratios         Lane Group    Approach
Lane    Group         Flow Rate                  
Grp     Capacity        (s)       v/c     g/C    Delay LOS     Delay LOS

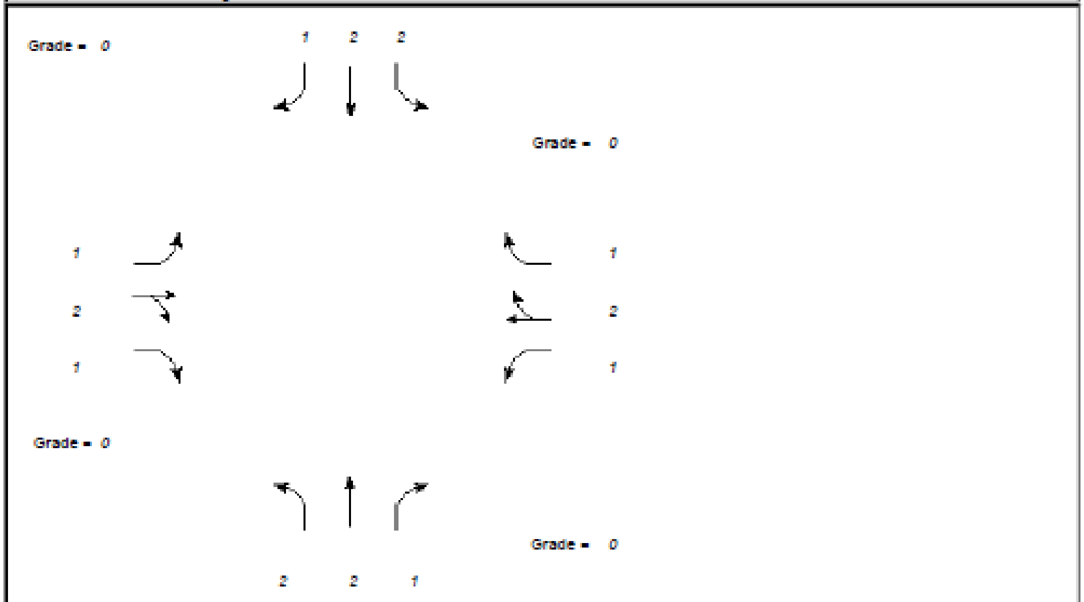
Eastbound
L        424          1671       1.09    0.25    97.4   F
TR       828          3263       0.75    0.25    30.1   C      54.0    D
R        379          1495       0.51    0.25    26.8   C
Westbound
L        387          1671       0.39    0.23    25.3   C
TR       758          3270       1.01    0.23    60.5   E      50.6    D
R        347          1495       0.46    0.23    27.1   C
Northbound
L        484          1671       1.04    0.29    76.6   E
T        848          3343       0.31    0.25    21.8   C      55.8    E
R        379          1495       0.12    0.25    20.4   C
Southbound
L        517          3242       0.90    0.16    50.2   D
T        412          3343       0.78    0.12    43.2   D      56.0    E
R        184          1495       0.99    0.12    93.8   F
         Intersection Delay = 53.9   (sec/veh)   Intersection LOS = D
```

1.4 Dowling Road/Old Seward Highway Alternative 3

INPUT WORKSHEET

General Information		Site Information	
Analyst	*Mahear Abou Eid*	Intersection	*Dowling Road and Old Seward Hw*
Agency or Co.		Area Type	*All other areas*
Date Performed	*3/10/2009*	Jurisdiction	
Time Period		Analysis Year	

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	418	473	328	136	586	304	454	235	76	420	291	179
% Heavy veh	8	8	8	8	8	8	8	8	8	8	8	8
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	P	P	P	P	P	P	P	P	P	P	P	P
Startup lost time	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext. eff. green	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Arrival type	3	3	3	3	3	3	3	3	3	3	3	3
Ped volume		0			0			0			0	
Bicycle volume		0			0			0			0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/hr												
Bus stops/hr	0	0	0	0	0	0	0	0	0	0	0	0
Ped timing		0.0			0.0			3.0			0.0	

	EB Only	WB Only	03	04	Excl. Left	Thru & RT	07	08
Timing	G = 18.5	G = 16.0	G =	G =	G = 12.0	G = 9.5	G =	G =
	Y = 1.0	Y = 1.0	Y =	Y =	Y = 1.0	Y = 1.0	Y =	Y =
Duration of Analysis (hrs) = 0.25					Cycle Length C = 63.0			

HCS2000™ Version 4.1

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                HCS2000: Signalized Intersections Release 4.1

Analyst: Mahear Abou Eid                Inter.: Dowling Road and Old Seward Hw
Agency:                                 Area Type: All other areas
Date:    3/10/2009                      Jurisd:
Period:                                 Year   :
Project ID: Alternative 3 (STANDARD-SPLIT PHASE)
E/W St: Dowling Road                    N/S St: Old Seward Hwy

_________________________SIGNALIZED INTERSECTION SUMMARY______________________
            |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
            |  L    T    R   |  L    T    R   |  L    T    R   |  L    T    R   |
            |                |                |                |                |
No. Lanes   |   1    2    1  |   1    2    1  |   2    2    1  |   2    2    1  |
LGConfig    |   L   TR    R  |   L   TR    R  |   L    T    R  |   L    T    R  |
Volume      |418  473  328   |136  586  304   |454  235  76    |420  291  179   |
Lane Width  |12.0 12.0 12.0  |12.0 12.0 12.0  |12.0 12.0 12.0  |12.0 12.0 12.0  |
RTOR Vol    |          66    |          61    |          36    |          15    |

______________________________________________________________________________
Duration     0.25        Area Type: All other areas
_____________________________________Signal Operations________________________
Phase Combination 1      2      3      4    |            5      6      7      8
EB   Left         P                         |  NB   Left   P
     Thru         P                         |       Thru          P
     Right        P                         |       Right         P
     Peds         X                         |       Peds          X
WB   Left                P                  |  SB   Left   P
     Thru                P                  |       Thru          P
     Right               P                  |       Right         P
     Peds                X                  |       Peds          X
NB   Right                                  |  EB   Right
SB   Right                                  |  WB   Right
Green            18.5   16.0                             12.0   9.5
Yellow           1.0    1.0                              1.0    1.0
All Red          1.0    1.0                              0.0    1.0
                                                      Cycle Length: 63.0    secs
______________________________Intersection Performance Summary________________
Appr/   Lane        Adj Sat    Ratios        Lane Group    Approach
Lane    Group       Flow Rate  __________    __________    __________
Grp     Capacity      (s)      v/c    g/C    Delay LOS     Delay LOS
______________________________________________________________________________
Eastbound
L        491       1671       0.95   0.29    50.8   D
TR       958       3263       0.65   0.29    22.9   C      32.7   C
R        439       1495       0.44   0.29    21.2   C
Westbound
L        424       1671       0.36   0.25    21.6   C
TR       830       3270       0.92   0.25    39.6   D      34.6   C
R        380       1495       0.42   0.25    23.0   C
Northbound
L        618       3242       0.82   0.19    35.8   D
T        504       3343       0.52   0.15    28.4   C      32.8   C
R        225       1495       0.20   0.15    25.3   C
Southbound
L        618       3242       0.76   0.19    32.5   C
T        504       3343       0.64   0.15    31.3   C      35.7   D
R        225       1495       0.81   0.15    51.9   D
         Intersection Delay = 33.9   (sec/veh)    Intersection LOS = C
______________________________________________________________________________
```
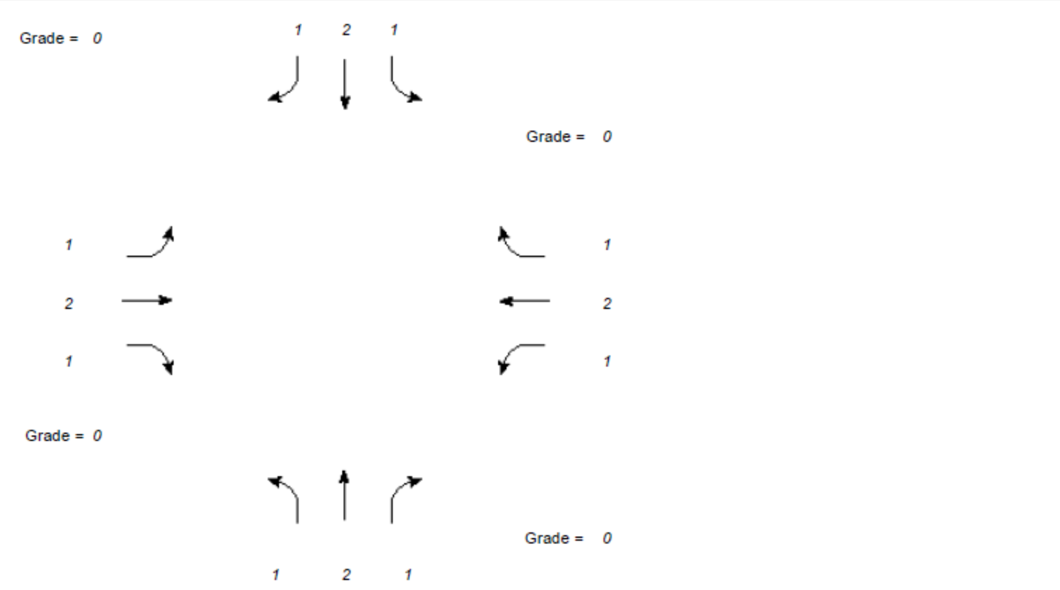

1.5 Dowling Road/C Street Alternative 1

INPUT WORKSHEET

General Information		Site Information	
Analyst	*Mahear Abou Eid*	Intersection	*Dowling Road and C Street*
Agency or Co.		Area Type	*All other areas*
Date Performed	*3/10/2009*	Jurisdiction	
Time Period		Analysis Year	

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	304	674	144	209	685	110	289	1143	103	156	1165	223
% Heavy veh	8	8	8	8	8	8	8	8	8	8	8	8
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	P	P	P	P	P	P	P	P	P	P	P	P
Startup lost time	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext. eff. green	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Arrival type	3	3	3	3	3	3	3	3	3	3	3	3
Ped volume	0			0			0			0		
Bicycle volume	0			0			0			0		
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/hr												
Bus stops/hr	0	0	0	0	0	0	0	0	0	0	0	0
Ped timing	0.0			0.0			3.0			0.0		

	Excl. Left	EB Only	Thru & RT	04	Excl. Left	NB Only	Thru & RT	08
Timing	G = 9.0	G = 4.0	G = 14.0	G =	G = 6.0	G = 6.0	G = 20.0	G =
	Y = 1.0	Y = 1.0	Y = 1.0	Y =	Y = 1.0	Y = 1.0	Y = 1.0	Y =
Duration of Analysis (hrs) = 0.25					Cycle Length C = 67.0			

HCS2000™ Version 4.1

HCS2000: Signalized Intersections Release 4.1

Analyst: Mahear Abou Eid
Agency:
Date: 3/10/2009
Period:
Project ID: Alternative 1
E/W St: Dowling Road

Inter.: Dowling Road and C Street
Area Type: All other areas
Jurisd:
Year :
N/S St: C Street

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	2	1	1	2	1	1	2	1	1	2	1
LGConfig	L	T	R	L	T	R	L	T	R	L	T	R
Volume	304	674	144	209	685	110	289	1143	103	156	1165	223
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
RTOR Vol			29			22			45			21

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left	P	P			NB Left	P	P		
Thru		P	P		Thru		P	P	
Right		P	P		Right		P	P	
Peds			X		Peds			X	
WB Left	P				SB Left	P			
Thru			P		Thru			P	
Right			P		Right			P	
Peds			X		Peds			X	
NB Right					EB Right				
SB Right					WB Right				
Green	9.0	4.0	14.0			6.0	6.0	20.0	
Yellow	1.0	1.0	1.0			1.0	1.0	1.0	
All Red	0.0	0.0	1.0			0.0	0.0	1.0	

Cycle Length: 67.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	349	1671	0.97	0.21	67.1	E		
T	948	3343	0.79	0.28	28.8	C	38.6	D
R	424	1495	0.30	0.28	20.6	C		
Westbound								
L	224	1671	1.04	0.13	98.8	F		
T	699	3343	1.09	0.21	87.2	F	84.1	F
R	312	1495	0.31	0.21	25.1	C		
Northbound								
L	324	1671	0.99	0.19	74.7	E		
T	1347	3343	0.94	0.40	33.5	C	40.7	D
R	602	1495	0.11	0.40	12.8	B		
Southbound								
L	150	1671	1.15	0.09	151.1	F		
T	998	3343	1.30	0.30	164.4	F	144.4	F
R	446	1495	0.50	0.30	23.4	C		

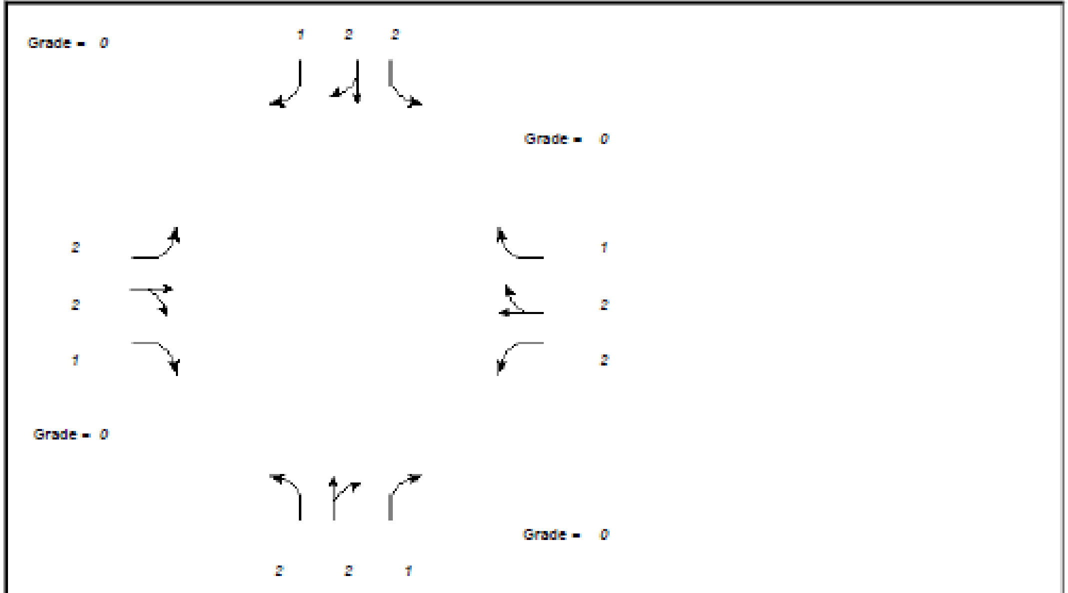
Intersection Delay = 79.6 (sec/veh) Intersection LOS = E

1.6 Dowling Road/C Street Alternative 2

INPUT WORKSHEET

General Information		Site Information	
Analyst	*Mahear Abou Eid*	Intersection	*Dowling Road and C Street*
Agency or Co.		Area Type	*All other areas*
Date Performed	*3/10/2009*	Jurisdiction	
Time Period		Analysis Year	

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	304	674	144	209	685	110	289	1143	103	223	1165	156
% Heavy veh	8	8	8	8	8	8	8	8	8	8	8	8
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	P	P	P	P	P	P	P	P	P	P	P	P
Startup lost time	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext. eff. green	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Arrival type	3	3	3	3	3	3	3	3	3	3	3	3
Ped volume		0			0			0			0	
Bicycle volume		0			0			0			0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/hr												
Bus stops/hr	0	0	0	0	0	0	0	0	0	0	0	0
Ped timing		0.0			0.0			3.0			0.0	

	Excl. Left	Thru & RT	03	04	Excl. Left	Thru & RT	07	08
Timing	G = 6.0	G = 14.0	G =	G =	G = 7.0	G = 24.0	G =	G =
	Y = 1.0	Y = 1.0	Y =	Y =	Y = 1.0	Y = 1.0	Y =	Y =
Duration of Analysis (hrs) = 0.25					Cycle Length C = 57.0			

HCS2000™ Version 4.1

HCS2000: Signalized Intersections Release 4.1

Analyst: Mahear Abou Eid
Agency:
Date: 3/10/2009
Period:
Project ID: Alternative 2
E/W St: Dowling Road

Inter.: Dowling Road and C Street
Area Type: All other areas
Jurisd:
Year :
N/S St: C Street

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	2	2	1	2	2	1	2	2	1	2	2	1
LGConfig	L	TR	R	L	TR	R	L	TR	R	L	TR	R
Volume	304	674	144	209	685	110	289	1143	103	223	1165	156
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
RTOR Vol			29			22			21			45

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	P				NB	Left	P			
Thru		P				Thru		P		
Right		P				Right		P		
Peds		X				Peds		X		
WB Left	P				SB	Left	P			
Thru		P				Thru		P		
Right		P				Right		P		
Peds		X				Peds		X		
NB Right					EB	Right				
SB Right					WB	Right				
Green	6.0	14.0					7.0	24.0		
Yellow	1.0	1.0					1.0	1.0		
All Red	0.0	1.0					0.0	1.0		

Cycle Length: 57.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	341	3242	0.99	0.11	72.1	E		
TR	817	3328	0.94	0.25	41.7	D	48.2	D
R	367	1495	0.29	0.25	19.4	B		
Westbound								
L	341	3242	0.68	0.11	35.0+	D		
TR	819	3334	0.95	0.25	41.9	D	38.7	D
R	367	1495	0.23	0.25	18.6	B		
Northbound								
L	398	3242	0.81	0.12	40.3	D		
TR	1406	3340	0.91	0.42	25.6	C	27.7	C
R	629	1495	0.13	0.42	10.6	B		
Southbound								
L	398	3242	0.62	0.12	30.9	C		
TR	1404	3335	0.94	0.42	28.7	C	27.9	C
R	629	1495	0.16	0.42	10.8	B		

Intersection Delay = 34.3 (sec/veh) Intersection LOS = C

Appendix C-4

Collision Data Tables

List of Tables

Table 1 Intersection Crash Data

				Angular							Surface Condition			Lighting Conditions			
Intersections	**Total Crashes**	**Property Damage**	**Injury**	**Right Turn**	**Left Turn**	**Other**	**Rear End**	**Bicyclist**	**Animal**	**Other**	**Dry**	**Wet**	**Snow/Ice**	**Day**	**Night**	**Twilight**	**Drug/Alcohol Related**
Dowling Road and Old Seward Highway	116	86	44	5	29	17	54	2	1	7	44	15	57	72	29	15	2
Dowling Road and Austin Street	27	20	8	1	9	4	10	1	1	1	10	5	12	18	6	3	0
Potter Drive/Dowling Road/Franklin Drive	14	11	7	2	4	3	4	0	0	1	5	3	6	11	2	1	0
Dowling Road and A Street	1	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0
Dowling Road and B Street	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Potter Drive and A Street	20	15	7	1	3	10	6	0	0	0	9	1	10	15	4	1	2
Potter Drive and B Street	7	6	1	1	3	2	0	0	0	1	5	1	1	4	2	1	0
Potter Drive and C Street	74	53	34	13	7	22	23	1	0	8	26	12	36	44	23	7	5
Total	**186**	**140**	**67**	**10**	**48**	**36**	**75**	**3**	**2**	**11**	**73**	**25**	**87**	**120**	**44**	**21**	**9**

Table 2 Intersection Crash Rates

Intersection	Total Crashes	Average Crashes Per Year	AADT	Average Crash Rate (CR/MEV)	Average Crash Rate (DOT&PF)
Old Seward Highway and Dowling Road	116	11.6	32,586	0.975	1.86
Potter Drive and C Street	74	7.4	19,220	1.055	1.86

Table 3 Road Segment Crash Data

				Angular							Surface Condition			Lighting Conditions			
Road Segments	Total Crashes	Property Damage	Injury	Right Turn	Left Turn	Other	Rear End	Bicyclist	Animal	Other	Dry	Wet	Snow/Ice	Day	Night	Twilight	Drug/Alcohol Related
Old Seward Highway to Austin Street	38	24	18	4	7	11	12	1	0	3	19	2	17	15	11	2	0
Austin Street to Franklin Drive	30	20	11	0	1	1	9	1	1	16	8	2	20	19	10	1	5
Franklin Drive to B Street	3	2	3	0	0	0	0	0	0	3	1	0	2	1	2	0	0
Franklin Drive to C Street	44	33	14	2	2	10	23	0	0	7	13	4	27	11	33	0	5
Total	115	79	46	6	10	22	44	2	1	29	41	8	66	46	56	3	10

Appendix C-5

Calculations

TABLE OF CONTENTS

LIST OF TABLES

1.0 HAND CALCULATIONS

The following shows the preliminary calculations that were done in order to acquire different cycle lengths and green times in order to enter reasonable values into the HCS2000 software. By completing these calculations the ratio of green time for each phase can be found and then input into the HCS2000 program. Once in the program these values can be optimized to achieve the highest LOS and lowest delay time.

Table 1 Dowling Road/Old Seward Highway Current

	Input Year	Years
West Dowling/Old Seward	2009	-21

Direction	Lane	Lanes	Shared (Y/N)	Growth	PHV	S_o	fw	fhv	fg	fp	fbb	fa	flu	flt	frt	flpb	S	Width	ROW	Bay Length	ROTR	% R-Shared
NB	Left-Ex	1		0.042	188	1900	1	0.999201	1	1	1	1	1	0.95	1	1	1803.6	12	48	500		
	Through	2		0.042	97	1900	1	0.999201	1	1	1	1	0.952	1	1	1	3614.7	12		500		
	Right	1	n	0.042	31	1900	1	0.999201	1	1	1	1	1	1	0.85	1	1613.7	12		500	6.292103	
SB	Left-Ex	2		0.042	174	1900	1	0.999201	1	1	1	1	0.971	0.95	1	1	3502.5	12	60	185		
	Through	2		0.042	120	1900	1	0.999201	1	1	1	1	0.952	1	1	1	3614.7	12		500		
	Right	1	n	0.042	74	1900	1	0.999201	1	1	1	1	1	1	0.85	1	1613.7	12		215	14.81956	
WB	Left-Ex	1		0.042	56	1900	1	0.999201	1	1	1	1	1	0.95	1	1	1803.6	12	36	500		
	Through	2		0.042	243	1900	1	0.999201	1	1	1	1	0.952	1	0.948764	1	3429.5	12		500		
	Right	1	y	0.042	126	1900	1	0.999201	1	1	1	1	1	1	0.948764	1	1801.2	12		500	25.16841	34.16%
EB	Left-Ex	1		0.042	173	1900	1	0.999201	1	1	1	1	1	0.95	1	1	1803.6	12	36	165		
	Through	2		0.042	196	1900	1	0.999201	1	1	1	1	0.952	1	0.938577	1	3392.7	12		500		
	Right	1	y	0.042	136	1900	1	0.999201	1	1	1	1	1	1	0.938577	1	1781.9	12		180	27.15539	40.95%

	SPLIT PHASE 1			PHASE A	PHASE B
	A	B	C	A	B
q	173.86	98.41	74.10	242.58	173.03
S	3502.51	1803.56	1613.71	3429.51	1803.56
Y	0.05	0.05	0.05	0.07	0.10
	4	**4**	**3**	**5**	**7**
∑Y=	0.317				
Cycle Length=	**38**	**seconds**			
Gte=	24				

Table 2 Dowling Road/Old Seward Highway Alternative 1

	Input Year	Years
West Dowling/Old Seward	2030	3

Direction	Lane	Lanes	Shared (Y/N)	Growth	PHV	S_o	fw	fhv	fg	fp	fbb	fa	flu	flt	frt	flpb	S	Width	ROW	Bay Length	ROTR	% R-Shared
NB	Left-Ex	1		0.0181	454	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	48	318		
	Through	2		0.01747	235	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	0.01802	76	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	15.2	
SB	Left-Ex	2		-0.0008	420	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	60	270		
	Through	2		-0.0011	291	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	-0.0019	179	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	35.8	
WB	Left-Ex	1		0.03079	136	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	36	270		
	Through	2		0.03035	586	1900	1	0.999	1	1	1	1	0.952	1	0.949	1	3429.5	12				
	Right	1	y	0.0298	304	1900	1	0.999	1	1	1	1	1	1	0.949	1	1801.2	12			60.8	34.16%
EB	Left-Ex	1		0.02056	418	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	36	318		
	Through	2		0.02109	473	1900	1	0.999	1	1	1	1	0.952	1	0.939	1	3392.7	12				
	Right	1	y	0.02097	328	1900	1	0.999	1	1	1	1	1	1	0.939	1	1781.9	12			65.6	40.95%

	SPLIT PHASE 1			SPLIT PHASE 2		
	A	B	C	A	B	C
q	420.00	237.73	179.00	136.00	282.00	890.00
S	3502.51	1803.56	1613.71	1803.56	1803.56	3429.51
Y	0.12	0.13	0.11	0.08	0.16	0.26
G_{ei} (Sec)	**23.0**	**25**	**21**	**14**	**30**	**50**
∑Y=	0.854					
Cycle Length=	**178**	**seconds**				
Gte=	164					

Table 3 Dowling Road/Old Seward Highway Alternative 2

	Input Year	Years
West Dowling/Old Seward	2030	3

Direction	Lane	Lanes	Shared (Y/N)	Growth	PHV	S_o	fw	fhv	fg	fp	fbb	fa	flu	flt	frt	flpb	S	Width	ROW	Bay Length	ROTR	% R-Shared
NB	Left-Ex	1		0.0181	454	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	48	318		
	Through	2		0.01747	235	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	0.01802	76	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	15.2	
SB	Left-Ex	2		-0.0008	420	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	60	270		
	Through	2		-0.0011	291	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	-0.0019	179	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	35.8	
WB	Left-Ex	1		0.03079	136	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	36	270		
	Through	2		0.03035	586	1900	1	0.999	1	1	1	1	0.952	1	0.949	1	3429.5	12				
	Right	1	y	0.0298	304	1900	1	0.999	1	1	1	1	1	1	0.949	1	1801.2	12			60.8	34.16%
EB	Left-Ex	1		0.02056	418	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	36	318		
	Through	2		0.02109	473	1900	1	0.999	1	1	1	1	0.952	1	0.939	1	3392.7	12				
	Right	1	y	0.02097	328	1900	1	0.999	1	1	1	1	1	1	0.939	1	1781.9	12			65.6	40.95%

	SPLIT PHASE 1			PHASE A	PHASE B
	A	B	C	A	B
q	420.00	237.73	179.00	586.00	418.00
S	3502.51	1803.56	1613.71	3429.51	1803.56
Y	0.12	0.13	0.11	0.17	0.23
G_{ei} (Sec)	**15.2**	**17**	**14**	**22**	**29**

∑Y= 0.765

Cycle Length= 111 seconds

Gte= 97

Table 4 Dowling Road/Old Seward Highway Alternative 3

	Input Year	Years
West Dowling/Old Seward	2030	3

Direction	Lane	Lanes	Shared (Y/N)	Growth	PHV	S_o	fw	fhv	fg	fp	fbb	fa	flu	flt	frt	flpb	S	Width	ROW	Bay Length	ROTR	% R-Shared
NB	Left-Ex	2		0.0181	454	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	60	318		
	Through	2		0.01747	235	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	0.01802	76	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	15.2	
SB	Left-Ex	2		-0.0008	420	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	60	270		
	Through	2		-0.0011	291	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	-0.0019	179	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	35.8	
WB	Left-Ex	1		0.03079	136	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	36	270		
	Through	2		0.03035	586	1900	1	0.999	1	1	1	1	0.952	1	0.949	1	3429.5	12				
	Right	1	y	0.0298	304	1900	1	0.999	1	1	1	1	1	1	0.949	1	1801.2	12			60.8	34.16%
EB	Left-Ex	1		0.02056	418	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	36	318		
	Through	2		0.02109	473	1900	1	0.999	1	1	1	1	0.952	1	0.939	1	3392.7	12				
	Right	1	y	0.02097	328	1900	1	0.999	1	1	1	1	1	1	0.939	1	1781.9	12			65.6	40.95%

	SPLIT PHASE 1			PHASE A	PHASE B
	A	B	C	A	B
q	420.00	34.00	179.00	586.00	418.00
S	3502.51	3502.51	1613.71	3429.51	1803.56
Y	0.12	0.01	0.11	0.17	0.23
G_{ei} (Sec)	**11.0**	**0**	**10**	**16**	**21**
∑Y=	0.643				
Cycle Length=	**73**	**seconds**			
Gte=	59				

Table 5 Dowling Road/C Street Alternative 1

	Input Year	Years
West Dowling/C Street	2030	3

Direction	Lane	Lanes	Shared (Y/N)	Growth	PHV	S_o	fw	fhv	fg	fp	fbb	fa	flu	flt	frt	flpb	S	Width	ROW	Bay Length	ROTR	% R-Shared
NB	Left-Ex	1		0	289	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	48	386		
	Through	2		0	1143	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	0	103	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	20.6	
SB	Left-Ex	1		0	223	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	48	302		
	Through	2		0	1165	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	0	156	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	31.2	
WB	Left-Ex	1		0	209	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	48	285		
	Through	2		0	685	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	0	110	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	22	
EB	Left-Ex	1		0	304	1900	1	0.999	1	1	1	1	1	0.95	1	1	1803.6	12	48	322		
	Through	2		0	674	1900	1	0.999	1	1	1	1	0.952	1	1	1	3614.7	12				
	Right	1	n	0	144	1900	1	0.999	1	1	1	1	1	1	0.85	1	1613.7	12		215	28.8	

	SPLIT PHASE 1			SPLIT PHASE 2		
	A	B	C	A	B	C
q	223	66	1077.00	209	95	685
S	1803.55715	1803.56	3614.71	1803.56	1803.56	3614.7
Y	0.12364454	0.03659	0.30	0.11588	0.05267	0.1895
G_{ei} (Sec)	**19**	**6**	**47**	**18**	**8**	**30**
∑Y=	0.816					
Cycle Length=	**141**	**seconds**				
Gte=	127					

Table 6 Dowling Road/C Street Alternative 2

	Input Year	Years
West Dowling/C Street	2030	3

Direction	Lane	Lanes	Shared (Y/N)	Growth	PHV	S_o	fw	fhv	fg	fp	fbb	fa	flu	flt	frt	flpb	S	Width	ROW	Bay Length	ROTR	% R-Shared
NB	Left-Ex	2		0	289	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	48	290		
	Through	2		0	1143	1900	1	0.999	1	1	1	1	0.952	1	0.988	1	3569.9	12				
	Right	1	y	0	103	1900	1	0.999	1	1	1	1	1	1	0.988	1	1874.9	12			20.6	8.27%
SB	Left-Ex	2		0	223	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	48	260		
	Through	2		0	1165	1900	1	0.999	1	1	1	1	0.952	1	0.98	1	3542.1	12				
	Right	1	y	0	156	1900	1	0.999	1	1	1	1	1	1	0.98	1	1860.3	12			31.2	11.81%
WB	Left-Ex	2		0	209	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	48	260		
	Through	2		0	685	1900	1	0.999	1	1	1	1	0.952	1	0.979	1	3539.7	12				
	Right	1	y	0	110	1900	1	0.999	1	1	1	1	1	1	0.979	1	1859.1	12			22	13.84%
EB	Left-Ex	2		0	304	1900	1	0.999	1	1	1	1	0.971	0.95	1	1	3502.5	12	48	270		
	Through	2		0	674	1900	1	0.999	1	1	1	1	0.952	1	0.974	1	3519.3	12				
	Right	1	y	0	144	1900	1	0.999	1	1	1	1	1	1	0.974	1	1848.4	12			28.8	17.60%

	SPLIT PHASE 1			SPLIT PHASE 2		
	A	B	C	A	B	C
q	223	66	1321.00	209	95	795
S	3502.50799	3502.51	3569.89	3502.51	3502.51	3539.7
Y	0.06366866	0.01884	0.37	0.05967	0.02712	0.2246
G_{ei} (Sec)	**8**	**2**	**47**	**8**	**3**	**28**
∑Y=	0.764					
Cycle Length=	**110**	**seconds**				
Gte=	96					

DESIGN STUDY REPORT

APPENDIX D

BRIDGE DESIGN

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

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April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AASHTO ....American Association of State Highway and Transportation Officials
ADF&G ....State of Alaska Department of Fish and Game
AWWU ....Anchorage Water and Wastewater Utility
ADOT&PF...State of Alaska Department of Transportation and Public Facilities
DNR – OHMP...............Department of Natural Resources - Office of Habitat Management and Permitting
DSR...Design Study Report
EA ....Environmental Assessment
LRFD ....Load Resistance Factored Design
MSE ....Mechanically Stabilized Earth
ROW ....right-of-way
WDR ....West Dowling Road

1.0 INTRODUCTION

It is the intent of this appendix to bring to light the problems with the existing West Dowling Road Bridge over Campbell Creek, outline the alternatives developed, and explain the rationale behind the choices made.

1.1 Background

The current bridge on WDR over Campbell Creek is in dire need of repair or replacement. Because of an inadequate foundation, the west side of the bridge has sagged more than eighteen inches, creating a large dip in the roadway. The east side has seen less significant sagging effects. In addition, the existing bridge causes some mild backwater issues as it leaves very little room for flood level creek flows to go under. Therefore, the design of a new bridge is proposed. In addition, pedestrians using the Campbell Creek trail currently need to cross over WDR just to the east of the bridge. This is dangerous as it forces cyclists, skiers, and other pedestrians to cross a busy street directly. With the number of lanes increasing to four with a median, this will no longer be acceptable. It is necessary that pedestrians, along with moose and other wildlife, are able to pass underneath the bridge structure.

1.2 Objectives

One of the main criteria for the new bridge is that it must accommodate four lanes of traffic plus sidewalks on either side. Another condition it must follow is, according to the wildlife section of chapter three in the EA compiled by HDR last year, to allow for ten to fourteen feet of overhead space above a twelve-foot pathway running parallel to Campbell Creek, which itself must be at an elevation that is at least equal to that of a five-year flood event of the creek *(*HDR, 2008). The new bridge will also be required to not create backwater problems or be susceptible to significant amounts of scour in one hundred-year flood events (HDR, 2008*)*.

2.0 DESIGN ALTERNATIVES

Many considerations were evaluated for all aspects of the bridge design process. While the costs of construction and maintenance were the most important design criteria to base the decisions on, other constraints such as construction feasibility, ROW acquisition limitations, and environmental concerns all were important in the decision making process for each portion of the bridge design portion of the project.

2.1 Campbell Creek Trail

While determining how to construct a trail underneath the bridge, factors such as construction feasibility and cost must be considered. The existing trail is approximately 12 feet wide, and it is desirable that this width be maintained underneath the bridge structure.

A tunnel that passes through one of the bridge approaches would allow for a lowered elevation of the bridge. However, based on the width restrictions of the roadway, the tunnel would need to be at least 70 feet wide. In general, tunnels are more expensive than other options (Marx, 2009) and based on personal observation, it is believed that moose and other wildlife would be apprehensive about passing through a constrictive-looking tunnel. In addition, a 12 foot width could not be maintained in a tunnel without incurring very significant costs, so the width would need to be narrowed in order to maintain construction feasibility.

A concrete pathway lowered below the creek elevation that runs underneath the bridge could also be used to lower the necessary bridge elevation while still maintaining 10-14 feet of clearance. A concrete barrier wall could be used on the side near the creek to keep water out. However, a similar pathway design is utilized along Chester Creek underneath C Street, and the pathway fills with ice every winter. It is expected that if this design were used for Campbell Creek at WDR the same problems would be encountered.

A standard paved pathway is the simplest design alternative. It would require a significant increase in bridge elevation, which causes a larger cost of the bridge structure. It would easily accommodate moose and other wildlife, and it could be designed to remain well above the desired 5-year flood elevation. It would also be simple to maintain a 12 foot width along the path.

2.2 Bridge Span

2.2.1 Height

The bridge height above the river depends on the elevation of Campbell Creek Trail, which is to run underneath the bridge parallel to Campbell Creek. The trail, according to appendix D of the EA, should be designed at or above the five-year flood level of the creek, as this is standard practice for the area (HDR, 2008). This elevation depends on the design of the bridge placement, width, and abutments. The ADF&G requested that the bridge provide 10 feet of clearance for wildlife, and DNR-OHMP later requested 14 feet of clearance. The final decision of the height of the bridge above the trail, while keeping the requested 10-14 feet of clearance, depends on the cost feasibility of every increase in height.

2.2.2 Length

The span length of the bridge depends on the height, placement, and abutment design of the bridge. The one main variable that will determine what the final length will be is the abutment design. If retaining walls are used at the abutments, the length will depend purely on the cross-sections of the creek basin at the location of the bridge. If 2-to-1 soil slopes were utilized at the abutments, the length would increase 4 feet for every additional foot of increased elevation.

2.2.3 Width

The width of the bridge is mainly determined by the geometry and cross-section of the roadway, as designed by the roadway geometry group. This cross-section includes a 6-foot sidewalk on one side of the road and a 12-foot path on the other, two 12-foot lanes per direction of traffic, and an 18-foot median or turning lane, along with 6-foot shoulders on the sides of the traffic lanes. Several alternatives within that framework were considered.

2.2.3.1 Option 1

Keeping the same cross-section over the bridge as exists for the rest of the roadway would be the simplest design, minimizing the effects on drivers crossing the bridge. It is also likely the most expensive design, as there are 18 feet of median space in between the main traffic lanes that would be spanned.

2.2.3.2 Option 2

Using a two-span structure with an 18-foot open space between the spans would allow the bridge to cross over Campbell Creek without causing any changes in traffic patterns except for the loss of a potential turning lane. It would reduce the cost of the structure because there would be 18 feet less of a width to span. This design could also help in the construction phasing, depending on the placement of the bridge, as it could allow for the building of one span at a time, while allowing traffic to flow first over the existing bridge, then the new span as the existing bridge is torn down and the second span is erected.

2.2.3.3 Option 3

Reducing the width of the median and bringing the opposing lanes closer together with only a concrete barrier wall in between is the most compact design alternative. It would alter the movement of traffic in that drivers traveling in one or both directions would enter a horizontal curve and a vertical curve simultaneously. It would be the cheapest design, as it would require the same amount of materials to span the bridge as option 2, but would require less cut-and-fill material in the bridge approaches.

Another variable is the width of the pedestrian paths on either side of the roadway. It is generally acceptable to narrow the width of pathways on bridges, and in this case it is possible to lower the widths of the pathways to as low as 5 feet each.

The bridge width will depend on the final cost of each alternative, how each design affects driving conditions, and available space constraints.

2.2.4 Structural Material

While choosing structural materials several key factors were looked at including strength, cost, maintenance, and aesthetics. The selection of the material was carefully weighted using the different factors. Three major types of structural material were considered including steel, timber, and reinforced concrete.

Structural steel is commonly used for bridges. The strength of steel will decrease the cross sectional area thus increasing the overall head height for moose crossing underneath the bridge. Creek crossings are a corrosive environment for steel. ADOT recommends against using structural steel due to high maintenance costs (Marx, 2009).

A timber bridge could be designed to look very aesthetic. The overall strength of timber is much less than steel thus increasing the overall size of the cross section and decreasing head height for moose. The possibility of timber rotting out over a short period is detrimental to a bridge.

Reinforced concrete girders are a high strength material with low maintenance costs (Marx, 2009). The pre-stressed girders provide high strength with minimal cross sectional depth. The use of pre-stressed bulb tee girders on most single span bridges in Alaska helps increase the constructability of the bridge and will speed up the construction process.

2.3 Pedestrian Sidewalks

For the bridge crossing, three alternatives were considered for the pedestrian sidewalks. Along most of the roadway, one sidewalk is 12 feet wide and the other 6-feet. The first option is to keep these dimensions along the length of the bridge span. This makes for the simplest design, as it does not alter that part of the original roadway cross-section design. It also is the most expensive alternative, as it is a total of 18 feet of bridge span to construct across Campbell Creek

The second alternative is to shrink the larger sidewalk down to 6 feet. This provides symmetry in the bridge structure as both sides would be the same. It also reduces the cost of construction because there would be 6 feet less span to construct.

The third alternative is to detach one or both sidewalks away from the main roadway and send them across the creek on small wooden footbridges. This alternative has visual appeal and enhances the landscape of the area. It also takes pedestrians away from traffic on the bridge, making it the safest alternative. However, the footbridges would need to fulfill the same requirements as the main bridge concerning floodway clearance. Therefore, the bridges would need to be nearly as long as the main channel. Building one or two additional structures with these constraints is likely more expensive than alternative two.

2.4 Abutments

The structural elements of abutments consist of wing walls, seats, pilings, and diaphragms. Single span bridges generally use reinforced concrete for the structural material for the diaphragms, wing walls, and seats (Marx, 2009). The pilings can consist of a variety of materials including drilled shafts, pipe piles and H piles (Corduto, 2001). These four parts of the bridge form the foundation.

2.4.1 Wing walls

The wing walls are made of reinforced concrete attached to the seat of the bridge (Marx, 2009). The dimensions of the wing wall are a standard thickness of 1.5 ft x 20 ft x depth of girders and seat (Marx, 2009). Wing walls are designed to hold the soil from the roadway and around the abutments in place.

2.4.2 Pilings

Two major types of foundations exist for a bridge, deep and shallow. A shallow foundation is not considered when the bridge crosses a body of water (Marx, 2009). The soil underneath a shallow foundation is easily undermined and compromised. Deep foundations can withstand large flood events and remain intact. Three major types of deep foundations were considered: drilled shafts, pipe piles, and H-piles.

Drilled shafts in Alaska offer unique challenges. Drilled shafts are a relatively new type of foundation being used around the Anchorage area. Installation of drilled shafts is a relatively difficult operation and the equipment is not readily available in Alaska. Renting the proper equipment from Seattle generally costs around one million dollars (Marx, 2009). If clayey soils are present the drilling procedure can alter the soils causing reduced shear strength and side friction (Corduto, 2001).

Pipe piles are a hollow steel pipe driven into the ground. In Alaska, pipe piles are filled with structural rebar and concrete to increase strength (Marx, 2009). The downward geotechnical load capacity is not increased from this internal structure (Corduto, 2001). The alpha method is generally used for determining the structural capacity of a pipe pile driven into clay (Corduto, 2001).

H piles are H shaped sections driven into the ground. H piles have a similar geotechnical capacity as pipe piles. In Alaska the HP14x117 is the standard H pile used (Marx, 2009). The alpha method for clayey soils is used in determining the length of pile needed.

2.4.3 Seat and Diaphragm

The seat is a large block of concrete on top of the piles where the girders sit. The diaphragm connects the ends of the girders and keeps soil from spilling through the abutment.

2.5 Approaches

The bridge approaches were considered after the new bridge elevation was designed. The elevation change between existing ground level and the elevation of the new bridge is 10.1 feet. There were three options considered:

Option 1: Extend the approaches 190 ft. This will develop the absolute lowest grade possible without increasing the right-of-way.

Option 2: Extend the approaches 100 ft. This would allow a grade of 1:10, which is considered a safe for driving. Just over 100 ft from both sides of the bridge are residential driveways; therefore, option 2 will offer no interference with those streets and save the construction costs involved with changing the elevation of the side streets.

Option 3: Extend the approaches less than 100 ft. The steeper gradients are considered less safe than lower grades. Making the approach less than 100 ft does not lessen right of way or save in fill volumes or construction cost. Because of safety, option 3 was not considered for design.

3.0 FINAL DESIGN

Alternatives were chosen or discarded based on the constraints listed in section 2.0.

3.1 Campbell Creek Trail

The trail along Campbell Creek will be designed as a simple pathway that runs parallel to the stream underneath the bridge span. This design was chosen both because of its simplicity, and because of the infeasibility of the other options.

Option one, which was to construct a tunnel underneath one of the approaches, is far too expensive to be feasible (Marx, 2009). The lowered pathway is also undesirable because it would flood with ice every winter, like the path along Chester Creek at C Street, and the costs and inconvenience of maintaining a clear channel every winter will almost certainly outweigh the possibility of a slightly lowered bridge span.

The trail will be at 96.1 feet (MSL), as that is the elevation of a 5 year flooding event, according to the HEC-RAS analysis based on the final dimensions chosen for the bridge span (Yeager, 2009).

3.2 Bridge Span

The dimensions and physical attributes of the bridge span were not chosen individually, rather, it was an iterative process because the height, length, width, and structural materials chosen for the bridge span were all interdependent on each other.

A concrete bulb-t girder design was chosen for two reasons: it is standard to the area and its commonness makes it cheap to construct, and because of corrosive elements in the Anchorage climate, steel and timber bridges do not have high-expected useful lives (Marx, 2009).

The elevation of the bridge span was chosen so that there is 12 feet of overhead clearance above the elevation of the Campbell Creek Trail. The reason for this is that it is very near the maximum height that, after finding the required elevation of the trail and choosing to use 2:1 sloped abutments, the bridge could be designed to be 105 feet across while still allowing for the use of 54-inch deep girders. According to an analysis done with the ADOT LRDF Bulb-T Girder Design Program (Marx, 2009), this is close to the maximum span length of a single-span bridge that a 54 inch concrete bulb-t girder can safely be used for, and an increase of 1 foot in elevation would correspond to a 4 foot increase in span length.

It is important for cost reasons that 54-inch girders are used. Increasing the height of the bridge would cause an increase in length and corresponding need for an increase in beam depth to accommodate the load combinations outlined in sections 3.6, 3.8, and 3.9 of the AASHTO LRFD Bridge Design Manual. The next standard beam depth is 66 inches. This extra foot of depth means that either the top of the bridge is another foot higher, resulting in more cut-and-fill expenses on the bridge approaches, or that the bottom chord of the bridge would need to be lowered a foot, negating any perceived benefits to using the larger beam.

The width was chosen to be 80 feet across. This is the absolute minimum width that could be used for the bridge that could still hold all the necessary lanes, sidewalks, and barriers. A single span bridge without a median lane was chosen because of spacing restraints on the south side of the bridge structure. South of the existing bridge, according to the base map provided of the area, lays an AWWU 48" concrete wastewater line with 6" walls. Because of huge costs of relocating the pipe, it is required that any bridge structures be constructed north of the sewer line. Other utility lines in the vicinity are not as cost-critical to move as the sewer line, and will be relocated or redesigned accordingly.

To allow the option to construct the bridge in two phases, the bridge was designed so that each direction of traffic would be completely supported by its own set of girders. Therefore, for the 80 foot bridge, twelve 80 inch girders were used, six to a side. During construction of the bridge, the north span, or the westbound lanes, could be constructed while traffic continues to use the old bridge span. Once the north lanes are complete, the old bridge structure can be torn down and the eastbound lanes could be constructed while two-lane traffic is redirected across the north span.

3.3 Pedestrian Sidewalks

The sidewalks were designed as identical 6-foot pathways that are attached to the main bridge structure.

The reasons that a 12-foot pathway was not maintained were that it is cheaper to build a narrower bridge and that, because of the 48” sewer line, and ROW and environmental permitting limits, it is much simpler to build as small a bridge as possible.

Separate wooden foot bridges were decided against based on the difficulty of designing them in the shortened period of creating this DSR and because they would need to be equally as safeguarded against flooding and as harmless to the creek environment as the main structure.

3.4 Abutments

Foundation design of a bridge spanning water requires deep foundations. Several options have been considered including H-piles, pipe-piles, and drilled shafts. The H-pile is the most economical type of deep foundation for a single span bridge and is the recommended alternative. Generally, one H-pile will be driven per girder per side of the span, so twenty-four H-piles will be driven for this bridge. The depth to which the H-piles will be driven depends on the soil composition of the area. This information is not yet available, so the current design calls for a conservative depth of 80 feet.

Three alternatives have been considered for the bridge abutments: an MSE wall, reinforced concrete retaining wall and sloped fill abutments. The unit price of the concrete retaining wall is determined by calculating the amount of concrete and rebar per square foot and using the prices of rebar and concrete in the ADOT bid tabs for a square foot price of retaining wall. The cost estimate for the alternatives is found in Table 1.

Table 1 Bridge Abutment Alternatives (ADOT, 2007)

Pay Item	Pay Unit	Quantity	Unit Price	Price Sloped Abutme	Price Retaining Walls
205(3) Foundation Fill	Cubic Yard	50	$ 25.00	$ 1,250.00	
Reinforced Concrete Retaining	sq. ft	2400	$ 230.00		$ 552,000.00
502(1) Post-Tensioning (Type)	Lump Sum	12	$ 78,000.00	$ 936,000.00	$ 842,400.00
				$ 1,873,250.00	$ 2,236,800.00
		Preferred Alternative		Sloped Abutment	

An MSE wall although is found to be a cheaper alternative cannot be considered for several reasons. A MSE wall within the flood plan of a stream is very likely to be undermined during a flood event (Marx, 2009). The location of the MSE wall within the flood plan of Campbell Creek also constitutes a corrosive environment that will cause corrosion of the support system of the MSE wall.

Rebar for the Seat design primarily consists of temperature and shrinkage steel. Spacing of the rebar is found using Equation 1 and a table of results is found in Table 2.

Table 2 Rebar spacing for Bridge Seat.

Rebar Location	Rebar type and Quantity	Spacing
Horizontal Rebar	#6 / 16	10 in OC
Vertical Rebar	#5 / 2	16 in OC

3.5 Wing walls and Pilings

Wing walls are reinforced concrete retaining walls supported by the bridge pilings and seat. The amount of rebar is determined by finding the maximum ultimate moment on the wall and treating the wing wall as a cantilever beam. Criteria for both bending moments and temperature and shrinkage, Equation 1, must be met for the rebar spacing. Rebar spacing for the wing wall is found in Table 3.

$$As = \frac{1.3bh}{2(b+h)f_y}$$

Equation 1 Rebar Spacing

Table 3 Rebar Spacing for Wing Walls.

Rebar Location	Rebar type	Spacing
Tension Side Horizontal	#9	6 in OC
Compression Side	#5	12 in OC
Temperature and Shrinkage	#5	12 in OC two layers

The cost estimate for the three types of piles is seen in Table 4. The alternative with the least cost is the H-Pile. The equipment rental for drilling the drilled shafts costs much more than the total cost of both pipe and H piles. The additional cost per pile and of the rebar and concrete makes the pipe piles less desirable than the H-piles. The H-Pile is the accepted design alternative for the bridge foundation.

Table 4 Foundation Cost Estimate

Pay Item	Pay Unit	H piles	Drilled Shafts	Pipe Piles
Concrete	Cubic Yard	0	$$$	$12000
Reinforcing Steel	Pound	0	$$$	$3920
Piles	Linear Foot	$128700		$204600
Drive Piles	Each	$120000		$168000
Equipment Rental	Lump Sum		$1000000	
Total		$248700	$1000000+	$388520
	Preferred Alternative	**H-Piles**		

The alpha method for calculating the capacity of the H-piles is accepted for clayey soils (Corduto, 2001). The general soil conditions, as seen in Figure 1, show a stiff silty to clayey soil. The alpha method requires undrained shear strength for the soil. A value of 1500 lb/ft^2 (Corduto, 2001) for the undrained shear strength of the soil is commonly used for stiff clay and silt. Details of the alpha method calculation, as well as the total bearing capacity of an H14x117 for different depths of soil can be found in Table 5. At a depth of 80-feet, the pile capacity meets the ultimate load of the bridge. A more detailed geotechnical report needs to be investigated before final pile design should be completed. A uniform soil condition has been assumed for stiff clayey soils. Soil conditions may be better or much worse at the site.

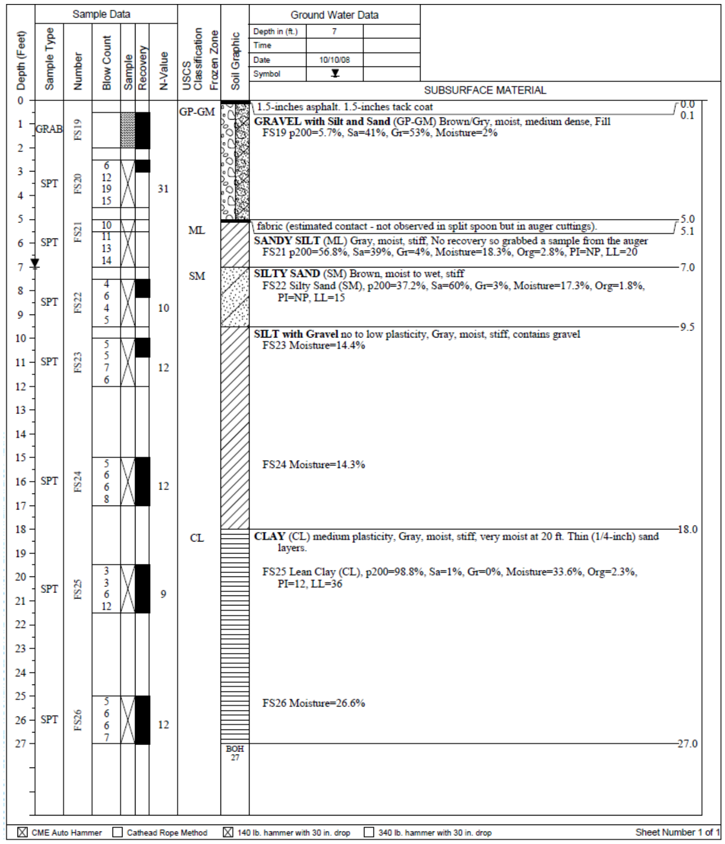

Figure 1   Geotechnical Report from ADOT at bridge location (ADOT, 2008).

Table 5   Alpha Method for HP14x117

depth	s_u		f_s	A_s	f_sA_s	total beari
ft	#/ft^2	alpha	#/ft^2	ft^2	(k)	kips
0	1500	0.5	750	0.00	0	17.4
5	1500	0.5	750	23.33	17.5	34.9
10	1500	0.5	750	46.67	35	52.4
15	1500	0.5	750	70.00	52.5	69.9
20	1500	0.5	750	93.33	70	87.4
25	1500	0.5	750	116.67	87.5	104.9
30	1500	0.5	750	140.00	105	122.4
35	1500	0.5	750	163.33	122.5	139.9
40	1500	0.5	750	186.67	140	157.4
45	1500	0.5	750	210.00	157.5	174.9
50	1500	0.5	750	233.33	175	192.4
55	1500	0.5	750	256.67	192.5	209.9
60	1500	0.5	750	280.00	210	227.4
65	1500	0.5	750	303.33	227.5	244.9
70	1500	0.5	750	326.67	245	262.4
75	1500	0.5	750	350.00	262.5	279.9
80	1500	0.5	750	373.33	280	297.4
85	1500	0.5	750	396.67	297.5	314.9
90	1500	0.5	750	420.00	315	332.4
95	1500	0.5	750	443.33	332.5	349.9
100	1500	0.5	750	466.67	350	367.4
105	1500	0.5	750	490.00	367.5	384.9
110	1500	0.5	750	513.33	385	402.4
115	1500	0.5	750	536.67	402.5	419.9
120	1500	0.5	750	560.00	420	437.4

3.6 Approaches

The proposed bridge elevation is 113.1 ft MSL, the current road elevation is 103.0 ft MSL. The optimal choice is a 1:10 grade increase over 100 ft on both sides of the bridge. This option has the lowest grade possible without interfering with existing side streets. The required volume for fill for the 1:10 approach is 260,000 cubic feet. Cross-section cut and fill volumes can be seen in Table 6.

Table 6 Cut and Fill Volumes

STA	CUT	FILL
	SQ FT	SQ FT
0+00	40.04	42.77
0+30	17.60	102.39
0+60	83.66	587.60
0+90	0.00	1536.41
1+20	0.00	1887.13
1+50	0.00	0.00
1+80	0.00	2278.46
2+10	0.00	1704.82
2+40	91.21	842.38
2+70	450.00	357.75
3+00	33.58	0.00
Volumes	CUT	FILL
	Cubic FT	Cubic FT
	20378.4	279549.75

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DESIGN STUDY REPORT

APPENDIX E

SOIL CONDITIONS AND PAVEMENT DESIGN

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

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April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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ACMP .... Alaska Coastal Management Plan
ADA .... Americans with Disabilities Act
ADF&G .... State of Alaska Department of Fish and Game
ADOT .... State of Alaska Department of Transportation and Public Facilities
AWMP .... Anchorage Wetlands Management Plan Maps
AWWU .... Anchorage Water and Wastewater Utility
CEA .... Chugach Electric Association, Inc.
DCM .... Design Criteria Manual
DEC .... State of Alaska Department of Environmental Conservation
DHV .... design hourly volume
DSR .... Design Study Report
EA .... Environmental Assessment
H&H .... Hydrologic and Hydraulic
HLB .... Heritage Land Bank
HPM .... Highway Preconstruction Manual
HTNA .... Highway Traffic Noise Study
LOS .... level-of-service
LRTP .... Long range Transportation Plan
LUST .... leaking underground storage tank
MEV .... million entering vehicles
MOA .... Municipality of Anchorage
mph .... miles per hour
MSE .... mechanically stabilized earth
MVM .... million vehicle miles
N/A .... not applicable
NWI .... National Wetlands Inventory
OSHP .... Official Streets and Highway Plan
PCM .... Preconstruction Manual
PDO .... Property Damage Only
PER .... Preliminary Engineering Report
PIH .... Plans-In-Hand
ROW .... right-of-way
TAG .... Technical Advisory Group
USACE .... United States Army Corps of Engineers
USC .... under separate cover
USFWS .... United States Fish and Wildlife Service
WDR .... West Dowling Road

1.0 ESAL CALCULATIONS

Equation 1 below is used in order to calculate the ESALs on a given roadway.

$$ESAL = AADT_0 \times G \times L \times Y \times D \times T \times T_f \times 365$$

Equation 1 **Equivalent Single Axle Load**

Where:

$AADT_0$ = Annual Average Daily Traffic at base year
G= Growth
L= Lane Distribution
Y= Design Years
D= Directional Split
T= Truck Percentage
T_f= Truck Factor

Each of the variables in the equation represents a characteristic on the roadway that must be determined.

1.1 Growth Rate

The method used for calculating the ESAL is based on data accumulated by the Asphalt Institute and AASHTO. The first step in this calculation was calculating the AADT. This process would be beyond the scope of our work so the ADOT was able to provide AADT values for 2007, 2010, 2020, and 2030. These values were also used in order to calculate the growth rate and can be seen in Table 1.

Table 1 AADT for the design life of project

Year	AADT	t(years)
2007	9257	0
2015	1500	8
2020	19015	13
2030	24104	23

The growth rate was found using Equation 2.

$$AADT_T = AADT_0 \, e^{kt}$$

Equation 2 **Population Growth**

Where:

k = growth rate
t = time

Solving for growth rate resulted in Equation 3.

$$k = ln\left(\frac{AADT_T}{AADT_0}\right) \times t^{-1}$$

Equation 3 **Growth Rate**

Using the AADT values for 2007 and 2030 resulted in a growth rate of 4.2 %. This growth rate along with design years was used in Equation 4 to determine G in the ESAL equation.

$$G = \frac{1}{2}\left[1 + (1 + k)^{Y}\right]$$

Equation 4 **Growth Factor**

1.2 Other Factors

Many of the other factors used were predetermined by the ADOT and listed in the design criteria. For example, the base AADT, truck percentage and design years were given as 9257, 8% and 20 years, respectively. The other factors that needed to be determined were primarily determined from tables of predetermined data compiled by AASHTO and the Asphalt Institute. The truck factor was determined by the classification of the corridor. In the design criteria provided by the ADOT classifies the Dowling corridor as a minor arterial in a rural system and with this data a truck factor of 0.21 was determined from Table 2.

Table 2 Truck Factors for Different Highway and Vehicle Classes

	Truck factors											
	Rural systems						Urban systems					
				Collectors								
Vehicle type	Interstate	Other Principal	Minor Arterial	Major	Minor	Range	Interstate	Other Freeways	Other Principal	Minor Arterial	Collectors	Range
Single-unit trucks												
2-axle, 4-tire	0.003	0.003	0.003	0.017	0.003	0.003–0.017	0.002	0.015	0.002	0.006	—	0.006–0.015
2-axle, 6-tire	0.21	0.25	0.28	0.41	0.19	0.19–0.41	0.17	0.13	0.24	0.23	0.13	0.13–0.24
3-axle or more	0.61	0.86	1.06	1.26	0.45	0.45–1.26	0.61	0.74	1.02	0.76	0.72	0.61–1.02
All single units	0.06	0.08	0.08	0.12	0.03	0.03–0.12	0.05	0.06	0.09	0.04	0.16	0.04–0.16
Tractor semitrailers												
4-axle or less	0.62	0.92	0.62	0.37	0.91	0.37–0.91	0.98	0.48	0.71	0.46	0.40	0.40–0.98
5-axle[b]	1.09	1.25	1.05	1.67	1.11	1.05–1.67	1.07	1.17	0.97	0.77	0.63	0.63–1.17
6-axle or more[b]	1.23	1.54	1.04	2.21	1.35	1.04–2.21	1.05	1.19	0.90	0.64	—	0.64–1.19
All multiple units	1.04	1.21	0.97	1.52	1.08	0.97–1.52	1.05	0.96	0.91	0.67	0.53	0.53–1.05
All trucks	0.52	0.38	$\boxed{0.21}$	0.30	0.12	0.12–0.52	0.39	0.23	0.21	0.07	0.24	0.07–0.39

a Compiled from data supplied by the Highway Statistics Division, U.S. Federal Highway Administration.
b Including full-trailer combinations in some states.
Source. After AI (1991).

