Manual of

STANDARD SPECIFICATIONS

2025

Published by
Utah LTAP Center
Utah State University
8205 Old Main Hill
Logan UT 84322-8205
(800) 822-8878 or (435) 797-2931

A Manual for General Contractors and the Construction Industry

UTAH CHAPTER
AMERICAN PUBLIC WORKS ASSOCIATION

UTAH CHAPTER
THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

Printed in the United States of America

Sixth Printing, January 2025

PREFACE

This manual has been prepared to assist public works contracting agencies and contractors in the State of Utah. It is designed to:

- Be compatible with the "Manual of Standard Plans" which is published by the LTAP Center in Logan Utah.
- To provide uniform construction practice among counties, cities, and other public agencies in the State of Utah.
- To provide standard requirements for the supply and installation of materials and systems in the public works environment.
- To follow the present industry-consensus on uniform organization and sequencing of specifications.

Changes in a specification are listed in red in the top right corner of the initial page.

To recommend an improvement to this document, submit the following information to the chairman of the Standard Specifications and Drawings Subcommittee. The web site is (http://utah.apwa.net/). In your submission

- Identify the problem.
- Recommend a solution.
- Provide written text or drawing to support your recommendation.

Construction experts and design professionals will carefully review the proposed changes in open meetings.

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PAVEMENT REMOVAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Remove roadway Pavement.

B. Remove curb, gutter, sidewalk, Driveway Approach, waterway and similar flat work.

1.2 MEASUREMENT PROCEDURES

A. Double saw cutting required for pavement removal or T-patches will not be measured or paid for separately.

1.3 REFERENCES

A. **APWA (Utah) Standards**:

Plan 256 Concrete pavement patch.

Plan 412 Invert cover.

Plan 802 Defective concrete.

1.4 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

PART 2 PRODUCTS Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26.

B. Coordinate utility locations, Section 01 31 13.

C. Preserve all active utilities.

D. Notify neighborhood at least 48 hours before day and time of operation.

E. Mark on redline drawings the location of any existing and active utility that is discovered.

3.2 PROTECTION

A. Install Invert Covers as shown in the Drawings of APWA Plan 412. Installation must be tight so no debris can by-pass the cover and enter the piping below.

B. Trees:

1. Avoid or minimize damage to trees and tree roots.

2. Provide certified arborist observation of root cuts larger than four (4) inches diameter. Roots provide anchorage, storage of energy, and absorption and conduction of water and mineral elements. Loss of root connection affects health and stability of tree and safety of people and property. Notify ENGINEER of such root cut.

C. Existing Surfaces:

1. Protect adjacent surfaces including concrete walls, planters, carriage walks, driveway approaches, rock walls, rock gardens, concrete steps, sidewalks, and curb cut assemblies. Replace damaged facilities at no additional cost to OWNER.

2. Use rubber cleats or Pavement pads when operating backhoes, outriggers, track equipment, or any other equipment on or crossing paved surfaces.

3. Restore paved surfaces that are damaged by removal operations at no additional cost to the OWNER. Match the existing Pavement surface plus 1 inch.

D. Environment:

1. Control dust, Section 01 57 00.

2. Protect plant and animal habitat. Follow federal, state, or local protection requirements.

E. Repair or replace any damage at no additional cost to OWNER.

3.3 REMOVE PORTLAND CEMENT CONCRETE PAVEMENT

A. Identify concrete pavement to be removed as shown in the Drawings or APWA Plan 802. If removal is not scheduled, secure removal approval from ENGINEER.

B. Identify concrete pavement to be removed as shown in the Drawings or APWA Plan 256 Sheet 1 or Sheet 2 as applicable.

C. Cutting:

1. DO NOT use machine mounted impact hammers.

2. Make concrete cuts straight, vertical, true, full-depth.

3. Cut along perimeter of panel to be removed. Where edge of existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.

4. Cut along any edge that is damaged during construction, including cavities underneath caused by construction or concrete removal.

D. Removal:

1. Remove concrete to the nearest expansion joint or vertical saw cut.

2. Remove panels without damaging remaining panels.

3. Remove all bonding inhibitors.

3.4 REMOVE BITUMINOUS CONCRETE PAVEMENT

A. Cutting:

1. Use any method that produces a true, vertical, full-depth cut.

2. When bituminous pavement overlays Portland cement concrete Pavement, DO NOT use machine mounted impact hammers.

3. If an edge of an existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.

4. Re-cut along any edge that is damaged during construction, and where cavities underneath pavement is caused by construction.

B. Remove Pavement: Remove pavement without damaging remaining.

3.5 REMOVE CONCRETE FLAT WORK

A. Saw cut flat work at weakened plane joints. Saw cut full depth.

B. Where edge of existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.

C. Saw along any edge that is damaged during construction, including cavities underneath caused by construction.

D. If flat work that is not scheduled for removal is damaged, remove and replace the flat work at no additional cost to OWNER.

3.6 CLEANING

A. Remove all debris and dust. Clean surrounding rails, sidewalks, Driveways, Driveway approaches, landscaping, concrete flat work, and other objects in vicinity of work.

END OF SECTION

DIVISION 03

CONCRETE

SECTION 03 11 00
CONCRETE FORMING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formwork for cast-in-place concrete.

B. Openings in formwork for other affected work.

C. Form accessories such as snap ties, bracing, etc.

D. Stripping formwork.

1.2 REFERENCES

A. **ACI Standards**.

347 Recommended Practice for Concrete Formwork.

1.3 DEFINITIONS

A. **Shoring**: The activity to support formwork.

B. **Reshoring**: The activity to reduce the amount of formwork supporting concrete elements. As concrete sets and strength increases, less need for formwork occurs gradually until concrete becomes free standing.

1.4 SUBMITTALS

A. Shop Drawings: Fabrication and erection drawings of forms for specific finished concrete surfaces, as indicated. Show general construction of forms, jointing, special joints or reveals, location and pattern of form tie placement, and other items affecting exposed concrete visibility.

B. Form Release Agent: Where concrete surfaces are scheduled to receive special finishes or applied coverings which may be affected by agent submit manufacturer's instructions for use of agent.

1.5 QUALITY ASSURANCE

A. Designer's Qualifications: Structural design professional who complies with Utah licensing law, has experience in concrete formwork, and is acceptable to the authority having jurisdiction.

B. Design Forms:

1. With sufficient strength to maintain finished tolerances indicated in Section 03 35 00, to support loads, pressures, and allowable stresses as outlined in ACI 347 and for design considerations such as wind loads, allowable stresses, and other applicable requirements of local Laws and Regulations.
2. To permit easy removal.
3. For required finishes.

C. Design, engineering, and construction of formwork is CONTRACTOR's responsibility.

1.6 JOB CONDITIONS

A. For reference purposes, establish and maintain sufficient control points and bench marks to check tolerances. Maintain in an undisturbed condition and until final completion and acceptance of Work.

B. Regardless of tolerances specified, allow no portion of Work to extend beyond legal boundaries.

1.7 FIELD SAMPLES

A. Prepare field Samples and submit per Section 01 33 00.

B. Construct and erect sample formwork panel for architectural concrete surfaces receiving special treatment or finish as a result of formwork. Formwork to include vertical and horizontal form joints and typical rustication joints when required.

C. Size panel to indicate special treatment or finish required, including form release agent.

D. Remove formwork after casting concrete.

1.8 **ACCEPTANCE**

A. Secure ENGINEER's inspection of form layout for concrete flat work.

PART 2 PRODUCTS

2.1 **FORM MATERIALS**

A. Faced with material which will produce smooth and uniform texture on concrete, unless indicated otherwise.

B. Arrange facing material orderly and symmetrical, keeping number of seams to a minimum.

C. Do not use material with raised grain, patches, or other defects which will impair texture of concrete surface.

2.2 **FORMWORK ACCESSORIES**

A. Form Ties:

1. Use ties constructed so end fasteners can be removed without spalling concrete faces.

2. After end fasteners of ties have been removed, embedded portion of ties are to terminate not less than two (2) times the diameter or thickness of the fasteners from formed faces of concrete, but in no case greater than 3/4 inch.

3. When formed face on concrete is not exposed, form ties may be cut off flush with formed surfaces. Use ties with 3/4 inch diameter cones on both ends or an approved equal for water retaining structures.

B. Premolded Expansion Joint Filler: F1 sheet, Section 32 13 73 unless indicated elsewhere.

C. Form Release Agent: Colorless material which will not stain concrete, absorb moisture, impair natural bonding or color characteristics of concrete. To prevent contamination, agents used on potable water structures are subject to review by ENGINEER before use.

D. Fillets for Chamfered Corners: Wood strips 1 inch x 1 inch size, maximum length possible.

PART 3 EXECUTION

3.1 **INSPECTION**

A. Verify lines, levels, and measurements before proceeding with formwork.

3.2 **FORM CONSTRUCTION**

A. Make forms sufficiently tight to prevent loss of concrete.

B. Unless indicated otherwise, place chamfer strips in corners of forms to produce beveled edges on permanently exposed exterior corners.

C. To maintain specified finish tolerances, camber formwork to compensate for anticipated deflections.

D. Provide positive means of adjustment using wedges, jacks, Shores, and struts to take up all settlement during concrete placing operation.

E. Provide temporary ports in formwork to facilitate cleaning and Inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. At construction joints, overlap forms over hardened concrete at least six (6) inches. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain true surface.

G. Construct wood forms for wall openings to facilitate loosening, or counteract swelling.

H. Fasten wedges used for final adjustment of forms before concrete placement in position after final check.

I. Anchor formwork to Shores, supporting surfaces or members to prevent upward or lateral movement and deflection of any part of formwork system during concrete placement.

J. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing.

K. Position expansion joint material and other embedded items accurately and support to prevent displacement.

L. To prevent entry of concrete, fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material.

M. For architectural concrete, limit deflection of facing materials between studs as well as deflection of studs and walers to 0.0025 times span.

N. For underground concrete work, do not use soil walls for forming unless authorized by ENGINEER.

3.3 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings for elements embedded in or passing through concrete.

B. Coordinate work of other sections for the forming and setting of openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

C. Install accessories per manufacturer's instructions. Ensure items are not disturbed during concrete placement.

3.4 FORM FINISHES

A. Use forms with smooth rubbed, scrubbed, sand floated finishes that meet ACI 347 unless indicated otherwise.

B. For As-cast Finishes:

1. Install form panels in orderly arrangement with joints planned in approved relation to building elements.
2. Where panel joints are recessed or otherwise emphasized, locate form ties within joints, not within panel areas.
3. Where an as-cast finish is required, no grouting will be permitted in the finishing operation.

C. Textured Finishes: As indicated.

3.5 APPLICATION OF FORM RELEASE AGENT

A. Apply form release agent on formwork per manufacturer's instructions. Apply before placing reinforcing steel, anchoring devices, and embedded items.

3.6 FORM REMOVAL

A. Do not pry against face of concrete. Use only wooden wedges.

B. When repair of surface defects or finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Perform needed repairs or treatment required on such sloping surfaces at once, followed by specified curing.

D. Loosen wood forms for wall openings as soon as it can be accomplished without damage to concrete.

E. Formwork for columns, walls, sides of beams, and other members not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

F. Where no Reshoring is planned, leave forms and Shoring used to support weight of concrete in beams, slabs, and other concrete members in place until concrete has attained its specified strength.

G. Where Reshoring is planned, supporting formwork may be removed when concrete has reached 70 percent of specified strength, provided Reshoring is installed immediately.

H. When Shores and other vertical supports are so arranged that non-load carrying, form-facing material may be removed without loosening or disturbing Shores and supports, facing material may be removed at an earlier age.

3.7 RESHORING

A. When Reshoring is permitted or required, plan operations in advance and obtain approval.

B. During Reshoring do not subject concrete in beam, slab, column, or any other structural member to combined dead and construction loads and live loads in excess of loads permitted for developed concrete strength at time of Reshoring.

C. Place Reshores as soon as practical after stripping operations are complete, but in no case later than end of working day on which stripping occurs.

D. Tighten Reshores to carry required loads without over-stressing.

E. Leave Reshores in place until the concrete being supported has reached its specified strength.

F. For floors supporting Shores under newly placed concrete, level original supporting Shore or Reshore:

1. Reshoring system shall have a capacity to resist anticipated loads in all cases equal to at least 1/2 the capacity of the Shoring system.

2. Unless otherwise specified locate Reshores directly under a Shore.

3. In multistory buildings, extend Reshoring through a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that design loads of floors and supporting Shores are not exceeded.

G. Design, engineering, and construction of Shoring and Reshoring is the responsibility of the CONTRACTOR.

3.8 **REMOVAL STRENGTH**

A. When removal of formwork or Reshoring is based on concrete reaching a specified strength, it shall be assumed that concrete has reached this strength when either of the following conditions has been met:

1. When test cylinders, field cured along with the concrete they represent, have reached the specified strength.

2. When concrete has been cured per Section 03 39 00 for the same length of time as the site-cured cylinders that reached specified strength. Determine the length of time the concrete has been cured in the structure by cumulative number of days or fractions thereof, not necessarily consecutive, during which the air temperature is above 50 deg F and concrete has been damp or sealed from evaporation and loss of moisture.

3.9 **REUSE OF FORMS**

A. Do not reuse forms if there is any evidence of surface wear or defect which would impair quality of concrete surface.

B. Thoroughly clean and properly coat forms before reuse.

3.10 **FIELD QUALITY CONTROL**

A. Before commencing a pour, verify connections, form alignment, ties, inserts and Shoring are placed and secure.

B. Observe formwork continuously while concrete is being placed to verify that the forms are plumb and there are no deviations from desired elevation, alignment, or camber.

C. If during construction any weakness develops and false-work shows undue settlement or discoloration, stop work, remove affected construction if permanently damaged, and strengthen false-work.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Reinforcing steel bars, wire fabric or rod mats for cast-in-place concrete.

B. Support chairs, bolsters, bar supports, and spacers for supporting reinforcement.

1.2 REFERENCES

A. **AASHTO Standards**:

M254 Corrosion Resistant Coated Dowel Bars.

B. **ACI Standards**:

301 Structural Concrete for Buildings.

315 Concrete Reinforcement.

C. **ASTM Standards**:

A82 Steel Wire, Plain, for Concrete Reinforcement.

A185 Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.

A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

A706 Low-Alloy Steel Deformed Bars for Concrete Reinforcement.

C1116 Fiber-Reinforced Concrete and Shotcrete.

D3963 Epoxy-Coated Reinforcing Steel.

D. **AWS Standards**:

D1.1 Structural Welding Code Steel.

D1.4 Structural Welding Code Reinforcing Steel.

E. **CRSI Standards**:

Manual of Standard Practice.

1.3 SUBMITTALS

A. **Manufacturer's Certificate**: Submit mill test certificates of supplied concrete reinforcement, indicating physical and chemical analysis.

B. **Welder's certification**.

C. **Shop Drawings**:

1. Indicate sizes, spacings, locations, and quantities of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices.

2. When required, prepare Shop Drawings by an engineer who complies with Utah licensing law and is acceptable to agency having jurisdiction.

1.4 QUALITY ASSURANCE

A. Perform concrete reinforcement work per CRSI Manual of Standard Practice.

B. Comply with ACI 301.

C. Welders: Certified to comply with AWS D1.1 or AWS D1.4 as applicable.

1.5 ACCEPTANCE

A. Unless specified otherwise, chairs for supporting reinforcement in flat slabs are spaced as follows:

1. Three (3) feet maximum for No. 5 and smaller bars.

2. Five (5) feet maximum for bars larger than No. 5.

B. Dowels are placed on dowel baskets and properly aligned.

C. Epoxy and galvanized coatings are not chipped or cut. Ends of cut bars are epoxy coated or galvanize painted before placement.

D. Minimum covering over reinforcement is as specified.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fiber Reinforcement: Glass, ASTM C1116.

B. Reinforcement:

1. Grade 60 ksi deformed steel bars, ASTM A615 and supplementary requirements S1 or ASTM A706 for welding.

2. Welded wire fabric. Plain steel type, ASTM A185 in flat sheets or coiled rolls. Dimensions of the mesh 4”x 4” or as indicated.

C. Stirrups: Steel, ASTM A82.

D. Dowel Bars for Expansion Joints: Grade 60 ksi smooth steel bar, ASTM A615.

1. Galvanized or epoxy coated in roadway Pavements.

2. Provide plastic cap to permit longitudinal movement of dowel bar within concrete section equal to joint width plus 1/4 inch.

3. For load transfer joints, paint bars with 1 coat of paint conforming to AASHTO M254 and coat 1/2 with grease.

E. Coatings for Corrosion Protection:

1. Epoxy coat, ASTM D3963.

2. Galvanized, Section 05 05 10.

2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type or an acceptable patented system.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during installation and placement of concrete.

2.3 FABRICATION

A. Fabricate reinforcement, ACI 315 providing for concrete cover.

B. Locate reinforcing splices not indicated on Drawings at points of minimum stress. Indicate location of splices on Shop Drawings.

C. Weld reinforcing bars; with AWS D1.4.

PART 3 EXECUTION

3.1 PLACING

A. All reinforcement to be free of loose mill scale, loose or thick rust, dirt, paint, oil or grease.

B. Place all reinforcement in the exact position indicated. With tie wire, tie bars together at all intersections except where spacing is less than 12 inches in each direction, in which case tie alternate intersections.

C. Maintain the distance from vertical forms and between layers of reinforcement by means of prefabricated chairs, ties, hangers, or other approved devices. Placing and fastening of reinforcement in each section of the Work must be approved before concrete is placed.

D. Overlap sheets of metal mesh one square plus six (6) inches to maintain a uniform strength. Securely fasten at the ends, edges, and supports to maintain clearances.

E. Flat Slab Work:

1. Support reinforcing steel of formed flat slabs with plastic chairs, precast concrete blocks or other non-oxidizing slab bolsters.
2. Size chairs or bolsters to position the steel in the exact location indicated.
3. Space chairs and bolsters not more than five (5) feet on centers in each direction.
4. Coat metal supports in contact with forms to prevent rust.
5. Tie down deck steel to beams or forms at regular intervals of not more than five (5) feet on centers along the beams or forms to prevent movement of steel during concrete placement.

3.2 **SPLICING**

A. Furnish all reinforcement in the full lengths indicated unless otherwise permitted. Splicing of bars, except where indicated is not permitted without ENGINEER's knowledge. Stagger splices where possible.

B. Unless indicated otherwise, overlap reinforcing bars a minimum of 30 diameters to make the splice. In lapped splices, place the bars and wire to maintain the minimum distance for clear spacing to the surface of the concrete.

C. Do not use lap splices on bars greater than No. 11 diameter unless approved.

D. Weld reinforcing steel only if indicated or if authorized in writing. Weld in conformance to AWS D1.4.

E. Do not bend reinforcement after embedding in hardened concrete.

F. Do not permit reinforcement or other embedded metal items bonded to the concrete, to extend continuously through any expansion joint, except dowels in floors bonded on only one side of joints.

3.3 **PLACING EMBEDDED ITEMS**

A. Place all sleeves, inserts, anchors and embedded items before concrete placement. Temporarily fill voids in embedded items to prevent entry of concrete.

B. Give all trades whose work is related to the concrete section (Section 03 30 04) ample notice and opportunity to introduce or furnish embedded items before concrete placement.

END OF SECTION

SECTION 03 30 04
CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Material requirements.

1.2 RELATED SECTIONS
A. 03 30 05 Concrete Testing
B. 03 30 10 Concrete Placement
C. 03 35 00 Concrete Finishing
D. 03 39 00 Concrete Curing
E. 03 40 00 Precast Concrete

1.3 REFERENCES
A. **ACI Standards**:
- 211.1 Selecting Proportions for Normal-Density and High-Density Concrete.
- 211.2 Selecting Proportions for Structural Lightweight Concrete.
- 211.3 Standard Practice for Selecting Proportions for No-Slump Concrete.
- 214 Evaluation of Strength Test Results of Concrete.
- 301 Specifications for Structural Concrete for Buildings.
- 305 Hot Weather Concreting.
- 306 Cold Weather Concreting.
- 318 Building Code Requirements for Reinforced Concrete.

B. **ASTM Standards**:
- C33 Concrete Aggregates.
- C39 Compressive Strength of Cylindrical Concrete Specimens.
- C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- C94 Ready-Mixed Concrete.
- C117 Material Finer than 75µ (No. 200) Sieve in Mineral Aggregates by Washing.
- C123 Lightweight Particles in Aggregate.
- C138 Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- C142 Clay lumps and Friable Particles in Aggregates.
- C143 Slump of Hydraulic-Cement Concrete.
- C150 Portland Cement.
- C172 Sampling Freshly Mixed Concrete.
- C227 Potential Reactivity of Cement-Aggregate Combinations (Mortar Bar Method).
- C231 Air Content of Freshly Mixed Concrete by the Pressure Method.
- C260 Air-Entraining Admixtures for Concrete.
- C289 Potential Reactivity of Aggregates (Chemical Method).
- C494 Chemical Admixtures for Concrete.
- C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- C595 Blended Hydraulic Cements.

C618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

C1064 Temperature of Freshly Mixed Portland Cement Concrete.

C1077 Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

C1116 Fiber-Reinforced Concrete and Shot Crete.

C1157 Blended Hydraulic Cement.

C1240 Use of Silica Fume as a Mineral Admixture in Hydraulic Cement Concrete, Mortar, and Grout.

C1260 Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).

C1293 Concrete Aggregates by Determination of Length Change of Concrete Due to Alkali-Silica Reaction.

C1567 Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).

C1602 Mixing Water Used in The Production of Hydraulic Cement Concrete.

CRD C662 Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

STP 15-C Manual on Quality Control of Materials.

1.3 **SUBMITTALS**

A. **Quality Assurance**:

1. Independent Laboratory: Submit names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM and ACI standards.
2. Mixing Equipment: Submit certification of plant equipment.

B. **Mix Design**: Allow ENGINEER 10 days to evaluate the submittal. Provide the following information.

1. Date of mix design. If older than 365 days from date of submission, recertify mix design.
2. Physical properties of the aggregate (this section article 2.3). Test results shall not be older 455 days from the date of submission. The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed.
3. Identify whether mix is for hot, cold, or normal weather placement.
4. Cement source, type and chemical composition.
5. Aggregate soundness and potential reactivity.
6. Average Strength (f_{cr}), per quality control chart.
7. Allowable range of slump and air content.
8. Water cement ratio.
9. Proportions of materials in the mix.
10. Unit weight.
11. Analysis of water if water is not potable.
12. Mortar bar or prism test results if a pozzolan is included in the mix.
13. Technical data sheets for additives to be used at the plant and at the job site. Certify additives are compatible with each other.

C. **Pre-approved Mix Design**: Submit name and address of Supplier and Suppliers mix design number if available.

D. **Before Changing Mix Design**: Submit a new design and allow ENGINEER 10 days to evaluate the changes.

1.4 **QUALITY ASSURANCE**

A. **General**:

1. Use a laboratory that follows and complies with ASTM C1077.
2. Reject concrete that does not meet requirements of this section.

3. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.

B. **At Source**:

1. Do not change material sources, type of cement, air-entraining agent, water reducing agent, other admixtures except as allowed by mix design.
2. Store bagged and bulk cement in weatherproof enclosures. Exclude moisture and contaminants.
3. Prevent segregation and contamination of aggregate stockpiles.
4. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing.

C. **At Site**: Admixtures may be used for meeting hot or cold weather placement requirements with field or trial batch verification.

1.5 **ACCEPTANCE**

A. **Materials**:

1. Aggregate Source:
   a. Verify suitability of aggregate source.
   b. Verify aggregate gradation.
   c. Verify percent of combined aggregate passing No. 200 sieve.
2. At the Site:
   a. Verify mix identification, batch time, slump, air content, and temperature.
   b. Verify drum rotation is less than 300 revolutions.
3. At the Laboratory: Verify strength in 28 days.

B. **Defective Material**: Popouts, scaling, etc.

1. Price adjustment, Section 01 29 00 and Section 03 30 10.
2. Dispute resolution, Section 01 35 10.

PART 2 PRODUCTS

2.1 **CEMENT**

A. **General**:

1. Do not use air entraining cement except for hand mixed applications.
2. Do not use cement containing lumps or is partially set.
3. Do not mix cement originating from different sources.

B. **Hydraulic Cement**:

1. Hydraulic cement based on Sulfate Exposure Class as per ACI 318.

C. **Blended Hydraulic Cement**: The following are cement equivalencies when substituting blended cement for a Portland cement.

Table 1 – Cement Equivalencies

Portland Cement	Blended Cement	
ASTM C150	ASTM C595	ASTM C1157
Type I	IP/IL/IT	GU
Type II	IP/IL/IT (MS)	MS
Type III	IP/IL/IT (HE)	HE
Type IV	--	--
Type V	IP/IL/IT (HS)	HS

D. **Rapid Set Cement**: As above and as follows:

1. Initial set time: 15 minutes minimum.

2. Color: Acceptable to the ENGINEER.

2.2 **WATER**

A. Clean, non-staining, non-detrimental per ASTM C1602.

B. Screen out extraneous material.

C. Do not use alkali soil water.

2.3 **AGGREGATES**

A. Gravel, crushed gravel, crushed stone, crushed concrete, slag, sand or combination with the following physical properties.

