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April 13, 2014

Wynstone Homeowners Association
PO Box 1217
North Sioux City, South Dakota 57049

Re: Infrastructure Evaluation Report

Dear Board Members:

EXECUTIVE SUMMARY

We recommend patching work on the main access roadway be completed soon. Some of the most severe pavement deterioration was noted in this area, particularly where water crossed the roadway in 2011. Some undermining of the sand base may also have occurred and should be fixed if encountered during patch work. Overall the condition of the Community's pavements is satisfactory given their age.

We recommend the community consider an annual appropriation (budget item) for roadway repair. Based on information in this report, $25,000 annually seems reasonable. The Board should consider possible larger infrastructure projects 10 or more years in the future. Conservative costs (worst case) are outlined elsewhere.

We do not recommend a full scale joint rehabilitation project at this time. We do recommend the Board consider joint work at the gated entrance—this is a heavy traffic point with stopped vehicles.

We do not recommend construction work to the ponds at this time. We do recommend trees be cleared from the 25 ft. easement area surrounding the ponds. We recommend the community work an arrangement with Clay County Rural Water to pay for some or all of their added electrical and pump wear/tear costs for water being lost through the pond liners in lieu of construction work to repair the ponds.

On November 26, 2013 Civil Engineers and Constructors, LLC (CEC, LLC) was hired to perform engineering services relating to infrastructure in the Wynstone Development in rural southeast South Dakota. Our Scope of Services were as follows:

1. Site visit and walk/drive property. Evaluate condition of all streets/visible drainage improvements (storm sewers). Provide written commentary as to condition and recommend repairs--both that should be completed soon and planned for in the future. Document existing condition in select areas with photographs and commentary.
2. Provide an estimate of probable cost for recommended repairs and an approximate timeline as to when these repairs will be necessary.

3. Evaluate, with help of Stephen, problematic drainage areas along roadways and suggest recommended improvements as applicable.
4. Provide an estimate of probable cost for drainage repairs.
5. Review pond drainage and condition. Recommend improvements necessary from said review and probable costs. (Note, assuming 6 hours of engineer time and 4 hours of project coordination time on this, the fee of which totals $1110.00.). This will be adequate for a brief cursory review. At the end we will present where we are and can discuss which direction we should head.

Initially the report was to be delivered in draft form by the end of the year, however weather conditions prevented pavement analysis in the field, thereby delaying report.

PAVEMENT ANALYSIS

Wynstone is an independent Homeowners Association constructed starting in the 1990's. As of 2014, it has approximately 156 homes. Approximately 55 lots await development. There is approximately 23,000 feet of paved concrete streets. Approximately 15,500 feet are what is termed "rural section" meaning no curb and gutter, while the remainder have curb and gutter and storm drain intakes. The development was constructed in phases as shown on Table 01. (All Tables are contained in Appendix B).

The paving is 6-inch Portland Cement Concrete with a sand subgrade. Overall the condition of the paving is good, with minor cracking to be expected. A reasonable design life for concrete paving of this nature is 20 years. As the table above illustrates, some areas are approaching this point. Some maintenance has been done over the years but not much has been needed.

All roadways in the development were evaluated. The goal is to determine not only the overall condition of the pavement, but provide a reasonable recommendation as to when maintenance work must be done. As such any obvious defects were noted and photographed. A rating system was utilized in an attempt to estimate community expenditures in future years on concrete pavement.

> A rating of 1 denotes a problem that should be monitored. We assumed replacement in 10+ years (13 average)
>
> A rating of 2 denotes a somewhat concerning problem. We assumed replacement within 5-10 years (7 on average)
>
> A rating of 3 denotes an issue that we feel should be addressed sooner than later. We assumed replacement with 0-5 years (3 on average).

Please see Table 02 which summarizes our findings. Photos were taken of many of the locations and they are included in Appendix A. The photos will serve as a "baseline" for future reference to see if areas identified are worsening or staying the same. As such the Board and Community Managers can modify recommendations in this report accordingly and prioritize improvements.

It should be noted that Table 02 is a snapshot of the paving condition in early 2014. We believe we identified most of the problem areas. If other areas are known by the Board or Community Managers, we ask that we be allowed to amend our table and include. We feel however that this is a representative list of the problems as they currently stand with respect to the pavement.

Based on the rating system we are able to estimate approximate quantities (and therefore costs) the Community should expect to spend in upcoming years on concrete pavement maintenance. Note that we

recommend a contingency amount be included to account for areas that may not appear until later or are worse than they appeared in 2014 requiring accelerated replacement. Further, because we are engineers and therefore conservative, we recommend a different contingency amount be applied for each rating category. We recommend 25% be applied for rating category 3, 40% be applied for rating category 2, and 60% for rating category 1. The further out is harder to estimate, thus we recommend increasing the contingency amount. The contingency could also include necessary incidental services such as traffic control, testing and supervision.

Table 04 shows one possible budget forecasting tool. We assumed a straight-line input/output for repair work. The amounts to be outlaid do not exactly add up to the above, but instead include a reasonable assumption on what costs the Association may incur in paving maintenance. The result to take away from this discussion is that a budgetary line item of $20,000-$25,000 annually starting this year should adequately build a fund for repair of *deficiencies currently present*.

Over the next few years however, further deterioration will occur in joints and panels as the paving ages. A conservative method to estimate what this repair bill may run is to simply take a paving segment and apply a percentage of probable repair quantity to each segment. One can then estimate an annual expense several years out (10+) that the Association Board can be cognizant of when setting budgets. It would be helpful to know that, in 10 years, a possible expense of $X thousand dollars may occur. Perhaps not every year, but occasionally. Setting up a reserve fund to ultimately repair deficient areas is prudent given the importance of infrastructure to a community of this caliber.

Our assumptions are as follows. Starting in 10 years (2024), when the Phase 1 Improvements are 26 years old, the Association will replace 2.5% of the total roadways annually. On this schedule, in 40 years all roadways will be fixed. We estimated a removal and replacement cost in 2014 dollars of $45/SY. Applying 2.5% inflation annually, we can estimate expenditures years down the road. The total length of roadways in Wynstone, approximately:

a. Phase 1: 15,590 feet
b. Phase 2: 7,760 feet

Please see Table 04. Assuming above, an annual expenditure starts at just over $100,000 and grows to $281,000 50 years from now. These are actual projected expenses with 2.5% inflation. Over 40 years (2024 to 2064), the community would spend $7.3M to completely remove and replace roadways.

Table 04 assumes complete removal and replacement. Other techniques exist such as:

a. Asphalt Overlay
b. Patching and Asphalt Overlay
c. Whitetopping

These other methods may very well be less expensive. In short it is best to at least be aware of the worst case scenario and realize it will likely be less expenditure than feared.

JOINTS

Sealing or not sealing of concrete joints is not settled science. There is conflicting information regarding sealing effectiveness and long-term pavement performance. Proponents of sealing argue that keeping water out of the joint reduces freeze thaw processes that damage joints. The biggest cause of damage to a joint or any concrete paving is repeated freezing (expansion) then thawing which causes joints and concrete pavement to spall and fail.

Non- sealing proponents argue that the use of a drainable base such as sand or modified subbase is more important as it allows water to escape the joint thereby decreasing the likelihood of freeze thaw damage. They argue that sealing a joint can actually trap water which is the exact opposite thing you want from a freeze thaw perspective.

This issue has been studied extensively with no definitive conclusion. Numerous studies have been completed arguing both sides of the issue. A Federal Highway Administration Bulletin Tech Brief in 2009 found "…., the faulting in the sealed-joint section was slightly higher than the faulting in the unsealed section at one site and slightly lower than in the unsealed section at another site…."in other words effectiveness of joint sealant is inconclusive. AASHTO (American Association of State and Highway Transportation Officials) state research projects in Fargo, ND and El Paso, TX show that pavement deterioration occurs more often in non-sealed joints.

Given the uncertainty, what can we say for sure? The performance of concrete pavements depends to a large extent upon the satisfactory performance of the joints. Most jointed concrete pavement failures can be attributed to failures at the joint, as opposed to inadequate structural capacity. Characteristics that contribute to satisfactory joint performance have been identified through research and field experience. It is important when completing maintenance work to be mindful of quality control (air entrained concrete, proper dowel bar installation, the amount of water added the mix, proper sawcutting, proper subbase) and conform to current details of construction. These are things we know.

Overall the existing joint condition at Wynstone is "ok". Some areas are marginal, but most have adequate material in them, do not seem to be deflecting horizontally or vertically, and appear in a similar state as to when originally constructed. If joint work is warranted or desired by the Board, we would recommend Routing & Sealing (removing the existing joint material, widening the joint slightly, cleaning of debris from the joint, then resealing) per Iowa Department of Transportation Specification Section 2542 Crack and Joint Cleaning and Sealing (Portland Cement Concrete Pavement). This would be in lieu of simply pouring additional sealant in a joint. Please see Appendix E which contains this specification.

Like most things in life, there is no black and white answer just shades of gray. Given the current state of the science, the presence of a drainable base at Wynstone, and the condition of the joints, we would not recommend a full joint-reseal program at this time.

There is approximately 100,000 linear feet of joints at Wynstone. It may be prudent to consider that, in the next 10 odd years, removing and replacing the joint material may be an option to consider—especially if horizontal or vertical deflection is noted. Budget pricing (in 2014 dollars) of $1.00-$1.25 per foot is reasonable to remove and replace joint sealant according to specification 2542. This may be a reasonable use of pavement dollars as the years unfold.

PAVEMENT REPAIR SPECIFICATIONS

Anything worth doing is worth doing right. This holds true for methods utilized to repair pavements. Much research has been completed in recent years on the most effective methods to rehabilitate aging pavements.

Please see Appendix E which contains the following documents:

- SUDAS Specification Section 7040 – Pavement Rehabilitation
- SUDAS Detail 7040.101
- SUDAS Detail 7010.101 (aka PV-101)
- Iowa DOT Specification Section 2542 – Crack & Joint Cleaning

SUDAS (Statewide Urban Design & Specifications) is a non-profit Iowa organization based out of Ames that, in conjunction with the Iowa DOT, has promulgated "best practices" for civil construction work, which includes paving rehabilitation. Area contractors are quite familiar with SUDAS, and it has been adopted by the vast majority of municipalities in Iowa.

Particular attention is directed to document 7040.101. This details proper methods to complete patching depending on where the failure is located in the roadway. The "joint" type called out (i.e. RD Joint, B Joint, etc.) can be found on detail 7010.101 (PV-101). *We highly recommend any work that occurs follow these standards and specifications*. As one example, research has shown that thickening the patch slightly (see 7040.101 lower right hand corner) provides much better long-term performance of the patch for very minimal concrete cost. When a patch is typically removed, some of the existing subgrade material below it comes with the patch. Research has proven that simply thickening the patch by up to 2-inches is best for long-term performance.

SUBDRAIN

The Phase 1 portion of the community was constructed without curbs. As such water that falls on the roadway drains to the edge. The theory is the water will flow onto grass and percolate away.

Over the years, sediment has accumulated at the edge of paving in areas which makes the design intent of percolation difficult. Water will stand along the edge of the slab, freeze saturate the subgrade, and over time potentially damage the paving through the freeze/thaw cycle. Photo 89 illustrates this.

We recommend, in problem areas, subdrain be installed parallel to the roadway at the edge of slab. Please refer to Figure 4040_231 Case E, Type 2. The curb does not matter, but it shows what we recommend. Water will be allowed to drain through the subdrain and be outlet through pipes as shown in attached detail RF-19E. These would be modified slightly, but the intent is to drain the subdrain through pipes placed perpendicular to the roadway along developed lot lines to the rear yards of residences. Obviously easements must be obtained from these property owners.

The Sample Subdrain Repair Section Estimate (please see Appendix C where all cost estimates are contained) is a cost estimate for a sample location nominally 400 ft in length (parallel to the roadway) with an outlet to a rear yard. If you choose to complete some of this work, we would delve deeper into specific locations where it is needed. Each one will be different, although you can get a flavor for the investment necessary. Note this will only be needed—in our opinion—in the Phase 1 portion of the development. Phase 2 was constructed with curb, gutter and storm sewer intakes that captures the water.

PONDS

A series of ponds border the westerly edge of Phase 1 and the easterly edge of Phase 2. Their size is approximately 17 Acres and they are utilized for irrigation and fire protection. The ponds are filled by Clay County Rural Water from two wells they own near the southwest corner. The original well was constructed during Phase 1 improvements and has a capacity of 450 GPM. A second well added in 2012 has a capacity of 1,200 GPM.

Residents are charged, based on irrigation meter usage, a rate of $1.45/1,000 gallons of water form these ponds. No further compensation is provided Clay County Rural Water other than this usage.

We divided the long series of ponds into three ponds, working south to north, Pond A, B, and C. See Table 05 that details volumes, etc. Based on original plan drawings the ponds have a uniform bottom

elevation of 1086.0 and 3:1 sideslopes up to approximately elevation 1094.0 Nominal water depth of 6 ft, so a design water level of 1092.0.

By scaling the original drawings, the ponds have an approximate volume when full of 31.8 MG (million gallons). Note this does not completely agree with Clay Rural Water's opinion that they hold roughly 21.9 MG. We simply scaled dimensions of the ponds from the drawings, taking the bottom and sideslopes into account, and calculated accordingly. Our calculation does not consider the detention basin at the west end, which will account for some volume loss. Please see Appendix D.

Clay Rural Water did water loss calculations in January of 2013. Measured approximately 0.65 ft of water loss over a month. Based on Clay's calculation, they called this approximately 2.3 MG. Our number would be higher (3.5 MG) due to our larger volume calculation of the lake. We did not inquire whether Clay had done any sort of volume calculation through meters (keep track of how much volume it takes to fill the lake a foot from the well), although this may be an option. We work for Wynstone and do not want to point out possible volume discrepancies, particularly when they could be negative for Wynstone, without discussing with you first.

Note they did relate to Stephen Jones that they pumped "roughly 3 MG of water" into the lake in January of 2014 which agrees with our number. Clay indicated this cost $230 in electricity plus wear and tear on the pump. Annually Clay says this is approximately 36 MG and $2,270 in electricity.

Clay requested Wynstone fix the ponds to reduce or eliminate the water loss through leakage. Below we explore possible costs for such repairs.

Unknown definitively where they are leaking, but believed the bottoms may have holes in the existing liner. If true, would be difficult if not impossible to simply repair the areas that are leaking as they would be difficult to find.

Evaluated Three Options for fixing

a. Clay Option: a 1-ft thick cohesive "fat" clay liner
b. A geosynthetic (PVC 30 mil) with a of gas collection system. We have seen locally a main issue with long-term viability of geosynthetic liners in areas with fluctuating groundwater is entrained air (gas) that is pushed to the surface creating bubbles in the liner.
c. A geosynthetic clay liner (composite).

The Clay Option involves draining the pond, removing the muck, then construction of a 1-ft thick clay liner. Depending on the clay source (lean clay loess or fat clay gumbo), bentonite may be needed to achieve a design permeability of 1×10^{-6} centimeters/second—the standard for this type of liner. With all options we must consider maintaining fire protection and irrigation needs while doing this work. Thus only do Pond A while keeping Ponds B and C in Service. Our estimate is for Pond A only. Further extrapolation can be done for the other ponds, but we are told this pond is the likely culprit for water loss. Please see Appendix C for an Estimate of Probable Construction Cost to complete this work for Pond A.

A Geosynthetic Plastic Liner is another option. This is the current liner system installed, based on observations of “bubbles” in the center of the pond during periods of high groundwater. Mechanism for formation of the bubbles is as follows: There is entrained air in the sand subsoil below the ponds. As the groundwater rises, it forces this air up and one result is “bubbles” in the plastic liner. These bubbles were at times popped and other times allowed to pop. There is no way to simply repair these locations as they were not definitely marked. We theorize the water loss emanates chiefly from these locations. This type of liner must be installed by a specialty contractor and requires welding of any seams in the field. We also included a gas collection system to collect and then vent any entrained air that would cause future bubble formation, and a 1-ft layer of soil (sand) to protect the liner from UV radiation and damage. Please see Appendix C for an Estimate of Probable Construction Cost to complete this work for Pond A.

A GCL (Geosynthetic Clay Liner) is our final option. A GCL is a composite “sandwich” product containing two layers of geotextile with bentonite between. Easily installed by a local contractor. Delivered to the jobsite in 15 ft by 150 ft rolls and simply spread out. No need for welding as with a Geosynthetic liner. A GCL will also “self heal” in the event of puncture. No gas collection system is envisioned but we did provide a 1-ft layer of soil (sand) to cover to protect it. Please see Appendix C for an Estimate of Probable Construction Cost to complete this work for Pond A.