Similarly, the lane distribution value was determined from Table 3 and Table 4. The Dowling corridor will have 2-lanes running in either direction, therefore the lane distribution from Table 3 is 45% and from Table 4 it is 80-100 percent. Since the value from Table 3 is given as traffic percentage based on all four lanes, the value must be multiplied by two. This would result in a 90% lane distribution that falls within the range given by Table 4. Therefore 90% was used as the lane distribution value.

Table 3 Lane Distribution, AI

Number of traffic lanes in two directions	Percentage of trucks in design lane
2	50
4	$\boxed{45}$ (35–48)[a]
6 or more	40 (25–48)[a]

[a] Probable range.
Source. After AI (1981a).

Table 4 Lane Distribution, AASHTO

No. of lanes in each direction	Percentage of 18-kip ESAL in design lane
1	$\boxed{100}$
2	80–100
3	60–80
4	50–75

Source. After AASHTO (1986).

The directional split is assumed at 50% unless traffic data can be recorded and the value proven different.

1.3 Calculated EASL

Once all the values needed for the EASL calculation were determined a result of 832,704 EASLs was found for the Dowling corridor. This value helps use determine the thickness of the pavement based on different methods. Some methods are limited by the EASL value. For example, the Excess fines method could only be used if the EASL is under one million.

2.0 EXCESS FINES METHOD

This method is used in order to determine the pavement thickness. Iteratively, it can also be used to determine base and subbase thicknesses. This method is part of the Alaska Flexible Pavement Design manual and relates deflection to fines found in the pavement structure. For this method, a P_{200} content for the base, subbase and subgrade must be evaluated and then compared with a graphical curve in order to determine the pavement thickness. By choosing the thicknesses of each layer an iterative process can take place until desired thicknesses are found. Table 5 shows the calculations required in order to determine the excess fines factor EFF for each 1-inch layer of material. Next, the EFF values are summed together and then entered into a formula to determine the maximum deflection, D_p. This value and the ESAL can then be used in Figure 1 to determine pavement thickness. With a D_P value of 0.65 and an ESAL of 832,704, the pavement thickness required was approximately 5 inches.

Table 5 Excess Fines Method Calculations

Layer Number	Depth	P_{200}	P_{CR}	Excess Fines	SRF @ Top	SRF @ Bottom	ΔSRF	EFF
1	0-1	5	5.745475	0	0	0.063842	0.063842	0
2	1-2	5	5.878895	0	0.063842	0.153625	0.089783	0
3	2-3	5	6.018658	0	0.153625	0.235296	0.081671	0
4	3-4	5	6.165228	0	0.235296	0.309397	0.074101	0
5	4-5	8	6.319115	1.680885	0.309397	0.376451	0.067054	0.10159
6	5-6	8	6.480881	1.519119	0.376451	0.436962	0.060511	0.084549
7	6-7	8	6.651147	1.348853	0.436962	0.491417	0.054455	0.069185
8	7-8	8	6.830601	1.169399	0.491417	0.540284	0.048867	0.055384
9	8-9	8	7.020007	0.979993	0.540284	0.584014	0.043729	0.043028
10	9-10	8	7.220217	0.779783	0.584014	0.623036	0.039022	0.031981
11	10-11	8	7.432181	0.567819	0.623036	0.657764	0.034728	0.022083
12	11-12	8	7.656968	0.343032	0.657764	0.688594	0.030829	0.013099
13	12-13	8	7.895776	0.104224	0.688594	0.7159	0.027307	0.004473
14	13-14	8	8.149959	0	0.7159	0.740042	0.024142	0
15	14-15	8	8.421053	0	0.740042	0.761358	0.021316	0
16	15-16	8	8.710801	0	0.761358	0.780171	0.018812	0
17	16-17	8	9.0212	0	0.780171	0.796782	0.016611	0
18	17-18	8	9.354537	0	0.796782	0.811477	0.014695	0
19	18-19	40	9.713453	30.28655	0.811477	0.824521	0.013044	0.19972
20	19-20	40	10.10101	29.89899	0.824521	0.836163	0.011642	0.176418
21	20-21	40	10.52078	29.47922	0.836163	0.846631	0.010469	0.156857
22	21-22	40	10.97695	29.02305	0.846631	0.856138	0.009507	0.140678
23	22-23	40	11.47447	28.52553	0.856138	0.864876	0.008738	0.127519
24	23-24	40	12.01923	27.98077	0.864876	0.873018	0.008143	0.117019
25	24-25	40	12.6183	27.3817	0.873018	0.880722	0.007704	0.108814
26	25-26	40	13.28021	26.71979	0.880722	0.888125	0.007403	0.102535
27	26-27	40	14.01542	25.98458	0.888125	0.895347	0.007221	0.097811
28	27-28	40	14.8368	25.1632	0.895347	0.902487	0.007141	0.094265
29	28-29	40	15.76044	24.23956	0.902487	0.90963	0.007143	0.091512
30	29-30	40	16.80672	23.19328	0.90963	0.916839	0.007209	0.089157
31	30-31	40	18.0018	21.9982	0.916839	0.92416	0.007321	0.086792
32	31-32	40	19.37984	20.62016	0.92416	0.93162	0.007461	0.083988
33	32-33	40	20.98636	19.01364	0.93162	0.93923	0.00761	0.080283
34	33-34	40	22.8833	17.1167	0.93923	0.94698	0.00775	0.075165
35	34-35	40	25.15723	14.84277	0.94698	0.954842	0.007862	0.068036
36	35-36	40	27.93296	12.06704	0.954842	0.96277	0.007928	0.058139
37	36-37	40	31.39717	8.602826	0.96277	0.970701	0.007931	0.044364
38	37-38	40	35.84229	4.157706	0.970701	0.978551	0.007851	0.024546

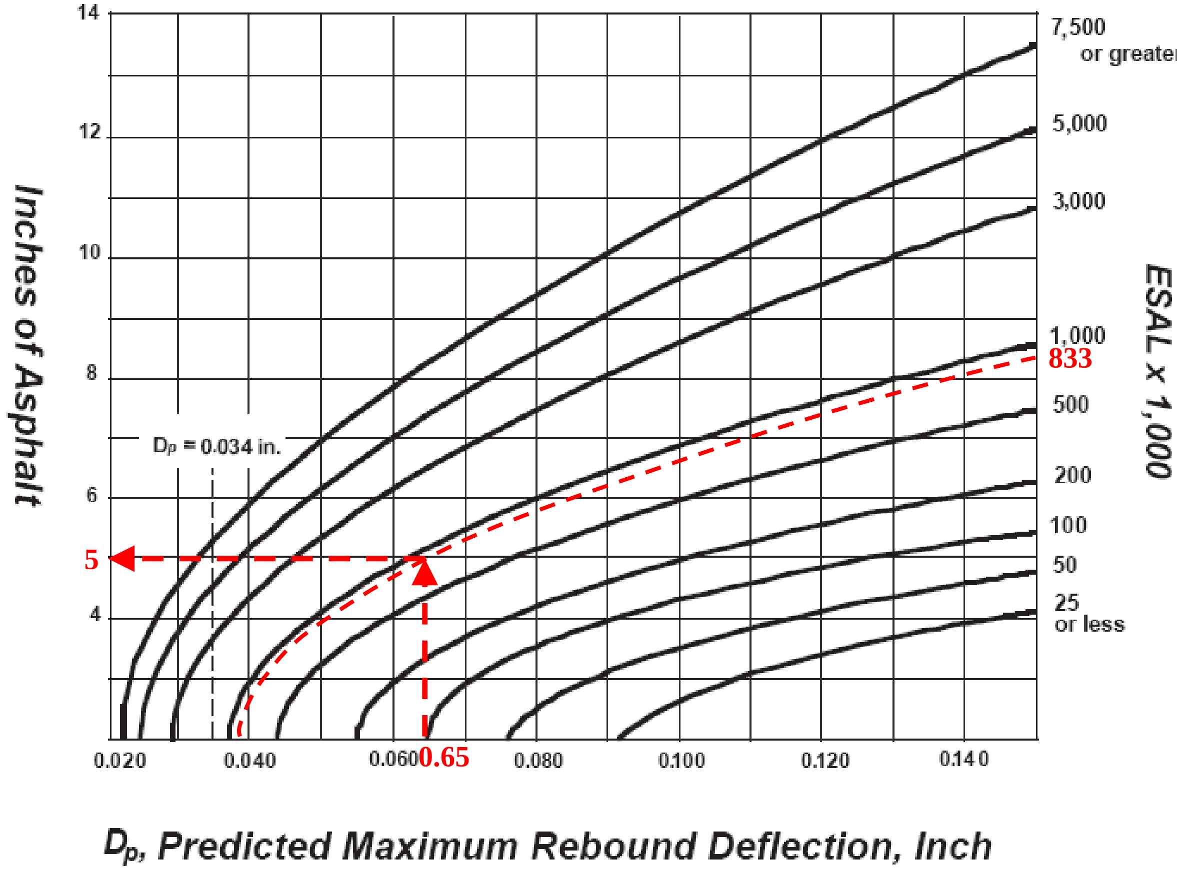

Figure 1 Pavement Design Chart

3.0 AASHTO DESIGN METHOD

The AASHTO method is based on design factors that are specific to the local area. Equation 5 is used in order to determine the layer thicknesses.

$$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

Equation 5 **AASTO Design Method**

Where:

SN= structural number
a_i= representative coefficient for layer i
D_i= actual thickness in inches of layer i
M_i= drainage coefficient for layer i

Using Equation 5 the structural number can be found for the embankment layer. Equation 5 can also be solved for each layer as shown in Figure 2. By calculating the SN value, the layer thickness can be determined without having to iterate or assume any values.

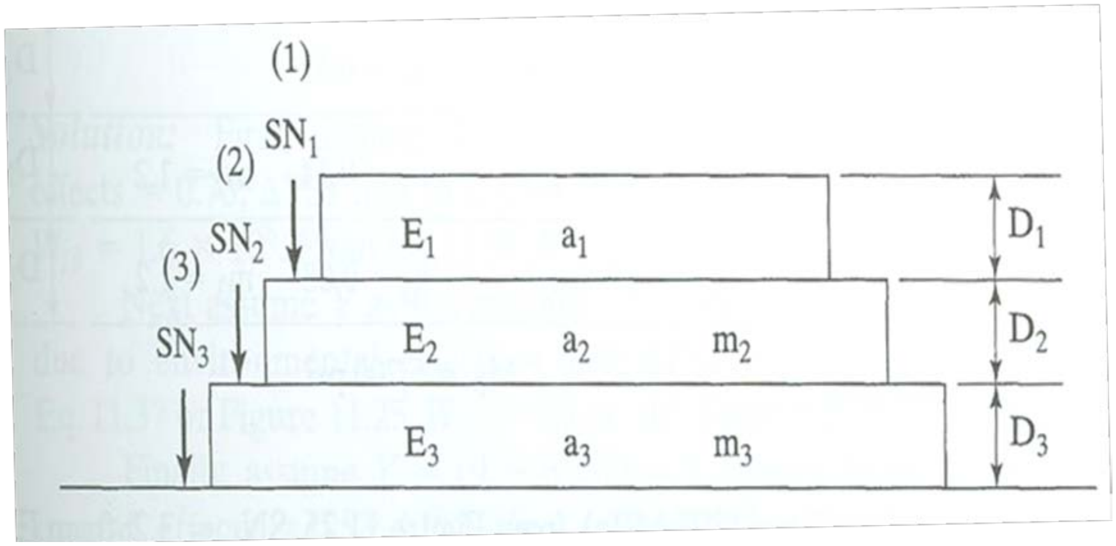

Figure 2 Thickness Determination

3.1 Representative Coefficient Determination

The representative coefficient depends mainly on material characteristics. This coefficient can be related to the material through various field tests and compiled data tables. The values most commonly used are the California Bearing Ratio, CBR and the Modulus or Resilience, M_R. There are also tables that relate the CBR and M_R to soil classifications such as sands, clays, silts or gravels.

For the Dowling Corridor, the coefficients were determined by using M_R values found in the Alaska Flexible Pavement Manual for the common subbase and base material used in Alaska.

3.2 Drainage Coefficient Determination

For the Alaska region, drainage is an important concern due to the cold differential climate. The main resource used to determine the drainage coefficients are shown in Table 6 and Table 7. Since surface pooling is common in Alaska the quality of drainage was assumed to be poor. In addition, the amount of time that the ground is saturated is very high in Alaska due to winter conditions and summer thawing. From these assumptions, a drainage coefficient of 0.6 was chosen for all layers.

Table 6 Drainage Quality

Table 19.5 *Definition of Drainage Quality*

Quality of Drainage	*Water Removed Within**
Excellent	2 hours
Good	1 day
Fair	1 week
Poor	1 month
Very poor	(water will not drain)

*Time required to drain the base layer to 50% saturation.

Table 7 Coefficient of Drainage

Quality of Drainage	Percent of Time Pavement Structure Is Exposed to Moisture Levels Approaching Saturation: Less Than 1%	1 to 5%	5 to 25%	Greater Than 25%
Excellent	1.40–1.35	1.35–1.30	1.30–1.20	1.20
Good	1.35–1.25	1.25–1.15	1.15–1.00	1.00
Fair	1.25–1.15	1.15–1.05	1.00–0.80	0.80
Poor	1.15–1.05	1.05–0.80	0.80–0.60	0.60
Very poor	1.05–0.95	0.95–0.75	0.75–0.40	0.40

3.3 Other Factors

In order to determine the SN values Figure 3 and Figure 4 were used for Alternative 1 and Alternative 2, respectively. These figures required other variables to be determined such as reliability, standard deviation and the initial and terminal serviceability indices. The reliability was found to range from 80 to 99 % for urban arterials. For the two alternatives, a different reliability was used. Since the data was not determined through precise calculations, lower reliability values needed to be used in order not to under design the structure. 80 and 90 % reliability values were used for Alternative 1 and 2, respectively. The standard deviation for flexible pavements is assumed to range from 0.40 to 0.50, so a value of 0.45 was used. The initial serviceability index depends on the construction and quality of the pavement, so it was assumed that the value would be 4.5. The terminal serviceability index is assumed to be 2.5. The difference of these two values is used in Figure 3 and Figure 4 as ΔPSI to determine SN. In addition, EASL and the M_R values that were used earlier will need to be used in order to plot the lines and determine the SN values.

3.4 Design Alternatives

Once all the preliminary data has been acquired, the lines are plotted in as shown in Figure 3 and Figure 4 to determine the SN values for each layer of the pavement structure. Next using Equation 5 the thicknesses for each layer may be determined. Figure 3 and Figure 4 show the results of these lines.

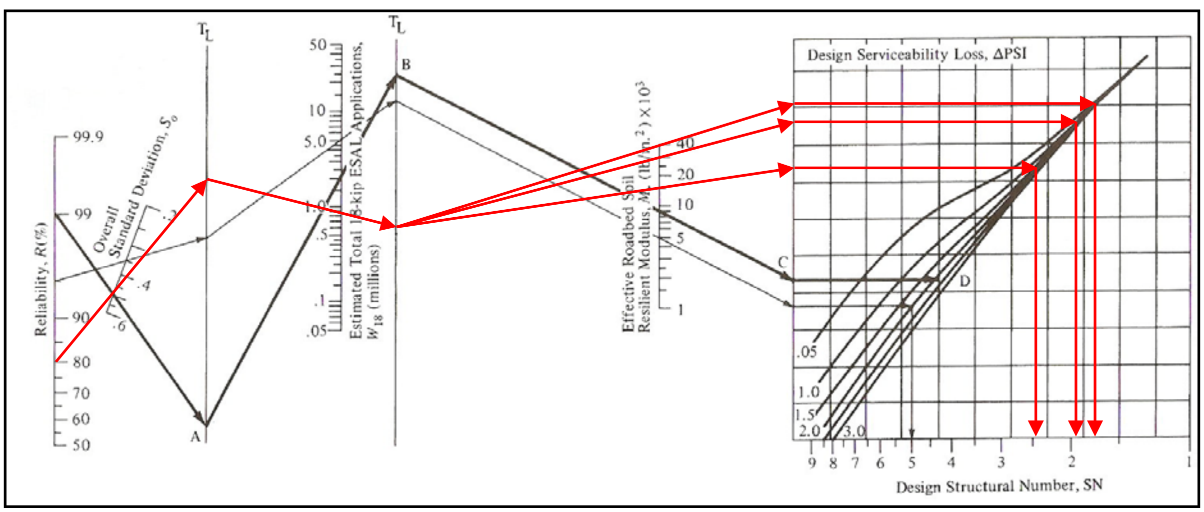

Figure 3 SN determination, Alternative 1

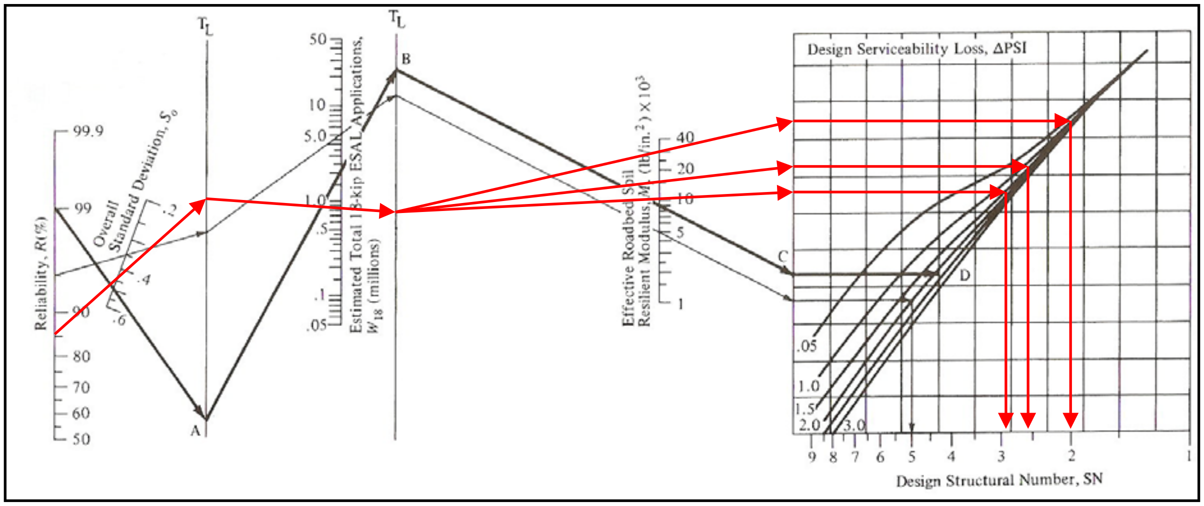

Figure 4 SN determination, Alternative 2

Table 8 and Table 9 show the results for the pavement thicknesses for Alternatives 1 and 2, respectively. Based on AASHTO standards, minimum thicknesses for the asphalt layer and base course must be met when designing the structure and can be seen in the tables.

Table 8 Layer Thicknesses, Alternative 1

Preliminary Data	P_i	Pt	ΔPSI	Reliability	Std Dev.
	4.5	2.5	2	80%	0.45

Description	M_r	m_i	a_i	SN	D_i (in)	Min. D (in.)	Chosen D (in)
Asphalt	450	----	0.45	1.7	4	3	4
Base	40	0.6	0.17	1.9	2	6	6
Subbase	30	0.6	0.15	2.45	7		7
Subgrade	15	0.6					

Table 9 Layer Thicknesses, Alternative 2

Preliminary Data	P_i	Pt	ΔPSI	Reliability	Std Dev.
	4.5	2.5	2	90%	0.45

Description	M_r	m_i	a_i	SN	D_i (in)	Min. D (in.)	Chosen D (in)
Asphalt	450	----	0.45	2	4	3	4
Base	30	0.6	0.139	2.6	8	6	8
Subbase	15	0.6	0.115	2.9	5		5
Subgrade	10	0.6					

4.0 PAVEMENT QUANTITIES

Quantities for each material in the pavement structure were calculated by multiplying the length of the project by the cross-sectional area of the material in the typical cross section. An additional fifteen percent was added on for intersections, minor roads and curve correction. The calculations can be viewed in Table 10.

Table 10 Pavement Quantities

Structure		Cross Section				Length	Volume		Plus 15% *
Layer	Material	Depth (in)	Depth (ft)	Width (ft)	Area (ft^2)	(ft)	(ft^3)	(yrd^3)	(yrd^3)
Wear	Type V-R	2.00	0.17	70.0	11.67	3444.6	40186.5	1488.4	1711.6
Binder	Type II	3.00	0.25	70.0	17.50	3444.6	60279.8	2232.6	2567.5
Base	50/50, RAP/D11	4.00	0.33	70.0	23.33	3444.6	80373.1	2976.8	3423.3
Sub-base	Select Material A	40.00	3.33	70.0	233.33	3444.6	803730.7	29767.8	34233.0
			TOTALS:		**285.83**		**984570.1**	**36465.6**	**41935.4**
			*Plus 15% for Intersections, minor roads and curve correction.						

5.0 SOURCES

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DESIGN STUDY REPORT

APPENDIX F

UTILITY CONFLICT REPORT

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
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April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ACS .... Alaska Communication System
AWWU .... Anchorage Water and Waste Water Utility
CB .... catch basin
CEA .... Chugach Electric Association
CMP .... corrugated metal pipe
DOT&PF .... State of Alaska Department of Transportation and Public Facilities
GCI .... General Communications, Inc.
LT .... left
OH .... overhead
ROW .... right-of-way
RT .... right
SD .... storm drain
SDMH .... storm drain manhole
SS .... sanitary sewer
SSMH .... sanitary sewer manhole
UG .... underground
X-ING .... crossing

1.0 PROJECT SUMMARY

The primary objective of the West Dowling Road Extension and Reconstruction project is to provide additional road connectivity and relieve traffic congestion in east Anchorage. The project area includes the West Dowling corridor between Old Seward Highway and C Street (see Figure 1 for Vicinity Map). Construction of a connection at Old Seward Highway will reduce the amount of traffic passing through the Lake Otis Parkway and Tudor Road intersection (a major congestion area) by providing an alternative routing for traffic between east and south Anchorage. The project includes reconstructing and upgrading the existing roadway to a 5-lane urban section from Old Seward Highway to C Street, a total of 0.6 miles. The project must be cost effective, compliant with current design standards, and meet the needs of the traveling public through the design year 2025.

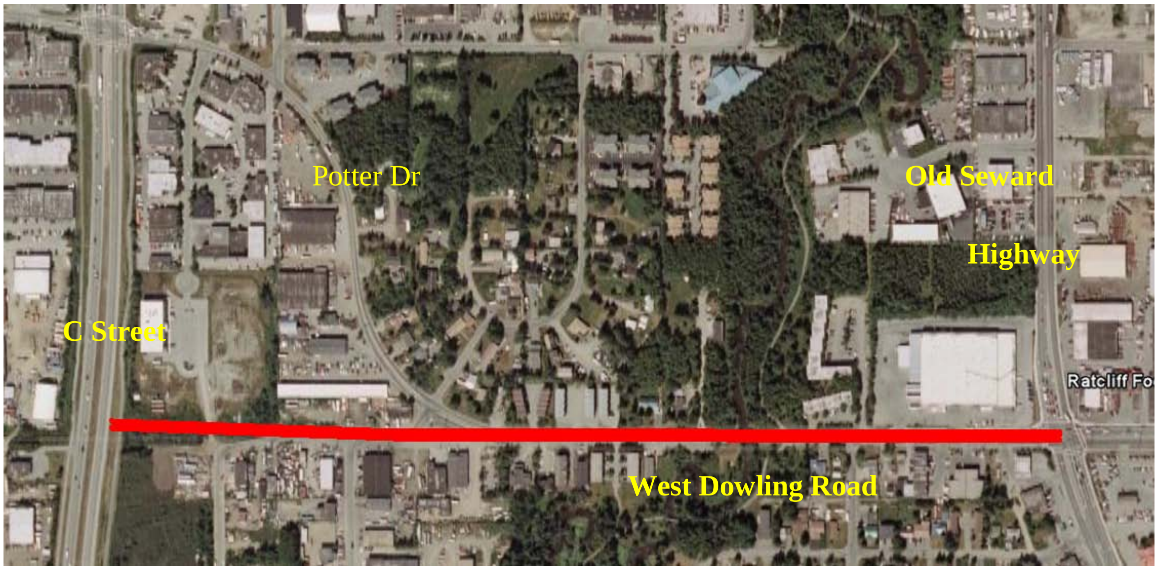

Figure 1 Vicinity Map

2.0 PURPOSE

This report presents conflicts identified between the proposed improvements and existing utilities within the project corridor and discusses recommendations for resolution that resulted from coordination with utility companies and the ADOT. Local review level plan and profile drawings of the corridor are available for use in viewing existing utilities, proposed improvements, and resulting conflicts. The plan sheets show proposed improvements over a base map compiled from field survey and as-built data. These same drawings will be sent to individual utility companies for their use in evaluating the accuracy of the base map and completing utility relocation designs, if any are required.

Design of the proposed water, sanitary sewer, and storm drain improvements are being designed by Blue Fox Universal. All other relocations will be designed by others.

2.1 Scope

Utilities covered in this report include:

- Water and sanitary sewer lines owned by Anchorage Water and Waste Water Utility (AWWU),
- Electrical distribution and transmission lines owned by CEA,
- Telecommunication lines and fiber optic cable owned by both Alaska Communication Systems (ACS) and General Communications Inc. (GCI),
- Traffic signalization,
- Natural gas lines owned by ENSTAR,
- Cable television lines owned by General Communications Inc. (GCI) and ACS

Utility appurtenances that may remain because no major conflicts result from proposed improvements will be adjusted to final grade. Such appurtenances include, but are not limited to, manholes (sanitary sewer and storm sewer), valve boxes, junction boxes, and all utilities pedestals.

3.0 FINDINGS BY UTILITY

The conflicts found between existing utilities and proposed improvements are presented here by utility. Section 4.0 lists these conflicts in tabular form by utility. The information below was synthesized using as-built (record) drawings, aerial photography data, and site visit information.

Minimum Standards utilized for this study include:

• Depth Bury	36 inches	17 AAC 15.211(d)
• Depth of Bury, Road	48 inches	17 AAC 15.211(d)
• Vertical Clearance, Existing	18 feet	17 AAC 15.201
• Vertical Clearance, New	20feet, 6 inches	T 1130-1 PCM
• Separation to Power	10 feet	AS 18.60.670
• Face of Curb Offset	2 feet	17 AAC 15.171(e)

3.1 Anchorage Water and Wastewater Utility Water Lines-AWWU

AWWU owns and operates a water system providing service in the project area. The primary features of the water system in the project area are as follows:

- A 16-inch water line runs on the south side of West Dowling Road from C Street to 50 feet west of A Street where it crosses to the north side of West Dowling Road.
- A water line crosses from the north side of West Dowling at Station 20+25 south along center of A Street.
- The 16 inch water line connects to a line that runs south at 24+75 to run along Cordova Street and connects to run north at 24+75 to connect with a 16 inch line that runs west up Potter and continues east along the north side of West Dowling Road.
- The 16-inch line is located to the north of West Dowling Road in the vicinity of the bridge crossing Campbell Creek. Possible conflict with the bridge pilings.
- Water line tapped to north at Station 38+10.
- The 16 water line located in the middle of West Dowling Road as approaches Old Seward Highway. Water tap occurs at Station 44+55, to the south along west side of Old Seward Highway.
- Valve boxes will require adjustments to finished grade.

3.2 Sanitary Sewer Line Facilities – AWWU

AWWU owns and operates a sanitary system including a 48-inch sanitary sewer main along West Dowling Road between C Street and Old Seward Highway. The sewer main runs along the south side of the existing bridge over Campbell Creek. Possible conflict with the proposed bridge pilings.

3.3 Storm Sewer Lines

Drainage from West Dowling Road between C Street and Old Seward Highway is collected in several storm sewer lines.

Proposed roadway improvements for West Dowling Road and intersecting roadways will include pavement surfacing with curb and gutter.

3.4 Electrical Distribution System – CEA

Electrical distribution lines in the corridor are owned and operated by CEA. Properties located along West Dowling Road have electrical power served by both overhead and underground distribution lines running parallel with West Dowling Road on both the north and south side.

CEA has an overhead transmission main line that routes the full length of the project corridor along the south side of West Dowling Road. This main line provides power to most of South Anchorage.

Electric overhead lines cross West Dowling Road five times within the project area. The crossings occur at these (approximate) locations:

- Station 21+80
- Station 25+00
- Station 27+75
- Station 28+60
- Station 37+15

Underground electric lines cross West Dowling Road once within the project area. This crossing occurs at this (approximate) location:

- From the electrical load centers at the NW corner of Old Seward Highway, south at 43+85 to the southwest corner crossing Old Seward Highway eastward to an electrical vault located at 45+40 on the southeast corner of Old Seward Highway.

Underground electrical lines will need to be relocated from within the project area. This conflict occurs at this (approximate) location:

- The underground drop from the load center at 35+80 North and east to North Austin.

Overhead electric lines cross Cordova, Potter, and Austin within the project area. Crossing heights will require checking to meet standards.

Several load centers are located within the proposed roadway area and will require relocation. These are located at these (approximate) locations:

- Station 23+50
- Station 31+90
- Station 35+80

The electrical distribution lines located to the north of West Dowling Road from C Street to Old Seward Highway are in the proposed project area and will have to be relocated. The service drops to customers will also need to be relocated.

Street luminaries will need to be replaced along the project corridor.

3.5 Telecommunications

Telecommunication facilities for the project are owned by ACS and GCI. Underground telephone lines are within the West Dowling Road ROW. The following summarizes ACS and GCI telecommunications conflicts:

- Underground telephone lines are present along the north side of West Dowling Road from Station 19+50 to 28+35.
- Underground telephone lines are present along the south side of West Dowling Road from Station 28+35 to 37+15.
- Underground telephone lines are present along the north side of West Dowling Road and Potter Street from West Dowling Road crossing at Station 25+35.
- Underground telephone lines are present along the north side of West Dowling Road from Station 37+15 to telephone vault at Station 43+50.
- Underground line from telephone vault at Station 43+50 crossing West Dowling Road south at Station 43+00 and crossing Old Seward Highway to telephone vault on southeast side of Old Seward Highway/West Dowling Road intersection.
- Underground line from telephone vault at Station 43+50 crossing Old Seward Highway to the north continuing south at Station 45+10 and crossing West Dowling Road to telephone vault on southeast side of Old Seward Highway/West Dowling Road intersection.
- Underground line from Station 45+10 along north West Dowling Road east of Old Seward Highway intersection.
- At Station 26+70 the telephone crosses from the south side of West Dowling Road on the overhead electrical poles to pedestal on the north side located at approximately 27+15. Apparent feed on north of West Dowling Road for Potter Road line
- Underground crossings of West Dowling Road occurs at these (approximate) locations:
    - At Station 20+40 from north side of West Dowling Road to the south and continues south on A Street's east side.
    - At Station 37+15from south side of West Dowling Road to telephone pedestal on north side and continues south on Austin Avenue west side.

Six telephone pedestals on the north side of West Dowling relocation due to proposed roadway alignment.

3.6 Traffic Signalization

Existing loop detectors are located in all traffic lanes at the intersection of Old Seward and West Dowling Road. Additional loops and associated hardware may be needed and loops may need to be relocated as part of the signal modifications. Additional loops and associated hardware will be needed and added at the upgraded intersection of West Dowling Road and C Street.

3.7 Natural Gas Lines – ENSTAR

ENSTAR owns and operates a natural gas distribution system providing service in the project area. ENSTAR has an underground gas line within the West Dowling Road ROW running parallel along the south side of West Dowling Road from C Street to Old Seward Highway. Underground crossings of West Dowling Road occur at these approximate locations:

- Station 23+05 north along west side E Potter Drive. Service connection crosses E Potter Drive east to Franklin Drive.
- Station 24+80 north for two service locations
- Station 25+95
- Station 27+15
- Station 36+00
- Station 42+25

Underground crossings of other streets within the project area occur at the following locations:

- Crosses A
- Crosses Austin Avenue
- Crosses south of Old Seward Highway intersection at Station 42+25 continuing east along Dowling Road.

Possible underground natural gas conflict with proposed bridge over Campbell Creek. Relocation may be necessary depending on new roadway alignment.

3.8 Cable Television and Fiber Optic Lines - GCI and ACS

GCI and ACS own underground cable television in the project area. GCI and ACS own optical lines in the project area. Both lines are north of the roadway and may have to be relocated. The underground cable lines run from Station 40+10 to the north west corner of Old Seward Highway. Caution will need to be taken during excavation.

4.0 ILLUMINATION

Dowling Road is classified as a Class III Major Arterial in the OSHP. Continuous lighting is recommended to reduce potential collisions between moose and vehicles.

4.1 Existing Conditions and Design Criteria

An average illumination level of 1.3-foot candles with an average to minimum uniformity ratio of 3:1 for medium pedestrian conflict areas is recommended according to Table 5-1 of the MOA DCM. Pedestrian facilities are required to meet the recommended values of Table 5-4 in the MOA DCM when continuous roadway lighting will be provided. Medium pedestrian conflict area average illumination levels identified in the table are 0.5 foot candle (horizontal), 0.2 foot candles (vertical), with a 4.1 average to minimum uniformity ratio.

Recommended road and pathway illumination levels will be achieved by mounting single luminaire electroliers along each side of the road at on-center pole spacing of 150 feet with approximately 29 pole locations along each side of WDR. Matching existing lighting is recommended as current LED technology does not provide recommended lighting values concerning light output.

5.0 SUMMARY OF UTILITY CONFLICTS AND POTENTIAL RESOLUTION

Existing monuments, traffic control junction boxes, valve boxes, key boxes, manhole lids, and cleanouts, which are to remain in their current locations (because they do not interfere with the proposed options), will be adjusted to final grade. Relocation of existing culverts, signage, driveways, fences, etc. is not covered in this report because it is not consistent with a reconnaissance level report. They will be covered in the construction documents.

6.0 PRELIMINARY COST ESTIMATES FOR RECOMMENDED RELOCATION WORK BY UTILITY

The following table presents preliminary cost estimates for utility relocations that have been proposed in this report. Factors that could increase costs include dewatering problems, traffic control and construction phasing, any requirement to extend muck excavation limits, and boring for utilities under Campbell Creek. Factors that could result in cost savings include joint trenching not already considered, modifying slope limits to remove conflicts, resolving to protect rather than relocate utilities, and reducing the extent of muck excavation. As coordination with each utility continues, conflict resolutions will be finally negotiated, and estimated costs for such work will be detailed.

Table 1 Relocation Cost Estimate

Utility	Costs
Water	$1,022,000
Sanitary Sewer	$302,000
Electric	$1,087,000
Telecommunication	$529,000
Traffic	$189,000
Natural Gas	$712,000
Cable Television	$203,000
Totals	$4,044,000

6.0 Sources

Alaska Department of Transportation and Public Facilities. (2006). *Alaska Highway Preconstruction Manual*.

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HDR. (2007). *West Dowling Road Connection Project Revised Environmental Assessment & Programmatic Section 4(f)/6(f) Evaluation STP-0532(5)/55012.* Anchorage: HDR Engineering, Inc.

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DESIGN STUDY REPORT

APPENDIX G

BRIDGE HYDRAULICS

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
Central Region
4111 Aviation Avenue
Anchorage, Alaska 99502

Prepared by:

Blue Fox Universal
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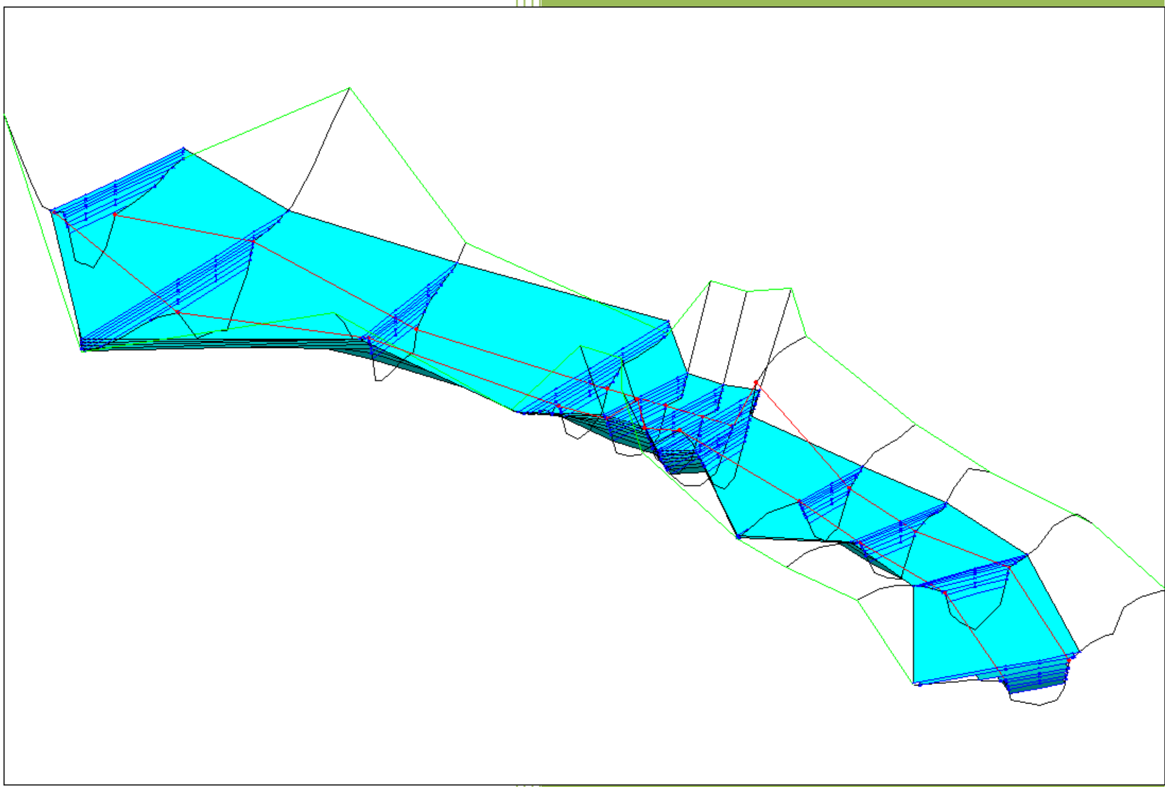
Garrett Yager
Lee Bolling
Ethan Perry

April 20, 2009

2009

West Dowling Phase I – Bridge Hydraulics



Bridge Hydraulics Technical Team

Blue Fox Universal

4/20/2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

FHWA .... Federal Highway Administration
H&H .... Hydrologic and Hydraulic
HEC .... Hydraulic Engineering Center
HEC-RAS .... Hydraulic Engineering Center-River Analysis System
MSL .... Mean Sea Level
SBR .... Set Back Ratio
USACE .... US Army Corps of Engineers
USGS .... US Geological Survey

1.0 MISSION STATEMENT

The bridge hydraulics technical team was established to provide the necessary hydraulic analysis for designing a safe, environmentally friendly and durable bridge for the West Dowling Road extension spanning Campbell Creek. To provide the most reliable data, our tasks will involve the acquisition of relevant hydrologic and topographic data, a hydraulic analysis to evaluate water elevations of different flood events with and without the proposed bridge, and to make scour prevention recommendations to protect the bridge in an environmentally friendly and cost effective manner. The engineers in the technical team will maintain the upmost care for accuracy and remain in constant communication with project managers and other technical teams.

2.0 SCOUR MITIGATION AND STREAM INSTABILITY METHODOLOGY

To address scour and stream instability, the bridge hydraulics engineers followed HEC-20 (Stream Stability and Geomorphic Assessment), HEC-18 (Hydrologic, Hydraulic and Scour Analysis) and HEC-23 (Bridge Scour and Stream Instability Countermeasures) flow charts as laid out in the Federal Highway Administrations Publication No. FHWA NHI 01-003.

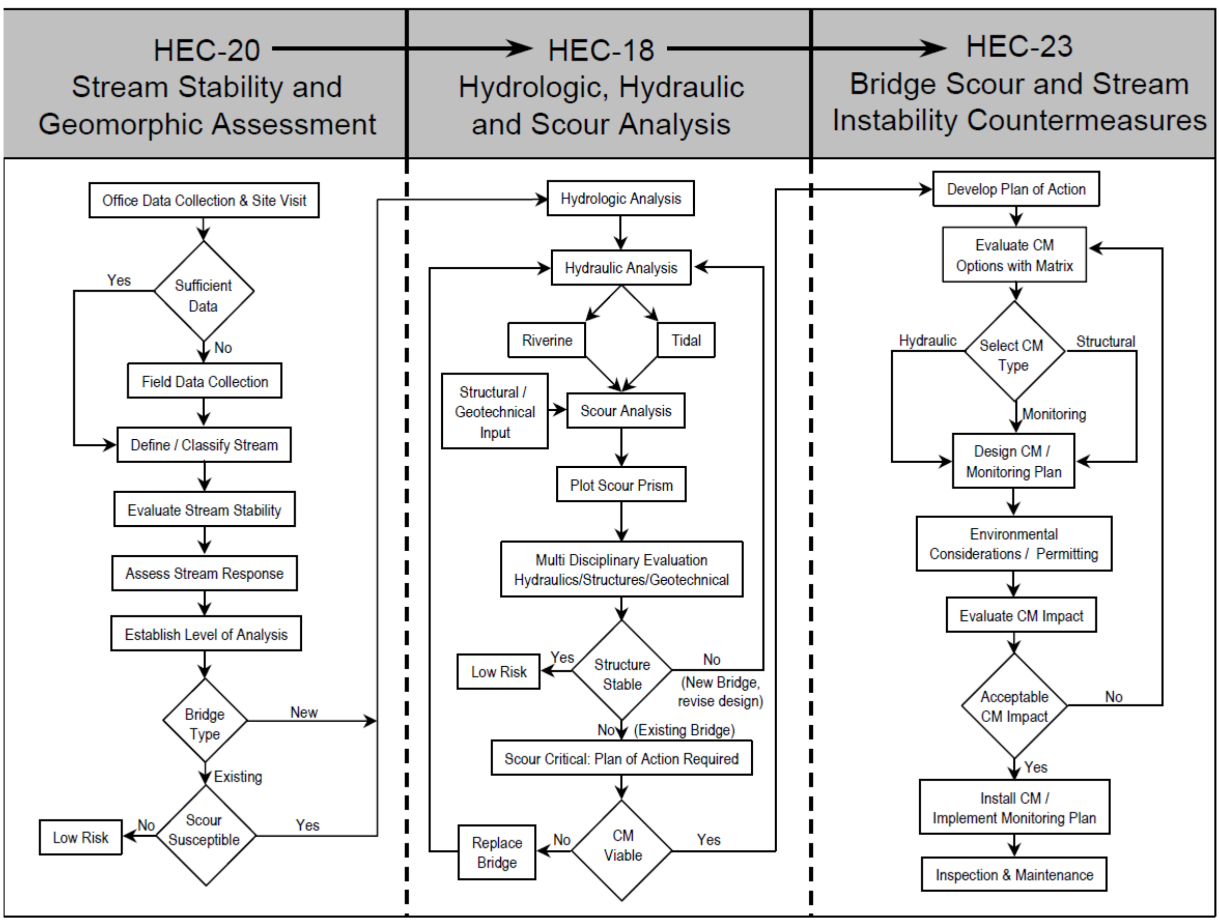


Figure 1 Flow chart for scour and stream stability analysis and evaluation (Federal Highway Administrations Publication No. FHWA NHI 01-003)

2.1 Stream Stability and Geomorphic Assessment (HEC 20)

The bridge hydraulics engineers used the field data provided in the Hydraulic and Hydrologic (H&H) Design study report compiled by HDR Alaska Inc. Do to the time constraints of the project, the H&H report was used to define and classify the stream for this analysis. A summary of the H&H report is detailed in the following sections.

2.1.1 Define/Classify Stream

2.1.1.1 Drainage Basin

Campbell Creek drains much of the front range of the Chugach Mountains immediately east of Anchorage, from Flattop Mountain on the south to Tanaina Peak on the north.

2.1.1.2 Flow Regime

Flow regimes of Campbell Creek

1. May, June and early July - **melting of the winter snow** pack in the upper mountainous part of the basin.
2. Late July and early August - snowmelt contribution declines leading to lower base flows. Rainfall typical of this period results in **peaks from storm runoff** superimposed on the lower base flows.
3. Late August until the end of September - declining temperatures and freeze up in the upper basin lead to a further reduction in base flow but the **largest rainstorms and corresponding highest peak flows of the year commonly occur during this period**.
4. In winter - the creek develops an ice cover and midwinter thaws often overflow the ice resulting in a thick layer of ice filling the creek typically to bankfull level.

2.1.1.3 Basin Characteristics

- 46 square miles drainage basin area of Campbell Creek at Dowling Road
- Influence of urbanization at this location is minimal.

Table 1 Campbell Creek at Dowling Road – Basin Characteristics (HDR Inc, Alaska)

Drainage Area	46	square miles
Mean Basin Elevation	2520	feet
Area of Lakes and Ponds	1	%
Area of Forest	30	%
Area of Glaciers	0	%
Mean Annual Precipitation	22	inches

2.1.1.4 Historical Streamflow Records

Table 2 Campbell Creek Streamflow Records (HDR Inc, Alaska)

Station #	Name	Location	Drainage Area	Period of Record
15273900	South Fork at Canyon Mouth	At Canyon Mouth (upstream of Dowling Road)	25.2	1966-79, 1981
15274000	South Fork near Anchorage	At Campbell Airstrip Road (upstream of Dowling Road)	29.2	1947-71, 1999-2001
15274300	North Fork near Anchorage	At Campbell Airstrip Road	13.4	1974-84, 1967-73
15274550	Little Campbell Creek at Nathan Drive	0.2 miles upstream of confluence with Campbell Creek. (downstream of Dowling Road)	15	1986-1992
15274600	Campbell Creek Near Spenard	At Dimond Boulevard (downstream of Dowling Road)	69.7	1966-1993

2.1.1.5 Peak Flows

- The site is **5 river miles** downstream of the gauging stations on the North and South Forks of Campbell Creek.
- There is approximately **3 square miles** of drainage area between the North and South Fork gauging stations and Dowling Road
- For a 100-year recurrence interval **(Q100)** the recommended design floodflow is **1250 cfs**
- The recommended 500-year flow (**Q500)** is **1700 cfs**.

Table 3 Estimated Flood Flows – Campbell Creek at Dowling Road (HDR Inc, Alaska)

Recurrence Interval (years)	Based on Drainage Area Comparison to South Fork and North Fork Campbell Creek (cfs)	Campbell Creek Discharge based on USGS Regression (cfs)
2	339	339
5	541	525
10	695	665
25	903	855
50	1069	1005
100	1244	1160
200	1429	1323
500	1691	1557
Peak observed	1068	N/A

2.1.1.6 Morphology

The morphology of Campbell Creek changes at Dowling Road.

- Upstream of Dowling Road
    - Creek is incised and the creek is stable.
    - This stability can be seen from historical aerial photography and from a field review of bank vegetation.
    - Numerous large boulders, evidence that the stream has incised into morainal soils.
    - The channel slope of Campbell Creek is **0.002** in the approximately 0.6 mile reach of creek upstream of Dowling Road to the Old Seward Highway.

- Downstream of Dowling Road
    - Creek is actively meandering within a broad floodplain.
    - The overall gradient of Campbell Creek also changes at this point.
    - In a similar valley, length downstream of Dowling Road the channel slope is **0.003**.

2.1.1.7 Ice

- Winter of 2004-05 had **extensive icing**
    - Resulted from a midwinter rain event.
    - The top of ice elevations at the surveyed stream cross sections were surveyed on January 28, 2005 and are shown in Table 4.
- During the same period, the ice was also observed at the existing bridge crossings at International Airport Road, the Old Seward Highway and at C Street.
    - **In all three locations the top of ice was nearly level with the top of the existing bike trail** but had not flowed over the trail.

Table 4 Campbell Creek Ice Elevations on 1/28/05 (HDR Inc, Alaska)

Cross Section #	Location	Ice Elevation
1	Furthest Downstream	93.57
2		93.75
3		94.04
4		94.29
5		94.64
6	South Edge of Existing Dowling Road Bridge	94.75
7	North Edge of Existing Dowling Road Bridge	94.75
8		95.17
9		95.2
10		95.21
11		95.46
12	Furthest Upstream	95.71

2.1.1.8 Sediment

- Deposition of coarser sediment occurs where the creek exits the mountain front.
- Water Investigations Report 91-4074 (USGS) describes sediment load
- Sediment is **25 percent sand and 75 percent silt-clay**.
- Majority of sediment is transported during rainfall generated floods
- Pebble count completed:
    - **D90 ~ 0.67 feet (8 inches)**
    - **D50 ~ 0.25 feet (3 inches)**
    - **D10 ~ 0.06 feet (0.75 inches)**
    - Large boulders in the streambed

2.1.2 Stream Stability

Review of the hydraulic and hydrologic report prepared by HDR, indicates that the stream is stable through the project area. Riprap already in place is, depending on the placement and design of the new bridge, already adequate to protect the stream banks against one hundred-year events, and because of the value of the creek to pink salmon runs every summer, **it is advised that no additional riprap be added below the normal high waterline**. The study advises that, if riprap is needed below this level, trench fill revetments be used.

HDR determined that for a 100 year flow depth, a D_{50} of 0.6 feet is sufficient, while 0.25 feet is present. The maximum scour was found to be about eight feet if the 0.25 feet were to erode. The bridge hydraulic engineers with Blue Fox Universal later verified this size of riprap in section 3.4 of this report.

2.1.3 Assess Stream Response

Initial stream response assessment was conducted by reviewing the Hydrologic and Hydraulic report compiled by HDR.

Table 5 Recurrence intervals and design considerations of flood events (HDR Inc, Alaska)

Recurrence interval	Q2	Q5	Q10	**Q100**	Q500
Exceedance probability	50.0%	20.0%	20.0%	**1.0%**	0.2%
Drainage area	42 sq. mi.	43 sq. mi.	44 sq. mi.	**45 sq. mi.**	46 sq. mi.
Design discharge	340 cfs	550 cfs	700 cfs	**1250 cfs**	1700 cfs
Design velocity	4.7 fps	5.2 fps	5.5 fps	**6.3 fps**	6.9 fps
Design average depth	2.7 ft	3.47 ft	4.0 ft	**5.7 ft**	6.8 ft
Design high water elevation	94.5 ft	95.3 ft	95.8 ft	**97.5 ft**	98.60 ft
Design top width	37 ft	39 ft	41 ft	**54 ft**	59 ft

This analysis is for the river without a bridge. Depending on placement and design, the bridge should have no effect on this analysis. Additional analysis for the proposed bridge design will be conducted using HEC-RAS analytical software.

According to the study, most bridges along the trail system in the area are designed so that anything larger than a five-year event floods the trail. Therefore, it is only necessary to design the trail to be at an elevation of **95.3 ft MSL**, which would also be flooded in these events. This provides a good baseline elevation for bridge design. This elevation was passed on to the bridge design technical team and used for initial design decision involving the bridge deck elevation.

2.2 Hydrologic, Hydraulic and Scour Analysis (HEC 18)

The hydraulic and hydrologic conditions of the proposed West Dowling Road Bridge were analyzed using the US Army Corps of Engineers program (USACE), HEC-RAS. Two conditions were modeled in HEC-RAS. The first hydraulic analysis was run with the existing bridge and streambed topography. The second hydraulic analysis replaced the creek cross sections under the bridge with cross sections designed for the proposed bridge and trail. The design cross sections included the 2:1 slopped abutments and the 12 ft wide trail at an elevation of 96.1 ft. The two hydraulic analyses were compared to evaluate backwater conditions for the proposed bridge design and to compute velocities for abutment scour countermeasure. The HEC-RAS results indicate that a trail at an elevation of 96.1 ft will be submerged with flood events larger than the 5-year flood event.

2.2.1 HEC-RAS Cross Sections Layout and Creek Alignment

The creek alignment used in the HEC-RAS model was digitized from an alignment built in CAD Civil 3D. Topographic data from topographic data of the existing creek bed was provided by DOWL HKM. The alignment was defined approximately 230 ft upstream to about 200 ft downstream of the bridge centerline. Cross sections were defined at each bend in the alignment with additional cross sections placed at the north, south and centerline of the bridge cut resulting in 12 cross sections for the analysis. An image of the creek terrain and alignment was imported into HEC-RAS and digitized to provide the alignment for the river reach in the HEC-RAS model (Figure 2). The cross sections for each river station in the model were built using elevation and offset data from the cross sections developed in the CAD Civil 3D drawing. Stream banks were defined for each cross section. Manning's roughness coefficients were determined to be 0.032 outside of the stream banks and 0.065 in the stream channel. The stream channel had a higher Manning's roughness coefficient because of the larger cobble observed in the streambed (Ref. 3.1.1.8 of this report).

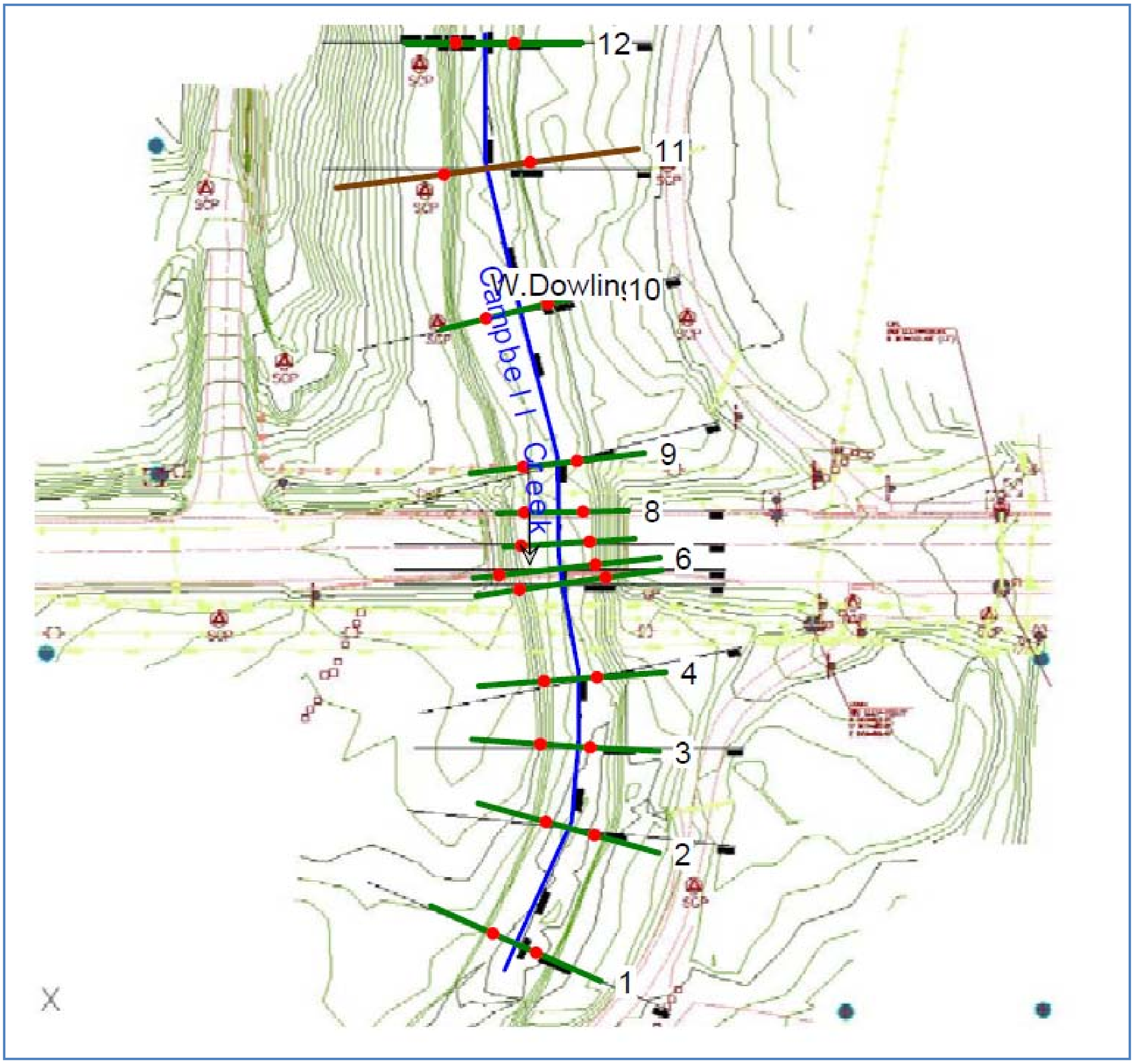
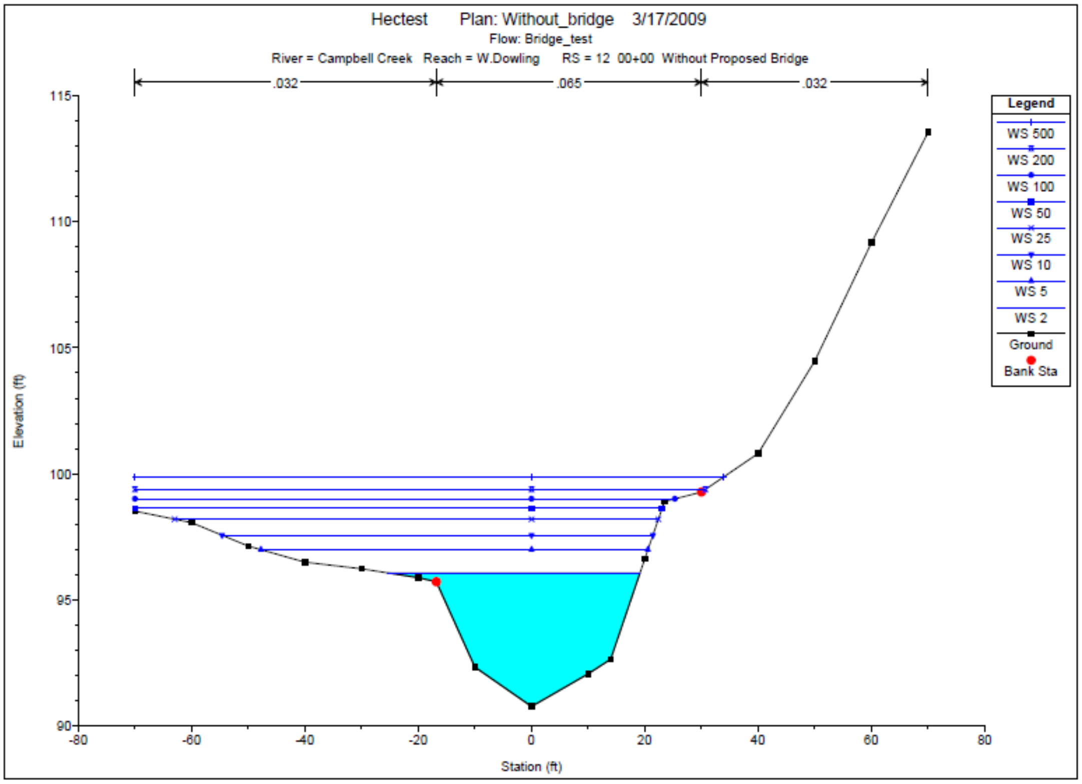


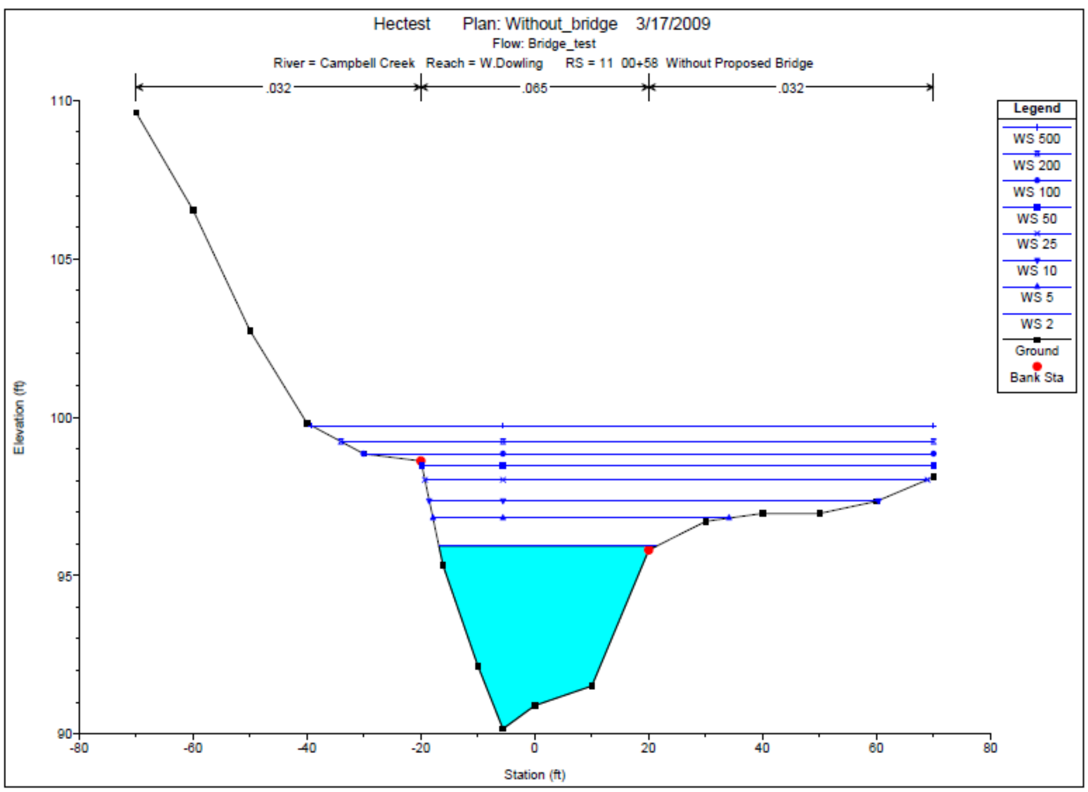
Figure 2 Cross section layout and creek alignment

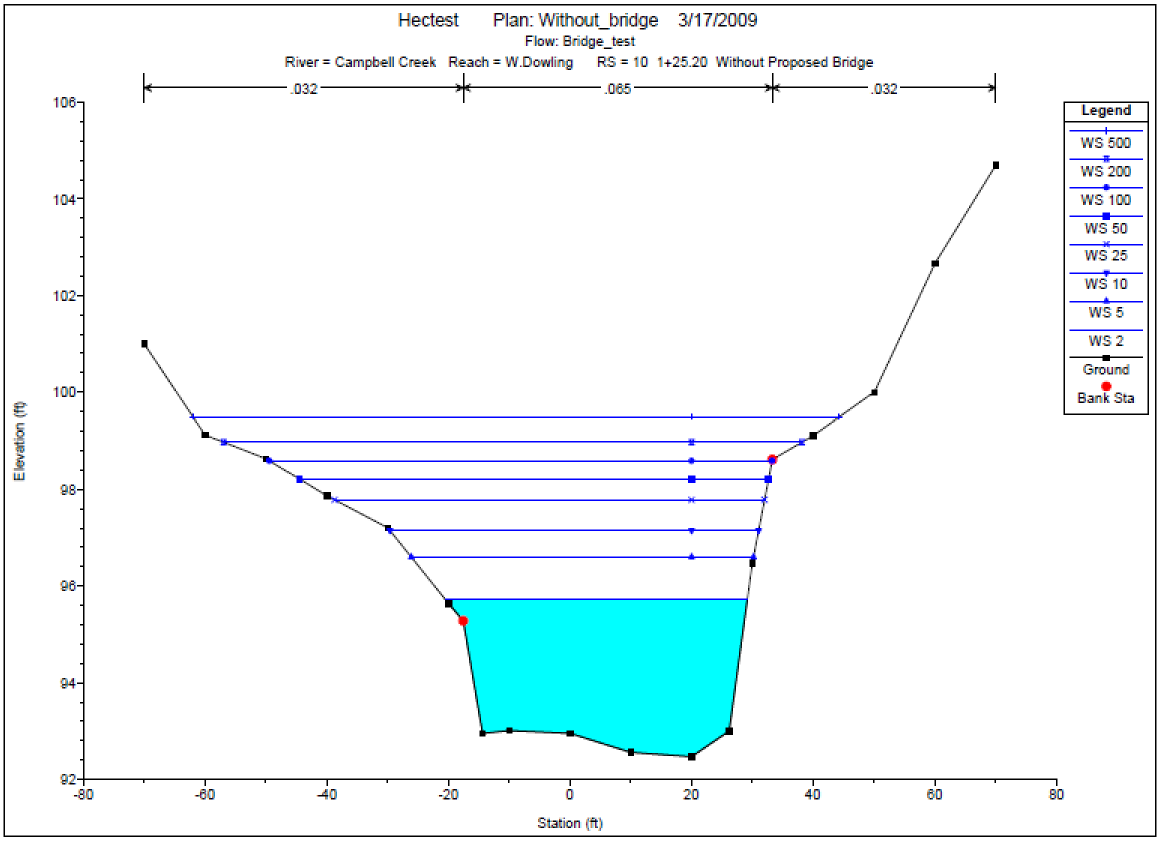
2.2.2 HEC-RAS Analysis

Steady state flow data was entered into the HEC-RAS model. The flow data used for the analysis was the flow data reported in the Hydrologic and Hydraulic Report (Table 5). A subcritical flow analysis was performed. The boundary condition used for the flow analysis was the average upstream of 0.002 reported by HDR in the hydraulic and hydrologic report (Ref. 3.1.1.6 of this report).