Table 2 – Physical Properties

		Standard	Min	Max
Coarse Aggregate				
Wear (hardness or toughness), percent (a)		(a)	--	50
Soundness (5 cycles), percent	Na_2SO_4	C88	--	12
	Mg_2SO_4	C88	--	18
Coal and lignite (SG = 2.4 min.), percent (b)		C123	0.5	1.0
Clay lumps, friable particles, chert, percent		C142	--	7
Material finer than 200 sieve, percent		C117	--	1.0
Fine Aggregate				
Soundness (5 cycles), percent	Na_2SO_4	C88	--	10
	Mg_2SO_4	C88	--	15
Fineness modulus		C33	2.3	3.1
Coal and lignite (SG = 2.4 min.), percent (b)		C123	0.5	1.0
Clay lumps, friable particles, chert, percent		C142	--	3.0
Aggregate blend (meets one of the following)				
1. Average prism length change in 12 months, percent (c)		C1293	--	0.04
2. Average mortar bar length change in 16 days, percent (c)		C1260	--	0.10
3. Petrography limits, percent				
Quartz ..... (d)		C295	--	5.0
Chert or chalcedony.....			--	3.0
Tridymite or cristobalite			--	1.0
Opal			--	0.5
Natural glass in volcanic rock			--	3
4. Historical data acceptable to ENGINEER				

NOTES

(a) Wear retained on No. 8 sieve. For aggregate less than 1 1/2" use ASTM C131. For larger aggregates use ASTM C535.

(b) Organic impurities producing a dark color concrete may cause rejection.

(c) Prism length change and mortar bar length change based upon unmodified ASTM tests.

(d) Quartz must NOT be optically strained, micro-fractured, or microcrystalline in nature.

2.4 **ADDITIVES**

A. Calcium Chloride: Not allowed in reinforced concrete.

B. Air Entrainment: ASTM C260. For extrusion enhancement use non-vinsal resin.

C. Set Enhancement and Water Reducing Agents: ASTM C494.

1. Type A: Water reducing.
2. Type B: Set retarding.
3. Type C: Set accelerating.
4. Type D: Water reducing and set retarding.
5. Type E: Water reducing and set accelerating.
6. Type F: High range water reducing (super plasticizer). *
7. Type G: High range water reducing and set retarding. *

* Keep the relative durability factor of water reducing additives not less than 90 and the chlorides content (as Cl^-) not exceeding 1 percent by weight of the admixtures.

D. Pozzolan:

1. Natural or fly ash per ASTM C618.
2. Silica fume per ASTM C1240.

E. Special Admixtures: Allowed if mix design submittal is accepted:

1. Lithium nitrate based solution for control of reactive aggregates.
2. Calcium nitrite based solution for corrosion protection of reinforced structures subject to chloride-induced corrosion.
3. Shrinkage reducer for controlling drying shrinkage in concrete.
4. Viscosity modifier for enhancement of self-consolidating concrete or for workability.

2.5 **MIX DESIGN**

A. **Class**: Unless specified elsewhere, as follows.

1. Above Ground: 5000 minimum.
2. At Ground Level: 4000 minimum.
3. Underground: 4000 minimum.

B. **Selection of Cement**: ASTM C150, C595 or C1157.

1. Use Type II (or equivalent) cement unless otherwise specified.

C. **Selection of Aggregates**:

1. Maximum Particle Size:
   a. 1/5 of narrowest dimension between forms.
   b. 1/3 of depth of slab.
   c. 3/4 of minimum clear spacing between reinforcing bars.
2. Gradation: ASTM C33.
   a. Coarse Aggregate: Choose from the following grades. Gradations are based upon percent of material passing sieve by weight.

Table 3 – Coarse Aggregate Gradation				
Sieve	**Grade**			
	357 (2")	**467 (1.5")**	**57 (1")**	**67 (3/4")**
2-1/2"	100	--	--	--
2 Inch	95 - 100	100	--	--
1-1/2"	--	95 – 100	100	--
1"	35 – 20	--	95 – 100	100
3/4"	--	35 – 70	--	90 – 100
1/2"	10 – 30	--	25- 60	--
3/8"	--	10 – 30	--	20 – 55
No. 4	0 – 5	0 – 5	0 – 10	0 – 10

b. Fine Aggregate:

Table 4 – Fine Aggregate Gradation	
Sieve	**Percent Passing by Weight**
3/8"	100
No. 4	95 to 100
No. 16	45 to 80
No. 50	10 to 30
No. 100	2 to 10

c. Silts and Clays: The amount of material smaller than the No. 200 sieve in any combined gradation sample is limited to the following percentages by weight of the combined sample:

1) 1.75 percent maximum for concrete subject to abrasion.

2) 3.0 percent maximum for all other concrete.

3. Optimized Gradation: ASTM C33.

a. A well-graded combined aggregate gradation may replace the gradation requirements in Tables 4 and 5 for all concrete classes when designed and approved as such.

b. Proportion well-graded combined aggregates to meet the Tarantula Curve Gradation Band in Table 5. The combined gradation must be within the boundary limits for each sieve size. Refer to the UDOT Materials Manual of Instruction, Section 975: Guidelines for Well-Graded Combined Aggregate Gradations for a graphical representation of the Tarantula Curve.

1) Slip formed pavements: retain at least 15 percent on the sum of the #8, #16 and #30 sieves.

2) Slip formed pavements: retain between 24 and 34 percent of fine sand on the sum of the #30 through #200 sieves.

3) Flowable applications: retain at least 20 percent on the sum of the #8, #16 and #30 sieves.

4) Flowable applications: retain between 25 and 40 percent of fine sand on the sum of the #30 through #200 sieves.

Table 5 – Tarantula Curve Gradation Band	
Sieve	**Percent Retained by Weight**
2 in.	0
1 ½ in.	0 to 5
1 in.	0 to 16
¾ in.	0 to 20
½ in.	4 to 20
3/8 in.	4 to 20
No. 4	4 to 20
No. 8	0 to12
No. 16	0 to 12
No. 30	4 to 20
No. 50	4 to 20
No. 100	0 to 10
No. 200	0 to 2.3

D. **Selection of Pozzolan**:

1. General: If a blended aggregate passes an unmodified ASTM C1293 test, use of a pozzolan is CONTRACTOR's choice. If aggregate does not pass ASTM C1293, select a pozzolan (or blended cement, or both) and determine the effective dosage to meet one of the following tests:

a. ASTM C1567. The expansion of a cement-pozzolan-aggregate job-mix mortar bar is less than or equal to 0.10 percent at 16 days. Do not use this test if a lithium admixture is used in the job-mix.

b. ASTM C1260. The expansion of a cement-pozzolan-aggregate job-mix mortar bar is less than or equal to 0.10 percent at 16 days. Do not use this test if a lithium admixture is used in the job-mix.

c. CRD C662 (Lithium Mitigation). The expansion of a cement-pozzolan-aggregate job-mix mortar bar determined after 28 days of exposure.

d. Submit to ENGINEER a quality history of the mitigator identifying a minimum of 20 of the most current ASTM C618 analysis.

2. Fly Ash (Class F): Allowed as a cement replacement under the following conditions:

a. If utilized, replace minimum 10 percent of the cement.

b. Use replacement percentage as required to meet performanve tests (C1260, C1293, C1567, or CRD C662) and project performance requirements.

3. Natural Pozzolan (Class N): Allowed as a cement replacement if the 14-day expansion test (ASTM C1567) with job aggregates, job cement and natural pozzolan does not exceed the 14-day expansion test of job aggregates, job cement and Class F fly ash.

4. Silica Fume: Allowed as a supplemental cementitious material or cement replacement material.

5. Lithium: Allowed as a cement replacement if the 28-day expansion test (CRD C662) with job aggregates, job cement and lithium does not exceed the 28 day expansion test

E. **Selection of Mix Properties**: Select and proportion the mix to produce appropriate strength, durability and workability. Use ACI 211.1, 211.2, or 211.3, and meet the following properties and limitations:

Table 6 – Mix Properties and Limitations						
Properties		**Standard**	**Class**			
			2000	**3000**	**4000**	**5000**
Compressive Strength (fc') at 28 days, psi, minimum		C39	2000	3000	4000	5000
Compressive Strength at 7 days, psi, (for reference only)		C39	1340	2010	2680	3350
Average Strength, psi (fcr)		214	(a)	(a)	(a)	(a)
Cement content, bags, minimum (b)		--	4.5	5.5	6.5	7.5
Water-cement ratio (by weight), maximum (c)		318	(d)	(d)	0.44	
Entrained air, percent (based upon aggregate size) (e)	2"	C231	3.0 to 6.0	4.5 to 7.5	4.0 to 7.0	
	1-1/2"		"	"	4.5 to 7.5	
	1"		"	"	5.0 to 7.5	
	3/4"		"	"	5.0 to 7.5	
Slump		C143	(d)	(d)	(d)	(d)

NOTES

(a) The amount by which average strength (fcr) exceeds compressive strength (fc') is based upon statistical assurance that no more than 1 test in 100 tests will fall below compressive strength (fc').

(b) May be adjusted by supplier to meet project strength and cure time requirements. Demonstrate compliance through trial batch.

(c) Includes all cementitious materials including Portland Cement, fly ash, pozzolans or other cementitious additives.

(d) Specific to exposure conditions and finishing need.

(e) Comply with ACI 211.1 if air content is changed.

(f) 1 bag of cement = 94 pounds.

1. Cold Weather: Follow ACI 306 temperature requirement as per Section 03 30 10 CONCRETE PLACEMENT, Article 3.4 Concrete Placement.

2. Hot Weather: Follow ACI 305 temperature requirement as per Section 03 30 10 CONCRETE PLACEMENT, Article 3.4 Concrete Placement.

3. Concrete Deposited Under Water: Increase cement content one (1) class for concrete placed under water or use viscosity modifying admixture.

F. **Selection of Fiber Reinforcement**: The basis for determining material proportions of fiber-reinforced concrete is the Supplier's responsibility per ASTM C1116 subject to mix property requirements of this Section. Unless specified otherwise provide synthetic fibers.

2.6 **SOURCE QUALITY CONTROL**

A. **General**: Collect Samples randomly. Do not change source quality control sampling point.

B. **Aggregate**:

1. Soundness, ASTM C88.
2. Alkali-silica reactivity, ASTM C289, C1567, C1260, C227 and C1293.
3. Petrographically examine fine and coarse aggregate sources once every three (3) years, ASTM C295.

C. **Concrete Mix**: Obtain samples per ASTM C172 and run the following tests:

1. Compressive strength, ASTM C39.
2. Unit weight, ASTM C138.

3. Slump, ASTM C143.
4. Air, ASTM C231.
5. Temperature, ASTM C1064.

D. **Concrete Quality Charts**: Comply with ACI 214 and ACI 301. Plot new results and identify trends on quality control charts that comply in form to ASTM STP 15-C. Show the Specified Strength (f_c'), the required Average Strength (f_{cr}), and the compressive strength versus date of Sample.

E. **Equipment**: Certify at least every two (2) years through the services of a design professional licensed in the State of Utah, that plant equipment complies with requirements of the National Ready Mixed Concrete Association and ASTM C94.

1. Transit Trucks: Equip transit trucks with plates indicating total volume, agitating volume and mix volume.
2. Weights and Measures: Comply with regulatory requirements of State of Utah.

PART 3 EXECUTION

3.1 INSTALLATION

A. Placement, Section 03 30 10.

3.2 FIELD QUALITY CONTROL

A. Truck Mixed Concrete (Dry Batch): ASTM C94.

1. Truck Mixer: Fill drum no more than 63 percent of the gross drum volume and no less than two (2) cubic yards. Use drum manufacturer's recommended mixing speed (between 12 – 18 rpm).
2. Truck Agitator: Do not fill drum greater than 80 percent of the gross drum volume. Use drum manufacturer's recommended agitating speed (between 2 – 6 rpm).

B. Mixing Plant: ASTM C94.

1. Use option C and requirements in this Section for preparing ready-mixed concrete.
2. Use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.
3. Mixing time must exceed 80 seconds after adding air entrainment admixture.

C. Hand Mixing:

1. Do not hand mix batches larger than 0.5 cubic yard.
2. Hand mix only on a watertight platform.
3. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency before adding water.

END OF SECTION

SECTION 03 30 10
CONCRETE PLACEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete placement for slabs on grade, slabs on fill, structural building frame, and other concrete components.

1.2 REFERENCES

A. **ACI Standards**:

301 Structural Concrete for Buildings.

305 Hot Weather Concreting.

306 Cold Weather Concreting.

309 Consolidation of Concrete.

B. **ASTM Standards**:

C881 Epoxy-Resin-Base Bonding Systems for Concrete.

C1059 Latex Agents for Bonding Fresh to Hardened Concrete.

1.3 SUBMITTALS

A. **Batch Delivery Ticket**: For each batch delivered to site, identify:

1. Date and Project description.
2. Producer and plant.
3. Name of contractor.
4. Serial number of ticket.
5. Mix identification number or code.
6. Truck number and time dispatched.
7. Volume of concrete.
8. Type and amount of cement.
9. Total water and water/cement ratio.
10. Water added for receiver of concrete and receiver's initials.
11. Admixture types.
12. Separate weights of fine and coarse aggregate.
13. Statement of whether batch is pre-mixed at plant or mixed in transit.

B. **Record of Placed Concrete**: Identify date of record, location of pour, quantity, air temperature, and CONTRACTOR's quality control test Samples taken.

C. **Bonding Compound**: Identify product name, type, and chemical analysis.

1.4 QUALITY ASSURANCE

A. Provide ACI certified finishers.

B. Remove and replace any placed concrete suffering hot or cold weather damage.

C. For control testing follow Section 03 30 05 requirements.

1.5 ACCEPTANCE

A. General:

1. Price adjustment, Section 01 29 00. CONTRACTOR may request ENGINEER determine appropriate Modifications or payment adjustments to pay for Defective work.
2. Retesting by CONTRACTOR, Section 01 35 10 and Section 03 30 05.

B. Concrete work that fails to meet any of the following requirements will be considered defective. Replace Defective Work at no additional cost to OWNER:

1. Placement:

a. Reinforcing steel size, quantity, strength, position, damage, or arrangement is not as specified or does not comply with code.

b. Formwork differs from required dimensions or location in such a manner as to reduce concrete's strength or load carrying capacity or physical esthetics.

c. Workmanship likely to result in deficient strength.

2. Finishing:

a. Concrete exposed to view has defects that adversely affect appearance.

b. Slab tolerances of Section 03 35 00 are not met.

3. Protection:

a. Method of curing is not as specified.

b. Inadequate protection of concrete during early stages of hardening and strength development from:

1) temperature extremes.

2) rapid moisture loss.

c. Mechanical injury, construction fires, accidents, or premature removal of formwork likely to result in deficient strength development.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete: Section 03 30 04. Class as indicated:

1. For roadway cuts, Section 33 05 25.

B. Bonding Compound: ASTM C1059. Either polyvinyl acetate base or acrylic base latex:

1. Use type I in areas not subject to high humidity or immersion in water with minimum bond strength of 400 psi.

2. Use type II in areas subject to high humidity or immersion in water with minimum bond strength of 1250 psi.

C. Vapor Retarder: 10 mil thick clear polyethylene sheet. Type recommended for below grade application.

D. Forms: Section 03 11 00.

E. Reinforcement: Section 03 20 00.

F. Coverings and Curing Compound: Section 03 39 00.

G. Shrinkage Compensating Grouts: Section 03 61 00.

H. Epoxy Adhesive: Section 03 61 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items to be cast into concrete are accurately placed and held securely.

B. Verify slump, air content range, mix identity, and batch time on delivery ticket matches mix design.

C. Verify slab steel mats are supported by steel chairs, precast concrete blocks, or other slab bolsters. Do not pour if absent.

3.2 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26.

B. Notify ENGINEER no later than 24 hours before commencement of concrete placement.

C. Do not allow construction loads to exceed structural capacity.

D. Clean previously placed concrete. Apply bonding compound per manufacturer's instructions.

E. At locations where new concrete is dowelled to existing work, drill, remove dust, insert and pack steel dowels with shrink compensating grout, and expansion caps where required.

3.3 **DELIVERY**

A. Concrete Temperature: Keep mixed concrete temperature before placement between 60 deg F. and 90 deg F.

B. Slump and Air Content: Keep within allowable ranges.

C. Transport Time:

Air Temperature	**Time After Initial Batching**
Less than 90 deg F	1–1/2 hours
Greater than 90 deg F	1–hour (without retarder)
Greater than 90 deg F	1–1/2 hours (with retarder)

To increase time past 1-1/2 hours, a hydration stabilizer that is acceptable to Supplier may be used.

D. Tempering:

1. Water may be added if all following conditions are met:
   a. The mix design water/cement ratio is not exceeded.
   b. The delivery ticket allows for addition of water based upon water/cement ratio.
   c. The amount of water added is accurately measured to within 1 gallon of the design addition.
   d. Water addition is followed by three (3) minutes of mixing at mixing speed before discharge.
   e. Supplier and CONTRACTOR mutually agree on who is authorized to add water.
2. **Do not add water after 1 cubic yard of concrete has discharged from the delivery vehicle.**

E. Super-plasticizer: Comply with manufacturer's requirements. If none, then as follows:

1. If added at site, add agent using injection equipment capable of rapidly and uniformly distributing admixture to concrete. Before discharge, mix for a minimum of five (5) minutes at a drum rate not less than 12 rpm or more than 15 rpm.

2. If added at plant, do not deliver to site unless batch delivery ticket displays water/cement ratio before super-plasticizer addition.

3.4 **CONCRETE PLACEMENT**

A. In General: ACI 301.

1. Do not disturb reinforcement, inserts, embedded parts, and formed joints.
2. Do not break or interrupt successive pours such that cold joints occur.
3. Honeycomb or embedded debris in concrete is not acceptable.

B. Hot Weather Placement: ACI 305. If the rate of evaporation approaches 0.2 lb./ft^2/hr. precautions against plastic shrinkage cracking are necessary. (i.e. dampening Subgrade and forms; placing concrete at the lowest possible temperature; erecting windbreaks and sunshades; fog sprays; use of evaporation retardants; or rescheduling time of placement).

C. Cold Weather Placement: ACI 306. Accelerating admixture may be used in concrete work placed at ambient temperatures below 50 deg F Use of admixtures will not relax cold weather placement, curing, or protection requirements. . If air temperature is forecasted to fall below 32 deg F. within 14 days of placement, proceed as follows:

1. Provide cold weather protection (cover, insulation, heat, etc.).

2. Do not use chemical "anti-freeze" additives in the concrete. (NOTE: this does not apply to normal accelerators.)

3. Do not proceed with the placement of concrete until the temperature of all contact surfaces is 35 degrees F and ambient temperature is ascending.

4. Protect the concrete from freezing until a compressive strength of at least 90 percent of design strength has been achieved, determined by either:

a. Maturity meter. Refer to AASHTO T 325, or.

b. Field cured cylinders.

5. Adequately vent combustion-type heaters that produce carbon monoxide.

6. When applying external heat, maintain moist conditions to avoid excessive moisture loss from concrete.

7. When removing heat, limit drop in temperature of concrete surfaces to 20 degrees F during any 12 hour period until the surface temperature of the concrete reaches that of the atmosphere.

D. Concrete Temperature: Keep mixed concrete temperature at time of placement between 60 deg F and 90 deg F

E. Do not disturb reinforcement, inserts, embedded parts, and formed joints.

F. Do not break or interrupt successive pours such that cold joints occur.

G. Honeycomb or embedded debris in concrete is not acceptable.

3.5 JOINTS AND JOINT SEALING

A. Steel edging and jointing tools are acceptable. Preferred are magnesium, aluminum or wood tools

B. Pavement joint sealing, Section 32 13 73.

3.6 CONSOLIDATION

A. Keep spare vibrator available during concrete placement operations.

B. Follow ACI 309 requirements.

3.7 CURING

A. Section 03 39 00. Use a membrane forming compound unless specified otherwise.

3.8 FINISHING

A. Section 03 35 00 and as follows.

Table 1 – Finishes

Type of work	Finish
Sidewalks, garage floors, ramps, exterior concrete Pavement	Broom or belt
Exterior platforms, steps, and landings, exterior and interior pedestrian ramps, not covered by other finish materials	Non-slip
Surfaces intended to receive bonded applied cementitious applications	Scratched
Surfaces intended to receive roofing, except future floors, waterproofing membranes, and roof surfaces that are future floors or sand bed terrazzo	Floated
Floors and roof surfaces that are floors intended as walking surfaces or to receive floor coverings	Troweled
Unpainted concrete surfaces not exposed to public view	Rough as-cast form finish
Unpainted concrete surfaces exposed to public view	Smooth as-cast form finish
Concrete surfaces to receive paint or plaster	Grout cleaned finish

3.9 PROTECTION AND REPAIR

A. Protection, Section 01 66 00:

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, graffiti, and mechanical injury.

2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

B. Repair:

1. Modify or replace concrete not conforming to required levels, lines, details, and elevations.

2. Structural analysis and additional testing may be required at no additional cost to OWNER when the strength of a structure is considered potentially deficient.

3. To patch imperfections refer to Section 03 35 00 requirements.

4. Remove graffiti and mechanical injury.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Finishing interior and exterior concrete surfaces.

1.2 REFERENCES

A. ACI Standards:

303 Guide to Cast-in-Place Architectural Concrete Practice.

1.3 SUBMITTALS

A. Name, type, chemical analysis and manufacturer's recommended rate of application for liquid chemical hardener.

1.4 PROJECT CONDITIONS

A. Protect adjacent materials and finishes from dust, dirt and other surface or physical damage during finishing operations. Provide protection as required and remove from site at completion of Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Masonry Mortar and Grout: Section 04 05 16.

B. Dry Shake: Blend of metallic or mineral aggregate with Portland cement concrete in proportions recommended by manufacture.

C. Proprietary Materials: If permitted or required, proprietary compounds may be used in lieu of or in addition to foregoing blended materials. Use such compounds per manufacturer's recommendations.

D. Liquid-Chemical Hardener: Colorless, aqueous solution containing a blend of magnesium fluosilicate, zinc fluosilicate and a wetting agent. Mixture contains not less than two (2) pounds fluosilicate per gallon and does not interfere with adhesives and bonding.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which work of this section will be performed.

B. Correct conditions detrimental to timely and proper finishing.

C. Do not proceed until unsatisfactory conditions are corrected.

3.2 FINISHING HORIZONTAL SLABS

A. **Do not apply water (i.e. sprinkle) to any surface of concrete when finishing slabs.**

B. Edges and Joints: Tools may be made out of steel. Preferred is wood, aluminum or magnesium.

C. Tolerances:

1. Class A: 1 in 1000.
2. Class B: 1 in 500.
3. Class C: 1 in 250.

D. Float Finish: After concrete has been placed, consolidated, struck-off, and leveled, do not work further until ready for floating:

1. Begin floating when water sheen has disappeared and surface has sufficient stiffness.

2. During or after first floating, check planeness of entire surface with a 10 feet long straightedge applied at two (2) or more different angles.

3. Cut down high spots and fill low spots to the required tolerance.

4. Refloat slab immediately to a uniform sandy texture.

E. Trowel Finish:

1. Do not use steel trowel or a power trowel on exterior concrete or on concrete that contains more than three (3) percent air.

2. First troweling shall produce smooth surface relatively free of defects but which may still show some trowel marks.

3. Second troweling after surface has stiffened shall make finished surface essentially free of trowel marks, uniform in texture and appearance.

4. On surfaces intended to support floor coverings, grind off defects that would show through floor covering.

F. Broom or Belt Finish: Sweep surface with brushes, rakes, tines or burlap belt before final set.

G. "Dry Shake" Finish: Give the surface a floated finish. Evenly apply approximately 2/3 of a blended unsegregated material:

1. Begin floating immediately after application of first "dry shake".

2. After material has been embedded by floating, apply remainder of blended material to surface at right angles to previous application.

3. Make second application heavier in any areas not sufficiently covered by first application.

4. Immediately follow with second floating.

5. After selected material has been embedded by second floating, complete operation with a broomed, floated, or troweled finish, as indicated.

H. Non-slip Finish: Give surface a "dry shake" application, using crushed ceramically bonded aluminum oxide particles. Apply at 25 pounds per 100 square feet.

I. Exposed Aggregate Finish: Immediately after surface of concrete has been leveled to tolerance and surface water has dissipated, spread aggregate uniformly over surface to provide complete coverage to the depth of a single stone:

1. Embed aggregate into surface by light tamping.

2. Float surface until embedded aggregate is fully coated with mortar and surface has been brought to tolerance.

3. Start exposure of aggregate after matrix has hardened sufficiently to prevent dislodgment.

4. Flow ample quantities of water, without force, over surface of concrete while matrix encasing aggregate is removed by brushing with a fine bristle brush.

5. Continue until aggregate is uniformly exposed.

6. An approved chemical retarder sprayed onto freshly floated surface may be used to extend working time.

J. Chemical-Hardener Finish: Apply liquid chemical-hardener finish to interior concrete floors where indicated. Do not apply liquid chemical hardener on floor areas scheduled to receive synthetic matrices terrazzo, setting beds for tile, terrazzo, vinyl flooring, or like items. Apply hardener after complete curing and drying of concrete surface per manufacturer's recommendations. Evenly apply each coat, and allow 24 hours for drying between coats. After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.3 **FINISHING FORMED SURFACES**

A. General:

1. Allow concrete to cure not more than 72 hours before commencing surface finish operations, unless approved otherwise.

2. Revise the finishes as needed to secure approval.

B. As-Cast Form Finish:

1. Rough: Patch defects, chip or rub off fins exceeding 1/4 inch height.

2. Smooth: Patch tie holes and defects and remove fins completely:

a. When surface texture is impaired and form joints misaligned, grind, bush-hammer, or correct affected concrete.

b. Slurry grout areas evidencing minor mortar Leakage to match adjacent concrete.

c. Repair major mortar Leakage as a defective area.

d. When workmanship is less than acceptable standard, provide one of rubbed finishes at no additional cost to OWNER.