Based on the forgoing, pricing ranges from $533,000 to $597,000. Understand that these are budget estimates from the manufacturers. They will build some amount of contingency into their pricing as there are many unknowns. It appears the most economical solution is Option C, a GCL liner.

However, one must consider the forest for the trees. We established earlier that Clay Rural Water is requesting less than $3,000 annually (including some allowance for pump replacement) to fill the ponds with water and overcome any leaking. It is our recommendation to continue to simply pay this to Clay County or try and negotiate some lower rate rather than complete extensive reconstruction of the pond liners. The information presented regarding relining of the ponds is useful though so we know what level of investment to expect if leakage increases beyond what you are currently seeing.

We do recommend that any trees or large shrubs within the community-owned easement surrounding the ponds be removed on an annual basis. This type of vegetation, particularly trees, form large root structures that will further damage a possibly intact liner. There is no reason to make the situation worse. Likely your covenant documents contain language that will allow the association to remove this type of vegetation. If not, we recommend you consider adding such language and competing the removal work.

Please do not hesitate to contact me at the numbers above or ryanc@ceconstructors.com.

Very truly yours,

CIVIL ENGINEERS & CONSTRUCTORS

Ryan P. Callaghan, PE

Encl.

	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of South Dakota. _____ _____ Ryan P. Callaghan, P.E. Date My license renewal date is December 31, 2014 Pages or sheets covered by this seal: Entire Letter Report _____

Table 02—Number 1—Photo 56
Wynstone Dr.—50 Ft. from Highway—
Previously sealed
2—12x10 Panels—26.67 sq yds
Rating 2

Table 02—Number 1—Photo 57
Wynstone Drive—50 Ft. from Highway—
Previously sealed
2—12x10 Panels—26.67 sq yds
Rating 2

Table 02—Number 2—Photo 58
Wynstone Drive—340 Ft. from Highway—
Previously sealed—severe vertical damage
3—12x10 Panels—40 sq yds
Rating 3

Table 02—Number 3—Photo 59
Wynstone Drive—750 Ft. from Highway SB and NB
10—12x10 Panels—133.34 sq yds
Rating 1

Table 02—Number 3—Photo 60
Wynstone Dr.—750 Ft. from Highway SB and NB
10—12x10 Panels—133.34 sq yds
Rating 1

Table 02—Number 3—Photo 61
Wynstone Drive—750 Ft. from Highway SB and NB
10—12x10 Panels—133.34 sq yds
Rating 1

Table 02—Number 3—Photo 62
Wynstone Drive—750 Ft. from Highway SB and NB
10—12x10 Panels—133.34 sq yds
Rating 1

Table 02—Number 3—Photo 63
Wynstone Drive—750 Ft. from Highway SB and NB
10—12x10 Panels—133.34 sq yds
Rating 1

Table 02—Number 5/5a—Photo 64
Wynstone Dr.—at curve by MJ Minor
5—12x10 Panels—66.67 sq yds/2—12x10 Pamels—26.67 sq yds
Rating 2/1

Table 02—Number 5/5a—Photo 65
Wynstone Dr.—at curve by MJ Minor
5—12x10 Panels—66.67 sq yds/2—12x10 Pamels—26.67 sq yds
Rating 2/1

Table 02—Number 5/5a—Photo 66
Wynstone Dr.—at curve by MJ Minor
5—12x10 Panels—66.67 sq yds/2—12x10 Pamels—26.67 sq yds
Rating 2/1

Table 02—Number 6—Photo 67
Gate entrance—no cracking but joint widening and deterioration—recommend route and seal here as visual place stopped traffic
Route/seal apprx 200 LF around entrance gate

Table 02—Number 6—Photo 68
Gate entrance—no cracking but joint widening and deterioration—recommend route and seal here as visual place stopped traffic
Route/seal apprx 200 LF around entrance gate

Table 02—Number 7—Photo 69
Pinewood Park Dr—Minimal cracking present, Joint replacement failure at entrance (Minor joints, low traffic)
30x4 Joint—14.0 sq yds
Rating 2

Table 02—Number 7—Photo 70
Pinewood Park Dr—Minimal cracking present, Joint replacement failure at entrance (Minor joints, low traffic)
30x4 Joint—14.0 sq yds
Rating 2

Table 02—Number 7—Photo 71
Pinewood Park Dr—Minimal cracking present, Joint replacement failure at entrance (Minor joints, low traffic)
30x4 Joint—14.0 sq yds
Rating 2

Table 02—Number 8—Photo 72
Wynstone Dr & Pinewood Park, full width replacement, prev. sealed, some spalling noted
30x12 (ft) - 40 sq yds
Rating 1

Table 02—Number 9—Photo 73
905 Wynstone Dr, 907 Wynstone Dr
12x10—13.34 sq yds
Rating 1

Table 02—Number 10—Photo 74
915 Wynstone Dr, prev. sealed
3—12x10 Panels—40 sq yds
Rating 1

Table 02—Number 11—Photo 75
Hiddenwood Hollow at Intersection, minor cracking, Standing water, NS subdrain
Rating 1

Table 02—Number 13—Photo 76
967 Wynstone Dr, full width replacement, slab settlement
1—30x12 (ft) - 40 sq yds
Rating 2

Table 02—Number 13—Photo 77
967 Wynstone Dr, full width replacement, slab settlement
1—30x12 (ft) - 40 sq yds
Rating 2

Table 02—Number 14—Photo 78
968 Wynstone Dr, spider cracking
5—12x10 Panels—66.67 sq yds
Rating 2

Table 02—Number 14—Photo 79
968 Wynstone Dr, spider cracking
5—12x10 Panels—66.67 sq yds
Rating 2

Table 02—Number 15—Photo 80
978 Wynstone Dr, prev. sealed
1—12x10 Panels—13.34 sq yds
Rating 2

Table 02—Number 16—Photo 81
981 Wynstone Dr
3—12x10 Panels—40 sq yds
Rating 2

Table 02—Number 17—Photo 82
982 Wynstone Dr., recently replaced, nonmatched joint lines
4—12x10 Panels—53.34 sq yds
Rating 3

Table 02—Number 17—Photo 83
982 Wynstone Dr., recently replaced, non-matched joint lines
4—12x10 Panels—53.34 sq yds
Rating 3

Table 02—Number 17—Photo 84
982 Wynstone Dr., recently replaced, non-matched joint lines
4—12x10 Panels—53.34 sq yds
Rating 3

Table 02—Number 17—Photo 85
982 Wynstone Dr., recently replaced, non-matched joint lines
4—12x10 Panels—53.34 sq yds
Rating 3

Table 02—Number 19—Photo 86
Subdrain
6—12x10 Panels—80 sq yds
Rating 2

Table 02—Number 19—Photo 87
Subdrain
6—12x10 Panels—80 sq yds
Rating 2

Table 02—Number 20—Photo 88
1000 ft E Nylen House, spalling
2—12x10 Panels—26.67 sq yds
Rating 3

Table 02—Number 20—Photo 89
1000 ft E Nylen House, spalling
2—12x10 Panels—26.67 sq yds
Rating 3

Table 02—Number 21—Photo 90
Fieldstone Ct, 50 ft route joint and seal
10x12 Patch—13.34 sq yds
Rating 3

Table 02—Number 22—Photo 91
Brookside 814, consider route seal
5—9x12 Panels—60 sq yds
Rating 2

Table 02—Number 23—Photo 92
Intersection of Birchwood and Brookside drainage

APPENDIX B

TABLE 01

	Constructed	20 Years	Age 2014
Phase 1 – Wynstone Drive	1998-1999	2018-2019	15 Years
Phase 2 – Brookside, etc.	2003-2004	2023-2024	10 Years

APPENDIX B

TABLE 02

Number	Description	Measurements	Sq Yd	Photo Number	Rating
1	Wynstone Dr. 50ft from Highway prev. sealed	2- 12 x 10 Panels	26.67	56, 57	2
2	Wynstone Dr. 340 ft from Highway perv. Sealed severe vertical damage	3- 12 x 10 Panels	40	58	3
3	Wynstone Dr. 750 ft from Highway SB and NB.	10- 12 x 10 Panels	133.34	59.60.61.62.63	1
3A	Wynstone Dr. 750 ft from Highway SB and NB, Panels with Vertical Deflection & Settlement	10- 12 x 10 Panels	133.34		2
4	Wynstone Dr. Center Lane 850 ft from Highway	1- 12 x 10 Panel	13.34		1
5	Wynstone Dr. at curve by MJ Minor, spalling starting	5- 12 x 10 Panels	66.67	64.65.66	2
5a	Wynstone Dr. at curve by MJ Minor, spalling starting	2- 12 x 10 Panels	26.67	64.65.66	1
6	Gate Entrance, No cracking but joint widening and deterioration, Rec. Route and Seal here as visual place stopped traffic	Route/seal apprx 200 LF around entrance gate		67.68	
7	Pinewood Park DR, minimal cracking present, joint replacement/failure at entrance, (Minor Joints, Low Traffic)	30 x 4 Joint	14	69.70.71	2
8	Wynstone Dr & Pinewood PK, full width replacement, prev. sealed, some spalling noted	30 x 12 (ft)	40	72	1
9	905 Wynstone DR; 907 Wynstone Dr	12 x 10	13.34	73	1
10	915 Wynstone DR, prev. sealed	3- 12 x 10 Panels	40	74	1
11	Hiddenwood Hollow at Intersection, minor cracking, STANDING WATER, NS subdrain			75	1
12	Consider Subdrain along many Spots; Ryan- find quantity				
13	967 Wynstone DR, full width replacement, slab settlement	1- 30 x 12 (ft)	40	76.77	2
14	968 Wynstone DR, spider cracking	5- 12 x 10 Panels	66.67	78.79	2
15	978 Wynstone Dr, prev. sealed	1- 12 x 10 Panels	13.34	80	2
16	981 Wynstone Dr	3- 12 x 10 Panels	40	81	2
17	982 Wynstone Dr, recently replaced, nonmatched joint lines	4- 12 x 10 Panels	53.34	82.83.84.85	3
18	984 Wynstone Dr.	2- 12 x 10 Panels	26.67		2
19	Subdrain	6- 12 x 10 Panels	80	86.87	2
20	1000 ft E Nylen House, Spalling	2- 12 x 10 Panels	26.67	88.89	3
21	Fieldstone CT, 50 ft route joint and seal	10 x 12 patch	13.34	90	3
22	Brookside 814, consider route seal	5- 9 x 12 Panels	60	91	2
23	Intersection of Birchwood and Brookside Drainage			92	
24	Across 866 Brookside, Maybe 4 or 5 minor patches on Brookside	4 - 12 x 10 patch	53.34		1

APPENDIX B

TABLE 03

	Square Yd	Unit Price	Extended + Contingency
Rating 1, Replace 10+ Years	320.0	$95.00	$48,640.00
Rating 2, Replace 7 Years	567.3	$85.00	$67,512.67
Rating 3, Replace 3 years	133.3	$75.00	$20,000.00

Year	Collected	Outlays	Net Account Balance
2014	$20,000	$5,000	$15,000
2015	$20,000	$5,000	$30,000
2016	$20,000	$5,000	$45,000
2017	$20,000	$20,000	$45,000
2018	$25,000	$20,000	$50,000
2019	$25,000	$20,000	$55,000
2020	$25,000	$20,000	$60,000
2021	$25,000	$25,000	$60,000
2022	$25,000	$25,000	$60,000
2023	$25,000	$25,000	$60,000
2024	$25,000	$25,000	$60,000

APPENDIX B

TABLE 04

Year	Sq Yd Replaced	Unit Price	Annual Expenditure
2024	1815	$57.60	$105,000.00
2025	1815	$59.04	$107,000.00
2026	1815	$60.52	$110,000.00
2027	1815	$62.03	$113,000.00
2028	1815	$63.58	$115,000.00
2029	1815	$65.17	$118,000.00
2030	1815	$66.80	$121,000.00
2031	1815	$68.47	$124,000.00
2032	1815	$70.18	$127,000.00
2033	1815	$71.94	$131,000.00
2034	1815	$73.74	$134,000.00
2035	1815	$75.58	$137,000.00
2036	1815	$77.47	$141,000.00
2037	1815	$79.41	$144,000.00
2038	1815	$81.39	$148,000.00
2039	1815	$83.43	$151,000.00
2040	1815	$85.51	$155,000.00
2041	1815	$87.65	$159,000.00
2042	1815	$89.84	$163,000.00
2043	1815	$92.09	$167,000.00
2044	1815	$94.39	$171,000.00
2045	1815	$96.75	$176,000.00
2046	1815	$99.17	$180,000.00
2047	1815	$101.65	$185,000.00
2048	1815	$104.19	$189,000.00
2049	1815	$106.79	$194,000.00
2050	1815	$109.46	$199,000.00
2051	1815	$112.20	$204,000.00
2052	1815	$115.01	$209,000.00
2053	1815	$117.88	$214,000.00
2054	1815	$120.83	$219,000.00
2055	1815	$123.85	$225,000.00
2056	1815	$126.94	$230,000.00
2057	1815	$130.12	$236,000.00
2058	1815	$133.37	$242,000.00
2059	1815	$136.71	$248,000.00
2060	1815	$140.12	$254,000.00
2061	1815	$143.63	$261,000.00
2062	1815	$147.22	$267,000.00
2063	1815	$150.90	$274,000.00
2064	1815	$154.67	$281,000.00

APPENDIX B

TABLE 05

Pond A			
Surface Area of Bottom	184,000	SF	
Surface Area with Sides	248,600	SF	
C.Y. Dirt Per 1-ft of Liner	9,300	CY	
Bottom Elevation	1086	Elevation	
Volume with 6 ft of Water	10.14	MG (Million Gallons)	
Pond B			
Surface Area of Bottom	213,600	SF	
Surface Area with Sides	287,700	SF	
C.Y. Dirt Per 1-ft of Liner	10,700	CY	
Bottom Elevation	1086	Elevation	
Volume with 6 ft of Water	11.76	MG (Million Gallons)	
Pond C			
Surface Area of Bottom	174,500	SF	
Surface Area with Sides	242,900	SF	
C.Y. Dirt Per 1-ft of Liner	9,000	CY	
Bottom Elevation	1086	Elevation	
Volume with 6 ft of Water	9.88	MG (Million Gallons)	
Totals			
Surface Area of Bottom	572,100	SF	
Surface Area with Sides	779,200	SF	
C.Y. Dirt Per 1-ft of Liner	29,000	CY	
Bottom Elevation	1086	Elevation	
Volume with 6 ft. of Water	31.8	MG (Million Gallons)	
Pond Surface Area @ 1091.5	739,250	SF	
Volume Between 1091-1092	5.5	MG (Million Gallons)	

APPENDIX C

ENGINEER'S ESTIMATE

CIVIL ENGINEERS & CONSTRUCTORS, LLC
DAKOTA DUNES | SOUTH DAKOTA
www.ceconstructors.com

600 STEVENS PORT DRIVE, SUITE 102
DAKOTA DUNES, SD 57049
PHONE: 866.990.2242, FAX: 866.990.8676

2/28/2014

Wynstone
Sample Subdrain Repair Section

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT AMT	TOTAL AMT
1	Mobilization & Incidentals	1.00	LS	$500.00	$500.00
2	4-iinch Subdrain Parralel to Roadway	400.00	LF	$10.00	$4,000.00
3	Subdrain Outlet Per RF-19E	1.00	LS	$500.00	$500.00
4	Irrigation Repair Allowance	1.00	LS	$500.00	$500.00
5	Surface Restoration (Sodding)	600.00	SF	$0.50	$300.00

SUBTOTAL	$5,800.00
CONTINGENCY (10%)	$580.00
ENGINEERING, STAKING, TESTING (15%)	$870.00
TOTAL PROBABLE COST	$7,250

APPENDIX C

ENGINEER'S ESTIMATE

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2/28/2014

Wynstone Pond A Repair
1-FT CLAY LINER OPTION

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT AMT	TOTAL AMT
1	Mobilization & Incidentals	1.00	LS	$50,000.00	$50,000.00
2	Dewatering and Temporary Piping/Pumping	1.00	LS	$25,000.00	$25,000.00
3	Muck Removal & Disposal	8,500.00	CY	$10.00	$85,000.00
4	Import and place 1-ft Clay Liner on Bottom & Sideslopes	9,300.00	CY	$20.00	$186,000.00
5	Bentonite, Furnish & Install	250.00	TONS	$400.00	$100,000.00

Pond A Only....