2.2.2.1 HEC-RAS Cross Sections Without Proposed Bridge Design



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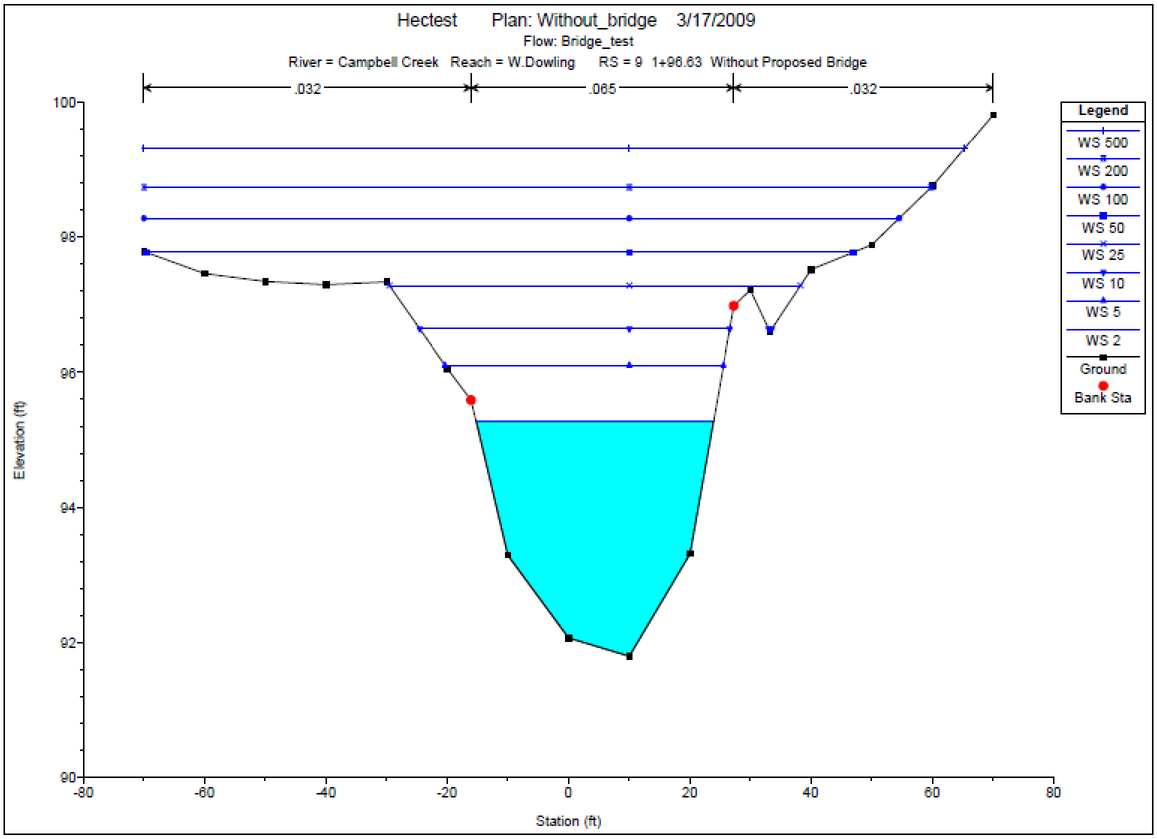
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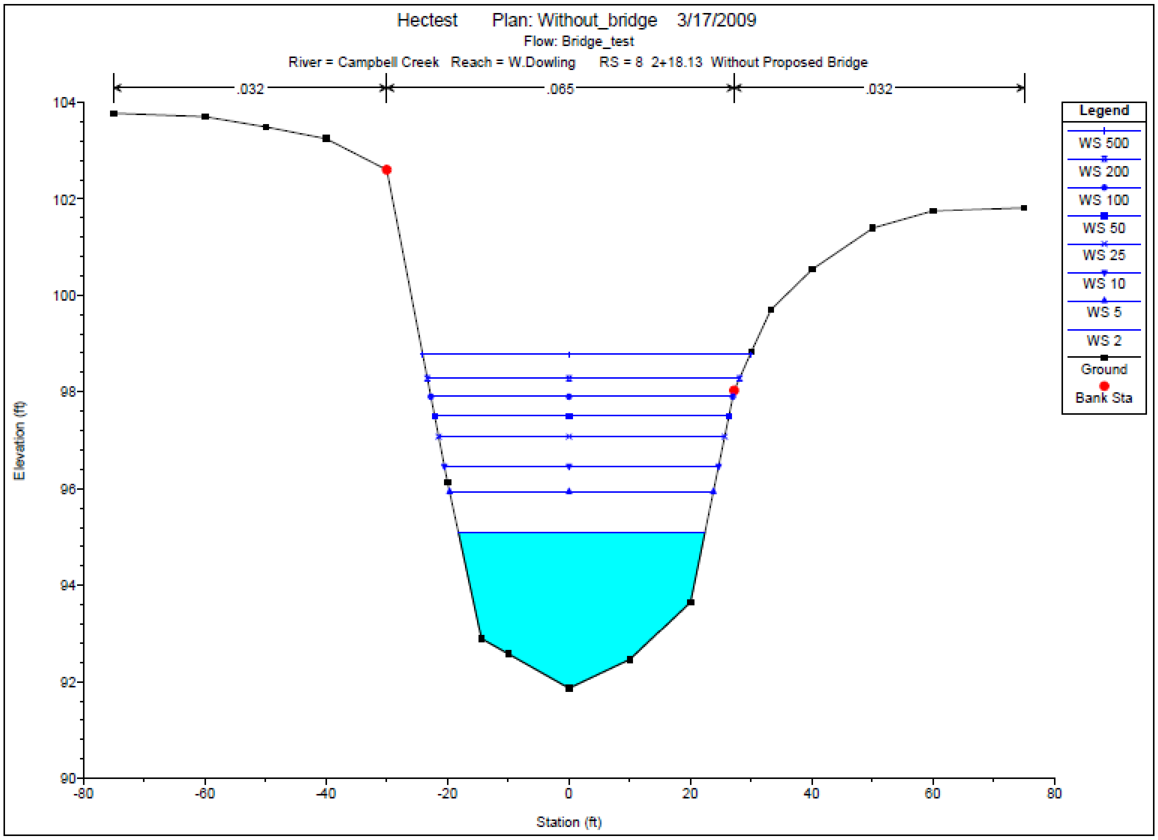
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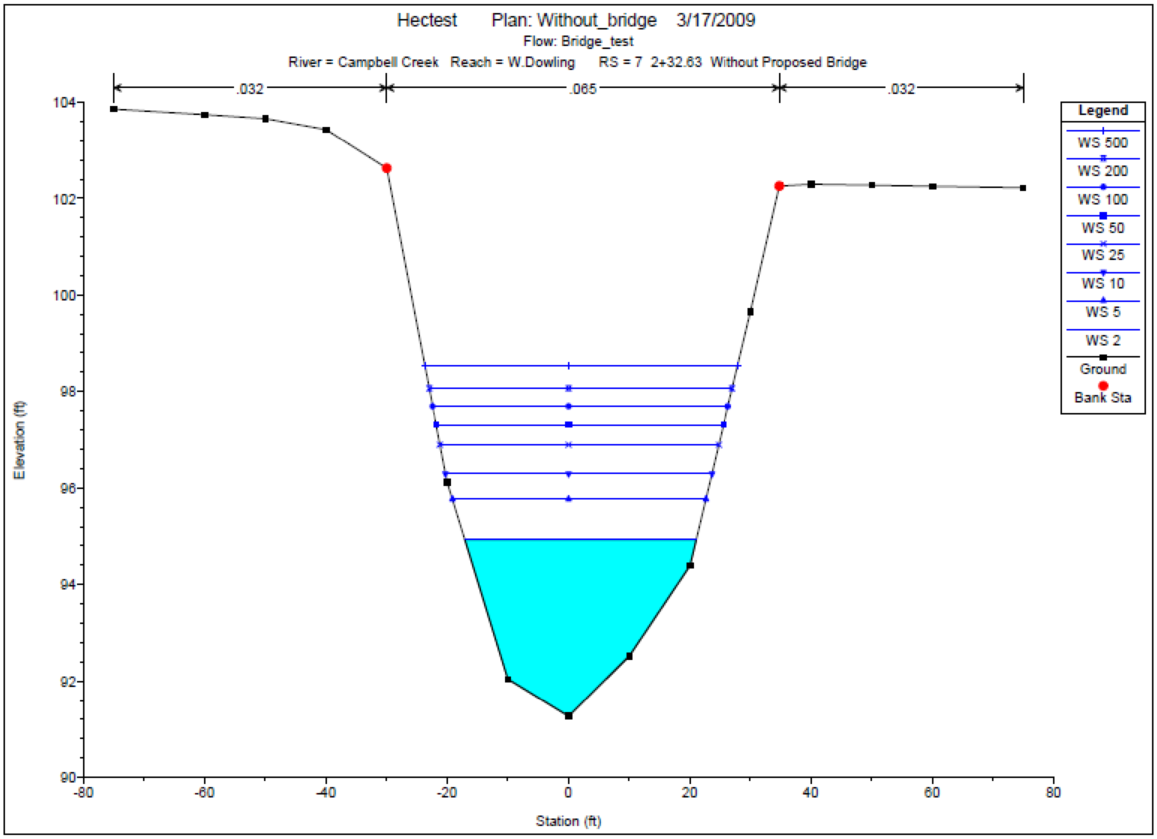
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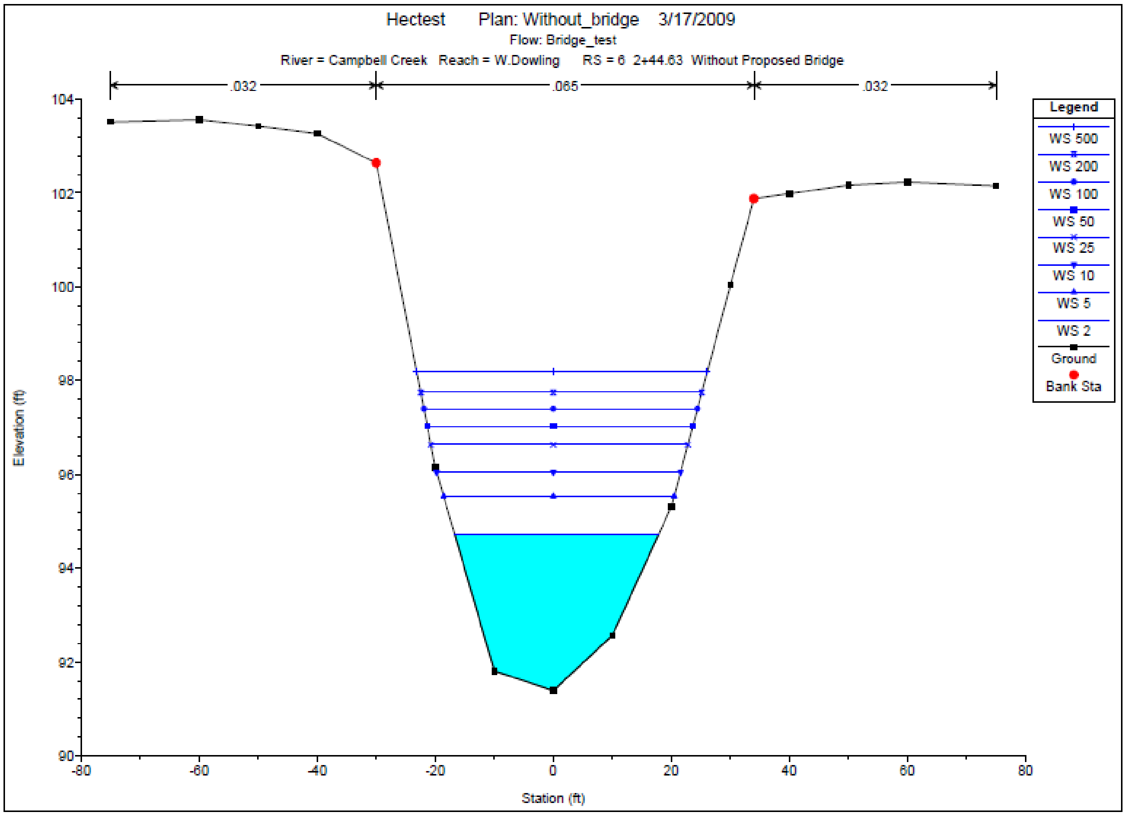
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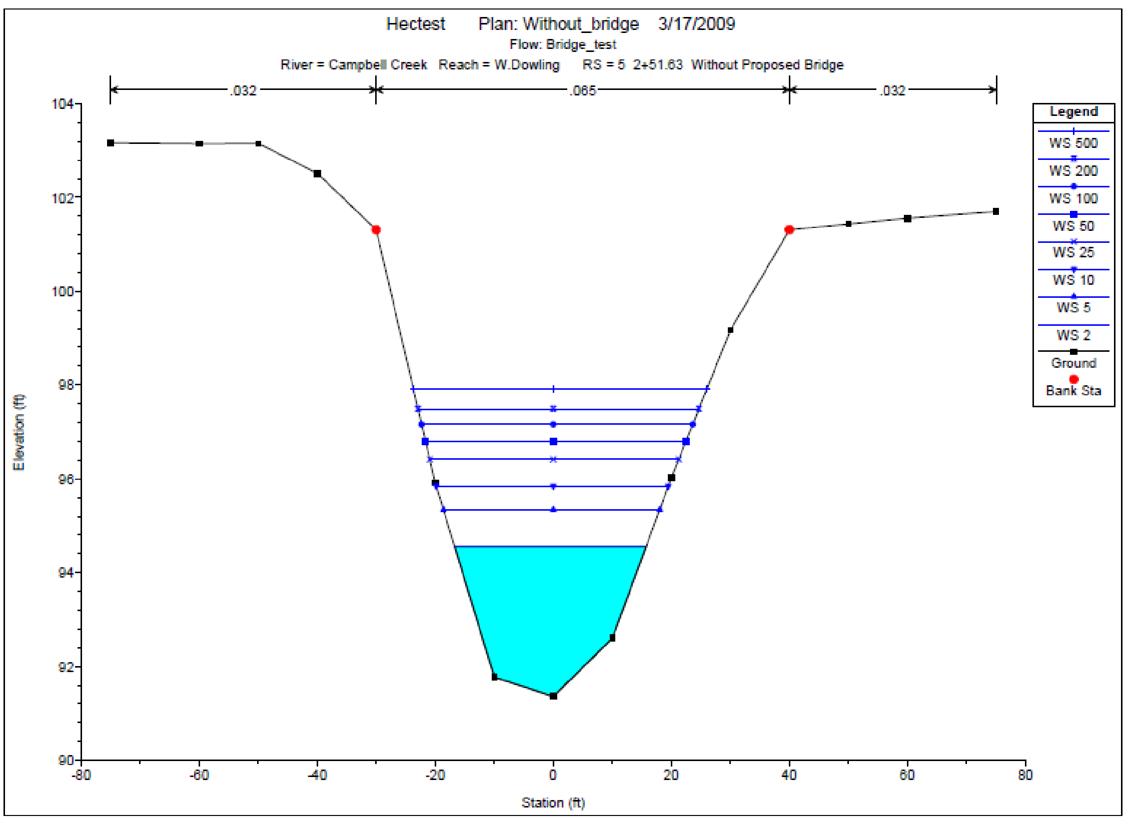
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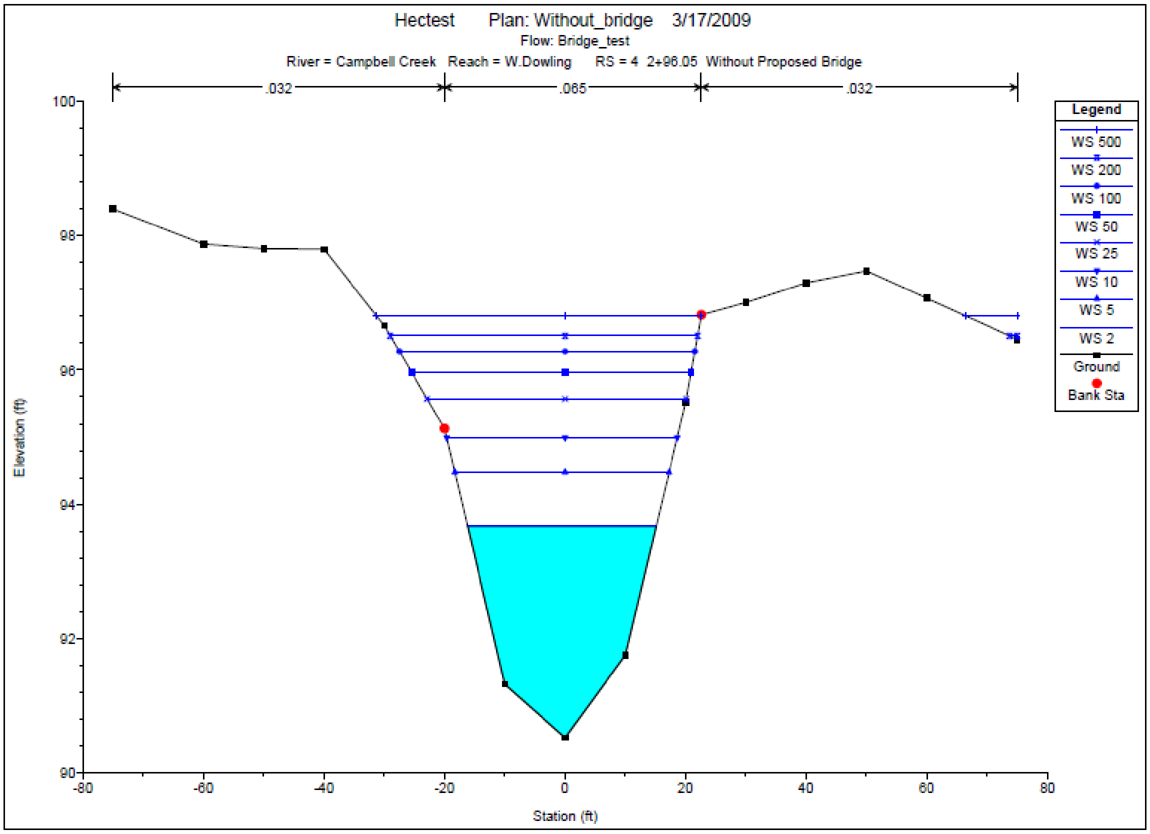
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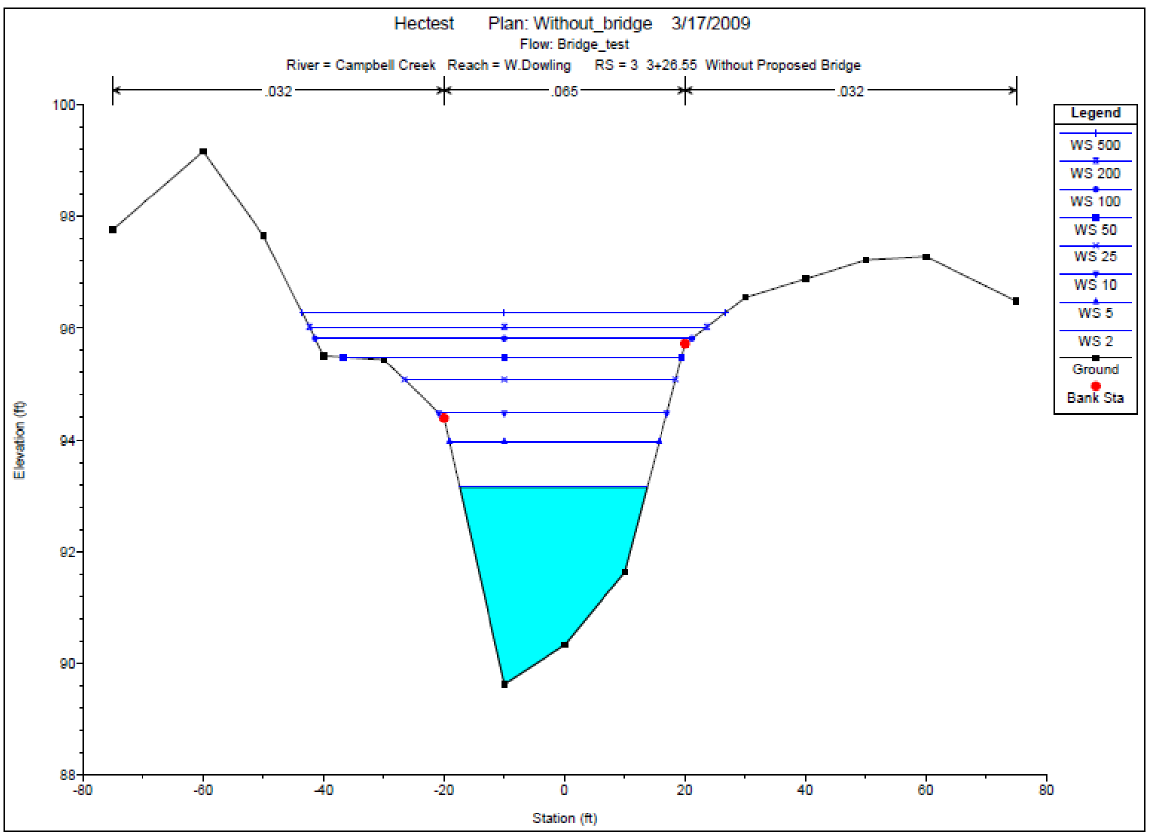
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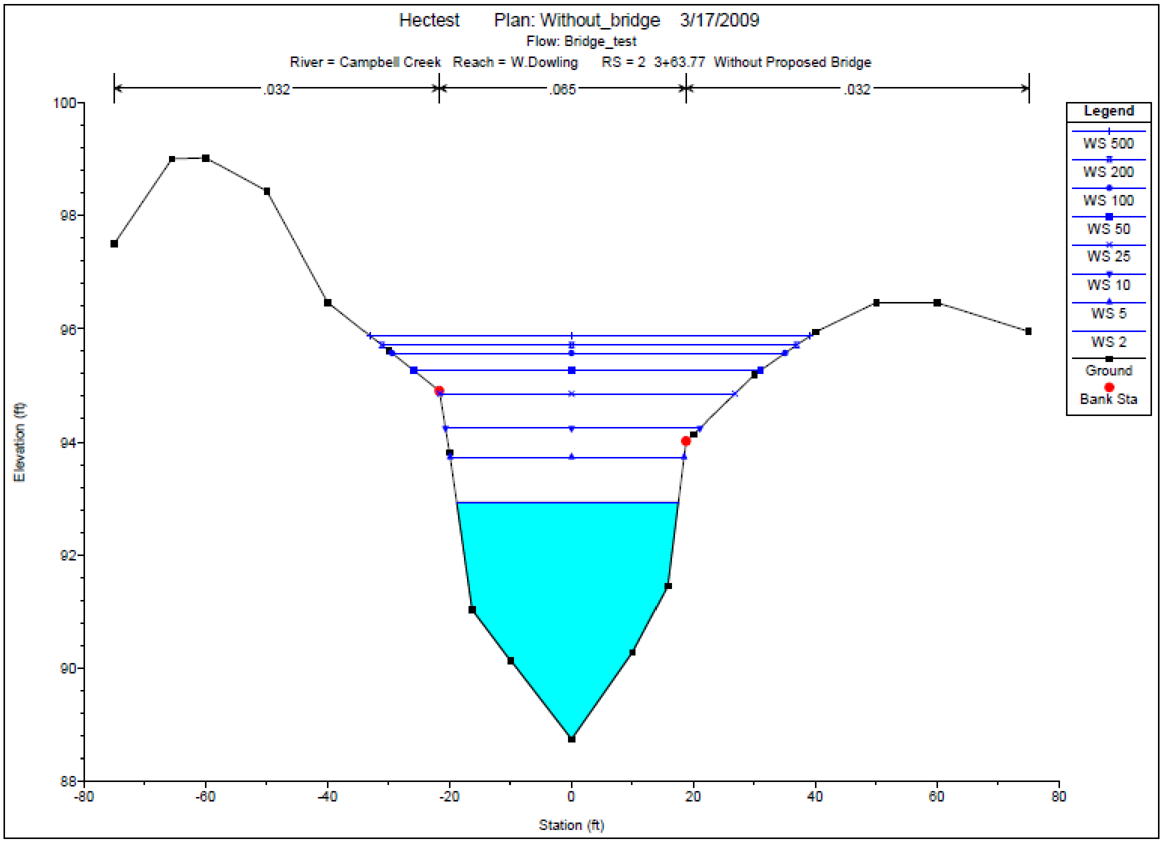
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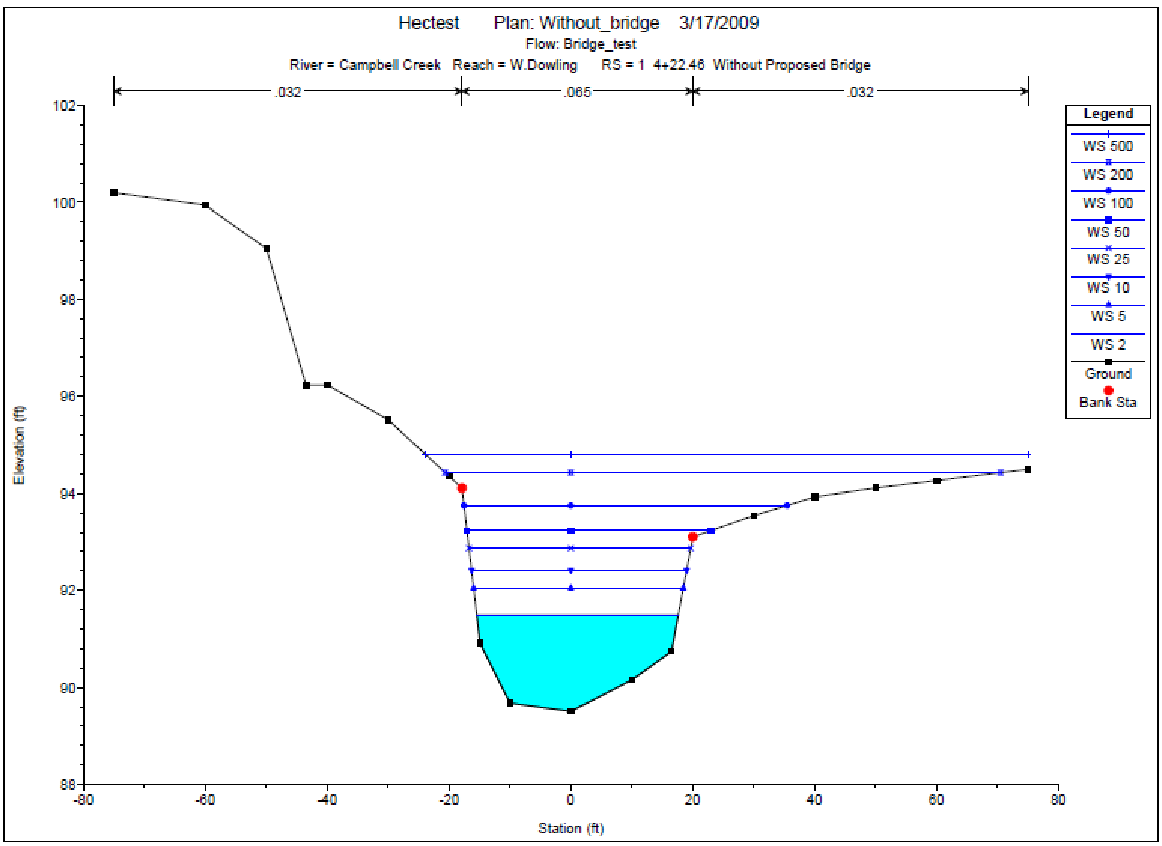
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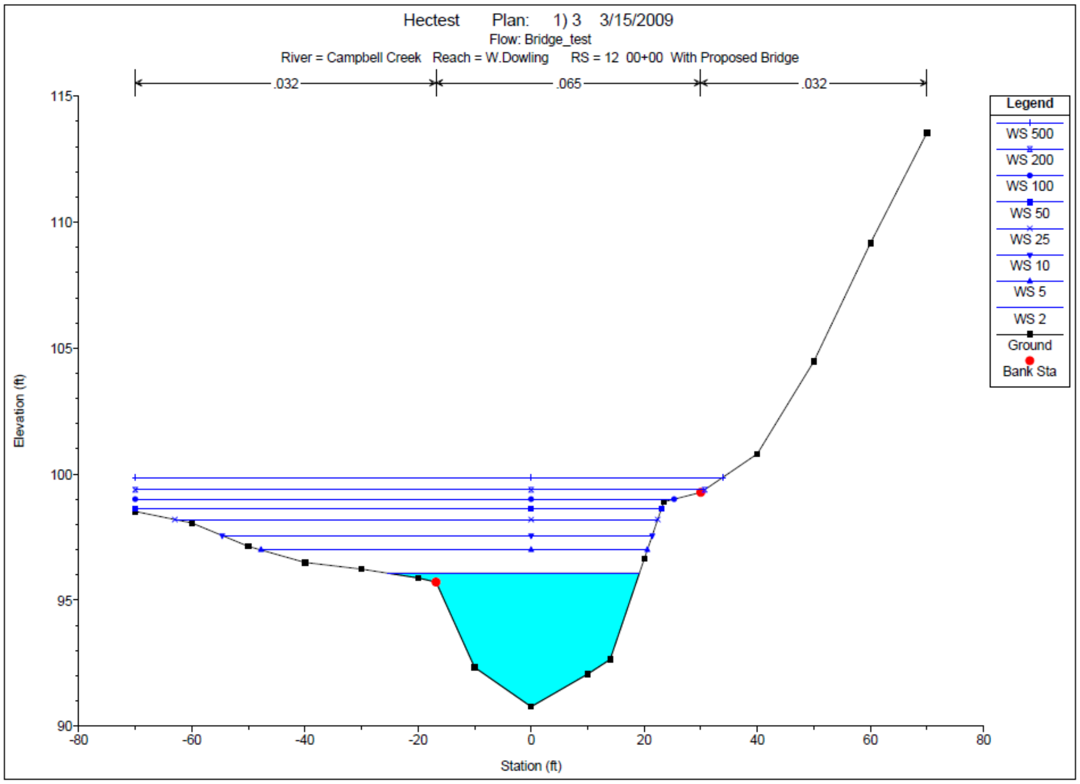
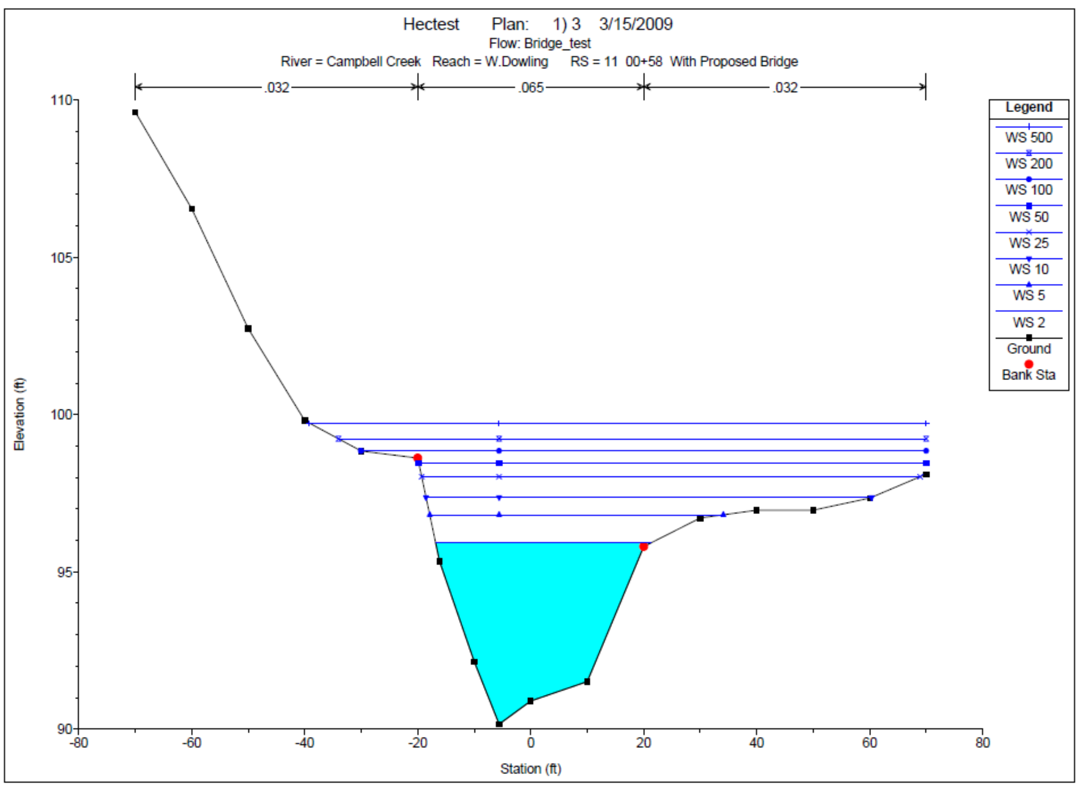
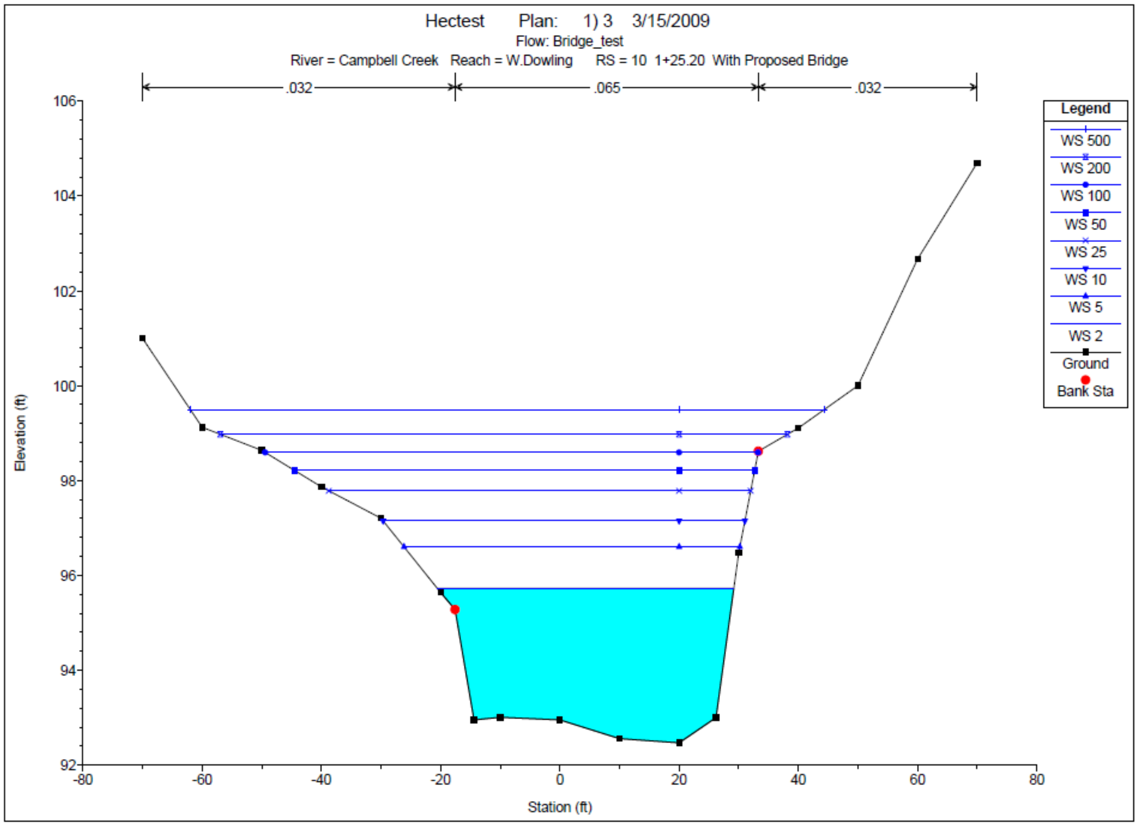
2.2.2.2 HEC-RAS Cross Sections With Proposed Bridge Design



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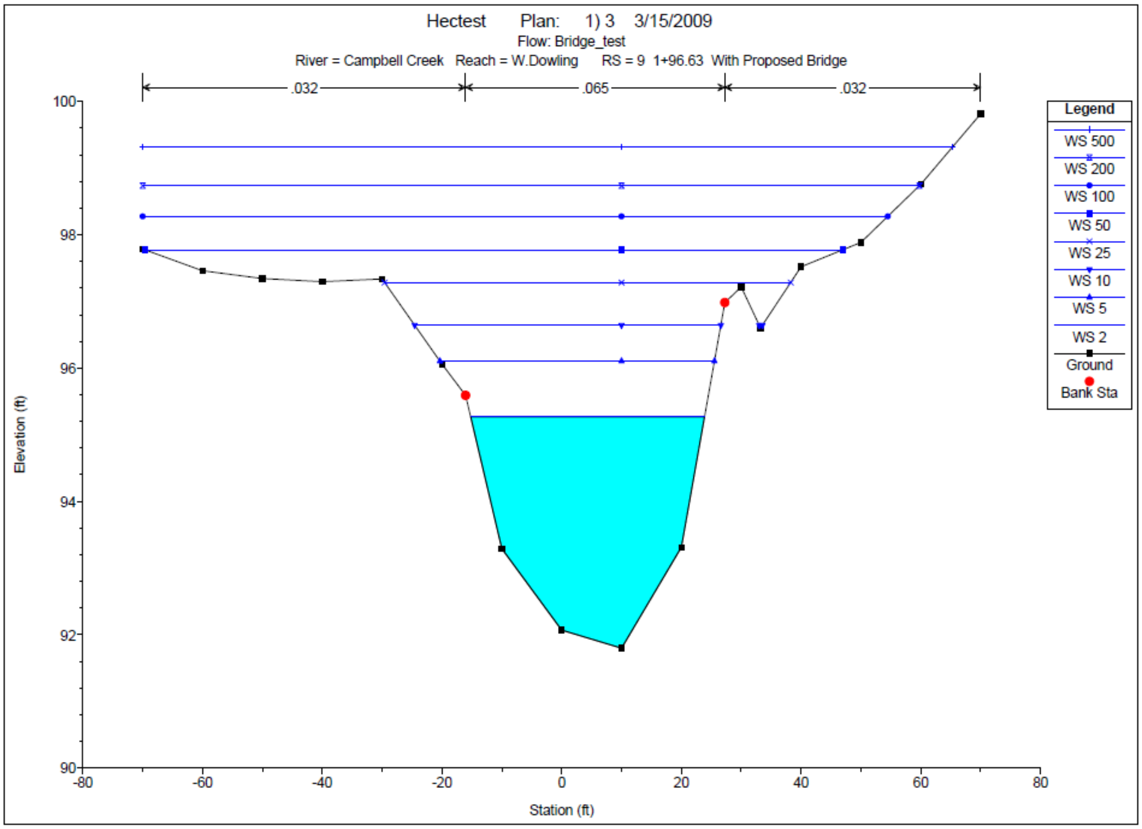
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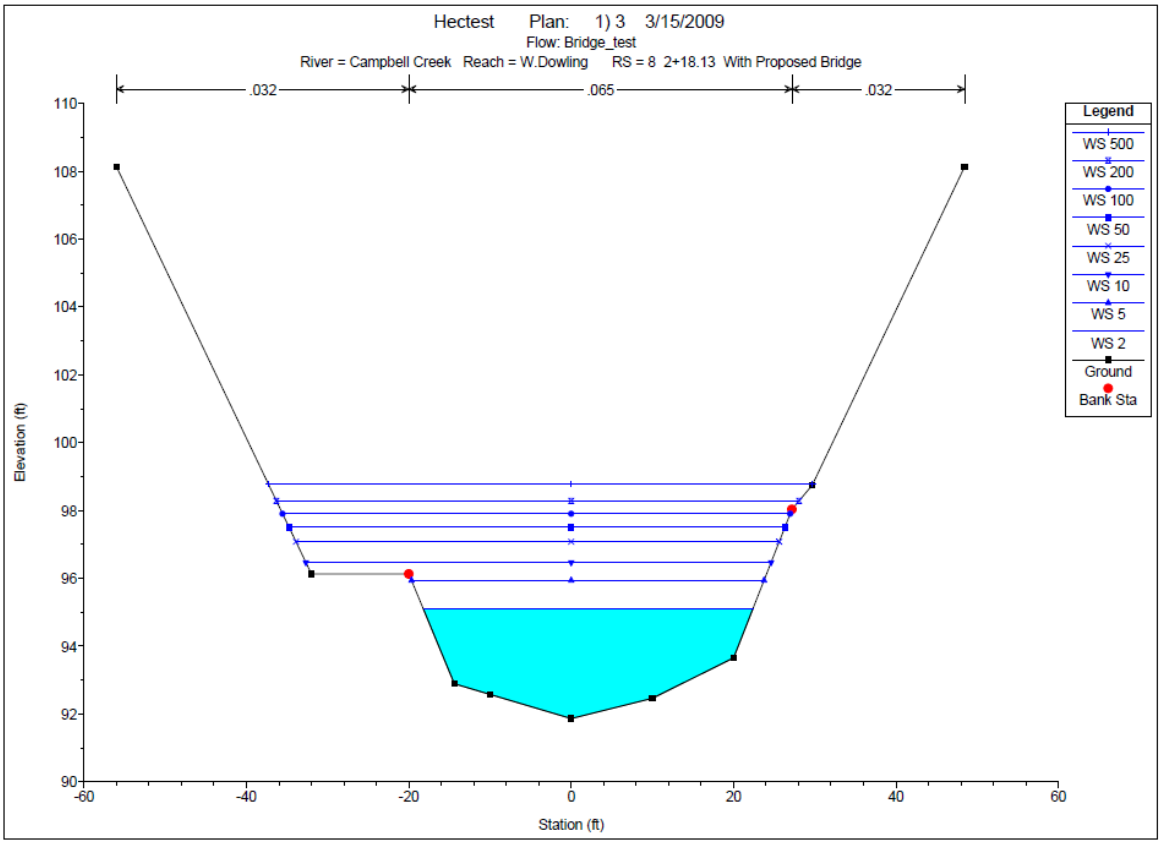
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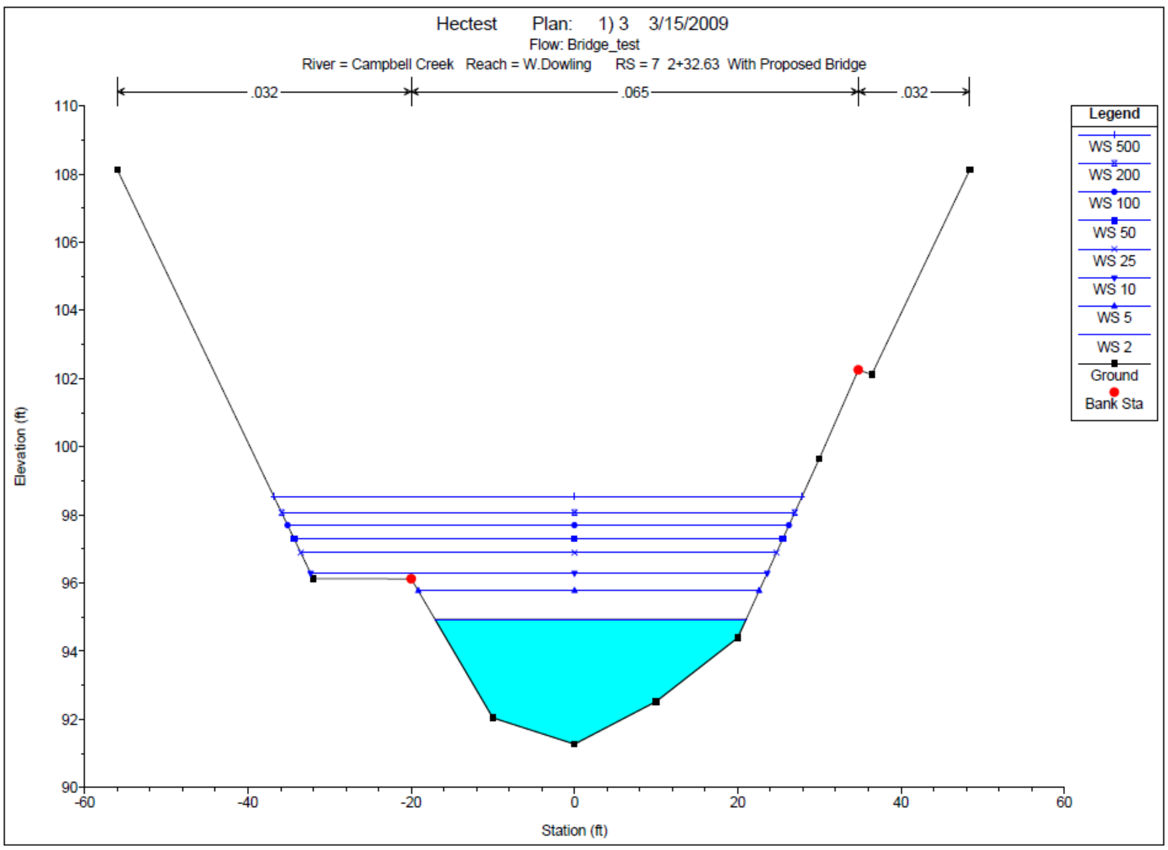
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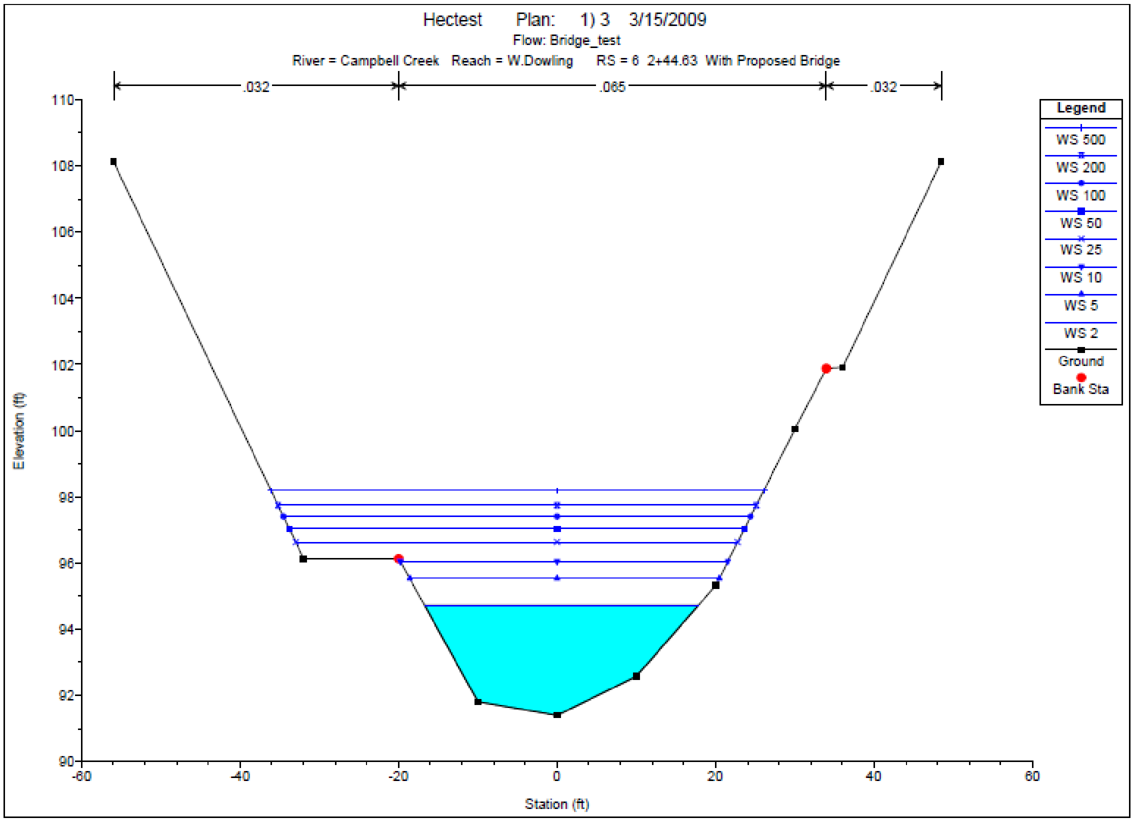
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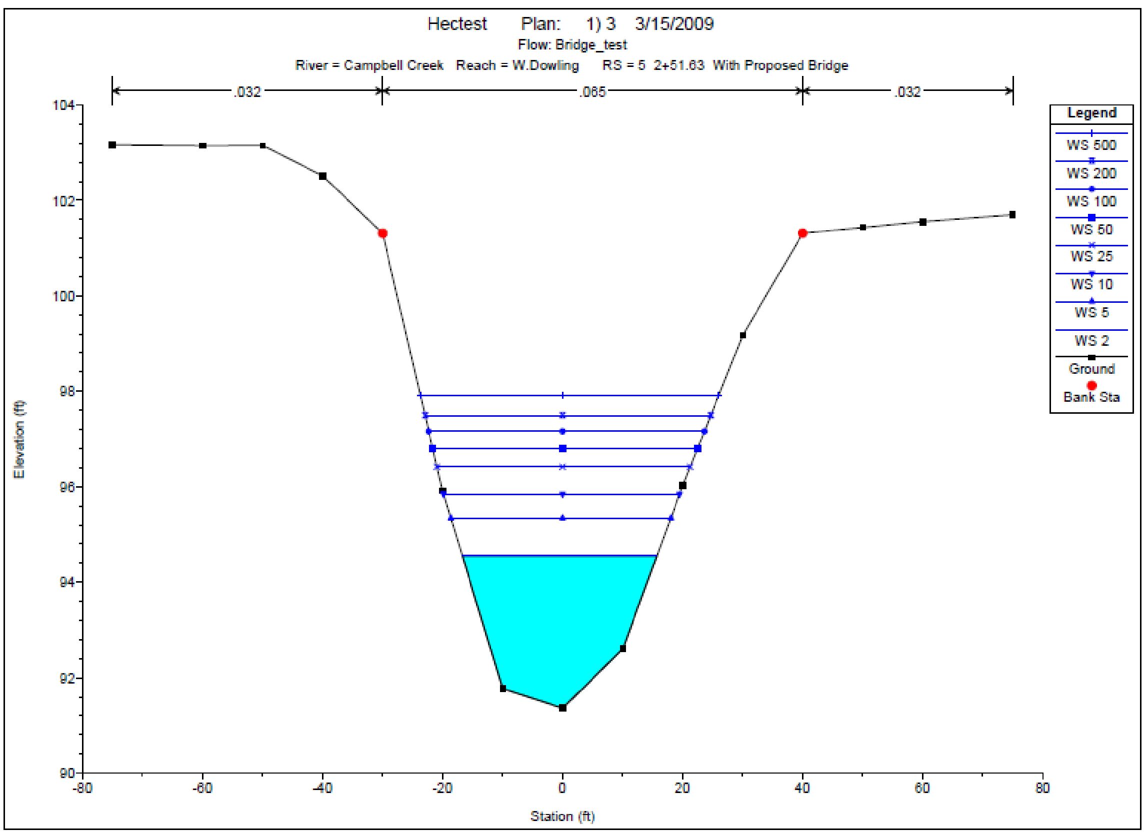
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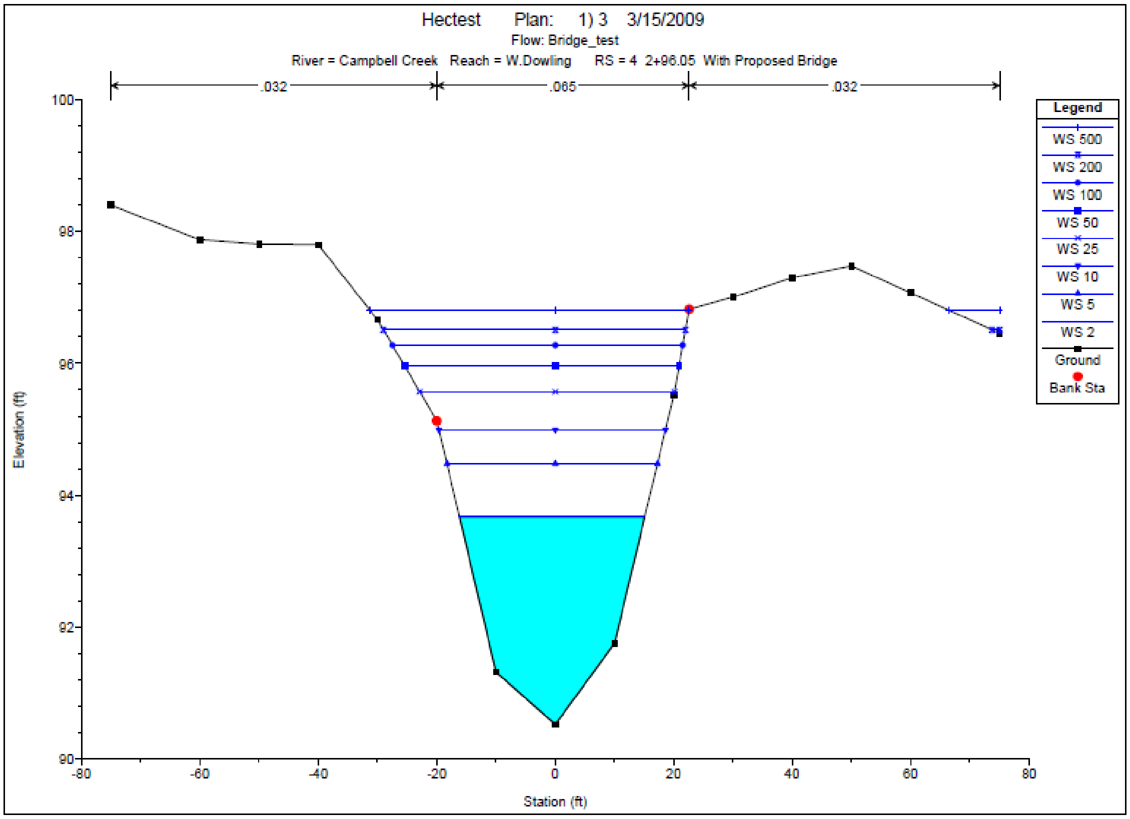
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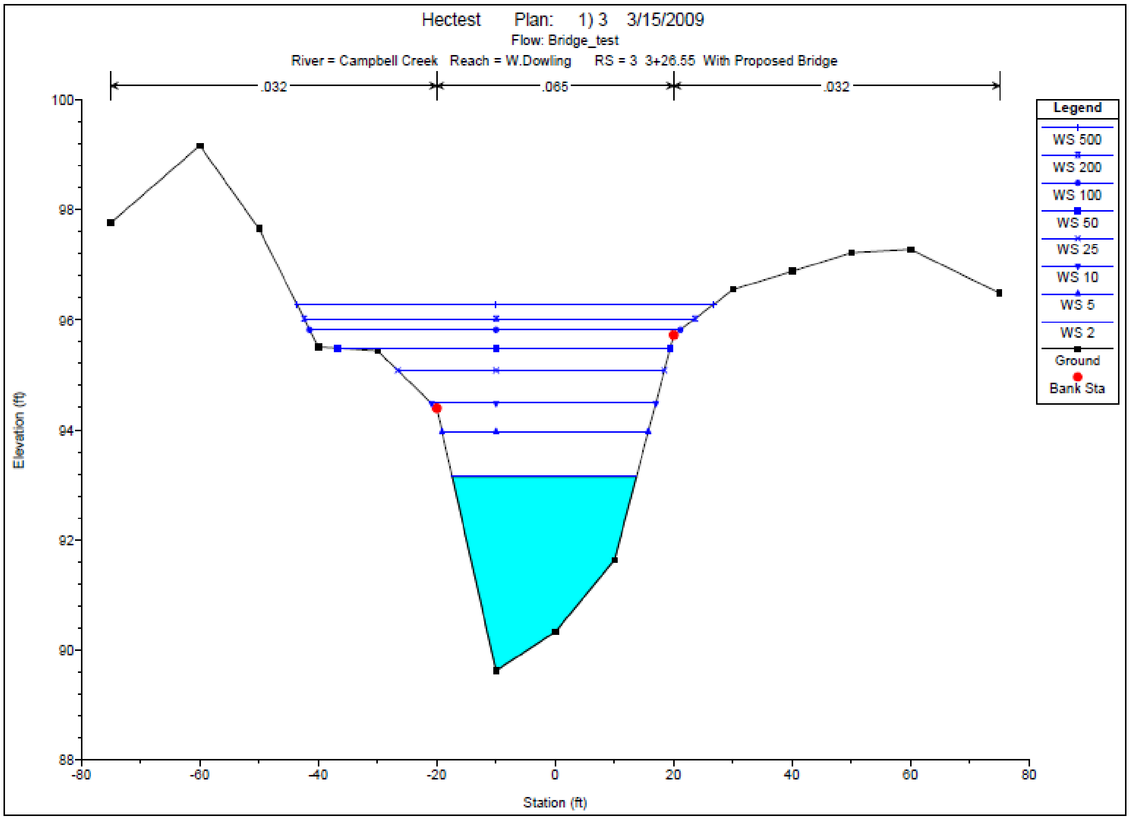
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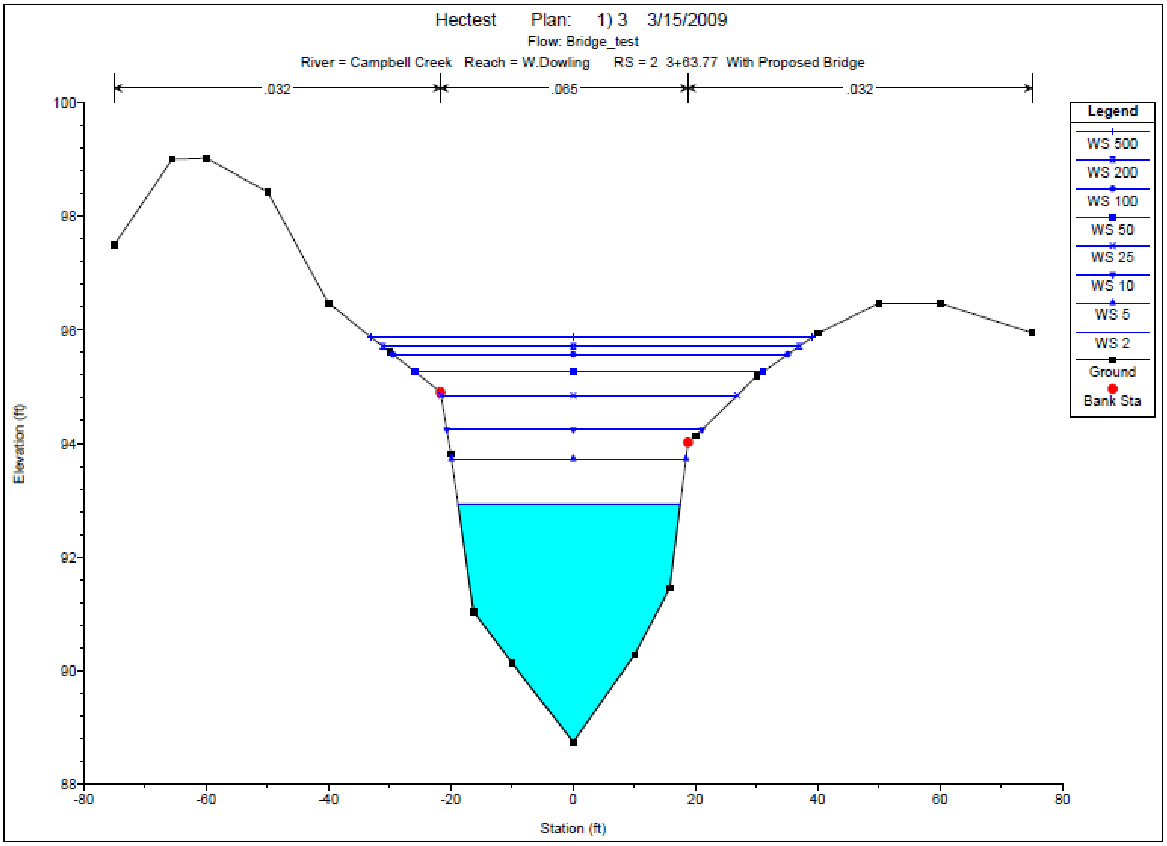
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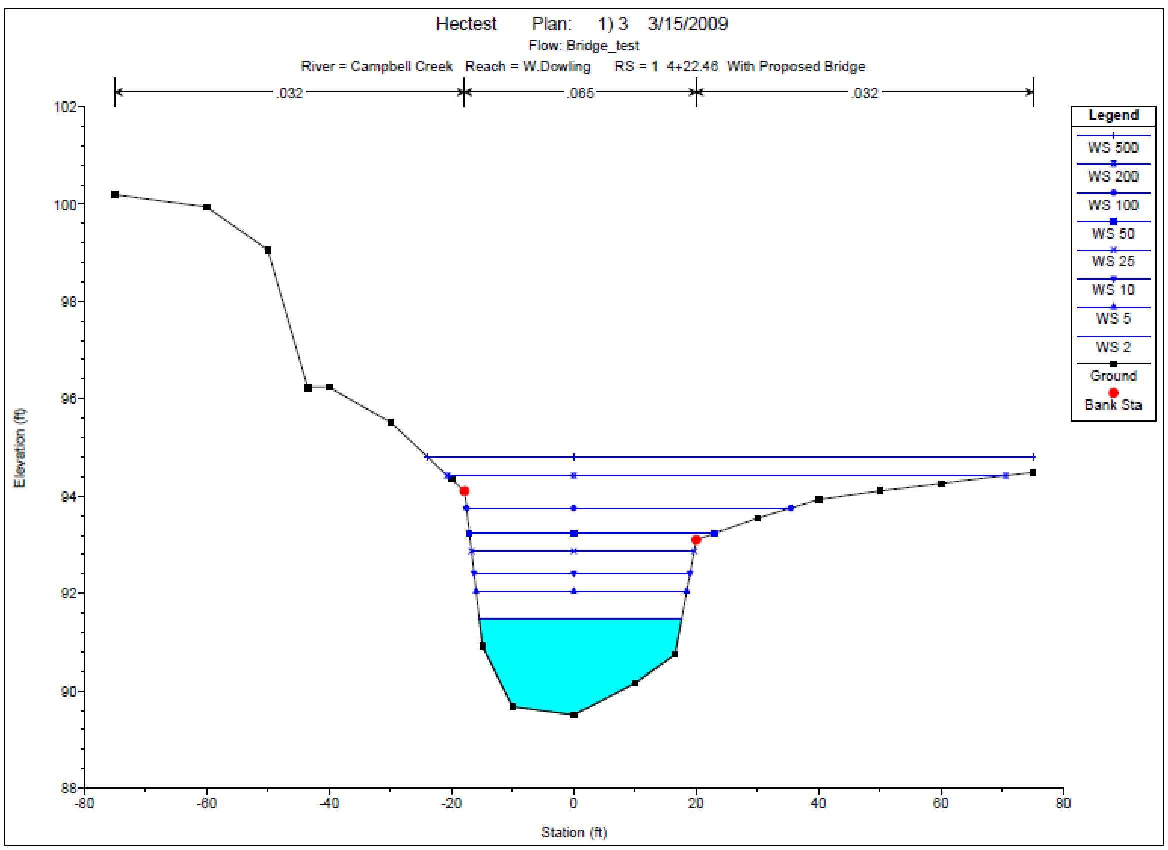
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2.3 Backwater Analysis

The proposed trail and sloped abutments result in a cut of bank material. As expected, this opens the channel under the bridge for larger flood events thus decreasing the elevation of the backwater at larger flood events upstream from the bridge. This is evident when comparing the water levels of different flood event of cross sections up stream of the bridge (river stations 8-12) with and without the proposed bridge. Figure 3 depicts a perspective plot of the river stations and water elevations with the proposed bridge design. Minor flooding is expected on the west side of the creek between river stations 8 and 12 with the proposed bridge at larger flood events (10 year floods and above).