C. Rubbed Finishes:

1. Smooth: Remove forms and perform necessary patching as soon after placement as possible:

a. Finish newly hardened concrete no later than 24 hours following form removal.

b. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.

2. Grout Cleaned: Undertake no cleaning operations until all contiguous surfaces are completed and accessible:

a. Wet surface of concrete sufficiently to prevent absorption of water from grout.

b. Apply grout uniformly.

c. Immediately after grouting, scrub surface with cork float or stone to coat surface and fill voids.

d. While grout is still plastic, remove excess grout by working surface with rubber float or sack.

e. After surface whitens from drying, rub vigorously with clean burlap.

f. Keep damp for at least 36 hours after final rubbing.

3. Cork Floated: Remove forms within two (2) to three (3) days of placement where possible:

a. Remove ties.

b. Remove all burrs and fins.

c. Dampen wall surface.

d. Apply mortar with firm rubber float or with trowel, filling all surface voids.

e. Compress mortar into voids.

f. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer.

g. Produce final texture with cork float using a swirling motion.

D. Unformed Finish:

1. After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces.

2. Float to texture that is reasonably consistent with formed surfaces.

3. Continue final treatment on formed surfaces uniformly across uniformed surfaces.

E. Blasted Finish:

1. Perform abrasive blasting within 24 to 72 hours after casting.

2. Coordinate with form work construction, concrete placement schedule, and formwork removal to ensure that surfaces are blasted at the same age for uniform results.

3. Reapply curing protection after blast finishing

F. Architectural Finish, ACI 303:

1. Tooled Finish:

a. Dress thoroughly cured concrete surface with electric, air, or hand tools to uniform texture, and give a bush hammered surface texture.

b. Remove sufficient mortar to exposed coarse aggregate in relief and to fracture coarse aggregate for tooled finish.

G. Patched Finish:

1. Repair defective areas:

a. Remove honeycomb and defective concrete to sound concrete.

b. Make edges perpendicular to surface or slightly undercut.

c. Feather edges are not permitted.

d. Dampen area to be patched and at least six (6) inches surrounding it to prevent absorption of patching mortar water.

e. Prepare bonding grout.

f. Mix to consistency of thick cream.

g. Brush into surface.

2. Tie Holes: Unless indicated otherwise, after being cleaned and thoroughly dampened, fill tie hole solid with patching mortar.

3. Make patches in concrete closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial and obtain a good color match with concrete when both patch and concrete are cured and dry:

a. Mix white and gray Portland cement as required to match surrounding concrete to produce grout having consistency of thick paint.

b. Use a minimum amount of mixing water.

c. Mix patching mortar in advance and allow to stand without frequent manipulation, without addition of water, until it has reached stiffest placeable consistency.

d. After initial set, dress surfaces of patches manually to obtain same texture as surrounding surfaces.

4. After surface water has evaporated from patch area, brush bond coat into surface:

a. When bond coat begins to lose water sheen, apply patching mortar.

b. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface.

c. Leave undisturbed for at least one (1) hour before final finish.

d. Keep patched area damp for 72 hours or apply curing compound.

e. Do not use metal tools in finishing an exposed patch.

5. Where as-cast finishes are indicated, total patched area may not exceed 1 in 500 of as-cast surface. This is in addition to form tie patches, if ties are permitted to fall within as-cast areas.

6. In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate:

a. Outer 1 inch of patch shall contain same aggregate as surrounding concrete.

b. For aggregate transfer finish, patching mixture shall contain same selected colored aggregates.

c. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

END OF SECTION

SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Concrete curing requirements.

1.2 REFERENCES
A. **ACI Standards**:
- 301 Structural Concrete for Buildings.
- 305 Hot Weather Concreting.
- 306 Cold Weather Concreting.

B. **ASTM Standards**:
- C171 Sheet Materials for Curing Concrete.
- C1315 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.3 SUBMITTALS
A. Curing agent data sheet.

B. Curing plan. Describe estimated cure quantity and procedure.

C. Manufacturer certificates, Section 01 33 00 that shows product meets performance criteria.

D. Manufacturer's recommended installation procedures which, when accepted by ENGINEER, will become the basis for accepting or rejecting installed product.

1.4 QUALITY ASSURANCE
A. Use workers knowledgeable of ACI 301, 305, 306.

1.5 PRODUCT HANDLING
A. Protect materials of this Section before, during, and after installation.

B. Protect the work and materials of other trades.

C. In the event of damage, immediately make replacements and repair at no additional cost to OWNER.

1.6 WEATHER LIMITATIONS
A. Above 75 deg F, ACI 305

B. Below 55 deg F, ACI 306.

PART 2 PRODUCTS

2.1 COVERS
A. Water or Fog-spay: Clean, non-staining and non-detrimental to concrete.

B. Sheet Coverings: White waterproof paper, polyethylene film, or polyethylene coated burlap sheet complying with ASTM C171.

C. Mat Coverings: Clean roll goods of cotton or burlap fabric.

D. Insulating Coverings: Non-staining curing blankets.

2.2 MEMBRANE FORMING COMPOUND
A. Material:
1. Styrene-acrylic.
2. Styrene-butadiene.
3. Alpha-methylstyrene.

B. Reference: ASTM C1315:
1. Type II Class A or B (white pigmented).
2. Type ID Class A (clear with fugitive dye).

C. Volatile Organic Compounds (VOC): Comply with local, state and federal requirements.

PART 3 EXECUTION

3.1 PREPARATION

A. *DO NOT DILUTE CURING COMPOUNDS.*

B. Do not use membrane forming curing compound on surfaces that are to receive hardeners.

C. Commence curing operation within 20 minutes after finishing.

3.2 APPLICATION – COVERS

A. Water: Apply water-fog spray or ponding.

B. Absorptive Mat: Place absorptive mat to provide coverage of concrete surfaces and edges. Lap over adjacent absorptive covers. Thoroughly saturate with water and keep continuously wet.

C. Moisture-Retaining Sheet: Place cover in widest practicable width with sides and ends lapped and sealed to prevent moisture loss. Repair any holes or tears during curing period.

D. Formed Surface Curing: Cure formed concrete surfaces, including underside of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period. If forms are removed before curing completion, applying cure film or penetrant or use methods indicated above, as applicable.

3.3 APPLICATION – MEMBRANE FORMING COMPOUND

A. Apply coating continuously and uniformly. Follow manufacturer's recommendations.

B. Protect continuity of film coatings and repair damage during cure period.

C. If forms are removed before expiration of cure period, apply coating to unprotected areas.

3.4 CONCRETE CURE TEMPERATURE

A. During cure period, eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete.

3.5 SCHEDULE

A. Concrete Exposed to Potable Water (as in Water Storage reservoirs):
1. Moisture cover curing, or
2. Acrylic cure, or
3. Styrene acrylic silane co-polymer cure.

END OF SECTION

SECTION 03 40 00
PRECAST CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pre-cast concrete, complete with required connecting and supporting devices.

1.2 REFERENCES

A. **ACI Standards**:

318 Building Code Requirements for Reinforced Concrete. This reference standard includes ASTM material standards.

B. **ASTM Standards**:

A36: Structural Steel.

C478 Precast Reinforced Concrete Manhole Sections.

C857 Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

C858 Underground Precast Concrete Utility Structures.

C891 Installation of Underground Precast Concrete Utility Structures.

C. **AWS Standards**:

D1.1 Structural Welding Code Steel.

D1.4 Structural Welding Code Reinforcing Steel.

D. **PCI Standards**:

Design Handbook.

MNL-116 Quality Control and Assurance for Plant Production of Prestressed Concrete.

MNL-117 Quality Control and Assurance for Plant Production of Architectural Precast Concrete.

1.3 DESIGN CRITERIA

A. Design structural precast concrete units, ACI 318 and PCI design handbook.

B. Design utility precast units, ASTM C857 and C858.

C. Under direct supervision of a design professional who is fully experienced in design of units.

D. Design units to support required stripping and handling loads, and live, dead and construction loads.

E. Design component connections to provide adjustment to accommodate misalignment of structure during installation.

1.4 SHOP DRAWINGS

A. Prepare Shop Drawings under seal of a licensed design professional.

B. Submit Shop Drawings, Section 01 33 00.

C. Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, and erection support points. Unit identification marks to appear on all manufactured units.

D. Do not proceed with fabrication until Shop Drawings have been accepted.

1.5 QUALITY ASSURANCE

A. Manufacturer:
1. Prestressed: PCI certified.
2. Precast Concrete Units: PCI or NPCA certified
3. Precast Utility Structures and Pipe: ACPA certified.

B. Transporter: Acceptable to manufacturer.

C. Erector:
1. Prestressed: PCI certified.

2. Precast: Has five (5) years minimum experience in erecting precast units.

D. Welders: Certified, AWS D1.1 and AWS D1.4.

1.6 **DELIVERY, STORAGE AND HANDLING**

A. Handle precast units in positions consistent with their shape and design. Lift and support only from support points indicated on Shop Drawings.

B. Embedded Lifting or Handling Devices: Capable of supporting units in positions anticipated during manufacture, storage, transportation, and erection.

C. Block and laterally brace units while stored at manufacturers. Provide lateral bracing that is sufficient to prevent bowing and warping that is clean, nonstaining, and will not inhibit uniform curing of exposed surfaces.

D. Provide edges of units with adequate protection to prevent staining, chipping, or spalling of concrete.

E. Unless otherwise approved in writing, do not deliver units to job site until required for installation.

PART 2 PRODUCTS

2.1 **CONCRETE**

A. Above Ground: 5000 psi minimum, Section 03 30 04 and ACI 318.

B. Underground: Class 4000 minimum, Section 03 30 04 and ASTM C478 or ASTM C858.

2.2 **ACCESSORIES**

A. Connecting and Supporting Devices: Steel, ASTM A36.

B. Bolts, Nuts, and Washers: High-strength steel. Section 05 05 23.

C. Reinforcement: Grade 60 billet steel bars, Section 03 20 00 plain finish

2.3 **FABRICATION**

A. Maintain plant records and quality control program during production of structural precast concrete. Make records available to ENGINEER.

B. Use molds which are rigid and constructed of material that will result in uniform finished products.

C. If self consolidating concrete is NOT used, vibrate concrete to ensure proper consolidation, elimination of unintentional cold joints, and minimize entrapped air on surface.

D. Fabricate required connecting devices, plates, angles, items fit to steel framing members, bolts and accessories.

E. Ensure reinforcing steel, anchors, inserts, plates, angles, and other cast-in items are sufficiently embedded, anchored and property located.

F. Ensure finished surfaces of precast structural units are uniform.

G. Cure units under identical conditions to develop specified concrete quality, and minimize appearance blemishes such as non-uniformity, staining or surface cracking.

2.4 **DESIGN DEVIATIONS**

A. Deviation: Provide installation equivalent to basic intent without additional cost to OWNER. Deviations from exact required cross-section will be permitted only with approval.

B. Manufacturer's Proposed Design: Supported by complete design calculations and drawings. When requested, submit design calculations for review bearing seal and signature of a licensed design professional.

2.5 **OPENINGS**

A. Provide required openings, six (6) inches or larger. If approved, smaller sizes may be field constructed by coring or sawing.

2.6 **FINISHES**

A. General: Required finish will be described in one of the following paragraphs. If no finish is indicated or selected by ENGINEER, provide Standard Finish.

B. Standard Finish: Produced in forms such as plastic or metal lined that impart a smooth finish to the concrete. Small surface holes, normal form joint marks, minor chips and spall are acceptable if approved. Major or unsightly imperfections, honeycomb or structural defects are not acceptable.

C. Commercial Finish: Produced in forms such as plywood or lumber that impart texture to concrete. Remove fins and large projections. Fill holes over 3/8 inch. Make faces true and well defined. Correct exposed ragged edges by rubbing or grinding.

D. Architectural Grade A Finish: Produced in forms such as plastic or metal lined that impart smooth finish to concrete. Fill holes over 1/4 inch in diameter with sand-cement paste. Grind smooth form offsets or fins over 1/8 inch. Coat with neat cement paste using float. After paste coat has dried, rub with burlap to remove loose particles.

E. Architectural Grade B Finish: Produced in forms such as plastic or metal lined that impart smooth finish to concrete. Fill holes over 1/4 inch in diameter with sand-cement paste. Grind smooth form offsets or fins over 1/8 inch.

F. Special Finishes: Sandblasting, acid washing, retarders or form liners as approved by ENGINEER. Special finishes require submittal of two 12 x 12 inch Samples showing a representative color and texture to be used.

G. Painted Finishes: On concrete to be painted, use a form release agent acceptable to the paint manufacturer.

2.7 **REPAIR**

A. Repair of damaged units is acceptable if structural integrity or appearance is not impaired.

2.8 **ALLOWABLE TOLERANCES**

A. Length: Plus or minus 3/4 inch, or plus or minus 1/8 inch per 10 feet of length, whichever is greater, or as indicated.

B. End Squareness: 1/2 inch maximum.

C. Blockouts: 1 inch of centerline location indicated.

PART 3 EXECUTION

3.1 **INSTALLATION**

A. Do not install precast units until concrete has attained its design compressive strength.

B. Install members plumb, level, and in alignment within PCI MNL-116 or PCI MNL-117 and indicated limits of erection tolerances.

C. Clean weld marks or other marks, debris, or dirt from exposed surfaces of units.

D. Install underground utility precast units per ASTM C891.

3.2 **PERFORMANCE REQUIREMENTS**

A. Conduct inspections, perform testing, and make repairs or replace unsatisfactory precast units as required.

B. Rejection: Units may be rejected for any one of the following:
1. Exceeding specified installation tolerances.
2. Damaged during construction operations.
3. Exposed-to-view surfaces which develops surface deficiencies.
4. Other defects as listed in PCI MNL-116 or PCI MNL-117.

END OF SECTION

DIVISION 31

EARTH WORK

SECTION 31 05 13
COMMON FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Common fill material.

1.2 REFERENCES

A. **ASTM Standards**:

C136 Sieve Analysis of Fine and Coarse Aggregates.

D448 Classification for Sizes of Aggregate for Road and Bridge Construction.

D1883 CBR (California Bearing Ratio) of Laboratory-Compacted Soils.

D2487 Classification of Soils for Engineering Purposes.

D2844 Resistance R-Value and Expansion Pressure of Compacted Soils.

D3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

F1647Organic Matter Content of Putting Green and Sports Turf Root Zone Mixes.

1.3 SUBMITTALS

A. **General**. If a change in source of material is required, submit name of Supplier, source and gradation analysis of material before delivery to site.

B. **Topsoil**. Submit certification from topsoil Supplier assuring topsoil product meets requirements in this Section.

C. **Borrow, granular borrow, granular backfill borrow, recycled fill, sand, gravel.** Before delivering material to site, identify:

1. Name of Supplier and source.
2. Gradation, classification and CBR.
3. Percent composition of reclaimed bitumionous concrete or Portland cement concrete included in the mix.

D. **Slag, pumice, scoria**. Identify name of supplier, source, and density.

1.4 QUALITY ASSURANCE

A. Use a laboratory that complies with ASTM D3740 and Section 01 45 00 requirements.

B. Reject fill products that do not meet requirements of this section.

C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.

1.5 ACCEPTANCE

A. **General**:

1. Acceptance is by Lot. One (1) lot is one (1) day productionl
2. Dispute resolution, Section 01 35 10.

B. **Roadway Backfill**: Sub-lot size is 5,000 tons.

PART 2 PRODUCTS

2.1 BORROW

A. Classifications A-1-a through A-4, ASTM D3282.

2.2 **GRANULAR BORROW**

A. Classifications A-1-a, A-1-b, A-2-4, or A-3, ASTM D3282.

B. Material meets design CBR-value (ASTM D1883) or R value (ASTM D2844) for suitability of source, not for project control testing.

2.3 **GRANULAR BACKFILL BORROW**

A. Classification A-1, ASTM D3282.

B. Well graded.

C. Particle size, two (2) inch maximum.

D. Material meets design CBR-value (ASTM D1883) or R value (ASTM D2844) for suitability of source, not for project control testing.

2.4 **RECYCLED FILL**

A. Material: Pulverized Portland cement concrete, pulverized bitumionous concrete pavement or combination, either mixed with or not mixed with a new aggregate.

B. Gradation: Meet requirements of this section based upon use; e.g. borrow, granular borrow, granular backfill borrow, etc.

2.5 **NATIVE**

A. When allowed by ENGINEER, material obtained from Excavations may be used as fill, provided organic material, rubbish, debris, and other objectionable materials are removed and CONTRACTOR has submitted the appropriate proctor density data (see Section 31 23 26).

2.6 **CLAY**

A. Classification CL, CL-ML, or ML, ASTM D2487.

B. Free of organic matter, frozen material, debris, rocks, and deleterious materials.

C. Homogeneous, relatively uniform.

2.7 **SAND**

A. Friable river or bank aggregate, free of loam and organic matter. Graded as follows.

Sieve	Percent Passing by Weight
3/8	100
100	1 – 10

2.8 **GRAVEL**

A. Material: Rock, stone, or other high quality mineral particle or combination.

Sewer Rock.

Nominal Size	ASTM Size No.
3.5 to 1.5”	1
2.5 to 1.5”	2
2 to 1”	3
1.5 to 3/4”	4
1 to 1/2"	5

Pea Gravel.

Nominal Size	ASTM Size No.
3/4 to 3/8”	6
1/2 to No. 4	7
3/8 to No. 8	8
No. 4 to No. 16	9
No. 4 (screenings)	10

2.9 **TOPSOIL**

A. Chemical Characteristics:

1. Acidity and alkalinity range: pH 5.5 to 7.7
2. Soluble Salts: Less than 2.0 mmhos/cm.
3. Sodium Absorption Ratio (SAR): less than 3.0
4. Nitrogen (NO_3N): 48 ppm minimum
5. Phosphorus (P): 11 ppm minimum
6. Potash (K): 130 ppm minimum
7. Iron (Fe): 5.0 ppm minimum

B. Physical Characteristics:

1. Fertile, loose, friable.
2. Free of weeds, subsoil, lumps or clods of hard earth, plants or their roots, sticks, toxic minerals, chemicals and stones greater than 1-1/2 inch diameter.
3. Composition, ASTM D2487:

Material	**Percent**
Sand	15 – 60
Silt	10 – 70
Clay	5 – 30
Organic matter	2 - 5

Humus determined by ASTM F1647. Peat may be used as an organic amendment to meet the humus requirements.

2.10 **SLAG, PUMICE, SCORIA**

A. Chemically inert, porous, durable, free draining.

Table 1 – Gradation and Density

Criteria		**Slag**	**Pumice**	**Scoria**
Gradation, US Sieve	3”	100	100	100
	1 1/2"	80 – 100	80 – 100	80 – 100
	3/4"	20 – 100	--	--
	3/8”	0 – 20	0 – 20	40 – 100
	No. 4	0 – 10	0 – 10	10 – 70
	No. 16	--	0 – 65	0 – 40
	No. 50	--	0 – 40	0 – 25
	No. 200	0 – 3	0 – 3	0 – 15
Density, pound per cubic foot		85 – 100	75 – 80	60 – 75

NOTES:
(a) Gradations are based upon percent of material passing sieve by weight, ASTM C136.
(b) Density measured as in-place target.

2.11 **SOURCE QUALITY CONTROL**

A. Verify gradation, ASTM C136.

B. Select samples on a random location and time basis.

C. If tests indicate materials do not meet specified requirements, change materials and retest at no additional cost to OWNER.

PART 3 EXECUTION Not Used

END OF SECTION

SECTION 31 05 15
CEMENT TREATED FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Controlled low-strength material (CLSM) requirements.

1.2 REFERENCES

A. **ASTM Standards**:

C25 Chemical Analysis of Limestone, Quicklime, and Hydrated Lime.

C33 Concrete Aggregates.

C39 Compressive Strength of Cylindrical Concrete Specimens.

C51 Terms Relating to Lime and Limestone (As Used by the Industry).

C110 Physical Testing of Quicklime, Hydrated Lime, and Limestone.

C150 Portland Cement.

C260 Air-Entraining Admixtures for Concrete.

C494 Chemical Admixtures for Concrete.

C595 Blended Hydraulic Cement.

C618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

D4832 Preparation and Testing of Soil-Cement Slurry Test Cylinders.

1.3 SUBMITTALS

A. Material analysis.

B. Mix design.

1.4 QUALITY ASSURANCE

A. Use a laboratory that complies with ASTM D3740 and Section 01 45 00 requirements.

B. Reject fill products that do not meet requirements of this section.

C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.

1.5 ACCEPTANCE

A. **General**:

1. Acceptance is by lot. One (1) lot is one (1) day production.

2. If non-complying fill material has been installed and no bid or negotiated price for the material is specified, apply pay adjustment against cost of work requiring CLSM as part of its installation. Section 01 29 00.

3. Dispute resolution, Section 01 35 10.

B. **Lime or Asphalt Cement Treated Backfill**: Data sheet.

C. **Cement Treated Flowable Fill**:

1. Sublot Size:

a. Trench backfill, 100 cubic yards.

b. Roadway backfill, 250 cubic yards

2. Strength: At ENGINEER's discretion and ASTM C39, a lot with deficient sub-lot strength may be accepted on a pay reduction basis (Section 01 35 10), or accepted at 50 percent pay if a sub-lot is in Reject, or the lot shall be removed and replaced.

Pay Factor	**PSI Below 28 day Compressive Strength**
1.00	Less than 60
0.75	60 to 120
Reject	greater than 120

1.6 **SAFETY**

A. Protect persons and property from lime or quicklime handling.

PART 2 PRODUCTS

2.1 **CEMENT TREATED FLOWABLE FILL**

A. Cement:

1. Types I or II, ASTM C150.
2. Types IP or IS, ASTM C595.

B. Aggregate: Non-plastic sand, ASTM C33.

C. Water: Non-detrimental.

D. Admixtures: As needed for strength and flowability.

1. Pozzolan (fly ash), ASTM C618.
   a. Class C or Class F.
   b. Loss on ignition plus or minus three (3) percent.
2. Air: Four (4) percent to 35 percent, , ASTM C173.

E. Strength: 60 psi maximum in 28 days, ASTM D4832.

2.2 **LEAN CONCRETE**

A. Physical Characteristics:

1. Cement: Type II, ASTM C150.
2. Slump: One (1) to four (4) inches.
3. Strength: 750 psi plus or minus 100 psi in seven (7) days.

B. Aggregate: Non-plastic, crushed, Section 03 30 04. Submit substitute gradations for acceptance before beginning construction. Do not substitute gradations without approval.

2.3 **LIME TREATED FILL**

A. Aggregate: Non-plastic Aggregate base course, Section 32 11 23; or Common fill, Section 31 05 13.

B. Water: Non-detrimental.

C. Lime: Dry hydrated lime or quicklime, ASTM C25, ASTM C51, and ASTM C110:

1. Minimum Chemical Composition:
   a. Hydrated Lime ($Ca(OH)_2$): 85 percent of chemical.
   b. Quicklime (CaO): 90 percent of chemical.
2. Gradation: ASTM C136. Percent passing by weight.

Table 1 - Hydrated Lime and Quicklime		
Sieve	**Hydrated Lime ($Ca(OH)_2$)**	**Quicklime (CaO)**
No. 4	100	100
No. 30	95 – 100	–
No. 100	–	0 – 20
No. 200	75 – 100	–
NOTES (a) Hydrated Lime: Washed sample for 15 minutes plus or minus 1 minute, ASTM C110. (b) Quicklime: Dry sieve only.		

2.4 **ASPHALT TREATED FILL**

A. Cement:

1. Medium-setting emulsified asphalt, Section 32 12 09.
2. Medium-cure cutback asphalt, Section 23 12 09.

B. Aggregate:

1. Non-plastic aggregate base course, Section 32 11 23.
2. Common fill, Section 31 05 13.
3. RAP, Section 32 12 16.18.

C. Water: Non-detrimental.

PART 3 EXECUTION

3.1 **FIELD QUALITY CONTROL**

A. Cement Treated Fill (Flowable Fill):

1. Mold three (3) test cylinder, ASTM D4832. Test cylinders at 28 days.
2. If a cylinder test shows improper sampling, molding, handling, curing, or testing, discard the cylinder. Use remaining cylinders to determine average strength.

END OF SECTION

SECTION 31 05 19
GEOTEXTILES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Geotextile fabrics.

1.2 REFERENCES

A. ASTM Standards:

D146 Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.

D276 Identification of Fibers in Textiles.

D882 Tensile Properties of Thin Plastic Sheeting.

D3786 Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method.

D4354 Sampling of Geotextiles for Testing.

D4355 Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon - Arc Type Apparatus).

D4491 Water Permeability of Geotextiles by Permittivity.

D4533 Trapezoid Tearing Strength of Geotextiles.

D4632 Breaking Load and Elongation of Geotextiles (Grab Method).

D4751 Determining Apparent Opening Size for a Geotextile.

D4759 Determining Specification Conformance of Geosynthetics.

D4833 Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

D4873 Identification, Storage, and Handling of Geotextiles.

E96 Water Vapor Transmission of Materials.

E154 Testing Materials for Use as Vapor Barriers Under Concrete Slabs and as Ground Cover in Crawl Spaces.