SUBTOTAL	$446,000.00
CONTINGENCY (10%)	$44,600.00
ENGINEERING, STAKING, TESTING (15%)	$66,900.00
TOTAL PROBABLE COST	$557,500

APPENDIX C

ENGINEER'S ESTIMATE

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DAKOTA DUNES, SD 57049
PHONE: 866.990.2242, FAX: 866.990.8676

2/28/2014

Wynstone Pond A Repair
GEOSYNTHETIC LINER (PLASTIC PVC 30 mil)

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT AMT	TOTAL AMT
1	Mobilization & Incidentals	1.00	LS	$57,500.00	$57,500.00
2	Dewatering and Temporary Piping/Pumping	1.00	LS	$25,000.00	$25,000.00
3	Muck Removal & Disposal	8,500.00	CY	$10.00	$85,000.00
4	Furnish/Install Geosynthetic Clay Liner	248,600.00	SF	$0.75	$186,450.00
5	Gas Collection System	6,000.00	LF	$5.00	$30,000.00
6	Sand Cap Over Geosynthetic	9,300.00	SF	$10.00	$93,000.00

Pond A Only....

SUBTOTAL	$476,950.00
CONTINGENCY (10%)	$47,695.00
ENGINEERING, STAKING, TESTING (15%)	$71,542.50
TOTAL PROBABLE COST	$596,188

APPENDIX C

ENGINEER'S ESTIMATE

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DAKOTA DUNES, SD 57049
PHONE: 866.990.2242, FAX: 866.990.8676

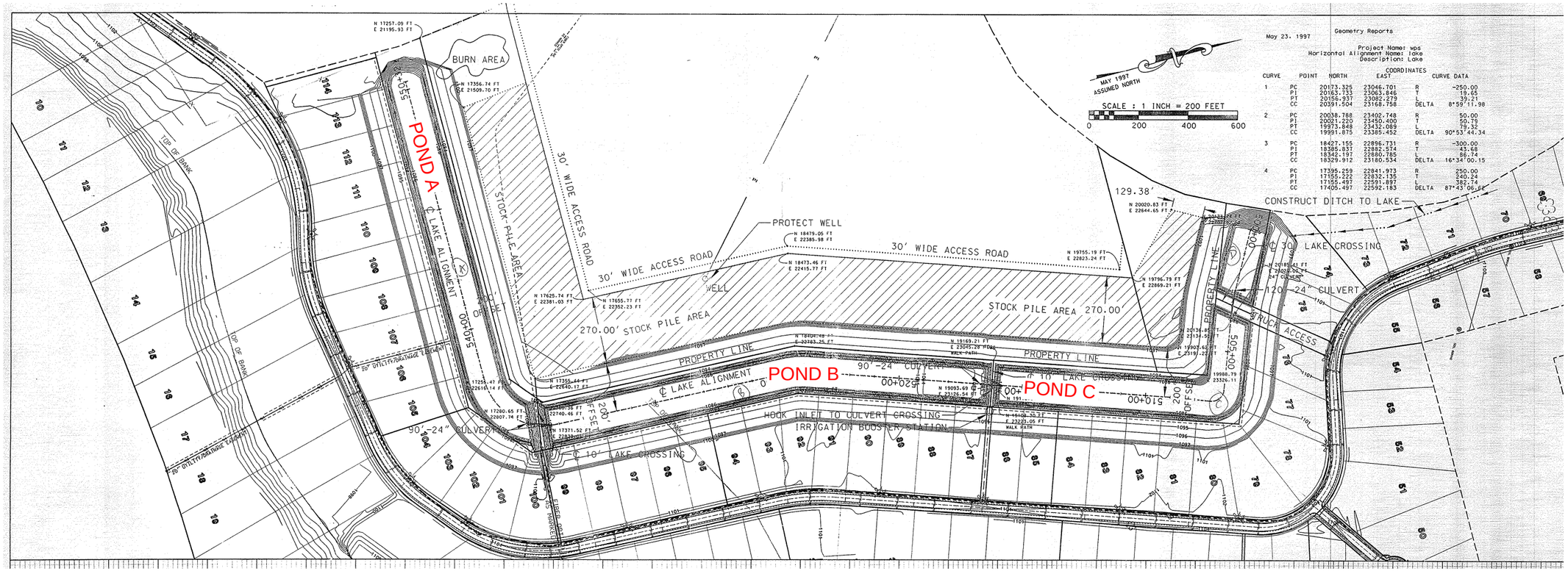
2/28/2014

Wynstone Pond A Repair
GCL COMPOSITE LINER

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT AMT	TOTAL AMT
1	Mobilization & Incidentals	1.00	LS	$50,000.00	$50,000.00
2	Dewatering and Temporary Piping/Pumping	1.00	LS	$25,000.00	$25,000.00
3	Muck Removal & Disposal	8,500.00	CY	$10.00	$85,000.00
4	Furnish/Install Composite GCL	248,600.00	SF	$0.70	$174,020.00
5	Sand Cap Over Geosynthetic	9,300.00	CY	$10.00	$93,000.00

Pond A Only....

SUBTOTAL	$427,020.00
CONTINGENCY (10%)	$42,702.00
ENGINEERING, STAKING, TESTING (15%)	$64,053.00
TOTAL PROBABLE COST	$533,775



CURVE	POINT	NORTH	EAST	CURVE DATA	
1	PC	20173.325	23046.701	R	-250.00
	PI	20163.733	23063.846	T	19.65
	PT	20156.937	23082.279	L	39.21
	CC	20391.504	23168.758	DELTA	8°59'11.98"
2	PC	20038.788	23402.748	R	50.00
	PI	20021.220	23450.400	T	50.79
	PT	19973.848	23432.089	L	79.32
	CC	19991.875	23385.452	DELTA	90°53'44.34"
3	PC	18427.155	22896.731	R	-300.00
	PI	18385.837	22882.574	T	43.68
	PT	18342.197	22880.785	L	86.74
	CC	18329.912	23180.534	DELTA	16°34'00.15"
4	PC	17395.259	22841.973	R	250.00
	PI	17155.222	22832.135	T	240.24
	PT	17155.497	22591.897	L	382.74
	CC	17405.497	22592.183	DELTA	87°43'06.66"

CIVIL ENGINEERS & CONSTRUCTORS, LLC
DAKOTA DUNES | SOUTH DAKOTA
www.ceconstructors.com

PROJECT
Wynstone, SD

TITLE
Pond Layout

DESIGN			FILE No.		
CADD			SCALE		
REVIEW			REV.		
PROJECT No.					

DRAWING: Appendix D

IOWA DOT ROUTING AND SEALING SPEC

Section 2542. Crack and Joint Cleaning and Sealing (Portland Cement Concrete Pavement).

2542.01 DESCRIPTION.
This work shall consist of routing or sawing and cleaning of random cracks and existing transverse and longitudinal joints in PCC pavement and sealing the prepared cracks and joints with an approved sealing material.

2542.02 MATERIALS.
Hot poured joint sealer and backer rod shall meet requirements of Article 4136.02. Installation of preformed elastomeric joint seals meeting the requirements of Article 4136.02 may be required in the contract documents. Substitution of elastomeric joint seal material for poured joint sealer material will not be allowed unless otherwise specified in the contract documents.

2542.03 EQUIPMENT.

A. Routing or Sawing Equipment.
Routing or sawing equipment, where required, shall be power driven, capable of cutting the cracks to the required dimensions without excessive spalling of the adjacent surface.

Sawing equipment, where required, shall be power driven (wet or dry) capable of sawing the sealant reservoir to the dimensions shown in the contract documents.

B. Water and Abrasive Blasting Cleaning Equipment.
Water cleaning equipment shall be capable of delivering water with a pressure of 2,000 psi (13.8 MPa) from a nozzle to the crack or joint being cleaned, to remove existing joint sealer, debris, and loose material from the crack or joint.

Abrasive blast equipment shall be capable of removing the existing sealant, saw slurry, silt, or other foreign material from the vertical face of the crack or joint to the specified depth, leaving a clean, dry, newly exposed concrete surface.

C. Air Compressors.
Air compressors shall provide moisture and oil free air and shall be of sufficient size to blow sand and other foreign material from the crack or joint prior to placing the sealant material.

D. Equipment for Heating and Placing Sealant Material.
Equipment used for heating and placing hot pour sealant material shall be an oil jacketed, double boiler type, heating kettle or other thermostatically controlled equipment of a type approved by the Engineer, capable of heating the material to 400°F (205°C) and pumping the material into the prepared crack or joint.

E. Auxiliary Equipment.
Auxiliary equipment, such as brooms, scrapers, etc., shall be provided as necessary to perform the work.

2542.04 CONSTRUCTION.
A partial depth finish patch may be required when joints or cracks have edge spalls or other distress greater than 3 inches (75 mm) in width. If not otherwise included as part of the contract work, these areas will be designated by the Engineer as extra work. Partial depth finish patches

shall be constructed in accordance with Section 2530. Joints or cracks less than or equal to 3 inches (75 mm) in width shall be sealed without patching.

Cracks and joints shall be cleaned of existing joint sealer, vegetation, dirt, and all other foreign material to the depth of the bottom of the backer rod. The edges shall be sand blasted throughout the proposed depth of the joint sealer, leaving a clean, dry, newly exposed concrete surface on the vertical edges. The angle of approach of the sand blast nozzle to each vertical face of the reservoir shall be approximately 30 degrees and the sand blast nozzle must have a guide which inserts in the joint and assures positive location and directional control of the nozzle. This will require two passes of the sand blasting operation for each joint and crack; one pass for each joint or crack edge. Sand blasting shall be done just prior to the application of the joint sealer. When cleaned joints or cracks are contaminated before being sealed, they shall be recleaned by sand blast before sealing. Rain will be considered contamination.

The bond breaker at the bottom of the joint or crack shall be a backer rod. It shall be dry when installed. If the width of opening exceeds the maximum size available, approved alternates of bond breakers at the bottom of the crack or joint may be used.

Cracks and joints in partial depth HMA finish patches shall be widened to 1/2 inch (13 mm), if widening is necessary, and the cleaning and sealing operation shall be extended across the joint or crack.

Joints and cracks shall be dry and blown clean with compressed air prior to placing the backer rod and joint sealer. Joints and cracks shall be filled to the level shown in the contract documents.

Sealer material shall be heated, handled, and applied according to the manufacturer's recommendations.

Cracks and joints which have an average opening of 3/8 inch (10 mm) or less shall be routed or sawed to provide a minimum sealant reservoir of 3/8 inch (10 mm) with by a nominal 1/2 inch (13 mm) depth. Backer rod shall be used for cracks and joints greater than 3/8 inch (10 mm) width. The backer rod, when required, shall be placed in the cracks and joints to a depth that will provide at least 5/8 inch (16 mm) clearance above the backer rod for the sealer. Cracks shall be cleaned of all foreign material to a depth necessary to accommodate the sealer material and the backer rod to be used. The backer rod shall be dry when placed.

2542.05 TRAFFIC CONTROL.
When there is a separate item for traffic control, all signs and traffic control devices, such as flaggers, barricades, traffic cones, warning lights, and pilot car signs (when required) shall be furnished by the Contractor in accordance withSection 2528. All traffic control devices are to be erected, maintained, and removed by the Contractor.

The work shall be conducted on only one lane of the pavement width at a time. When work encroaches on an adjacent lane, a flagger will be required at that location.

Articles 1107.08, 1107.09, and 1108.03 shall apply.

2542.06 LIMITATIONS.
When other work is included in the contract, the operations shall be sequenced so that undersealing, longitudinal subdrains, patching, grinding or milling, installation of retrofit load transfer, and crack and joint sealing are done in the area in that order.

Joint and crack sealing shall be performed only when the ambient air and pavement surface temperatures are above 40°F (4°C). When near this minimum temperature, additional air blasting or drying time or both may be necessary to assure a satisfactory bond to the joint surfaces.

Lanes may be opened to traffic only after the sealer has set sufficiently so it will not pick up under traffic. Blotting material may be applied to the sealer, but only after the sealer surface has set so as to avoid penetration of the blotting material into the sealer. Old sealant, other debris, and saw slurry shall be removed from the pavement surface before the pavement is opened to traffic. Dry sawed or routed joints or cracks shall be cleaned with a stream of air sufficient to remove all dirt, dust, and deleterious material that can adhere to the joint face before the pavement is opened to traffic. This work shall be done within 3 hours after the joint or crack has been dry sawed or routed. Wet sawed joints shall be cleaned with high pressure water immediately after sawing to remove residue produced by the sawing operation.

Joints and cracks shall be sealed within 5 working days after completion of any sawing or routing or removing old joint sealant material or debris from the crack or joint.

Crack and joint sealing after September 30 will not be allowed. When joint sealer cannot be placed in an otherwise completed joint or crack prior to this date due to temperature or other conditions, the Contractor shall temporarily seal these joints or cracks with a joint sealer over the winter shutdown period. This shall be removed, and the joint or crack shall be recleaned and resealed according to this specification at the Contractor's expense during the next construction season.

Overfilling with sealant will not be allowed. Sealant placed on the pavement surface shall be removed immediately.

2542.07 METHOD OF MEASUREMENT.

A. Crack and Joint Cleaning and Sealing (PCC Pavement)
The Engineer will calculate the number of miles (kilometers) of main line pavement on which cracks and joints were cleaned and sealed to the nearest 0.1 mile (0.1 km). The calculations will be based on the center line distance of main line, two-lane pavement, corrected for main line pavement of more than two lanes, including climbing lanes. At intersections, rest areas, and interchanges designated for cleaning and sealing, the additional areas of widened pavement, ramps, storage lanes, turning lanes, paved medians, and parking in rest areas will not be separately measured for payment. Between limits for which cleaning and sealing is intended for either pavement or shoulders, no deductions will be made for bridges, intersections, or other interruptions where cracks or joints are not to be cleaned and sealed.

B. Sealer Material (PCC Pavement)
The Engineer will measure in pounds (kilograms) the amount of sealer material used in cracks and joints.

2542.08 BASIS OF PAYMENT.

A. Crack and Joint Cleaning and Sealing (PCC Pavement)
For the number of miles (kilometers) of pavement or shoulders on which the cracks and joints were cleaned and sealed, the Contractor will be paid the contract unit price per mile (kilometer). This payment shall be considered full compensation for all labor, equipment, and materials (except for sealer, but including backer rod) for cleaning and sealing cracks and joints.

B. Sealer Material (PCC Pavement).
For the number of pounds (kilograms) measured, the Contractor will be paid the contract unit

price per pound (kilogram). This payment shall be full compensation for furnishing the sealer material only.

If not otherwise included as part of the contract work, partial depth finish patches designated by the Engineer will be paid for as extra work in accordance with Article 1109.03, B.

PAVEMENT REHABILITATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Full and Partial Depth PCC Patches

B. Full and Partial Depth HMA Patches

C. Full Depth Composite Patches

D. Diamond Grinding

E. Milling

F. Cleaning and Filling Joints and Cracks

G. Curb and Gutter Replacement

1.02 DESCRIPTION OF WORK

A. Construct full depth PCC, HMA, and composite patches.

B. Construct partial depth PCC and HMA patches.

C. Grind existing PCC pavement surface for profile improvement using a diamond grinder.

D. Mill the surface of HMA or PCC pavement to improve the surface profile and cross-section in preparation for resurfacing.

E. Clean and fill longitudinal and transverse joints and random cracks in PCC and HMA pavement.

F. Remove existing pavement and curb and gutter.

1.03 SUBMITTALS

Follow the General Provisions (Requirements) and Covenants, as well as the following:

A. PCC mix design.

B. HMA mix design.

1.04 SUBSTITUTIONS

Follow the General Provisions (Requirements) and Covenants.

1.05 DELIVERY, STORAGE, HANDLING, AND SALVAGING

Follow the General Provisions (Requirements) and Covenants, as well as the following:

A. PCC: See Section 7010.

B. HMA: See Section 7020.

1.06 SCHEDULING AND CONFLICTS

Follow the General Provisions (Requirements) and Covenants.

1.07 SPECIAL REQUIREMENTS

None.

1.08 MEASUREMENT AND PAYMENT

A. Full Depth Patches

1. **Measurement:** Measurement will be in square yards for each type of full depth patch. Patches less than 2 square yards in area will be considered 2 square yards.

2. **Payment:** Payment will be made at the unit price per square yard for each type of full depth patch.

3. **Includes:** Unit price includes, but is not limited to, sawing, removing, and disposing of existing pavement and reinforcing; restoring the subgrade; furnishing and installing tie bars and dowel bars; furnishing and placing the patch material, including the asphalt binder and tack coat; forming and constructing integral curb; surface curing and pavement protection; joint sawing and filling; and placing backfill and restoring disturbed surfaces.

B. Subbase Overexcavation:

1. **Measurement:** Measurement will be in tons of subbase material placed for authorized overexcavation.

2. **Payment:** Payment will be made at the unit price per ton of subbase material.

3. **Includes:** Unit price includes, but is not limited to, removal of existing subbase or subgrade, disposal of materials removed, furnishing and placing subbase material, and any additional excavation required for subbase placement.