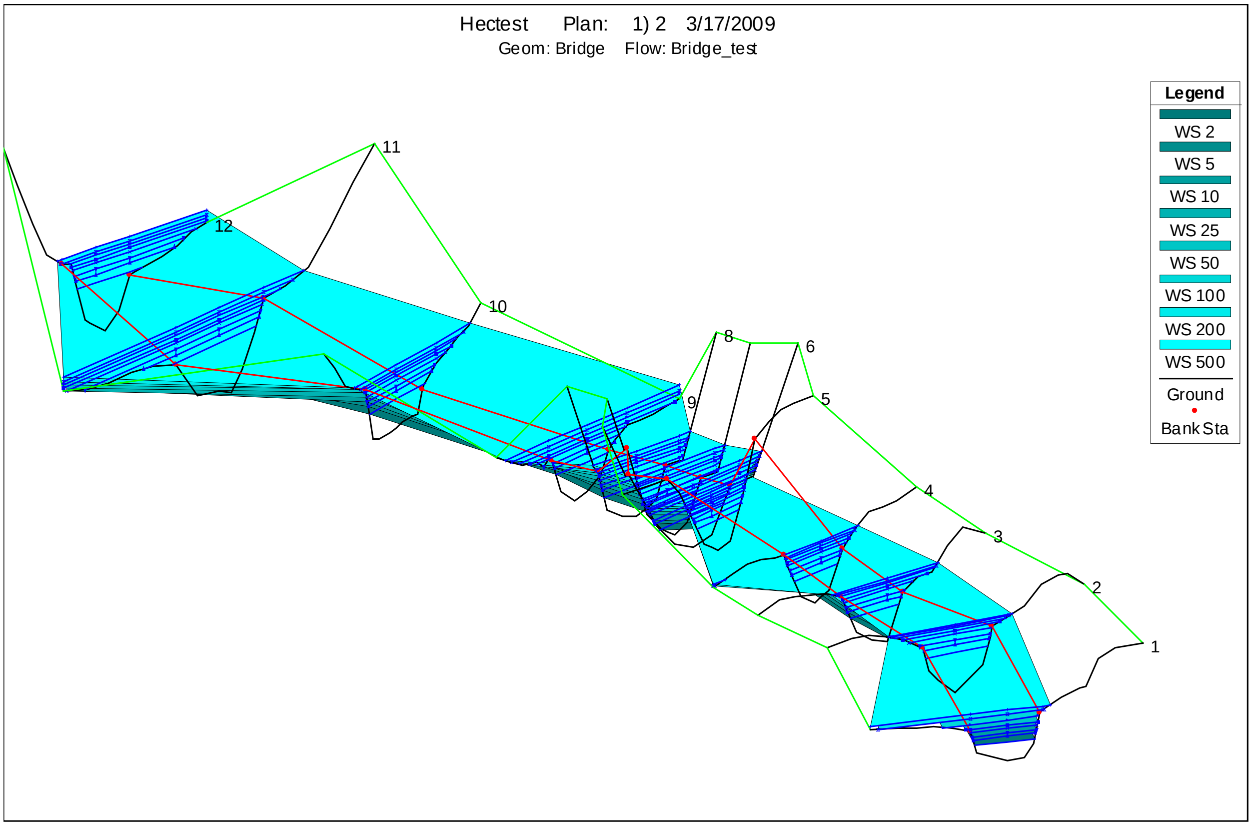

Figure 3 HEC-RAS perspective plot with water surface elevations used for back water analysis

2.4 Bridge Scour and Stream Instability Countermeasures (HEC 23)

Riprap sizing for the bridge abutment was determined using section 8.7 (Sizing Rock for Riprap Abutments) in the HEC Manual 23. In order to properly calculate the dimensions of the riprap the Set Back Ratio (SBR), over bank flow, characteristic velocity and Froude number had to be determined, sequentially using the bank geometry and Q100 flows. With these values, the appropriate method for determining the D50 of the rock could be determined. Since the Froude number (calculated as 0.691) is less than 0.80 the specific D50 must be used with a K value equal to 0.89 since a spill-through abutment is used. Using the D50 equation with the specific gravity of the rock equal to 2.65, the D50 was calculated. A factor of safety of 1.2 was used. The D50 for the riprap was calculated to be 6 in. in diameter, which is a standard size.

Using the 8.7 method the riprap geometry was also calculated. The Apron extension from the toe of the slope must be 4 ft and must wrap around the entire abutment. The Vertical extent of the riprap must be 4 in. above the overbank bottom, which is where the trail will be. Finally, the thickness of the riprap must be 9 in. thick or the size of the D100 of the riprap.

2.4.1 Calculations:

Y= Maximum Water Depth at Q100 of XS 6-8=1.78'

Q100=1244cfs

A= minimum over bank area of XS 6-8 = 22.22ft

At=Minimum total area of XS 6-8 = 249.26 sqft

S = Average Setback length from toe of slope to edge of main channel = 14ft

SBR = (S/Y) = 7.87 (Greater than 5 so use over bank flow only to compute characteristic Velocity)

Q=overbank flow = (A/At)*Q100 = 110.9 cfs

V=Q/A = 4.99= characteristic Velocity

Fr=(V/sqrt(gY))=0.691 (Less than 0.80 so use appropriate D50 equation)

K=0.89 for spill through abutment (given in method)

S=2.65=specific gravity of rock

(D50/Y)=(K/(S-1))*(V^2/(gY))=0.2343

D50=0.417 ft = 5"

Apron Extension from tow of slope= 2(Y)=3.56ft (given in method)

Vertical Extent= 2+1.78=3.78ft (given in method)

FS=1.2

D50=6"

FS=1.15

Apron Extension=4ft

Vertical Extension=4ft

Mat Thickness= 1.5 (D50) = 9" or size of D100 (From Method)

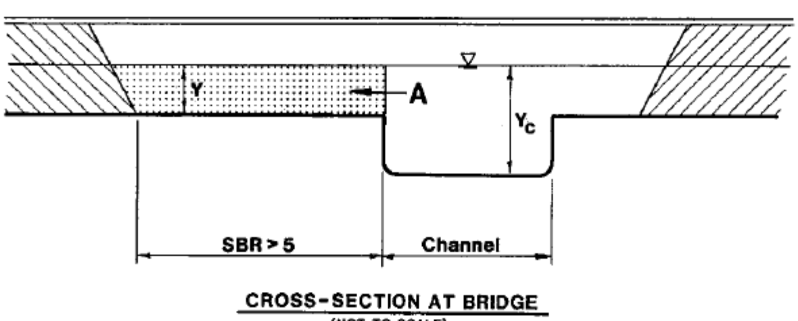

Figure 4 Overbank flow is used for SBR>5 (Hec 23 Manual)

2.4.2 Summary of Calculations

Using the HEC 23 method it was calculated that riprap with a D50 of 6 in. should be used. The apron extension will be 4ft from the slope toe and the vertical height of the riprap will be 4ft above the trail base. The thickness of the riprap mat cannot be less than either 9 in. or the size of the D100.

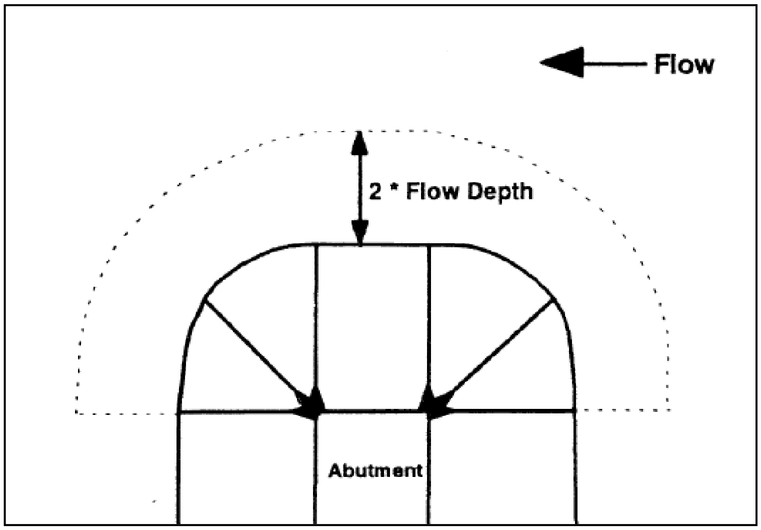

Figure 5 Plan view of riprap apron extension (Hec 23 Manual)

3.0 SCOUR MITIGATION ALTERNATIVES

3.1 Do Nothing

The Do Nothing alternative would utilize the riprap already in place assuming it is adequate to protect against one hundred-year events. Do to environmental consideration, no additional riprap will be added below the normal high waterline. The new bridge abutment will not include any additional scour protection. This alternative poses serious risk to the proposed bridge design do to the impact of flood events larger than 10 year. It is recommended that this alternative be rejected and scour mitigation be implemented to protect the bridge abutments.

3.2 Replace Riprap below Waterline

A second alternative would replace the existing 0.25 ft D_{50} riprap with larger 6-inch D_{50} to help protect the new trail cut from a 100 year flood event. This alternative would require the removal of the existing riprap that could possibly lead to degradation of salmon habitat. The environmental permitting team has advised that no additional riprap be added below the normal high-water line. Avoiding this alternative will also be a cost saving measure.

3.3 Leave existing riprap below the high waterline and add riprap to toe of bridge abutment

HEC-RAS analysis with the new bridge abutment cross sections, indicate that flood events exceeding the 5-year flood event will affect the toe of the sloped abutments. This alternative would leave the existing 0.25 ft D_{50} riprap below the high waterline up to an elevation of 96.1 ft. and add additional riprap along the toe of the new bridge abutment. HEC 23 results indicate that riprap size 6 in. D50 will be sufficient for placement along the abutment. The riprap apron will wrap around the toe of the abutment with a mat thickness of 9 in. and extend 4 ft from the toe of the abutment. The riprap will extend a vertical height of

4 ft up the abutment from the trail elevation of 96.1 ft. MSL. This will provide sufficient protection from a 100-year storm event.

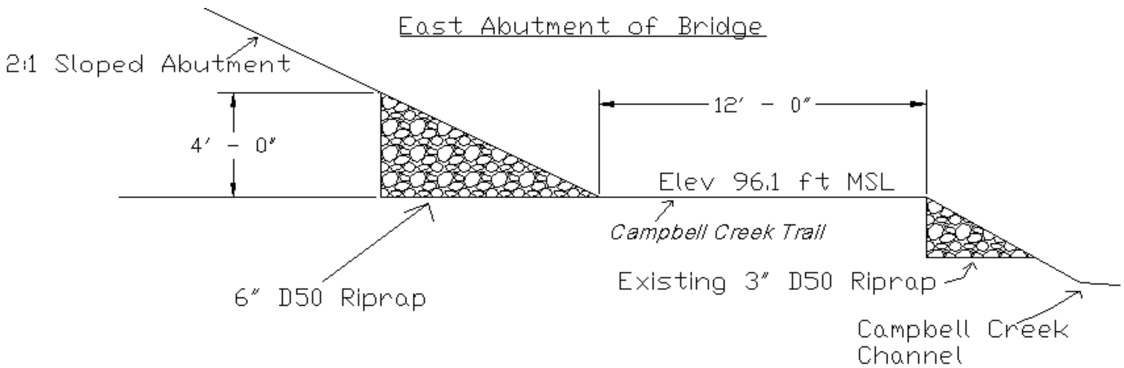

Figure 6 Typical Cross-Section of Bridge Riprap (East Side)

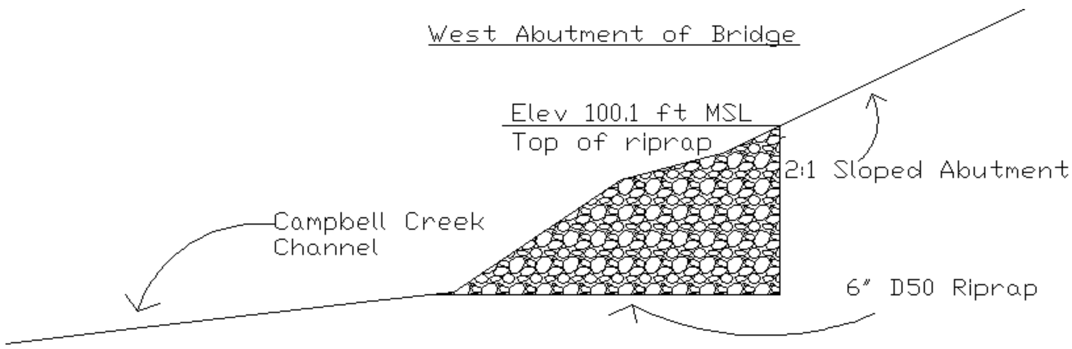

Figure 7 Typical Cross-Section of Bridge Riprap (West Side)

4.0 RECOMMENDATIONS

The bridge hydraulics technical team has recommends that the trial be built at an elevation of 96.1 ft MSL that will be flooded in flood events surpassing a 5-year flood. After performing hydraulic analysis with the proposed bridge design, it is recommended that the existing riprap below the high waterline be left in place and additional riprap be added to the toe of the new sloped bridge abutment. This alternative will provide sufficient protection to the proposed bridge abutment. Utilizing existing riprap below the high waterline is a cost effective alternative that will minimize construction activity in the creek.

5.0 SOURCES

1 Anonymous "HEC-RAS River Analysis System Hydraulic Reference Manual," CPD-69, (2002).

2 Alaska Department of Transportation and Public Facilities, "Alaska Highway Drainage Manual," 2009 (2/05), (2006).

3 HDR Inc Alaska, "Campbell Creek at Dowling Road-DRAFT Hydrology and Hydraulic Study," Draft, (2006).

4 P. Lagasse, J. Schall and E. Richardson, "STREAM STABILITY AT HIGHWAY STRUCTURES," FHWA NHI 01-002 HEC-20, (2001).

5 P. Lagasse *et al.*, "BRIDGE SCOUR AND STREAM INSTABILITY COUNTERMEASURES," FHWA NHI 01-003 HEC-23, (2001).

6 E. Richardson and S. Davis, "EVALUATING SCOUR AT BRIDGES," FHWA NHI 01-001 HEC-18, (2001).

7 Personal communications with University of Alaska Anchorage engineering professor Dr. Orson Smith on 2/11/2009 and 3/06/2009.

DESIGN STUDY REPORT

APPENDIX H

STORM WATER CONTROL

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
Central Region
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Anchorage, Alaska 99502

Prepared by:

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University of Anchorage Alaska

Michael Johnson
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Joshua Satterfield

April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

MOA .... Municipality of Anchorage
ADOT .... Department of Transportation and Public Facilities (Alaska)
DSR .... Draft Study Report
CPEP .... Corrugated Polyethylene Pipe
FEMA .... Federal Emergency Management Agency
IBEW .... International Brotherhood of Electrical Workers
PCMP .... Precoated Corrugated Metal Pipe
DPW .... Department of Public Works
FPS .... Feet per second
GPD .... Gallons per day
CFS .... Cubic feet per second

1.0 INTRODUCTION

1.1 Objectives

The Alaska Department of Transportation and Public Facilities has prepared an environmental assessment that has evaluated the options for increasing the carrying capacity of Dowling Road between Old Seward Highway and Minnesota Dr. The study includes evaluation of Alternatives to extend Dowling Road to Minnesota Dr. A draft study report (DSR) is also being prepared by Dowl HKM, LLC. This "West Dowling Hydrology & Hydraulic Study – Storm Water Analysis" provides drainage information to be used in the DSR.

1.2 Project Description

The project area is along Dowling Road from Old Seward Highway to Potter Dr and then extends along the preferred Alternative outlined in the Environmental Assessment to C Street. This section includes a summary of climate, soils, land uses, and major water bodies within the drainage basin. It includes a description of the four basins delineated for use in this study.

1.2.1 Climate

Meteorological information has been collected at Anchorage International Airport since 1964 (weather data has been collected in Anchorage since 1915). The airport is located approximately 4.5 miles east of the Dowling Road project corridor and at nearly the same elevation. Information collected at the airport likely represents the climatic conditions within the project corridor and will be used to summarize typical climatic conditions. (HDR, 1995)

Anchorage International Airport receives an average of approximately 15.5 inches of rainfall each year. Nearly one-half (46%) of this precipitation falls between mid-July and early September. In September, the wettest month, Anchorage typically receives approximately 2.7 inches of precipitation. Early spring is the driest time of year for Anchorage. An average of only 0.5 inches of precipitation falls in Anchorage during April, the driest month. Anchorage receives an average of 69 inches of snow, and December yields the greatest monthly snowfall; 14.8 inches. Freeze-up generally occurs some time during mid-October and breakup usually begins in mid-April (HDR, 1995).

1.2.2 Soils and Land Use

Soils in the project drainage area vary from poorly drained peat to well-drained silt loam. Large areas are covered with fill material. Land within the project drainage basin is flat, with ground slopes generally less than 5%. (HDR, 1995)

The majority of land within the project drainage basin is developed (81%). The undeveloped portion consists of approximately 14.7 acres of wetland and 24.6 acres of upland. The area is zoned residential, commercial and industrial. (HDR, 1995)

1.2.3 Water Bodies

The water bodies within the project area are shown in Figure 2 and Figure 3. The water bodies which pertain to Phase 1 of the project include Campbell Creek and the wetlands at the intersection of C Street and the proposed West Dowling alignment.

Campbell Creek flows south through the project area, crossing under Dowling Road approximately 1,000 feet west of the Old Seward Highway. The North Fork of Little Campbell Creek flows west roughly

1,500 feet to the south of Dowling Road and joins the main channel of Campbell Creek approximately 3,000 feet south of Dowling Road. The fork crosses under the New Seward Highway approximately 1 mile further downstream of this crossing. Both Campbell Creek and North Fork Little Campbell Creek convey runoff from drainage areas within the project corridor's drainage basin. Both creeks have a 100-year floodplain designated by the Federal Emergency Management Agency (FEMA). The regulatory 100-year flood zones are shown on Figure 1.

One wetland areas exist within the project corridor's drainage area as described above. Wetland areas are important components of a drainage area because they provide flood storage, attenuate peak flows, and help to purify water.

1.2.4 Drainage Basins

The drainage area has been divided into four major basins. These basins are defined on characteristics of overland flow as well as conveyance patterns of existing drainage systems. Figure 4 - Project Area Drainage Basins show the two Alternatives for drainage basins in the project corridor. These Alternatives are discussed further in section 2.1 Basin Alternatvies.

2.0 HYDROLOGIC ANALYSIS

2.1 Previous Studies

One drainage study that covered the project was reviewed. The study was the Dowling Road Hydraulic Study and was prepared by HDR Engineering, Inc October 1995. (HDR, 1995) A portion of this document uses excerpts from that report to characterize the current drainage conditions. This information was then tailored to the West Dowling Road Project prepared by Seawolf Engineering 2009. A storm water system was designed based on this information.

2.2 Flood Risk

The area around Campbell Creek lies within the 100-year floodplain (Figure 1). This is an important aspect that must be considered in design, because portions of the project must be built to withstand 100-yr floods.

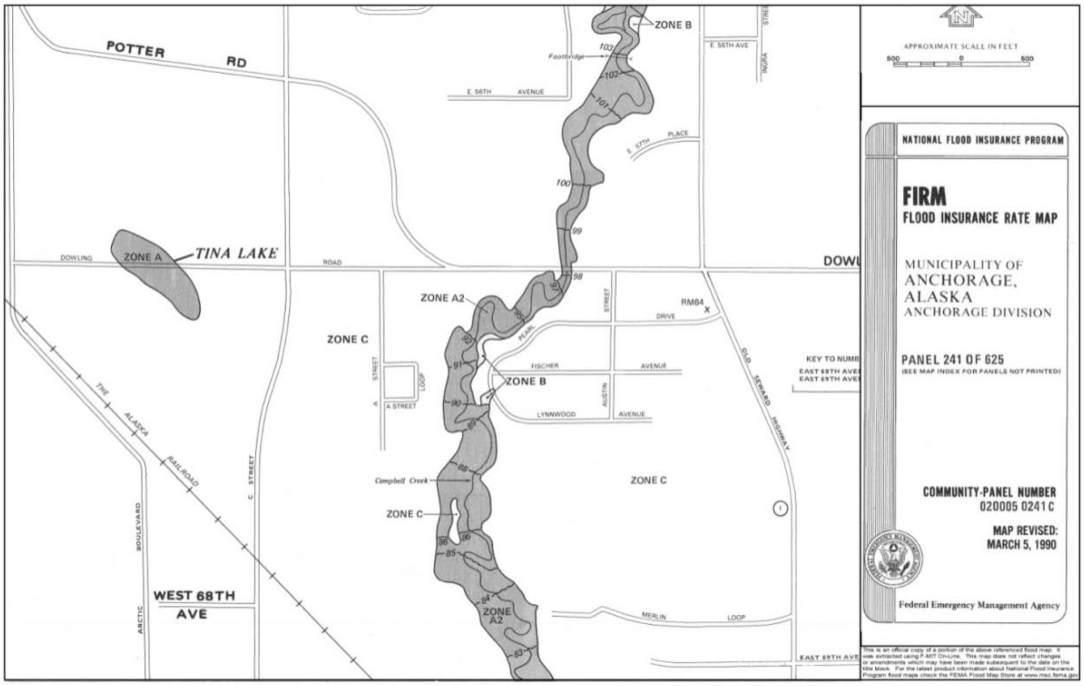

Figure 1 FEMA Flood Map of Project Area

2.3 Methodology

All drainage systems for Dowling Road upgrades have been preliminarily sized to meet the design criteria for this project. Table 1 in section 8.0 (Tables) presents both routing and treatment design criteria. The criteria used to design routing systems was found in the Alaska Department of Transportation (ADOT) “Preconstruction Manual.”

The criteria used to design sedimentation basins are based on the following publications produced by MOA (Municipality of Anchorage): Project Management and Engineering Design Criteria Manual (DCM) (PM&E, 2007) and ADOT Drainage Design Guidelines (ADOT, 1995). Sedimentation basins are to be sized to treat flow from the 2-year, 6-hour rainfall event. The basin must facilitate settlement of sediment that has a 20-micron diameter or greater. The cross-sectional area of the basin must be great enough to sustain a peak horizontal velocity less than or equal to 0.04 feet per second (fps). All basins would be designed to bypass flows greater than the treatment design storm. Table 1 lists the design storms proposed for design of bypass structures.

All proposed storm drains were assumed to be placed at a 0.3% slope and are to be constructed of corrugated metal unless otherwise noted. Pipe diameters could be reduced if slopes are increased or a pipe with less roughness used. (PM&E, 2007)

Topographic maps along with drainage basins from the previous Dowling Road Hydraulic Report were used to determine drainage basins in the project area. A field reconnaissance visit of the entire project corridor from Old Seward Highway to C Street was made in Spring 2009. MOA maps were also analyzed to determine existing storm drainage systems (see Figure 2, Figure 3).

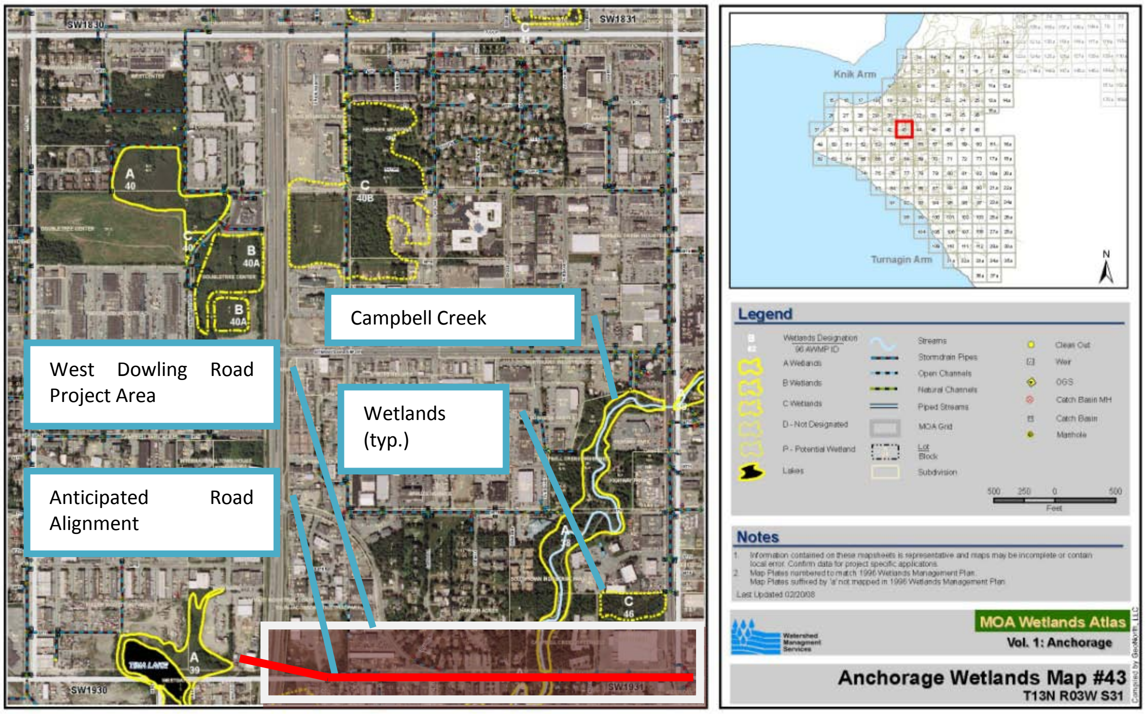

Figure 2 MOA Storm Water System and Wetlands (Overview)

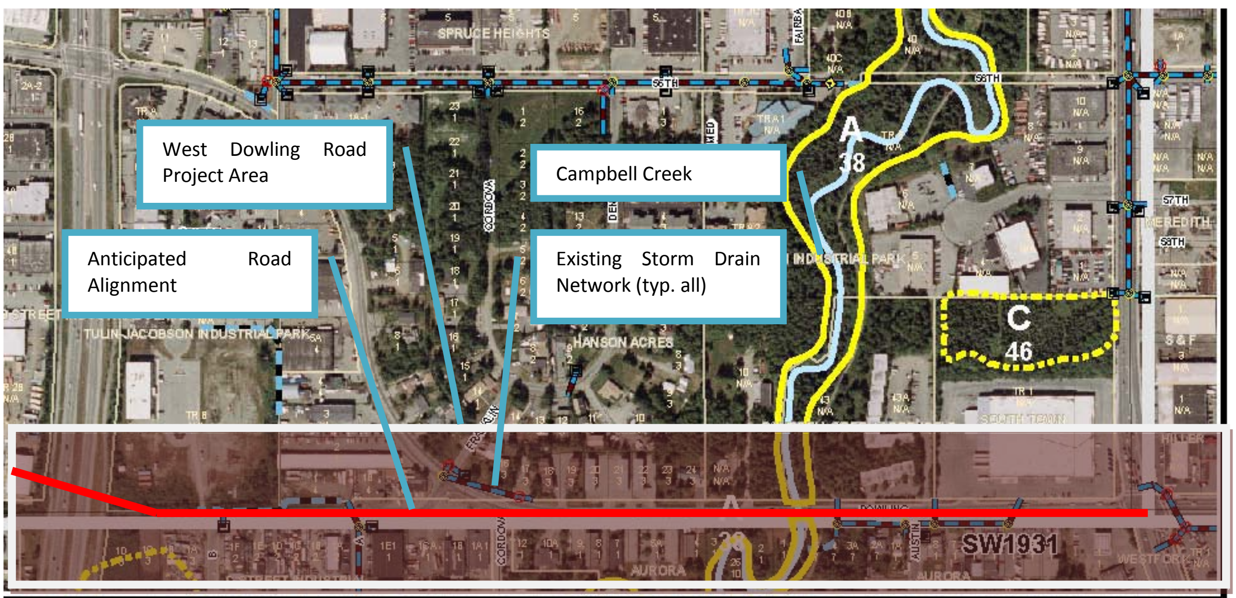

Figure 3 MOA Storm Water System and Wetlands (Site Area)

2.4 Rational Method

The rational method was used to calculate flow rates for each of the basins in the project area (Equation 1). Where Q is the flowrate (cfs), C is the rational constant, i is the rainfall intensity (in/hr) and A is the area of the drainage area (acres).

$$Q = CiA$$

Equation 1 Rational Method

A summary of drainage basins A,B,C and D is provided in Table 1. A summary of the road drainage areas 1,2,3 and 4 is provided in Table 4. After the information regarding proposed roadway profile became available, the drainage basins were revised to reflect the new road geometry and a max flowrate for any inlet along the system was calculated (Table 5).

3.0 HYDRAULIC ANALYSIS

3.1 Basin Alternatives

The existing drainage basins for the project were analyzed using topographic maps of the area, the previous report (HDR, 1995) and two site visits during Spring 2009. Two Alternatives for the drainage basins were proposed (Figure 4, Figure 5).

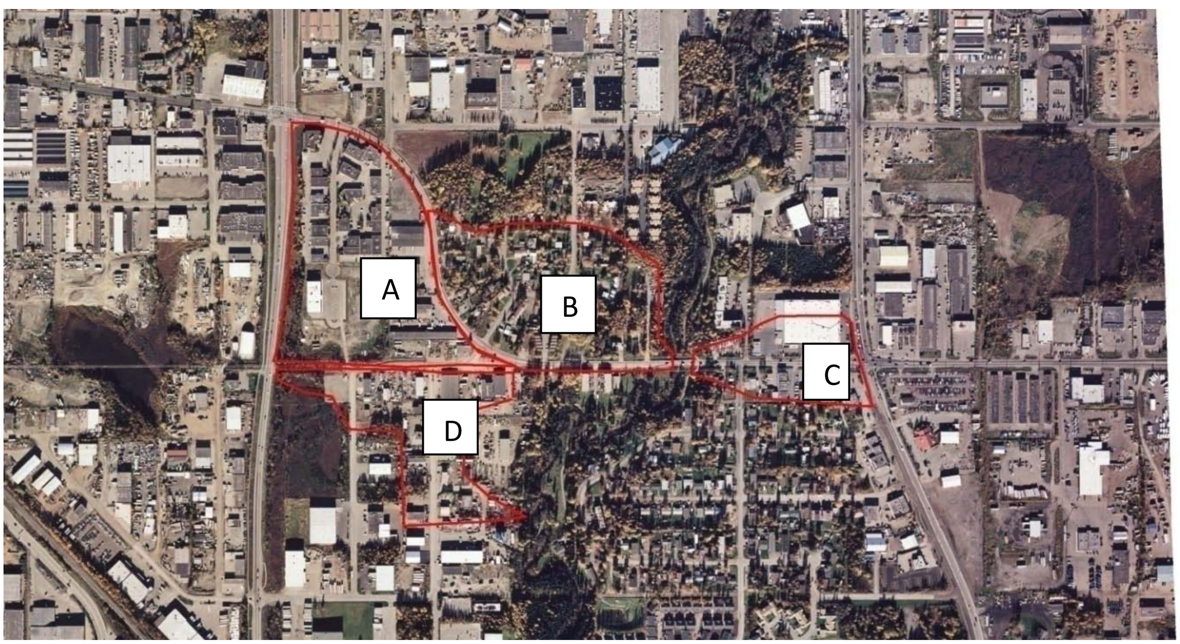

Figure 4 Project Area Drainage Basins (Alternative 1)

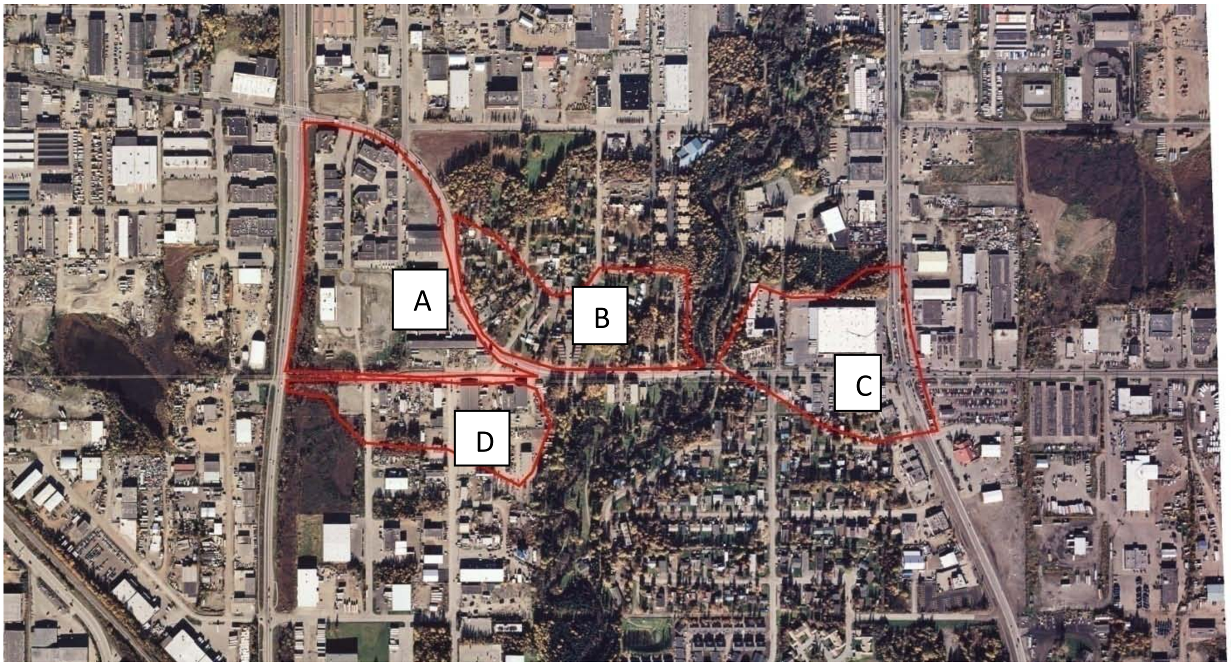

Figure 5 Project Area Drainage Basins (Alternative 2)

3.1.1 Alternative 1

Alternative 1 placed more emphasis on the conditions encountered during site visits along with topographic data. The existing road network, storm drain networks, drainage patterns, and hydrographic features were analyzed to determine the boundaries of each basin. The methodology of determining each basin boundary is further explained in section 3.2 Existing Conditions.

3.1.2 Alternative 2

Alternative 2 focused primarily on analyzing topographic data and previous reports. The tools available in AutoCAD 2009 were used to develop the boundaries of the basins in this Alternative. This Alternative was primarily developed based on information available before the second site visit in Spring 2009.

3.1.3 Preferred Alternative

Both Alternatives were analyzed to predict flow rates generated from each basin. Both Alternatives produced similar results with regard to flowrates, however Alternative 1 was ultimately chosen as the Preferred Alternative, since it represented the conditions encountered during field visits more accurately.

3.2 Existing Conditions

This section describes the existing conditions of basins A,B,C and D for Alternative 1. The existing drainage in the area consists of limited storm drains in isolated areas. The majority of the flow from basins A,B,C and D is routed through drainage ditches along either side of Dowling Road which flow into Campbell Creek.

The existing drainage in the area is deemed inadequate and will be replaced by a system encompassing basins A,B and D which will outfall into Campbell Creek (Figure 2, Figure 3).

3.2.1 Basin A

Basin A, as shown in Figure 4 - Project Area Drainage Basins, drains from north to south and extends from C Street to Potter Drive and is bounded by on the south side by the proposed alignment for West Dowling Road. The roads are crowned and as such define the extents of the drainage area.

The majority of this basin is zoned for commercial and industrial land use. The south west corner of the basin contains undeveloped land with wetland features, although it actually lies north of the area designated wetland on the MOA map (Figure 3).

The area surround the IBEW training facility ditches on the north east corner and the south edge of the IBEW training facility has one culvert along the north side of the road along with storm water pipe which connects into the system serving areas south of West Dowling road. The rest of the drainage area has no storm water system.

3.2.2 Basin B

Basin B, as shown in Figure 4, drains from north to south and extends from Potter Drive to the area west of Campbell Creek and is bounded on the south side by Dowling Road. The northern portion of the basin is bounded by a high point in the neighborhood which bounds the drainage.

The majority of the basin is zoned for residential land use. The eastern edge of the basin includes undeveloped area around Campbell Creek.

3.2.3 Basin C

Basin C, as shown in Figure 4, drains from north to south and extends from the area east of Campbell Creek to the east side of Old Seward Highway and south of Dowling Road. This basin is bounded by Old Seward Highway on the east which has C&G system.

The area contains both residential and commercially zoned lands. The area also includes undeveloped land around Campbell Creek.

3.2.4 Basin D

Basin D, as shown in Figure 4, drains from south to north and extends from the south side of the proposed West Dowling Road alignment to the industrial areas south of the road.

The majority of the basin is zoned for industrial land use. The area does contain undeveloped land that has been designated wetland area (Figure 3).

4.0 WATER QUALITY TREATMENT

4.1 Structural Treatment

There are several Alternatives available for treatment of the storm water collected along the proposed West Dowling Road. (PM&E, 2007)

4.1.1 Alternative 1 – Sedimentation Basins

Sedimentation basins can provide a means of treating storm water. Basins provide an area for separation of sediment particles from the storm water stream. One of the disadvantages of sedimentation basins are the relatively large footprint that they tend to have. Another disadvantage is that sedimentation basins may not provide adequate treatment periods of cold temperatures due to freezing problems. Since this project has limited ROW and design of sedimentation basins in an arctic environment would be problematic, this Alternative was not considered preferable.

4.1.2 Alternative 2 – Oil and Grit (O&G) Separators

Oil and grit separators provide a means of removing not only sediment from the storm water stream, but also diesel range organics such as oil. Also, oil and grit separators have a relatively small footprint and can be buried underground. One of the disadvantages is the large capital cost of purchasing and installing O&G separators. Because of the ROW restrictions on the project and the improved treatment qualities of O&G separators, they were chosen as the preferred Alternative.

Oil and grit separators will be installed on either side of Campbell Creek to treat storm water before entering Campbell Creek (Figure 8). The software provided by Stormceptor was used to size the oil and grit separator. The software incorporates over 35 years of rainfall data from Anchorage International Airport along with drainage basin characteristics in order model rainfall events. The recommended size for oil and grit separators on either side of Campbell Creek was the STC 900 model. This model will provide for the following percent removals of TSS for a fine (organics, silts and sand) particle size distribution (Details of the particle distribution are provided in the Stormceptor reports found in the appendix):

3.1.3 Alternative 3-Infiltration Galleries

Infiltration may be used as treatment for storm water runoff. Oversize pipe would be required for storage during the infiltration process and an over-flow meter will be placed near Campbell Creek. Due to the proximity of the creek, high ground water levels will slow infiltration and according to test bores the silt levels are not acceptable for infiltration. Other issues associated with the use of infiltration galleries will be icing issues and frost heaving near the storm drain system. Oversize pipe will be a cost increase and, due to poor infiltration rates along Dowling Road, make the use of infiltration galleries impractical.

4.2 Bioswale Treatment

In addition to treating the storm water collected along the proposed West Dowling Road, treatment will also be required for the proposed parking lot the will be constructed east of Campbell Creek on the north side of West Dowling Road. Bioswales will be placed to the east of Campbell Creek on the north side of Dowling Road, adjacent to the proposed Campbell Creek parking lot (Figure 8).

5.0 RECOMMENDATIONS

5.1 Drainage Improvements

For the purposes of analyzing drainage for the proposed West Dowling Road, the drainage basins were divided into basins which will drain into drainage ditches along the road, that is, the drainage basins A,B,C and D. The road drainage was divided into drainage areas 1,2,3 (Figure 6).

Figure 6 Proposed Road Drainge Area (1,2,3)

5.2 Basin A, B, C &D

5.2.1 Alternative 1 – Drainage Swales

Basins A,B,C & D will be connected into a system of swales along each side of the road (Figure 7). The treated water will discharge to the Campbell Creek. One of the main concerns with a swale system along the roadside is the large amount of ROW that would need to be acquired to accommodate the swales. This projected is restricted on the amount of ROW that can be acquired, thus this is not a preferred Alternative.

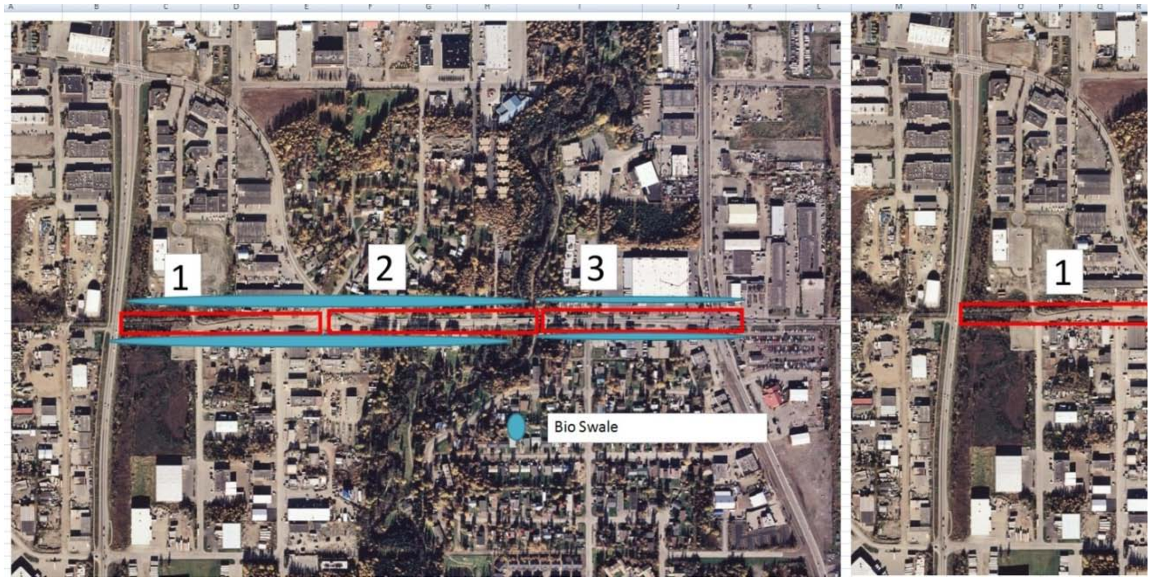

Figure 7 Alternative 1 – Drainage Swales

5.2.2 Alternative 2 – No Swales, Limited Drainage Ditches

Basins A,B,C & D will not be connected into the system that discharges to Cambell Creek. Rather the water from each of these drainage areas will be diverted from West Dowling Road by sloping the sides of the road 2:1 where the road is above current grade and providing drainage ditches where the profile of the road is below current grade. This is the preferred Alternative, since it represents less ROW acquisition.

5.3 Basin 1

5.3.1 Alternative 1

Basin 1 will be connected into the storm drain system that discharges to the O&G separator west of Campbell Creek (Figure 8). This is the preferred Alternative, since it will not add excess water to the existing storm drain network south of the project. Furthermore, treatment in the new O&G separator will probably be superior to the existing treatment regime.

Figure 8 Proposed Storm Drain System – Alternative 1

5.3.2 Alternative 2

Alternatively, this basin may be connected into the existing storm drain system south of Dowling Road along A Street (Figure 9). This is not the preferred Alternative

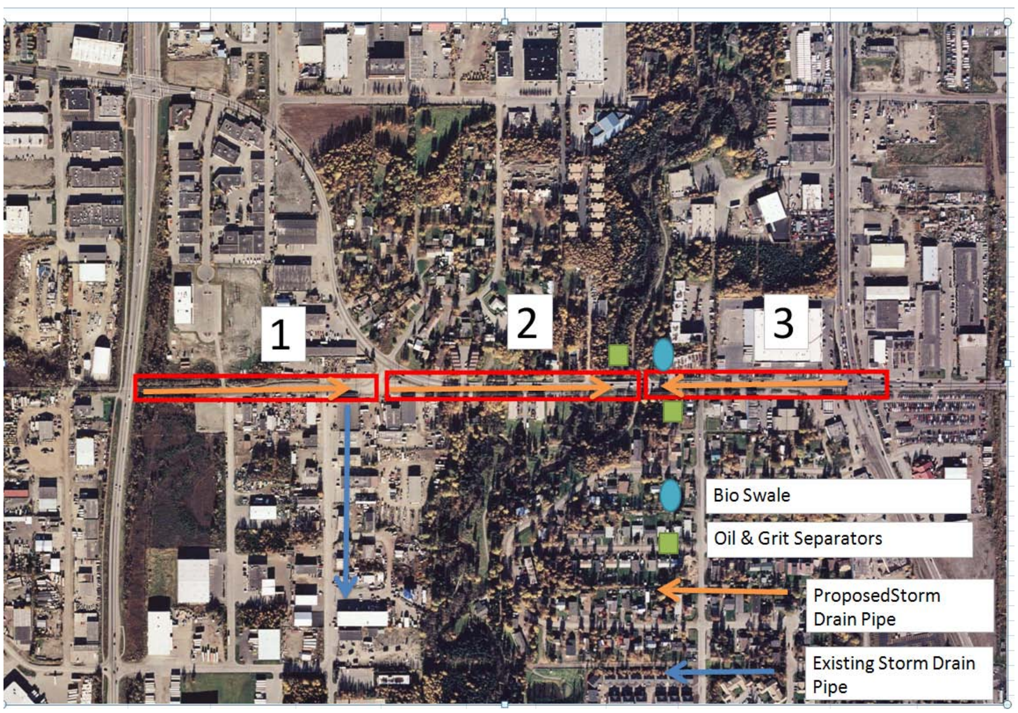

Figure 9 Proposed Storm Drain System - Alternative 2

5.4 Basin 2

Basin B will be connected into the system that discharges to the O&G separator west of Campbell Creek.

5.5 Basin 3

Basin C will be connected into the storm drain system that discharges to the east of Campbell Creek.

5.6 System Layout

The anticipated system layout is as described above in each basin description. With regard to an exact alignment, three Alternatives were analyzed.

5.6.1 Alternative 1 – North Side of West Dowling Road

This Alternative would place the primary storm drain pipes on the north side of West Dowling Road. Lateral connections to the catch basins on the south side of the road would connect to the primary storm drain pipes on the north side.

5.6.2 Alternative 2 – South Side of West Dowling Road

This Alternative would place the primary storm drain pipes on the south side of West Dowling Road. Lateral connections to the catch basins on the north side of the road would connect to the primary storm drain pipes on the south side.

5.6.3 Alternative 3 – Centerline of West Dowling Road

This Alternative would place the primary storm drain pipes on the centerline of West Dowling Road. Lateral connections to the catch basins on the north and south sides of the road would connect to the primary storm drain pipes along the centerline.

5.6.4 Preferred Alternative

Placing the storm drain alignment along the centerline is not preferable for two reasons:

1. Maintenance will be more difficult than if the line was placed along the side of the road.
2. Manhole placement in the travel lanes in not ideal from a traffic perspective.

If we examine the utilities along the proposed road corridor, both to the west of Campbell Creek and to the east of Campbell Creek we find that both the north and the south sides of the road have current utilities including overhead electric lines, fiber optic lines, sanitary sewer lines, water lines, gas lines and telephone lines (Figure 10, Figure 11). The south side of the road appears to have a higher number of utilities and placement of the storm drain line would be easier on the north side of the road.

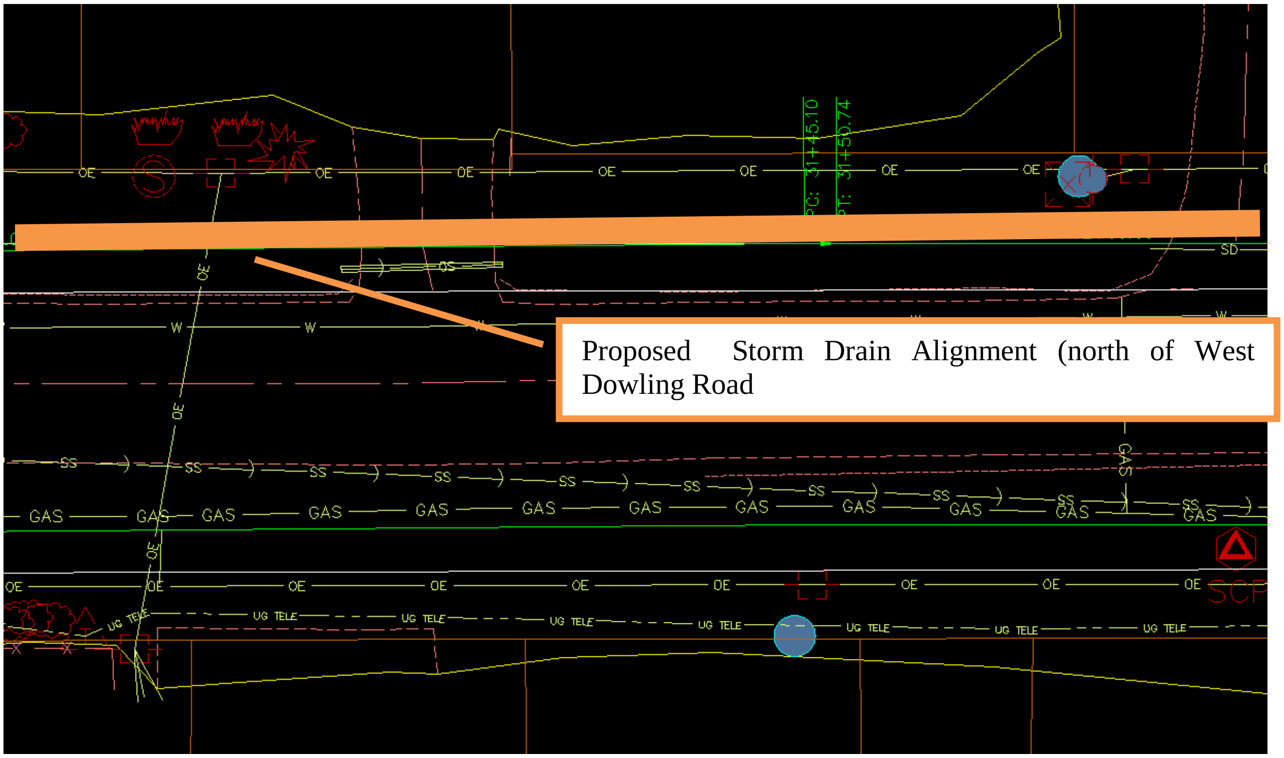

Figure 10   Sample Section of West Dowling Road between Campbell Creek and Potter

5.7 Storm Drain and Pipe Material

All pipe will be 24" Type S Precoated Corrugated Metal Pipe (PCMP) or Type S Corrugated Polyethylene Pipe (CPEP) unless otherwise noted (PM&E, 2007).