1.3 DEFINITIONS

A. **MARV**: Acronym for minimum average roll value. A statistical value of a particular test property embracing 95 percent confidence level of all possible values of that property. For a normally distributed set of data, it is approximately the mean value plus and minus two standard deviations.

B. **Permitivity**: - of geotextiles, the volumetric flow rate of water per unit cross sectional area per unit head under laminar flow conditions, in the normal direction through a geotextile.

1.4 SUBMITTALS

A. Submit before use:

1. Sample of geotextile.
2. Manufacturer's certificate that each fabric complies with requirements of this section.

1.5 DELIVERY STORAGE AND HANDLING

A. Label fabric, ASTM D4873.

B. Deliver geotextile dry, in a wrapping that protects it from the elements during shipping and storage. Keep fabric dry.

C. Protect geotextile from ultraviolet light and temperature greater than 140 deg F until application.

1.6 QUALITY ASSURANCE

A. Provide manufacturer’s on-site technical supervision and assistance.

PART 2 PRODUCTS

2.1 GEOTEXTILE - GENERAL

A. **Stated values in this section are for non-critical, non-severe applications.**

B. Fabric consists of synthetic fibers at least 85 percent by weight of polyolefins, polyesters or polyamides.

C. Resistant to chemical attack, rot and mildew.

D. No tears or defects that adversely alter fabric's physical properties.

E. All numerical values represent minimum average roll values in the weaker principal direction.

2.2 STABILIZATION-SEPARATION GEOTEXTILES

A. Woven or non-woven fabric. Meet the following properties and survivability ratings.

Table 1 – Stabilization-Separation Geotextile

	Standard	MARV			
		Moderate		High	
		Woven	Non Woven	Woven	Non Woven
Grab tensile strength, lbs.	D4632	180	115	270	180
Grab elongation, percent	D4632	<50	>50	<50	>50
Trapezoid tear, lbs.	D4533	70	40	100	75
Puncture resistance, lbs.	D4833	70	40	100	60
Apparent opening size (AOS), US sieve, minimum.	D 4751	30	60	30	60

Construction Survivability

Subgrade, CBR	1		1 – 2		> 2	
Tire pressure, psi	<50	>50	<50	>50	<50	>50
6 inches cover thickness	NR	NR	H	H	M	M
12 inches cover thickness	NR	NR	H	M	M	M
18 inches cover thickness	H	M	M	M	M	M

NOTES
(a) H = High; M = Medium; NR = Not Recommended

2.3 SILT FENCE GEOTEXTILE

A. Use woven fabric. Meet standard or high performance properties:

Table 2 – Silt Fence Geotextile

	Standard	MARV	
		Standard	High
Grab tensile strength, lbs.	D4632	90	120
Grab elongation, percent	D4632	< 40	< 40
Flux, gal/min/ft^2	D4491	15	90
Apparent opening size (AOS), US sieve, minimum.	D4751	20	30
Ultraviolet degradation, percent	D4355	70	90

NOTES
(a) Percent of grab elongation retained determined after ultraviolet light and water, ASTM D4355 for 500 hours.
(b) No deviation from any requirement due to presence of seams.

B. High performance fence to have tape yarns in one principle direction only.

C. Add stabilizers or inhibitors to make filaments resistant to sunlight or heat deterioration.

D. Finish edges to prevent outer yarn from pulling away from the fabric.

E. Sheets of fabric may be sewn or bonded together. Provide minimum width recommended by manufacturer.

F. Manufactured with pockets for posts, hems with cord, or with posts pre-attached using staples or button head nails.

2.4 EROSION CONTROL GEOTEXTILES

A. Class A erosion control applications are those where the geotextile is used under conditions where installation stresses are greatest (more severe than Class B), i.e., stone placement height should be no more than five (5) feet and stone weights should not exceed 250 pounds.

B. Class B erosion control applications for geotextiles are used under conditions where installation stresses are more severe than Class C, i.e., stone placement height should be less than three (3) feet and stone weights should not exceed 250 pounds.

C. Class C erosion control applications are those where the geotextile is used in structures or under conditions where the geotextile is protected by a sand cushion or by "zero drop height" placement of stone.

D. Use woven or non-woven fabric.

Table 3 – Erosion Control Geotextile

	Standard	MARV		
		Class A	Class B	Class C
Grab tensile strength, lbs.	D4632	300	200	100
Grab elongation, percent, min.	D4632	15	50	50
Puncture resistance, lbs.	D4833	100	60	30
Trapezoid tear, lb.	D4533	80	50	40
Flux, gal/min/ft^2	D4491	25	25	25
Apparent opening size (AOS), US sieve, minimum	D4751	60	60	60
Ultraviolet degradation, percent	D4355	70	70	70
Permittivity, sec.$^{-1}$	D4491	0.1	0.1	0.1

NOTES

(a) Percent of grab elongation strength retained determined after ultraviolet weathering, ASTM D4355 for 500 hours.

(b) Permittivity number reflects typical not minimum values for this test method only. The k value of the geotextile shall be greater than the k value of the soil.

2.5 ROADWAY PAVEMENT GEOTEXTILES

A. Sheet Fabric: Non-woven. Heat bonded only on one side to assist in preventing bleed through of tack coat and sticking of fibers to wheels of lay-down equipment.

Table 4 – Roadway Paving Geotextile			
	Standard	MARV	
		Standard duty	Heavy Duty
Grab tensile strength, lbs.	D4632	80	120
Grab elongation, percent	D4632	50	50
Asphalt retention, gal/yd^2	--	0.2	0.3
Melting point, deg F	D276	300	300
Ultraviolet degradation, percent	D4355	70	70
Apparent opening size (AOS), US sieve, minimum	D4751	60	60
NOTES (a) Percent of grab elongation retained determined after ultraviolet weathering, ASTM D4355 for 500 hours.			

B. Crack Patch Fabric: Needle-punched non-woven coated with an Asphalt Binder and a rubberized asphalt adhesive.

Table 5 – Crack Patching Geotextile		
	Standard	MARV
Strip tensile, lbs/in.	D882	50
Puncture resistance, lb	E154	200
Permeance, perms	E69 Method B	0.10 (max)
Pliability	D146	No crack in fabric or rubberized asphalt
NOTES (a) Strip tensile uses 12 inch/minute test speed and 1 inch initial distance between grips. (b) Pliability uses 180 degree bend on 1/4 inch mandrel at –25 deg F		

2.6 **DRAINAGE GEOTEXTILES**

A. Class A drainage applications are for fabrics where installation stresses are more severe than Class B, i.e. very coarse sharp angular aggregate is used, a heavy degree of compaction (greater than or equal to 95 percent relative to a standard proctor density, Section 31 23 26) is specified, or depth of trench is greater than 10 feet deep.

B. Class B drainage applications are those where fabric is used with smooth graded surfaces having no sharp angular projections, no sharp angular aggregate, compaction requirements are light, (less than 95 percent standard proctor, Section 31 23 26), and trenches are less than 10 feet deep.

C. Use non-woven fabric.

Table 6 – Drainage Geotextile			
	Standard	MARV	
		Class A	Class B
Grab tensile strength, lbs.	D4632	200	100
Grab elongation, percent, minimum	D4632	50	50
Puncture strength, lbs.	D4833	60	30
Trapezoid tear, lbs.	D4533	50	40
Flux, gal/min/ft^2	D4491	25	25
Apparent opening size (AOS), US sieve, minimum.	D4751	60	60
Permittivity, sec.$^{-1}$ (b)	D4491	0.1	0.1
NOTES (a) Percent of grab elongation retained determined after ultraviolet weathering, ASTM D4355 for 500 hours. (b) Permittivity number reflects typical not minimum values for this test method only. The k value of the geotextile shall be greater than the k value of the soil.			

2.7 **WEED BARRIER GEOTEXTILE**

A. Use non-woven fabric.

Table 7 – Weed Barrier Geotextile		
	Standard	MARV
		Standard
Grab tensile strength, lbs.	D4632	90
Grab elongation, percent, minimum	D4632	50
Puncture strength, lbs.	D4833	25
Trapezoid tear, lbs.	D4533	30
Apparent opening size (AOS), US sieve, minimum.	D4751	50
Ultraviolet degradation, percent	D4355	70
NOTES (a) Percent of grab elongation retained determined after ultraviolet weathering, ASTM D4355 for 500 hours.		

2.8 **POSTS**

A. Minimum length, four (4) feet.

B. Steel: Round, U shaped, T shaped, or C shaped with a minimum weight of 1.3 pounds per foot, and have projections for fastening wire.

C. Wood:

1. Soft wood posts at least three (3) inches in diameter, or nominal 2 x 4 inches and straight to provide a fence without noticeable misalignment.
2. Hard wood post providing a minimum cross sectional area of 2.25 square inches.

D. Fasteners for Wood Posts:

1. Wire staples No. 17 gage minimum with a crown at least 3/4 inches wide and legs at least 1/2 inch long.
2. Nails 14 gage minimum, 1 inch long with 3/4 inch button heads.

2.9 **SOURCE QUALITY CONTROL**

A. Sampling practices, ASTM D4354.

B. Conformance verification, ASTM D4759.

PART 3 EXECUTION

3.1 STABILIZING POOR LOAD BEARING SOILS

A. Remove all organic material larger than 1 inch in diameter from the subgrade and grade to elevations required for overlaying backfill.

B. Compact subgrade to the extent allowed by substrate condition.

C. Roll fabric onto subgrade so subgrade remains smooth. Do not dag.

D. Fold or overlap geotextile in direction of drainage.

Table 8 - Geotextile Overlap

Soil CBR Rating	Overlap Required	
	Unsewn, inches	Sewn, inches
Less than 1	--	4
1 - 2	36	4
2 - 3	30	3
3 - 5	24	--
Greater than 5	18	--

NOTES

(a) Sewn seams both factory and field seams shall conform to 90 percent of the grab tensile strength requirements.

E. Place granular material on top of fabric and spread carefully to insure no puncture. Minimum backfill lift on fabric, six (6) inches.

F. Cover fabric with 12 inches of sand before placing rock larger than four (4) inches diameter on fabric.

G. Avoid sudden stops or turning motions by equipment operating on aggregate placed over the fabric.

H. Compact backfill soils over fabric to 95 percent or greater relative to a standard proctor density, Section 31 23 26.

I. Repair any puncture by covering with new fabric using the same overlap dimensions indicated in Table above.

3.2 SILT FENCE

A. Beginning work means acceptance of existing conditions.

B. The quantity of temporary silt fences may be increased, decreased, or eliminated entirely at CONTRACTOR's discretion at no additional cost to OWNER. Maintain the silt fence until the Work is accepted or until the fence and silt accumulations are removed.

C. Clear area of any debris and obstructions that may damage geotextile.

D. Place post in all low points.

E. Install posts a maximum of eight (8) feet apart with at least 18 inches in the ground. If not possible to achieve depth, secure posts to prevent overturning.

F. Attach filter fabric by wire, cord, pockets, staples, nails, or other effective means:

1. When using a wire support fence, provide at least six (6) horizontal wires with a minimum of 12 gage wire. Space vertical wires six (6) inches maximum. Secure geotextile to the up slope side of the post. Extend wire into the Trench a minimum of two (2) inches and extend a maximum of 36 inches above the ground surface.

G. Install fabric so six (6) to eight (8) inches of fabric is left at the bottom to be buried. Splice together only at support posts with a minimum overlap of 18 inches. Extend buried portion six (6) inches deep and the rest upstream of the fabric fence.

H. Sediment Removal: Remove sediment before deposit reaches 1/2 of the height of the silt fence, or extend height of silt fence. After removal of sediment, dress landscape.

I. Schedule of Locations: Typical locations include the toe of fill slopes, the downhill side of fill slopes, the downhill side of large cut areas, and at natural drainage areas. Limit geotextile materials to handle an area equivalent to 1,000 square feet per 10 feet of fence. Use caution should site slope be steeper than 1:1, and water flow rates exceed 1 cubic foot per second per 10 feet of fence face.

3.3 **EROSION CONTROL**

A. Install fabric in locations shown on the Drawings.

B. Unless specified elsewhere, overlap geotextile at least 2 feet (2) at all longitudinal and transverse joints, or the geotextile shall be sewn.

C. If overlapped, place geotextile so upstream sheet overlaps downstream sheet.

D. For placement on slopes, overlap the next downhill strip.

E. Anchor the geotextile by using key trenches or aprons at the crest and toe of the slope.

F. Pins, usually 18 inches in length, may be helpful in securing geotextile during installation.

G. Repair: Place patch over damaged area and extend three (3) feet beyond the perimeter of any tear or damage.

3.4 **ROADWAY PAVING FABRICS**

A. Preparing Bituminous Concrete Surface:

1. Brush road surface clean of debris, dust and gravel. Remove all water from surface and allow to dry.
2. Patch holes and level uneven areas with bituminous concrete.
3. Fill cracks between 1/8 inch to 1/2 inch with asphalt cement. Allow cement to cure before geotextile placement.
4. Clean cracks larger than 1/2 inch to a depth of 3 inches and fill with bituminous concrete. Where pavement is severely cracked, rutted, deformed or distressed, secure approval for providing an bituminous concrete leveling course before geotextile placement.

B. Tacking Bituminous Surface for Pavement Fabric: Use tack asphalt recommended by fabric manufacturer. Apply tack as follows:

1. Dry pavement surface; 0.20 to 0.30 gallons per square yard. Within street intersections, on steep grades and in zones where vehicle speed changes are commonplace, reduce the application rate to no less than 0.20 gallons per square yard.
2. Heavy duty fabrics; 0.30 to 0.40 gallons per square yard.
3. Provide a tack width equal to geotextile width plus six (6) inches.
4. Apply tack only as far in advance of geotextile installation as is appropriate to insure a tacky surface at the time of geotextile placement.
5. Allow tack time to cure with no moisture remaining before placing the geotextile and overlay.
6. Clean excess tack material from the road surface.

C. Fabric Placement:

1. Place fabric into the asphalt tack with a minimum amount of wrinkling or folding. Slit and lay flat wrinkles or folds in excess of 1 inch.
2. Shingle lap all transverse joints and slit folds or wrinkles in the direction of the paving operation.
3. Maximize geotextile contact with the pavement surface by brooming or pneumatic rolling.
4. Additional hand placed asphalt tack may be required at laps and repairs.

D. Protection and Repair:

1. Do not allow traffic except necessary construction equipment and emergency vehicles to drive on the fabric.
2. Turn paver and other vehicles gradually and keep turning to a minimum to avoid movement and damage to the geotextile. Do not permit abrupt starts and stops.
3. Remove and replace damaged geotextile with the same type of geotextile, and shingle lap the overlaps in the direction of paving. Restrict overlaps to a maximum of six (6) inches.

3.5 **SUBSURFACE DRAINAGE**

A. Excavate trench to size and depth indicated.

B. Cut fabric to width required and place in trench. Prevent damage to geotextile.

C. Overlap geotextile 12 inches or the full width of the trench, whichever is less at the top of trench.

D. Overlap successive pieces of geotextile a minimum of 12 inches in the direction of flow.

E. Place fill to hold fabric in place.

F. Repair any damage to geotextile by placing patches extending three (3) feet in all directions beyond the damaged area.

3.6 **WEED BARRIER**

A. Preparation:

1. Remove sharp objects, large stones and undesirable vegetation.

2. If placing geotextile over existing bed, cut an "X" over each plant and push geotextile under plant base. If placing over new bed, roll geotextile over soil and cut an "X" for each plant hole. Fold excess geotextile under and cover with specified landscaping materials.

B. Surface Cover: Provide at least four (4) inches of cover on all areas on the geotextile unless otherwise specified by ENGINEER. If using large landscape rock, increase thickness of cover material over geotextile to three (3) times the diameter of the largest rock material. Do not leave any portion of geotextile exposed to direct sunlight.

C. Repair: Repair immediately. Clear the damaged area plus an additional three (3) feet and apply geotextile patch.

D. Maintenance: Maintain surfaces and supply additional landscape materials where necessary, including areas affected by erosion.

3.7 **FIELD QUALITY CONTROL**

A. Reject fabric at the time of installation, if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, handling or storage.

END OF SECTION

SECTION 31 05 21
GEOGRIDS AND GEOCOMPOSITES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Geogrid and geocomposite reinforcement in embankments, over subgrades, in granular bases, and in roadway pavements.

1.2 REFERENCES

A. **AASHTO Standards:**

R50 Geosynthetic Reinforcement of the Aggregate Base Course of Flexible Pavement Structures

T289 Determining pH of Soil for Use in Corrosion Testing.

B. **ASTM Standards**:

D276 Melting Point Minimum.

D4354 Sampling of Geotextiles for Testing.

D4355 Resistance to Loss of Load Capacity under UV light and Weathering.

D4759 Determining Specification Conformance of Geosynthetics.

D4873 Identification, Storage, and Handling of Geotextiles.

D6637 Determining Tensile Properties of Geogrid.

D7737 Load Transfer Capability.

D7748 Flexural Rigidity of Geogrids, Geotextiles and Related Products.

C. **ASCE Publications:**

1. Giroud, J.P., and Han, J. (2004). "Design Method for Geogrid-Reinforced Unpaved Roads. Part I – Development of Design Method." Journal of Geotechnical and Geoenvironmental Engineering, 130 (8), 775-786.

2. Giroud, J.P., and Han, J. (2004). "Design Method for Geogrid-Reinforced Unpaved Roads. Part II – Calibration and Applications." Journal of Geotechnical and Geoenvironmental Engineering, 130 (8), 787-797.

D. **EPA Standards:**

9090 - Compatibility Test for Wastes and Membrane.

E. **FHWA Standards**:

NHI-09-087 Corrosion/Degradation of Soil Reinforcement for MSE Walls and Reinforced Soil Slopes.

NHI-10-024 Design and Construction of MSE Walls and Reinforced Soil Slopes – Volume I.

NHI-10-025 Design and Construction of MSE Walls and Reinforced Soil Slopes – Volume II.

F. **GRI Standards**:

GG9Torsional Behavior of Bidirectional Geogrids When Subjected to In-Plane Rotation

1.3 DEFINITIONS

A. **BCG**: Acronym for base course geogrid.

B. **Geocomposite**: Fabric composed of a geogrid and either a geotextile or a tack film.

C. **LAG**: Acronym for large aggregate geogrid.

D. **MARV**: Acronym for minimum average roll value (defined in Section 31 05 19).

E. **MSE**: Acronym for mechanically stabilized earth.

F. **SAG**: Acronym for small aggregate geogrid.

1.4 SUBMITTALS

A. Submit the following at least one (1) week prior to product placement.

1. Geogrid product data and sample.
2. Geocomposite product data and sample.
3. Manufacturer's warranty.
4. Installer's warranty.
5. Tack coat grade.
6. Information requested by ENGINEER.

B. If a bituminous surface is placed concurrent with the reinforcement, check temperature requirements and minimum thicknesses. Submit daily report to ENGINEER. Report the following.

1. Tack temperature (minimum 4 times per day).
2. Tack application rate (minimum 4 times per day).
3. Bituminous concrete temperatures (minimum 4 times per day).
4. Bituminous concrete thickness (minimum 4 times per day using depth probe after initial breakdown rolling).
5. Average tack application rate based on yield calculation using applicator weights and measured surface area

1.5 **DELIVERY STORAGE AND HANDLING**

A. Label, handle and store product, ASTM D4873.

B. Prevent mud, wet concrete, epoxy or other deleterious materials from coming in contact with and affixing to in-place geogrid and geocomposite materials.

C. Protect product as recommended by the manufacturer. This may include protection from ultraviolet light, moisture, high or low temperatures, or roll orientation during storage.

D. Cover product within 14 days of deployment.

1.6 **QUALITY ASSURANCE**

A. **Pre-Placement Conference**: Arrange a conference at least 48 hours prior to installation of geogrid or geocomposite. Attendees are ENGINEER, Inspector, Supplier, and installer. Discuss installation and inspection procedures and the following.

1. Location.
2. Overlap.
3. Tensioning (if required).
4. Construction equipment and installation practices.
5. Critical items that can affect design criteria or warranty.

B. **Supplier or Manufacturer**:

1. For embankment installations and mechanically stabilized earth (MSE) structures provide at least two (2) days of on-site supervision and technical assistance.
2. For roadway projects, provide one (1) day's on-site assistance.

1.7 **ACCEPTANCE**

A. **Pavement Subgrade**: Geogrid equivalence for subgrade stabilization should be determined based on the Giroud-Han method (this section article 1.2).

B. **Roadway Structures**: Geogrids utilized as part of the pavement structure should be reviewed based on the AASHTO R50.

C. **MSE Structures**: If CONTRACTOR requests substituting a rectangular or square geogrid for a triangular geogrid, CONTRACTOR must show the structural benefit and stability of a rectangular or square geogrid is equivalent to or better than the triangular geogrid. As a minimum the following conditions must be met.

1. For large aggregate geogrids (LAG) the aperture pitch is between 1.7 and 2.2 inches.
2. For small aggregate geogrids (SAG) the aperture pitch is between 0.5 and 0.9 inches.

1.8 **WARRANTY**

A. Manufacturer or Supplier: Warrant product to meet the specifications.

B. Installer: Warrant workmanship for two (2) years.

PART 2 PRODUCTS

2.1 GEOGRIDS AND GEOCOMPOSITES - GENERAL

A. Synthetic fiber at least 85 percent by weight of polypropylene, polyethylene, polyester, polyvinyl alcohol, fiberglass, modified polymer, or polyamide.

B. Resistant to chemical attack, rot and mildew, EPA 9090.

C. No tears or defects that will adversely alter properties of product.

2.2 GEOGRID FOR EMBANKMENTS

A. For environments tested in accordance with AASHTO T289, (FHWA-NKI-09-85):

1. Polypropylene (PP) can be used where pH is 3 or greater. Do not use when pH is below 3.

2. High denisty polyethylene (HDPE) can be used where pH is 3 ot 9. Do not use when pH is below 3 or above 9.

3. Were pH is 3 to 9, high molecular weight (Mn) and low carboxyl end group concentration (CEG) polyester products can be used. Do not use when pH is below 3 or above 9.

Table 1 – Embankment Geogrid

Property	Standard	MARV		
		Type	Type 2	Type 3
Ultimate strength, lb/ft	D6637	1500	4000	9000
Long term allowable design strength, lb/ft	(a)	450	1700	3600
Resistance to UV degradation, percent minimum	D4355	95	95	95
Resistance to long term degradation, percent minimum	EPA 9090	100	100	100

NOTES

(a) Long term allowable design strength is calculated by dividing the ultimate tensile strength by the product of the reduction factors for creep, installation damage and degradation for the design period. Values used for these reduction factors must be based on testing outlined by FHWA-NHI-09-087.

2.3 GEOGRID FOR ROADWAY SUBGRADE OR BASE COURSE

A. Base course geogrid (BCG) is used for gradations of aggregate where the median of the aggregate size (D50) is between 0.75-inches and 1.25-inches.

B. Large aggregate geogrid (LAG) is used where (D50) is greater than 1.25-inches.

C. Small aggregate geogrid (SAG) is used where (D50) is less than 0.75-inches.

Table 2 – Subgrade and Base Course Geogrid							
Property	**Standard**	**MARV**					
		BCG		**LAG**		**SAG**	
Rib shape		□	△	□	△	□	△
UV resistance at 500 hours, percent	D4355	70	70	70	70	70	70
Chemical resistance, percent	EPA 9090	100	100	100	100	100	100
Junction efficiency, percent	D7737	90	90	90	90	90	90
Ribs per junction	Observed	4	6	6	6	6	6
Aperture pitch, in.	Measured	1.0–1.3 (a)	1.6 (b)	2.4 (b)	2.4 (b)	1.3 (b)	1.3 (b)
Radial stiffness at 0.5% strain , lb/ft (c)	D6637	--	15,400	23,900	23,900	13,700	13,700
Isotropic stiffness ratio (d)	D6637	--	0.6	0.6	0.6	0.6	0.6
Torsional rigidity at 20 kg.cm, m-N/deg	GG9	6.5	--	--	--	--	--
Flexural rigidity (mg-cm)	D7748	750,000	--	--	--	--	--
Tensile strength at 2% strain (lb/ft)	D6637	400 x 600	--	--	--	--	--
Ultimate tensile strength (lb/ft)	D6637	1300 x 1900	--	--	--	--	--

NOTES

(a) Machine and cross machine direction

(b) Determined by measuring the spacing between sets of parallel ribs in any direction.

(c) ASTM D6637 Method B with a 2 aperture gage length tested in all "rib" and "mid-rib" directions. The radial stiffness is computed as the minimum measured modulus at 0.5 percent strain for each direction.

(d) Minimum measured radial stiffness at 0.5 percent strain divided by the maximum measured radial stiffness at 0.5 percent strain.

2.4 GEOGRID AND GEOCOMPOSITE FOR ROADWAY PAVEMENT

A. Placement is between bituminous pavement layers. Do not use with less than 2-inches of bituminous concrete cover.

B. Polyester geocomposite (PGC) is composed of a high modulus polyester geogrid bonded to a lightweight non-woven fabric.

C. Fiberglass geogrid (FG) is composed of a fiberglass geogrid coated with an elastomeric polymer.

D. Fiberglass geocomposite with a tack film (FGT) is composed of a fiberglass geogrid coated with an elastomeric polymer and bonded to a 100% polymer tack film.