C. Partial Depth Patches:

1. **Measurement:** Measurement will be in square feet for each type of partial depth patch. Patches less than 1 square foot in area will be considered 1 square foot.

2. **Payment:** Payment will be made at the unit price per square foot for each type of partial depth patch.

3. **Includes:** Unit price includes, but is not limited to, sawing, removing, and disposing of existing pavement; furnishing tack coat or bonding agent; furnishing and placing the patch material; curing; joint filling (PCC patches only); placing backfill; and restoring disturbed surfaces.

4. **Extra Payment:** When partial depth patches are constructed to full depth at the direction of the Engineer, payment will be at 2 times the unit price per square foot for each type of partial depth patch.

1.08 MEASUREMENT AND PAYMENT (Continued)

D. Crack and Joint Cleaning and Filling, Hot Pour:

1. **Measurement:** Measurement will be in linear feet measured along the cracks or joints.

2. **Payment:** Payment will be made at the unit price per linear foot of crack and joint cleaning and filling.

3. **Includes:** Unit price includes, but is not limited to, furnishing crack and joint filler material and routing, sawing, cleaning, and filling joints or cracks.

E. Crack Cleaning and Filling, Emulsion:

1. **Crack Cleaning and Filling, Emulsion:**
   a. **Measurement:** Measurement will be in linear feet measured along the cracks. Map cracked areas will not be measured.
   b. **Payment:** Payment will be made at the unit price per linear foot of crack cleaning and filling.
   c. **Includes:** Unit price includes, but is not limited to, furnishing emulsified crack filler material, cleaning cracks, placing soil sterilant, and filling cracks.

2. **Hot Mix Asphalt for Crack Filling:**
   a. **Measurement:** Measurement will be in tons of HMA used for filling cracks greater than 1 inch. Quantity will be based upon scale tickets. Mixture not used in the work will be deducted based upon scaled weights.
   b. **Payment:** Payment will be made at the unit price per ton for HMA used in filling cracks over 1 inch.
   c. **Includes:** Unit price includes, but is not limited to, cleaning, applying tack coat, and furnishing and placing HMA for crack filling.

F. Diamond Grinding:

1. **Measurement:** Measurement will be in square yards for the area of diamond grinding.

2. **Payment:** Payment will be made at the unit price per square yard of diamond grinding.

3. **Includes:** Unit price includes, but is not limited to, diamond grinding pavement, testing for smoothness according to the contract documents, and removal of slurry and residue from the project site.

G. Milling:

1. **Measurement:** Measurement will be in square yards for the area of milling.

2. **Payment:** Payment will be made at the unit price per square yard of milling.

3. **Includes:** Unit price includes, but is not limited to, milling pavement; furnishing water; and salvaging, stockpiling, and removing cuttings and debris.

1.08 MEASUREMENT AND PAYMENT (Continued)

H. Pavement Removal:

1. **Measurement:** Measurement will be in square yards. No deduction in area will be made for manholes, storm sewer intakes, valve boxes, or other structures less than 2 square yards in area. Pavement removal for patching is included as part of the patching item and will not be measured separately.

2. **Payment:** Payment will be made at the unit price per square yard.

3. **Includes:** Unit price includes, but is not limited to, sawing, breaking, removing, and disposing of existing pavement and reinforcing steel.

I. Curb and Gutter Removal:

1. **Measurement:** Measurement will be in linear feet measured along the back of curb.

2. **Payment:** Payment will be made at the unit price per linear foot of curb and gutter removed.

3. **Includes:** Unit price includes, but is not limited to, sawing, breaking removing, and disposing of existing curb and gutter.

J. Sampling and Testing: Required sampling and testing for pavement repair and rehabilitation work is incidental to other project costs and will not be paid for separately.

PART 2 - PRODUCTS

2.01 MATERIALS

A. PCC:

1. **Standard Patching:** Use Class C mix complying with Section 7010. Comply with Iowa DOT Materials I.M. 401. Construct all patches as standard patches unless otherwise specified in the contract documents.

2. **High Early Strength Patching:** Use Class M mix complying with Section 7010. Do not use calcium chloride unless otherwise specified in the contract documents.

3. **Partial Depth Patching:** Use a coarse aggregate in concrete mix complying with Iowa DOT Article 4109.02, Gradation No. 5.

B. HMA: Provide a minimum 300,000 ESAL mixture complying with Iowa DOT Article 2303.02, unless otherwise specified in the contract documents. Provide mixture with a PG 64-22 asphalt binder.

C. Crack and Joint Filler Material:

1. **Hot Pour Crack and Joint Filler:** Comply with Iowa DOT Section 4136.

2. **Emulsified Asphalt Crack Filler:** Provide CRS-2 or CRS-2P emulsions complying with Iowa DOT Section 4140.

3. **HMA for Filling Cracks:**
   a. Provide a 3/4 inch, 1/2 inch, or 3/8 inch HMA mixture complying with Section 7020, or a similar mixture from a commercial source subject to approval from the Engineer.
   b. Upon approval of the Engineer, a high performance bituminous cold premix may be used, depending on the availability of the specified hot mix asphalt.

4. **Blotting Material:** Provide sand complying with Iowa DOT Sections 4124 or 4125, or similar sand approved by the Engineer.

5. **Soil Sterilant:** Provide soil sterilant as specified in the contract documents.

D. Primer or Tack Coat Bitumen: Comply with Iowa DOT Article 2303.02.

E. Epoxy for Bonding Dowel and Tie Bars: Comply with Iowa DOT Materials I.M. 491.11.

F. Tie Bars and Dowel Bars: Provide epoxy coated bars complying with Iowa DOT Section 4151.

G. Subbase Material: Unless otherwise specified in the contract documents, use modified subbase complying with Section 2010.

H. Liquid Curing Compound: Comply with Iowa DOT Section 4105.

I. Cement Grout: Provide a water cement grout mixture with a ratio of one part water to one part cement.

PART 3 - EXECUTION

3.01 GENERAL

A. Conduct all operations to minimize inconvenience to traffic. Confine operations to one traffic lane, unless the road is to be closed to traffic. Minor encroachment into the adjacent lane, such as for sawing and installing forms, will be acceptable with the use of a flagger according to MUTCD.

B. Do not remove pavement for either full depth or partial depth patching unless the patch can be completed before the end of the working day.

C. Construct full depth and partial depth patches to the dimensions specified in the contract documents or as marked by the Engineer in the field. Construct all full depth patches to full panel width.

D. Make saw cuts parallel or perpendicular to the centerline.

E. Remove and dispose of materials not designated for salvage.

F. Restore the area outside the pavement by placing and compacting backfill material, placing topsoil, and sodding or seeding as specified in the contract documents.

3.02 FULL DEPTH PATCHING

A. Pavement Removal:

1. Saw pavement to full depth at the edges of the patch. A second saw cut, 2 inches inside the initial saw cut, may be required to prevent damage to adjacent pavement.

2. Do not damage pavement that is to remain. Do not use heavy equipment adjacent to new concrete until the opening strength is achieved.

B. Restoring Subgrade or Subbase:

1. Excavate 2 inches below the bottom of the existing pavement. If more than 2 inches is excavated, place and compact new subbase material as required to bring the subbase to a level 2 inches below the bottom of the existing pavement. Correct unauthorized over-excavation at no additional cost to the Contracting Authority.

2. Compact the exposed subgrade or subbase by a minimum of four complete passes with a plate-type vibratory compactor with a minimum force rating of 3,500 pounds.

3. When unstable material or excessive moisture is encountered, the Engineer may order removal and replacement of the unstable material.
   a. Remove existing unstable subgrade or subbase, or both, to the depth directed by the Engineer.
   b. Place and compact new subbase material as required to bring the subbase to a level 2 inches below the bottom of the existing pavement.

C. Placing PCC Patches:

1. **Equipment:** Comply with Iowa DOT Article 2301.03, A, specifications on equipment for standard concrete pavement.

3.02 FULL DEPTH PATCHING (Continued)

2. **Tie Bars and Dowel Bars:** Comply with Section 7010 and the figures in Sections 7010 and 7040.
   a. When there is a common line between two adjacent patches, a bent bar may be placed in a keyway and later straightened.
   b. Coat dowel bars extending into the patch area with a bond breaker. Do not coat tie bars.

3. **Forms:** Comply with Section 7010, 3.02, D, as well as the following.
   a. Use forms on all exposed edges and along the centerline for patches that extend into an adjacent lane, unless full pavement width patches are constructed.
   b. Rigid wood forms may be used in lieu of steel.

4. **Placing, Consolidation, and Finishing the Concrete:**
   a. Moisten the subbase or subgrade, or cover with a single layer of polyethylene film lapped at 12 inches for large areas.
   b. Except for preplanned joints, place the patch continuously until the patch is completed.
   c. When a delay of 45 minutes cannot be avoided, construct a day's work ('DW') joint.
   d. Carefully place concrete into the patch area to avoid segregation; spread into place and consolidate with a mechanical vibrator. Place full lane width patches over 25 feet in length with a suitable finishing machine that has at least one vibrating screed. Avoid excessive vibrating.
   e. Finish patches per Section 7010, 3.02, H.
   f. For joints with tie bars, tool the edge. For joints with dowel bars, saw to a depth of approximately 1 1/8 inch, leaving an opening of at least 3/8 inch in width to provide a reservoir for joint filler.
   g. Texture the patch to match the adjacent surface.

5. **Curing:** Comply with Section 7010, 3.02, I. Cure the concrete, including exposed vertical edges, immediately after the concrete has been finished and the surface water has evaporated.

6. **Joints:** Construct and fill joints according to Section 7010, 3.02. Place joints at locations specified in the contract documents.

7. **Pavement Protection:** Comply with Section 7010, 3.05.

8. **Use of Pavement:** Comply with opening strength requirements of Section 7010, 3.06. Maturity testing is not required.

D. Placing HMA Patches:

1. Use equipment complying with Iowa DOT Article 2303.03. Use of a paving machine is not required.

2. Apply tack coat to the vertical edges of the remaining pavement at a rate of 0.10 to 0.15 gallons per square yard.

3. Place HMA patch mixture in lifts that will not exceed 3 inches in thickness after compaction, with the top lift not exceeding 2 inches in thickness when compacted.

4. Compact each lift while hot by rolling or compacting with a vibratory compactor. Subsequent lifts may be placed as soon as the preceding lift has been properly compacted.

3.02 FULL DEPTH PATCHING (Continued)

5. Smooth the final lift with a steel-tired finish roller. Ensure the final compacted surface is level with, or no more than 1/8 inch above, the adjacent pavement and has a smooth riding surface. If the patch becomes distorted for any reason, smooth the surface by blading, scraping, grinding, filling, or other approved means.

6. Do not extend patch material beyond the edge of the existing pavement; remove patch material that extends outside the patch limits.

7. Do not open to traffic until the mixture has cooled sufficiently to provide stability.

3.03 PARTIAL DEPTH PATCHING

A. Pavement Removal:

1. Ensure all patches are square or rectangular in shape.

2. Saw to a depth of 2 inches at the removal limits.

3. Using a 15 pound maximum size pneumatic hammer, remove the deteriorated pavement down to sound pavement.

4. In lieu of sawing and removal with a pneumatic hammer, the designated patch area may be milled to the prescribed depth. Saw edges of milled removal areas to create vertical face, unless otherwise specified in the contract documents.

5. Remove pavement to the appropriate depth. If the required depth to sound pavement exceeds the maximum removal depth, construct a full depth patch.
   a. PCC Pavement: Minimum removal depth of 2 inches or a maximum depth of 1/3 of the pavement thickness.
   b. HMA Pavement: Minimum removal depth of 2 inches or a maximum depth of 1/2 of the pavement thickness.

B. PCC Patch Placement:

1. Clean removal area by sandblasting, followed by airblasting, until the area is clean and dry. Ensure the compressed air used for cleaning is oil and moisture free. Place concrete the same day as sandblasting.

2. Place resilient filler material complying with Iowa DOT Article 4136.03 along existing joints. Filler material is to extend 1 inch below the patch and 3 inches beyond the patch boundaries.

3. Thoroughly coat the bottom and sides of the patch area with a cement grout immediately prior to placement of concrete. Do not allow grout to set prior to placement of concrete. Remove grout set by sandblasting and reapply.

4. Deposit concrete in the patch; finish patch from the center outward. Ensure concrete does not infiltrate into existing cracks or joints.

5. Apply joint filler material to expansion joints. At the interface between the patch and the slab, apply cement grout to fill.

6. Texture the patch similar to the adjacent surface.

7. Cure patch according to Section 7040, 3.02.

3.03 PARTIAL DEPTH PATCHING (Continued)

C. HMA Patch Placement:

1. Clean removal area by airblasting until the area is clean and dry. Ensure the compressed air used for cleaning is moisture free.

2. Cover the entire removal area with tack coat at a rate of 0.10 to 0.15 gallons per square yard.

3. Place HMA patch mixture in lifts that will not exceed 3 inches in thickness after compaction, with the top lift not exceeding 2 inches in thickness when compacted.

4. Compact each lift while hot by rolling with an adequately weighted pneumatic tire roller or by tamping with a mechanical tamper. Succeeding lifts may be placed as soon as the preceding lift has been properly compacted.

5. Smooth the final lift with a steel-tired finish roller. Ensure the final compacted surface is level with, or not more than 1/8 inch above, the adjacent pavement and has a smooth riding surface. If the patch becomes distorted for any reason, smooth the surface by blading, scraping, grinding, filling, or other approved means.

6. Do not open to traffic until the mixture has cooled sufficiently to provide stability.

3.04 DIAMOND GRINDING

A. Use equipment complying with Iowa DOT Article 2532.03, A.

B. Grind and texture the entire surface of the pavement parallel to the centerline until the pavement surface on both sides of transverse joints and all cracks are in the same plane and meets the required smoothness.

C. Ensure the ground surface is of uniform texture. In each lane, ensure at least 95% of the area in each 100 foot section has a newly textured surface.

D. Except at joints and cracks, ensure grinding depth does not exceed 1/2 inch. At joints and cracks, ensure grinding depth does not exceed 3/4 inch.

E. For multiple passes, ensure overlaps do not exceed 1 inch. Begin at the crown of the roadway, proceeding toward the pavement edge with each subsequent pass. Ensure each subsequent pass is at least as deep as the previous pass in order to provide transverse drainage. All passes are to begin and end at the same station location.

F. Assemble and adjust the grinding head as necessary during the project to produce the following tolerances on pavements with the indicated coarse aggregates. Both the distance between grooves and the texture depth must be within the specified range to be in compliance.

	Crushed Stone	Gravel
Blade Segment Thickness	0.130” max.	0.130” max.
Distance Between Grooves*	0.100” to 0.125”	0.080” to 0.110”
Texture Depth**	Target of 1/16” with average between 1/32” and 3/32”	

*Based on an average of a minimum of ten measurements across the ground width for one pass.
**Based on an average of a minimum of six measurements across the ground width for one pass.

3.04 DIAMOND GRINDING (Continued)

G. Prior to enforcement of the tolerances listed above, a 1,000 square yard test area will be allowed for a new head that has been restacked, provided a surface texture in reasonable conformance with the specifications, as determined by the Engineer, is being produced.

H. Ensure the transverse slope of the ground pavement is uniform to a degree that there are no depressions or misalignment of slope greater than 1/4 inch in 12 feet when tested by string line or straightedge placed perpendicular to the centerline.

I. Continuously remove all slurry or residue resulting from the grinding operations, and remove from the project limits. Ensure residue from grinding operations does not flow across lanes occupied by public traffic or into gutters, storm sewers, ditches, or other drainage facilities.

J. When pavement smoothness testing is specified in the contract documents, measure smoothness with a profilograph, which produces a profilogram (profile trace) of the surface tested, according to Iowa DOT Materials I.M. 341 and the following requirements:

1. Prior to performing any grinding work, provide a control profilogram for each lane and/or segment over 50 feet in length that is to be ground. Ensure pavement is relatively clean and free of debris prior to establishing the control profilogram.

2. Ensure each segment of the finished ground surface has a final profile index less than or equal to 35% of the control profilogram trace or 22 inches per mile, whichever is greater, and does not include any bumps exeeding 1/2 inch in 25 feet.

3. Depressed pavement areas due to subsidence or other localized causes and areas where the maximum cut restricts further grinding will be excluded from testing with the profilograph when approved by the Engineer.

3.05 MILLING

A. Use equipment complying with Iowa DOT Article 2531.03, A.

B. Mill the entire pavement area designated to the depth specified in the contract documents. Mill in straight lines. Make sufficient passes, or cuts, such that all irregularities or high spots are eliminated.