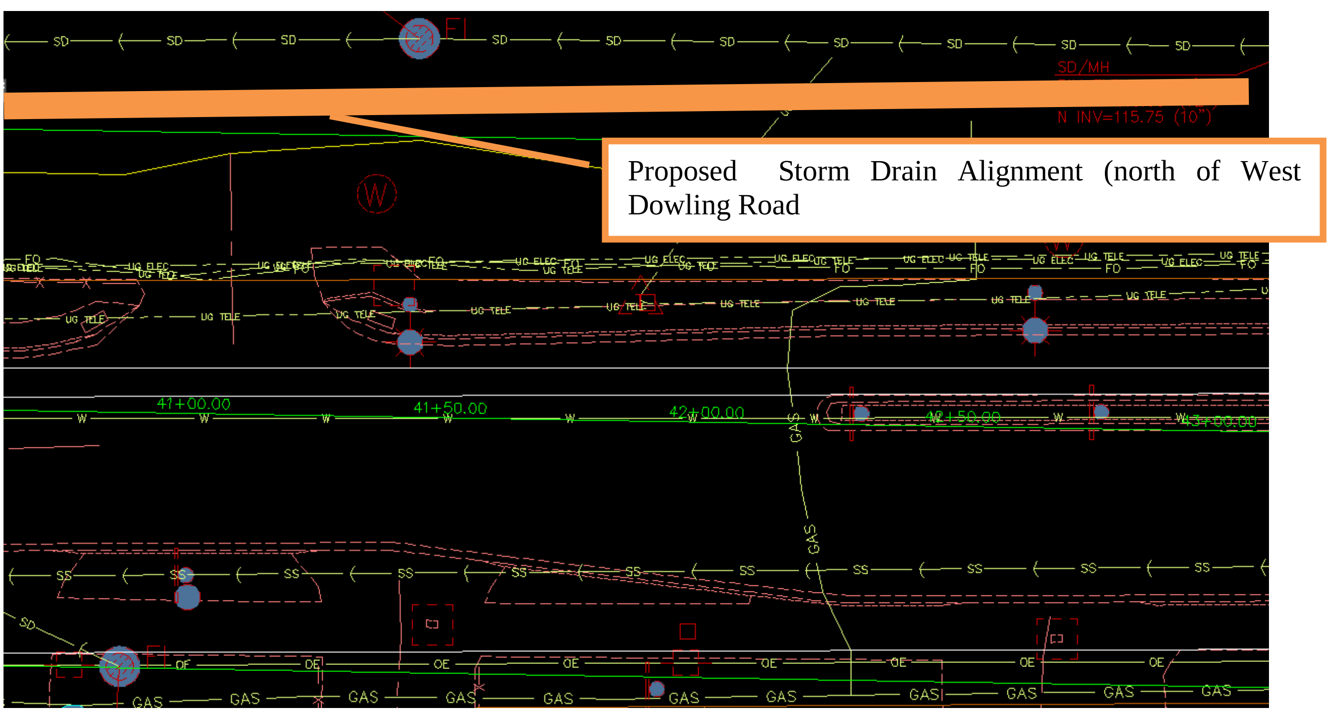

Figure 11   Sample Section of West Dowling Road between Campbell Creek and Old Seward

6.0 STORM DRAIN NETWORK LAYOUT

6.1 Design Criteria

The criteria used to design the storm drain network incorporated various elements already discussed in the report including: flow rates from each basin, minimum grade of 0.3% for all pipes, maximum manhole spacing of 300’, minimum invert difference on manholes of 0.05’, and minimum pipe bury of 4.5’(PM&E, 2007). Additional design criteria that was used to determine inlet locations included: placing inlets at all low points in the gutter grade, at median breaks, intersections, crosswalks, and on side streets at intersections where drainage flows into highway pavements (Mays, 2005). The capacity of each inlet was calculated. All inlets were assumed to be combination inlets, since combination inlets provide superior capacity in environments where grates may freeze. Capacities for combination inlets in sag locations were calculated based on (Equation 2). Where Q_i is the inlet capacity, A is the clear opening of the grate, g is acceleration due to gravity, and d is the depth of water over the inlet in ft (Mays, 2005). The capacity of sag combination inlets is 10.6 cfs for a 0% clogged grate and 3.8 cfs for a 100% clogged grate. Both of these capacities are well above the maximum system flowrate of 0.4 cfs . Note that this system flowrate is not the same as the flowrates discussed for each of the road drainage basins. The 0.4 cfs number takes into account the proposed road profile, which was not available previously. The 0.4 cfs number is therefore taken to be a refinement of previous calculations and overrides previously mentioned flowrate calculations.

$$Q_i = 0.67A(2gd)^{0.5} + 0.67hL(2gd)^{0.5}$$

Equation 2 Sag Combination Inlet Capacity pg.646 (Mays, 2005)

Capacities for combination inlets on grade were calculated based on Equation 3. Where Q_i is the inlet capacity, Q is the flowrate, R_f is the frontal-flow interception efficiency, R_s is the side flow interception efficiency and E_0 is the frontal-flow efficiency. The calculated capacity of combination inlets on grade is 0.26 cfs. The inlets on grade will decrease the maximum system flowrate of 0.4 cfs from reaching the sag combination inlets which are already more than adequate. From a strict system design standpoint these on grade inlets are not necessary. However, good design practices dictate that inlets should be placed in all the locations previously discussed in this section.

$$Q_i = Q[R_f E_0 + R_s(1 - E_0)]$$

Equation 3 On Grade Combination Inlet Capacity pg. 639 (Mays, 2005)

7.0 CONCLUSION

The existing drainage system in the West Dowling Road corridor is deemed inadequate. The system improvements made during construction of the proposed West Dowling Road will provide sufficient treatment of storm water runoff before discharge to Campbell Creek. Drainage ditches along the north and south sides of West Dowling Road will transport water from drainage basins adjacent to the project area to Campbell Creek. Storm water collected along West Dowling Road will be collected in a storm drain system, transported to oil and grit separators, treated and discharged to Campbell Creek. Storm water along the entire project corridor will be treated at oil and grit separators on either side of Campbell Creek (Figure 8). Alternatively, a the storm water collected between Potter and C Street may be routed to the existing storm drain system south of Dowling Road along A Street (Figure 9). The existing conditions of this system must be analyzed in order to determine if the additional inflow of storm water can be handled by the system.

8.0 TABLES

Table 1 Design Criteria ((PM&E, 2007)

Routing and Treatment Design Criteria		
Design Element		Design Criteria
Water Quality Sedimentation Ponds		
	Treatment Capacity	2-year, 6-hour rainfall event
	Outlet Capacity	50-year, 3-hour rainfall event
	Flood Discharge Capacity	100-year, 3-hour rainfall event
Water Quality Swales		
	Treatment Capacity	2-year, 6-hour rainfall event
	Conveyance Capacity	50-year, 3-hour rainfall event
Culverts, Ditches, Storm Drains		50-year, 3-hour rainfall event

Table 2 TSS Percent Removal

	Old Seward to Bridge	Bridge to Potter	Potter to C Street	Bridge to C Street
Percent Removal for STC 900 Stormceptor Model*	86%	86%	87%	81%

*For fine particle distribution (sand, silt, organics) –Details of distribution provided in appendix – Stormceptor Oil & Grit Seperator tor Sizing Reports

Table 3 Rational Method for Basins A,B,C & D

	A	B	C	D
Area (SF)	991,000.00	627,000.00	995,000.00	528,000.00
Area (acres)	22.75	14.39	22.84	12.12
i (in/hr)	0.28	0.28	0.28	0.28
C	0.87	0.87	0.87	0.87
Q (CFS)	5.8	3.7	5.8	3.1

Table 4 Initial Estimates Road Drainage Areas 1,2,3 & 4

	Old Seward to Bridge	Bridge to Potter	Potter to C Street	Bridge to C Street
Road length	1050	1140	1020	2160
Road width	106	106	106	106
Area (SF)	111,300.00	120,840.00	108,120.00	228,960.00
Area (acres)	2.56	2.77	2.48	5.26
i (in/hr)	0.28	0.28	0.28	0.28
C	0.96	0.96	0.96	0.96
Q (CFS)	0.7	0.8	0.7	1.5
Q (GPM)	322.9	350.5	313.6	664.2

Table 5 Revised Max System Flowrates

	Maximum Inlet Drainage Area
Road length	1200
Road width/2	53
Area (SF)	63,600.00
Area (acres)	1.46
i (in/hr)	0.28
C	0.96
Q (CFS)	0.4

9.0 SOURCES

ADOT. (1995). *Alaska Highway Drainage Manual.* Anchorage: Alaska Department of Transportation.

HDR. (1995). *Dowling Road Hydraulic Study.* Anchorage: HDREngineering, Inc.

Mays, L. W. (2005). *Water Resources Engineering.* Hoboken, NJ: John Wiley & Sons.

PM&E. (2007). *Design Criteria Manual - Chapter 2 Drainage.* Anchorage: Project Managment and Engineering Department.

10.0 APPENDICES

10.1 Stormceptor Oil & Grit Separator Sizing Reports

Stormceptor®

Appendix 1
Stormceptor Design Summary

Project Information

Date	3/5/2009
Project Name	West Dowling Road
Project Number	CE 438
Location	Potter to C Street

Designer Information

Company	Seawolf Engineering
Contact	Storm Water Group

Notes

N/A

Drainage Area

Total Area (ac)	2.48
Imperviousness (%)	100

The Stormceptor System model STC 450i achieves the water quality objective removing 80% TSS for a Fine (organics, silts and sand) particle size distribution.

Rainfall

Name	ANCHORAGE INTL AP
State	AK
ID	280
Years of Records	1962 to 1999
Latitude	61°10'N
Longitude	149°59'W

Water Quality Objective

TSS Removal (%)	80

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	**80**
STC 900	87
STC 1200	87
STC 1800	87
STC 2400	90
STC 3600	90
STC 4800	92
STC 6000	92
STC 7200	94
STC 11000	96
STC 13000	96
STC 16000	97

5

Rinker MATERIALS™

Figure 12 Stormceptor Report - Potter to C Street

Stormceptor®

Appendix 1
Stormceptor Design Summary

Project Information

Date	3/2/2009
Project Name	W Dowling Street
Project Number	CE 438
Location	Old Seward to Bridge

Designer Information

Company	Seawolf Engineering
Contact	Blue Fox Engineering

Notes

N/A

Drainage Area

Total Area (ac)	2.56
Imperviousness (%)	100

The Stormceptor System model STC 900 achieves the water quality objective removing 86% TSS for a Fine (organics, silts and sand) particle size distribution.

Rainfall

Name	ANCHORAGE INTL AP
State	AK
ID	280
Years of Records	1962 to 1999
Latitude	61°10'N
Longitude	149°59'W

Water Quality Objective

TSS Removal (%)	80

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	79
STC 900	**86**
STC 1200	86
STC 1800	87
STC 2400	89
STC 3600	90
STC 4800	92
STC 6000	92
STC 7200	94
STC 11000	95
STC 13000	96
STC 16000	96

5

Rinker MATERIALS™

Figure 13 Stormceptor Report - Old Seward to Bridge

Stormceptor®

Appendix 1
Stormceptor Design Summary

Project Information

Date	3/5/2009
Project Name	West Dowling Road
Project Number	CE 438
Location	Bridge to Potter

Designer Information

Company	UAA Seawolf Engineering
Contact	Storm Water Group

Notes

N/A

Drainage Area

Total Area (ac)	2.77
Imperviousness (%)	100

The Stormceptor System model STC 900 achieves the water quality objective removing 86% TSS for a Fine (organics, silts and sand) particle size distribution.

Rainfall

Name	ANCHORAGE INTL AP
State	AK
ID	280
Years of Records	1962 to 1999
Latitude	61°10'N
Longitude	149°59'W

Water Quality Objective

TSS Removal (%)	80

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	79
STC 900	**86**
STC 1200	86
STC 1800	86
STC 2400	89
STC 3600	89
STC 4800	92
STC 6000	92
STC 7200	93
STC 11000	95
STC 13000	95
STC 16000	96

5

Rinker MATERIALS™

Figure 14 Stormceptor Report - Bridge to Potter

DESIGN STUDY REPORT

APPENDIX I

ENVIRONMENTAL AND PERMITTING

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
Central Region
4111 Aviation Avenue
Anchorage, Alaska 99502

Prepared by:

Blue Fox Universal
University of Anchorage Alaska

Lee Bolling
Garrett Yager
Inho Chung
Chan Ohlfs

April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AADT .... annual average daily traffic
AASHTO .... American Association of State Highway and Transportation Officials
ACMP .... Alaska Coastal Management Plan
ADA .... Americans with Disabilities Act
ADF&G .... State of Alaska Department of Fish and Game
AWMP .... Anchorage Wetlands Management Plan Maps
AWWU .... Anchorage Water and Wastewater Utility
CEA .... Chugach Electric Association, Inc.
DCM .... Design Criteria Manual
DEC .... State of Alaska Department of Environmental Conservation
DHV .... design hourly volume
DOT&PF .... State of Alaska Department of Transportation and Public Facilities
DSR .... Design Study Report
EA .... Environmental Assessment
H&H .... Hydrologic and Hydraulic
HLB .... Heritage Land Bank
HPM .... Highway Preconstruction Manual
HTNA .... Highway Traffic Noise Study
LOS .... level-of-service
LRTP .... Long range Transportation Plan
LUST .... leaking underground storage tank
MEV .... million entering vehicles
MOA .... Municipality of Anchorage
mph .... miles per hour
MSE .... mechanically stabilized earth
MVM .... million vehicle miles
N/A .... not applicable
NWI .... National Wetlands Inventory
OSHP .... Official Streets and Highway Plan
PCM .... Preconstruction Manual
PDO .... Property Damage Only
PER .... Preliminary Engineering Report
PIH .... Plans-In-Hand
ROW .... right-of-way
TAG .... Technical Advisory Group
USACE .... United States Army Corps of Engineers
USFWS .... United States Fish and Wildlife Service
WDR .... West Dowling Road

1.0 EXECUTIVE SUMMARY

The environmental technical group for Blue Fox Universal is responsible for all environmental processes and alternatives for the West Dowling Extension project. This Appendix contains all of the work that the technical group has completed. Included in this report is the technical group's mission and goals, methodologies for completing the project, environmental draft permits and environmental design alternatives. All references for the completion of the group's work are documented in the references section at the end of the report.

1.1 Mission

The goal of the environmental technical group is to reduce the impact of the West Dowling Extension project on the health and welfare of the surrounding community and natural environment. This mission is accomplished by following the National Environmental Protection Act (NEPA) process and by coming up with design ideas that enhance the project while also benefitting the community and environment. The technical group was also responsible for communicating the commitments of the completed Environmental Assessment (EA) to the rest of the Blue Fox Universal technical groups for proper design.

2.0 METHODOLOGY

The general methodology of the environmental technical group began by looking at the tasks that must be completed by the group. Once these tasks were determined, a plan was developed to complete these tasks while following the main mission of the group: to reduce the impact of the project on the community and environment. Using this mission, the tasks could be properly completed.

The tasks that must be completed can be summarized into three major groups: (1) Environmental Commitment Communication, (2) Environmental Draft Permits and (3) Environmental Design Alternatives. Each of these groups will be discussed in detail in this report. These tasks were completed sequentially in the order listed above because of their natural order and efficiency that it gave the group.

In summary, the environmental commitment communication task involved a major analysis of the EA and a summary of all pertinent design information for the increased quality of all of Blue Fox Universal's technical groups. This document had to be written at the beginning of the project so that all technical teams could be consistent and reach a design that addressed all of the environmental issues.

The environmental draft permits task was completed next with the contribution of information from the group's mentor and the EA document. In a real project, the environmental permitting process involves an ongoing dynamic process of review and design evolution between the project team and the appropriate government and municipal agencies, due to the NEPA process. The West Dowling Project completed by Blue Fox Universal has a scope that does not include the review and evolution part of the NEPA process. Regardless, the environmental technical group collected and filled out the permits to its best abilities. This is the reason the permits are considered "draft permits." An important sub-section of this task involved the determination of the amount of wetlands affected by the project. The wetland credit/debit method was also researched.

Finally, the environmental design alternatives task was completed. This task involves the determination of important design alternatives in the environmental realm. The design alternatives looked at include alternatives for noise reduction barriers for the affected real estate, sustainable landscaping design and trail and recreation design. These three areas have significant impact on the final project and are important undertakings for the environmental group to succeed in its mission.

3.0 ENVIRONMENTAL COMMITMENT COMMUNICATION

The environmental communication task involved the distribution of pertinent design information to the rest of the Blue Fox Universal technical groups to ensure that project design addressed environmental concerns. Methodology for this task began with the analysis of the EA followed by the creation of the Environmental Commitments Document. The EA can be found in the references section under HDR Alaska, 2007. All data was gathered from this source for this specific task.

The heart of the EA is in Chapter 3: Environmental Consequences see Table 1. This chapter was divided into sections that were read and summarized.

Environmental Assessment

- Cover
- Signed FONSI
- Signature Page
- Table of Contents
- Acronyms
- Chapter 1 - Introduction
- Chapter 2 - Alternatives
- Chapter 3 - Environmental Consequences
  - Air Quality
  - Waterbodies
  - Floodplains
  - Water Quality
  - Coastal Zone
  - Vegetation
  - Wetlands
  - Fish and Essential Fish Habitat
  - Wildlife
  - Threatened and Endangered Species
  - Land Use and Zoning
  - Land Ownership
  - Socio-Economics
  - Traffic and Transportation
  - Noise
  - Archeology and Historic Preservation
  - Recreation Resources
  - Utilities
  - Contaminated Sites
  - Visual
  - Cumulative Effects
  - Commitment of Resources
  - Productivity
- Chapter 4 - Consultation and Coordination
- Chapter 5 - List of Preparers
- Chapter 6 - References

Table 1 West Dowling Environmental Assessment outline (ADOT, 2009)

3.1 Environmental Commitment Document

Upon reading and summarizing the W. Dowling Environmental Assessment, the Environmental Commitment Document could be produced by the environmental technical team. This document is shown below in its full form. The document was delivered to all Blue Fox technical groups for their reference in their appropriate area of design.

Senior Design – BLUE FOX Environmental & Permitting (Bolling, Chung, Ohlfs, Yager) 2/12/09

Environmental Commitments Document

Environmental commitments stated in the EA for the W. Dowling Extension.
Incorporate the below commitments and mitigation measures in the project design.

Water Quality

- Strom water runoff must be treated

Wetland impacts

- The alignment was shifted to the north in the vicinity of Tina Lake
- Limit Construction staging areas to uplands
- Disturbed areas would be recontoured to approximate original conditions and reseeded with native vegetation to minimize erosion and stabilize stream banks

Vegetation Impacts

- Impact to vegetation can be minimized through proper erosion and sedimentation control, covering fill material stock piles, revegetation of disturbed areas, limit heavy equipment to within the construction footprint, stabilize slopes to Campbell Creek and use contaminant free materials surface construction.

Concern regarding adversely affect EFH and anadromous fish resources.

- No work will be performed below Ordinary High Water
- Campbell Creek supports Chinook and Coho Salmon rearing and spawning habitat

Campbell Creek Bridge

- The replacement is longer and wider than the existing bridge for pedestrian crossings on the bridge and underneath the bridge.
- The bridge abutments will be above ordinary high water.
- No riprap will be placed below ordinary high water. The placement of in-stream riprap in Campbell Creek should be avoided through the use of trench fill revetments. This is because Campbell Creek supports Chinook and Coho Salmon rearing and spawning habitat.
- Disturbed areas would be revegetated to stabilize soils and to minimize further runoff except in areas where vegetation will not grow such as under bridges.
- The bridge will have greater than or equal to 10 feet of clearance.
- Lighting should be provided on the upgraded road to allow pedestrians and motorists to see moose that may get onto bridges.
- The trail will be re-directed to go under the bridge.
- The MINIMUM required bridge dimensions to avoid an impact on the 100-year flood is an **89 ft opening**.
- Work within the 100-year floodplain has been minimized to comply with Executive Order 11988

Green Belt and Trails

- MOA Parks and Recreation supports the project and grade separated trail crossing
- By grade-separating the trail, users of the greenbelt would not affected by visual and/or noise impacts associate with the road.
- Pedestrian detours would be established during construction
- Make project enhance the Campbell Creek Trail Greenbelt

Railroad Crossings

- A grade-separated rail crossing.
- The existing at-grade crossing of the Alaska Railroad by Arctic Boulevard will remain.

4.0 DRAFT PERMITS

The environmental draft permits task was completed with information contributions from the group's mentor and the EA document. As stated earlier, in a real project, the environmental permitting process is an ongoing process of review and design evolution between the project team and the appropriate agencies, due to the NEPA process. Although the West Dowling Project completed by Blue Fox Universal has a scope that does not include the review and evolution part of the NEPA process, the environmental technical group collected and filled out the permits to its best abilities. This is the reason the permits are considered "draft permits." An important sub-section of this task involved the determination of the amount of wetlands affected by the project. The wetland credit/debit method was also researched.

4.1 Summaries of Necessary Permits

To facilitate the permit process a brief summary of all the necessary permits for the W. Dowling project will be discussed below. In these summaries are important websites for accessing each of these permits.

4.1.1 U.S. Army Corps of Engineers (USACE)

The US Army Corps of Engineers (USACE) requires a Clean Water Act Section 404 permit for the placement of fills into waters of the US. This permit is required because of the proximity of the project to a water body (Campbell Creek) and the potential for fill material to enter the water body. The information required for submitting this permit include: the names, addresses and phone numbers of the responsible parties; agent information if an agency is representing the responsible party in this process; a statement of authorization; the name, address and purpose of the project; name of the water body impacted by the project; directions to the project site; nature of activity of the project including structural dimensions, types of construction materials, construction methods, whether or not dredged or fill materials will be discharged into water body and the identification of structures being constructed on fill, piles or floating platforms; a brief description of the general purpose of the project and estimated dates of completion; if discharging materials into a water body the applicant must indicate the reasons for discharge, the type of material discharged and the amount of materials in cubic yards that will be discharged; if the project includes filling wetlands, the applicant will need to include the surface area of filled wetlands; the names and addresses of adjacent property owners; status of other environmental applications pertaining to this project and the applicants signature.

Drawings are also required for the Section 404 permit. The required drawings include a vicinity map, plan view and cross sections for the project.

The permit application and permit instructions can are available at the following website. http://www.poa.usace.army.mil/reg/permitapp.htm

4.1.2 Alaska Department of Environmental Conservation (DEC)

The Alaska Department of Environmental Conservation requires a Section 401 Certificate of Reasonable Assurance because there will be activities that require permits under the Clean Water Act. An individual application to DEC may not be necessary because the Section 404 application to the USACE will cover this Section 401 Certificate.

4.1.3 Alaska Department of Fish and Game (ADF&G)

The Fish Habitat (Title 16) Permit is an authorization from the Alaska Department of Fish and Game, Division of Habitat for an individual or government agency is required to obtain by notifying for activities within or across a stream used by fish if Habitat determines that such uses or activities could represent an impediment to the efficient passage of fish. The Fish Habitat Permit is required if any specified anadromous fish stream is located on the project site. Some common activities which require a Fish Habitat Permit are stream fords, heavy equipment operated on the ice, water withdrawal, boat launch and dock construction, and culvert placement. In order to obtain the permit, the following information is needed:

1) Name, address, and telephone number and the name, address, and telephone number of the contractor who will be doing the work, if known.
2) The type of project and purpose of the project.
3) Name of the water body in or adjacent to which the project will occur.
4) Plans with the following items shown: access to the site, plan view showing all project features and dimensions, or crossing/fording sites: material removal plans
5) Specifications, if available
6) A current aerial photograph, if available.
7) The time of year when project construction will occur.
8) Precautions to be taken to insure the species are protected from adverse impacts, Precautions to be taken to maintain State Water Quality Standards
9) The water body characteristics at the project site.
10) Hydraulic information for the types of projects indicated.

The Permit Application can be found at http://www.habitat.adfg.alaska.gov/fhpermits.php

4.1.4 Municipality of Anchorage (MOA)

The MOA requires a flood hazard permit and a noise permit. Also, the MOA requires plans to be submitted to the Municipal Department of Community Planning and Development describing how proposed fill would minimize impacts to nesting habitat, such as timing windows, additional setbacks (other than the 25-feet required), vegetative screening, reduction of fill, and onsite enhancement. A hydrologic analysis shall be done and shall meet the standards of the Municipal Department of Public Works in order to prevent flooding, maintain both surface and subsurface cross drainage, and prevent drainage of adjacent wetlands. It shall be used in determining the placement of fill that would minimize interference with the local hydrology.

4.1.4.1 Flood Hazard Permit

The flood hazard permit is important because it ensures that potential impacts on floodways are considered. Flood Hazard Permit is required because there would be work within a flood plain. The flood plain map for the project area can be seen in figure 1.

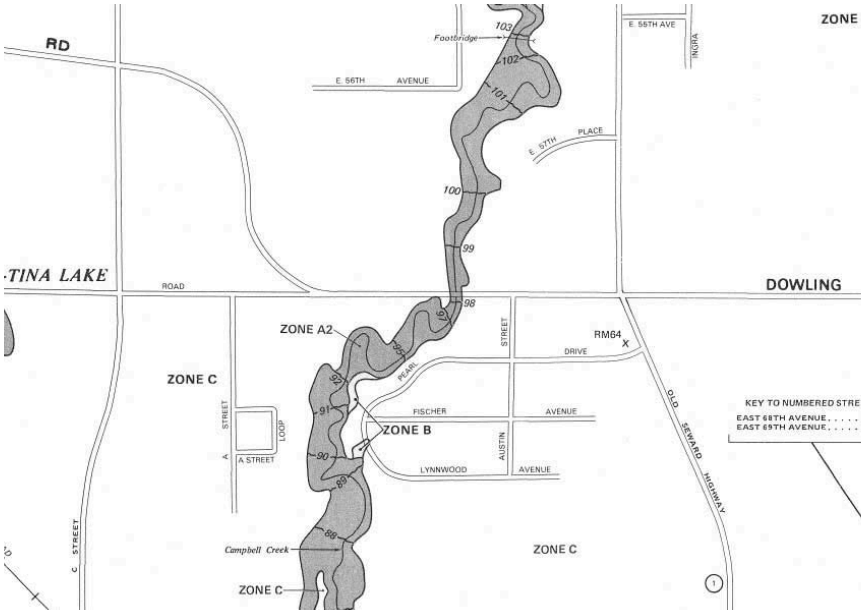

Figure 1 Flood plain map of the W. Dowling Project area (wms.geonorth.com/library/LibraryMapsFEMA.aspx, 2009)

The flood hazard permit can be accessed at the website: http://www.muni.org/iceimages/zoning/App_FloodHazard.pdf%20. This permit contains many pages including a flood hazard questionnaire and repeated information about concurring permits with the other agencies. The first page of the flood hazard permit is shown below. It is filled out for our specific project.

Municipality of Anchorage
Department of Public Works
Project Management and Engineering
3500 East Tudor Road
Anchorage, Alaska

Department of Public Works

Application for Flood Hazard Permit

Permit #

APPLICANT COMPLETES PARTS I – IV

I. IDENTIFICATION – NAME	MAILING ADDRESS	
OWNER Alaska Department of Transportation and Public Facilities (DOT&PF)	P.O. Box 196900 Anchorage, AK 99519-6900	PHONE # 269-0546
CONTRACTOR Unknown		PHONE #
ARCHITECT, ENGINEER The Blue Fox Universe	3211 Providence Drive Anchorage, AK 99508	PHONE # 786-1900

II. LOCATION OF PROPOSED DEVELOPMENT

ADDRESS (Street No., Street and Zip)		
West Dowling Road between Old Seward Highway and C Street.	TAX PARCEL # — — TAX PARCEL # — — TAX PARCEL # — —	
	LOT	BLOCK	SUBDIVISION

III. DESCRIPTION OF PROPOSED WORK – CHECK APPLICABLE BLOCKS

- ☐ Structure
  - ☐ New
  - ☐ Addition
  - ☐ Alteration
  - ☐ Residential
  - ☐ Commercial
- ☐ Mobile Home
  - ☐ Private Lot
  - ☐ Mobile Home Park
- ☒ Grading, Excavation, Fill
- ☐ Subdivision
- ☐ Watercourse Alteration
- ☒ Utility Service Connection
- ☒ Utility Mainline (Specify) Transmission Line Relocation
- ☒ Road Construction
- ☒ Other (Specify) ____________

IV. PLANS, SPECIFICATIONS, CERTIFICATIONS REQUIRED WITH APPLICATION

Provide THREE SETS of detailed plans of the proposed development which include:

(1) Plot plans stamped by a registered land surveyor, showing mean sea level (MSL) elevation of the lowest floor including basement of all structures.

(2) MSL elevation to which any proposed structure will be floodproofed.

(3) Certification by a registered professional engineer or architect that the floodproofing methods are adequate to prevent flood damage.

(4) A description of watercourse alterations/relocations or work within a floodway, with hydrological calculations stamped by a registered professional engineer.

(5) Provide base flood (100 yr.) elevation data for a development or subdivision greater than 50 lots or 5 acres, whichever is least.

(6) Copies of permits required by other local, state and federal agencies.

(7) Information regarding limits of work for any fill or excavation proposed to be placed or removed during construction of the development.

(8) Indicate total area (sq.ft.) located in floodplain boundaries. Provide impervious surface area (as %) for development in floodplain boundaries. Impervious surfaces prevent the entrance or passage of water into the soil, e.g. building sites, asphalt surfaces, etc.

NOTE: If a permit is issued, an as-built drawing stamped by a registered professional engineer, land surveyor or architect, as appropriate, must be submitted to this office upon completion of the project or the permit will be cancelled.

Your application will be approved or denied within 30 days of receipt of the last required information. It is YOUR RESPONSIBILITY to submit a complete application.

Signature of owner/applicant	Date

Revised 03/07/01 M:\WORD\FORMS\ApplFloodHazardPermit

4.1.4.2 Noise Permit

A Municipal Noise Permit is also required. This permit is filled out and shown below. This permit was obtained at http://www.muni.org/iceimages/healthesd/Noise%20Permit%20Application%20Form.pdf. In addition, the allowable noise levels for various properties in the MOA are shown in table 2.

Affected Property	Time	Sound Level dB(A)
Residential	7:00 AM--10:00 PM 10:00 PM-- 7:00 AM	60 50
Commercial	7:00 AM--10:00 PM 10:00 PM-- 7:00 AM	70 60
Industrial	At all times	80

Table 2 Allowable Noise Levels in the MOA (MOA, 2009)

Municipality of Anchorage, Department of Health & Human Services
ENVIRONMENTAL SERVICES DIVISION
825 L Street • P.O. Box 196650 • Anchorage, AK 99519-6650 •
(907) 343-4200 fax (907) 343-4786
www.muni.org

NOISE PERMIT APPLICATION

Name of Applicant (Please Print): UAA Senior Project, the Blue Fox Universe   Date: 7 March 2009

Name of Organization / Company: Alaska Department of Transportation and Public Facilities (DOT&PF)   Phone: 786-1900

Mailing Address: 3211 Providence Drive, Anchorage, AK 99508

Type of activity: Construction ☒ Explosives, firearms, fireworks ☐ Public event ☐ Snow removal ☐ Motor vehicle racing ☐

Dates and times of planned activity: June 1, 2011 - Oct 31, 2013   M-F 0800-1700

Location(s) of activity (street address or legal description): West Dowling Road between C Street and Old Seward Highway

Description of event, noise source(s), equipment: Heavy road construction equipment

Estimated noise level(s) during event: 80-120 dB(A)

Number of persons expected to attend or participate: Variable

Zoning of location and surrounding area: (e.g. residential, industrial, business) Residential Industrial Business   Distance to nearest residential property line ______

Demonstration of need for permit: Why are you requesting the permit? What hardship will result for you, the community or others if the permit is not granted? (See AMC 15.70.070B) Attach additional sheets or supporting documentation if necessary.

The purpose of the project is to relieve traffic congestion on nearby arterial roads and improve access to Anchorage International Airport. The proposed extension will provide east/west traffic flow, reduce traffic on Tudor Road and help to implement the goal of developing a more connected roadway pattern as identified in the Anchorage Long-range Transportation Plan (LRTP).

Describe any actions you intend to take to abate the impacts of the noise created by the planned activity. Please attach supporting documentation if necessary.

See Noise Mitigation Attachment 1.

______________________________   ______________________
Signature of Applicant   Date

4.1.5 Department of Natural Resources Department of Coastal and Ocean Management (DCOM)

Coastal Consistence Determination is required through the Alaska Coastal Management Program (ACMP) because there will be activities in the coastal zone that affect a natural resource. The Costal Project Questionnaire is located at http://www.alaskacoast.state.ak.us/Projects/pcpq3.html . This questionnaire requires information regarding the project location, land ownership, coastal district, DNR approvals, Department of Fish and Game approvals, Department of Environmental Conservation approvals, USACE approvals, BLM approvals, EPA approvals, FAA approvals, and other federal agency approvals.

4.1.6 Environmental Protection Agency (EPA)

National Pollutant Discharge Elimination System (NPDES) Permit limits the storm water runoff from construction activities that can have a significant impact on water quality. NPDES storm water program requires construction site operators engaged in clearing, grading, and excavating activities that disturb one acre or more, including smaller sites in a larger common plan of development or sale, to obtain coverage under an NPDES permit for their storm water discharges.

The following information is needed to obtain the permit:

1) Facility owner/operator (applicant) information
2) Project/Site Information
3) Approval from the responsible corporate officer for the project

Detailed information about the permit can be found at the following web sites:

http://yosemite.epa.gov/r10/water.nsf/Stormwater/stormwater+permits,
http://cfpub.epa.gov/npdes/stormwater/const.cfm

The Permit application can be found at ftp://ftp.dot.state.tx.us/pub/txdot-info/env/storm/bappendixnoi.pdf

4.2 Anchorage Wetland Debit-Credit Methodology

The Anchorage Debit-Credit Methodology (U.S. Army Corps of Engineers et al. 2000) is a set of procedures designed to apply a uniformed and formatted approach to quantify wetlands disturbance and compensatory measures within the Municipality of Anchorage (MOA).

The Methodology works in conjunction with the Anchorage Wetlands Management Plan (AWWP), and provides a means to measure impacts from a proposed development project on wetlands and waterways in terms of direct impacts (the actual footprint of fill or disturbance), indirect impacts (the areas near the direct fill or disturbance that may be slightly affected due to proximity), and temporary impacts, such as those due to construction.

The Methodology also takes into consideration the value of the wetland type and relative ecological value (REV); higher value wetlands are more expensive to disturb, and alternatively, are more beneficial if preserved or protected. More detailed information about the Methodology and some calculation for debit-credit can be found in the following website http://www.dowlprojects.com/wdowlingroad/Media/wdowlingroad/E8Debit_Credit_Package.pdf\.

4.3 Water Quality

4.3.1 Introduction

Water is the lifeblood of the environment, essential to the survival of all living things and we must do everything possible to maintain its quality for today and the future. In this report, there are some ways to keep the water quality and even improve the water quality on the West Dowling Project. Also A calculation of wetland area within the project corridor in phase I will be performed in this report. There are two wetlands and Campbell Creek within the project corridor. The area of the wetland is important component to be concerned since they provide flood storage, decrease peak flows, and help to purify water.

4.3.2 Existing Condition

The water bodies that pertain to Phase 1 of the project include Campbell Creek and the wetlands at the intersection of C Street and the proposed West Dowling alignment. Campbell Creek flows south through the project area, crossing under Dowling Road approximately 1,000 feet west of the Old Seward Highway. The North Fork of Little Campbell Creek flows west roughly 1,500 feet to the south of Dowling Road and joins the main channel of Campbell Creek approximately 3,000 feet south of Dowling Road. The fork crosses under the New Seward Highway approximately 1 mile further downstream of this crossing. Both Campbell Creek and North Fork Little Campbell Creek convey runoff from drainage areas within the project corridor's drainage basin. Both creeks have a 100-year floodplain designated by the Federal Emergency Management Agency (FEMA).

4.3.3 Water Quality Improvement Plan

There is no effect expected on the water quality during the construction. However, here is an effective method of dealing with any negative effects on water quality that could occur during the construction.

1. Identify the water quality problem in a stream or lake
2. Locate where the problem is coming from
3. Determine how, with improvement, would change the water quality
4. Suggest ways that communities and businesses can improve their stream or lake

As mentioned above, there is no significant impact on water quality. There is always a better way to improve the water quality.

1. Reduce storm water runoff from residential areas
2. Use native plants for vegetation
3. Proper disposal of hazardous waste to be regulated

The first two points will be discussed in depth in the Landscaping section.

4.3.4 Wetlands Area

The table 3 below is from the West Dowling Project website, showing the area of different kinds of wetlands exists on the project corridor. The area of the wetland located behind the Sears Storage Building, which is labeled as C46 in figure 2, is calculated to be approximately 2.3 acres, and the wetland on C Street and Dowling Road, labeled as C38C, is approximately 5.4 acres. The calculation was performed by using AutoCAD drawing.

Wetland/ Upland Type	NWI Code	Description	Total Area (acres)	Percent of Wetland Total Area	Percent of Total Study Area
Emergent wetlands	PEM1B	*Palustrine, emergent, persistent, saturated*	1.8	3.1%	.40%
	PEM1H	*Palustrine, emergent, persistent, permanently flooded*			
Scrub/ Shrub wetlands	PSS1/4/EM1B	*Palustrine, scrub/shrub, broadleaf deciduous/needle-leaf evergreen/emergent, persistent, saturated*	10.0	17.2%	2.0%
	PSS1/EM1B	*Palustrine, scrub/shrub, broadleaf deciduous/emergent, persistent, saturated*			
	PSS1B	*Palustrine, scrub/shrub, broadleaf deciduous, saturated*			
Dwarf black spruce wetlands	PSS1/4B	*Palustrine, scrub/shrub, broadleaf deciduous/needle-leaf evergreen, saturated*	38.0	65.5%	8.0%
Forested wetlands	PFO1/4C	*Palustrine, broad-leaved deciduous and needle-leaved evergreen forested wetland, seasonally flooded*	2.2	3.8%	.50%
	PFO1/SS4B	*Palustrine, broad-leaved deciduous forested wetland with scrub/shrub, needle-leaved evergreen understory, saturated*			
	PFO1B	*Palustrine, broad-leaved deciduous forested wetland, saturated*			
Ponds	PAB3H	*Aquatic bed*	5.6	9.7%	1.0%
	PUBH	*Unconsolidated bottom*			
Stream	R2UBH	*Creek, unconsolidated bottom*	0.4	.7%	.10%
		Total Wetlands	**58**	**100%**	**12%**
Upland	U	**Upland (non-wetland)**	**438**	**0%**	**88%**

Table 3 Types of Wetlands and Total Area of the Wetlands

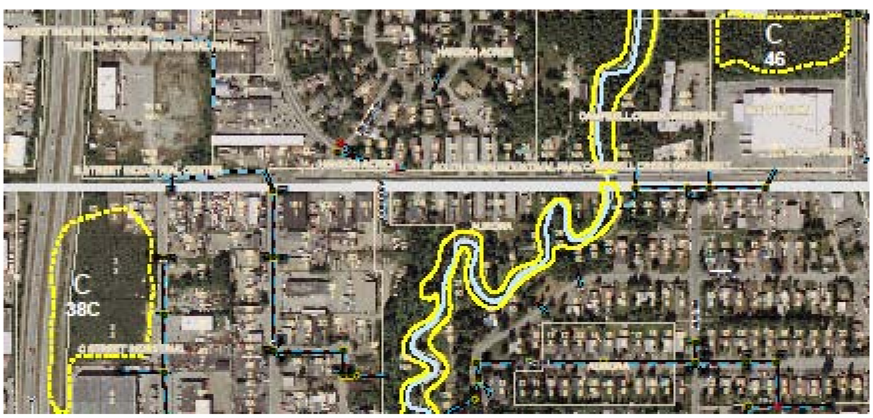

Figure 2 Wetlands on the Phase I of the Project

4.3.5 Water Quality Summary

There is no significant impact on neither the water quality nor the wetlands. As described above there are some general ways to improve water quality during and after construction. The calculation of the wetlands area was done, so that it could benefit the understanding and designing of the Storm Water Team.

5.0 ENVIRONMENTAL DESIGN ALTERNATIVES

The environmental design alternatives task involved the determination of important design alternatives in the environmental realm. The design alternatives looked at include alternatives for noise reduction barriers for the affected real estate, sustainable landscaping design and trail and recreation design. These three areas have significant impact on the final project and are important undertakings for the environmental group to succeed in its mission.

5.1 Noise Barriers

If a project is solely funded by the State, the Department of Transportation (DOT) makes decisions on noise mitigation. When a project is proposed for the construction of a highway on a new location or the reconstruction of an existing highway the State DOT determines if there will be traffic noise impact and determines requirements, if any, for noise mitigation. If the DOT identifies potential impacts, it may implement abatement measures, possibly including the construction of noise barriers, where reasonable and feasible. The cost of these measures is sometimes shared between the State and affected homeowners or other private concerns. In this project, the noise mitigation is mainly concerned with residences because the commercial business occupants are mostly industrial and are self-equipped with noise mitigation devices such as headphones during working hours.

5.1.1 Existing noise level conditions

According to noise measurements conducted by the contractor (Dowl Engineering Company), the 15 out of 21 residences currently receive 67 dB (A) which exceeds the national abatement of 65 dB by 2 dB(A). On other hand, the noise level of 67 dB (A) is well below the national abatement for a commercial business zone which is 70-75 dB (A).

5.1.2 Expected traffic volume, speed and noise Level

As the traffic lanes are increased, it is expected the traffic volume will increase and subsequently the noise level will increase as well. According to the contractor’s analysis (Dowl Engineering Company), by the year 2030 the traffic volume will be double that of today. There is also a new proposed 10 MPH speed limit increase to 45 MPH. The combination of these factors is expected to increase the noise level by roughly 7dB (A)

5.1.3 Basic Noise level Calculation

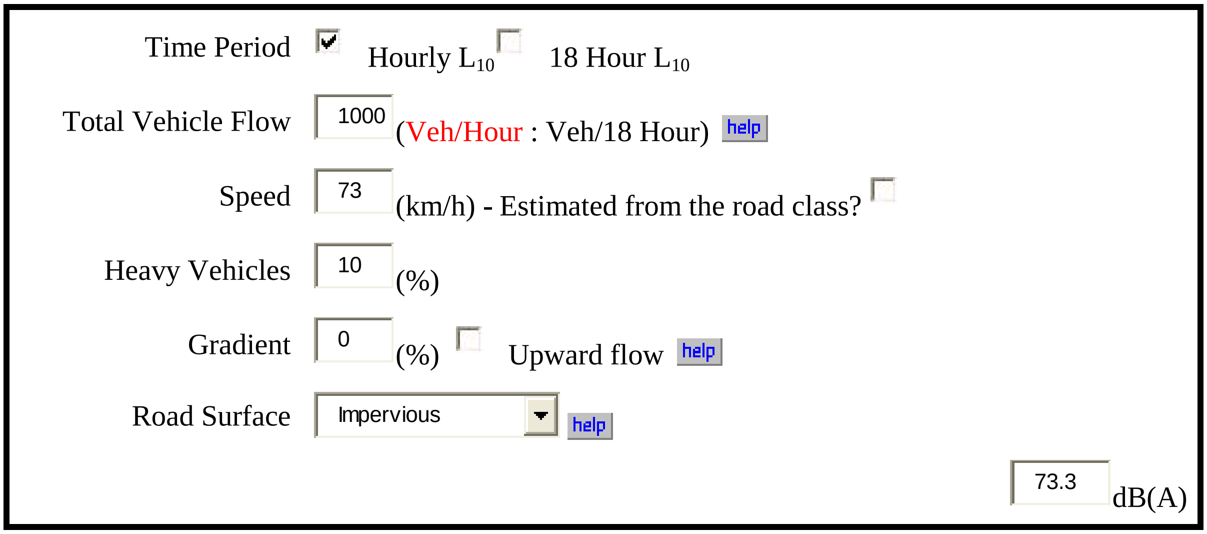

Figure 3 Basic Noise Level Calculation (West Dowling Road 2030 Forecast traffic volume, UK National Physical Laboratory Noise Calculator)

As above calculation shows, this level of noise might affect the residents living quality and health. Therefore, traffic noise is a concern.

5.1.4 Potential Noise Mitigation Techniques

- Fencing – Due to the numerous openings required directly from the right of way for access, fencing would be a poor noise mitigation technique in this area. Fencing could have a positive psychological impact, however, and contribute to a sense of privacy and security. See figure 4 for an example.

Figure 4 Example of Noise Barrier Facing in New Road Construction

- Vegetation barriers – Vegetation barriers are also a poor noise mitigation technique for the same reason as fencing. These barriers can also have a positive psychological impact, however and can greatly add to the ambiance of the area.
- Window Noise Insulation - Double pane noise reducing windowpanes and insulation can greatly affect the amount of interior noise and is feasible. See figures 5 and 6.

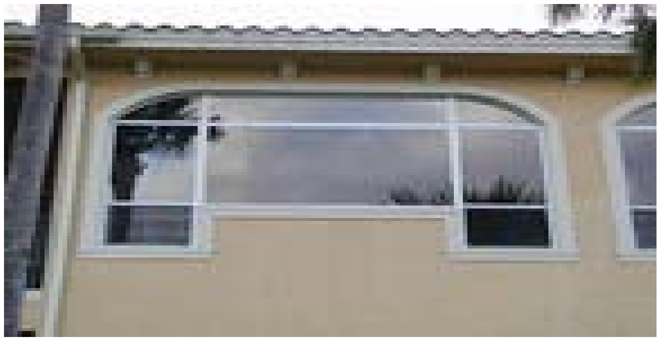

Figure 5 Example of a double pane window

Sound intensity	Single Pane window STC Rating 26-28	Double pane window STC Rating 26-33	Soundproof and double pane window STC Rating 43-49

Figure 6 Comparison of Sound transmission Class (STC) Sound Intensity rating between Single Pane, Double Pane and soundproof windows.

- Rubberized asphalt – In 2003 the Arizona Department of Transportation adopted a Quiet Pavements Program to overlay most of the Regional Freeway System with rubberized asphalt. The mixture of 80% Asphalt Cement (AC) and 20% crumb rubber from recycled tires has resulted in an overall 3 to 5 dB (A) decrease in noise. This is definitely a feasible option for the Dowling Road project.

5.1.5 Recommended mitigation method for north side of road

A combination of rubberized asphalt, wooden fencing, and some shrubs inside the fencing is recommended. Installation of this combination can substantially reduce traffic noise and psychologically isolate the noise receivers. An 8’ tall wooden fence that extends the length of the property line, excluding the entrances is also recommended. The fence color should be “wet wooden” because Dowling road has a relatively dry appearance with no vegetation and a natural wood color is friendlier.

In order to create a psychological ambiance, property owners should plant large shrubs, such as the fast growing and Alaska friendly Siberian Pea along the inner fence line. If the shrubs are planted along the outer fence line they may block driver visibility.

Property owners should also invest in good quality double pane/soundproof windows with noise insulating attributes. Combined with the other mentioned noise mitigation techniques this can cause a marked improvement.

5.1.6 Noise Barrier Conclusion

In designing this noise mitigation plan, the focus of this proposal is the North side of the road where most residences are occupied. Businesses on the south side of the road will also benefit from the noise reduction gains from rubberized asphalt and window insulation. Fencing is not feasible on the south side of the road because it would restrict business operations. Creating flower vases along the South side road will also add to a friendly atmosphere, but this option requires consultation with a landscape team.

5.2 Landscaping

The use of appropriate landscaping throughout any project can increase water quality, environmental sustainability and add value to the community real estate. The amount of landscaping done will be related to the amount of money available for such improvements. If the client finds it reasonable, many improvements can be completed.

5.2.1 Vegetation

The design strategy of vegetation should involve two major factors: environmental sensitivity and low operations and maintenance costs. Using these factors the main type of vegetation that should be used are native plants. The use of native plants keeps the surrounding ecosystem robust and lowers the O&M costs because the vegetation is already in its suitable climate. A list of native plants of Alaska can be found at www.fhwa.dot.gov/environment/rdsduse/ak.htm. A knowledgeable landscape architect can also be hired to find the most appropriate native plants for the project. Other design factors must include an understanding of the dimensions of the proposed plants throughout their lifetime. This will eliminate poor placement of non-appropriate plants, such as large spruce trees under utility lines.

5.2.2 Small-Scale Swales

Due to the narrow project area the Storm water Technical group did not utilize large swales in the project. This is an appropriate decision but there are other ways to incorporate smaller swales into the project. On a small scale, swales can be created by recontouring the topography to create small depressed areas. Storm water flows into these depressions and drain into the soil. Appropriate design of these swales can allow planted vegetation to be irrigated by placing the plants at the bottom of the swale.

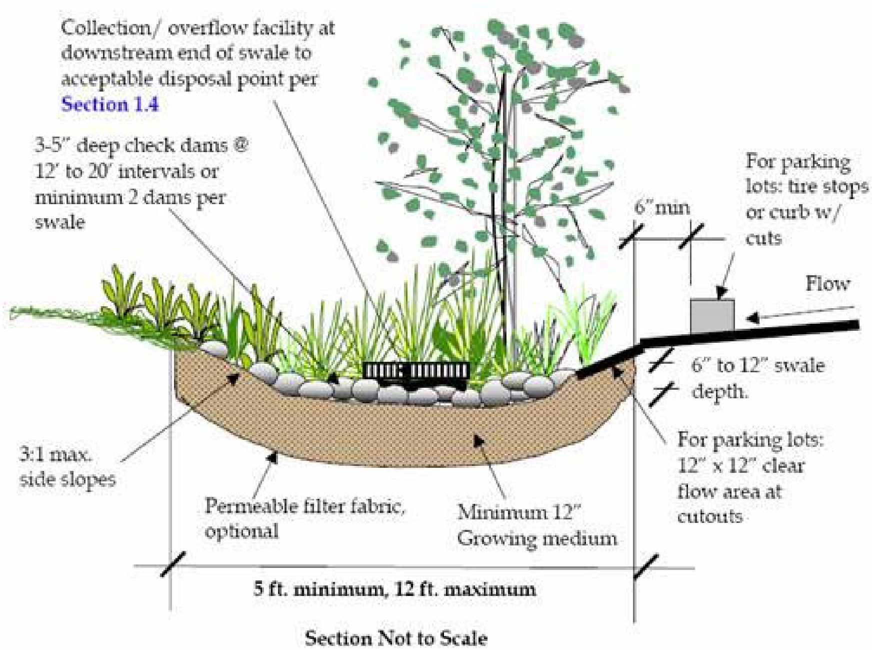

Figure 7 Potential Swale (City of Sandy Website)

Figure 7 shows a possible example, although swales can be used that have smaller cross-sections and no piped overflow. Smaller swales can be staggered so that one overflows into another. Smaller swales allow plants to be irrigated thus lowering O&M costs and allow water quality to be improved.

5.2.3 Landscaping Conclusion

By using appropriate plants and small-scale swales, the landscaping of this project will enhance water quality and improve the environment. With the environment around the project enhanced, the community will benefit because their surrounding environment will be healthier.

5.3 Trails and Recreation

Design alternatives for the trails and recreation areas surrounding the project were looked at. Specifically, No-Net-Loss of Parkland was considered along with signs and surface materials for trails and parking lots.

5.3.1 Finding of No Significant Impact (FONSI)

No net loss of parkland is expected in the development of this project. The existing Campbell Creek Greenbelt parking area on the southwest corner of the Campbell Creek Bridge will be acquired for transportation purposes; however, this will be mitigated by transferring land northeast of the Campbell Creek Bridge to the municipality for greenbelt parking and trailhead. The Campbell Creek Greenbelt will be improved through this project by connecting the trail system underneath the new bridge allowing trail users and wildlife unrestricted passage through West Dowling Road. Trail access will be included in the design for accessing the greenbelt trail from both the north and south sidewalks along West Dowling Road.

5.3.2 Campbell Creek Greenbelt Trail and Parking

Environmental considerations for the design of the Campbell Creek Greenbelt trail through the project area and the parking facility at the trailhead include the surface materials for both parking and trail construction and the placement of signs for trail users. The design decisions are detailed in the following sections.

5.3.2.1 Surface materials

When considering surface materials for trail construction the following criteria were evaluated.

Initial capital cost – The initial capital cost will include excavation, sub-base preparation, aggregate base placement, and application of the selected trail surface. Areas that have existing trail will most likely have to be resurfaced.

Maintenance and long-term durability- Since this will be a trail subjected to high traffic durability is an important consideration. A more durable trail in general will require less maintenance.

Existing soil and environmental conditions – The trail should be built on a solid and permeable base surface. Flooding events should also be anticipated when designing the subsurface.

Anticipate Use/Functionality- Campbell Creek Trail is used for many forms of recreation and transportation. In order to accommodate all the different usages, a surface material that is durable to withstand the heavy impact, smooth for ease of travel and aesthetically pleasing should be selected. Anticipated modes of transportation on the trail include pedestrian traffic, bicycle traffic, large mammal (moose) traffic and occasional vehicular traffic for maintenance.

5.3.2.2 Alternative 1- Porous pavement for trail surface and parking area

Porous pavement is an attractive technology to implement in the trail surface along Campbell Creek and the new parking facility. Porous pavement will provide a permeable surface so that storm water will infiltrate through the surface and reduce the amount of runoff entering the creek. The porous pavement provides groundwater recharge and helps reduce erosion in streambeds and along riverbanks (Lake County Forest Preserves, 2003). The general profile of porous pavement is a permeable pavement surface placed over a uniformly sized aggregate base material with approximately 40% void space (Figure 8). A geosynthetic fabric lines the base of the aggregate base material to provide additional filtration of finer particulates. The application of porous pavements in parking facilities and trails often qualifies for LEED (Leadership in Energy and Environment Design) credits. The close proximity of Campbell Creek to the parking facility and the trail system makes this a practical alternative to reduce storm water runoff entering the creek. However, porous asphalt may not be an option in cold climates such as Anchorage. Water infiltrating through the asphalt and subgrade has the potential to freeze causing expansion. This expansion will most likely result in heaving and surface cracking increasing the maintenance costs.

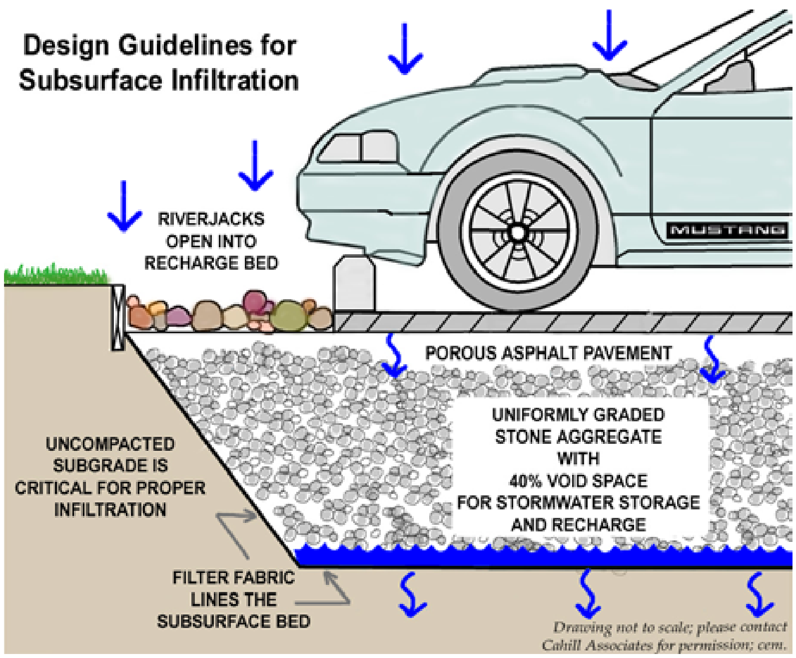

Figure 8 Profile of porous pavement parking facility (Penn. DEP, 2005)

5.3.2.3 Alternative 2- Porous pavement for parking area and regular asphalt for trail

A second alternative could include the implementation of porous pavement in the parking area, which would otherwise be a large impervious surface subject to large quantities of runoff into Campbell Creek, and pave the trail with regular asphalt. This alternative would most likely be more cost effective than porous pavement on the trail and parking facility. The trail will be subject to fewer pollutants than the parking are, thus the recommendation to pave the trail with regular asphalt and allow the storm water to drain directly into the creek. This will also result in a smooth transition between existing trail on either side of the project area and the newly constructed trail. Again, porous asphalt may not be an option in cold climates such as Anchorage.

5.3.2.4 Alternative 3- Regular asphalt for trail and parking area

A third alternative would include paving the trail and the parking area with regular asphalt. Regular pavement would increase the amount of impervious surface around the creek, resulting in an increase of pollutants entering the creek. This surface water runoff from the parking facility will have to be treated before entering the creek. The implementation of regular asphalt for trail and parking areas will withstand cold climate conditions better than porous pavement requiring less long-term maintenance. This option is also a more cost effective solution than the porous pavement.

5.3.3 Signs

Trail signs will conform to the wooden sign convention used throughout Anchorage's greenbelt trails (Figure 8). There will be a sign located at the trailhead in the newly constructed parking area. There will also be informative signs about wildlife and the Campbell Creek ecosystem posted in the parking facility.

Signposts directing trail users to major landmarks, including West Dowling Road, and general trail information will be placed at both north and south trail junctions (Figure 8). Trail regulations and user guidelines will also be posted on the signposts. A location map will be placed at the trailhead referencing users to their location in relation to the Anchorage Greenbelt network.

Figure 9 Anchorage greenbelt trail sign convention and landmark direction sign post examples on the Tony Knowls Coastal Trail (Alaska Bike Rentals, 2007)

5.3.4 Trails and Recreation Conclusion

The environmental committee is confident to report a Finding of No Significant Impact (FONSI) to parkland resulting from the implementation of the West Dowling Road extension project. Parkland acquired for the completion of the project will be mitigated by transferring land northeast of the Campbell Creek Bridge on West Dowling road to the municipality for trailhead parking facilities.

Upon reviewing the alternatives for surface materials for the parking facility and the portion of the Campbell Creek trail extending through the project area, the environmental review committee has decided that the trail and parking facility should be constructed from regular asphalt. The storm water runoff from the parking facility will contain pollutants and must be included in the storm water treatment design. Storm water from the trail will be relatively free of pollutants and may drain directly into the creek. A "Campbell Creek Greenbelt" sign and locator map will be placed at the trailhead in the parking facility. Signposts with directions and trail regulations will be placed at the junctions of the Campbell Creek trail and the trails extending off the north and south sides of West Dowling Road.

6.0 SOURCES

ADOT. www.wdowlingroad.com. Website of West Dowling Road Project. Accessed Spring 2009.

HDR Alaska. West Dowling Road Connection Project – Revised Environmental Assessment & Programmatic Section 4(f)/6(f) Evaluation. STP-052(5)/55012. November 2007

Elliot, Brian. Environmental Permits and Approvals for West Dowling Road. Email communication between Lee Bolling, UAA and Mr. Brian Elliot, Mentor, ADOT. February 23, 2009.

Dowl Website. www.dowlprojects.com/wdowlingroad/Media/wdowlingroad/E8Debit_Credit_Package.pdf. Accessed Spring 2009.

6.1 Draft Permits

http://www.poa.usace.army.mil/reg/permitapp.htm

http://www.sf.adfg.state.ak.us/SARR/FishDistrib/PDFListing/scn/ANC250.pdf

http://www.habitat.adfg.alaska.gov/fhpermits.php

http://wms.geonorth.com/library/LibraryMapsFEMA.aspx

http://www.muni.org/projectmgmt/floodhazard.cfm

http://www.ci.anchorage.ak.us/healthesd/fssforms.cfm

http://www.muni.org/homepage/CaLicensePermits.cfm

http://www.alaskacoast.state.ak.us/Projects/pcpq3.html

http://yosemite.epa.gov/r10/water.nsf/Stormwater/stormwater+permits

http://cfpub.epa.gov/npdes/stormwater/const.cfm

6.2 Water Quality and Wetlands

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DESIGN STUDY REPORT

APPENDIX J

COST ESTIMATING

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
Central Region
4111 Aviation Avenue
Anchorage, Alaska 99502

Prepared by:

Blue Fox Universal
University of Anchorage Alaska

Ben Still
Michael Johnson
Inho Chung

April 20, 2009

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ACMP	Alaska Coastal Management Plan
ADA	Americans with Disabilities Act
ADF&G	State of Alaska Department of Fish and Game
AWMP	Anchorage Wetlands Management Plan Maps
AWWU	Anchorage Water and Wastewater Utility
CEA	Chugach Electric Association, Inc.
DCM	Design Criteria Manual
DEC	State of Alaska Department of Environmental Conservation
DHV	design hourly volume
DOT&PF	State of Alaska Department of Transportation and Public Facilities
DSR	Design Study Report
EA	Environmental Assessment
H&H	Hydrologic and Hydraulic
HLB	Heritage Land Bank
HPM	Highway Preconstruction Manual
HTNA	Highway Traffic Noise Study
LOS	level-of-service
LRTP	Long range Transportation Plan
LUST	leaking underground storage tank
MEV	million entering vehicles
MOA	Municipality of Anchorage
mph	miles per hour
MSE	mechanically stabilized earth
MVM	million vehicle miles
N/A	not applicable
NWI	National Wetlands Inventory
OSHP	Official Streets and Highway Plan
PCM	Preconstruction Manual
PDO	Property Damage Only
PER	Preliminary Engineering Report
PIH	Plans-In-Hand
ROW	right-of-way
TAG	Technical Advisory Group
USACE	United States Army Corps of Engineers
USC	under separate cover
USFWS	United States Fish and Wildlife Service
WDR	West Dowling Road

1.0 INTRODUCTION

1.1 Background

West Dowling Road is located within Anchorage, Alaska. West Dowling Road is in need of expansion and the surrounding transportation network is congested.

1.2 Objectives

The solution with the least cost and detriment to the environment and surrounding residents will be the best alternative chosen. Environmental and residential impacts are hard to quantify, but engineering judgment and experience from others will help in estimating costs in these areas. The costs for material and labor are being found using ADOT bid tabs and the municipality of Anchorage bid tabs for similar projects within Anchorage, Alaska.

2.0 COST ESTIMATING

2.1 Right of Way

ROW cost estimate is found within Appendix A: Right of Way. A total of $11.3 million is found to include all of the ROW acquisition needed.

2.2 Tear Up and Demolition

The removal of the existing WDR and the clearing and demolition on the newly acquired ROW is determined using the ADOT Bid Tabs and the MUNI Bid Tabs. The pricing of the demolition, clearing, and tear up is found in Table 1.

Table 1 Tear Up and Demolition Cost Estimate (ADOT, 2007)

Pay Item	Pay Unit	Quantity	Unit Price	Price
201(3B) Clearing and Grubbing	Lump Sum	1	$100,000.00	$100,000.00
202(2) Removal of Pavement	Lump Sum	1	$55,000.00	$55,000.00
202(3) Removal of Sidewalk	Lump Sum	1	$12,000.00	$12,000.00
202(4) Removal of Culvert Pipe	Lump Sum	1	$23,000.00	$23,000.00
202(6) Removal of Manhole	Lump Sum	1	$7,000.00	$7,000.00
202(8) Removal of Inlet	Lump Sum	1	$1,000.00	$1,000.00
202(9) Removal of Curb and Gutter	Lump Sum	1	$35,000.00	$35,000.00
			Total	$233,000.00

2.3 Roadway Geometry/Traffic

Table 2 Roadway Geometry/Traffic Cost Estimate

Pay Item	Pay Unit	Quantity	Unit Price	Price
615(1) Standard Sign	Lump Sum	1	$50,000.00	$50,000.00
618-621 Lanscaping	Lump Sum	1	$450,000.00	$450,000.00
639(1) Residence Driveway	Lump Sum	1	$100,000.00	$100,000.00
639(2) Commercial Driveway	Lump Sum	1	$25,000.00	$25,000.00
660(1) Traffic Signal System Complete (C Street and Dowling Road)	Lump Sum	1	$450,000.00	$450,000.00
660(1) Traffic Signal System Adjustment (Old Seward Highway and Dowling Road)	Lump Sum	1	$100,000.00	$100,000.00
660(3) Highway Lighting System Complete	Lump Sum	1	$350,000.00	$350,000.00
663(1) Signal Interconnect	Lump Sum	1	$100,000.00	$100,000.00
670(10) Methyl Methacrylate Pavement Markings	Lump Sum	1	$375,000.00	$375,000.00
			Total	$2,000,000.00

2.4 Bridge Design

Three alternatives have been considered for the bridge abutments an MSE wall, reinforced concrete retaining wall and sloped fill abutments. The unit price of the concrete retaining wall is determined by calculating the amount of concrete and rebar per square foot and using the prices of rebar and concrete in the ADOT bid tabs for a square foot price of retaining wall. A more detailed analysis is found in Appendix D bridge design of the reasoning behind the different alternatives and the cost estimate is located in Table 3.