Table 3 – Roadway Pavement Geogrids and Geocomposites				
Property	**Standard**	**MARV**		
		PGC	**FG**	**FGT**
Opening size, in.	Measured	0.5-1.0	0.5-1.0	0.5-1.0
Ultimate tensile strength, lb/ft	D6637	3425 x 3425	6720 x 6720	6720 x 6720
Minimum tensile strength at 2% strain, lb/ft	D6637	--	4704 x 4704	4704 x 4704
Tensile strength at 3% strain, lb/ft	D6637	825 x 825	6720 x 6720	6720 x 6720
Melting point (geogrid), deg F	D276	490	430	430
Softening point (geotextile), deg F	–	220	--	--
Softening point (tack film), deg F	--	--	--	285
Adhesive Backing	--	--	Pressure Sensitive	Pressure Sensitive

2.5 **CLAMPS, TAPE, RUBBER PADS**

A. Recommended by Supplier.

2.6 **TACK COAT**

A. Recommended by geocomposite Supplier.

2.7 **SOURCE QUALITY CONTROL**

A. Sample geogrids and geocomposites using ASTM D4354 standard practices.

B. Verify specification conformance, ASTM D4759.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Instruct workers about protecting product of this Section.

B. Repair damage to subgrade surface before installation.

C. Round edges of excavation and grade changes.

3.2 **GEOGRID REINFORCEMENT FOR GRANULAR BASE**

A. Deploy each geogrid panel per manufacturer's recommendations.

B. Install panels so overlapping panel is upgrade of the underlying panel. Ties or stakes can be used to maintain overlaps. Overlap as follows.

Soil CBR Rating	**Recommended Overlap**
2 +	1.0 foot
1 – 2	2.0 feet
less than 1	3.0 feet

C. Do not bend or fold panels past 90 degrees without a minimum of 6 inches of material between bent or folded layers.

D. At least six (6) inches of fill cover is required if tracked vehicles are operated over geogrid.

E. Wheeled traffic may operate over polypropylene products if subgrade supports equipment without deforming. Repair any damage.

3.3 GEOGRID REINFORCEMENT FOR ROADWAY PAVEMENTS

A. Preparation:

1. Clean surface of bituminous concrete base course.
2. Seal cracks wider than 1/8 inch, Section 32 01 17. Repair larger cracks, potholes, depressions, and irregularities.
3. Place bituminous concrete leveling course if required.

B. Spray on tack coat uniformly at 0.08 - 010 gal-yd^2.

C. Place geogrid per manufactures recommendations.

D. Overlap geogrid in a shingle fashion on tack coat in the direction of overlay placement. Overlap geogrid edges and ends six (6) inches minimum, unless required otherwise by Supplier.

3.4 SOIL REINFORCEMENT

A. Compact embankment subgrade.

B. Place geogrids or geocomposites in embankments at the locations and elevations shown on the plans or as recommended by Supplier.

C. Do not bend or fold panels past 90 degrees without a minimum of 6 inches of material between bent or folded layers.

D. Unless specified elsewhere, compact the fill to 95 percent or greater relative to a modified proctor density.

END OF SECTION

SECTION 31 11 00
SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of trees, stumps, roots, and tree debris.

B. Clearing site of plant life, root systems and shrubs.

C. Removal of fences, fence posts, mail box posts, and miscellany.

1.2 REFERENCES

A. NAA Standards:

Pruning Standards for Shade Trees.

B. **Utah Shade Tree Pruning Standards**.

1.3 QUALITY ASSURANCE

A. Provide at least one person, who is familiar with NAA pruning standards for the type of tree involved, to be present during tree pruning operations.

1.4 SITE CONDITIONS

A. Repair or replace damaged trees and shrubs at no additional cost to OWNER.

1.5 PROTECTION

A. Protect roots and branches of trees to remain.

B. Construct temporary barricading at tree's approximated drip line. Place continuous barricades at least three (3) feet high.

C. When setting posts, avoid damaging tree roots.

D. Do not permit heavy equipment or stockpiling of materials or debris within the barricaded area, or permit earth surface to be changed.

E. Provide water and fertilizer to maintain existing trees.

PART 2 PRODUCTS

2.1 STUMP TREATMENT SOLUTION

A. Formulated to kill existing vegetation.

PART 3 EXECUTION

3.1 EXAMINATION

A. The drawings do not purport to show all trees and shrubs existing on site.

B. Verify with ENGINEER which plantings are to be removed or to remain.

C. Tree root inspection:

1. Assist ENGINEER by removing and replacing existing surface improvements.

2. Cost of removals and replacements will be paid for using existing payment prices, or if none, then by using contract Modification prices.

3.2 PREPARATION

A. Locate utilities. Preserve utilities that are to remain in service, Section 31 23 16.

B. Review work procedures with ENGINEER.

C. Schedule work carefully with consideration for property owners and general public.

D. Before starting, arrange for disconnection of all utility services that are to be removed or which interfere with work.

3.3 **SITE CLEARING**

A. Remove all vegetation outside of excavation, fill slope lines, and limits of slope rounding.

B. Remove fences, posts, appurtenances, and miscellaneous objects.

3.4 **TREE REMOVAL**

A. Remove branches, limbs, and debris.

B. Remove stumps and roots to 18 inches below proposed grade.

C. For stumps larger than six (6) inches caliper remove and treat as follows:

1. Remove chips and debris from around remaining stump.

2. Apply stump treatment solution in accordance with manufacturer's recommendations.

3. Do not allow chemical solution to mist, drip, drift, or splash onto adjacent ground surfaces or desirable vegetation.

4. Replace any existing vegetation damaged or killed through improper use of chemical at no additional cost to OWNER.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavation and disposal of excavated materials.

B. Protection of existing facilities such as utilities, vegetation, structures affected by excavation, etc.

1.2 REFERENCES

A. **APWA (Utah) Standards:**

Plan 245 Subgrade stabilization.

1.3 PAYMENT PROCEDURES

A. No Contract Time extension shall be granted, and no additional compensation shall be made if buried utilities or structures that conflict with the Work have not been found by Keyholing.

B. Perform Incidental Excavation at no additional cost to OWNER.

1.4 DEFINITIONS

A. **Authorized Over Excavation**: Upper limit of excavation is proposed excavation limit. Lower and lateral limits are as authorized by ENGINEER.

B. **Classified Excavation**: The excavation of specified materials.

C. **Incidental Excavation**: Excavation done for CONTRACTOR's benefit, excavation error, dewatering of excavation, slough, or over-break.

D. **Unclassified Excavation**: The excavation of all materials encountered regardless of the nature, size, or manner in which they are removed. Presence of isolated boulders or rock fragments will not be sufficient cause to change classification of surrounding materials.

E. **Keyholing**: The process of making a small, precisely controlled hole for “day-lighting”, or uncovering and exposing underground utilities, to locate or inspect them.

1.5 STORAGE AND HANDLING

A. Stockpile excavated material to cause minimum inconvenience to public and provide for emergency services as necessary.

B. Provide free access to existing fire hydrants, water valves, gas valves, and meters.

C. Provide free flow of storm water in all gutters, conduits, and natural water courses.

D. Utilize traffic control signs, markers, and procedures in product storage and handling activities.

E. Promptly remove other material from site.

PART 2 PRODUCTS

2.1 BACKFILL MATERIALS

A. Common fill, Section 31 05 13.

B. Aggregate base course, Section 32 11 23.

C. Stabilization fill, aggregate base course or common fill with maximum rectilinear particle size of two (2) inches.

D. Stabilization fabric, Section 31 05 19.

PART 3 EXECUTION

3.1 PREPARATION

A. Photograph existing surfaces where work will take place to document conditions before excavation, Section 01 78 39.

B. Use white paint and mark the proposed excavation.

C. Call the one-call center and wait the required amount of time. Colors of one call center marks indicate the following:

White	Proposed excavation
Red	Electric power lines, cables, conduit and lighting cables
Yellow	Gas, oil, steam, petroleum or gaseous materials.
Orange	Communications, alarm, signal, cables or conduits.
Blue	Potable water.
Purple	Reclaimed water, irrigation and slurry lines.
Green	Sewer and storm drain lines.
Pink	Temporary survey markings.

D. Implement traffic control plan requirements, Section 01 55 26.

E. For temporary controls, refer to Section 01 57 00.

3.2 PROTECTION

A. Identify required lines, grades, contours, and benchmarks, Section 01 71 23.

B. Utilities:

1. Keyhole, expose or otherwise locate utilities as necessary to give utility agency at least one (1) day notice to protect, preserve, or relocate a utility that may interfere with or may be damaged by excavation work. Preserve utilities that remain in service.

2. Where utilities or structures conflict with design grades, report conflict to appropriate utility company and ENGINEER 14 days before initiating work within the conflict area.

C. Support and protect from damage any existing facility and structure that exists in, passes through, or passes under the site.

D. Protect existing landscape sprinkler systems. When sprinkler system disturbance is required, interrupt and repair system so operation of system is maintained, Section 02 41 13.

E. Carefully remove soil around tree roots so ENGINEER can assess stability and health of tree.

3.3 GENERAL EXCAVATION REQUIREMENTS

A. Excavate topsoil from areas to be relandscaped or regraded and other marked areas.

B. Excavate site to line and grade indicated. Legally dispose of excavated material.

C. Carefully excavate soils in vicinity of buried utility marks placed by the one-call center.

D. Where soil has been softened or eroded by flooding or hardened by drying, rework all damaged areas or replace with approved material at no additional cost to OWNER.

E. Notify ENGINEER of unexpected subsurface conditions.

F. Underpin adjacent structure, service utilities and pipe chases that may be damaged by excavation work.

G. Protect excavation walls as required. If conditions permit, slope excavation sides to maintain a safe and clean working area. Remove loose materials.

H. Where ENGINEER deems subgrade material to be susceptible to frost heave or otherwise unsatisfactory, excavate additional depth.

3.4 TOPSOIL

A. Excavate topsoil only to depth that will preserve topsoil quality.

B. Do not mix topsoil with subsoil during stockpiling or spreading.

3.5 SHORING

A. Slope, shore, sheet, brace or otherwise support excavations over four (4) feet deep, Section 31 41 00.

B. When soil conditions are unstable, excavations shallower than four (4) feet deep must also be sloped, supported, or shored.

3.6 DEWATERING

A. Keep excavation free from surface and ground water.

B. If ground water is in the intended construction operations, dewater excavations.

C. If there are no olfactory or visual indications of contamination in the water, discharge according to requirements of Federal, State, or local agency having jurisdiction.

D. If any evidence of contamination in the water, based on olfactory or visual indications, cease excavation work until potential risks are evaluated. During evaluation, handle water as a contaminated material.

E. Pay for damages and costs resulting from dewatering operations.

3.7 ROADWAY EXCAVATION

A. In advance of setting line and grade stakes, clear and grub area of brush, weeds, vegetation, grass, and debris. Drain all depressions or ruts.

B. Roadway excavation is Unclassified Excavation. It includes Portland cement concrete or bituminous concrete pavement removal and removal of any aggregate base or sub-base material to line and grade established by Drawings or ENGINEER.

C. Roadway Subgrade Stabilization. As shown in the Drawings or APWA Plan 245.

3.8 STRUCTURAL AND LANDSCAPE EXCAVATION

A. Provide shoring, cribs, cofferdams, caissons, pumping, bailing, draining, sheathing, bracing, and related items.

B. For piling work, coordinate special requirements for piling. Protect excavation walls.

C. If conditions permit, slope excavation sides as excavation progress. Maintain a safe and clean working area.

D. Support excavations. Do not interfere with the bearing of adjacent foundations, pipelines, etc.

3.9 TRENCH EXCAVATION

A. Grade bottom of trenches to provide uniform bearing surface.

B. If necessary, make bell holes and depressions required for laying and joining pipe or box.

C. Limit width of trench excavations to the dimensions suitable for worker access per pipe manufacturer's recommendation. Provide enough space for compaction equipment. Notify ENGINEER if excavation operations exceed any indicated line and grade limits.

D. In roadways and regardless of trench depth, limit length of open trenches to 200 lineal feet day or night. Provide barricading, Section 01 55 26. Protect trenches overnight.

3.10 STABILIZATION EXCAVATION

A. Perform stabilization excavation as Incidental Excavation.

3.11 AUTHORIZED OVER EXCAVATION

A. Over excavation must be permitted by ENGINEER to be classified as authorized over excavation. Volume will be determined by the method of average-end-areas in the original position.

3.12 TOLERANCE

A. Grading: Top surface of Subgrade = plus or minus 1 inch.

END OF SECTION

SECTION 31 23 26
COMPACTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Compaction of granular fill materials.

1.2 REFERENCES

A. **ASTM Standards**:

D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

D2216 Laboratory Determination of Water (Moisture) Content of Soil and Rock.

D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

D3740 Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

1.3 DEFINITIONS

A. **A-1 Soil**: Defined in ASTM D3282.

B. **Modified Proctor Density**: The maximum laboratory density, as defined in and determined by ASTM D1557 using procedure A, B or C as applicable.

C. **Relative Density (or Relative Compaction):** The ratio of field dry density to the maximum laboratory density expressed as a percentage.

D. **Standard Proctor Density**: The maximum laboratory density, as defined in and determined by ASTM D698 using procedure A, B or C as applicable.

1.4 QUALITY ASSURANCE

A. Use a soil and rock laboratory that complies with ASTM D3740.

PART 2 PRODUCTS Not Used

PART 3 EXECUTION

3.1 COMPACTION

A. Moisten or dewater backfill material to obtain optimum moisture for compaction.

B. When no density compactive effort is specified, compact the entire area to 95 percent and eliminate unstable zones.

C. Correct deficient compaction conditions. Replace or repair materials and damaged facilities.

3.2 FIELD QUALITY CONTROL

A. **Testing**: Perform control testing of materials. Perform additional testing at no additional cost to OWNER, for

1. Changes in source of materials or proportions requested by CONTRACTOR, or
2. Failure of materials to meet specification requirements, or
3. Other testing services needed or required by CONTRACTOR.

B. **Optimum Soil Density**: Use ASTM D2216 and the following industry standards.

1. For A-1 Soils: Method C of ASTM D1557 (Modified Proctor)
2. For All Other Soils: Method C of ASTM D698 (Standard Proctor).

C. **Field Density**:

1. Use ASTM D3017 and test method C of ASTM D2922 for shallow depth nuclear testing.
2. No density determinations are required on any material containing more than 65 percent material retained on the number 10 sieve or more than 60 percent material retained on the number 4 sieve. In lieu of reporting densities in such cases, report the sieve analysis to document the material type.

3.3 **REPORT**

A. For each material tested, document the following:

1. Vertical and horizontal location of the test.
2. Optimum laboratory moisture content.
3. Field moisture content.
4. Maximum laboratory dry density.
5. Field density.
6. Percent compaction results.
7. Certification of test results by Independent Testing Agency.

END OF SECTION

SECTION 31 37 00
RIPRAP OR ROCK LINING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Placement of loose riprap, hand-placed riprap, or grouted riprap.

1.2 REFERENCES

A. ASTM Standards:

C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.3 SUBMITTALS

A. Submit before use in the Work product data showing riprap source, gradation, aggregate wear and placement technique.

PART 2 PRODUCTS

2.1 AGGREGATE

A. Durable, angular, hard stone free from seams and cracks.

B. Graded in size to produce a reasonably dense mass.

C. The greatest dimension of 25 percent of the stones shall be at least, equal to but not more than 1-1/2 times the thickness of riprap indicated.

D. The greatest dimension of 50 percent of the stone shall be at least 3/4, but not more than 1-1/2 times the thickness of riprap indicated.

E. Not more than 10 percent of the aggregate shall have a dimension less than 0.1 times the thickness of riprap.

F. At least 95 percent of the stones shall have at least two (2) fractured or clean angular faces.

2.2 ACCESSORIES

A. Portland cement grout, Section 03 61 00.

B. Geotextile fabric, Section 31 05 19.

C. Grout, Section 04 05 16.

2.3 SOURCE QUALITY CONTROL

A. Aggregate: Wear not greater than 40 percent when tested, ASTM C535.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove all brush, trees, stumps, and other objectionable materials and dress area to a smooth surface. Make Excavation to provide a firm foundation and protect against undercutting. Secure approval before backfilling.

B. Install required geotextile in accordance with Section 31 05 19.

3.2 LOOSE-PLACED RIPRAP

A. Place stones to secure a Rock mass with the minimum thickness and height indicated. Manipulate Rock to secure a regular surface of graded size and mass stability.

3.3 HAND-PLACED RIPRAP

A. Place and bed rocks, one against the other, and key together. Fill irregularities between stones with suitable size spalls.

B. Place so finished surface of riprap is even, tight, and true to line and grade. Extend riprap sufficiently below ground surface to secure a firm foundation.

3.4 **GROUTED RIPRAP**

A. After placement and wetting the stones, sweep sand or fine gravel into the interstices to fill to within four (4) inches of the outer surface of the riprap.

C. Fill the remaining volume of the interstices flush with a well-mixed grout.

D. Keep grout wet by sprinkling or covering with wet material for at least three (3) days. Protect grout from stream water or any other disturbance during this cure period.

E. Do not place grout in freezing weather.

END OF SECTION

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 32 01 13.52
MASTIC SEAL

PART 1 GENERAL

1.1. **SECTION INCLUDES**

A. Application of an asphalt-aggregate *mastic* seal coat as a high density roadway surface preservation treatment.

1.2 **REFERENCES**

A. **AASHTO Standards**:

T85 Specific Gravity and Absorption of Coarse Aggregate.

T308 Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method.

T327 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.

B. **ASTM Standards**:

C117 Material Finer Than 0.075mm Sieve in Aggregate.

C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

C136 Sieve Analysis of Fine and Coarse Aggregates.

D5 Penetration of Bituminous Materials.

D244 Emulsified Asphalts.

D3628 Selection and Use of Emulsified Asphalts.

D3666 Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.

D6934 Residue by Evaporation of Emulsified Asphalt

D6937 Determining Density of Emulsified Asphalt.

E1911Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester.

C. **ISSA Standards**:

TB 100 Wet Track Abrasion of Slurry Surfaces, Modified.

1.3 **SUBMITTALS**

A. **Mix Design**: Provide the following. Allow ENGINEER 10 days to evaluate the submittal. Do not mix aggregate and emulsions designated for other public or private projects.

1. Date of mix design. If older than 60 days from date of submission, recertify mix design.
2. Proportions of aggregate, filler, water, polymer, and emulsion in the mix.
3. Residual in-place bitumen content, in ***pounds per square yard***.
4. Residual in-place aggregate or mineral solids content, in ***pounds per square yard***.
5. Thickness target for each application coat, in ***gallons per square yard***.
6. Total minimum thickness, in ***gallons per square yard***.
7. Results of a wear resistance or wet track abrasion test current within one (1) calendar year of the proposed mix design.

B. **Before Placement**: Submit 48 hours before delivery.

1. Traffic control plan, Section 01 55 26.
2. List of construction equipment to be used.
3. Certification from emulsion supplier stating emulsion meets requirements in this section.
4. Names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM standards.
5. Warranty.

C. **Reports**: If requested by ENGINEER, submit the following.

1. List of five (5) projects that have successful product application on bituminous surfaces. Provide names of project contacts.
2. Source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 **QUALITY ASSURANCE**

A. Foreman of CONTRACTOR's crew or Supplier's representative has completed at least three (3) projects of similar scope. If crew foreman does not have such experience, Supplier must provide a full-time representative on site during application.

B. Use a laboratory that complies with ASTM D3666 and follows Section 01 45 00 requirements.

C. Verify mixture delivered to site contains the same emulsion specified in the mix design.

D. Do not change source of the asphalt emulsion or aggregate without supporting changes in the mix design.

E. Reject product or work that does not meet requirements.

1.5 **WEATHER**

A. Temperature:

1. Apply seal coat when air and pavement surface temperatures in the shade are 55 deg F. and rising.
2. Cease application if air or pavement surface temperatures are projected to fall below 40 deg F within 48 hours.

B. Moisture and Wind:

1. Do not apply seal coat to a wet surface (no visible standing water or high sheen), during rain, 24 hours prior to forecast rain, or in unsuitable windy weather.
2. Cease work if weather or other conditions prolong opening pavement surface to traffic.

1.6 **NOTICE**

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying surface treatment material.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice advising when work will be performed.

1.7 **ACCEPTANCE**

A. **General:**

1. Acceptance is by Lot.
2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00..
3. Dispute resolution, Section 01 35 10.
4. Opening surface treatment to vehicular traffic does not constitute acceptance.
5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. **Asphalt Binder**:

1. Lot size is total contracted product placement. Sub-lot size is one (1) day production.
2. Of all sub-lot samples collected, randomly select one sub-lot and test it for physical properties in this section. The lot is acceptable if tests on this sub-lot sample meets requirements. If the sample does not meet requirements, continue testing other samples for a sample that complies.
3. Pay Reduction: At ENGINEER's discretion, a lot with a deficient sub-lot test may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

C. Placement:

1. Mat appearance.
   a. No runoff onto concrete curbs, gutter pans, and shoulders.
   b. No streaking, drag marks, or squeegee marks.
   c. No light spots.
   d. No de-bonding.
   e. Straight longitudinal edges with proper joints.
2. Mat thickness, bitumen content and aggregate content.
   a. Lot size is one (1) day production. Sub-lot size is 0.5 lane mile.
   b. Collect and test five (5) equally spaced samples from the initial sub-lot. Upon review of the initial sub-lot test results and at ENGINEER's discretion, acceptance of subsequent sub-lots may be based upon one or less samples from each subsequent sub-lot.
3. Pay Adjustment: Not applicable. Correct mat placement deficiencies at no additional cost to OWNER.

1.8 **WARRANTY**

A. Both the CONTRACTOR and Supplier shall provide a two (2) year minimum written warranty when the existing pavement is in an appropriate condition (CONTRACTOR and Supplier to determine condition). Warranty covers delaminating, peeling and pre-mature surface wear.

1. Before placement, notify ENGINEER if pavement condition or application condition voids the warranty.
2. ENGINEER may allow or cancel product application at no cost to OWNER if warranty cannot be given.

B. Acceptable performance after two (2) year period is no delaminating, peeling, or inter-aggregate loss in surface wear. Mechanical disturbances by snow plow chatter, studded tires, etc. are excluded from warranty. Repair defective coverage at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 **ASPHALT BINDER**

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13. Use a tack coat that is compatible with seal coat application.

C. Emulsified Asphalt: Grades SS-1, SS-1H, CSS-1, or CSS-1h, selected in accordance with ASTM D 3628 and the following.

Table 1 – Asphalt Properties			
	Standard	Min	Max
Tests on Emulsion			
Viscosity at 25 deg C, seconds	D 244	15	100
Particle Charge Test (a)		Positive	
Residue by distillation, percent		57	--
Tests on Residue from Evaporation			
Penetration at 25 deg C, 100 g, 5 seconds	D 5	15	150
NOTES (a) In case of inconclusive particle charge, material having a pH value of 6.0 will be acceptable as a CSS type.			

2.2 **AGGREGATE**

A. Material: Clean and free from organic matter or other detrimental substances. Light weight with the following properties.

Table 2 - Aggregate Properties			
	Standard	Min	Max
Water absorption, percent	T 85	--	10
Wear (hardness or toughness), percent	C 131	--	50
Micro-Deval, percent (b)	T 327	--	20
NOTES (a) Test results are on aggregate received before blending into sealer. (b) Micro-Deval wear of aggregate retained on No. 60 sieve.			

B. Gradation: Analyzed on a dry weight and percent passing basis.

1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.
2. Target Grading Curve must lie within the Master Grading Band.

Table 3 – Master Grading Band and Target Tolerance Limits			
Sieve	Standard	Master Grading Band Limits Percent Passing	Target Tolerance
No. 8	C136	100	
No. 16		80 - 100	+/- 5
No. 30		75 - 100	+/- 5
No. 60		50 - 85	+/- 5
No. 100		40 - 65	+/- 5
No. 200	C117	25 - 65	+/- 5
NOTES (a) Test results are on aggregate received before blending into sealer. (b) Target tolerance is the allowable variation from the Target Grading Curves.			

2.3 **ADDITIVES**

A. Use water that is clean, non-detrimental, and free from salts and contaminant.

B. Polymers, clays, other additives as necessary to achieve mix design performance.

2.4 **MIX DESIGN**

A. Asphalt Binder: Select type and grade of emulsified asphalt, ASTM D3628.

B. Set and Cure Time: Select to meet opening to traffic requirements.

C. Provide a mix containing a minimum of 18 percent aggregate by weight of the wet mixture meeting the following requirements.

Table 4 – Mix Properties			
	Standard	**Min**	**Max**
Tests on Mix			
Weight per gallon, pounds (a)	D6937	Report	
Solids content by evaporation at 130 C, percent (b)	D6934	48	--
Tests on Residue from Evaporation			
Asphalt binder content of cured mix, (130 deg C method), percent (d)	T308	30	--
Mineral aggregate and fines content of cured mix (130 deg C method), percent (d)	T308	50	--
Wet-track abrasion loss, (72 hour soak), g/m^2	TB100	--	80
Asphalt content by ignition method, percent (a)	T308	30	--
Dynamic friction test number, 20 km/h(e)	E1911	> 90 percent of base value	

NOTES

(a) Use the modified method to account for a fine emulsion mixture. Required for calibration of application equipment and for field control and acceptance

(b) A 500 to 1000 gram representative sample of the mix shall be dried in a suitable oven until weight loss ceases. Solids content shall then be defined as the net residual weight divided by net original weight expressed in percent. Retain this residual dried mix for AASHTO T 308 tests if required.