C. Control milling operations to provide a surface that is true within a nominal tolerance of 1/4 inch and 1/4 inch at longitudinal joints where adjacent passes meet. The profile may be inspected by checking with a 10 foot surface checker placed parallel to the centerline. Correct variations greater than 1/4 inch.

D. Load cuttings directly into dump trucks and remove the remaining small cuttings and debris from the street. Sweep the scarified surface with a rotary broom before opening to traffic. Unless otherwise specified in the contract documents, all materials removed are property of the Contractor.

E. Do not operate metal tracked equipment on streets, other than those being milled.

F. Ensure excessive dust does not become airborne during construction. Additional water may be required at any time for dust control.

G. Mill around manholes and utility valves. Correct any damage to manholes or valves by the milling operation at no additional cost to the Contracting Authority.

H. Do not leave a vertical drop of more than 2 inches at the centerline or lane line overnight. Taper the ends of milled sections subject to traffic to provide a uniform and gradual transition.

3.06 CRACK AND JOINT CLEANING AND FILLING, HOT POUR

A. General:

1. Use equipment complying with Iowa DOT Articles 2541.03 (HMA) and 2542.03 (PCC).

2. Route or saw joints and cracks with an average opening of 3/8 inch or less to provide a minimum sealant reservoir of 3/8 inch wide by a nominal 1/2 inch deep. For joints and cracks less than 3/8 inch wide, widen by routing or sawing to a minimum width of 3/8 inch and depth of 1/2 inch.

B. Crack and Joint Cleaning:

1. Clean cracks or joints of existing joint filler material, backer rod, vegetation, dirt, and other foreign material.

2. Clean joints or cracks by air blasting or by other methods as necessary to remove debris.

3. If specified in the contract documents, clean wet sawn joints with high pressure water immediately after sawing to remove residue produced by the sawing operation.

4. When cleaned joints or cracks are contaminated before being filled, clean them again before filling.

C. Crack and Joint Filling:

1. Ensure cracks and joints are dry prior to placement of filler material.

2. Heat, handle, and apply joint filler material to the proper level as specified in the contract documents and as recommended by the manufacturer.
   a. PCC Pavement: Do not overfill joint or crack with filler material. Immediately remove filler material placed on the pavement surface.
   b. HMA Pavement: Slightly overfill the entire crack reservoir with filler material. Smooth with a narrow V-shaped squeegee immediately after placement of the filler material to within 1/2 inch on each side of the crack edge.

4. Place joint filler material when the pavement and ambient air temperatures are 40°F or higher. When near this minimum, additional air blasting or drying time, or both, may be necessary to ensure a satisfactory bond to the joint surfaces.

5. Lanes may be opened to traffic only after the filler material has set sufficiently so it will not pick up under traffic. Blotting material may be applied to the filler material, but only after the surface has set to avoid penetration of the blotting material into the filler material.

3.07 CRACK CLEANING AND FILLING, EMULSION

Use emulsified asphalt for filling cracks in HMA surfaces only. Do not use on PCC pavements.

A. General:

1. Clean cracks with either high pressure air or water equipment. Do not use water when freezing temperatures exist or are forecasted.

2. Ensure vegetation is removed from cracks. Alternative cleaning methods may be necessary to remove vegetation.

3.07 CRACK CLEANING AND FILLING, EMULSION (Continued)

3. When specified in the contract documents, apply a soil sterilant in crack prior to placing the filler material.

4. For filling cracks, use a hand operated wand or pouring pot, capable of placing the filler material into the crack and filling to the adjacent surface. Use a spout or nozzle small enough to place the filler material into the crack without soiling the adjacent surface.

5. Immediately after placement of the filler material, tightly spread the emulsion using a 2 inch, or less, V-shaped rubber-edged squeegee. Take proper measures to hold the filler in place and prevent runout at edge of pavement or at low areas.

B. Cracks Wider Than 1 inch:

1. Clean the cracks of loose and spalled material, sand, and other foreign debris to a depth of 3 inches using high pressure water.

2. When specified in the contract documents, utilize additional methods to clean cracks of old crack filler.

3. Blow the cleaned cracks free of water with high pressure air.

4. Lightly apply a tack coat to the crack surfaces.

5. Fill the cracks with hot mix asphalt.
   a. Ensure mix is warm and pliable when placed.
   b. Rod and tamp the mix into place level with the adjacent surface.
   c. Place mixture prior to filling cracks with emulsion.

6. Place a thin application of emulsion over the hot mix asphalt and tightly spread with a squeegee.

C. Cracks 1/4 inch to 1 inch in Width:

1. Clean the cracks of loose and spalled material, sand, and other foreign debris with high pressure air or high pressure water. Clean crack down to sound material, but a depth greater than 3 inches will not be required.

2. When specified in the contract documents, utilize additional methods to clean cracks of old crack filler.

3. Fill cracks with emulsion filler material.

D. Cracks Less Than 1/4 inch in Width:

1. Clean sufficiently to remove sand and other foreign debris.

2. Fill cracks with emulsion filler material.

E. Map-cracked (Alligator) Areas:

1. Cover area with emulsion filler material.

2. Spread emulsion over area with squeegee, working emulsion into cracks. Provide a thin, smooth application.

3. Promptly cover the filler material with a light application of blotter material.

3.08 PAVEMENT REMOVAL

A. Saw full depth at pavement removal limits.

B. Extend pavement removal limits to existing joint lines as directed by the Engineer.

C. Protect existing pavement, beyond removal limits, from damage. Remove to a new saw line and replace, at no additional cost to the Contracting Authority, all concrete broken or damaged beyond the removal limits designated by the Engineer.

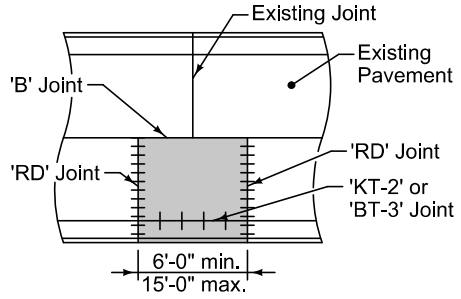
3.09 CURB AND GUTTER REMOVAL

A. Saw longitudinally along the existing gutter joint or at a location directed by Engineer. Saw transversely at the curb and gutter removal limits.

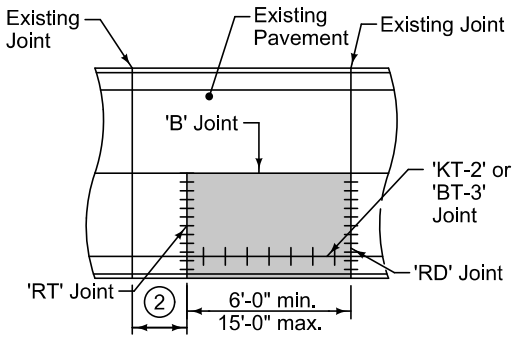
B. Remove existing curb and gutter without damaging the existing pavement to remain.

END OF SECTION

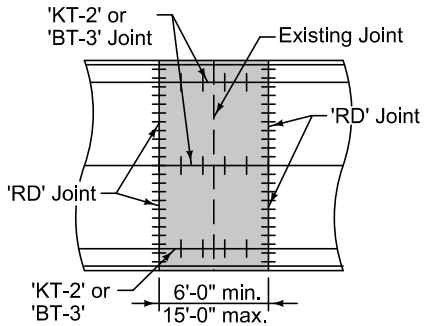
GUTTERLINE JOINTING



ONE PANEL WIDTH PATCH WITH OPPOSING JOINT

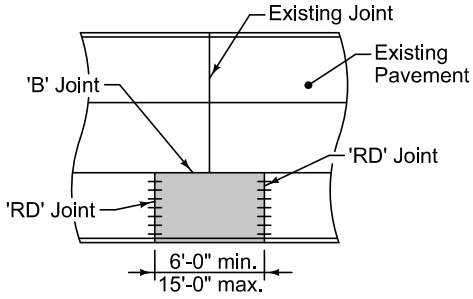


ONE PANEL WIDTH PATCH NO OPPOSING JOINT

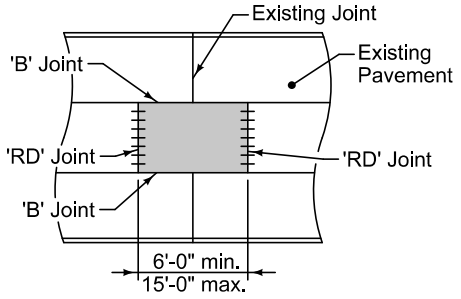


FULL ROADWAY WIDTH PATCH

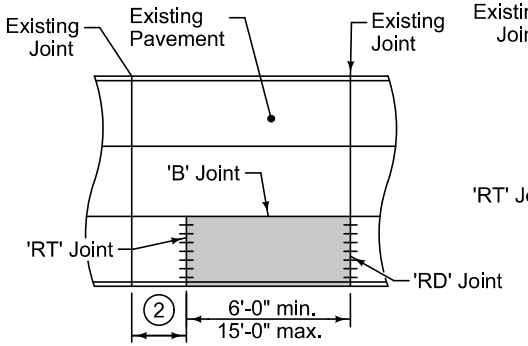
THIRD POINT JOINTING (1)



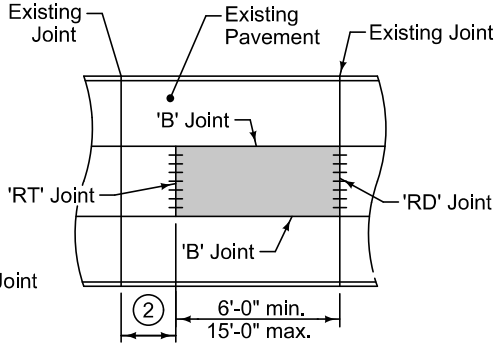
OUTSIDE PANEL PATCH WITH OPPOSING JOINT



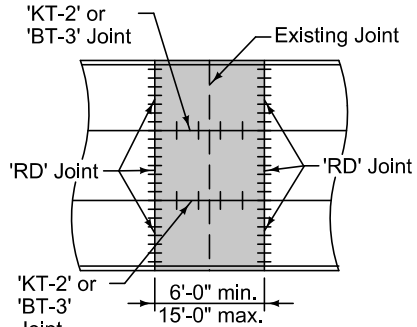
CENTER PANEL PATCH WITH OPPOSING JOINTS



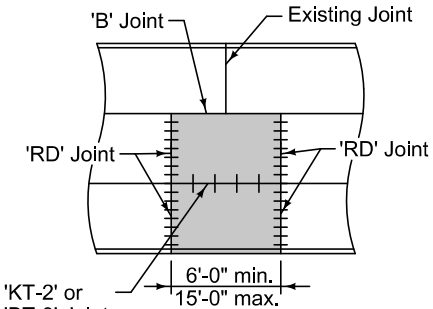
OUTSIDE PANEL PATCH NO OPPOSING JOINT



CENTER PANEL PATCH NO OPPOSING JOINT



FULL ROADWAY WIDTH PATCH



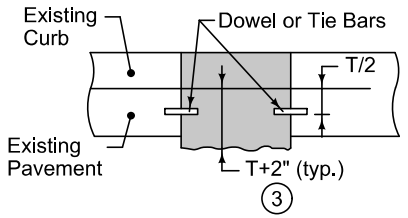
ADJACENT PANELS PATCH

(1) Patches on roadways with quarter point jointing will be similar to third point jointing details.

(2) Minimum distance between existing joint and patch is 6 feet. If distance is less than 6 feet, extend patch to existing joint.

(3) If subgrade or subbase material is required below patch, bring material to bottom of pavement.

LONGITUDINAL SECTION THRU PCC PATCH



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7040.101

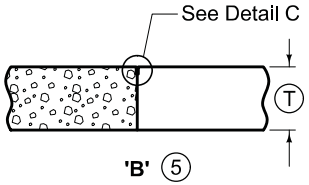
SHEET 1 of 1

SUDAS Standard Specifications

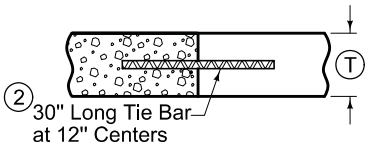
FULL DEPTH PCC PATCHES
LESS THAN OR EQUAL TO 15' LONG

FIGURE 7040.101

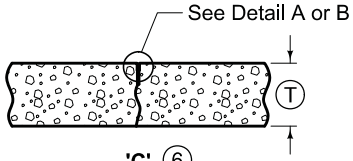
SHEET 1 OF 1



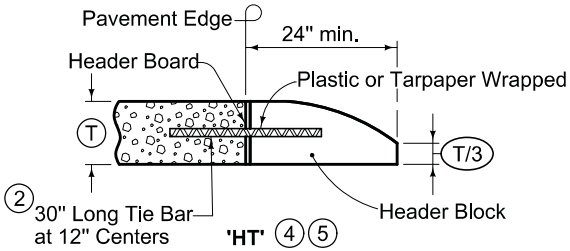
'B' (5)
PLAIN JOINT
(Abutting Pavement Slabs)



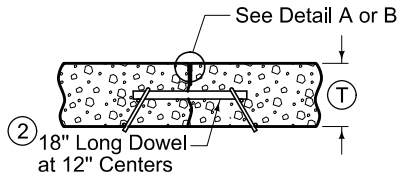
'DW' (3)(4)(7)
DAY'S WORK JOINT(Non-working)



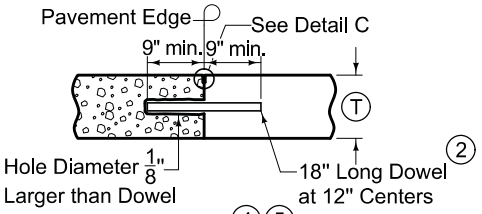
'C' (6)
CONTRACTION JOINT



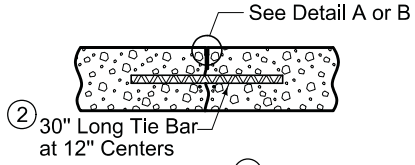
'HT' (4)(5)
HEADER JOINT
(End Rigid Pavement)



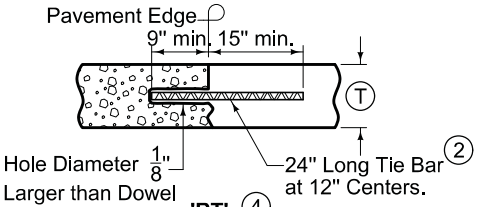
'CD' (1)(4)(6)
DOWELED CONTRACTION JOINT



'RD' (4)(5)
ABUTTING PAVEMENT JOINT



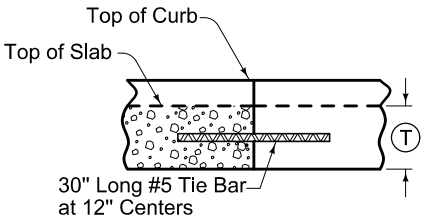
'CT' (4)
TIED CONTRACTION JOINT



'RT' (4)
ABUTTING PAVEMENT JOINT
RIGID TIE

TRANSVERSE CONTRACTION

1. See dowel assemblies for fabrication details.
2. See Bar Size Table.
3. Locate 'DW' joint at a mid-panel location between future 'C' or 'CD' joints. Place no closer than 5 feet to a 'C' or 'CD' joint.
4. Place bars within the limits shown under dowel assemblies.
5. Edge with 1/4 inch tool for length of joint indicated if formed; edging not required when cut with diamond blade saw. Remove header block and board when second slab is placed.
6. Unless otherwise specified, use 'CD' transverse contraction joints in mainline pavement when (T) is greater or equal to 8 inches. Use 'C' joints when (T) is less than 8 inches.
7. 'RT' joint may be used in lieu of 'DW' joint at the end of the days work. Remove any pavement damaged due to the drilling at no additional cost to the Contracting Authority.



'DW - CG' (3)(4)
DAY'S WORK JOINT
CURB AND GUTTER UNIT

FIGURE 7010.101 SHEET 1 OF 8

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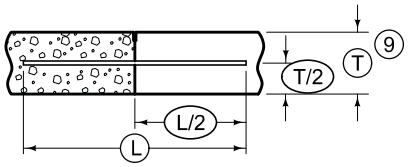
FIGURE 7010.101 | STANDARD ROAD PLAN | **PV-101** | SHEET 1 of 8

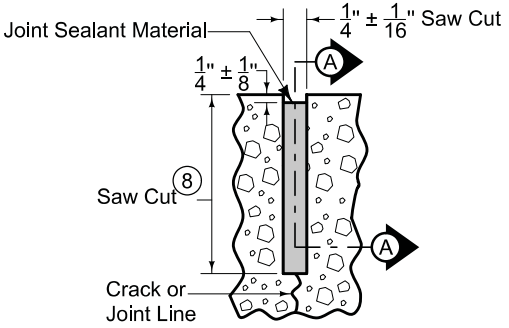
REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.