Table 3 Bridge Abutment Alternatives (ADOT, 2007)

Pay Item	Pay Unit	Quantity	Unit Price	Price Sloped Abutme	Price Retaining Walls
205(3) Foundation Fill	Cubic Yard	50	$ 25.00	$ 1,250.00	
Reinforced Concrete Retaining	sq. ft	2400	$ 230.00		$ 552,000.00
502(1) Post-Tensioning (Type)	Lump Sum	24	$ 78,000.00	$ 1,872,000.00	$ 1,684,800.00
				$ 1,873,250.00	$ 2,236,800.00
		Preferred Alternative		Sloped Abutment	

Cost estimates for the foundation bridge alternatives are found within Appendix D Bridge Design.

The preferred alternative cost estimate is found in Table 4. All of the unit prices are current prices found in Alaska (Marx, 2009). This design meets the strength and environmental standards and is the least price. Most item quantities include about 10% extra to keep the project running in case of construction error or change of plans. Specialty items such as the bridge girders are an exact quantity due to the expense and size of the items (Marx, 2009).

Table 4 Bridge Cost Estimate for preferred alternative (ADOT, 2007)

Pay Item	Pay Unit	Quantity	Unit Price	Price
202(1) Removal of Structures	Lump Sum	sq ft	$224,000	$224,000
205(3) Foundation Fill	Cubic Yard	2800	$ 25.00	$70,000
501(2) Class A-A Concrete	Cubic Yard	300	$1,400	$420,000
501(4) Class A Concrete	Cubic Yard	190	$ 1,200.00	$ 228,000.00
502(1) Post-Tensioning (Type	Lump Sum	12	$ 78,000.00	$ 936,000.00
503(1) Reinforcing Steel	Pound	20200	$ 2.45	$ 49,490.00
503(2) Epoxy-Coated Reinfor	Pound	15000	$ 2.50	$ 37,500.00
505(5) Furnish Structural Stee	Pound	2000	$ 64.35	$ 128,700.00
505(6) Drive Structural Steel	Each	24	$ 5,000.00	$ 120,000.00
507(2) Pedestrian Railing	Linear Foot	220	$ 275.00	$ 60,500.00
508(1) Waterproofing Memb	Lump Sum	1	$ 23,100.00	$ 23,100.00
606(12) Guardrail/Bridge Rail	Each	4	$ 3,000.00	$ 12,000.00
611(1) Riprap, Class II	Cubic Yard	140	$ 50.00	$ 7,000.00
614(1) Concrete Barrier	Linear Foot	110	$ 120.00	$ 13,200.00
				$2,329,490

2.5 Storm Water

The cost estimate for storm water is found in Table 5.

Table 5 Storm Water Cost Estimate

Pay Item	Pay Unit	Quantity	Unit Price	Price
603(17) 12 Inch Pipe CPEP	Linear Foot	1100	$50.00	$55,000.00
603(17) 24 Inch Pipe CPEP	Linear Foot	4600	$75.00	$345,000.00
604(1) Storm Sewer Manhole	Each	17	$3,500.00	$59,500.00
604(5) Inlet, Type B	Each	10	$2,500.00	$25,000.00
604(8) oil/water separator	Each	2	$30,000.00	$60,000.00
			Total	$544,500.00

2.6 Pavement

The depths of each layer in the pavement were used to determine the volume of each material needed for the pavement. Then, the volumes were converted into weights in tons, which the items are going to be paid by. The price of each item was determined using the ADOT Bid Tabs and the MUNI Bid Tabs. The cost estimate of the pavement is found in Table 6.

Table 6 Pavement Cost Estimate

Pay Item	Pay Unit	Quantity	Unit Price	Price
203(6) Borrow	Ton	210000	$20.00	$4,200,000.00
301(1) Aggregate Base Course	Ton	23000	$30.00	$690,000.00
401(1) Asphalt Concrete, Type V	Ton	10600	$85.00	$901,000.00
401(1) Asphalt Concrete, Type II	Ton	15800	$85.00	$1,343,000.00
401(1) Asphalt Concrete, Type III	Ton	490	$100.00	$49,000.00
401(2) Asphalt Cement, Grade PG52-28	Ton	583	$700.00	$408,100.00
401(2) Asphalt Cement, Grade 64-34	Ton	1027	$800.00	$821,600.00
402(1) STE-1 Asphalt for Tack Coat	Ton	240	$700.00	$168,000.00
608(1a) Concrete Sidewalk, 4 inches thick	Square Yard	2200	$70.00	$154,000.00
			Total	$8,580,700.00

2.7 Utilities

Bid examples from the AK DOT were used to compile the preliminary cost estimate for each utility. A total of $4,044,000 was estimated for the West Dowling Road project. These figures are an estimate for the project based on the information available at the time of submittal. The Table 7 presents the cost estimate for utility relocation in each category.

Table 7 Utility Cost Estimate

Utility	Costs
Water	$1,022,000
Sanitary Sewer	$302,000
Electric	$1,087,000
Telecommunication	$529,000
Natural Gas	$712,000
Cable Television	$203,000
Totals	$3,855,000

2.8 Construction Phasing

Table 8 Construction Phasing

Pay Item	Pay Unit	Quantity	Unit Price	Price
640(1) Mobilization and Demobilization	Lump Sum	1	$525,000.00	$525,000.00
641(1) Erosion and Pollution Control Administration	Lump Sum	1	$100,000.00	$100,000.00
641(2) Temporary Erosion and Pollution Control	Contingent Sum	1	$200,000.00	$200,000.00
642(1) Construction Surveying	Lump Sum	1	$175,000.00	$175,000.00
643(2) Traffic Maintenance	Lump Sum	1	$450,000.00	$450,000.00
643(15) Flagging	Contingent Sum	1	$650,000.00	$650,000.00
643(25) Traffic Control	Contingent Sum	1	$500,000.00	$500,000.00
644(1) Field Office	Lump Sum	1	$75,000.00	$75,000.00
			Total	$2,675,000.00

3.0 FINAL COST ESTIMATE

The final cost estimate of WDR can be found in Table 9. The cost is close to the $38 million budget.

Table 9 Final Cost Estimate

Phase	Cost
Tear up and Demolition	$233,000.00
Pavement Design	$8,580,700.00
Bridge Construction	$2,329,490.00
Storm Water	$544,500.00
Utilities	$3,855,000.00
Construction Phasing	$2,675,000.00
Construction Cost (20% Contingent)	$21,861,228.00
Construction Engineering	$3,279,184.20
Right of Way	$11,300,000.00
Environmental	$100,000.00
Subtotal	$36,540,412.20
ICPA	$1,702,783.21
Total	$38,243,195.41

Table 10 Division of Labor and Authorship

Section	1st Author	2nd Author
1.0 Introduction	Ben Still	Inho Chung
2.1 ROW	Ben Still	Inho Chung
2.2 Tear Up and Demolition	Michael Johnson	Ben Still
2.3 Roadway Geometry/Traffic	Michael Johnson	Ben Still
2.4 Bridge Design	Ben Still	Michael Johnson
2.5 Storm Water	Ben Still	Michael Johnson
2.6 Pavement	Michael Johnson	Ben Still
2.7 Utilities	Inho Chung	Michael Johnson
2.8 Construction Phasing	Michael Johnson	Ben Still
3.0 Final Cost Estimate	Ben Still	Inho Chung

DESIGN STUDY REPORT

APPENDIX K

PUBLIC INVOLVEMENT

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

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April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

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CEA .... Chugach Electric Association, Inc.
DCM .... Design Criteria Manual
DEC .... State of Alaska Department of Environmental Conservation
DHV .... design hourly volume
DSR .... Design Study Report
EA .... Environmental Assessment
H&H .... Hydrologic and Hydraulic
HLB .... Heritage Land Bank
HPM .... Highway Preconstruction Manual
HTNA .... Highway Traffic Noise Study
LOS .... level-of-service
LRTP .... Long range Transportation Plan
LUST .... leaking underground storage tank
MEV .... million entering vehicles
MOA .... Municipality of Anchorage
mph .... miles per hour
MSE .... mechanically stabilized earth
MVM .... million vehicle miles
N/A .... not applicable
NWI .... National Wetlands Inventory
OSHP .... Official Streets and Highway Plan
PCM .... Preconstruction Manual
PDO .... Property Damage Only
PER .... Preliminary Engineering Report
PIH .... Plans-In-Hand
ROW .... right-of-way
TAG .... Technical Advisory Group
USACE .... United States Army Corps of Engineers
USC .... under separate cover
USFWS .... United States Fish and Wildlife Service
WDR .... West Dowling Road

1.0 PROJECT SUMMARY

The primary objective of the West Dowling Road Extension and Reconstruction project is to provide additional road connectivity and relieve traffic congestion in east Anchorage. The project area includes the West Dowling corridor between Old Seward Highway and C Street (see Figure 1 for Vicinity Map). Construction of a connection at Old Seward Highway will reduce the amount of traffic passing through the Lake Otis Parkway and Tudor Road intersection (a major congestion area) by providing an alternative routing for traffic between east and south Anchorage. The project includes reconstructing and upgrading the existing roadway to a five-lane urban section from Old Seward Highway to C Street, a total of 0.6 miles. The project must be cost effective, compliant with current design standards, and meet the needs of the traveling public through the design year 2025.

Figure 1 Vicinity Map

2.0 PURPOSE AND SCOPE

Public Involvement is defined as the total effort, both informal and formal, made by the Contractor and the Contracting Agency to keep the public and agencies informed about the project, to ensure that all reasonable alternatives are identified, and that public and agency concerns are considered and addressed.

3.0 CONTRACTOR RESPONSIBILITIES

The following are the basic responsibilities the contractor has to the community.

- Develop a Public Involvement Plan (PIP)
- Conduct Three Open House Public Meetings
  - Three Open House Public Meetings will be held during the course of the project. The first meeting will occur prior to the Plans-in-Hand submittal, the second meeting shall occur before beginning Right-of-Way acquisition at the 65% submittal, and the third shall be

near the end of the project at the 95% submittal. After each public meeting, a written summary of comments and responses during these meetings shall be submitted.

- Written summary of all informational materials available for public display / presentation at the Open House Public Meetings
- Provide/maintain a publicly available project web site
- Compile public meetings results
    - Oral and written testimony summary
    - Comments received analysis
    - Any recommendations received
    - Present results in the Design Study Report
- Community & City Council project presentations

4.0 PUBLIC COMMENT SUMMARIES

4.1 Business and Agencies

A few of the comments made and reported follow.

- Busiest season May 1 through October
- Supports east/west arterials
- Don't move electrical transmission lines; too costly
- In water work at Chester Creek? How affect fish habitat?
- Permits and certifications needed?
- Stream bank stabilization?
- Bridge clearance for moose
- Downstream erosion?
- Mitigation credits and debits
- Capture of runoff and road outfall
- Utility locations and handling of relocations
- ROW acquisitions and public relocations

4.2 Public Comments

The following are representative of the general public comments collected during the 2002 and 2003 meetings.

- Too Much Noise; barriers possible?
- Need east/west corridor linking Old Seward to Minnesota
- Project area traffic movement to interchanges
- Project won't handle traffic count increases
- High density Anchorage bowl development west and south of airport
- Buffers and transitional areas needed from higher density to lower
- Will fire and police response time be quicker
- Will subdivision and neighborhood access be hindered
- Will B Street access eliminate hazardous Potter Street access
- Dowling access from B Street hazardous
- Need grade separated foot and trail crossing of New Dowling Road
- Coordination with MOA Trails Plan

- West-east road connections to major highways very poor causing major congestion
- Potter residential. 68th more industrial, usage compatibility issues
- Industrial traffic mixing with local residential and through traffic
- Improve Potter. Relocate high power lines; wide enough right-of-way; no need condemn Potter land
- No long term planning done; city departments don't work together; residences and businesses built on what should have been highway (street) right-of-way and continuing to happen
- Land use and zoning coordinated with traffic created by cross town movement
- When will owners/renters know if relocate? How soon?
- How much will receive monetarily? Compensation concerns
- Air quality concerns in residential areas with increased traffic
- Pedestrian traffic concerns especially in winter; plowed roadway snow doesn't cover sidewalks
- Inefficient bus service
- Polaris school at New Seward difficult to access
- Speed concerns with residential and school children

5.0 PUBLIC INVOLVEMENT REQUIREMENT COMPLETIONS

The following Public Involvement requirements have been completed.

5.1 Scoping meetings for stakeholder public comments were held in August 2002, October 2002, and May 2003.

5.2 An official West Dowling Road Project website for public information, review, and comment has been established.

5.3 In January 2007, The Environmental Assessment Public Open House was held.

5.4 In November 2008, the Public Involvement Plan (PIP) was completed and will be updated and revised as needed during the project.

6.0 SOURCES

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DESIGN STUDY REPORT

APPENDIX L

CONSTRUCTION PHASING

WEST DOWLING ROAD PHASE I

ANCHORAGE, ALASKA

STATE PROJECT NO. 50898

Prepared for:

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Prepared by:

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Cindy Cluchey
Don Jourdian

April 20, 2009

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ACRONYMS

AWWU .... Anchorage Water and Wastewater Utility
BMP .... Best Management Practices
CEA .... Chugach Electric Association, Inc.
ESCP .... Erosion and Sediment Control Plan
ROW .... Right-of-Way
SWPPP .... Storm Water Pollution Prevention Plan
TCE .... Temporary Construction Easement
TCP .... Traffic Control Plan
WDR .... West Dowling Road

1.0 OBJECTIVE

The purpose of phasing the construction of the West Dowling Road Phase 1 State funded project is primarily to provide a safe passageway through the project for the traveling public for the duration of construction. With a construction phasing plan the project has the potential of not only being completed in the scheduled amount of time but to be completed within budget as well.

The project goals include completing construction within the project time frame while maintaining business and residential access, allowing through traffic, and employing Best Management Practices through the duration of the project.

2.0 CRITICAL PATH

2.1 Season 1

West Dowling Road season one construction will be prepared by purchasing and clearing Right of Way of buildings and other obstacles encountered for the entire project. Advance relocation of Chugach Electric Association's facilities that are in conflict near the C Street Connection will be shifted further south and a surcharge will be added to that area.

The west bound lanes from the Old Seward Highway to Potter Drive as well as the northernmost span of the bridge will be constructed leaving traffic open on the existing roadway. Utilities will be relocated concurrently with the exception of the above mentioned power lines and a portion of Anchorage Waste Water Utility's water main that is in conflict with the bridge. AWWU's facility will be relocated prior to construction of the bridge. Figure 1 shows the construction areas of Season 1.

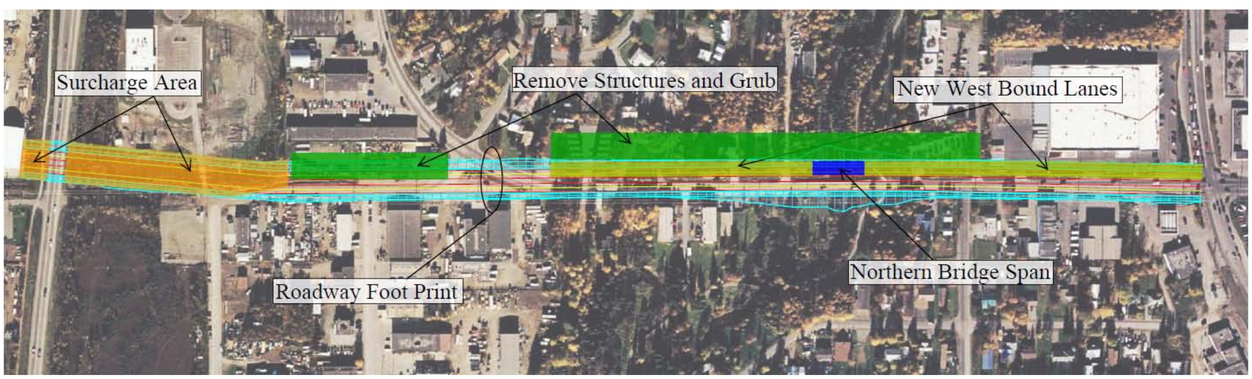


Figure 1 Season 1 Construction

2.2 Season 2

Construction during the second and season of the project will include the southern span of the bridge as well as the east bound traffic from the Old Seward Highway to Potter Drive. It will also include the removal of the surcharge and the construction of all four lanes from the C Street connection to Potter Drive plus the intersection at Potter Drive. Once the Potter Drive intersection is complete the Franklin cul-de-sac may be completed. The extension to the west of the C Street intersection will be built as well. Finally, the intersections at the Old Seward Highway and C Street will be constructed. West Dowling Road can be opened to through traffic once the intersections are built. The Campbell Creek Parking Lot may be constructed at this time. Figure 2 displays the construction for Season 2.

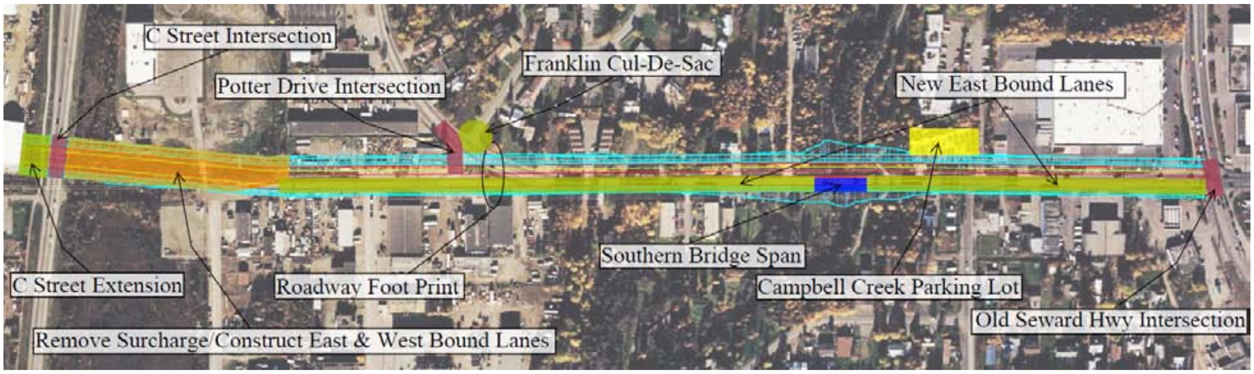


Figure 2 Season 2 Construction

3.0 ALTERNATIVES AND PHASING SEQUENCE

Two feasible alternatives resulted after many were considered. The major difference between the two subsequent options is the construction of the Campbell Creek Bridge. The proposed alignment makes it possible to either construct the bridge at one time or construct each span separately due to the new East bound lanes alignment directly over the existing roadway. The chosen alternative of constructing the bridge in two spans would allow for traffic to remain in operation during the course of construction with minimal closures.

3.1 Rejected Alternative

The rejected alternative of constructing the bridge all at once would require closing West Dowling Road at the bridge for a period of at least 6 – 12 months. This would cause an increase in traffic through the intersections on International Airport Road with C Street and the Old Seward Highway. In addition, local travelers could become unruly due to the lengthy road closure. This alternative was also rejected due to the cost of winter construction that would be necessary to complete the bridge.

3.2 Preferred Alternative

The preferred alternative is to construct the bridge over two seasons. This allows for through traffic continuously during construction. During Season 1 the northern span of the bridge will be constructed and traffic will remain on the existing bridge. For Season 2 traffic will be diverted to the newly constructed northern span, the existing bridge will be removed and the southern span will be constructed.

3.3 Phasing Sequence

3.3.1 Phase 1

The west end of the project, between C Street and B Street, is a wetland area and an undisturbed area of construction. Excavation of organics and surcharge of the area will be necessary and can be done without affecting traffic. The ROW acquired in this area will be sufficient for a staging area for this portion of the project. The Structure located in the acquired ROW West of Potter will be removed concurrently to allow for the new connection to Potter.

3.3.2 Phase 2

Remove structures within the Right of Way on the north side of the existing Dowling Road. Four condominiums and one residence to the west of Campbell Creek and one Condominium to the east will be removed. Utilities, both overhead and underground will be relocated in this area once clearing is achieved. These sites provide large staging areas for the remainder of the project.

3.3.3 Phase 3

The northern roadway corridor and north span bridge construction can be done outside of the existing traffic corridor and will be done in the first season. Due to the raised elevation of the new bridge temporary retaining walls must be installed to allow traffic to be unaffected. Bridge construction will be addressed in greater depth in Section 9.0 "Campbell Creek Bridge" of this report.

3.3.4 Phase 4

Traffic will be shifted to the newly constructed west bound lanes while work on the existing bridge and southern corridor takes place in the second season. The existing bridge can then be removed and disposed of and the new southern span of the bridge constructed. During construction, special care will be taken to avoid the existing 48" sanitary sewer and other existing utilities in the area when driving pile. The existing southern roadway can then be removed and crushed for reuse in the base course of the new roadway.

3.3.5 Phase 5

After construction of the bridge is complete, the Campbell Creek parking area can be completed. The site was used for a staging area for the bridge. Final grading and paving can be done without affecting traffic.

3.3.6 Phase 6

The new east bound lanes from the Old Seward Highway to Potter Drive can be brought up to final grade and temporary retaining walls at the bridge can be removed. The excavations on site are minimal but there is a significant amount of fill necessary to bring the bridge to final grade.

3.3.7 Phase 7

The surcharge site between C Street extension and B Street can be brought to grade and base course laid. Short closures of C Street will be necessary to construct the intersection of West Dowling Road and C Street. The Potter intersection can then be completed with possible weekend closures for the connection. At this time the Franklin Cul-de-sac will be finished as well. The curb and gutter system can then be finalized before the final lift is laid and bike paths completed.

3.3.8 Phase 8

Equipment and temporary mediation devices can be removed. Final lighting and signalization will be completed. Landscaping and re-vegetation must be completed by August 15 for the entire project area and may be performed concurrently with other construction activities.

4.0 EXCAVATION

4.1 Surcharge

The west end of the project, between C Street and B Street, is an undisturbed wetland area. The organics will be excavated to a depth determined by the soils report located in Appendix E "Soil Conditions and Pavement Design." A geotextile will be placed and surcharge added to the site. Transport of surcharge material will be done during off peak hours to avoid unnecessary traffic congestion.

4.2 Bridge Fill

Fill will be necessary in the vicinity of the bridge construction. The final bridge grade is 10ft above the existing grade which will require significant fill quantities. The cut and fill quantities can be found in Appendix E "Soil Conditions and Pavement Design." Utility facilities, such as manholes and pedestals, will need to be addressed and brought up to final grade. Excavations for bridge foundations and driven piles are discussed in more detail the Bridge section of this report.

5.0 UTILITIES

5.1 Sanitary Sewer

Sanitary Sewer lines run the length of the project. It is desirable to avoid alterations where possible due to associated costs and service disruptions. The 48 inch diameter concrete sewer line running just to the south of the existing bridge will require preconstruction and post construction surveys to assess if damage has occurred during construction. The new bridge piles will be driven a minimum of 10 feet from this facility.

5.2 Water

The 16 inch water line parallel to West Dowling Road to the north of the current bridge location will need to be relocated to accommodate the northern bridge span. Placement of the relocated line with directional drilling and trenching as necessary will occur prior to termination of the existing waterline as well as prior to bridge construction to ensure uninterrupted service.

5.3 Power Distribution and Telecommunication

The overhead and underground utilities to the north of the existing roadway will be relocated underground to the north of the projected final roadway corridor. The structures within the right of way need to be removed and construction staking performed prior to utility relocation. The utilities will be installed in accordance with regulations.

6.0 RIGHT OF WAY

Prior to construction, ROW must be acquired or TCE's obtained for temporary easements. The structures on the acquired properties will be removed. Structures that are not relocated will be demolished and disposed of at a designated disposal site. The new alignment is further north than existing and includes forested areas that will be cleared and grubbed. These acquired properties will also serve as staging areas for the project.

7.0 STAGING AREAS

Equipment staging areas are required for the entire project, with special attention given to the area of bridge construction and the C Street Connection surcharge area. The staging areas will also accommodate material stockpiling. Bridge construction will stock pile material in the staging area east of Campbell Creek. Major stockpiling and large equipment staging will be provided by the large staging area on the site of the removed structures to the north center section as seen in Figure 3 below.

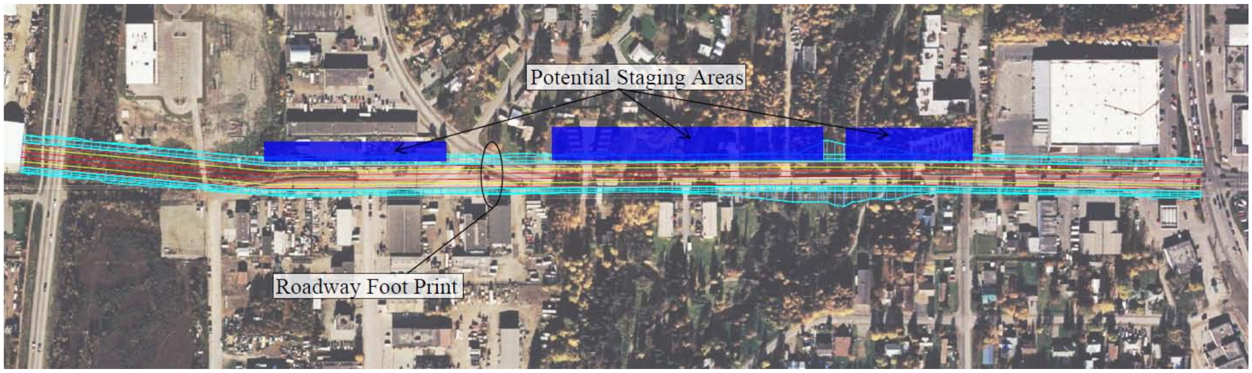


Figure 3 Staging Area Locations

8.0 MATERIALS

The contractor will supply the materials for this project. This has been determined to be the most advantageous to the owner because it reallocates the liability of shipping, storage and the quality of the products to the contractor. (1)

The rejected alternative of the owner supplying the materials can cause conflict between the owner and the contractor as well as cost the owner additional monies. Conflict can be attributable to shipping delays and damage accrued during storage and/or shipping. Additional delays can occur due to received materials not meeting specifications. Further costs to the owner can ensue due to the delays and damages.

9.0 CAMPBELL CREEK BRIDGE

The Campbell Creek Bridge will be constructed over the course of two seasons. The bridge consists of two spans: two lanes in each direction. During the first year of construction, the northernmost span that will carry the west bound traffic will be constructed. The southernmost span will be constructed during the second year. The existing bridge will be in service until the second year at which point the northern span will accept through traffic.

The construction of each span will occur independently but in the same order of necessary stages. Achievement of all excavation and build-up of the approaches will be prior to driving the H-piles. It may be required to install temporary retaining walls in-between the construction area and the existing bridge to ensure the safety of the traveling public. Concrete seats will be poured on both ends of the bridge span and will be supported by the driven H-piles. Wingwalls will be cast in place on the outside ends of the bridge to hold in the approaches. Pre-cast girders will then be placed on the seats spanning the length of the bridge. The finishing of the bridge span will include paving, and adding items such as barriers, sidewalks, guardrails, as well as curb and gutter. (2)

During construction, Best Management Practices will be observed and Utilities will be protected and circumvented.

10.0 TRAFFIC CONTROL PLAN (TCP)

The purpose of a Traffic Control Plan (TCP) is to insure public safety during road construction and inform the driving public of a change in traffic patterns. This is accomplished with consideration of the construction phasing. Every road project has construction boundaries and exiting traffic patterns within those boundaries. It is necessary to plan for how traffic will be routed in or around the construction area. As construction progresses traffic patterns may need to be adjusted to allow access for construction activities. Ideally, a road closure would be the easiest and safest way to protect the public and construction workers; however, this is not possible for this project. A TCP provides a means for keeping traffic moving through the construction area during construction. This is accomplished with the use of an approved Traffic Control Plan. A TCP organizes the use of traffic control devices, consisting of signage, traffic personnel, “Flaggers,” and pilot cars to aid the construction personnel by controlling the flow of traffic in and out of the construction area.

10.1.1 Alternative Traffic Control Plan

The rejected alternative of closing the road to through traffic and building the entire bridge without traffic would allow construction of West Dowling Road between C Street and the Campbell Creek Bridge to occur within one construction season. This would have least impact to Campbell Creek and wildlife as well as the least amount of required traffic control. Traffic control signage would include: “Road Closed,” and the covering of all turning indicators onto Dowling from any direction. In addition, road closure electronic indicators would be used on both C Street and the Old Seward Highway for Dowling Road with the location and duration of the road closure. This alternative would incite the public as well as hurt local businesses.

10.1.2 Preferred Alternative Traffic Control Plan

The preferred Traffic Control Plan is to allow through traffic, albeit at a reduced speed, for the duration of the project with minimal closures for intersection construction. Advance notification of any road closures for any time duration will be implemented via radio, television, newspaper, and with the projects website. Use of proper signage as well as use of traffic control personnel will allow traffic to progress through the project during construction. The safety of the traveling public in addition to construction staff is of the utmost importance.

11.0 EROSION AND SEDIMENT CONTROL PLAN (ESCP)

The Erosion and Sediment Control Plan (ESCP) will specify environmentally sensitive areas as well as provide an overview of anticipated sources of sediment to be controlled during construction. The contractor is required to submit a Storm Water Pollution Prevention Plan (SWPPP) for approval prior to construction that complies with the ESCP. This SWPPP document is a detailed and continually updated document that will be available on site at all times. The contractor will be expected to preserve indigenous vegetation where possible and mitigate and stabilize disturbed areas. Stabilization methods are listed in the SWPPP as Best Management Practices (BMPs). These include silt fences, sediment basins, geotextiles, and other approved stabilization methods (3). Permanent measures such as retaining walls will be considered where necessary due to elevated final grade.

There are five potential drainage basins along the project corridor: wetlands at the C Street connection, the S-curve of Campbell Creek which is close to the east bound lanes just west of the bridge, and both sides of the creek at the bridge crossing. These locations will need special consideration to prevent direct untreated run-off into Campbell Creek and the designated wetland areas. Water that may infiltrate excavated locations during construction that require pumping will need to be treated.

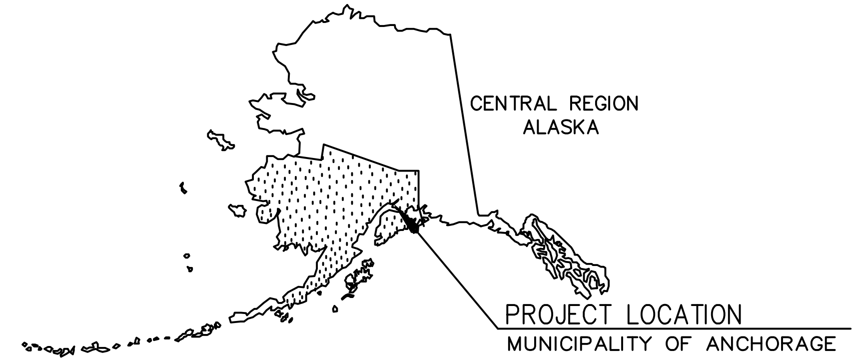
12.0 REFERENCES

1. Port Mackenzie Construction Presentation by Mark Van Dongen, 20 March 2009
2. Conversation with Bridge Design Team Leader Ethan Perry
3. GeoSyntec Consultants, *Erosion and Sediment Control Manual*. San Diego, California April 2005

bluefox UNIVERSAL

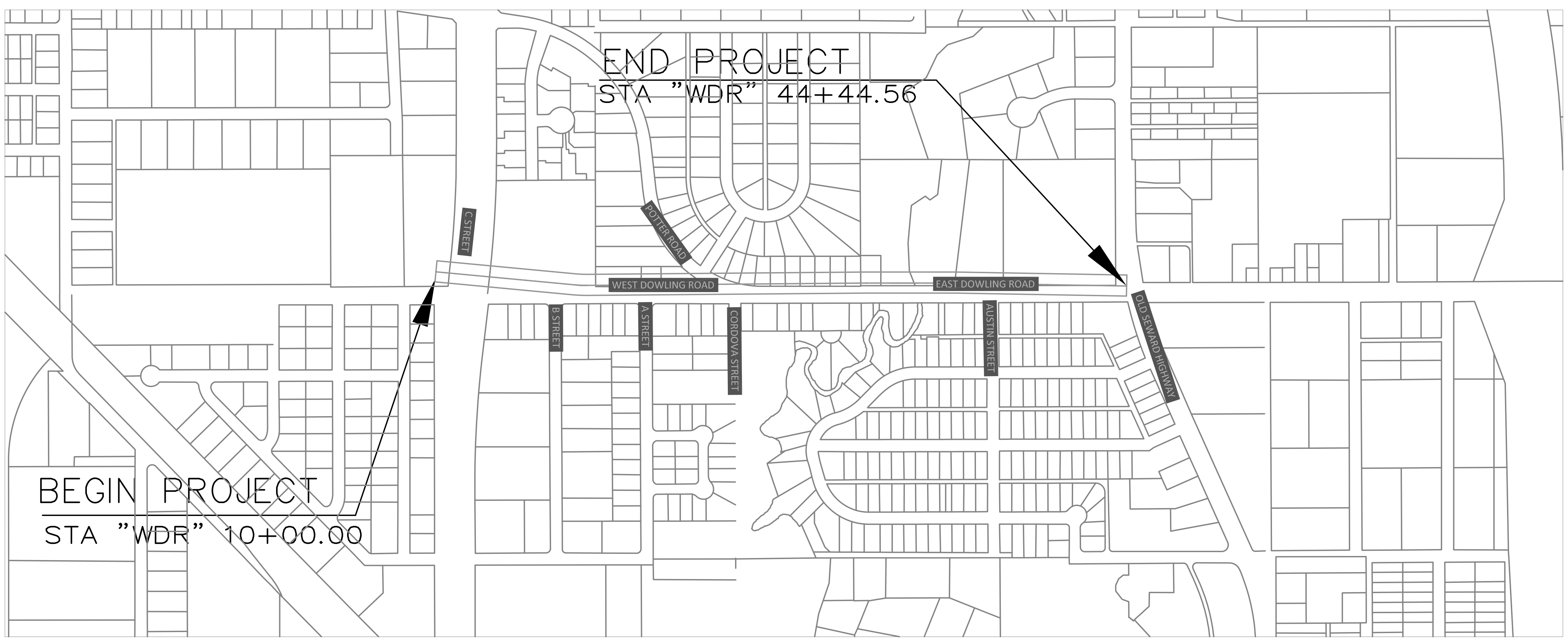
PROPOSED HIGHWAY PROJECT

WEST DOWLING ROAD
EXTENSION AND RECONSTRUCTION



PROJECT SUMMARY		
ROADWAY	PAVEMENT WIDTH	LENGTH
WEST DOWLING ROAD	106 FT	3445 ft

DESIGN DESIGNATIONS EAST DOWLING ROAD	
	LAKE OTIS PARKWAY TO NORM DRIVE
AADT 2007	9,257
AADT 2030	24,104
DHV (%)	10.5%
V	45 mph
(%) TRUCKS	8.0%
D (E%/W%)	50/50
DESIGN SPEED	45 mph



	RECOVERED	TO BE SET THIS PROJECT
GOV'T SECTION CORNER	6 5 7 8 SEC. COR.	
GOV'T 1/4 SECTION CORNER	5 6 1/4 COR.	
GOV'T 1/16 SECTION CORNER	1/16 COR.	
GOV'T SURVEY MONUMENT		
GOV'T CONTROL STA.		
PRIMARY MON. [BRASS/AL CAP]		
SECONDARY CORNER		
PRIMARY CENTERLINE MONUMENT		
SECONDARY CENTERLINE MONUMENT		
SURVEY CONTROL POINT	CP	
SECONDARY SURVEY CONT. POINT	SCP	
GPS CONTROL POINT	GPS	
BENCH MARK	BM	
TEMPORARY BENCH MARK	TBM	
ROCK MONUMENT		
INTERNATIONAL BOUNDARY LINE	ALASKA CANADA	
TOWNSHIP & RANGE LINE	T. 13 N. T. 12 N. R. 2 W. R. 3 W.	
SECTION LINE		
1/4 SECTION LINE		
1/16 SECTION LINE		
CORPORATE or CITY LIMITS		
EXISTING RIGHT-OF-WAY		
RIGHT-OF-WAY REQUIRED		
PROJECT RIGHT-OF-WAY LINE	ROW	
EXISTING PROPERTY LINE		
CONTROLLED ACCESS LINE	C/A	
PERMIT LINE		
EXISTING EASEMENT LINE		
STATION EQUATION	STA. 14+33.22 BK. = STA. 16+90.17 AHD.	
PROJECT CENTERLINE	27+00	
EXISTING CENTERLINE		
RAILROAD CENTERLINE		
HIGHWAY MILEPOST	6.5 23+12.56	
RAILROAD MILEPOST	R.R. 2580+60 HWY. 126+33 842	

ROADWAY OBLITERATION
LIMIT OF CUT SLOPE
LIMIT OF FILL SLOPE
PROPOSED ROADWAY
EXISTING ROADWAY
NOISE BARRIER
FENCE
STONE FENCE
HEAD & WINGWALLS
GUARD RAIL EXISTING
PROPOSED
RETAINING WALL
TUNNEL
INTERMITTENT DRAINAGE
INTERCEPTOR DITCH
MARSHLAND
CREEK
RIVER
LAKE (LAKE)
RESERVOIR (RES.)
CHANNEL CHANGE
PLANTER
VENT
TANK VENT
WELL
SEPTIC
TANKS
Above Ground
Below Ground (UG)
SATELLITE DISH
PRIVATE SIGN
GAS PUMP
POST
BOULDER OR BOULDERS
LANDSCAPE LIGHT
DECIDUOUS TREE
CONIFER TREE
SHRUB OR SHRUBS

	EXISTING	PROPOSED
PIPELINES: (BELLS INDICATE DIRECTION OF FLOW)		
SANITARY SEWER	SS	SS
OIL	O	O
GAS	G	G
WATER	W	W
STORM DRAIN	SD	SD
SIDEWALK		
CONCRETE CURB		
CONCRETE CURB & GUTTER		
DRIVEWAY, APPROACH, & SIDEDRAIN		
BRIDGE		
RIPRAP		

	EXISTING	
TELEPHONE	(OVERHEAD)	OT
	(DIRECT BURY)	UT
ELECTRIC	(OVERHEAD)	OE
	(DIRECT BURY)	UE
FIBER OPTIC		FO
CABLE TV	(OVERHEAD)	O TV
	(DIRECT BURY)	U TV
U.G. DUCT		
TELEPHONE MANHOLE		T
ELECTRIC MANHOLE		E
FOUNDATION		
BUILDING		

	EXISTING	PROPOSED
MANHOLE	M.H.	M.H.
FIRE HYDRANT		
METER		
VALVE		
PIPE CULVERT w/ END SECT.		
UTILITY POLE		
ELECTROLIER		
UTILITY POLE WITH LUMINAIRE		
POLE ANCHOR /w GUY		
TRANSMISSION TOWER [WOOD]		
TRANSMISSION TOWER [STEEL]		
ELECTRICAL OUTLET		
ELECTRICAL PEDESTAL		
TELEPHONE PEDESTAL		

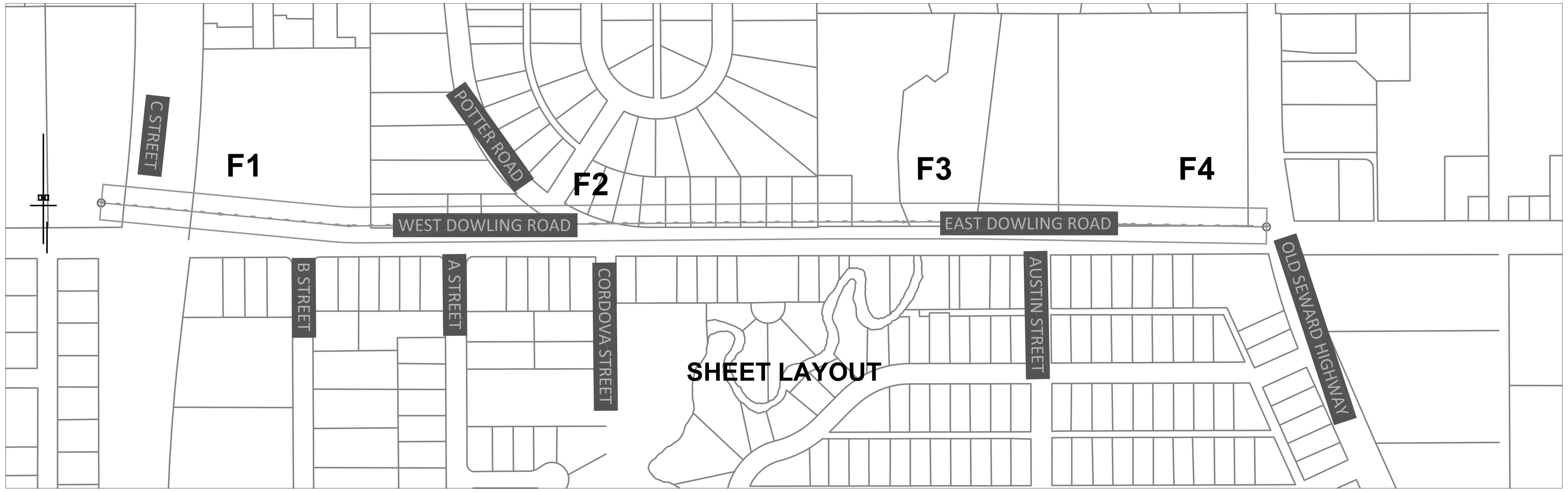
	EXISTING	PROPOSED
CABLE T.V. PEDESTAL		
MAILBOX		MB
SIGN (FACING		
DELINEATOR (FACING		
PVC CONDUIT	PVC	PVC
RMC CONDUIT	RMC	RMC
SIGNAL FACE, VEHICULAR		
SIGNAL FACE, LEFT TURN,		
SIGNAL FACE, PEDESTRIAN	X	X
JUNCTION BOX, TYPE IA	X	X
JUNCTION BOX, TYPE II	X	X
JUNCTION BOX, TYPE III	X	X
DETECTOR, LOOP	X	X
DETECTOR, OPTICOM		
PEDESTRIAN PUSH BUTTON (DIRECTION	X	X
SIGNAL CONTROLLER		
LOAD CENTER		
SIGNAL POLE	X	X
SIGNAL POLE w/MASTARM	X	X
SOLID WHITE STRIPE	W	
SOLID YELLOW STRIPE	Y	
BROKEN WHITE or YELLOW STRIPE	W Y	
DASH YELLOW STRIPE	Y	
SOLID YELLOW STRIPE with BROKEN YELLOW STRIPE	Y	

X = ACTUAL NUMBER

TRAFFIC SYMBOLS ON SHEET K1 SUPERSEDE THIS SHEET

STORM DRAIN MANHOLE
CATCH BASIN MANHOLE
CATCH BASIN

LEGEND SHEET



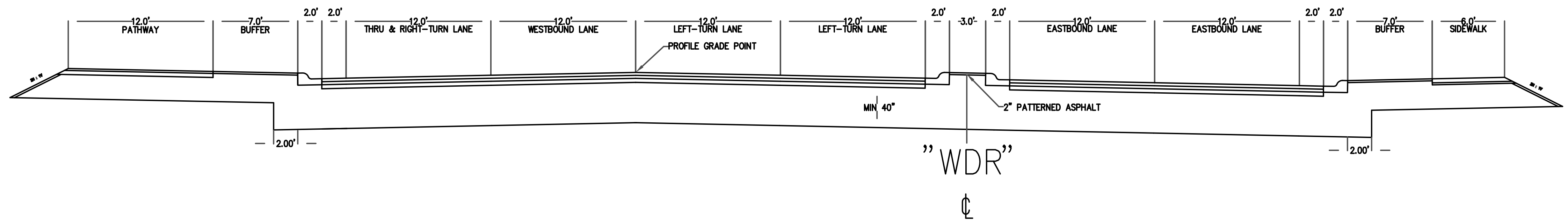
ABBREVIATIONS

@	AT	FDN	FOUNDATION	NO	NUMBER, NUMBERING	V	VENT, VOLT, VALVE, VACUUM
&	AND	FG	FINISH GRADE	NTS	NOT TO SCALE	VB	VALVE BOX
AB	ANCHOR BOLT, AGGREGATE BASE	FH	FIRE HYDRANT	OC	ON CENTER	VC	VERTICAL CURVE
AC	ASPHALT CONCRETE	FI	FIELD INLET	OD	OUTSIDE DIAMETER, OVERFLOW DRAIN	VERT, VT	VERTICAL
ACI	AMERICAN CONCRETE INSTITUTE	FIG	FIGURE	OF	OUTSIDE FACE, OVERFLOW	VPI	VERTICAL POINT OF
ADH AB	ADHESIVE ANCHOR BOLT	FL	FLOW LINE (ELEV)	OH	OVERHEAD		INTERSECTION
ADOT	ALASKA DEPARTMENT OF TRANSPORTATION	FLG	FLANGE	OPNG	OPENING	W/	WITH
AL	ALUMINUM	FNSH	FINISH	PI	POINT OF INTERSECTION	W	WEST, WATER
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE	FT	FOOT OR FEET	PL	PLACE, PLATE, PROPERTY LINE	WL	WATER LINE
APPROX	APPROXIMATE	FTG	FOOTING	PC, POC	POINT OF CURVATURE	WS	WATER SURFACE,
APPD	APPROVED	F	DEGREE FAHRENHEIT	PCC	PORTLAND CEMENT CONCRETE		WATER STOP
AWG	AMERICAN WIRE GAGE	G	GAS	POT, PT	POINT OF TANGENCY	WSP	WELDED STEEL PIPE
BFV	BUTTERFLY VALVE	GA	GAGE	PP	POWER POLE	WT	WATER TABLE, WEIGHT
BM	BENCH MARK	GALV	GALVANIZED	PRV	PRESSURE REDUCING VALVE	WWF	WELDED WIRE FABRIC
BOP	BOTTOM OF PIPE	GB	GRADE BREAK	PSF	POUNDS PER SQUARE FOOT		
BOT	BOTTOM	GPM	GALLONS PER MINUTE	PSI	POUNDS PER SQUARE INCH		
BRG	BEARING	GSP	GALVANIZED STEEL PIPE	PSIG	POUNDS PER SQUARE INCH GAUGE		
C	HAZEN WILLIAMS FRICTION COEFFICIENT, CHANNEL (BEAM)	GV	GATE VALVE	PT	POINT		
CC	CURB CUT	HGL	HYDRAULIC GRADE LINE	PVC	POLYVINYL CHLORIDE PLASTIC		
C&G	CURB AND GUTTER	HORIZ	HORIZONTAL	PVI	POINT OF VERTICAL INTERSECTION		
CARV	COMBINATION AIR RELEASE VALVE	HP	HORSE POWER	PVMT	PAVEMENT		
CB	CATCH BASIN, CIRCUIT BREAKER	ID	INSIDE DIAMETER	Q	FLOW		
CBMH	CATCH BASIN MANHOLE	IV	INVERT ELEVATION	R, RAD	RADIUS		
CFM	CUBIC FEET PER MINUTE	IF	INSIDE FACE	RD	ROAD		
CFS	CUBIC FEET PER SECOND	IN	INCH	RDCR	REDUCER		
CI	CAST IRON	INVT, INV	INVERT	REF	REFER OR REFERENCE		
CJ	CONSTRUCTION JOINT	J, JB	JUNCTION BOX	REINF	REINFORCED, REINFORCING, REINFORCED		
CJP	COMPLETE JOINT PENETRATION	JT	JOINT	REQD	REQUIRED		
CL	CENTER LINE	KV	KILOVOLT	RJ	RESTRAINED JOINT		
CLR	CLEAR	KVA	KILOVOLT AMPERES	ROW, R/W	RIGHT-OF-WAY		
CMP	CORRUGATED METAL PIPE	KW	KILOWATT	RT	RIGHT		
COL	COLUMN	L	LEFT, LENGTH	S	SOUTH		
CONC	CONCRETE	LB	POUNDS	SCH	SCHEDULE		
CONN	CONNECTION	LB/CU FT	POUNDS PER CUBIC FOOT	SD	STORM DRAIN		
CONT	CONTINUOUS, CONTINUATION	LF	LINEAR FEET	SH, SHT	SHEET		
CORP	CORPORATION	LG	LONG	SHLD	SHOULDER		
CPLG	COUPLING	LT	LEFT	SIM	SIMILAR		
CSP	CORRUGATED STEEL PIPE	MAX	MAXIMUM	SPECS	SPECIFICATIONS		
CTRD	CENTERED	MB	MACHINE BOLT	SQ	SQUARE		
CTR	CENTER	ME	MATCH EXISTING	SS	SANITARY SEWER		
CU	CUBIC, COPPER	MEP	MATCH EXISTING PAVEMENT	SST	STAINLESS STEEL		
CY	CUBIC YARD	MFR	MANUFACTURER	ST	STREET, STEEL PIPE, SHUNT TRIP		
DET	DETAIL	MGD	MILLION GALLONS PER DAY	STA	STATION		
DI	DROP INLET, DUCTILE IRON	MH	MANHOLE	STD	STANDARD		
DIA	DIAMETER	MHCB	MANHOLE WITH CATCH BASIN INLET	STL	STEEL		
DIAG	DIAGONAL	MIN	MINIMUM	SYMM	SYMMETRICAL		
DIP	DUCTILE IRON PIPE	MISC	MISCELLANEOUS	T	TANGENT, THERMOSTAT, THICKNESS		
DWG	DRAWING	MJ	MECHANICAL JOINT	TBC	TOP BACK OF CURB		
E	EAST	MOA	MUNICIPALITY OF ANCHORAGE	TEL	TELEPHONE		
EA	EACH	MUTCD	MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES	TEMP	TEMPERATURE		
EF	EACH FACE	N	NORTH	TOC	TOP OF CURB		
ELEV, EV	ELEVATION	NC, NIC	NOT IN CONTRACT	T&S	TOPSOIL & SEED		
ENGR	ENGINEER	NO	NUMBER, NUMBERING	TW	TOP OF WALL		
EP	EDGE OF PAVEMENT	NTS	NOT TO SCALE	TRANS, TR	TRANSITION		
EW	EACH WAY	OC	ON CENTER	TYP	TYPICAL		
EXP	EXPOSED, EXPANSION	OD	OUTSIDE DIAMETER, OVERFLOW DRAIN	UBC	UNIFORM BUILDING CODE		
EXST, EX	EXISTING	OF	OUTSIDE FACE, OVERFLOW	UG	UNDERGROUND		
FDN	FOUNDATION	N	NORTH	UNK	UNKNOWN		
FG	FINISH GRADE	NC, NIC	NOT IN CONTRACT				

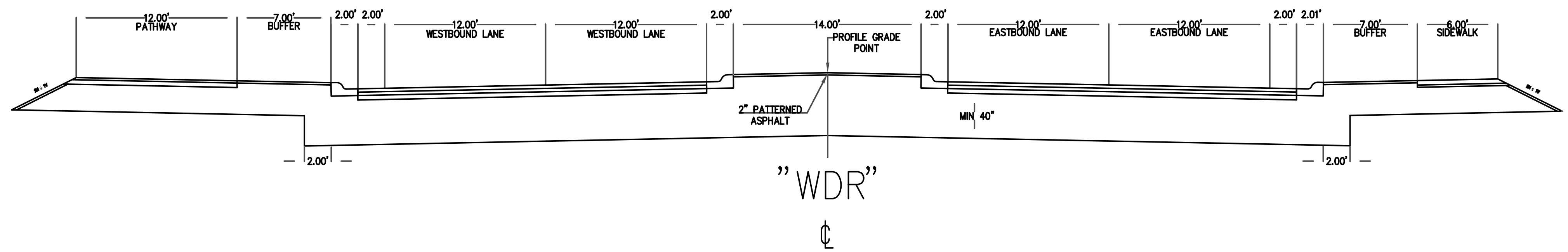
SUPPLEMENTAL LEGEND

DESCRIPTION	EXISTING	PROPOSED
DITCH		
COMBINATION AIR RELEASE VALVE	CARV	
EDGE OF TREE LINE/CLEARING LIMITS		
FENCE (MOOSE)	x x	x x
FENCE (SILT)		
FENCE (WOOD)		
INTERCONNECT		I-C
LUMINAIRE		
OVERHEAD ELECTRIC	OH ELEC	
PEDESTRIAN PUSH BUTTON		
RETAINING WALL		
SANITARY SEWER CLEANOUT		
SIGNAL POLE & LUMINAIRE		
STORM DRAIN CATCH BASIN MANHOLE		
STORM DRAIN FIELD INLET		
STORM DRAIN MANHOLE, TYPE II		MH
SURCHARGE		
TCE		

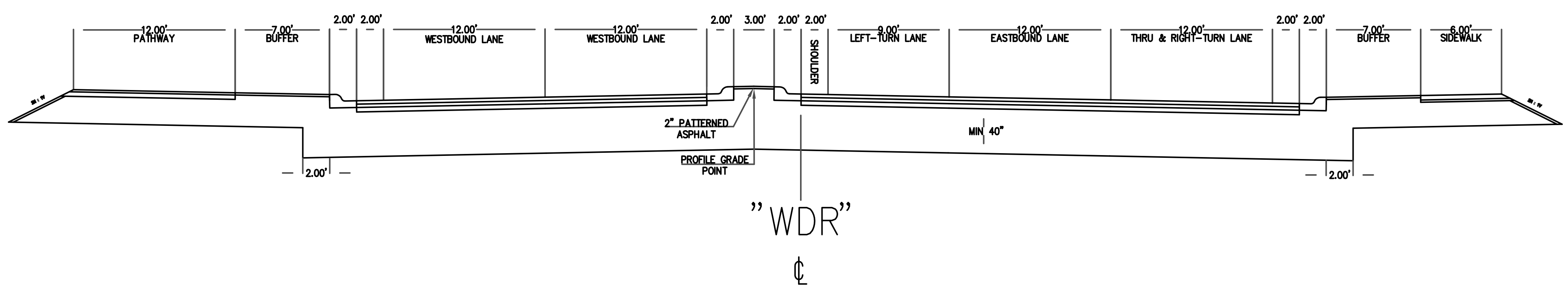
KEYMAP, SUPPLEMENTAL LEGEND,
AND ABBREVIATIONS



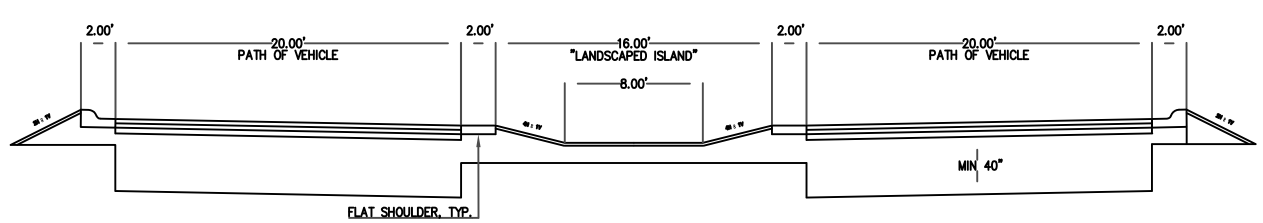
C STREET
INTERSECTION
EAST



C STREET –
OLD SEWARD



OLD SEWARD HWY
INTERSECTION
WEST



FRANKLIN ST.
CUL DE SAC

Y:\!_SENIOR DESIGN-BLUE FOX ENGINEERING(alpha)\CAD\cross section BAO.dwg

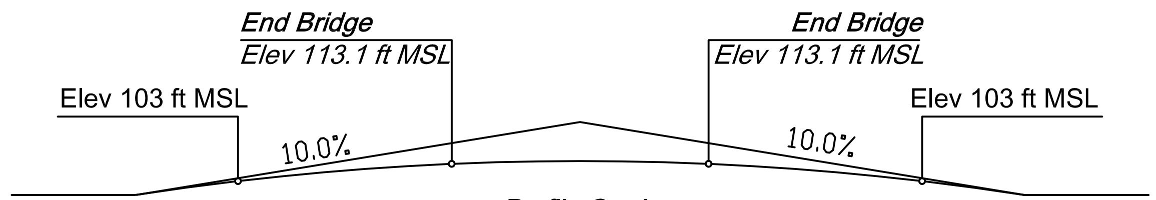
REV.	DATE	BY	REVISION

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

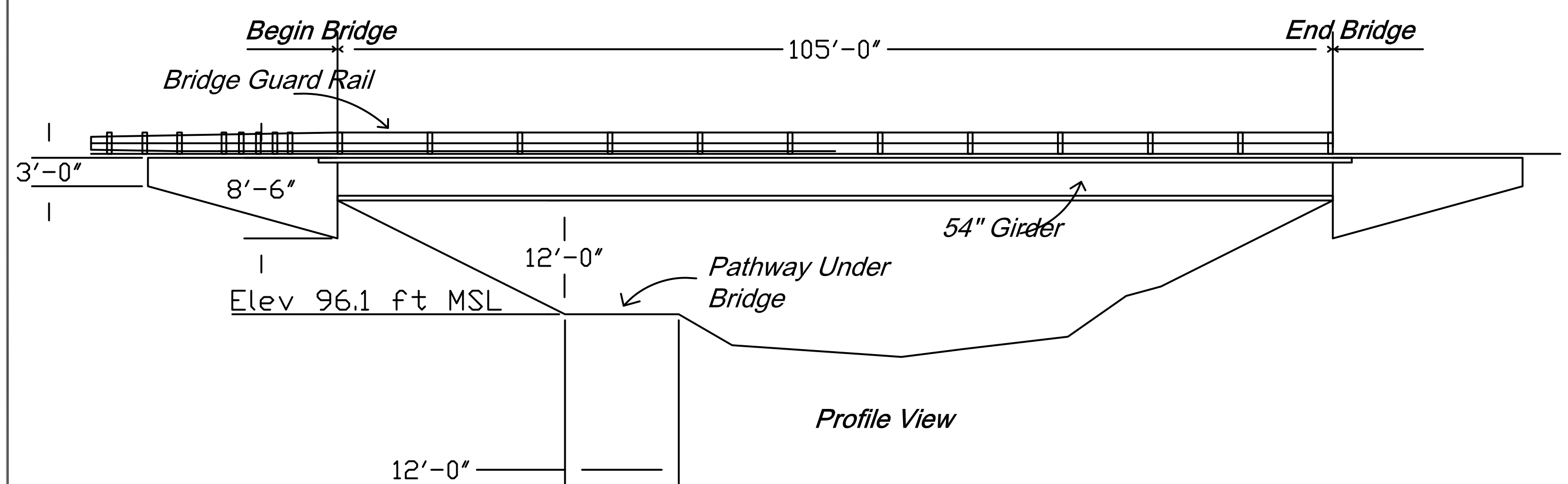
PROJECT : **WEST DOWLING ROAD**

TITLE: **ROAD CROSS SECTIONS**

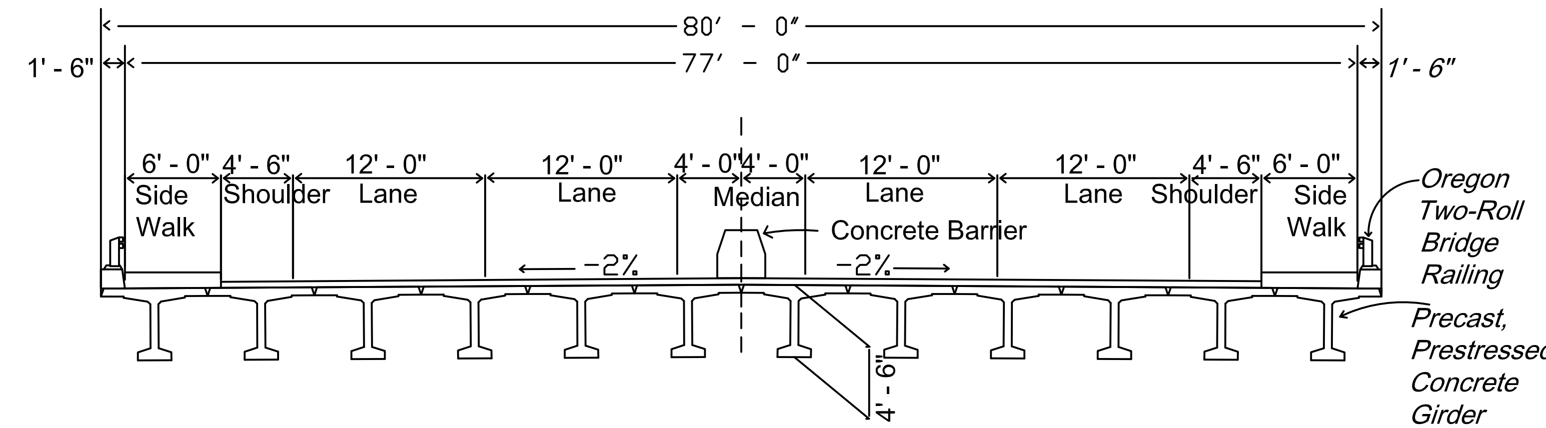
DESIGNED BY: BAO DRAWN BY: BAO CHECKED BY: APPROVED BY:	SCALE : AS NOTED DATE :	DWG NO. **B1** OF **B1**