(c) Rotational viscosity acceptable range shall be provided by the Supplier. Test device, spindle type, size and rotational speed shall be included with the submitted certification test results.

(d) Due to the high binder content of the mix the sample size processed in the ignition oven may need to be adjusted to not exceed the binder content allowable for a particular model ignition oven.

(e) Establish base friction value using prepared laboratory compacted slab of any ENGINEER approved mix as surface to be tested. The Dynamic Friction Test (DFT) number ratio should indicate that after application of the mastic seal, the surface retains required minimum percentage DFT number of the original pavement surface. Based on a minimum of three (3) slabs with three (3) measurements per slab. Value for information only. Will not be used for project control.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Paver: Use a continuous-flow mixing unit.

1. Capable of applying at least 15,000 square yards of material per day.
2. Equipped with full sweep agitation system to assure proper suspension of fine aggregates.
3. Equipped with an operator control station that adjusts material spread rate in accordance with project calibration process.
4. Equipped with a filtering system to catch particles that plug nozzles.

5. Equipped with a retractable spray bar capable of applying mixture without drilling. The bar should be positioned to meet calibration requirements.

B. Storage Tanks:

1. When delivering mix from the central mixing plant to a job site storage tank, use only storage tanks with a capacity to contain the entire transport load.

2. Ensure that all site storage tanks have internal full sweep mixing mechanisms and mixing capability that can provide at any given point in the tank a homogenous mix.

3.2 PREPARATION

A. **Paver Calibration**: On a test strip at least 300 feet long, determine the correct pump settings, spray bar height, and ground speed for the application equipment. Apply material with pump settings at 80 percent of maximum output (plus or minus 5 percent) and a ground speed of 300 to 400 feet per minute.

1. Do not begin or continue application without ENGINEER's knowledge of the calibration process and equipment settings.

2. Do not deviate from calibration settings without ENGINEER's knowledge.

B. **Surface Repair**: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled asphalt surfaces or on brick or on Portland cement concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17.

4. Pushing or shoving pavement to be repaired as follows.

a. Mill damaged area at least three (3) inches below required surface elevation. Section 32 01 16.71

b. Install and compact PG64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. - See additional requirements in Section 33 05 25.

C. **Masking**: Mask-off Street Fixtures, end of streets, intersections.

D. **Traffic Control**:

1. Implement traffic control plan requirements, Section 01 55 26. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost is included in the work of this section.

E. **Cleaning**:

1. Remove loose material, mud spots, sand, dust, oil, vegetation and other objectionable material.

2. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees, Plants, Ground Cover:

1. Protect trees, plants and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section Section 32 01 93. Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION

A. General:

1. Two separate application coats are required. The first application must be thoroughly set and free of any damp areas before the second application begins.

2. Adjust application rates according to surface conditions, only after obtaining review by ENGINEER and the asphalt emulsion manufacturer.

B. Spreading:

1. Keep material delivery at a constant rate even if forward speed of lay-down machine varies.
2. Do not reduce application rate along edges or around manhole covers.
3. Apply both applications right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges on either application.
4. Make straight lines at all locations.
5. Place product out to right-of-way line on side streets and intersections.
6. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.
   a. Provide complete and uniform coverage.
   b. Avoid unsightly appearance from hand work.

C. Joints:

1. Make transverse joints straight-cut butt type, not over-lap type.
2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.
3. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

D. Lines:

1. Make straight lines along lip of gutters, shoulders, end of streets, and in street intersections. No runoff on these areas will be permitted.
2. Vary edge lines no more than one (1) inch per 100 feet.

3.5 **TOLERANCES**

A. Each coat thickness = **at least 40 percent of the total thickness.**

B. Total thickness = **0.30 gallons per square yard minimum**.

3.6 **FIELD QUALITY CONTROL**

A. Emulsion density testing, ASTM D6937. If testing shows material non-compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.

B. Measure the total amounts of material installed, and verify it meets the application rate.

3.7 **AFTER APPLICATION**

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Do not apply permanent pavement markings or striping material until layout and method of payment has been determined by ENGINEER and final application of surface treatment material has been in-place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 **REPAIR**

A. Remove delaminated or non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide a good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.

F. Repair collateral damage caused by construction.

3.9 **OPENING TO TRAFFIC**

A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off of treated surface until seal coat does not track out.

END OF SECTION

SECTION 32 01 13.61
SLURRY SEAL

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Stone and an asphalt binder slurry evenly mixed and spread as a seal coat for roadways and thoroughfares.

1.2 REFERENCES

A. **AASHTO Standards**:

R9 Acceptance Sampling Plans for Highway Construction.

B. **ASTM Standards**:

C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

C117 Material Finer Than 0.075 mm Sieve in Aggregate.

C131 Resistance to Degradation of Small-Size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

C136 Sieve Analysis of Fine and Coarse Aggregates.

D5 Penetration of Bituminous Materials.

D36 Softening Point of Bitumen (Ring-and-Ball Apparatus).

D242 Mineral Filler for Bituminous Paving Mixtures.

D1664 Coating and Stripping of Bitumen-Aggregate Mixtures.

D2170 Kinematic Viscosity of Asphalts (Bitumens).

D2419 Sand Equivalent Value of Soils and Fine Aggregate.

D3319 Accelerated Polishing of Aggregates Using the British Wheel.

D3628 Selection and Use of Emulsified Asphalts.

D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

D3910 Design, Testing, and Construction of Slurry Seal.

D5821 Determining the percentage of Fractured Particles in Coarse Aggregate.

D6937 Density of Emulsified Asphalt.

1.3 SUBMITTALS

A. **Mix Design:** Provide the following. Allow ENGINEER 10 days to evaluate the submittal. Do not mix aggregate and emulsions designated for other public or private projects.

1. Date of mix design. If older than 180 days from date of submission recertify mix design.
2. Target Grading Curve for aggregate.
3. Percentages of emulsion, aggregate, water and additives in the mix.
4. Emulsion type and time target for opening up a thoroughfare to traffic.
5. Slurry application rate.
6. Aggregate physical properties (this section article 2.4). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from the date of submission.

B. **Before Placement**: Submit at least 48 hours before delivery.

1. Traffic control plan, Section 01 55 26.
2. List of the construction equipment to be used.
3. Certification from emulsion supplier stating emulsion meets requirements in this section.

C. **Reports**:

1. Provide daily reports to OWNER's representative including weight of material used, application rate, area covered. Indicate date, type, and project names.

2. Provide delivery tickets for each emulsion delivery. Include certification from manufacturer that emulsion meets specifications.

3. Submit oil quantities in CONTRACTOR's emulsion storage tankers prior to transfer, after transfer and at the end of each working day.

1.4 **QUALITY ASSURANCE**

A. Foreman of paving crew has completed at least three (3) projects of similar scope.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 requirements.

C. Verify mixture delivered to site contains the same emulsion specified in the mix design

D. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.

E. Reject product that does ot meet requirements.

1.5 **WEATHER**

A. Temperature:

1. Apply seal coat when air and pavement surface temperatures in the shade are 45 deg F and rising.

2. Cease application if air or pavement temperatures are below 55 deg F and falling or if the finished product will freeze before 24 hours.

B. Moisture and Wind:

1. Do not apply seal coat to a wet surface (no visible standing water or high sheen), during rain, if humidity prolongs curing, or in unsuitable windy weather.

2. Cease work if weather or other conditions prolong opening pavement surface to traffic.

1.6 **NOTICE**

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying seal coat.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice advising when work will be performed.

1.7 **ACCEPTANCE**

A. **General**:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring compling material as part of its installation, Section 01 29 00.

3. Dispute resolution, Section 01 35 10.

4. Opening surface treatment to traffic does not constitute acceptance.

5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. **Asphalt Binder**:

1. Lot size is total contracted product placement. Sub-lot size is one (1) day production.

2. Of all sub-lot samples collected, randomly select one sub-lot and test it for the physical properties in this section The lot is acceptable if tests on this sub-lot sample meets requirements. If the sample does not meet requirements, continue testing other samples for a sample that complies.

3. Pay Reduction: At ENGINEER's discretion, a lot with a defieient sub-lot test may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

C. **Aggregate**: Lot size is one (1) day's production with 300 tons sub-lots. Collect Samples randomly before mixing. Test gradation, ASTM C 136. Test thickness. Lot will be acceptable if:

1. Average gradation of each sieve for the Lot is within the Target Grading Band for that sieve, and
2. Number of Samples in the Lot with any sieve measurement outside of the Target Grading Band does not exceed two (2), and
3. Material on 200 sieve does not exceed allowable.
4. Price Adjustment: Aggregate gradation defects may be accepted if 2.5 percent price reduction is applied against lot for each condition not met. Maximum price reduction for a lot is five (5) percent.

D. **Placement**:

1. Mat Appearance:
   a. No runoff onto concrete curbs, gutter pans, and shoulders.
   b. No streaking, drag marks or squeegee marks.
   c. No light spots.
   d. No de-bonding.
   e. Straight longitudinal edges with proper joints.
2. Price Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 ASPHALT BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13. Use a tack coat that is compatible with seal coat application.

C. Emulsified Asphalt: Unless specified elsewhere provide CQS-1h quick traffic type, ASTM D3628 with a two (2) hour return to traffic quickset. Provide the following properties.

Table 1 – Physical Properties				
	Standard	Target	Min	Max
Tests on Emulsion				
Viscosity at 25 deg C, second	D 244	32	15	90
Sieve test, percent		0.01	--	0.30
Settlement, 5 day, percent		3.5	--	5
Storage stability, 1 day, percent		0.6	--	1
Residue by distillation, percent		64.2	60	--
Tests on Residue from Evaporation				
Penetration at 25^{O} C, 0.1 mm	D 5	51	40	90
Softening point, deg. C.	D 36	60	57	--
Kinematic viscosity, cSt/sec	D 2170	--	650	--
Saybolt furol viscosity at 77^{O} F., seconds		--	--	50
Polymer solids based on mass of residual asphalt, percent	--	3 to 6	3	--
NOTES (a) Polymer is a solid synthetic rubber or latex material. (b) Cement mixing test waived. (c) Polymer solids are to be milled or blended into the asphalt or emulsifier solution before the emulsification process.				

2.2 **AGGREGATE**

A. **Material**: Stone, slag, or other high quality particle or combination clean and free from organic matter or other detrimental substances with the following properties.

Table 2 – Aggregate Properties				
		Standard	Min	Max
Angularity (fractured faces), percent		D 5821	80	--
Wear (hardness or toughness), percent		C 131	--	35
Soundness (weight loss in 5 cycles), percent		C 88	--	10
Clay content (sand equivalent), percent	SS Type I	D 2419	45	--
	SS Type II	D 2419	55	--
	SS Type III	D 2419	60	--
Polishing, BPN		D 3319	28	--
Water absorption, percent		--	--	1.25
NOTES (a) Angularity of aggregate retained on No. 4 sieve with at least one (1) mechanically fractured face or clean angular face. Provide 100 percent (maximum) for thoroughfares with a Road Class III (Section 32 12 05). (b) Wear of aggregate retained on No. 12 sieve after 500 revolutions. (c) Soundness for combined coarse and fine aggregate measured using five (5) cycles Na_2SO_4. (d) Clay content before additives.				

1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.
2. Target Grading Curve must lie within one (1) of the following Master Grading Bands. Field Samples shall not vary from the Target Grading Curve by more than the Target Tolerance.

Table 3 – Master Grading Band and Target Tolerance Limits					
Sieve	Standard	Master Grading Band Limits Percent Passing			Target Tolerance
		SS Type I	SS Type II	SS Type III	
3/8 in.	C136	--	100	100	--
No. 4		100	90 - 100	70 - 90	+/- 5
No. 8		90 - 100	65 - 90	45 - 70	+/- 5
No. 16		65 - 90	45 - 70	28 - 50	+/- 5
No. 30		40 - 65	30 - 50	19 - 34	+/- 5
No. 50		25 - 42	18 - 30	12 - 28	+/- 4
No. 100		15 - 30	10 - 21	7 - 18	+/- 3
No. 200	C117	10 - 20	6 - 15	5 - 15	+/- 2
NOTES (a) Target tolerance is the allowable variation from the Target Grading Curve. (b) Portion retained on the No. 4 sieve clean and free of clay coatings. (c) Portion passing No. 200 sieve includes mineral filler.					

2.3 **ADDITIVES**

A. Use water that is clean, non-detrimental, and free from salts and contaminant.

B. Mineral Filler: ASTM D242.

C. Portland cement, hydrated lime, limestone dust, fly ash, or aluminum sulfate to regulate setting time and improve workability.

D. Limestone dust, fly ash, and rock dust to alter aggregate gradation.

2.4 **MIX DESIGN**

A. Asphalt Binder: Select type and grade of emulsified asphalt, ASTM D3628.

B. Proportioning: Use the consistency test of ASTM D3910 to determine optimum ratio of aggregate, filler, water, and emulsion.

C. Set and Cure Time: Select to meet opening to traffic requirements.

D. Stripping: More than 90 percent of bituminous-coated particles retain asphalt coating, ASTM D1664.

PART 3 EXECUTION

3.1 **CONSTRUCTION EQUIPMENT**

A. Paver: Use a continuous-flow mixing unit:

1. Capable of applying at least 15,000 square yards of material per day.

2. Capable of accurately delivering a predetermined portion of aggregate, water, and asphalt emulsion to the mixing chamber.

3. Prevent loss of slurry from the distributor by using a mechanical type squeegee distributor equipped with flexible material in contact with the pavement surface.

4. Has a lateral control device and a flexible strike-off capable of being adjusted to lay the slurry at the mix design application rate.

3.2 **PREPARATION**

A. **Meter Calibration**: On a test strip at least 500 feet long, determine the correct meter settings on the mixing equipment. The settings are to produce a product that complies with the following:

1. Set time 30 minutes maximum. Initial set occurs when blotting the surface of the material yields only water (no emulsion).

2. No distress when exposed to traffic two (2) hours after placement.

B. **Surface Repair**: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled bituminous pavement or on brick or on Portland cement concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17.

4. Pushing or shoving pavement to be repaired as follows.

a. Mill damaged area at least three (3) inches below required surface elevation. Section 32 01 16.71

b. Install and compact PG64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. See additional requirements in Section 33 05 25.

C. **Masking**: Mask-off Street Fixtures, end of streets, intersections.

D. **Traffic Control**:

1. Implement traffic control plan requirements, Section 01 55 26. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost is included in the work of this section.

E. **Cleaning**:

1. Remove loose material that may cause drag marks.

2. Remove mud spots, sand, dust, oil, vegetation, and other objectionable material.

3. Do not flush water, or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees, Plant, Ground Cover:

1. Protect trees, plants, and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage to no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION

A. General:

1. Machine meter settings must match mix design. Water and additives may be adjusted (per mix design) for better consistency or set time.

2. Wait at least two (2) hours if an adjacent pass has broken and started to cure.

3. The seal coat, when cured shall present a uniform, skid-resistant appearance with all cracks filled.

4. Do not apply lane marking tape or paint for traffic control until layout and placement has been verified with ENGINEER.

B. In the Spreader Box:

1. Do not exceed four (4) minutes total mixing time.

2. No additional water.

3. No lumping, balling or unmixed aggregate.

4. No segregation of the emulsion and aggregate fines from the coarse aggregate.

5. No breaking of emulsion.

6. No overloading. Carry a sufficient amount of slurry in all parts of the spreader box for complete coverage.

C. Spreading:

1. Dampen surface immediately before application of surface treatment (prevents premature breaking and improves bonding). All surfaces are to be uniformly damp with no free water standing on the surface or in cracks.
2. Keep material delivery at a constant rate even if forward speed lay-down machine varies.
3. Do not reduce application rate along edges or around manhole covers.
4. Apply seal coat right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges.
5. Make straight lines at all locations.
6. Place seal coat out to right-of-way line on side streets and intersections.
7. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.
   a. Provide complete and uniform coverage.
   b. Avoid unsightly appearance from hand work.
8. If coarse aggregate settles to bottom of mix, remove slurry from pavement.

D. Joints:

1. Make transverse joints straight-cut butt type, not over-lap type.
2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.
3. Tolerance for joint match is 1/4 inch difference in elevation when measured with a 10 feet long straight edge over the joint.
4. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

E. Lines

1. Make straight lines along lip of gutter, shoulders end of streets, and in street intersections. No runoff on these areas will be permitted.
2. Vary edge lines no more than one (1) inch per 100 feet.

3.5 TOLERANCES

A. Thickness: Measured in pounds per square yard. Standard application rate applies unless specified elsewhere.

Slurry	Standard	Heavy
SS Type I	8 to 12	10 to 13
SS Type II	12 to 16	15 to 18
SS Type III	15 to 18	22 to 25

3.6 FIELD QUALITY CONTROL

A. Emulsion density testing, ASTM D6937. If testing shows material non-compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.

B. If an ASTM C136 sieve analysis shows aggregate gradation non-compliance, either remove the material or blend in other aggregates to bring it into compliance. This may require a new mix design. Screening may be required at the stockpile to remove any defective material.

C. Measure the total amounts of material installed, and verify it meets the application rate. Make all emulsion deliveries in the presence of OWNER's representative.

3.7 AFTER APPLICATION

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Leave no streaks caused by oversized aggregate particles or buildup on squeegees.

D. Leave no holes, bare spots, or cracks. The seal coat shall be uniform and skid-resistant when cured.

E. Do not apply permanent pavement markings or stripe material until layout and method of payment has been determined by ENGINEER and final application of seal coat has been in-place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 **REPAIR**

A. Remove delaminated or non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.

F. Repair collateral damage caused by construction.

3.9 **OPENING TO TRAFFIC**

A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off of treated surface until seal coat does not track-out.

END OF SECTION

SECTION 32 01 13.64
CHIP SEAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Asphalt binder and cover aggregate evenly spread as a uniform, skid-resistant seal coat on roadways and thoroughfares.

B. Application of a slurry seal over a chip seal (cape seal) if specified.

1.2 REFERENCES

A. **ASTM Standards**:

C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

C117 Amount of Material Finer Than 0.075 mm Sieve in Aggregate.

C131 Resistance to Degradation of Small-Size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

C136 Sieve Analysis of Fine and Coarse Aggregates.

C142 Clay Lumps and Friable Particles in Aggregates.

D5 Penetration of Bituminous Materials

D36 Softening Point of Bitumen (Ring and Ball Apparatues).

D242 Mineral Filler for Bituminous Paving Mixtures.

D1664 Coating and Stripping of Bitumen-Aggregate Mixtures.

D2170 Kinematic Viscosity of Asphalts (Bitumens).

D2419 Sand Equivalent Vlue of Soils and Fine Aggregate

D3319 Accelerated Polishing of Aggregates Using the British Wheel.

D3628 Selection and Use of Emulsified Asphalts.

D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

D3910 Design, Testing, and Construction of Slurry Seal.

D4791 Flat or Elongated Particles in Coarse Aggregate.

D5821 Determining the percentage of Fractured Particles in Coarse Aggregate.

1.3 SUBMITTALS

A. **Mix Design**: Provide the following. Allow ENGINEER 10 days to evaluate the submittal. Do not mix aggregate and emulsions designated for other public or private projects.

1. Date of mix design. If older than 60 days from date of submission, recertify mix design.
2. Type and grade of asphalt binder to be used (if not specified).
3. Target Grading Curve for aggregate.
4. Asphalt and aggregate compatibility.
5. Asphalt additives.
6. Asphalt and aggregate application rates.
7. Aggregate physical properties (this section article 2.3). The information is for suitability of source and not for project control. Test results shall not be older than 455 days from the date of submission.

B. **Before Placement**: Submit 48 hours before delivery:

1. Traffic control plan, Section 01 55 26.
2. List of construction equipment to be used.

3. Certification from emulsion supplier stating emulsion meets requirements in this section.

C. **After Installation:** Submit the asphalt bill of lading. Identify weight of asphalt, weight of emulsified asphalt (after water has been added).

D. **Reports**: If requested by ENGINEER, submit source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 **QUALITY ASSURANCE**

A. Foreman of CONTRACTOR's crew has completed at least three (3) projects of similar scope.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 requirements.

C. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.

D. Reject product that does not meet requirements.

1.5 **WEATHER**

A. Temperature:

1. Apply seal coat when air and pavement surface temperatures in the shade are 70 deg F and rising.

2. Allow four (4) weeks of warm weather cure time. This generally limits performance of work from May 15 to August 31.

3. Do not apply seal coat if pavement surface is above 120 deg F

B. Moisture and Wind: Do not apply seal coat during rain, if humidity prolongs curing, or in unsuitable windy weather.

1.6 **NOTICE**

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying seal coat.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice advising when work will be performed.

1.7 **ACCEPTANCE**

A. **General**:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring seal coat as part of its installation. Section 01 29 00.

3. Dispute resolution, Section 01 35 10.

4. Opening chip seal surface to traffic does not constitute acceptance.

5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. **Asphalt Binder**:

1. Lot size is total contracted product placement. Sub-lot size is one (1) day production.

2. Of all sub-lot samples collected, randomly select one sub-lot and test it for the physical properties in this section. The Lot is acceptable if tests on this sub-lot sample meets requirements. If the sample does not meet requirements, continue testing other samples for a sample that complies.

3. Pay Reduction: At ENGINEER's discretion, a lot with deficient sub-lot tests may be accepted if pay for lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

C. **Aggregate**: Verify suitability of aggregate source

1. Lot size is one (1) day production with 500 tons sub-lots. Collect samples randomly from the hauling equipment. Test gradation, ASTM C 136. Lot will be acceptable if:

a. Average gradation of each sieve for lot is within the Target Grading Band for that sieve, and

b. Number of samples in lot with any sieve measurement outside of the Target Grading Band does not exceed two (2), and

c. Material on 200 sieve gradation does not exceed allowable.

2. Price Adjustment: Aggregate gradation defect may be accepted if 2.5 percent pay factor is applied against lot for each condition not met. If a lot has multiple defective sub-lots, maximum cumulative pay factor for a lot is five (5) percent.

D. **Placement**:

1. Asphalt Binder:

a. No runoff onto concrete curbs, gutter pans, shoulders, etc.

b. No streaking, drilling, bare spots.

c. No light spots.

d. Uniform with no ridging.

2. Aggregate:

a. Asphalt See-through: Not more than 15 percent black (asphalt) can be seen through the newly laid and compacted rock chip after sweeping.

b. Embedment: After rolling and evaporation, random sampling reveals large particles are embedded in the asphalt binder on their flat side to a depth of 50 percent to 70 percent.

3. Pay Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Emulsified Asphalt: Cationic or anionic emulsion, Section 32 12 03. Use any of the following additives to match aggregate particle charge, weather conditions, and mix design:

1. Anti-strip: To change or neutralize particle charges.

2. Enhancer: To promote greater film thickness on the aggregate.

3. High Float Agent: To improve temperature susceptibility of the asphalt and impart a gel structure to the asphalt.

4. Polymer: To reduce stripping, improve coating, decrease temperature susceptibility and increase stability of mix.

5. Rejuvenator: To adjust penetration of base asphalt or soften reclaimed asphalt.

2.2 COVER AGGREGATE

A. Material: 100 percent crushed stone, slag or other high quality particle or combination. Clean and free from organic matter or other detrimental substances with the following properties.

Table 1 – Physical Properties			
	Standard	**Min**	**Max**
Dry-unit weight (rodded), lb/ft^3	C 29	--	100
Wear (hardness or toughness), percent	C 131		30
Angularity (2 fractured or angular faces), percent	D 5821	60	--
Soundness (weight loss), percent	C 88	--	12
Polishing, BPN	D 3319	30	--
Flats or elongates (1:3 ratio), percent	D 4791	--	10
Friable particles, percent	C 142	--	3
NOTES (a) Wear of aggregate retained on No. 8 sieve. (b) Soundness for combined coarse and fine aggregate measured using five (5) cycles Na_2SO_4.			

B. Gradation: Analysed on a dry weight and percent passing basis and graded as follows.

Table 2 – Master Grading Band				
Sieve	**Standard**	**Grade A**	**Grade B**	**Grade C**
1/2 in.	C 136	100	–	100
3/8 in.		85 – 100	–	70 – 90
No. 4		0 – 20	–	0 – 5
No. 8		0 – 5	85 – 100	0 – 3
No. 16		–	10 – 25	–
No. 50		–	0 – 5	–
No. 200	C 117	0 – 1	0 – 2	0 – 2
NOTES (a) Portion retained on No. 4 sieve clean and free of clay coatings. (b) Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum. (c) Portion passing No. 200 sieve includes mineral filler, ASTM C117.				

2.3 **MIX DESIGN**

A. Select type and grade of emulsified asphalt, ASTM D3628.

B. Determine asphalt application rate based upon achieving an aggregate embedment of 50 to 70 percent.

Note: It is difficult to get adequate embedment of 3/8 inch aggregate with an asphalt application rate of 0.30 gallons per square yard.

PART 3 EXECUTION

3.1 **CONSTRUCTION EQUIPMENT**

A. Distributor Truck: Use triple overpass distributor bar setting. Apply asphalt binder uniformly (no drilling).

B. Aggregate Spreader: Variable width up to 20 feet in a single pass. Distribution varies no more than one (1) pound per yard.

C. Rollers: Rubber tire pneumatic with a gross load adjustable to apply 200 to 250 pounds per inch of rolling width.

3.2 **PREPARATION**

A. Equipment Calibration:

1. Do not begin or continue application without ENGINEER's knowledge of the calibration process and equipment settings.

2. Do not deviate from calibration settings without ENGINEER's knowledge.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled bituminous pavement or on brick or Portland cement concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17.