Paul D. Wigand, SUDAS DIRECTOR | Brian Smith, DESIGN METHODS ENGINEER

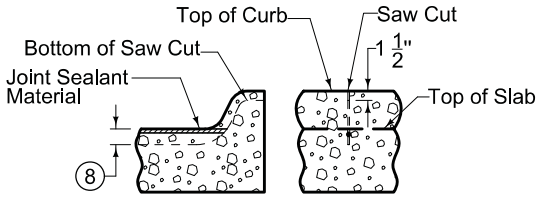
JOINTS



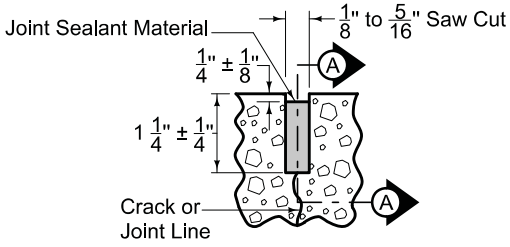
BAR PLACEMENT
(Applies to all joints unless otherwise detailed.)



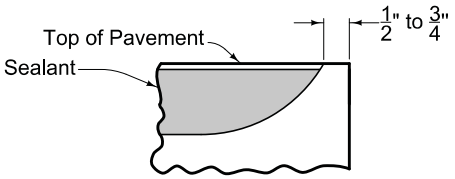
DETAIL A
(Saw cut formed by conventional concrete sawing equipment.)



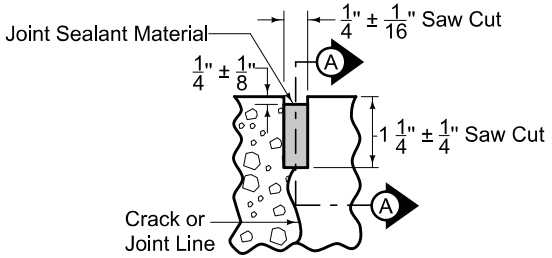
'C' JOINT IN CURB
(Match 'CT', 'CD', or 'C' joint in pavement.)



DETAIL B
(Saw cut formed by approved early concrete sawing equipment.)



SECTION A-A
(Detail at Edge of Pavement)



DETAIL C

(8) Saw 'CD' joint to a depth of T/3 ± 1/4"; saw 'C' joint to a depth of T/4 ± 1/4".

(9) When tying into old pavement, (T) represents the depth of sound PCC.

BAR SIZE TABLE		
(T)	Dowel Diameter	Tie Bar Size
< 8"	3/4"	#6
≥ 8" but < 10"	1 1/4"	#10
≥ 10"	1 1/2"	#11

FIGURE 7010.101 | SHEET 2 OF 8

TRANSVERSE CONTRACTION

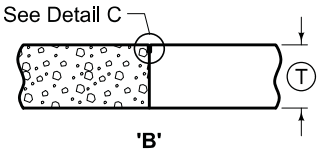
SUDAS | Iowa Department of Transportation | REVISION 3 04-15-14

FIGURE 7010.101 | STANDARD ROAD PLAN | **PV-101** | SHEET 2 of 8

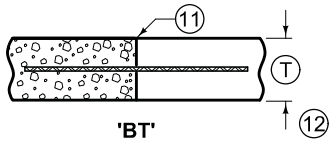
REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.

Paul D. Wigand, SUDAS DIRECTOR | Brian Smith, DESIGN METHODS ENGINEER

JOINTS

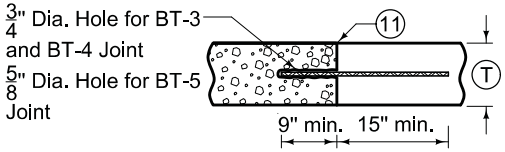


'B'
PLAIN JOINT
(Abutting Pavement Slabs)



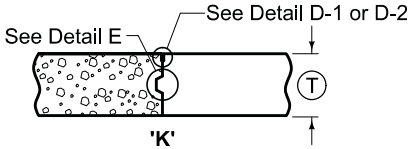
'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE

Ⓣ	Joint	Bars	Bar Length and Spacing
< 8"	'BT-1'	#4	36" Long at 30" Centers
≥ 8"	'BT-2'	#5	36" Long at 30" Centers

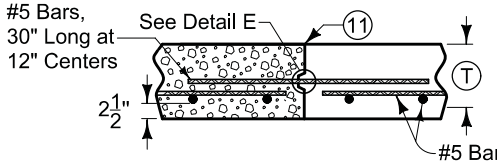


'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE (Drilled)

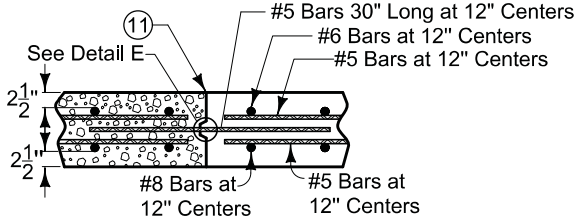
Ⓣ	Joint	Bars	Bar Length and Spacing
< 8"	'BT-5'	#4	24" Long at 30" Centers
≥ 8"	'BT-3'	#5	24" Long at 30" Centers
	'BT-4'		24" Long at 15" Centers



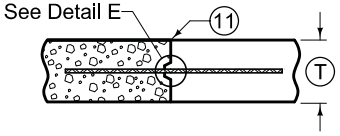
'K'
KEYED JOINT FOR ADJACENT SLABS
(Where T is 8" or more)



'KS-1'
[Single Reinforced Pavement (Bridge Approach)]



'KS-2'
[Double Reinforced Pavement (Bridge Approach)]



'KT' ⑩⑫
ABUTTING PAVEMENT JOINT - KEYWAY TIE

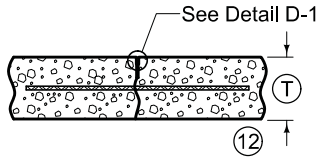
Ⓣ	Joint	Bars	Bar Length and Spacing
< 8"	'KT-1'	#4	30" Long at 30" Centers
≥ 8"	'KT-2'	#5	30" Long at 30" Centers
	'KT-3'		30" Long at 15" Centers

LONGITUDINAL CONTRACTION

⑩ Bar supports may be necessary for fixed form paving to ensure the bar remains in a horizontal position in the plastic concrete.

⑪ Sawing or sealing of joint not required.

⑫ The following joints are interchangeable, subject to the pouring sequence:
'BT-1', 'L-1', and 'KT-1'
'KT-2' and 'L-2'
'KT-3' and 'L-3'



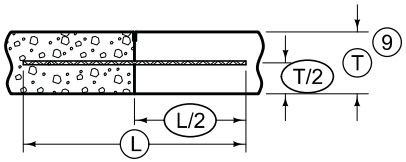
'L'
CONTRACTION JOINT

Ⓣ	Joint	Bars	Bar Length and Spacing
< 8"	'L-1'	#4	36" Long at 30" Centers
≥ 8"	'L-2'	#5	36" Long at 30" Centers
	'L-3'		36" Long at 15" Centers

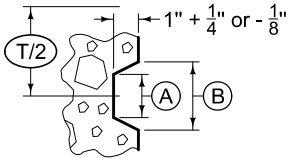
SUDAS | Iowa Department of Transportation | REVISION 3 04-15-14
FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101 | SHEET 3 of 8
REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.
Paul D. Wigant, SUDAS DIRECTOR | Brian L. Smith, DESIGN METHODS ENGINEER

JOINTS

FIGURE 7010.101 SHEET 3 OF 8

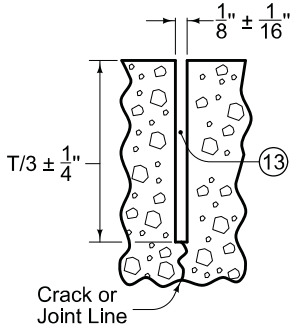


TIE BAR PLACEMENT
(Applies to all joints unless otherwise detailed.)

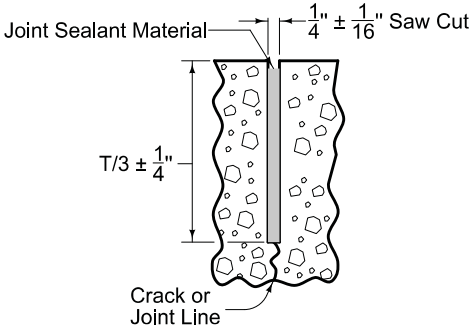


DETAIL E

KEYWAY DIMENSIONS			
Keyway Type	Pavement Thickness (T)	(A)	(B)
Standard	8" or greater	$1\frac{3}{4}$"	$2\frac{3}{4}$"
Narrow	Less than 8"	1"	2"



DETAIL D-1
(Required when the Department of Transportation is the Contracting Authority, or when specified in the contract documents.)



DETAIL D-2
(Required when the Department of Transportation is not the Contracting Authority, or when specified in the contract documents)

(9) When tying into old pavement, (T) represents the depth of sound PCC.

(13) Sealant or cleaning not required.

LONGITUDINAL CONTRACTION

FIGURE 7010.101 | SHEET 4 OF 8

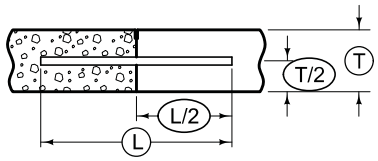
SUDAS | Iowa Department of Transportation | REVISION 3 04-15-14

FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101 | SHEET 4 of 8

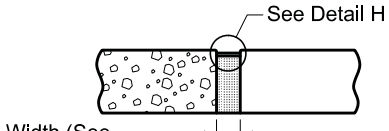
REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.

Paul D. Wigand, SUDAS DIRECTOR | Brian Smith, DESIGN METHODS ENGINEER

JOINTS

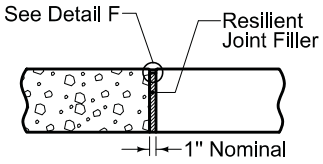


DOWEL PLACEMENT
(Applies to all joints unless otherwise detailed.)

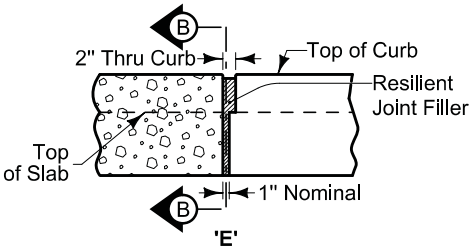


'CF' JOINT

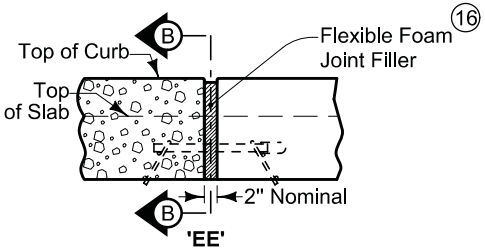
TYPE	WIDTH
CF-1	2"
CF-2	$2\frac{1}{2}$"
CF-3	3"
CF-4	$3\frac{1}{2}$"



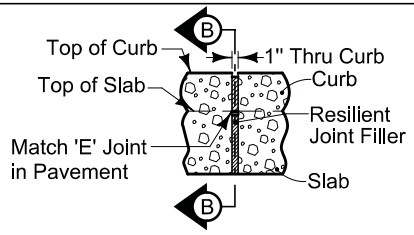
'E'
1" EXPANSION JOINT



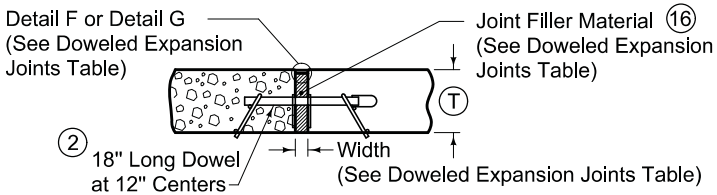
'E'
JOINT IN CURB
(View at Back of Curb)



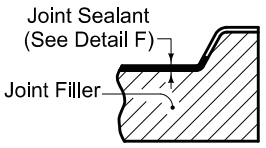
'EE'
JOINT IN CURB
(View at Back of Curb)



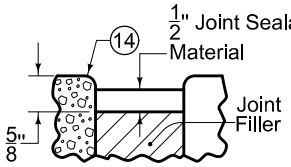
'ES'
JOINT IN CURB
(View at Back of Curb)



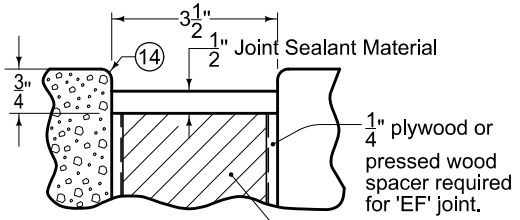
'ED', 'EE', 'EF' 15
DOWELED EXPANSION JOINT



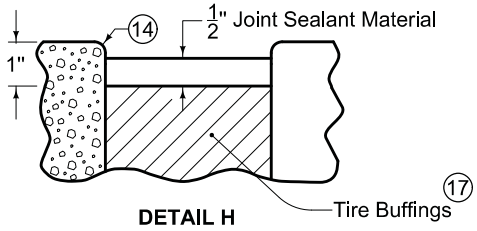
SECTION B-B



DETAIL F



DETAIL G



DETAIL H

EXPANSION

2 See Bar Size Table.

14 Edge with 1/4 inch tool for length of joint indicated if formed; edging not required when cut with diamond blade saw.

15 See Dowel Assemblies for fabrication details and placement limits. Coat the free end of dowel bar to prevent bond with pavement. At intake locations, dowel bars may be cast-in-place.

16 Predrill or preform holes in joint material for appropriate dowel size.

17 Compact tire buffings by spading with a square-nose shovel.

DOWELED EXPANSION JOINTS		
TYPE	WIDTH	FILLER MATERIAL 16
ED	1"	Resilient (Detail F)
EE	2"	Flexible Foam (Detail F)
EF	$3\frac{1}{2}$"	Flexible Foam (Detail G)

BAR SIZE TABLE			
T	< 8"	≥ 8" but < 10"	≥ 10"
Dowel Diameter	$\frac{3}{4}$"	$1\frac{1}{4}$"	$1\frac{1}{2}$"

FIGURE 7010.101 SHEET 5 OF 8

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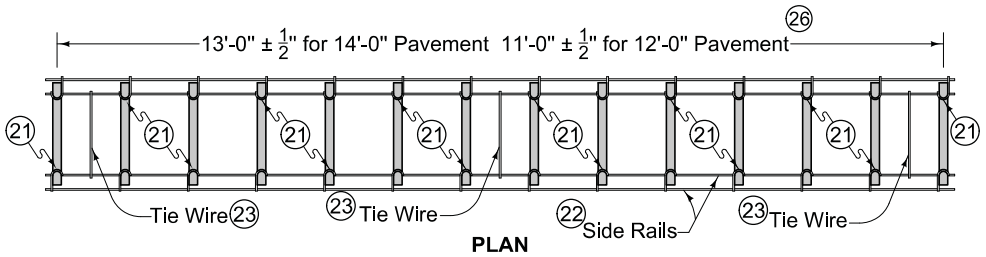
FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101 | SHEET 5 of 8

REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.

Paul D. Wigant, SUDAS DIRECTOR | Brian Smith, DESIGN METHODS ENGINEER

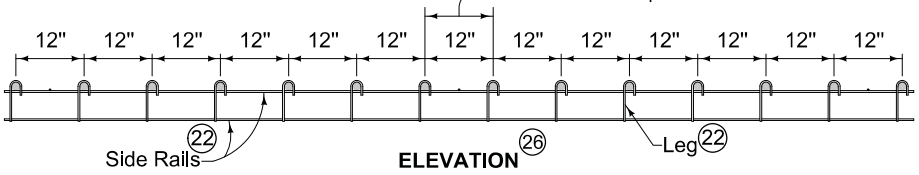
JOINTS

CONTRACTION JOINTS

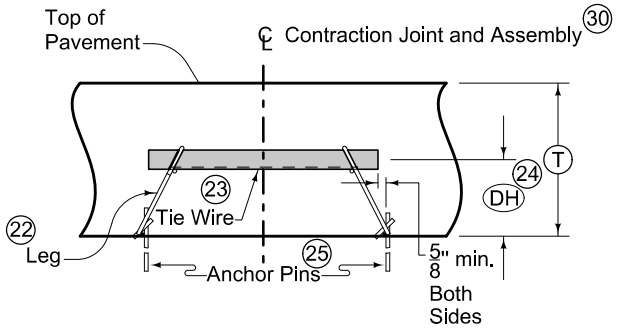


PLAN

Spaces between dowel bars are nominal dimensions with a $\frac{1}{4}$" allowable tolerance.