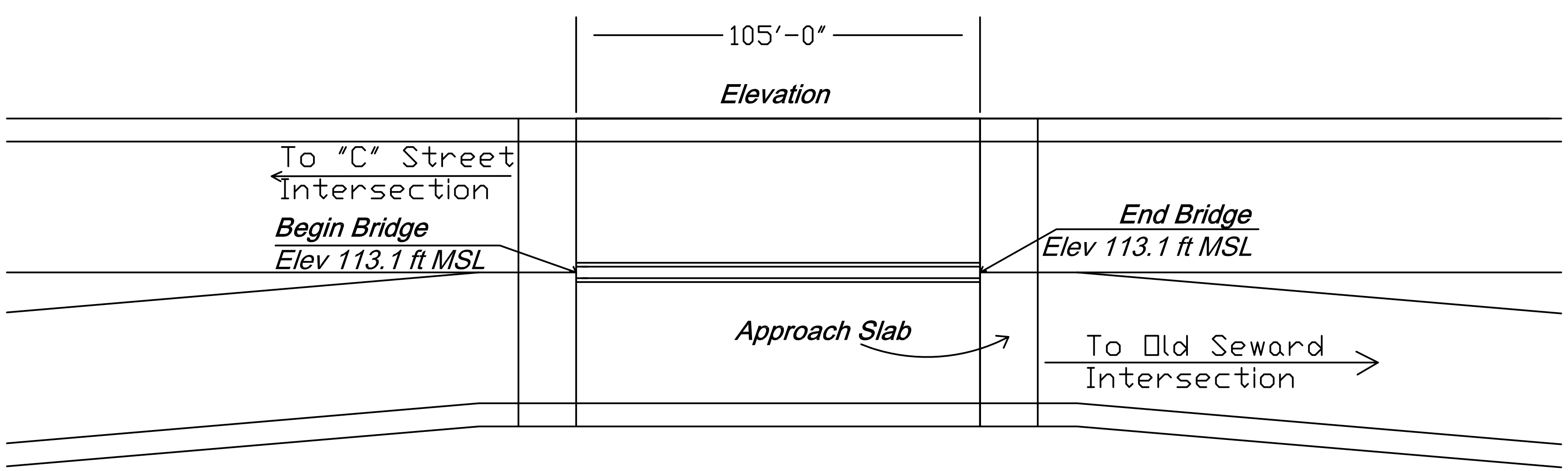
Profile Grade
no scale



Profile View



Typical Section



Elevation

Bridge Drawing Index

Title	Dwg. No.
Bridge General Layout	1
Abutments	2
Wingwalls	3
Typical Section and Framing Plan	4
Girder Section and Profile	5
Steel Bridge Railing	6

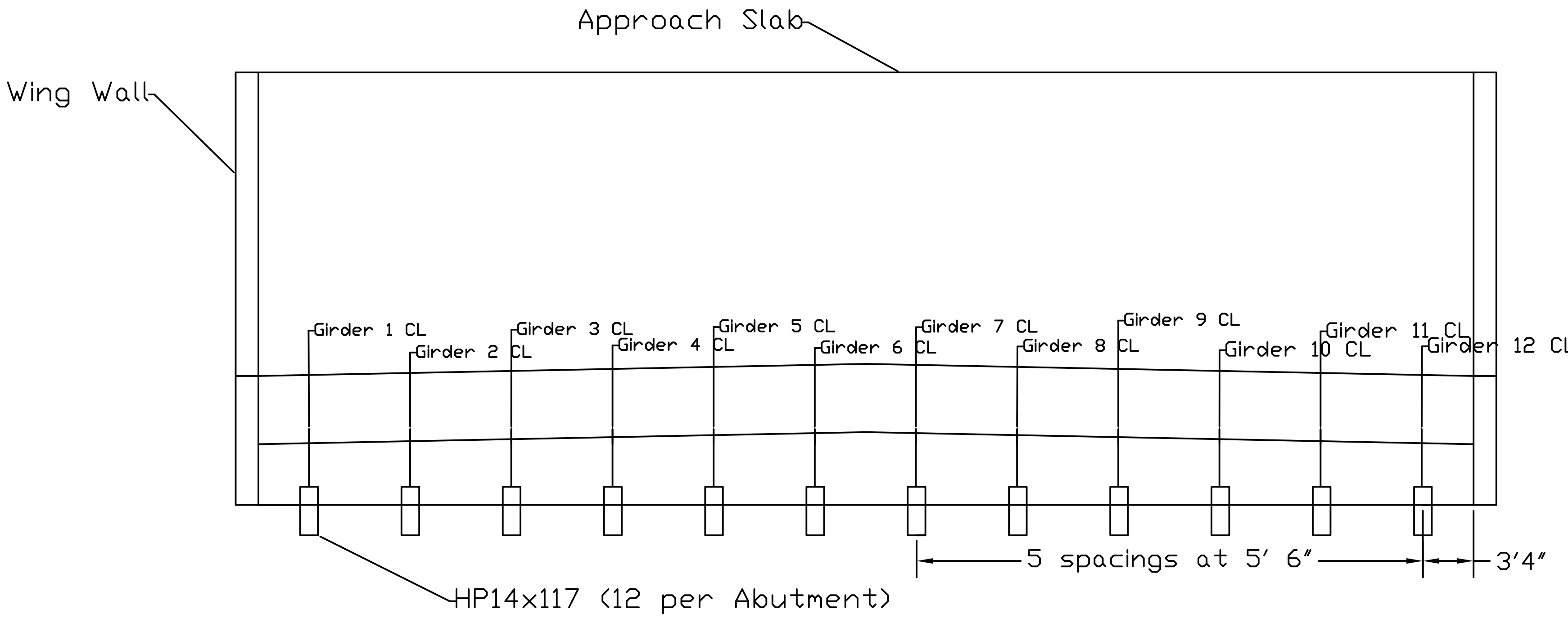
REV.	DATE	BY	REVISION

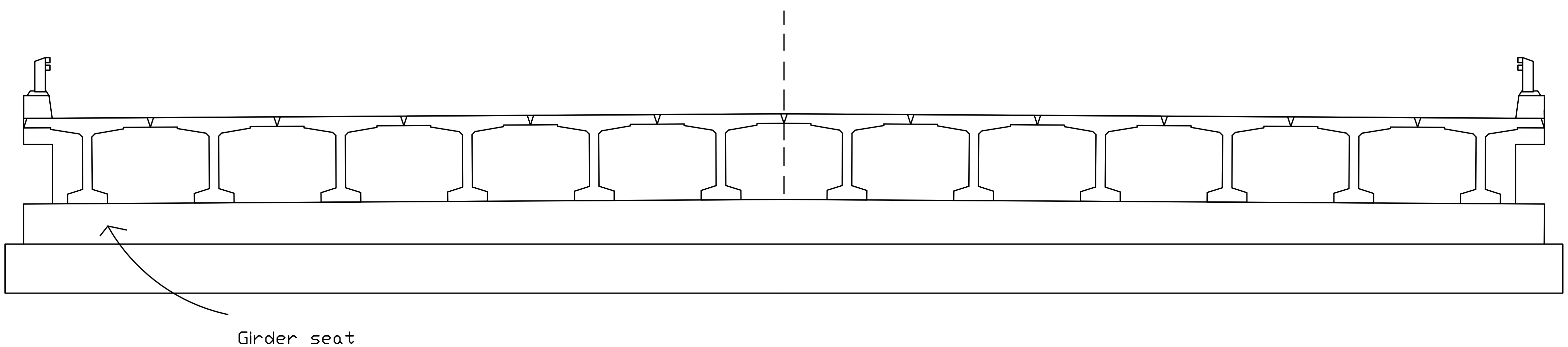
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT: WEST DOWLING ROAD BRIDGE DESIGN

TITLE: GENERAL LAYOUT

DESIGNED BY: EP, BS
DRAWN BY: EP
CHECKED BY:
APPROVED BY:
SCALE : Varied
DATE : 04/06/09
DWG NO. D1 OF D6





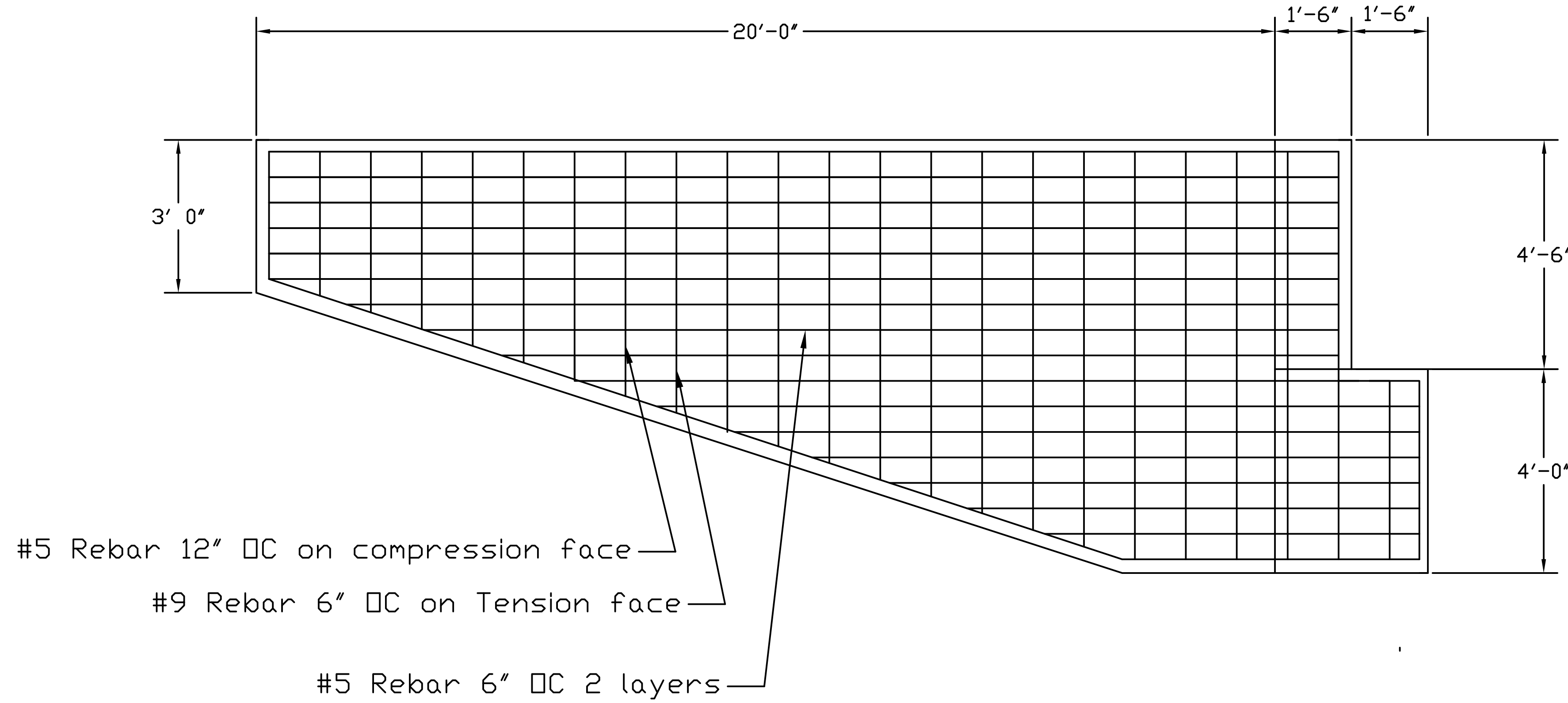
REV.	DATE	BY	REVISION

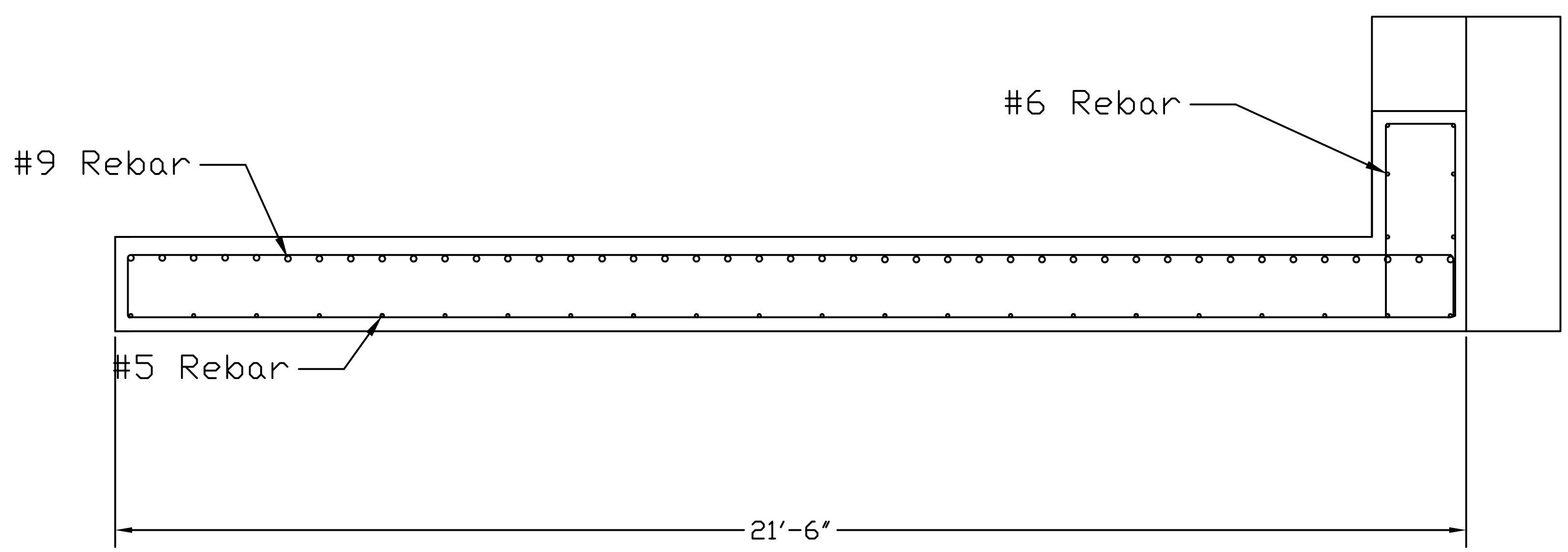
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

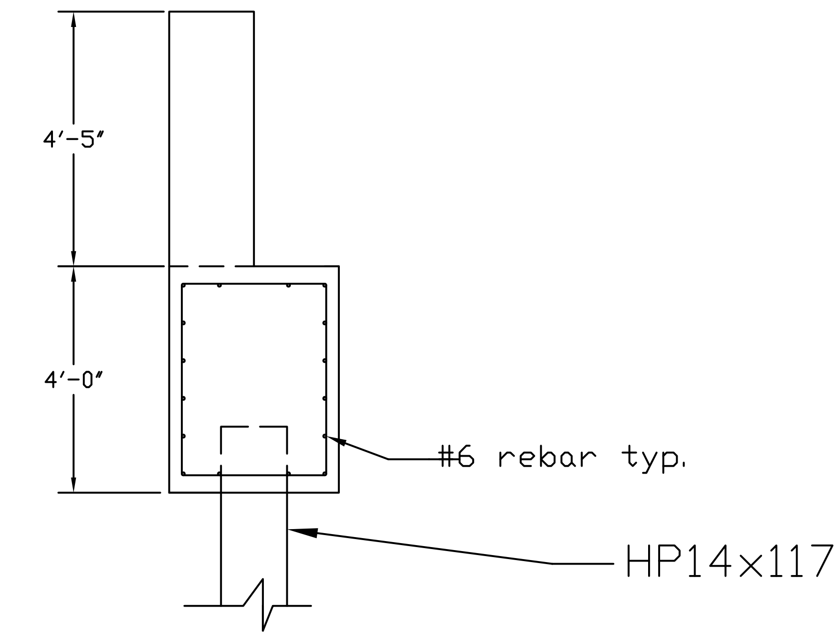
PROJECT:
WEST DOWLING ROAD BRIDGE DESIGN

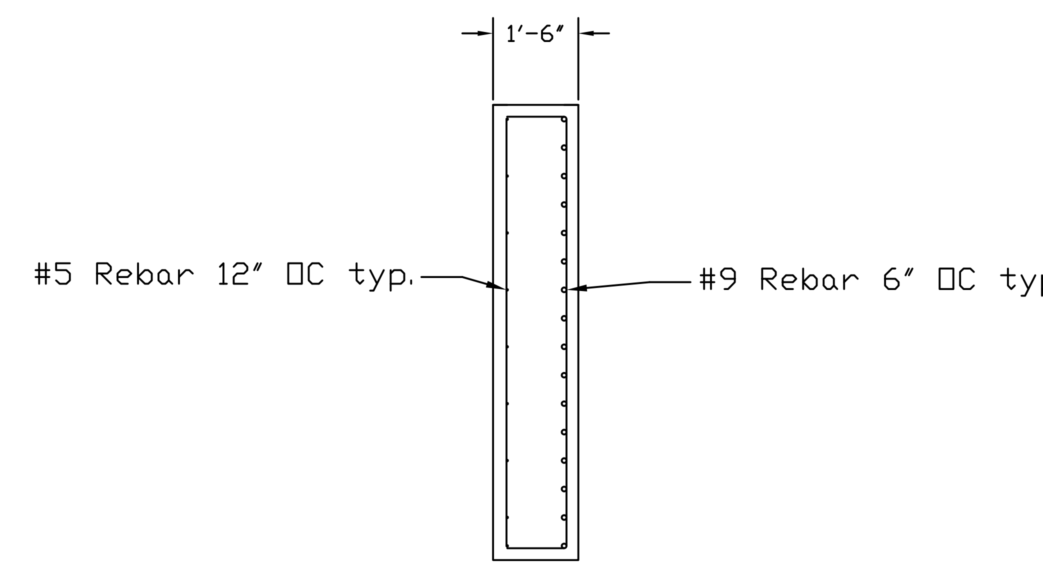
TITLE:
ABUTMENTS

DESIGNED BY: EP, BS	SCALE : Varied	DWG NO. D2 OF D6
DRAWN BY: EP, BS		
CHECKED BY: ____	DATE : 04/06/09	
APPROVED BY: ____		









REV.	DATE	BY	REVISION

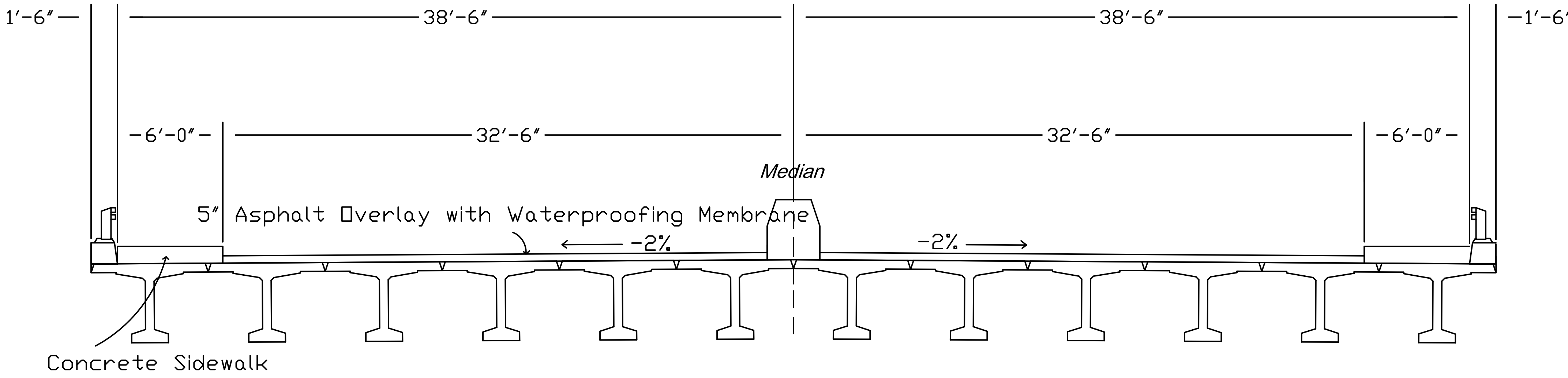
bluefox UNIVERSAL

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

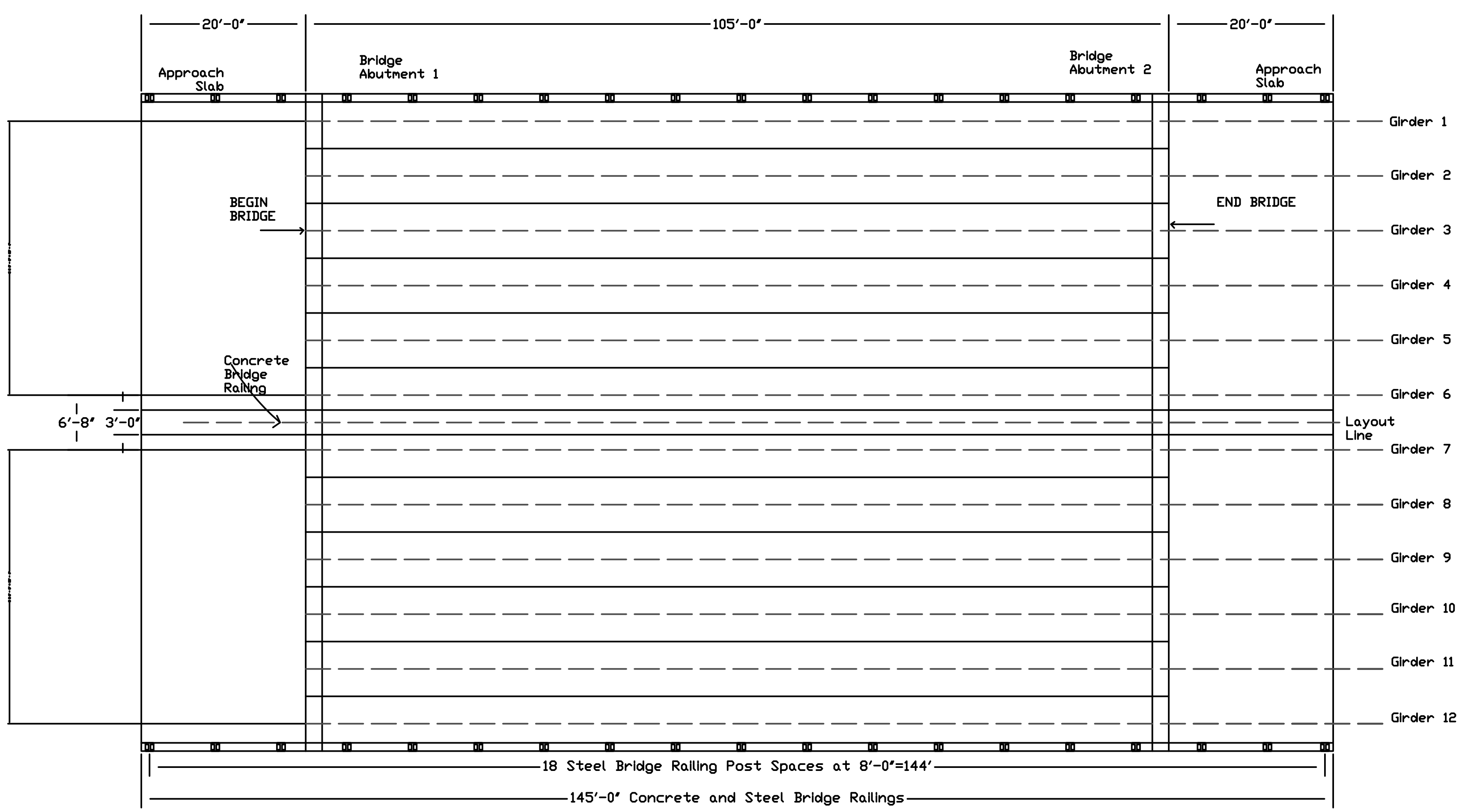
PROJECT :
WEST DOWLING ROAD BRIDGE DESIGN

TITLE:
WINGWALLS

DESIGNED BY: BS	SCALE :		DWG NO.
DRAWN BY: BS			**D3** OF **D7**
CHECKED BY: EP	DATE :	04/06/09	
APPROVED BY:			



Typical Section



Framing Plan

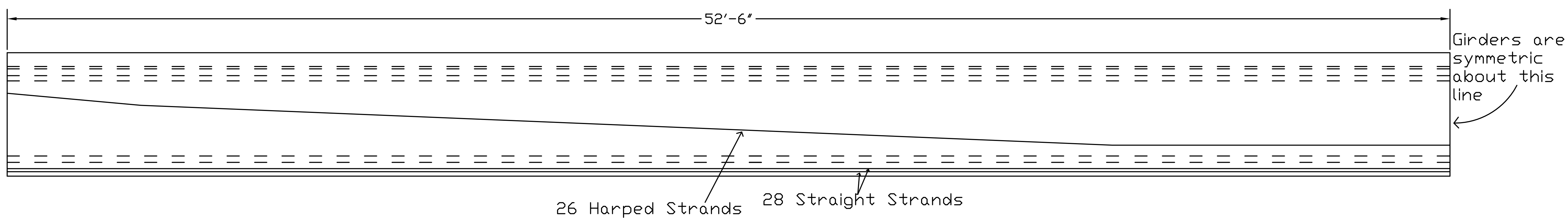
REV.	DATE	BY	REVISION

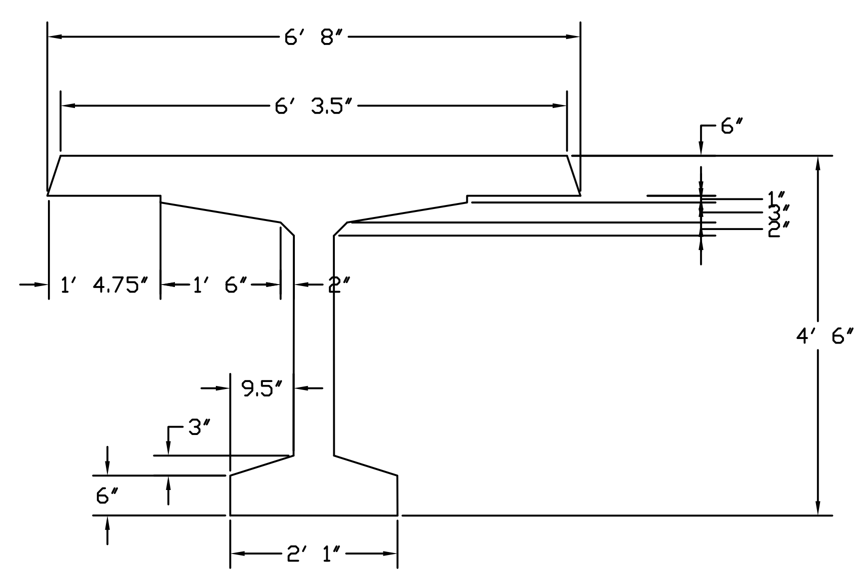
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

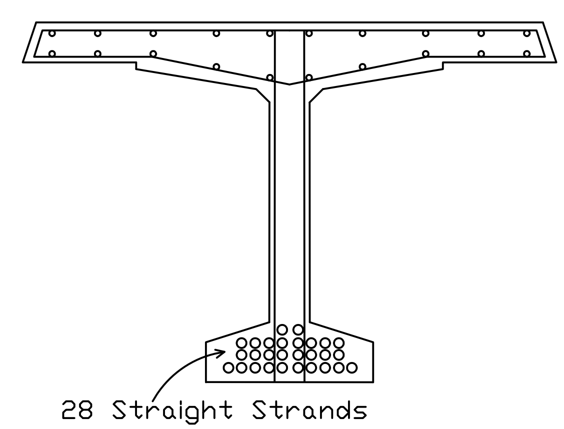
PROJECT:
WEST DOWLING ROAD BRIDGE DESIGN

TITLE:
TYPICAL SECTION AND FRAMING PLAN

DESIGNED BY: EP,BS,SP	SCALE : Varied	DWG NO.	
DRAWN BY: EP		**D4** OF **D7**	
CHECKED BY:	DATE : 04/06/09		
APPROVED BY:			







Girder Notes
Alaska-style girder used
12 total girders for bridge
Straight Strand Pattern: 10 1st row, 8 2nd row, 8 3rd row, and 2 4th row
Harped Strand Pattern: 10 1st row, 8 2nd row, 8 3rd row
f'ci release = 7500 psi
f'c service = 8500 psi
Cast length = 109 feet; Bearing length = 105 feet

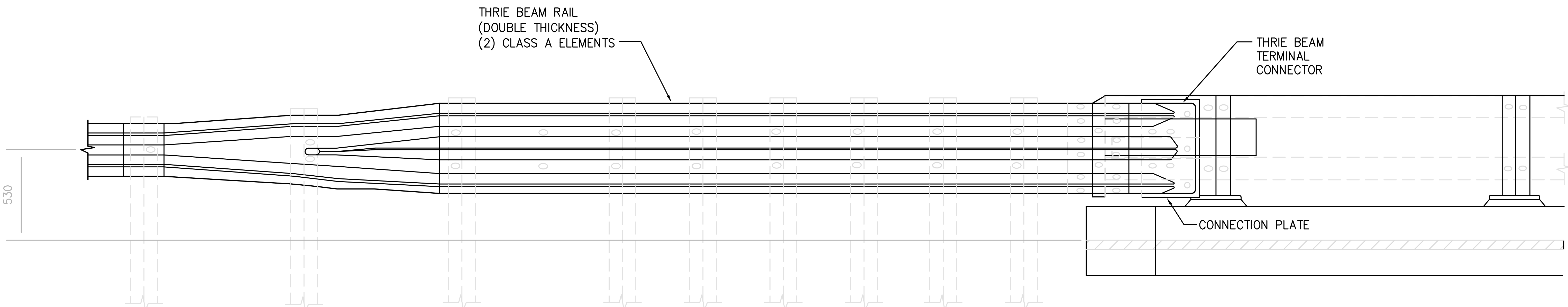
REV.	DATE	BY	REVISION

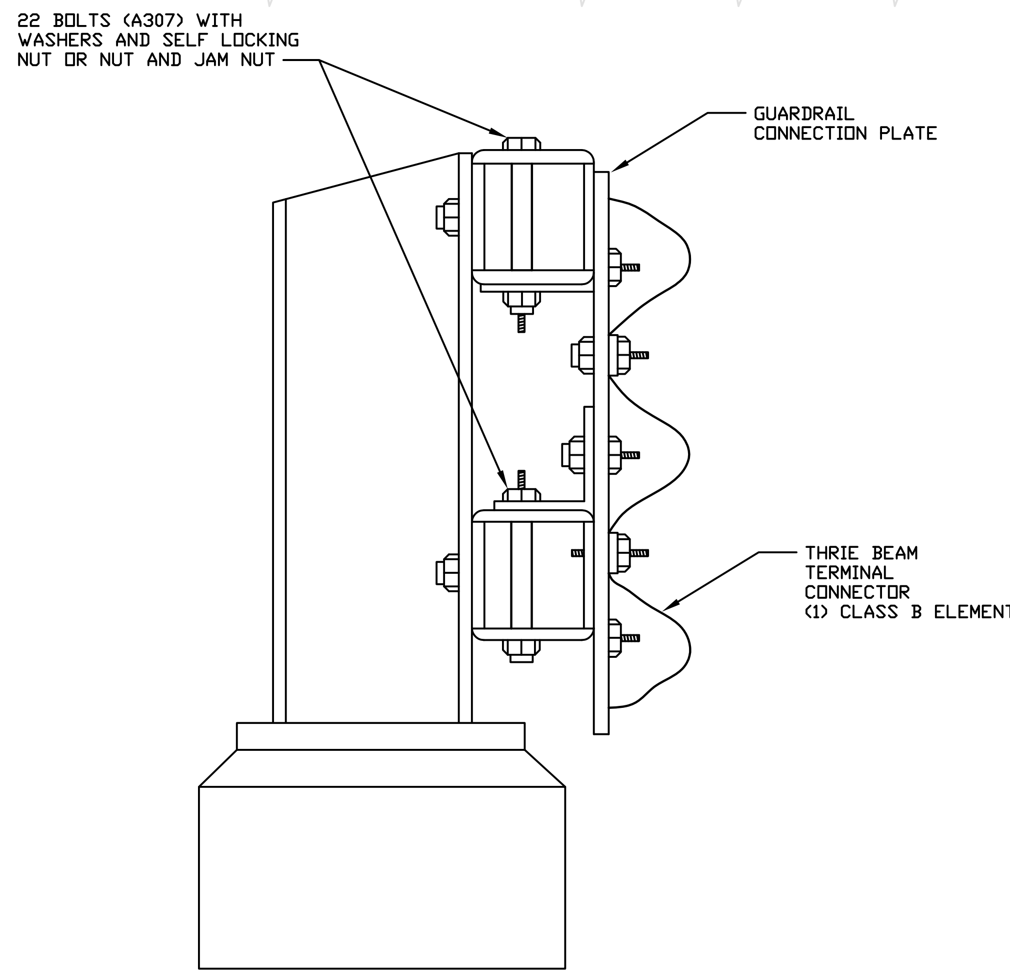
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT: **WEST DOWLING ROAD BRIDGE DESIGN**

TITLE: **GIRDER SECTION AND PROFILE**

DESIGNED BY: EP, BS	SCALE : Varied		DWG NO.
DRAWN BY: EP			D5 OF D6
CHECKED BY:	DATE : 04/09/09		
APPROVED BY:			





REV.	DATE	BY	REVISION

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT :
WEST DOWLING ROAD BRIDGE DESIGN

TITLE:
BRIDGE RAILINGS

DESIGNED BY: EP, BS
DRAWN BY: EP
CHECKED BY:
APPROVED BY:

SCALE : Varied
DATE : 04/06/09

DWG NO. D6 OF D6

General Notes

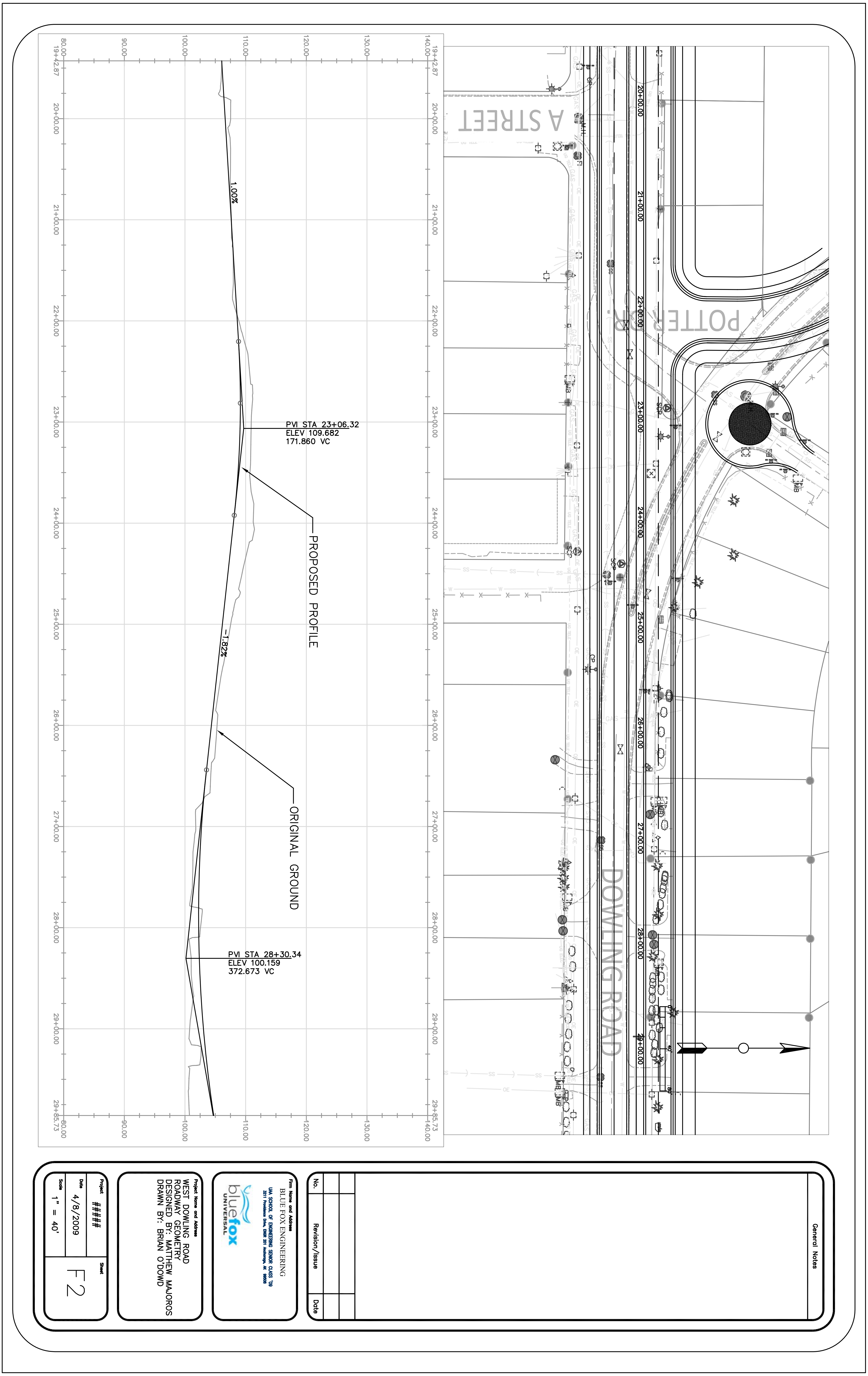
No.	Revision/Issue	Date

Firm Name and Address
BLUE FOX ENGINEERING
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, EMGR 201 Anchorage, AK 99508

Project Name and Address
WEST DOWLING ROAD
ROADWAY GEOMETRY
DESIGNED BY: MATTHEW MAJOROS
DRAWN BY: MAHEAR ABOUEID

Project #####	Sheet F1
Date 4/8/2009	
Scale 1" = 40'	

---- 3/19/2007 ROAD SHEETS -MAJOROS.dwg



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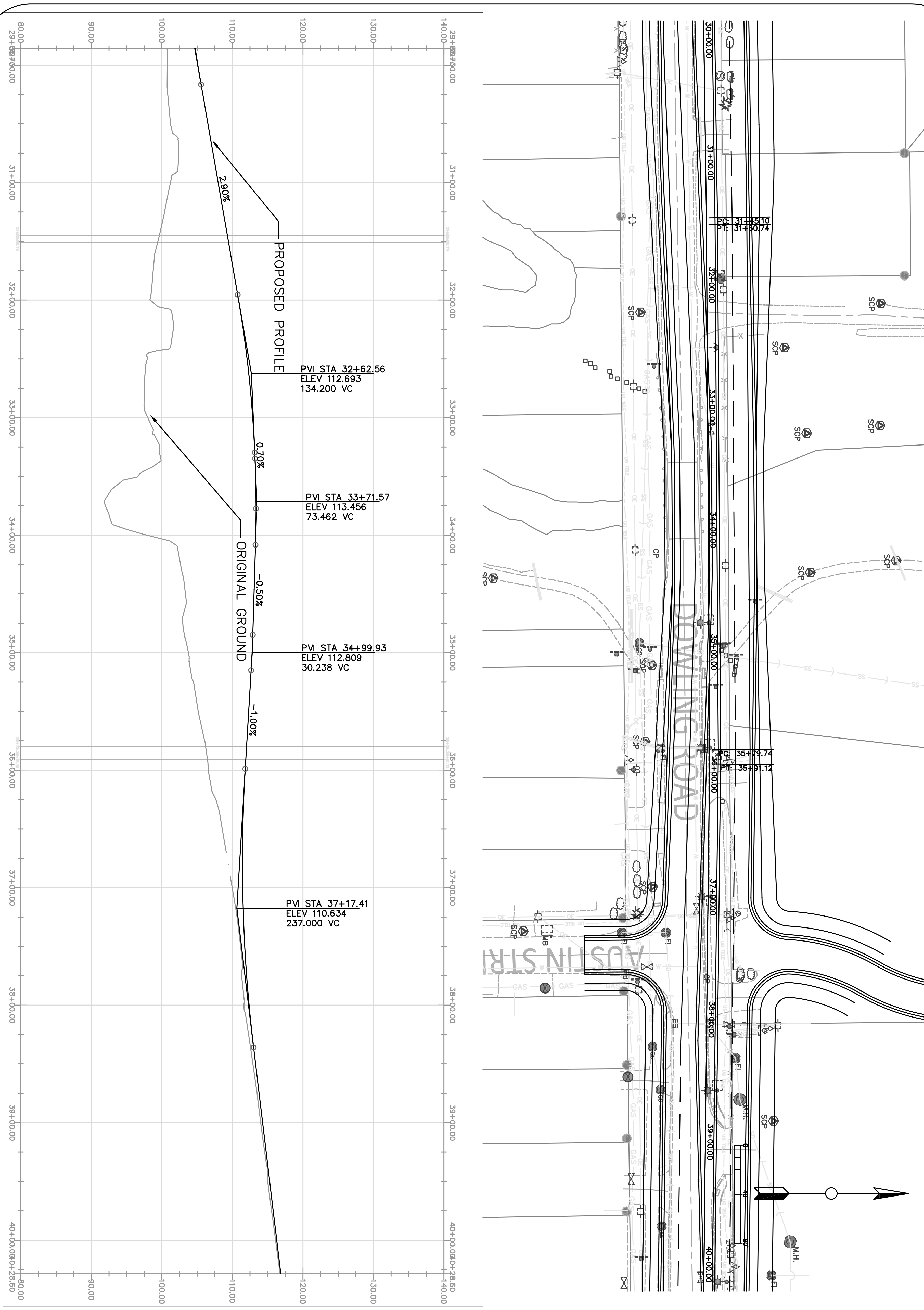


General Notes

No.	Revision/Issue	Date

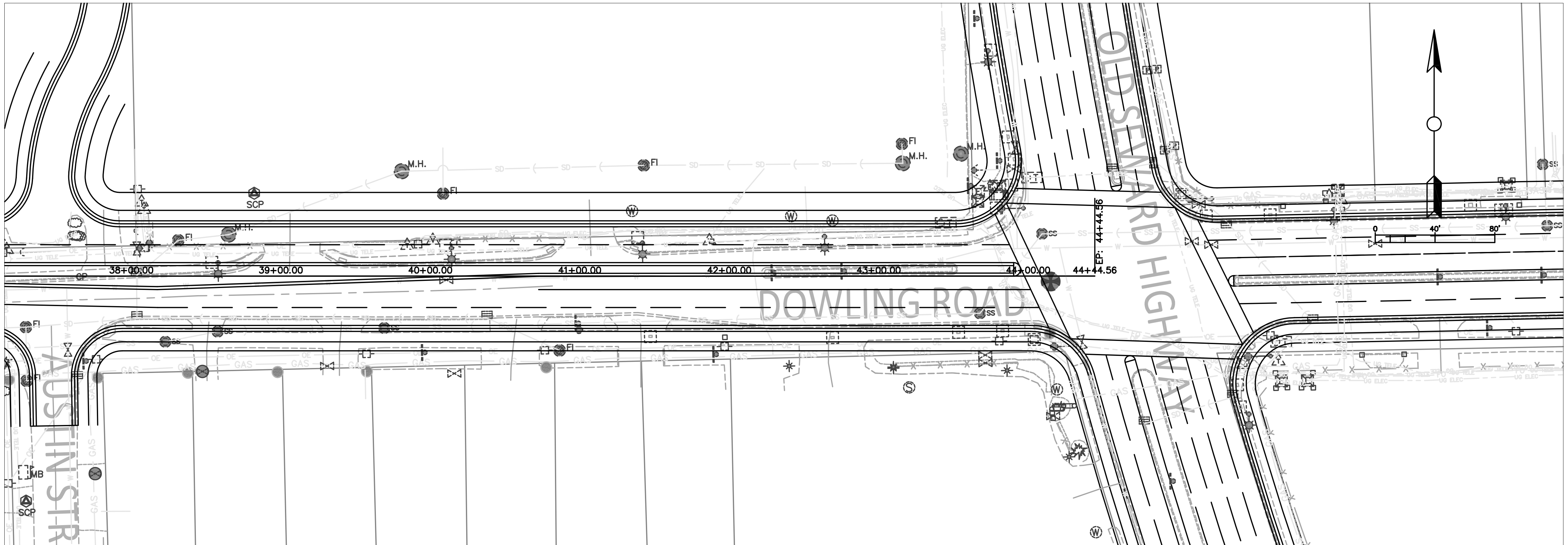
Firm Name and Address
BLUE FOX ENGINEERING
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, EIB# 201 Anchorage, AK 99508

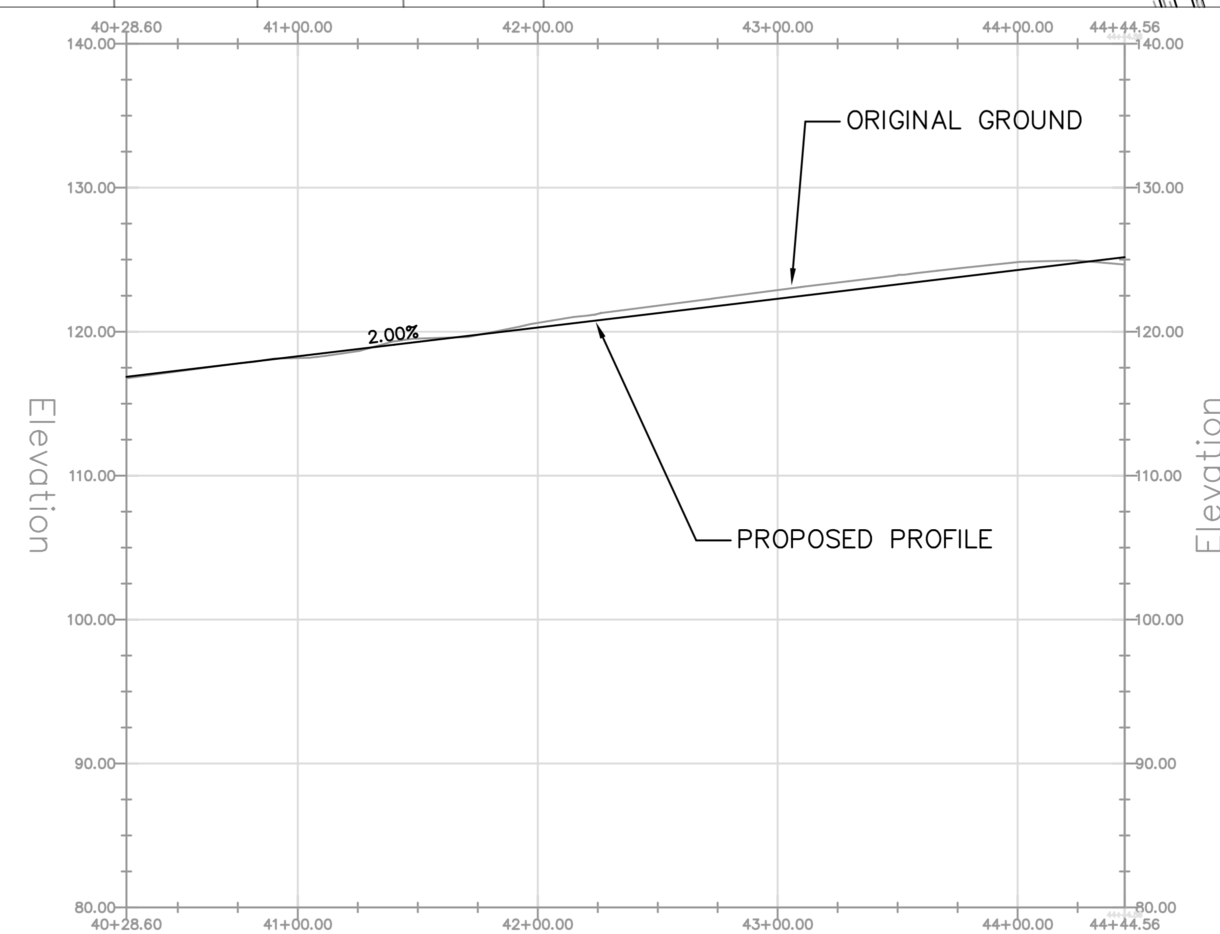
bluefox UNIVERSAL

Project Name and Address
WEST DOWLING ROAD
ROADWAY GEOMETRY
DESIGNED BY: MATTHEW MAJOROS
DRAWN BY: WILL KEMP

Project ####
Date 4/8/2009
Scale 1" = 40'
Sheet F3

----   3/19/2007   ROAD SHEETS —MAJOROS.dwg





General Notes

No.	Revision/Issue	Date

Firm Name and Address
BLUE FOX ENGINEERING
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

bluefox UNIVERSAL

Project Name and Address
WEST DOWLING ROAD
ROADWAY GEOMETRY
DESIGNED BY: MATTHEW MAJOROS
DRAWN BY: WILL KEMP

Project	#####	Sheet
Date	4/8/2009	F4
Scale	1" = 40'	

---- 3/19/2007 ERSP- sheets.dwg

General Notes

Silt Fence

Inlet Protection

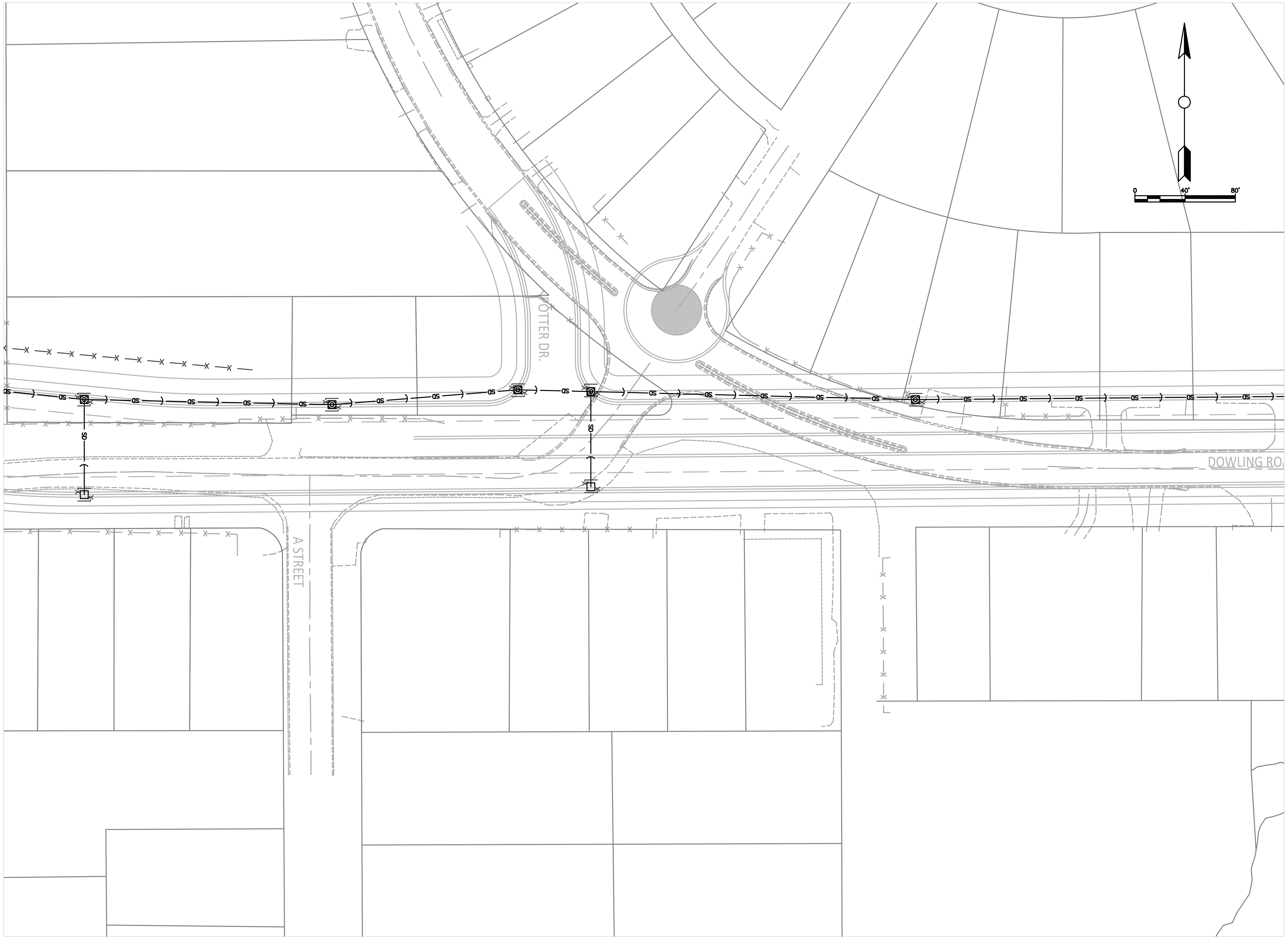
No.	Revision/Issue	Date

Firm Name and Address
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

Project Name and Address
CE 438
West Dowling Road
Erosion & Sediment Control Plan
Drawn By: Michael Johnson

Project #####
Date 4/6/2009
Scale 1" = 40'
Sheet M1

---- 3/19/2007 ERSP- sheets.dwg



General Notes

Silt Fence

Inlet Protection

No.	Revision/Issue	Date

Firm Name and Address

BLUE FOX UNIVERSAL

UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

Project Name and Address

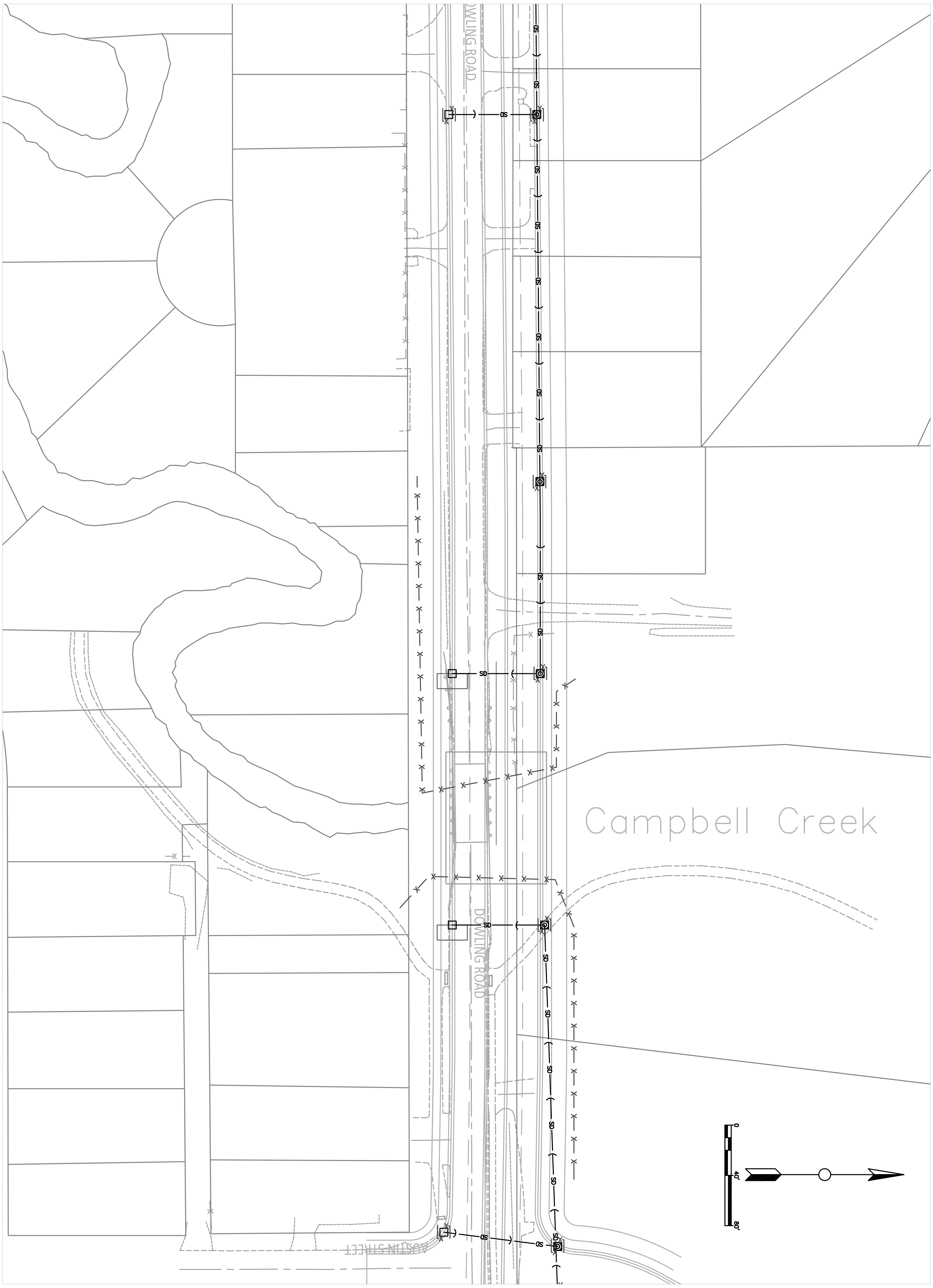
CE 438
West Dowling Road
Erosion &Sediment Control Plan
Drawn By: Michael Johnson

Project: #####

Date: 4/5/2009

Scale: 1" = 40'

Sheet: M2



General Notes

Silt Fence

Inlet Protection

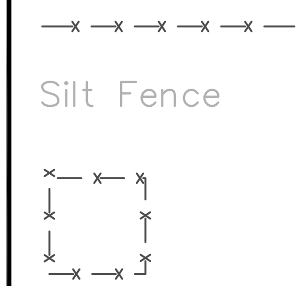
No.	Revision/Issue	Date

Firm Name and Address
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

Project Name and Address
CE 438
West Dowling Road
Erosion & Sediment Control Plan
Drawn By: Michael Johnson

Project ####
Date 4/6/2009
Scale 1" = 40'
Sheet M3

General Notes



No.	Revision/Issue	Date

Firm Name and Address

BLUE FOX UNIVERSAL

UAA SCHOOL OF ENGINEERING SENIOR CLASS '09

3211 Providence Drive, ENGR 201 Anchorage, AK 99508

Project Name and Address

CE 438
West Dowling Road
Erosion & Sediment Control Plan
Drawn By: Michael Johnson

Project #####	Sheet M4
Date 4/6/2009	
Scale 1" = 40'	

EXISTING ROW

PROPOSED ROW

REV.	DATE	BY	REVISION

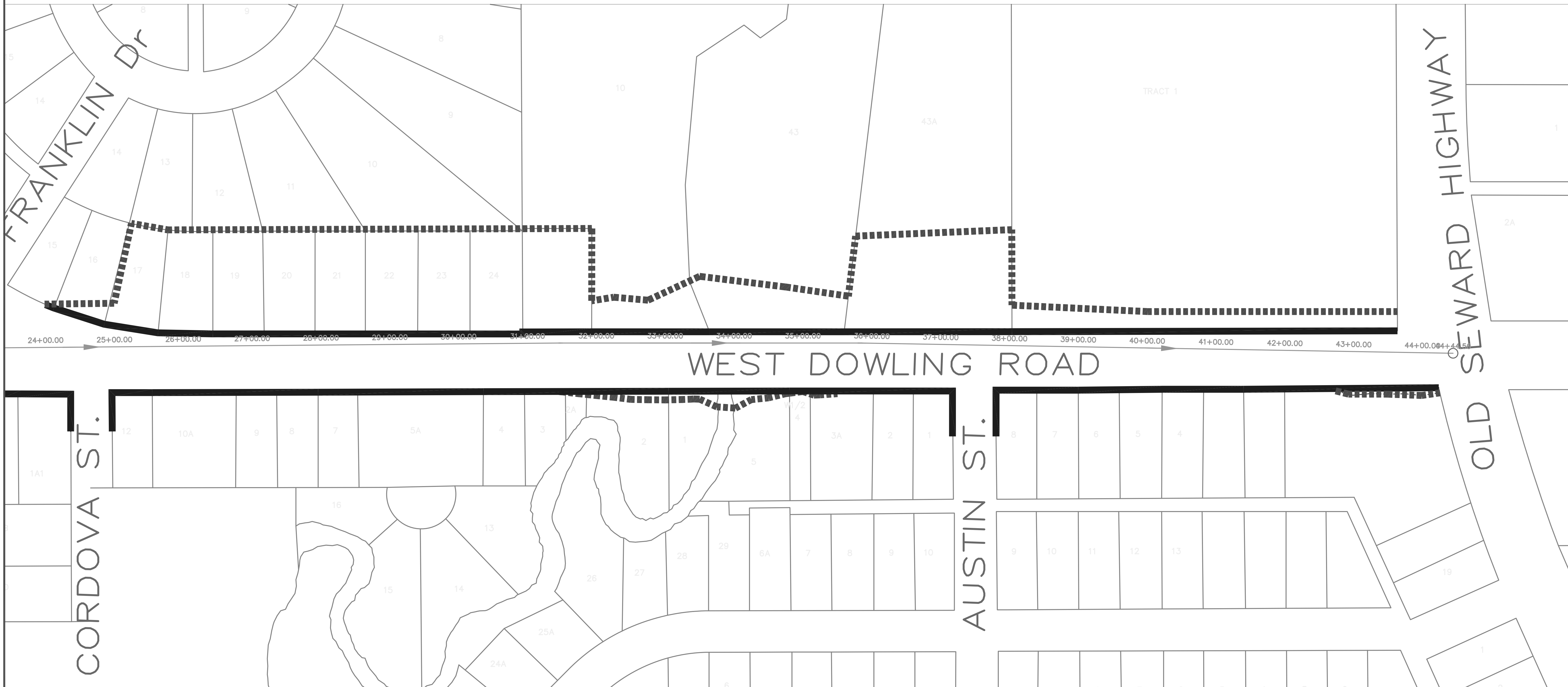
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT : WEST DOWLING ROAD