4. Pushing or shoving pavement to be repaired as follows.

a. Mill damaged area at least three (3) inches below required surface elevation. Section 32 01 16.71

b. Install and compact PG 64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. See additional requirements in Section 33 05 25.

C. Masking: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:

1. Implement traffic control plan requirements, Section 01 55 26. Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:

1. Remove loose material, mud spots, sand, dust, oil, vegetation, and other objectionable material.

2. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 **PROTECTION**

A. Trees Plants, Ground Cover;

1. Protect trees, plants and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks guard rails, guide posts, etc. from physical damage.

3.4 **APPLICATION**

A. General: Wait at least seven (7) days before placing chip seal on new bituminous surfaces

B. Asphalt Emulsion: Keep viscosity between 50 and 100 centistokes, ASTM D2170 during application

1. Make straight lines along lip of gutter and shoulders, end of streets and in street intersections. No runoff onto these areas will be permitted.

2. Leave no holes, bare spots, or cracks.

3. Vary edge lines no more than one (1) inch per 100 feet.

4. Protect curb, gutter, and sidewalk from spatter, mar, or overcoat.

C. Chips: Apply aggregate within +1 to –2 pounds per square yard of mix design:

1. For polymer and latex modified emulsions, apply chips immediately.

2. For other emulsions, maintain a distance of not more than 100 feet between distributor and chip spreader.

3. Use a damp chip but not saturated. (Note. If water can be seen running out of the haul truck, the chips are too wet).

4. Spread larger aggregate first.

5. Hand broom cover material if necessary to distribute the aggregate uniformly over Pavement surface.

D. Blotting: If bleeding occurs, apply a blend of 25 to 50 percent hydrated lime with sand (blotting material). Use sand to cool chips.

3.5 **ROLLING**

A. Use a rubber tire roller to seat aggregate. Apply at least two (2) complete rolling coverage.

B. Complete rolling before the bituminous material cools or hardens.

C. Keep traffic off at least four (4) hours or until moisture leaves remaining chips. Sweep surface before allowing uncontrolled traffic on chips.

3.6 **FOG SEAL**

A. If a fog seal is specified, see Section 32 01 13.50.

B. Apply within 24 hours of placing chips. Keep viscosity between 50 and 100 centistokes during application, ASTM D2170.

3.7 **CAPE SEAL**

A. If a cape seal is specified, remove loose chips (by sweeping), fog the chip seal surface with water, and apply slurry seal, Section 32 01 13.61 within 48 hours of chip seal application.

3.8 **FIELD QUALITY CONTROL**

A. Emulsion density testing, ASTM D6937. If testing shows material non-compliance, halt operations, remove installed product and install new material known to be in compliance.

B. Measure the total amounts of material installed, and verify it meets the application rate.

3.9 **AFTER APPLICATION**

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Do not apply permanent pavement markings or stripe material until layout and method of payment has been determined by ENGINEER and final application of seal coat has been in-place at least 14 days, or as permitted otherwise by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.10 **REPAIR**

A. Remove non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide a good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying Pavement.

F. Repair collateral damage caused by construction.

END OF SECTION

SECTION 32 01 16.71

COLD MILLING BITUMINOUS PAVEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Lower surface elevation of bituminous concrete Pavement by milling.

B. If grinding is required to smouth-out surface bumps or depressions refer to Section 32 01 26.

1.2 PAYMENT PROCEDURES

A. No payment for leveling course to correct over milling or for additional milling to correct shallow milling.

1.3 REFERENCES

A. **APWA (Utah) Standards:**

Plan 253 Bituminous concrete pavement overlay.

1.4 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. Arborist's certification.

C. Pre-milling profilographs for full width mills.

D. Redline drawings showing discovered existing utilities.

1.5 QUALITY ASSURANCE

A. Provide a person capable of calculating grades and cross-slopes in degrees and percentages. Cross slopes vary when the crown line is not parallel to pavement edge line.

1.6 SITE CONDITIONS

A. Existing Street Fixtures may have been paved over making them hidden (or buried). Locate and protect them. Failure to find them may result in damage to milling equipment. Repair damaged CONTRACTOR machinery and Street Fixtures at no cost to OWNER.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Detector: Able to find Street Fixtures (utility frames and covers, valve boxes, etc.) that are buried under pavement surface.

B. Milling Machine:

1. Equipped to prevent air pollution.
2. Equipped with a system to control depth and slope of mill cut.

C. Cleaning equipment able to pick up millings and waste water.

3.2 PREPARATION

A. Notify neighborhood at least 48 hours before day and time of milling.

B. Coordinate utility locations, Section 01 31 13. Preserve all active utilities.

C. Implement traffic control plan requirements in Section 01 55 26.

D. Mark areas in the field that are to be milled. Mark existing utilities on redline drawings.

E. Use a detector to find hidden (or buried) Street Fixtures.

3.3 **PROTECTION**

A. Install Invert Covers, Section 01 71 13.

B. Lower utility frames, covers, and other Street Fixtures.

C. Trees may require pruning, Section 32 01 93. Avoid or minimize damage to tree branches. Provide certified arborist observation of tree branch cuts larger than four (4) inches diameter. Notify ENGINEER of such tree branch cut or damage.

D. CONTRACTOR is liable for any property damage due to loose material on pavement surface, vertical pavement cuts, drop-offs, etc.

E. Protect plant and animal habitat. Follow federal, state or local work permit requirements.

3.4 **MILLING**

A. If not indicated elsewhere meet cross slopes and depth of milling shown on APWA Plan 253.

B. Meet profile grade required or indicated by ENGINEER.

C. Do not disfigure adjacent work or existing surface improvements by accidentally cutting into them. Make appropriate repairs.

D. If milling exposes smooth underlying pavement surface, mill the smooth surface to make it rough.

E. Mill off additional material if standing water has a potential to accumulate or if surface has been damaged by water since beginning of milling operation.

F. Where vehicles or pedestrians must pass over milled edges provide safe temporary ramps suitable to speed of user vehicles (or suitable for wheel chair user needs).

G. Unless stipulated elsewhere, all residues from the milling process become property and responsibility of CONTRACTOR. Waste millings legally. Do not discharge millings into storm drains, ditches, or waters of the State.

H. If work equipment is removed from the milling site and milled surface awaits further work, provide appropriate traffic control and cleaning.

I. Notify ENGINEER when milling exposes weak or unstable surfaces. Verify extent of exposure by proof rolling at no additional cost to OWNER.

3.5 **TOLERANCES**

A. Milling Depth: As indicated plus or minus 10 percent not uniformly high or uniformly low.

B. Striation Texture: Uniform, discontinuous, longitudinal, 3/16 inch deep maximum, 3/4 inch center to center.

C. Smoothness:

1. On Longitudinal Grade: Plus or minus 5/16 inch in 25 feet.
2. At Longitudinal Grade Breaks: Plus or minus 1/4 inch in 10 feet.

D. Cross Slope:

1. In the Parking Lane: Two (2) percent target, five (5) percent maximum.
2. In the Travel Lane: Two (2) percent target, 1.5 percent minimum.

3.6 **FIELD QUALITY CONTROL**

A. Edge Mill: Verify cross slopes. Advise ENGINEER if a two (2) percent maximum break-over angle on an edge mill indicated on APWA Plan 253 cannot be achieved.

B. Full Width Mill:

1. Verify cross slopes. Advise ENGINEER if a four (4) percent maximum break-over angle on a full width mill indicated on APWA Plan 253 cannot be achieved.

2. On thoroughfares exceeding 25 mph use laser profiling to determine depth of milling along the proposed crown line or other breakover point.

3. Verify cut depth calculations with ENGINEER before milling.

3.7 **CLEANING**

A. Unless indicated elsewhere, all residues from the milling process become property and responsibility of CONTRACTOR. Waste millings legally. Do not discharge millings into storm drains, ditches, or waters of the State. Legally dispose of milled material.

END OF SECTION

SECTION 32 01 17

SEALING CRACKS IN BITUMINOUS PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Filling and sealing cracks in bituminous concrete pavements.

1.2 REFERENCES

A. **APWA (Utah) Standards**:

Plan 265 Crack sealing. B. **ASTM Standards**:

D 36 Softening Point of Bitumen (Ring-and Ball Apparatus)

D 977 Emulsified Asphalt. D 2397 Cationic Emulsified Asphalt. D 6690 Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

D 5078 Crack Filler for Asphalt Concrete and Portland Cement Concrete Pavements.

D 5329 Sealants and Fillers, Hot-Applied for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements.

D 8260 Hot-Applied Asphalt Aggregate-Filled Mastic.

1.3 DEFINITIONS

A. **Crack Sealing**: The placement of specialized crack sealing materials in or above cracks to prevent the intrusion of incompressibles and water into the crack. The crack receives unique crack configuration prepartion.

B. **Wide Crack Sealing**: The placement of specialized mastic materials in or above cracks greater tha 1 ½" to prevent the intrusion of incompressibles and water into the crack, adding structure and stability.

1.4 SUBMITTALS

A. Product Data sheets.

B. Demonstrate compliance with D 5078, D 8260, or D 6690 (Type I, II, III, or IV) as specified in project documents.

1.5 QUALITY ASSURANCE

A. Do not use crack repair product that has been over-heated or suffered prolonged heating according to manufacturer's recommendations, ravels, or can be pulled out by hand after placement.

B. Do not mix different manufacturer's brands or different types of crack repair material.

C. Do not allow crack repair product temperature at the point of placement to drop below the manufacturer's recommended application temperature during installation.

D. When loading product into product tank allow material to reach manufacturer's recommended application temperature prior to application.

E. Rework Defective Work.

1.6 NOTICE

A. Send written notice to residents and businesses within affected area at least three (3) days before preparation and application of Crack Sealing material.

B. Indicate date, time, and location of affected area and when it must be cleared of vehicles. Provide notice of when pavement surface can be used following application.

C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

D. Send a new notice, at least one (1) day in advance, identifying the new starting date should work not occur on the specified day.

1.7 **ACCEPTANCE**

A. Visually inspect areas for adhesion Failure, damage to crack repair product, missed cracks, foreign objects in the product, or other problems that indicate work is not acceptable.

PART 2 PRODUCTS

2.1 **SEALER MATERIAL**

A. Follow Table 1.

Table 1 – Fillers and Sealers

Material Type	Standard	Application
Hot-applied		
Rubberized Asphalt	D 5078 D 6690	Sealing
Low Modulus Rubberized Asphalt	D 6690 (Type IV)	Sealing
Hot Applied Mastic	D 8260	Sealing
Chemically Cured		
Silicone	(a)	Sealing

PART 3 EXECUTION

3.1 **CONSTRUCTION EQUIPMENT**

A. Sealant Heating Equipment: Indirect heating using double boiler or circulating hot oil heat transfer for heating product. Do not use direct heat transfer units (tar pots). Unit must have means of constant agitation.

B. Compressed Air Lance or Hot Air Lance: Provide clean, oil-free compressed air at a minimum volume of 90 cubic feet per minute at a pressure of 120 pounds per square inch.

C. Router: Use equipment sufficiently maneuverable to follow meandering cracks and that provides a uniform and controlled routing depth. Maintain bits that are sharp enough to create a clean cut.

3.2 **PREPARATION**

A. Allow at least one week for repaired cracks to cure and harden before placing thin overlays (chip seal, slurry seal, micro-surface, etc.).

B. Routing should be considered in areas with increased thermal movement or when a high performance product is desired.

C. Blow cracks clean. Remove foreign matter, loosened particles, and weeds.

D. Use a hot air lance when surfaces are wet or when air temperature is less than 40 deg F. Do not use on saturated pavements or burn the surrounding Pavement. Seal cracks immediately before cool down.

E. If a thin overlay is to be applied within six (6) months, remove crack overfill by squeegee.

3.3 **CRACK SEALING AND WIDE-CRACK SEALING**

A. Refer to APWA Plan 265, unless otherwise indicated.

B. Reapply material to any crack segment where material shrinkage or insufficient material was applied in a previous pass or application.

3.4 **PROTECTION**

A. Use non-abrasive deblotting product if traffic or construction activities are likely to cause pull out. Replace pull out at no additional cost to OWNER.

B. Repair vehicles or other property damaged by crack repair operation.

3.5 **LIMITATIONS**

A. Cracks that are less than 1/8” in width are not recommended for crack sealing, consider a surface preservation treatment.

B. Cracks that are over 1 ½” in width are not recommended for crack sealing, consider hot-applied mastic repair.

END OF SECTION

SECTION 32 01 19
PATCHING RIGID PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Full depth removal and replacement of Portland cement concrete roadway pavement panels.

1.2 REFERENCES
A. **APWA (Utah) Standards**:

Plan 256 Concrete pavement patch.

Plan 261 Concrete pavement joints.

B. **ASTM Standards:**

A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcing.

C1315 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.3 SUBMITTALS
A. Joint filler board data sheet.

B. Joint sealer data sheet.

C. Bond breaker data sheet.

D. Traffic control plan, Section 01 55 26.

E. Concrete mix design.

1.4 ACCEPTANCE
A. Concrete compressive strength.

B. Profile and cross-section tolerance.

PART 2 PRODUCTS

2.1 REINFORCEMENT
A. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel, ASTM A615:

1. Dowel Bar: Smooth.
2. Tie Bar: Deformed.
3. Mat: Deformed.

B. Dowel Bar End Cap: Non-metallic that allows 1/4 inch longitudinal movement of bar.

2.2 CONCRETE
A. Class 4000 cast-in-place, Section 03 30 04.

B. Slump range per mix design.

2.3 ACCESSORIES
A. Bond Breaker: Paraffin wax, lithium grease, or other semi-solid, inert lubricant.

B. Expansion Joint Filler: F1 sheet 1/2 inch thick, Section 32 13 73.

C. Contraction Joint Filler (Backer Rod): Closed cell, Type 1 round, Section 32 13 73.

D. Contraction Joint Sealer: HAS1 or HAS4 hot applied, Section 32 13 73.

E. Curing and Sealing Compound: Membrane type, ASTM C1315. Type II Class A or B (white pigmented).

F. Tackifier: Epoxy gel Type II, Section Section 03 61 00 for attaching plastic concrete to existing hard concrete or for securing dowel and deformed tie bars in drilled holes.

G. Water Repellant: Penetrating compound, Section 07 19 00.

2.4 **SOURCE QUALITY CONTROL**

A. Use concrete accelerating admixtures in cold weather only when approved in the mix design. Use of admixtures will not relax cold weather placement requirements.

B. Use set retarding admixtures during hot weather only when approved by ENGINEER.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Implement traffic control plan requirements, Section 01 55 26.

B. Make full depth saw cuts around the perimeter of the rectangular section to be removed. Do not over cut.

C. Make full depth re-cuts along any edge that is damaged during repairs, including failures on the underneath of the slab caused by insufficient saw-cut depths.

D. Remove panels without damaging remaining panels. Use chains and lift pins.

E. Repair foundation materials, grade, and compact.

F. Repair concrete damaged by removal operations

3.2 **LAYOUT**

A. Panels:

1. Follow APWA Plan 256 requirements.
2. Determine extent and dimensions of removal from Drawings, or acceptable to ENGINEER.
3. Form any side that does not have an adjacent panel. Form to match existing panels providing a vertical edge.

B. Joints:

1. Follow APWA Plan 261 requirements.
2. Tackifier required on vertical surface of cold joints, both transverse and horizontal. Do not apply bond breaker to cold joints
3. Keep existing pavement joint layout when scoring
4. Saw new concrete joint on same line if repairs straddle an existing joint line.

3.3 **BAR PLACEMENT**

A. Drill holes for bars using a rigid drill frame. Prevent bits from wandering.

B. Drill holes at mid-depth of the slab. Do not damage remaining pavement section. Remove contaminants from holes.

C. Deformed Bar: For drilled holes that receive deformed bars, place adhesive at far end of each hole. Fit retention ring to bar to prevent adhesive grout from flowing out of hole.

D. Dowel Bar: For drilled holes that receive smooth dowel bars, place grease at far end of drilled bar hole.bar before insertion. Grease and place an expansion end cap on protruding end of dowel bars.

E. Repair any bar coating damage with appropriate repair material.

F. Repack loose bars prior to placing concrete mix.

G. Before placing concrete in the work area:

1. Allow firm set of adhesive grout around bar.
2. Coat dowel bar extension with bond breaker.

3.4 **CONCRETE PLACEMENT**

A. Section 03 30 10.

B. Make sure base course is uniformly damp at time of placement.

C. Prevent segregation of concrete mix.

D. Consolidate concrete along face of existing panels and under reinforcement. Keep vibrators away from joint assemblies and reinforcement. Do not dislocate reinforcement, dowels, and tie bars during consolidation.

3.5 **FINISH**

A. Section 03 35 00.

B. Profile and cross-section tolerance is ± 1/8 inch.

C. Do not tool joints that are to be saw-cut and sealed.

D. Texture surface to match existing.

3.6 **CURING**

A. ASTM C1315. Apply total coverage in two (2) directions after texturing.

B. Eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete slab.

3.7 **PROTECTION AND REPAIR**

A. General: Protection and repair expenses are at no additional cost to OWNER.

B. Protection: Section 03 30 10:

1. Do not open to traffic until 4000 psi concrete strength is reached.

2. Protect concrete pavement surface against damage and marking. Place barricades at the proper locations to prevent traffic from using the pavement.

C. Repair:

1. Remove and replace any concrete slab replacement that exhibit cracking, shrinkage, or failure caused by traffic.

2. Correct patch profiles in excess of 1/8 inch **higher** or **lower** than the existing pavement profile through surface grinding or removal and replacement. Apply water repellant over surface grindings.

END OF SECTION

SECTION 32 01 29

CONCRETE PAVING RAISING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Raise Portland cement concrete pavement and flat work to grade by jacking.

1.2 REFERENCES

A. **ASTM Standards**:

C150 Portland Cement.

C618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

C1107 Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

D1621 Compressive Properties of Rigid Cellular Plastics.

D1622 Apparent Density of Rigid Cellular Plastics.

D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

D1621 Compressive Properties of Rigid Cellular Plastics.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. Plan for containing grout in the jacking process.

C. Data sheet for polyurethane or shrinkage resistant grout.

D. Procedure to be used in verifying injection fluid usage.

E. Injection sequence for raising roadway pavement panels.

F. Verify elevation of roadway pavement panel raising.

1.4 QUALITY ASSURANCE

A. Provide a licensed professional land surveyor to verify elevation changes in the roadway pavement profile.

PART 2 PRODUCTS

2.1 POLYURETHANE

A. High density, water based formulation.

Table 1 – Physical Properties

	Standard	Min	Max
Density, lb/ ft^3	D1622	3.8	4.3
Tensile strength, psi	D790	100	--
Elongation, percent	--	5.1	--
Compressive strength at yield point, psi	D1621	90	--

NOTES
(a) Maximum time of set is 15 minutes.
(b) Use value of flexural strength or flexural yield as tensile strength.

2.2 PORTLAND CEMENT GROUT

A. Type I or II, ASTM C150 with silica sand and a shrinkage-compensating agent with plasticizing and water reducing agents.

2.3 **PORTLAND CEMENT DRY MIX**

A. Select from the following options. Obtain ENGINEER's approval for any deviation from the option selected:

1. **Option 1:**
   a. One volume Portland cement, type I or II, ASTM C1107.
   b. Three volumes pozzolan, ASTM C618, type F.
   c. Shrinkage compensating agent with plasticizing and water reducing agents.
   d. Adjust water to meet field conditions.
2. **Option 2:**
   a. One volume Portland cement, type I or II, ASTM C1107.
   b. One volume pozzolan, ASTM C618, type F.
   c. Two volumes clean sand.
   d. Shrinkage compensating agent with plasticizing and water reducing agents.
   e. Adjust water to meet field conditions.

PART 3 EXECUTION

3.1 **CONSTRUCTION EQUIPMENT**

A. Pumping injection unit.

B. Drills and injection tubes.

C. Laser levels or dial micrometers.

D. Dynamic cone penetrometer.

E. Concrete saw.

F. Generators and other equipment.

3.2 **PREPARATION**

A. Pay applicable license or royalty fees.

B. Implement traffic control plan requirements, Section 01 55 26.

C. Use professional land surveyor elevation measuring device to establish target profile grade for roadway panels.

3.3 **PROTECTION**

A. Protect down-stream fish habitat. Remove slurry deposits from surfaces.

B. Do not permit rain or sprinkler system water to wash away dust.

C. Contain injected material during the jacking process. If containment is lost, implement remediation procedures immediately.

D. Protect against displacement of adjacent surfaces

3.4 **ROADWAY PAVEMENT FOUNDATION STABILIZATION**

A. Discover voids and soil conditions with penetrometer.

B. Limit concrete drill holes to 5/8 inch diameter maximum.

C. By injection, fill voids until pavement until lift is initiated.

3.5 **JACKING**

A. Saw-cut between failed and non-failed slabs as necessary to prevent damage to non-failed slabs.

B. Drill injection holes where necessary. Provide injection sequence for raising roadway pavement panels or concrete flat work without cracking. ENGINEER may order removal and replacement of panels cracked by CONTRACTOR at CONTRACTOR's cost.

C. Inject grout at proper depth to evenly raise pavement and flat work level with adjacent surface.

D. Do not displace adjacent surfaces.

E. After jacking, grade must be plus or minus 1/8 inch of target.

F. Fill injection holes with at least four (4) inches of non-shrink grout.

G. Patch drill holes.

3.6 **REPAIR**

A. Repair construction damage at no additional cost to OWNER. Damages include but are not limited to the following.

1. Raised adjacent slabs or structures not scheduled for rising.
2. Material or work product that shrinks, deteriorates, or otherwise fails by the end of the correction period.

END OF SECTION

SECTION 32 01 31
PAVEMENT SMOOTHNESS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Smoothness tolerances for placing flexible pavements, rigid pavements, and pavement patches.

B. Procedure for correcting defective smoothness.

1.2 REFERENCES

A. **ASTM Standards**:

E950 Measuring the Longitudinal profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference.

E1274Measuring Pavement Roughness Using a Profilograph.

1.3 DEFINITIONS

A. **Must Grind**: Areas of roadway pavement not meeting profile deviation tolerance.

B. **Road Class**: Attribute of a public or private thoroughfare based upon equivalent single axel loads (ESAL).

Class I: (ESAL < 10^4 per year) Includes maintenance mixes, bike paths, parking lots, residential driveways, light traffic residential streets, light traffic rural farm roads.

Class II: (ESAL between 10^4 and10^6 per year). Includes heavy traffic residential streets, rural farm collector roads, non-industrial parking lots, urban low volume collector streets.

Class III: (ESAL > 10^6 per year). Includes high volume collectors, arterials, industrial parking lots (primary load from 3-axle or greater vehicles), climbing lanes, truck weigh stations.

C. **Wheel Path**: A continuous parallel line inside a travel lane 2.5 feet from the lane line or median line.

1.4 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. Certifications for profilographs, profilers, and operators.

C. Summary report of smoothness profile testing.

1.5 QUALITY ASSURANCE

A. Provide testing equipment and a person capable of calculating grades and cross-slopes in degrees and percentages. Cross slopes vary when the crown line is not parallel to pavement edge line.

1.6 ACCEPTANCE

A. **General**:

1. Acceptance is by Lot.
2. Dispute resolution, Section 01 35 10.
3. Opening a profiled surface to traffic does not constitute acceptance.
4. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. **Profile Roughness**:

1. Lot is 0.1 lane mile (528 feet long one lane wide). Add segments shorter than 250 feet to preceding lot. Treat partial segments longer than 250 feet as a lot.
2. Excluded from the lot are turn lanes, parking lanes, medians, Street Fixtures, crowns of intersecting streets, bridge decks, grades greater than eight (8) percent, and vertical curves less than 1,000 feet radius (including super-elevation transitions).

C. **Profile Deviation**: Verify "Must Grind" bumps and depressions are removed from the lot surface. Lot is area of total placement. No area is excluded.

PART 2 PRODUCTS Not Used

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. **Profilograph**:

1. Capable of producing results required by ASTM E950 and ASTM E1274.
2. Set profilograph readings with corresponding project survey stationing, or as a minimum, correlate equipment station 0+00 with a specific project station number. ENGINEER to select.

B. **Milling and Grinding Machines**:

1. Equipped to prevent air pollution.
2. Equipped with a system to control depth and slope of pavement cut.

C. Cleaning equipment able to pick up millings and waste water.

3.2 PREPARATION

A. **Traffic Control**: Implement traffic control plan requirements, Section 01 55 26. Provide safe passage for pedestrians and vehicles. Do not proceed without certified flaggers if work requires.

B. **Surface Repair**: Method of payment to be determined by ENGINEER if preliminary profiling of existing pavement is required before placement of thin bonded overlay, micro-surfacing, slurry seal, chip seal, etc.

3.3 TOLERANCES

A. **Profile Roughness and Profile Deviation**: Verify bumps and depressions meet tolerance. Trace all wheel paths in direction of travel. Begin traces 50 feet before edge of new pavement or patch and end traces 50 feet after edge of new pavement or patch. Areas (including the 50 feet end trace areas) exceeding profile deviation tolerance are "Must Grind" areas.