ELEVATION



LONGITUDINAL SECTION

DOWEL ASSEMBLIES (18)(19)(20)

DOWEL HEIGHT AND DIAMETER		
(T)	(DH)(24)	Diameter
7" to 7$\frac{1}{2}$"	3$\frac{1}{2}$"	$\frac{3}{4}$"
8" to 9$\frac{1}{2}$"	4$\frac{1}{4}$"	1$\frac{1}{4}$"
10" to 11$\frac{1}{2}$"	5$\frac{1}{4}$"	1$\frac{1}{2}$"
12" to 13"	6$\frac{1}{4}$"	1$\frac{1}{2}$"

(18) Use 18 inch long dowel bars with a tolerance of ± 1/8 inch. Ensure the centerlines of individual dowels are parallel to the other dowels in the assembly within ± 1/8 inch.

(19) Wire sizes shown are the minimum required. Use wires with a minimum tensile strength of 50 ksi.

(20) Details apply to both transverse contraction and expansion joints.

(21) Weld alternately throughout.

(22) #1/0 gauge (0.306 inch diameter) wire.

(23) #10 gauge (0.135 inch diameter) wire, welded or friction fit to upper side rail, both sides.

(24) Measured from the centerline of dowel bar to bottom of lower side rail + 1/4 inch.

(25) Per lane width, install a minimum of 8 anchor pins evenly spaced (4 per side), to prevent movement of assembly during construction. Anchor assemblies placed on pavement or PCC base with devices approved by the Engineer.

(26) If dowel basket assemblies are required for curbed pavements, the assembly length is based on the jointing layout. See PV-101, sheet 8.

(30) Ensure dowel basket assembly centerline is within 2 inches of the intended joint location longitudinally and has no more than 1/4 inch horizontal skew from end of basket to end of basket.

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FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101 | SHEET 6 of 8

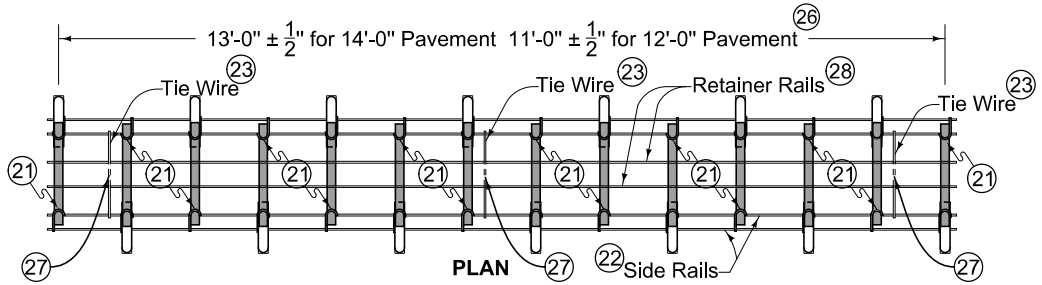
REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.

Paul D. Wigand, SUDAS DIRECTOR | Brian Smith, DESIGN METHODS ENGINEER

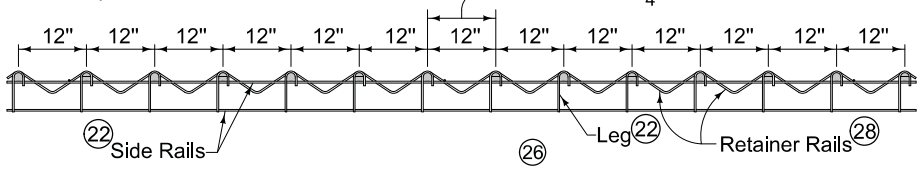
JOINTS

FIGURE 7010.101 SHEET 6 OF 8

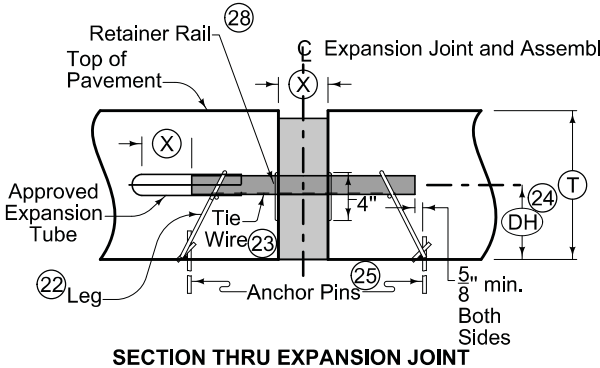
EXPANSION JOINTS



Spaces between dowel bars are nominal dimensions with a 1/4" allowable tolerance.



ELEVATION



SECTION THRU EXPANSION JOINT

JOINT OPENING AND EXPANSION TUBE EXTENSION		
Joint Type	(X)	Minimum Tube Length
"ED"	1"	6"
"EE"	2"	7"
"EF"	3 1/2"	9"

DOWEL HEIGHT AND DIAMETER		
(T)	(DH) (24)	Diameter
7" to 7 1/2"	3 1/2"	3/4"
8" to 9 1/2"	4 1/4"	1 1/4"
10" to 11 1/2"	5 1/4"	1 1/2"
12" to 13"	6 1/4"	1 1/2"

DOWEL ASSEMBLIES (18) (19) (20)

(18) Use 18 inch long dowel bars with a tolerance of ± 1/8 inch. Ensure the centerlines of individual dowels are parallel to the other dowels in the assembly within ± 1/8 inch.

(19) Wire sizes shown are the minimum required. Use wires with a minimum tensile strength of 50 ksi.

(20) Details apply to both transverse contraction and expansion joints.

(21) Weld alternately throughout.

(22) #1/0 gauge (0.306 inch diameter) wire.

(23) #10 gauge (0.135 inch diameter) wire, welded or friction fit to upper side rail, both sides.

(24) Measured from the centerline of dowel bar to bottom of lower side rail + 1/4 inch.

(25) Per lane width, install a minimum of 8 anchor pins evenly spaced (4 per side), to prevent movement of assembly during construction. Anchor assemblies placed on pavement or PCC base with devices approved by the Engineer.

(26) If dowel basket assemblies are required for curbed pavements, the assembly length is based on the jointing layout. See PV-101, sheet 8.

(27) Clip and remove center portion of tie during field assembly.

(28) 1/4 inch diameter wire.

(30) Ensure dowel basket assembly centerline is within 2 inches of the intended joint location longitudinally and has no more than 1/4 inch horizontal skew from end of basket to end of basket.

FIGURE 7010.101 SHEET 7 OF 8

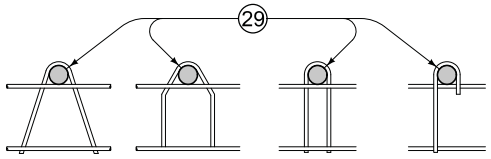
SUDAS | Iowa Department of Transportation | REVISION 3 04-15-14

FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101 | SHEET 7 of 8

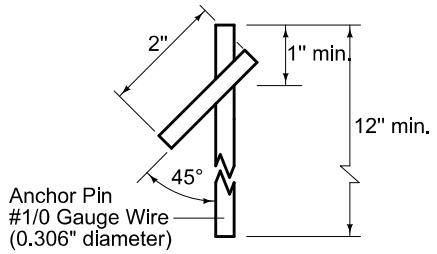
REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.

Paul D. Wigand, SUDAS DIRECTOR | Brian Smith, DESIGN METHODS ENGINEER

JOINTS



OPTIONAL LEG SHAPES



ANCHOR PIN

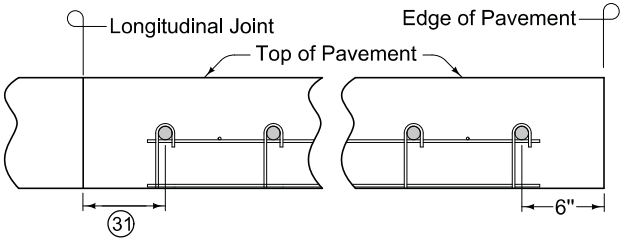
(18) Use 18 inch long dowel bars with a tolerance of ± 1/8 inch. Ensure the centerlines of individual dowels are parallel to the other dowels in the assembly within ± 1/8 inch.

(19) Wire sizes shown are the minimum required. Use wires with a minimum tensile strength of 50 ksi.

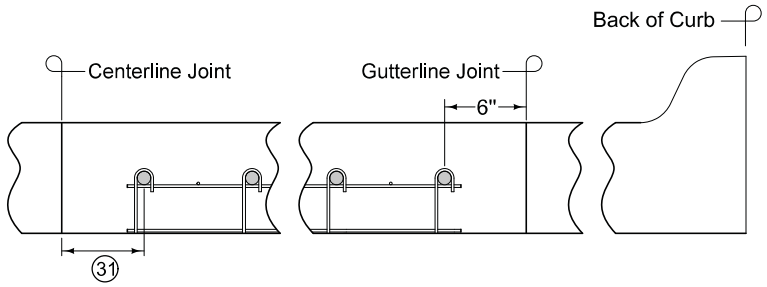
(20) Details apply to both transverse contraction and expansion joints.

(29) Diameter of bend around dowel is dowel diameter + 1/8 to 3/16 inches.

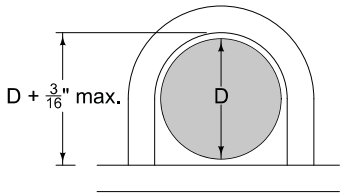
(31) For uniform lane widths: 3" - 6". For taper and variable width pavements: 3" - 12".



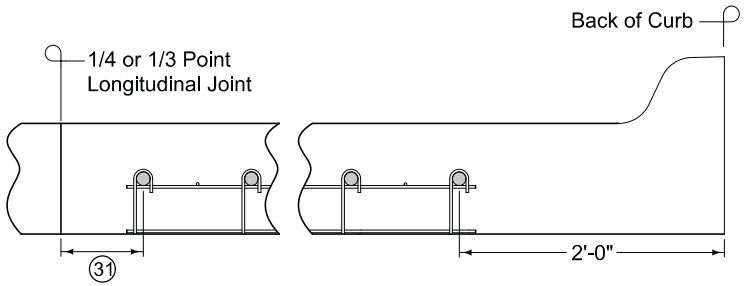
PLACEMENT LIMITS
(Rural Section)



PLACEMENT LIMITS
(Curb and Gutter - Gutterline Jointing)



BEND AROUND DOWEL (29)



PLACEMENT LIMITS
(Curb and Gutter - 1/4 or 1/3 Point Jointing)

DOWEL ASSEMBLIES (18) (19) (20)

FIGURE 7010.101 | SHEET 8 OF 8

SUDAS | Iowa Department of Transportation

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FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101

SHEET 8 of 8

REVISIONS: Added "Days Work Joint Curb and Gutter Unit" to page 1.

Paul D. Wigand, SUDAS DIRECTOR | Brian Smith, DESIGN METHODS ENGINEER

JOINTS

SUBDRAINS AND FOOTING DRAIN COLLECTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Subdrains

B. Subdrain Cleanouts and Outlets

C. Footing Drain Collectors

D. Storm Sewer Service and Connections

1.02 DESCRIPTION OF WORK

A. Construct subdrains, subdrain cleanouts and outlets, and footing drain collectors.

B. Construct storm sewer service and connections.

1.03 SUBMITTALS

Follow the General Provisions (Requirements) and Covenants.

1.04 SUBSTITUTIONS

Follow the General Provisions (Requirements) and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Follow the General Provisions (Requirements) and Covenants.

1.06 SCHEDULING AND CONFLICTS

Follow the General Provisions (Requirements) and Covenants.

1.07 SPECIAL REQUIREMENTS

None.

1.08 MEASUREMENT AND PAYMENT

A. Subdrains:

1. **Measurement:** Each type and size of pipe installed will be measured in linear feet from end of pipe to end of pipe along the centerline of pipe, exclusive of outlets. Lengths of elbows and tees will be included in length of pipe measured.

2. **Payment:** Payment will be made at the unit price of each type and size of pipe.

3. **Includes:** Unit price includes, but is not limited to, trench excavation, furnishing and placing bedding and backfill material, engineering fabric, connectors, and elbows and tees.

1.08 MEASUREMENT AND PAYMENT (Continued)

B. Footing Drain Collectors:

1. **Measurement:** Each type and size of pipe will be measured in linear feet along centerline of pipe from end of pipe to end of pipe.

2. **Payment:** Payment will be made at the unit price for each type and size of pipe.

3. **Includes:** Unit price includes, but is not limited to, trench excavation, pipe, wyes, tap, fittings, and furnishing and placing bedding and backfill material.

C. Subdrain or Footing Drain Cleanouts:

1. **Measurement:** Each type and size of subdrain or footing drain cleanout will be counted.

2. **Payment:** Payment for each cleanout will be made at the unit price for each type and size of subdrain or footing drain cleanout.

D. Subdrain or Footing Drain Outlets and Connections:

1. **Measurement:** Each type and size of outlet or connection to a structure will be counted.

2. **Payment:** Payment for each outlet or connection to a structure will be made at the unit price for each type and size installed.

3. **Includes:** Unit price includes, but is not limited to, pipe, non-shrink grout, coupling bands, and rodent guards for pipes 6 inches or smaller.

E. Storm Sewer Service Stub: The storm sewer service stub is the portion of the storm sewer service from the footing drain collector or storm sewer to a point 10 feet outside of the right-of-way or as specified in the contract documents.

1. **Measurement:** Each type and size of pipe will be measured in linear feet along centerline of pipe from the centerline of storm sewer or footing drain collector to 10 feet outside of the right-of-way.

2. **Payment:** Payment will be made at the unit price per linear foot for each type and size of storm sewer service stub.

3. **Includes:** Unit price includes, but is not limited to, trench excavation, furnishing bedding material, placing bedding and backfill material, tap, fittings, and plugs.

PART 2 - PRODUCTS

2.01 FOOTING DRAIN COLLECTORS

A. Polyvinyl Chloride Pipe and Fittings (Solid Wall PVC):

1. Comply with ASTM D 3034, minimum thickness SDR 35, 46 psi minimum pipe stiffness.
2. Use PVC plastic conforming to ASTM D 1784, Cell Classification 12454.
3. Integral bell and spigot type rubber gasket joint complying with ASTM D 3212 and ASTM F 477.

B. Corrugated Polyvinyl Chloride Pipe and Fittings (Corrugated PVC):

1. Use corrugated exterior, smooth interior, PVC.
2. Comply with ASTM F 949, minimum pipe stiffness, 46 psi.
3. Use PVC plastic complying with ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot type rubber gasket joint complying with ASTM D 3212 and ASTM F 477.

C. High Density Polyethylene Pipe and Fittings (HDPE):

1. AASHTO M 252 or M 294, Type S corrugated exterior and smooth interior.
2. Integral bell and spigot joints with O-ring rubber gasket meeting ASTM F 477.

D. Reinforced Concrete Pipe (RCP): Comply with Section 4020, 2.01.

2.02 TYPE 1 SUBDRAINS (LONGITUDINAL SUBDRAIN)

A. Polyvinyl Chloride Pipe and Fittings (Solid Wall PVC):

1. Comply with Section 4040, 2.01.
2. Slot subdrain pipe according to ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.

B. Corrugated Polyvinyl Chloride Pipe and Fittings (Corrugated PVC):

1. Comply with Section 4040, 2.01.
2. Slot subdrain pipe according to ASTM F 949.

C. Corrugated Polyethylene Tubing and Fittings (Corrugated PE):

1. Comply with AASHTO M 252, Type C, corrugated interior and exterior or Type S, corrugated exterior and smooth interior.
2. Use only fittings supplied or recommended by pipe manufacturer for soil tight service.
3. Slot or perforate according to AASHTO M 252, Type CP or Type SP.

2.03 TYPE 2 SUBDRAINS (COMBINATION SUBDRAIN/FOOTING DRAIN COLLECTOR)

A. Use materials complying with Section 4040, 2.01.

B. Perforate all pipe per the following requirements:

1. Solid Wall PVC Pipe: Comply with ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.

2. Corrugated PVC Pipe: Comply with ASTM F 949.

3. HDPE Pipe: Comply with AASHTO M 252 or M 294, Type CP or Type SP.

2.04 POROUS BACKFILL MATERIAL

A. Crushed Stone or Processed Gravel: Comply with Iowa DOT Section 4109, Gradation No. 29 and the quality requirements of Section 4131.

B. Pea Gravel: Comply with Iowa DOT Section 4109, Gradation No. 20 or No. 21 and the quality requirements of Section 4131.