TITLE: PROPOSED ROW

DESIGNED BY: WILL KEMP
DRAWN BY: WILL KEMP
CHECKED BY:
APPROVED BY:
SCALE : AS NOTED
DATE :
DWG NO. R1 OF R2

Y:\!_SENIOR DESIGN–BLUE FOX ENGINEERING(alpha)\Alpha – ROW\ROW takes.dwg



EXISTING ROW

PROPOSED ROW

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

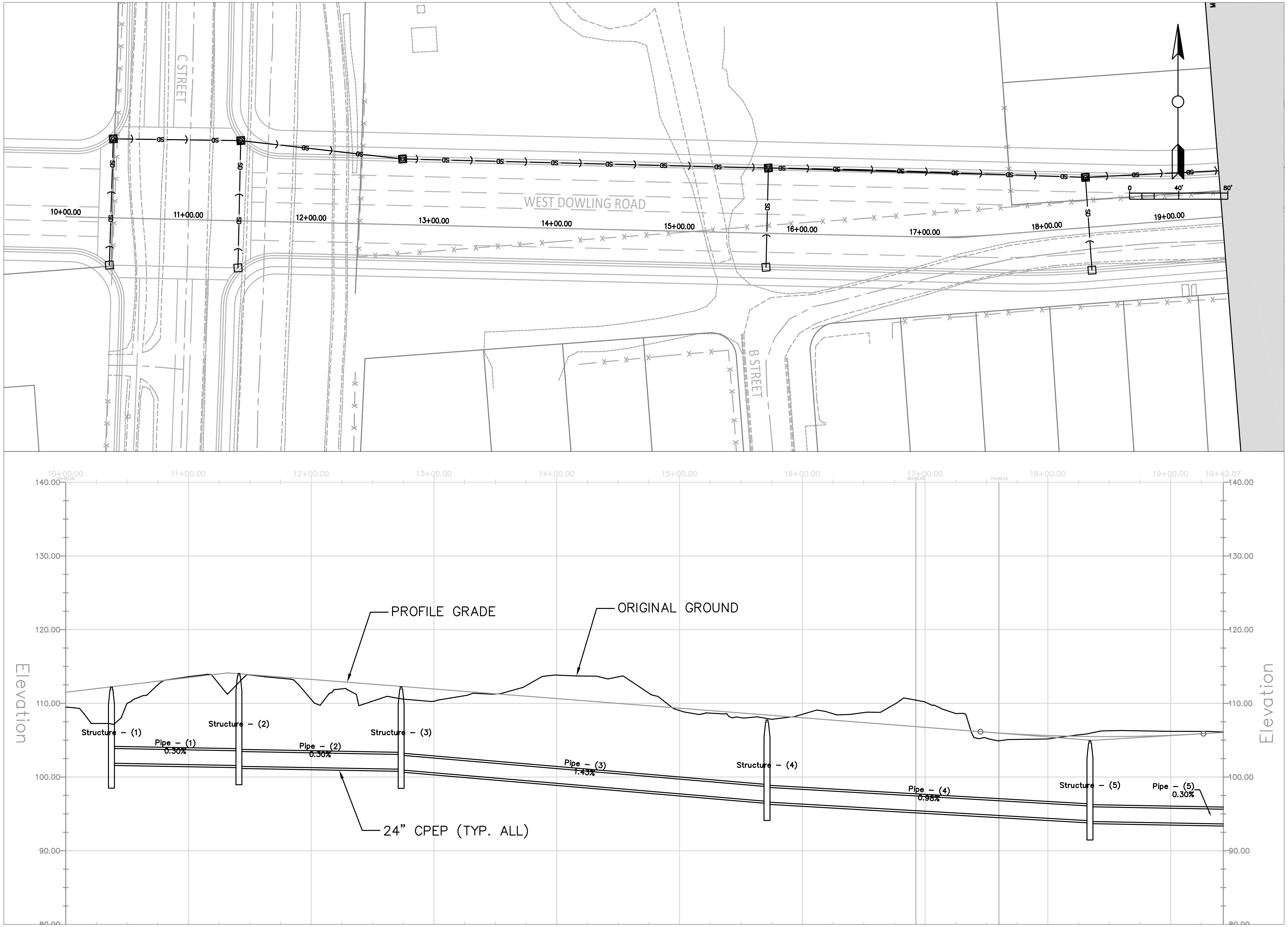
PROJECT : WEST DOWLING ROAD

TITLE: PROPOSED ROW

REV.	DATE	BY	REVISION

DESIGNED BY: WILL KEMP
DRAWN BY: WILL KEMP
CHECKED BY:
APPROVED BY:
SCALE : NTS
DATE :
DWG NO. R2 OF R2

Y:\!_SENIOR DESIGN-BLUE FOX ENGINEERING(alpha)\Alpha - ROW\ROW takes.dwg



General Notes

No.	Revision/Issue	Date

Firm Name and Address

BLUE FOX UNIVERSAL

UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

Project Name and Address

CE 438
West Dowling Road
Storm Water Design
Drawn By: Will Kemp

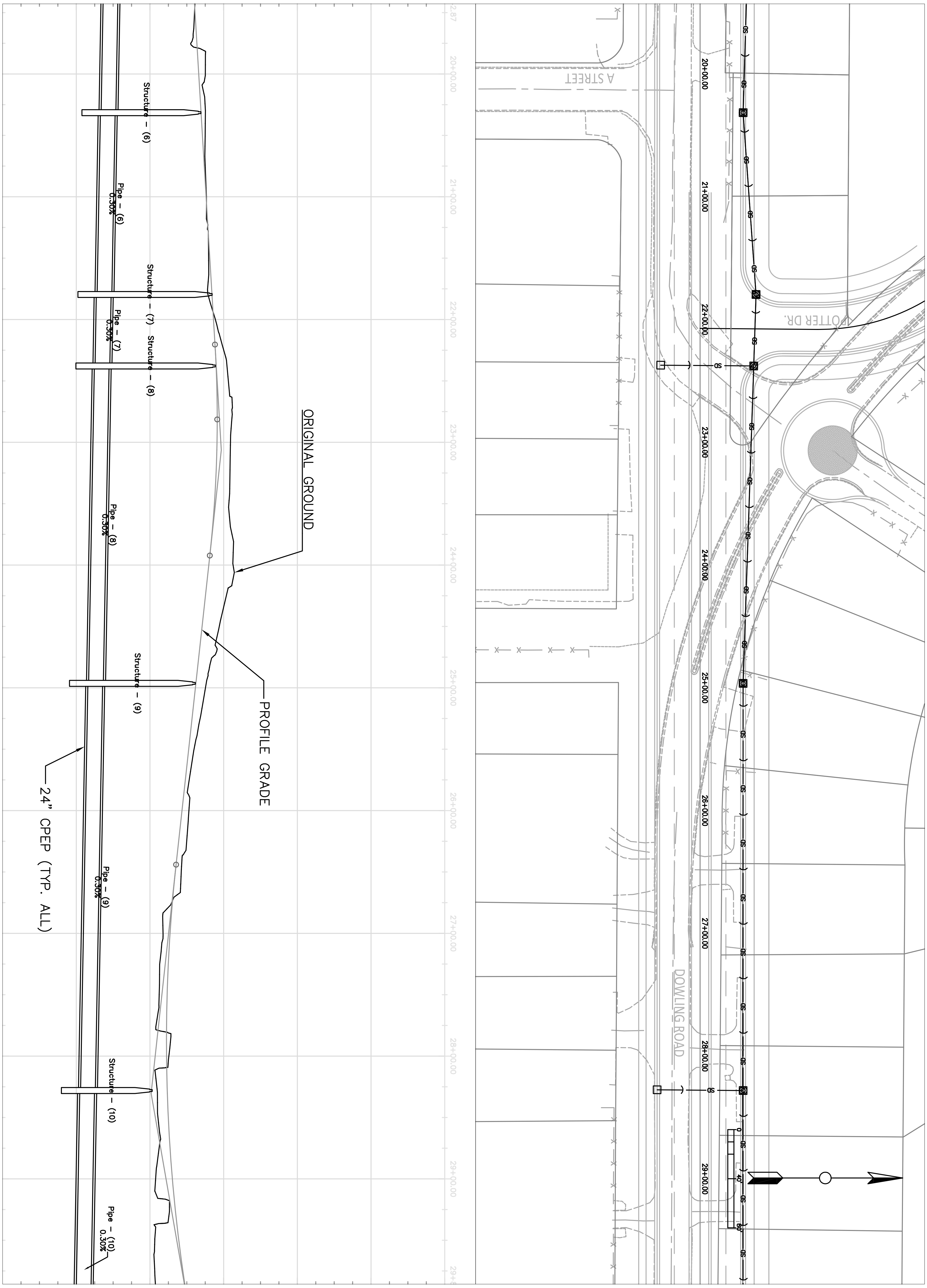
Project

Date 4/5/2009

Scale 1" = 40'

Sheet S1

---- 3/19/2007 Storm water- sheets.dwg



General Notes

No.	Revision/Issue	Date

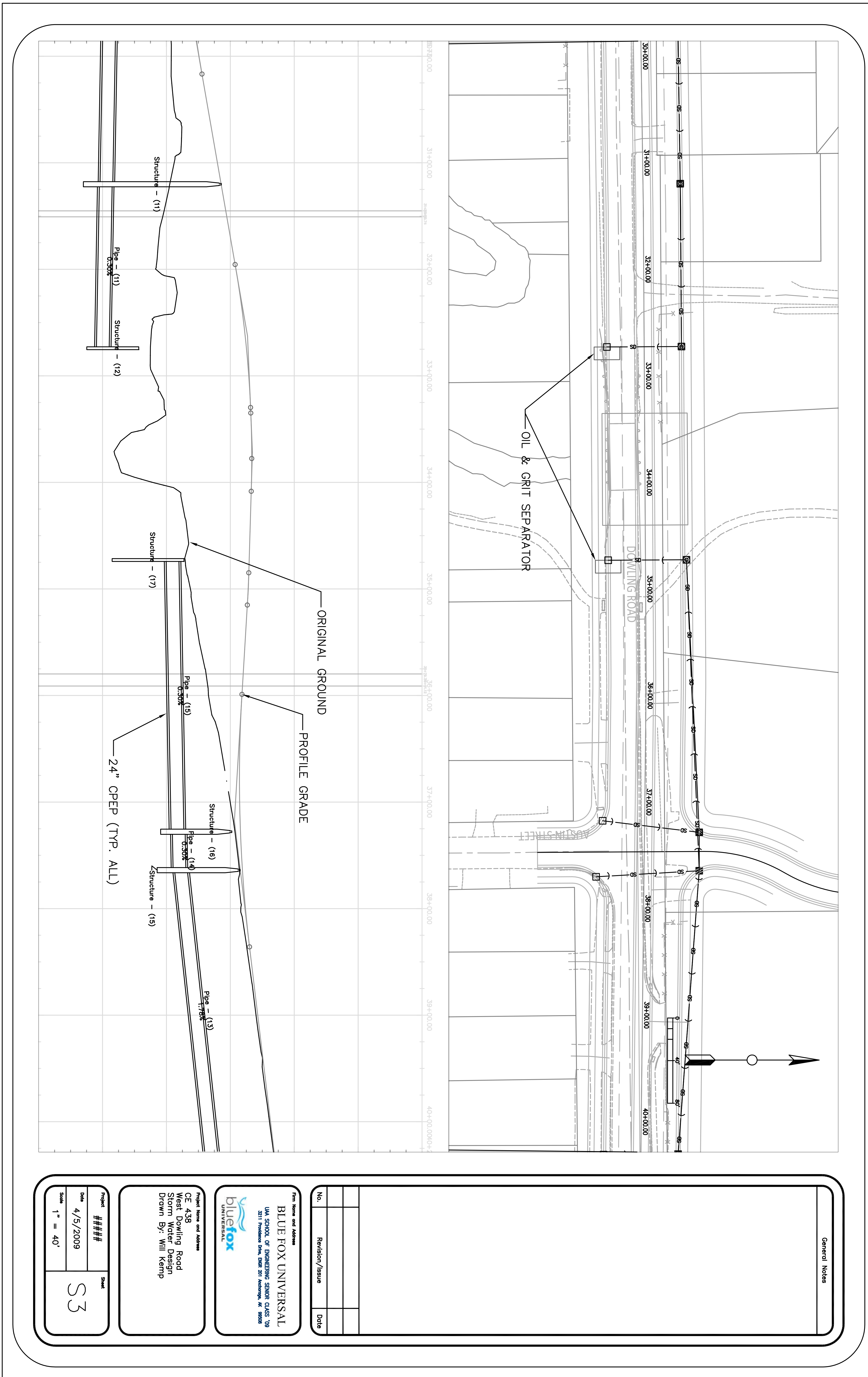
Firm Name and Address
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

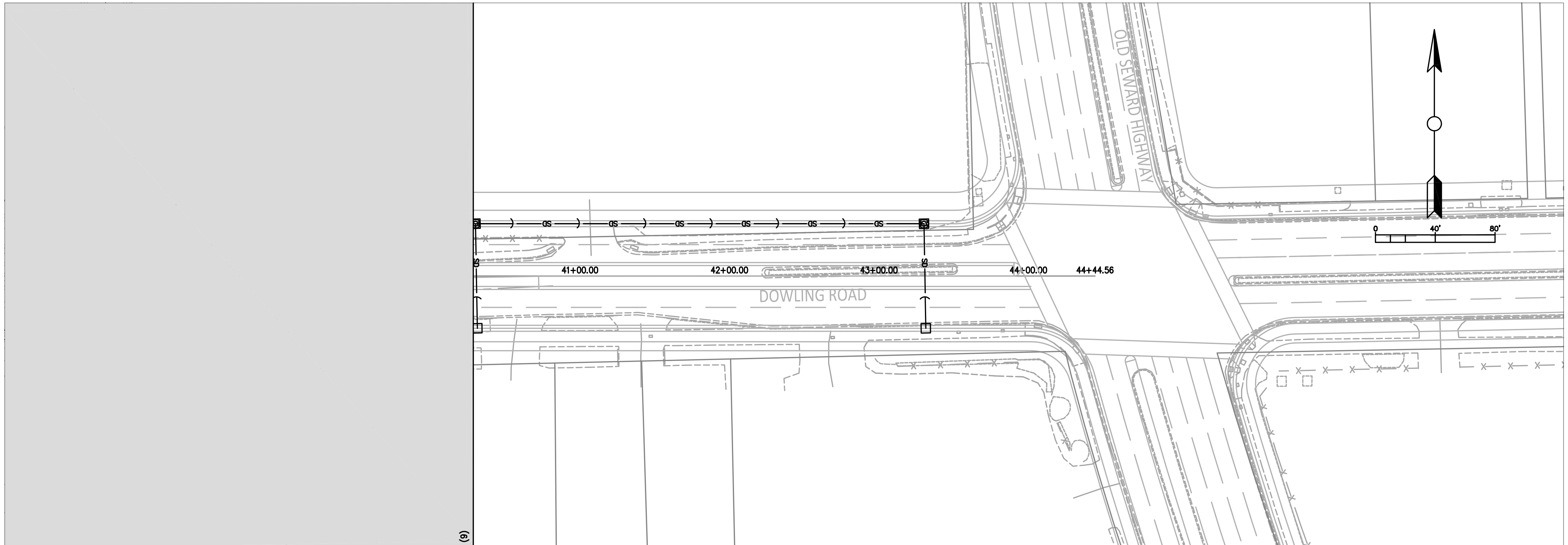
bluefox UNIVERSAL

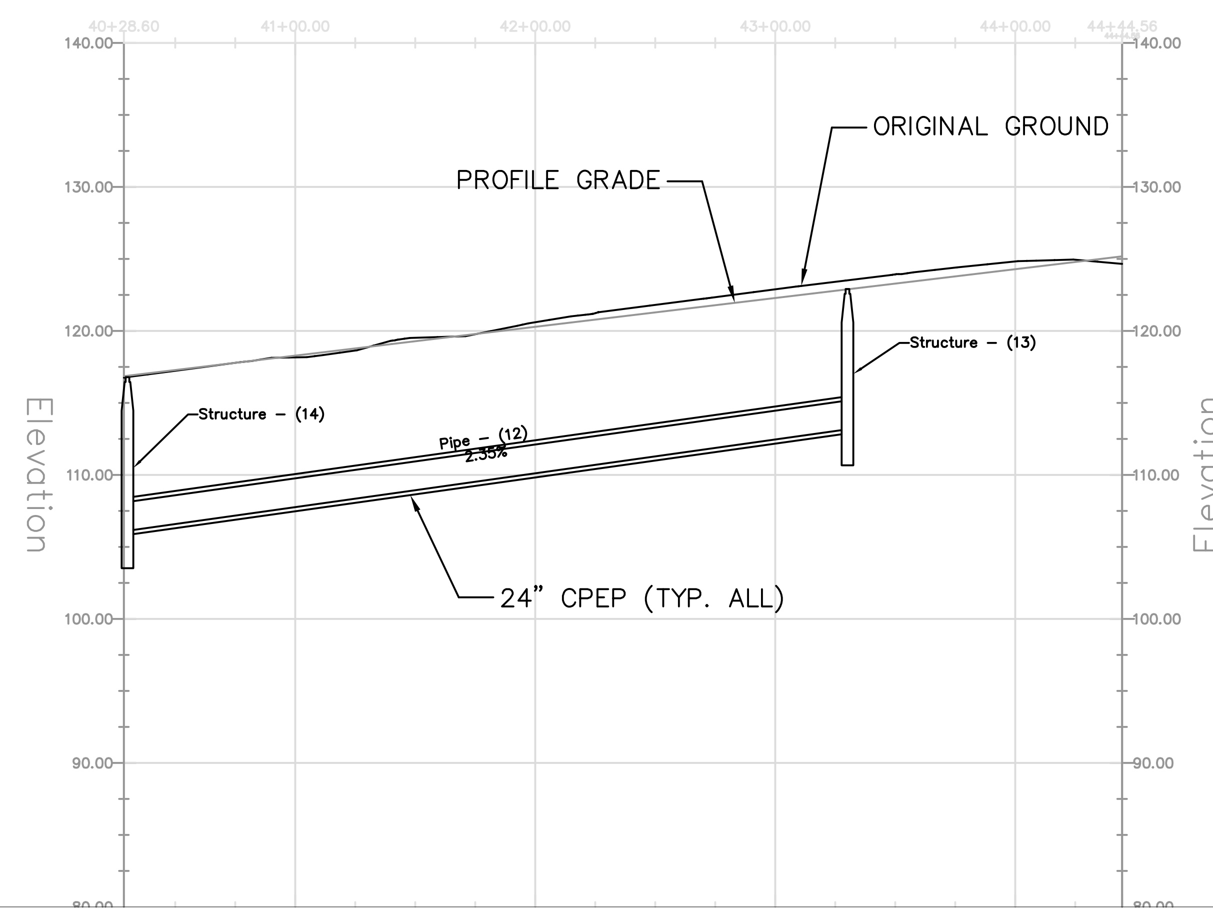
Project Name and Address
CE 438
West Dowling Road
Storm Water Design
Drawn By: Will Kemp

Project ####
Date 4/5/2009
Scale 1" = 40'
Sheet S2

---- 3/19/2007 Storm water- sheets.dwg







General Notes

No.	Revision/Issue	Date

Firm Name and Address

BLUE FOX UNIVERSAL

UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

bluefox UNIVERSAL

Project Name and Address

CE 438
West Dowling Road
Storm Water Design
Drawn By: Will Kemp

Project #####	Sheet S4
Date 4/5/2009	
Scale 1" = 40'	

WEST PIPE NETWORK

Pipe Table

Pipe Name	Size	Length	Slope
Pipe – (1)	24.000	103.812	0.30%
Pipe – (2)	24.000	132.685	0.30%
Pipe – (3)	24.000	298.003	1.43%
Pipe – (4)	24.000	258.376	0.98%
Pipe – (5)	24.000	197.344	0.30%
Pipe – (7)	24.000	58.260	0.30%
Pipe – (8)	24.000	258.678	0.30%
Pipe – (9)	24.000	331.632	0.30%
Pipe – (11)	24.000	154.178	0.30%
Pipe – (10)	24.000	292.135	0.30%
Pipe – (6)	24.000	148.452	0.30%

Structure Table

Structure Name	Structure Details
Structure – (2)	RIM = 114.045 SUMP = 99.459 Pipe – (1) INV IN = 101.559 Pipe – (2) INV OUT = 101.459
Structure – (3)	RIM = 112.239 SUMP = 98.961 Pipe – (2) INV IN = 101.061 Pipe – (3) INV OUT = 100.961
Structure – (1)	RIM = 112.204 SUMP = 98.989 Pipe – (1) INV OUT = 101.871
Structure – (8)	RIM = 108.867 SUMP = 90.454 Pipe – (7) INV IN = 92.554 Pipe – (8) INV OUT = 92.454
Structure – (11)	RIM = 108.591 SUMP = 87.507 Pipe – (10) INV IN = 89.607 Pipe – (11) INV OUT = 89.507
Structure – (7)	RIM = 108.436 SUMP = 90.727 Pipe – (6) INV IN = 92.827 Pipe – (7) INV OUT = 92.727
Structure – (4)	RIM = 107.748 SUMP = 94.600 Pipe – (3) INV IN = 96.700 Pipe – (4) INV OUT = 96.600
Structure – (6)	RIM = 106.914 SUMP = 91.273 Pipe – (5) INV IN = 93.373 Pipe – (6) INV OUT = 93.273
Structure – (9)	RIM = 106.145 SUMP = 89.578 Pipe – (8) INV IN = 91.678 Pipe – (9) INV OUT = 91.578
Structure – (5)	RIM = 104.899 SUMP = 91.965 Pipe – (4) INV IN = 94.065 Pipe – (5) INV OUT = 93.965
Structure – (10)	RIM = 100.307 SUMP = 88.483 Pipe – (9) INV IN = 90.583 Pipe – (10) INV OUT = 90.483
Structure – (12)	RIM = 95.675 SUMP = 88.037 Pipe – (11) INV IN = 89.044

EAST PIPE NETWORK

Structure Table

Structure Name	Structure Details
Structure – (13)	RIM = 122.913 SUMP = 111.168 Pipe – (12) INV OUT = 113.168
Structure – (14)	RIM = 116.787 SUMP = 104.026 Pipe – (12) INV IN = 106.126 Pipe – (13) INV OUT = 106.026
Structure – (15)	RIM = 111.518 SUMP = 99.042 Pipe – (13) INV IN = 101.275 Pipe – (14) INV OUT = 101.042
Structure – (16)	RIM = 110.236 SUMP = 99.588 Pipe – (14) INV IN = 100.934 Pipe – (15) INV OUT = 100.727
Structure – (17)	RIM = 102.751 SUMP = 92.003 Pipe – (15) INV IN = 99.959

Pipe Table

Pipe Name	Size	Length	Slope
Pipe – (12)	24.000	300.000	2.35%
Pipe – (13)	24.000	266.742	1.78%
Pipe – (15)	24.000	256.092	0.30%
Pipe – (14)	24.000	36.046	0.30%

REV.	DATE	BY	REVISION

bluefox UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT : WEST DOWLING ROAD

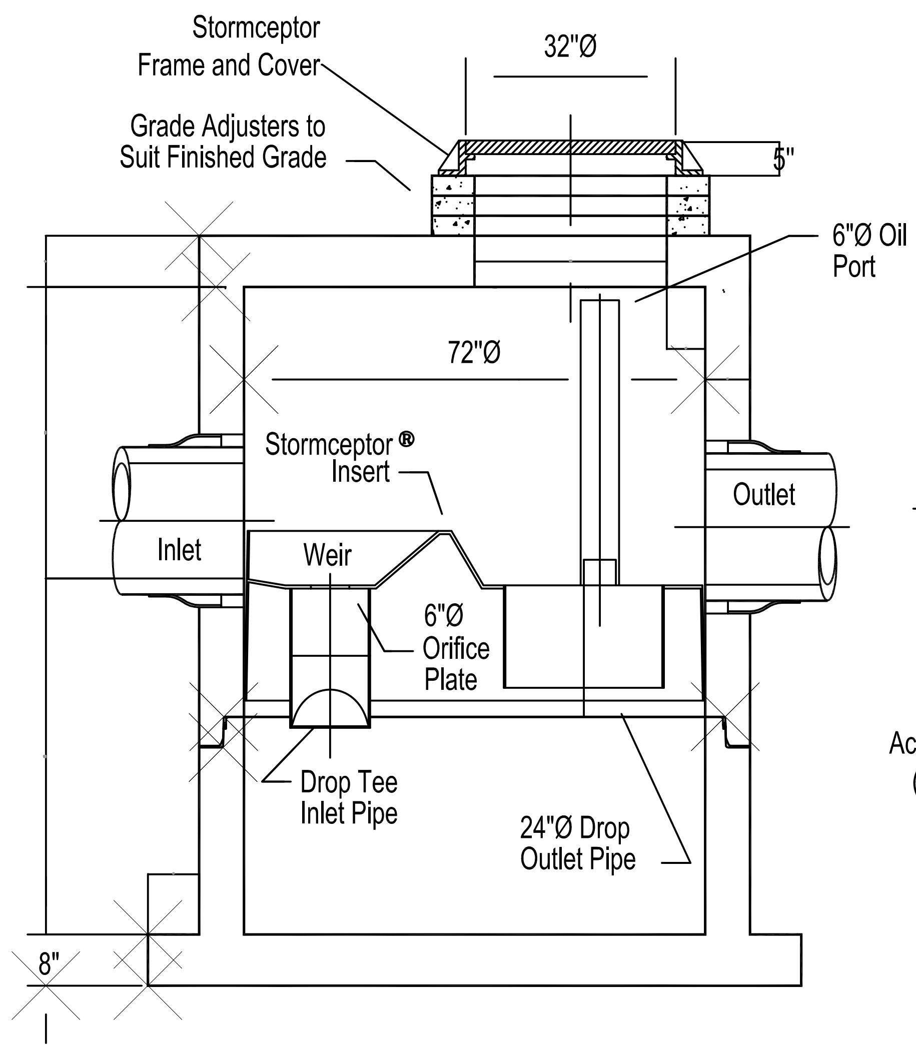
TITLE: STORM WATER DESIGN

DESIGNED BY: WMK
DRAWN BY: WMK
CHECKED BY:
APPROVED BY:
SCALE : AS NOTED
DATE :
DWG NO. S5 OF S6

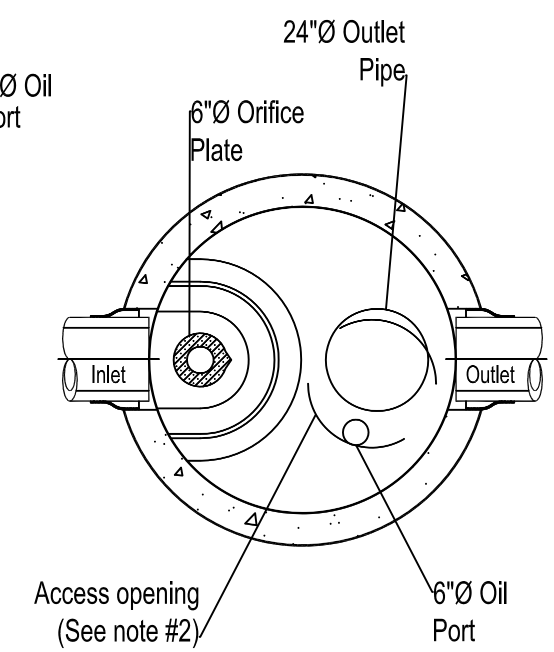
Rinker MATERIALS™

Concrete Pipe Division

STC 900 Precast Concrete Stormceptor®
(900 U.S. Gallon Capacity)



Section Thru Chamber



Plan View

Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The Cover Should be Positioned Over The Outlet Drop Pipe and The Oil Port.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.

Rinker 028

Y:_SENIOR DESIGN–BLUE FOX ENGINEERING(alpha)\CAD\Storm Water – wmk.dwg

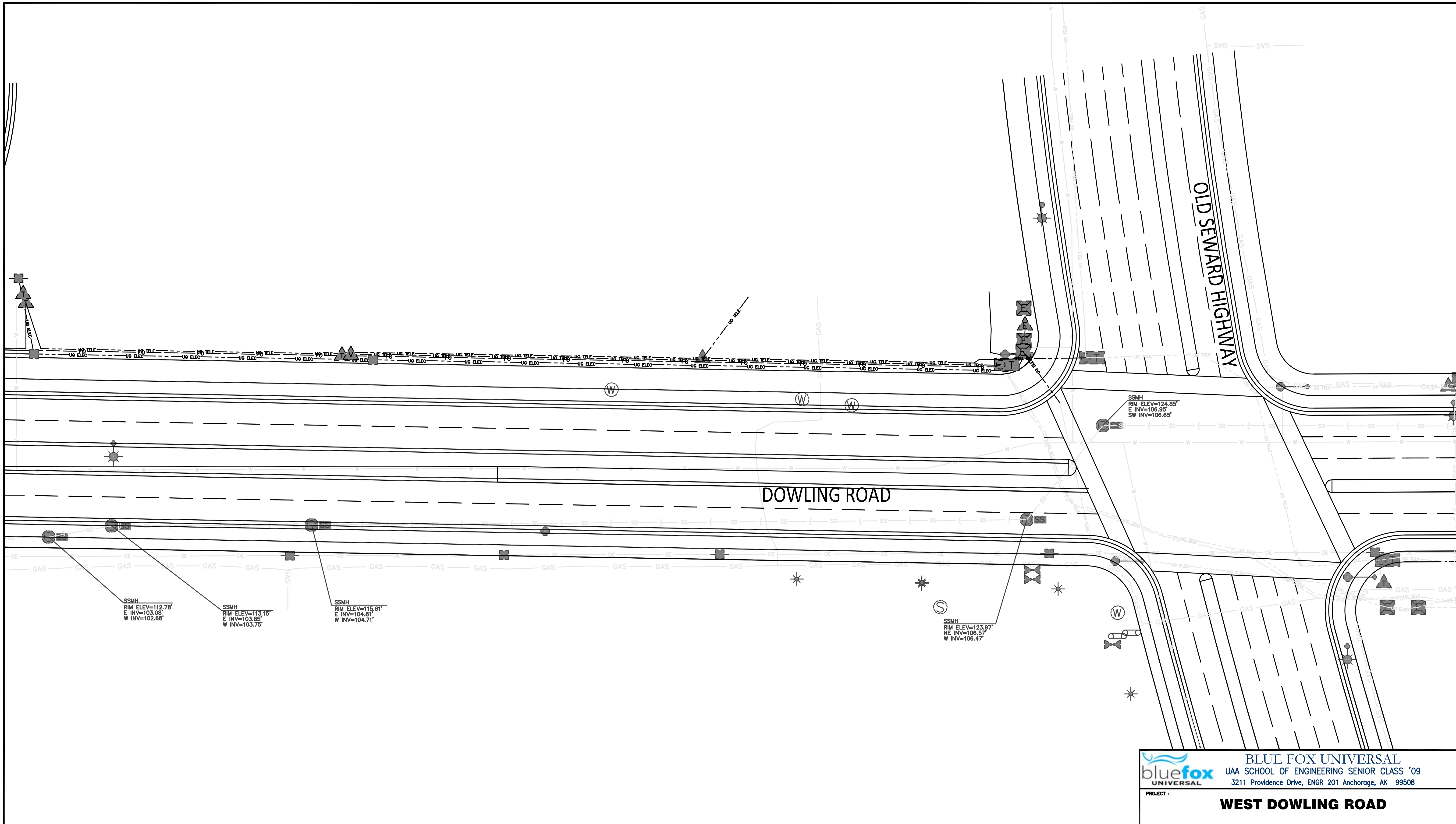
REV.	DATE	BY	REVISION

bluefox UNIVERSAL — UAA SCHOOL OF ENGINEERING SENIOR CLASS '09, 3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT: **WEST DOWLING ROAD**

TITLE: **STORM WATER DESIGN**

DESIGNED BY: WMK	SCALE : AS NOTED	DWG NO.
DRAWN BY: WMK		S6 OF S6
CHECKED BY:	DATE :	
APPROVED BY:		



REV.	DATE	BY	REVISION

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT : WEST DOWLING ROAD

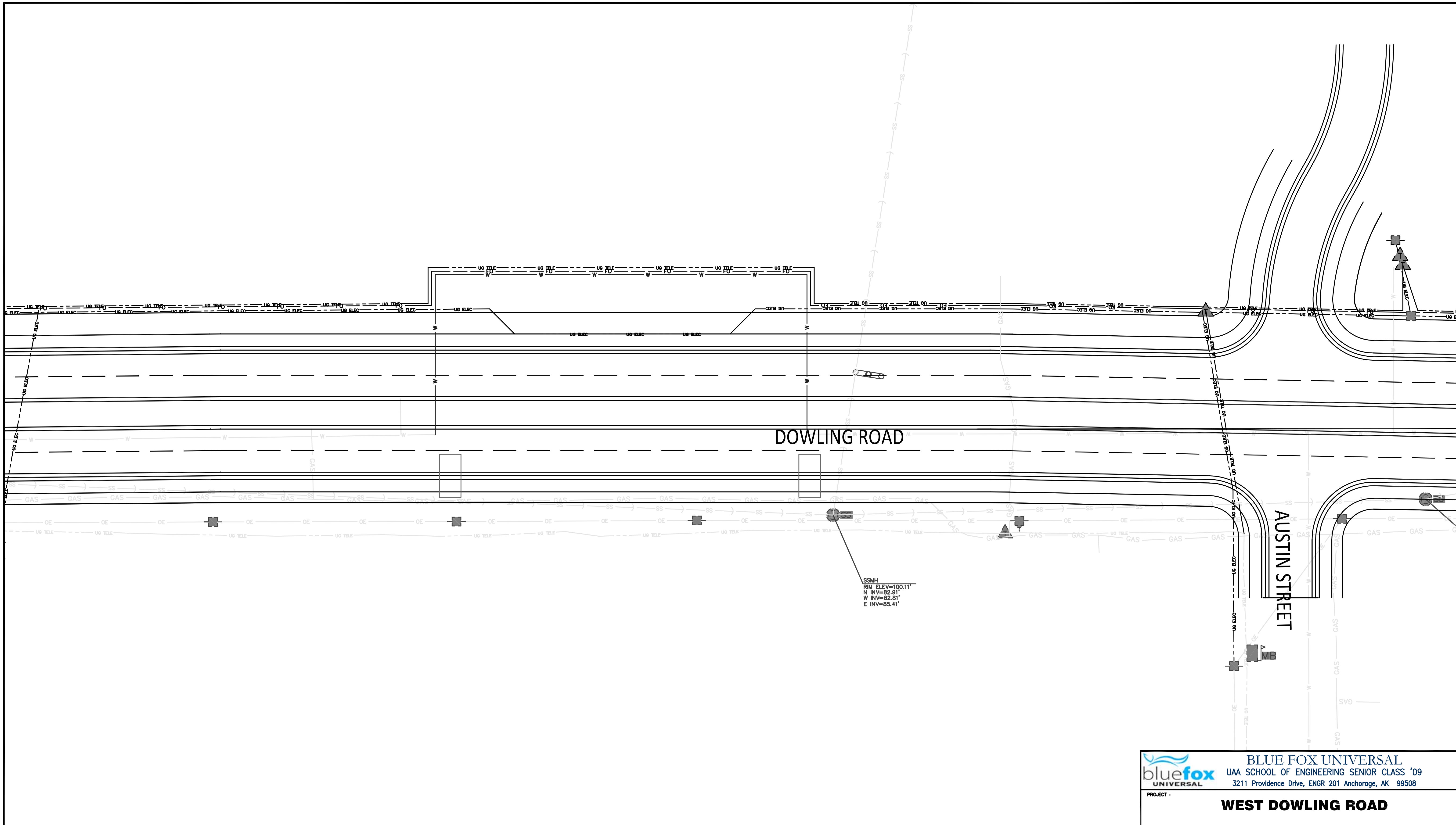
TITLE: UTILITY PLAN

DESIGNED BY: LAW
DRAWN BY: LAW
CHECKED BY:
APPROVED BY:

SCALE : 1:50
DATE :

DWG NO. U1 OF U7

Y:\!_SENIOR DESIGN-BLUE FOX ENGINEERING(alpha)\CAD\Utilities\cross section BO.dwg



BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT : **WEST DOWLING ROAD**

TITLE: **UTILITY PLAN**

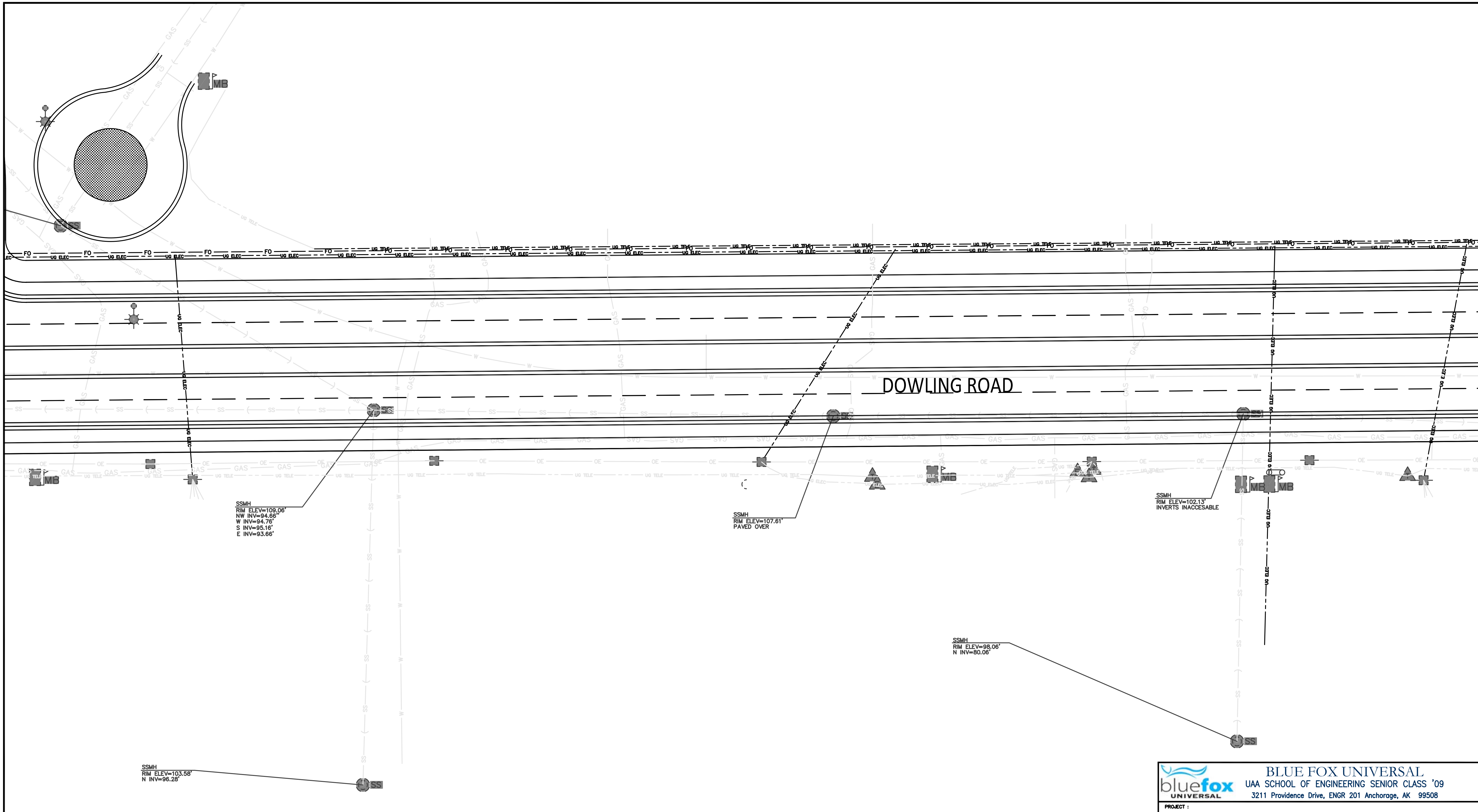
REV.	DATE	BY	REVISION

DESIGNED BY: LAW
DRAWN BY: LAW
CHECKED BY:
APPROVED BY:

SCALE : 1:50
DATE :

DWG NO. U2 OF U7

Y:\!_SENIOR DESIGN–BLUE FOX ENGINEERING(alpha)\CAD\Utilities\cross section BO.dwg



REV.	DATE	BY	REVISION

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT :
WEST DOWLING ROAD

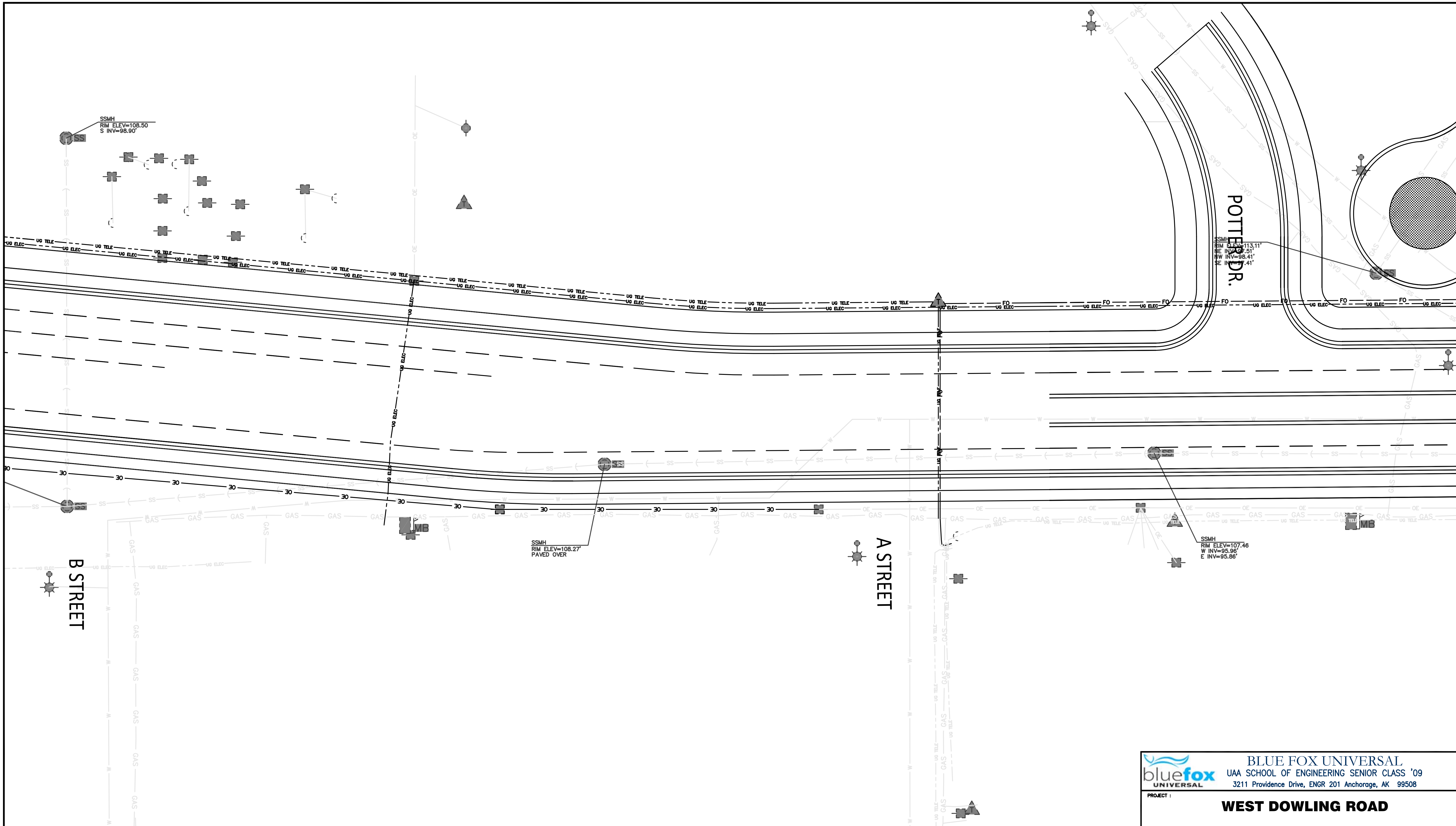
TITLE:
UTILITY PLAN

DESIGNED BY: LAW
DRAWN BY: LAW
CHECKED BY:
APPROVED BY:

SCALE : 1:50
DATE :

DWG NO. **U3** OF **U7**

Y:\!_SENIOR DESIGN–BLUE FOX ENGINEERING(alpha)\CAD\Utilities\cross section BO.dwg



Y:\!_SENIOR DESIGN-BLUE FOX ENGINEERING(alpha)\CAD\Utilities\cross section BO.dwg

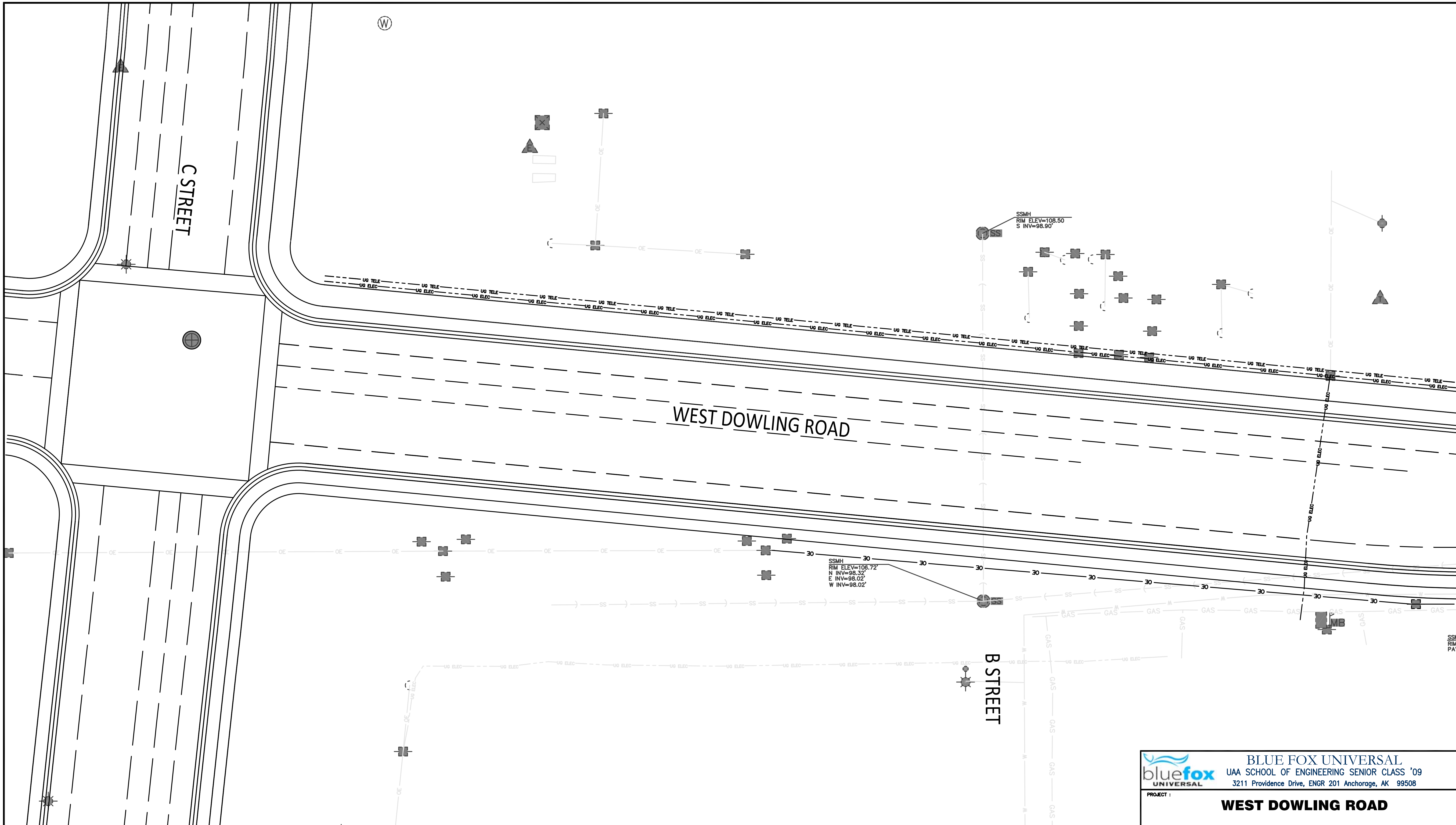
REV.	DATE	BY	REVISION

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT : **WEST DOWLING ROAD**

TITLE: **UTILITY PALN**

DESIGNED BY: LAW	SCALE : 1:50	DWG NO. U4 OF U7
DRAWN BY: LAW		
CHECKED BY:	DATE :	
APPROVED BY:		



Y:\!_SENIOR DESIGN-BLUE FOX ENGINEERING(alpha)\CAD\Utilities\cross section BO.dwg

REV.	DATE	BY	REVISION

BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT : **WEST DOWLING ROAD**

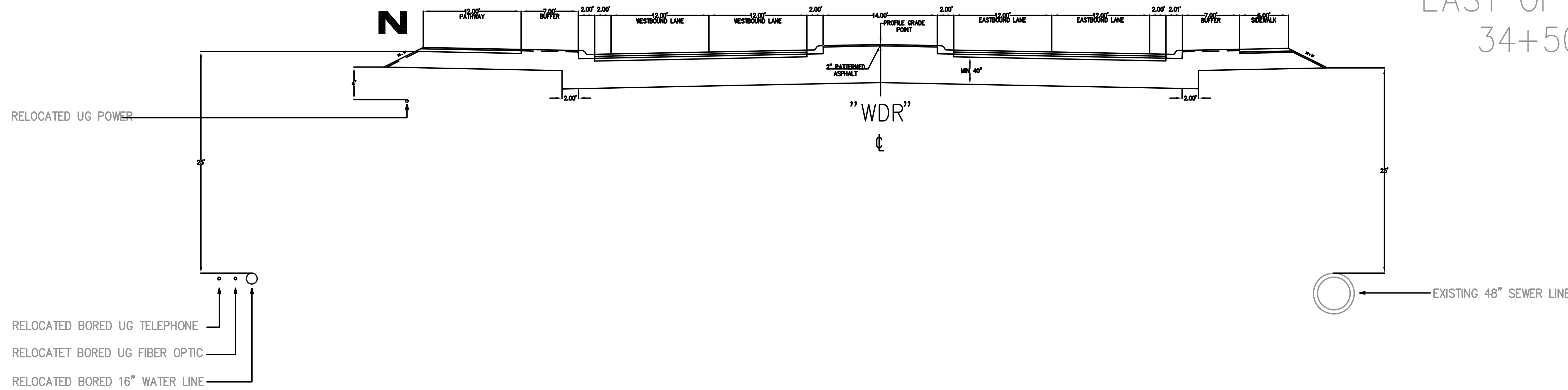
TITLE: **UTILITY PLAN**

DESIGNED BY: LAW
DRAWN BY: LAW
CHECKED BY:
APPROVED BY:

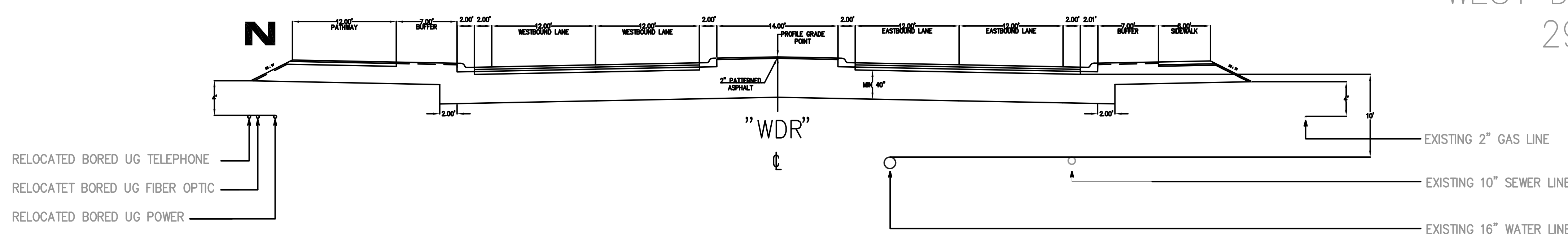
SCALE : AS NOTED
DATE :

DWG NO. U5 OF U7

WEST DOWLING ROAD
EAST OF BRIDGE
34+50.00



WEST DOWLING ROAD
29+00.00



REV.	DATE	BY	REVISION

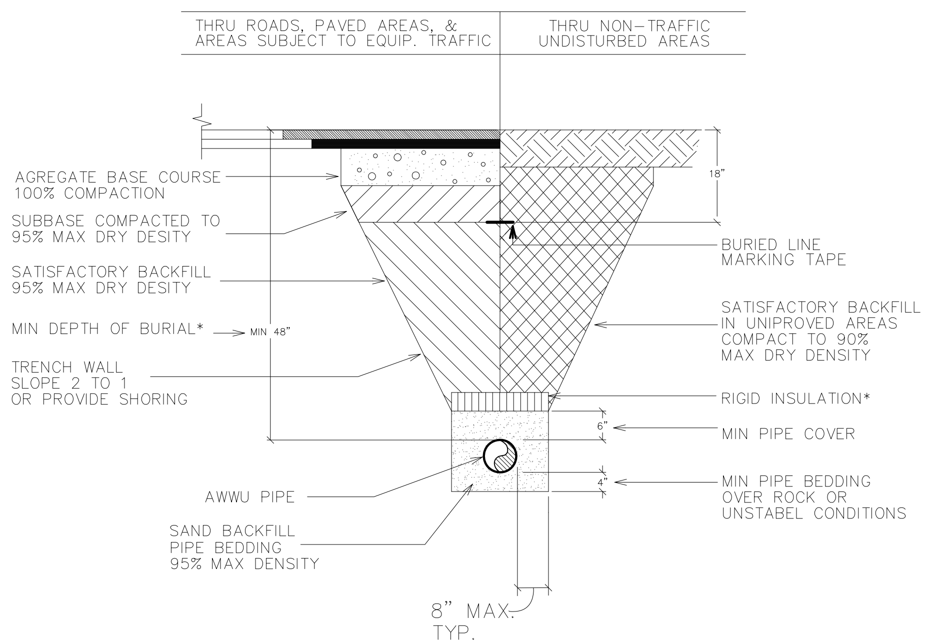
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT :
WEST DOWLING ROAD

TITLE:
UTILITY CROSS SECTIONS

DESIGNED BY: LAW
DRAWN BY: LAW
CHECKED BY:
APPROVED BY:
SCALE : 1:16
DATE :
DWG NO. U6 OF U7

Y:\!_SENIOR DESIGN-BLUE FOX ENGINEERING(alpha)\CAD\Utilities\cross section BO.dwg



BURIAL DEPTHS*

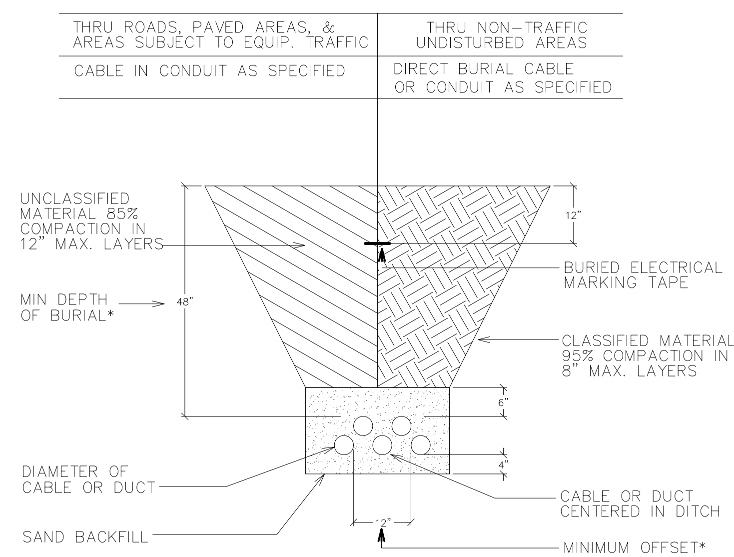
36" MIN GENERAL by 17AAC 15.211(d)
48" MIN ROAD by 17 AAC 15.211(d)17

* 2" RIGID INSUL. WHEN LESS THAN 10' OF COVER PROVIDED
* 4' RIGID INSUL. WHEN LESS THAN 8' OF COVER PROVIDED

MINIMUM OFFSETS*

24" MIN CURB by 17 AAC 15.171(e)
12" MIN POWER SUPPLY TO COMMUNICATION LINE by NESC 320.B.2

TYPICAL WATER AND WASTE WATER TRENCH SECTION



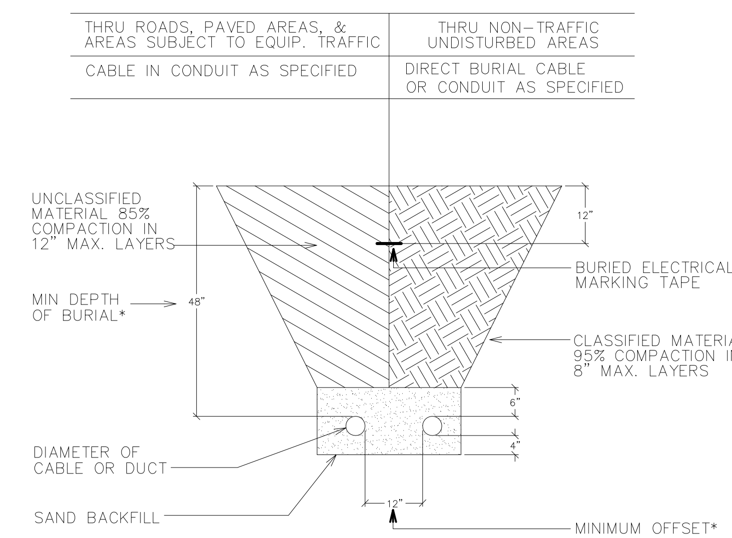
BURIAL DEPTHS*

36" MIN GENERAL by 17AAC 15.211(d)
48" MIN ROAD by 17 AAC 15.211(d)17

MINIMUM OFFSETS*

24" MIN CURB by 17 AAC 15.171(e)
12" MIN POWER SUPPLY TO COMMUNICATION LINE by NESC 320.B.2

TYPICAL DUCT BANK SECTION



BURIAL DEPTHS*

36" MIN GENERAL by 17AAC 15.211(d)
48" MIN ROAD by 17 AAC 15.211(d)17

MINIMUM OFFSETS*

24" MIN CURB by 17 AAC 15.171(e)
12" MIN POWER SUPPLY TO COMMUNICATION LINE by NESC 320.B.2

TYPICAL DUCT BANK SECTION

Y:\I_SENIOR DESIGN-BLUE FOX ENGINEERING(alpha)\CAD\Utilities\FINAL Trench_Section Detail.dwg

REV.	DATE	BY	REVISION

bluefox UNIVERSAL
BLUE FOX UNIVERSAL
UAA SCHOOL OF ENGINEERING SENIOR CLASS '09
3211 Providence Drive, ENGR 201 Anchorage, AK 99508

PROJECT : WEST DOWLING ROAD

TITLE: TYPICAL TRENCH

DESIGNED BY: LAW	SCALE : AS NOTED	DWG NO. U7 OF U7	
DRAWN BY: LAW	DATE :		
CHECKED BY:			
APPROVED BY:			