2.05 SUBDRAIN OUTLETS

A. Corrugated Metal Pipe (CMP):

1. Comply with AASHTO M 36, Type 1.

2. Zinc coating complying with AASHTO M 218.

3. Use a corrugated steel circular section with annular or helical corrugation.

4. Minimum thickness of 0.052 inch.

B. Corrugated HDPE:

1. Comply with Section 4040, 2.01.

2. Pipe to be double-walled.

C. PVC: Comply with Section 4040, 2.01.

D. Coupling Bands: Match annular or helical corrugations on coupling bands to pipe ends.

E. Rodent Guard: Comply with Iowa DOT Materials I.M. 443.01.

2.06 SUBDRAIN OR FOOTING DRAIN CLEANOUTS

A. Type A-1 or A-2 Cleanouts:

1. Use 8 inch riser pipe of the same material as the adjacent subdrain or footing drain pipe. Comply with Figure 4040.232.

2. When a PVC cap is used on top of the cleanout, drive a 1 foot length of reinforcing steel into the ground immediately adjacent to the cleanout to allow future location.

2.06 SUBDRAIN OR FOOTING DRAIN CLEANOUTS (Continued)

B. Type B Cleanouts: Comply with Figure 4040.232.

1. Use 24 inch diameter Class III RCP riser for subdrain 8 inches or smaller. Use 30 inch diameter Class III RCP riser for 10 inch and 12 inch subdrains.

2. Use RCP complying with Section 4020, 2.01.

3. Manufactured cleanouts may be used with the approval of the Engineer.

C. Castings: Use a heavy duty cast iron casting complying with Section 6010, 2.10.

2.07 ENGINEERING FABRIC

Use fabric complying with Iowa DOT Article 4196.01.

2.08 STORM SEWER SERVICE STUBS

Use materials complying with Section 4040, 2.01.

PART 3 - EXECUTION

3.01 SUBDRAINS

A. Install Type 1 or Type 2 subdrain where specified in the contract documents. Comply with Figure 4040.231.

1. Excavate trench and provide pipe bedding and backfill as shown on the figures. Install engineering fabric if specified in the contract documents.

2. Begin subdrain installation at the outlet and continue upgrade.

3. Lay subdrain pipe to the proper line and grade. Place pipe with the perforations down.

4. If concrete pipe is specified for Type 2 subdrains, wrap exterior of each joint with engineering fabric and do not use joint sealant.

5. Place porous backfill material over installed pipe in layers not more than 6 inches thick. Thoroughly tamp each layer with mechanical tampers.

6. Restore pavement subbase material, shoulder material, or ground above subdrain trench as applicable.

B. Provide cleanouts where specified in the contract documents. Comply with Figure 4040.232.

C. Provide outlets where specified in the contract documents.

1. Comply with Figure 4040.233 for outlets to structures.

2. Install a rodent guard on all subdrain outlet pipes 6 inches and smaller.

3.02 FOOTING DRAIN COLLECTORS

A. Install footing drain collectors according to Section 3010.

B. If specified, install engineering fabric.

C. Provide cleanouts and connections where specified in the contract documents.

1. Connect footing drain sewer collectors to storm sewer manhole or intake.

2. Provide fabricated or preformed wye or tee service fitting for each platted lot or building.

D. Provide manholes, where specified, according to Section 6010.

3.03 FOOTING DRAIN SERVICE STUBS

A. Provide footing drain service stubs at locations specified in the contract documents.

B. Install wye or tee for each service connection.

1. For new storm sewer and footing drain collector construction, except RCP sewers, install wye or tee fittings according to the manufacturer's requirements.

2. For existing storm sewers, existing footing drain collectors, and all RCP sewers, saw or drill a neat hole in main and install preformed saddle wyes or tees according to the manufacturer's requirements.

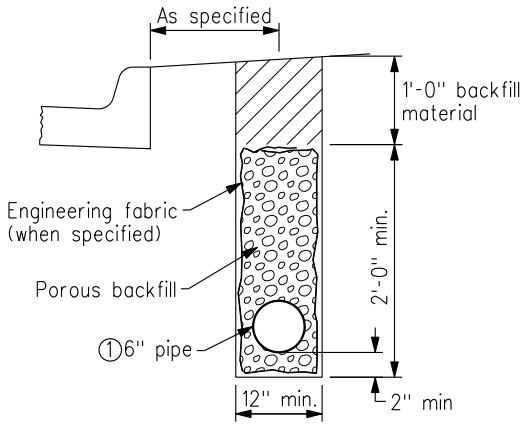
3.03 FOOTING DRAIN SERVICE STUBS (Continued)

C. Install footing drain service stub to a location 10 feet beyond the right-of-way line or as specified in the contract documents.

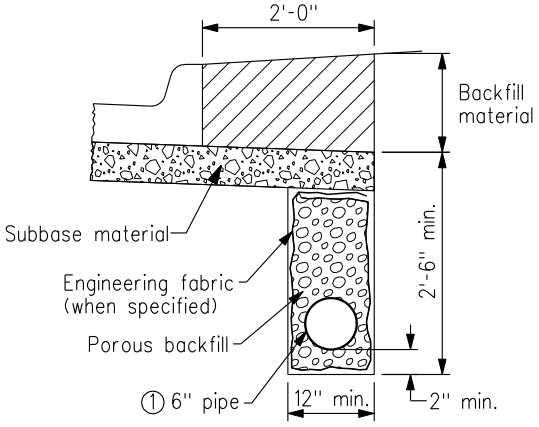
1. For undeveloped properties, place a watertight stopper or plug in the end of the storm sewer service.

2. For reconnection of existing service pipe to new sewer service pipe, use a manufactured flexible connection.

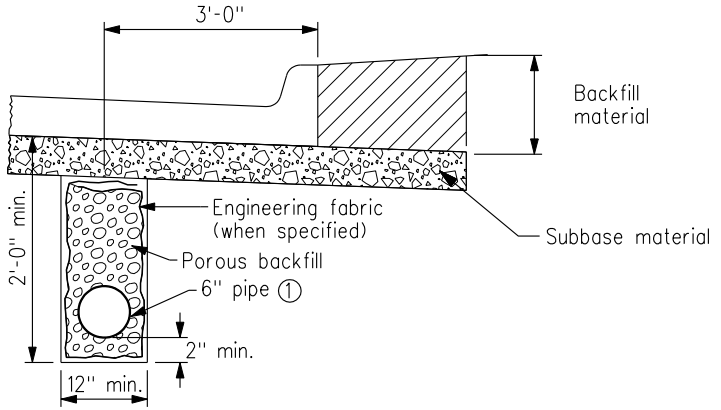
END OF SECTION



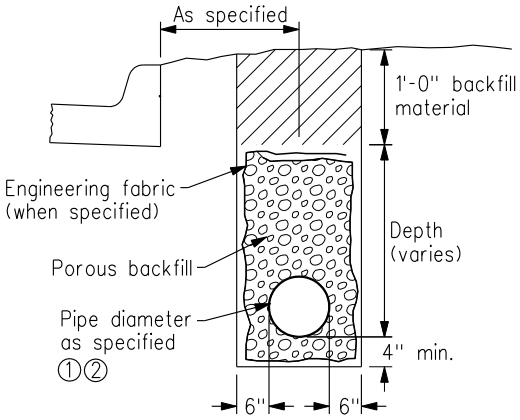
CASE A
TYPE 1



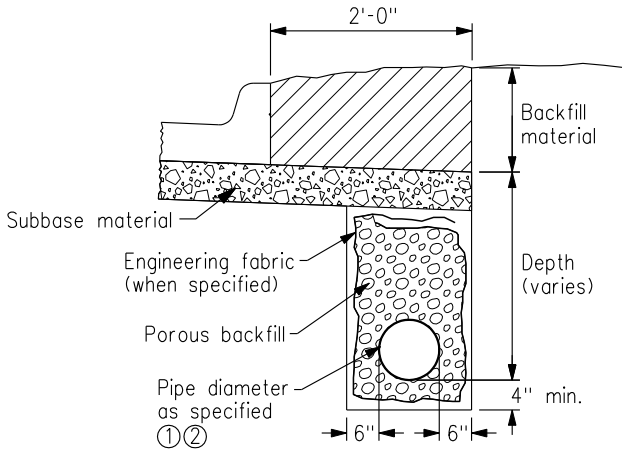
CASE B
TYPE 1



CASE C
TYPE 1



CASE D
TYPE 2



CASE E
TYPE 2

Note: Type 1 installation is for longitudinal subdrain only. Type 2 installation is for combination subdrain/footing drain collectors.

(1) Place perforations down for all installations.

(2) When concrete pipe is specified, wrap pipe joints with engineering fabric. Do not apply joint sealant. Comply with Figure 4020.211.

FIGURE 4040.231 SHEET 1 OF 1

SUDAS

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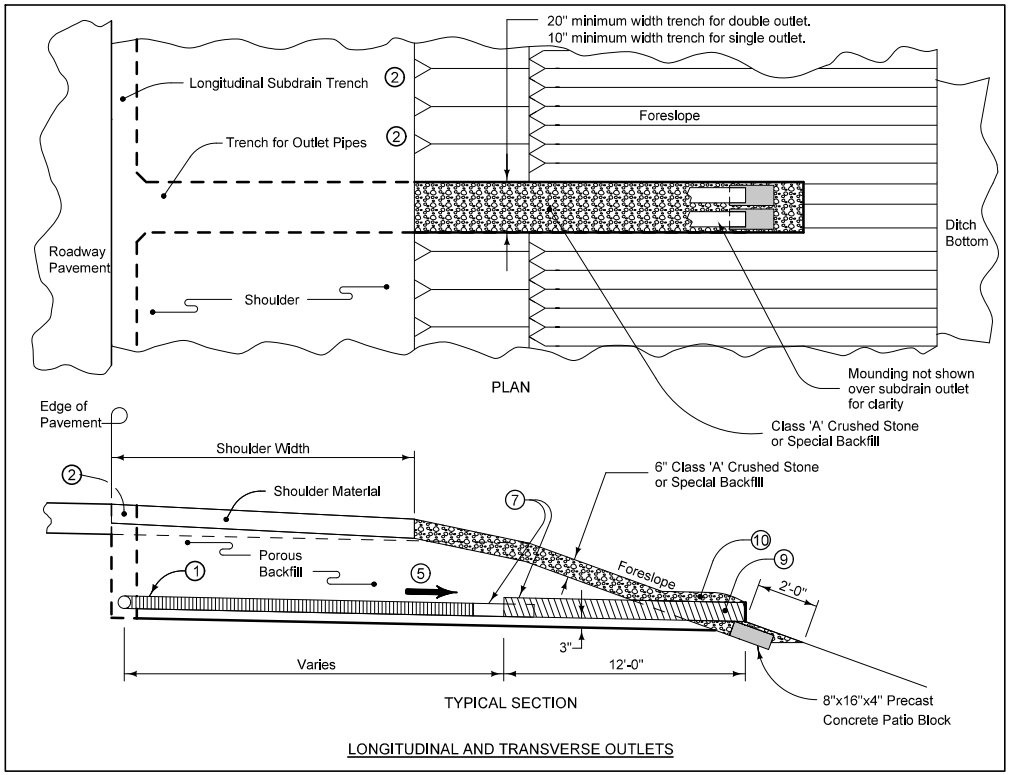
NEW	10/21/08

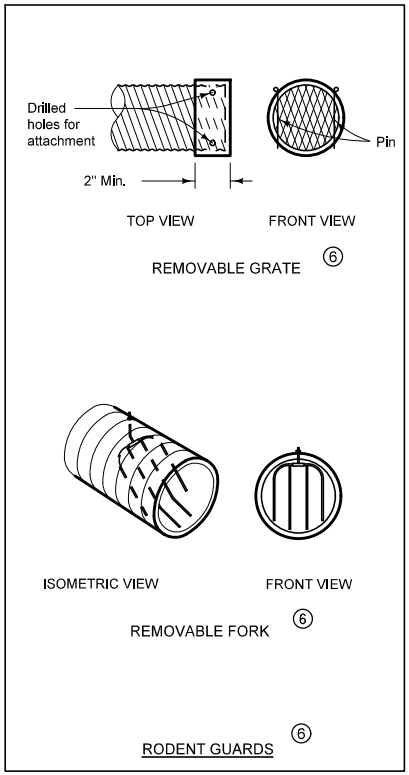
FIGURE 4040.231

SHEET 1 OF 1

SUBDRAINS



LONGITUDINAL AND TRANSVERSE OUTLETS



RODENT GUARDS

Transverse and backslope subdrains require only single outlets. Install double outlet pipes on all longitudinal subdrain systems, except at the beginning and end of the system. At these locations, install a single outlet pipe.

(1) Perforated Subdrain (Polyethylene Corrugated Tubing).

(2) On projects where existing shoulder material is removed, replace the shoulder material in accordance with Article 2502.03, C of the Standard Specifications.

(3) 'Y' or 'T' connection will not be allowed. Place subdrain on 1 foot minimum radius.

(4) Direction of flow.

(5) 6" minimum drop in elevation between longitudinal subdrain and outlet. 12" minimum drop for projects using recycled PCC subbase.

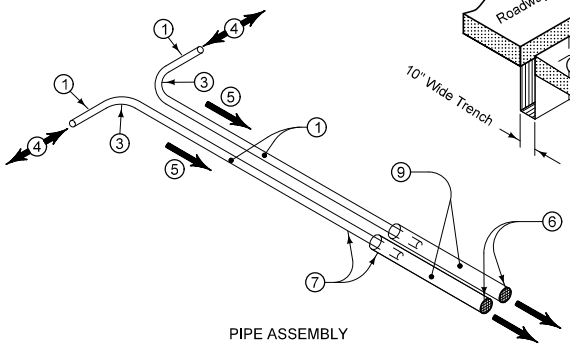
(6) Install a removable grate rodent guard on all projects except those using recycled PCC subbase. For projects using recycled PCC subbase, install a removable fork rodent guard. See Materials I.M. 443.01.

(7) Corrugated metal pipe outlet 2" larger than subdrain pipe or corrugated double-walled PE or PVC pipe of the same diameter as the subdrain pipe with an appropriate coupler. If metal pipe is used, the pipes should be coupled in one of the following ways: (1) Use an inside fit reducer coupler (coupler must be inserted a minimum of 12" into CMP);or (2) Insert 12" of the 4" subdrain into the 6" metal outlet pipe, then fully seal the entire opening with grout.

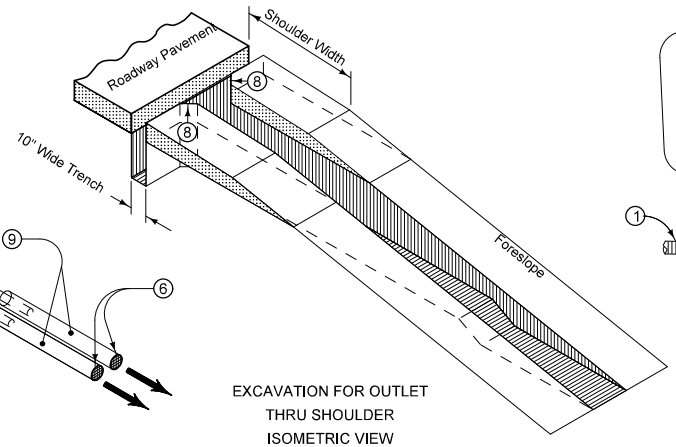
(8) Bevel the trench to provide a minimum of 3" of porous backfill surrounding all portions of subdrain pipe.

(9) Corrugated metal pipe outlet 2" larger than existing subdrain pipe, or corrugated double-walled PE or PVC pipe of the same diameter as the existing subdrain pipe.

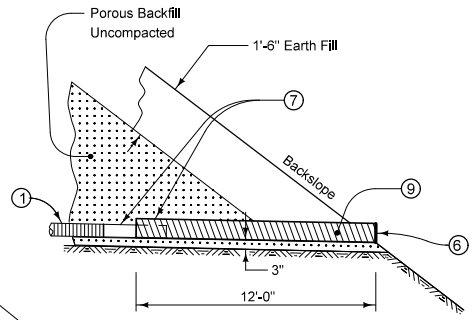
(10) Place class 'A' crushed stone or Special Backfill over outlet and carefully compact to avoid damaging outlet pipe.



PIPE ASSEMBLY
ISOMETRIC VIEW



EXCAVATION FOR OUTLET
THRU SHOULDER
ISOMETRIC VIEW



BACKSLOPE OUTLET
TYPICAL SECTION

Possible Contract Item:

Subdrain Outlet, RF-19E

Possible Tabulation:

104-5C

Iowa Department of Transportation

STANDARD ROAD PLAN

REVISION	
15	10-16-12

RF-19E

SHEET 1 of 1

REVISIONS: Revised circle notes 1 and 7.

Deanna Maifield
APPROVED BY DESIGN METHODS ENGINEER

OUTLETS FOR LONGITUDINAL, TRANSVERSE AND BACKSLOPE SUBDRAINS