Table 1 – Roughness and Deviation Tolerance

Speed mph	Road Class	Profile Roughness Index (PRI) Inches / Mile				Profile Deviation Inches/25 feet Maximum
		IRI		PI		
		Min	Max	Min	Max	
0 to 30	I	–	–	–	–	0.4
	II or III	129	177	46	66	0.4
31 to 45	I or II	90	155	35	50	0.4
	III	70	90	21	35	0.4
>45	All Classes	–	70	–	21	0.3

NOTES
(a) IRI (International Roughness Index), ASTM E 950. Use a 1/4 car.
(b) PI (Profile Index), ASTM E 1274. Use a zero blanking band.
(c) Profile deviation applies to bump and depression measurements.

3.4 REPAIR

A. **General**:

1. Do not begin repairs without ENGINEER's knowledge of such activity.
2. All repair expenses are at no additional cost to OWNER.

B. **Bituminous Concrete Repair**:

1. Smooth out profile irregularities by grinding. See Section 32 01 26.

2. Apply Section 32 12 03 cationic or anionic emulsion at 0.11 ± 0.01 gallons per square yard and a sand friction blotter over all grind areas.

3. If depressions cannot be corrected by grinding, do a cold mill and inlay repair per Section 32 01 16.71 or do a remove and replace patch repair per Section 33 05 25. **Raising depressions with a skin patch and feathered edges is NOT ACCEPTABLE**. Patch profile must meet this section's smoothness requirements.

C. **Portland Cement Concrete Repair**:

1. Smooth out profile irregularities by grinding. See Section 32 01 26.

2. Apply penetrating sealer over all grind areas. See Section 07 19 00.

3. If depressions cannot be corrected by grinding, remove concrete and provide a concrete pavement patch per Section 32 01 19. Patch profile must meet this section's smoothness requirements.

END OF SECTION

SECTION 32 05 10
BACKFILLING ROADWAYS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Roadway backfill materials.

B. Roadway backfilling requirements.

1.2 REFERENCES

A. **APWA (Utah) Standards**:

Plan 245 Subgrade stabilization.

B. **ASTM Standards**:

D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

D1557 Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D4832 Preparation and Testing of Soil-Cement Slurry Test Cylinders.

1.3 DEFINITIONS

A. **Embankment**: A raised earthen structure.

B. **Pavement**: A surface or covering, as of Portland cement concrete, bituminous concrete, brick, concrete paver, etc., specifically a paved street, sidewalk, curb, gutter, curb cut assembly, ramp, apron, Driveway, etc.

C. **Subgrade**: A surface of native earth or Rock leveled off as to receive backfill materials.

1.4 SUBMITTALS

A. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material.
2. Each type of fill to be used.

B. Submit aggregate batch delivery tickets showing name of material source, serial number of ticket, date and truck number, name of Supplier, job name and location, volume or weight, and aggregate classification or Supplier's identification code.

1.5 QUALITY ASSURANCE

A. Do not change material sources, or aggregate without ENGINEER's knowledge.

B. Reject backfill material that does not comply with requirements specified in this section.

C. If requested, submit a quality control Inspection and testing report describing source and field quality control activities performed by CONTRACTOR and Suppliers.

1.6 STORAGE

A. Safely stockpile backfill materials.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

1.7 SITE CONDITIONS

A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.

B. Control traffic and erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.

C. Reshape and compact damaged structural roadway section to required density.

D. Soil Cement: Do not spread soil cement mixture when air temperature is less than 40 deg F in the shade.

E. Drainage: Immediately before suspension of construction operations for any reason, provide proper and necessary drainage of work area.

1.8 **ACCEPTANCE**

A. General: Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.

B. Material: For material acceptance refer to:

1. Common fill, Section 31 05 13.
2. Aggregate base course, Section 32 11 23.
3. Cement treated fill, Section 31 05 15.

C. Lift Thickness: One test per Lot.

D. Compaction: One test per Lot. Verify density using nuclear tests, ASTM D2922. Compaction standard and Lot size as follows:

Table 1 – Compaction Standard and Lot Sizes

Material	Proctor	Lot Size
Subgrade	Standard	1000 square yards
Common Fill	Standard	PCC or AC Surface Course: 1,000 square yards per lift Driveway Approach: 400 square feet per lift Sidewalk: 400 linear feet per lift
Aggregate base course	Modified	PCC or AC Surface Course: 1,000 square yards per lift Driveway Approach: 400 square feet per lift Sidewalk: 400 linear feet per lift Curb, Gutter, and Waterways: 200 linear feet per lift

NOTES
(a) Standard proctor, ASTM D698.
(b) Modified proctor, ASTM D1557.

E. Flowable Fill Strength: Lot size is one day production with sub-lots of 250 cubic yards or part thereof. Verify strength using cylinders, ASTM D4832.

F. Grade, Cross Slope: Measured at random locations.

1.9 **WARRANTY**

A. Repair incidental settlement or settlement damage at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 **BACKFILL MATERIALS**

A. Common fill, Section 31 05 13: Granular material, CONTRACTOR's choice.

B. Aggregate base course, Section 32 11 23: Untreated base course.

C. Cement treated fill, Section 31 05 15: Use a flowable fill so vibration is not required.

2.2 **WATER**

A. Make arrangements for sources of water during construction and make arrangements for delivery of water to site.

B. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.

2.3 **GEOTEXTILE**

A. Stabilization separation fabric, Section 31 05 19: Woven, high MARV.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Implement traffic control plan requirements, Section 01 55 26.

B. Verify:

1. Backfill material meets gradation requirements.
2. Areas to be backfilled are free of debris, snow, ice or water.
3. Bearing surfaces are not frozen.

C. If ground water is in the intended backfill zone, dewater.

3.2 **PROTECTION**

A. Protect existing trees, shrubs, lawns, structures, fences, roads, sidewalks, paving, curb and gutter and other features.

B. Protect above or below grade utilities. Contact utility companies to repair utility damage. Pay all cost of repairs.

C. Avoid displacement of and damage to existing installations while compacting or operating equipment. Do not fill adjacent to structures until excavation is checked by ENGINEER.

D. Do not use compaction equipment adjacent to walls or retaining walls that may cause wall to become over-stressed or moved from alignment.

E. Do not disturb or damage foundation perimeter drainage, foundation, damp-proofing, foundation waterproofing and protective cover, or utilities in trenches. Movement of construction machinery over work at any stage of construction is solely at CONTRACTOR's risk.

F. Restore any damaged structure to its original strength and condition.

3.3 **LAYOUT**

A. Identify required line, levels, contours, and datum.

B. Stake and flag locations of underground utilities.

C. Upon discovery of unknown utility or concealed conditions, notify ENGINEER.

D. Maintain all benchmarks, control monuments and stakes, whether newly established by surveyor or previously existing. Protect from damage and dislocation.

E. If discrepancy is found between Contract Documents and site, ENGINEER shall make such minor adjustments in the Work as necessary to accomplish the intent of Contract Documents without increasing the Cost of the Work to CONTRACTOR or OWNER.

3.4 **SUBGRADE**

A. Protect Subgrade from desiccation, flooding, and freezing.

B. Before backfilling over Subgrade, get ENGINEER's review of Subgrade surface preparations.

C. If Subgrade is not readily compactable, get ENGINEER’s permission to stabilize the Subgrade:

1. Excavation for Subgrade stabilization is incidental work. Section 31 23 16.
2. Place geotextile fabric per APWA Plan 245. Place acceptable fill in lifts over the geotextile, compact and wrap.

3.5 **EMBANKMENTS**

A. Place backfill material in lifts not exceeding equipment compaction capability.

B. Build shoulders to a grade higher than that of adjacent fills. Provide surface runoff at all times.

C. Commence compaction along edge of area to be compacted and gradually advance toward center.

D. Operate compaction equipment along lines parallel or concentric with the center-line of the embankment being constructed.

E. Do not damage subsurface structures or utilities.

3.6 **BASE COURSES**

A. Place backfill material in lifts not exceeding eight (8) inches before compaction.

B. Maintain moisture content in compaction operations.

C. Avoid segregation when spreading backfill. Keep surfaces free from pockets of coarse and fine aggregate.

D. Rework fills that do not conform to compaction requirements until requirements are met.

E. Protect cement treated fill against freezing and traffic for seven (7) days.

3.7 **MODIFIED BACKFILL LAYER METHOD**

A. Section 33 05 20.

3.8 **TOLERANCES**

A. Compaction: Ninety-five (95) percent or greater relative to a standard or modified proctor density, Section 31 23 26.

B. Lift Thickness (before compaction):

1. Eight (8) inches when using riding compaction equipment.
2. Six (6) inches when using handheld compaction equipment.
3. As proven in the modified backfill layer method, Section 33 05 20.

C. Cement Treated Fill: Compressive strength targets are 60 psi in 28 days. Maximum is 90 psi in 28 days.

3.9 **FIELD QUALITY CONTROL**

A. Test roadway backfilling until a compaction pattern acceptable to CONTRACTOR and ENGINEER is achieved. Continue random quality control compaction testing.

B. Proof Rolling Test:

1. Before placing fill material for roadbed backfills, proof roll subgrade using gross weight of 18,000 pounds/tandem axle, with a tire pressure at least 90 psi.

2. All proof roll passes will traverse the subgrade parallel to the roadbed centerline. All subsequent passes will be offset 1/2 the vehicle width until the entire subgrade is tested.

3. ENGINEER will analyze, determine, designate and measure the areas, if any, requiring additional compaction or reconstruction.

4. Once subgrade passes the proof rolling test, protect the surface from construction operations and traffic damage. Repair all cuts, ruts, and breaks. Keep surface in a satisfactory condition until geotextile fabric or base course has been placed.

3.10 **CLEANING**

A. Remove stockpiles from site when work is complete. Grade site to prevent free standing surface water.

B. Leave borrow areas clean and neat.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Treated and untreated base course production and placement.

1.2 REFERENCES

A. **AASHTO Standards**:

R9 Acceptance Sampling Plans for Highway Construction.

B. **ASTM Standards**:

C29 Unit Weight and Voids in Aggregate.

C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

C117 Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Agtgregates by Washing.

C136 Sieve Analysis of Fine and Coarse Aggregates.

D75 Sampling Aggregates.

D448 Sizes of Aggregate for Road and Bridge Construction.

D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

D1883 CBR (California Bearing Ratio) of Laboratory-Compacted Soils.

D2216 Laboratory Determinations of Water (Moisture) Content of Soil and Rock.

D2419 Sand Equivalent Value of Soils and Fine Aggregate.

D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D3665 Random Sampling of Construction Materials.

D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

D5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.

1.3 DEFINITIONS

A. **Master Grading Band**: A graphical area defined by gradation limits allowed for various sieve sizes ranging from the maximum sieve size to the No. 200 sieve.

B. **Target Grading Curve**: A smooth locus of points within the limits of the Master Grading Band.

C. **Target Grading Band**: Gradation limits defined by the allowable variance from the Target Grading Curve. It is possible that these limits may lie outside of the Master Grading Band.

D. **Mean of Deviations**: The sum of the absolute values of the variance between each screen target value and each measured value divided by the number of tests in the Lot.

E. **RAP**: Acronym for reclaimed asphalt pavement. See Section 32 12 16.18.

F. **Lot**: (a) Quantity of aggregate delivered to a site when considering gradation, (b) area of aggregate placed at a site when considering density.

1.4 SUBMITTALS

A. **Mix Design**: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.

1. Date of mix design. If older than 365 days from date of submission, recertify mix design.
2. Name of supplier and aggregate source.

3. Target gradation for each sieve size,

4. Percent composition of reclaimed asphalt or concrete included in the mix.

5. Unit weight, CBR, relative density, and relative moisture content.

6. Aggregate physical properties (this section article 2.1). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from date of submission.

B. **At Delivery**: Submit batch delivery ticket identifying serial number of ticket, date and truck number, job name, weight of aggregate, mix identification, and description.

1.5 **QUALITY ASSURANCE**

A. Do not change aggregate source until ENGINEER accepts new source and new mix design.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 requirements.

C. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.

1.6 **ACCEPTANCE**

A. **General:**

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00.

3. ENGINEER is not obligated to accept changes in gradation target after any material is delivered to site.

4. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements in Section 01 35 10 are met.

5. Dispute resolution, Section 01 35 10.

B. **Gradation**: Lot size is one (1) day production. Sub-lot size is 500 tons. Collect samples from grade before compaction. Conduct at least one (1) gradation analysis for each lot. Lot is acceptable if gradation test deviations are within pay factor 1.00 limits. At ENGINEER's discretion, a lot with a sub-lot deviation greater than pay factor 0.70 limits may stay in place at 50 percent pay.

Table 1- Gradation Pay Factors						
Criteria	Pay Factor	Mean of Deviations of Acceptance Tests From the Target Grading Curve Expressed in Percentage Points				
		1 Sample	2 Samples	3 Sample	4 Sample	5 or More Samples
1/2" and Larger Sieves	1.00 0.95 0.90 0.80 0.70	0 – 15 16 – 17 18 – 19 20 – 21 22 – 23	0.0 – 12.1 12.2 – 13.9 14.0 – 15.1 15.2 – 17.2 17.3 – 18.8	0.0 – 10.8 10.9 – 12.4 12.5 – 13.5 13.6 – 15.3 15.4 – 16.7	0.0 – 10.0 10.1 – 11.5 11.6 – 12.5 12.6 – 14.2 14.3 – 15.5	0.0 – 9.5 9.6 – 11. 11.1 – 11.9 12. – 13.5 13.6 – 14.7
3/8" Sieve	1.00 0.95 0.90 0.80 0.70	0 – 15 16 – 17 18 – 19 20 – 21 22 – 23	0.0 – 11.5 11.6 – 13.2 13.3 – 14.4 14.5 – 16.3 16.4 – 17.9	0.0 – 9.8 9.9 – 11.3 11.4 – 12.3 12.4 – 13.9 14.0 – 15.2	0.0 – 8.8 8.9 – 10.1 10.2 – 11 11.1 – 12.5 12.6 – 13.6	0.0 – 8.0 8.1 – 9.2 9.3 – 10.0 10.1 – 22.4 11.5 – 12.4
No. 4 Sieve	1.00 0.95 0.90 0.80 0.70	0 – 14 15 – 17 18 19 – 20 21 – 22	0.0 – 10.5 10.6 – 12.1 12.2 – 13.1 13.2 – 14.9 15.0 – 16.3	0.0 – 8.8 8.9 – 10.1 10.2 – 11 11.1 – 12.5 12.6 – 13.6	0.0 – 7.8 7.9 – 9.0 9.1 – 9.8 9.9 – 11.1 11.2 – 12.1	0.0 – 7.0 7.1 – 8.0 8.1 – 8.7 8.8 – 10.0 10.1 – 10.8
No. 16 Sieve	1.00 0.95 0.90 0.80 0.70	0 – 11 12 – 13 14 15 – 16 17	0.0 – 8.2 8.3 – 9.4 9.5 – 10.3 10.4 – 11.6 11.7 – 12.7	0.0 – 6.9 7.0 – 7.9 8.0 – 8.6 8.7 – 9.8 9.9 - 10.7	0.0 – 6.2 6.3 – 7.1 7.2 – 7.8 7.9 – 8.8 8.9 – 9.6	0.0 – 5.6 5.7 – 6.4 6.5 – 7.0 7.1 – 8.0 8.1 – 8.7
No. 200 Sieve	1.00 0.95 0.90 0.80 0.70	0 – 4.5 4.6 – 5.2 5.3 – 5.6 5.7 – 6.4 6.5 – 7.0	0.0 – 3.4 3.5 – 3.9 4.0 – 4.3 4.4 – 4.9 4.9 – 5.3	0.0 – 2.9 3.0 – 3.3 3.4 – 3.6 3.7 – 4.1 4.2 – 4.5	0.0 – 2.5 2.6 – 2.9 3.0 – 3.1 3.2 – 3.6 3.7 – 3.9	0.0 – 2.3 2.4 – 2.6 2.7 – 2.9 3.0 – 3.3 3.5 – 3.6
NOTES (a) ENGINEER has 36 hours after Lot placement to accept aggregate gradation. CONTRACTOR may place material over the crushed aggregate base material during the 36 hours interval at its own risk. Pay factors for the Lot will NOT be applicable if ENGINEER performs tests after the 36 hours interval.						

C. **Relative Density**: Lot size 10,000 cubic yards. Conduct at least one laboratory determination to be used as a standard for field density and field moisture content determinations.

D. **Field Density**: Lot size is one (1) day placement. Number of density tests varies according to placement type, location and sub-lot size (Table 2). Conduct at least one (1) field density test in the lot. Select each test location randomly.

Table 2 - Placement Type, Location, Sub-lot Size

Type	Location	Sub-lot Size
I	Pavement (includes curb, gutter and water way when in conjunction with pavement placement).	1,000 square yards
II	Curb, gutter, waterway	200 linear feet
	Sidewalk	400 linear feet
	Driveway approach, curb cut assembly, waterway transition structure, flat work	400 square feet
III	Landscaping and other non-structural, non-load bearing areas	--

PART 2 PRODUCTS

2.1 UNTREATED BASE COURSE

A. **Material**: Crushed rock, gravel, sand, or other high quality mineral particle, or combination that is free of organic matter, free of chemical or petroleum contamination, and meets the following physical properties.

Table 3 – Untreated Base Course Physical Properties

	ASTMs	Aggregate Class		
		A	B	C
Coarse aggregate				
Angularity (2 fractured faces), min., percent	D5821	50	–	–
Wear (toughness or hardness), max., percent	C131	50		
Fine aggregate				
Liquid Limit, max.	D4318	25		
Plastic Index, max.	D4318	0	0	6
Sand Equivalent, min., percent	D24 19	35		
Blended aggregate				
Dry Rodded Unit Weight, min., percent	C29	75		
CBR, min., percent	D1883	70	55	--

NOTES

(a) Faces: Retained on No. 4 sieve.

(b) Wear: Retained on No. 12 sieve after 500 revolutions.

(c) Liquid limit and plastic index: Passing No. 40 sieve.

(d) Sand equivalent (clay content or cleanliness): Passing No. 4 sieve.

(e) CBR: Use a surcharge of 10 pounds measured at 0.20 inch penetration at 95 percent relative to a modified proctor density. A reduction in aggregate class may be accepted providing any costs for difference in excavation, backfill, and alternate design for CBR does not increase Concrete Price.

B. **Gradation**: Analyzed according to ASTM C136 on a dry weight and percent passing basis. Target Grading Curve must lie within the selected aggregate grade in table 4. Field gradation shall not vary from target by more than the target tolerance.

Table 4 – Master Grading Bands				
Sieve	Aggregate Grade			Target Tolerance
	Grade 1-1/2	Grade 1	Grade 3/4	
1-1/2"	100	–	–	(Pay factor 1.00 in Table 1)
1 "	–	100	–	
3/4 "	70 – 85	–	100	
1/2 "	–	79 – 91	–	
3/8 "	55 – 75	–	78 – 92	
No. 4	40 – 65	49 – 61	55 – 67	
No. 16	25 – 40	27 – 35	28 – 38	
No. 200	7 – 11	7 – 11	7 – 11	

NOTES
(a) It is assumed fine and course aggregate have same bulk specific gravity.
(b) Target tolerance for 3/4 sieve in Grade 3/4, and 1" sieve in Grade 1 is not applicable.
(c) Percentage of fines passing No. 200 sieve determined by washing, ASTM C117.

C. **Changing Source**: A new material properties report is required.

2.2 **TREATED BASE COURSE**

A. Treatment includes addition of lime, cement slurry, asphalt emulsion, RAP, crushed concrete, or any combination, or other material acceptable to ENGINEER.

B. Base course containing RAP:

1. Meet requirements of this section article 2.1 and the following:
   a. Sand equivalent and fractured face measured after asphalt residue is burned off.
   b. Plasticity and wear requirements apply to virgin aggregate portion only.
   c. Allowable asphalt content is controlled by allowable CBR.
2. Remove debris from crushed RAP aggregate by screening.
3. Mechanically blend virgin and RAP aggregates. Do not use windrows for blending.

C. Base course containing crushed concrete.

1. Meet requirements of this section article 2.1 and the following:
   a. Cement with its chemical components is allowed.
   b. Wear test and fractured face test not required.

2.3 **SOURCE QUALITY CONTROL**

A. Reject crushed aggregate base products that do not meet requirements of this Section.

B. Sampling Protocol: Random location selection, ASTM D3665. Sample collection, ASTM D75.

C. Testing Protocol: Gradation, ASTM C136. Maximum density, ASTM D1557. Optimum moisture content, ASTM D2216.

PART 3 EXECUTION

3.1 **SUB-BASE PREPARATION**

A. Trenches, Section 33 05 20.

B. Structures, Section 31 23 23.

C. Landscaping, Section 32 91 19.

D. Pavements, Section 32 05 10.

3.2 PLACEMENT

A. General:

1. Place uniform lifts not exceeding eight (8) inches before compaction.
2. Maintain optimum moisture content plus or minus two (2) percent.
3. Use appropriate compaction equipment.
4. Do not place additional material on any unaccepted layer or on any frozen surface.

B. Provide aggregate suitable for the following locations.

Table 5 - Placement Type, Location, Aggregate Class

Type	Location	Aggregate Class		
		A	B	C
I	Pavement (includes curb, gutter and waterway when in conjunction with pavement placement)	**X**		
II	Concrete flat work (includes driveway approach, curb cut assembly, curb, gutter, sidewalk, waterway, etc.	**X**	**X**	
III	Landscape (includes non-structural, non-load bearing areas.	**X**	**X**	**X**

NOTES:
(a) **X** indicates where placement is allowed.

C. Compaction:

1. Type I and Type II Placement: 95 percent minimum.
2. Type III Placement: Suitable to overlying surface, or installation, or use. Verify compactive effort with ENGINEER.

D. Finish: Uniform with surface deviation no more than 3/8 of an inch from line and grade in 10 feet in any direction.

3.3 FIELD QUALITY CONTROL

A. Sampling Protocol: Random location selection, ASTM D3665. Sample collection, ASTM D75.

B. Testing Protocol: Gradation, ASTM C136. Field density, ASTM D2922. Moisture content, ASTM D3017.

3.4 REPAIR OR REMOVAL

A. If product is correctable and at no additional cost to OWNER, provide laboratory data showing design CBR has not been reduced and material in-place has been compacted to 97 percent minimum.

B. Remove any product that cannot be corrected and install acceptable product at no additional cost to OWNER.

END OF SECTION

SECTION 32 11 24

PULVERIZED PAVEMENT BASE COURSE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Full depth reclamation by pulverizing and mixing an existing asphalt pavement and/or road base with a hydraulic cement, pozzolan or chemical stabilizer in-place to produce a stabilized base course mix. This specification is not intended for use with emulsion, foamed asphalt or other bituminous stabilizing agents.

1.2 REFERENCES

A. **ASTM Standards**:

C 136 Sieve Analysis of Fine and Coarse Aggregates.

C 150 Portland Cement.

C 593 Fly Ash and Other Pozzolans for Use with Lime for Soil Stabilization.

C 595 Blended Hydraulic Cement.

C 618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete.

C 977 Quicklime and Hydrated Lime for Soil Stabilization.

C 1157 Blended Hydraulic Cement (Performance)

D 558 Moisture-Density Relations of Soil-Cement Mixtures.

D 1633 Compressive Strength of Molded Soil-Cement Cylinders.

D 1883 California Bearing Ratio (CBR) of Laboratory-Compacted Soils.

D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.Technical Documents

1. NCHRP 144: Recommended Practice for Stabilization of Subgrade Soils and Base Materials
2. PCA Guide to Full-Depth Reclamation (FDR) with Cement.
3. PCA Soul Cement Laboratory Handbook

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. List of equipment to be used.

C. Mix design showing percentage and quantity of stabilizer and moisture needed..

1.4 WEATHER

A. Temperature: Do not pulverize when the soil, aggregate or subgrade is frozen, or when the ambient temperature is below 40 deg F or when freezing temperatures are anticipated within seven (7) days of the end of the full depth replacement process.

1. CONTRACTOR may request permission from ENGINEER to process in above conditions. Submit a cold weather plan detailing changes to mix design, construction practices, curing practices and testing practices to achieve design results. Obtain written approval of cold weather plan and permission to process from the ENGINEER before beginning pulverization efforts.

1.5 ACCEPTANCE

A. Gradation: Random measure, 2 times per day, minimum.

B. Depth: Random measure each 1,000 square yards.

C. Density: Nuclear gauge each 1.000 square yards.

D. Moisture Content: 2 times per day, minimum, and immediately after a precipitation event.

E. Quantity of stabilizer added matches submittal data.

PART 2 PRODUCTS

2.1 TACK COAT CURING COMPOUND

A. Cationic or anionic emulsified asphalt, Section 32 12 03.

2.2 STABILIZER

A. Hydraulic Cements:

1. Type I or II, ASTM C150
2. Type GU or MS, ASTM C 1157
3. Type IP or IS, ASTM C 595
4. Non-specification cement is acceptable, provided mix design requirements are met and CONTRACTOR can demonstrate consistency of cement to be supplied for duration of the stabilization efforts.

B. Lime and Pozzolans

1. Lime: Hydrated or Quicklime, ASTM C 977
2. Pozzolans: Fly Ash, Class C or Class F, ASTM C 618;

C. Chemical Stabilizer: Use type allowed by ENGINEER

D. Aggregate: Gravel, untreated base course, Recycled Asphalt Pavement (RAP), crushed Portland cement concrete.

2.3 MIX DESIGN

A. Mix Design Requirements:

1. Unless stabilizer content is otherwise specified or approved, follow mix design recommendations of NCHRP 144: Recommended Practice for Stabilization of Subgrade Soils and Base Materials.
2. Perform mix design on materials obtained from project. Do not use “Representative” materials not obtained from project site.
3. Unless otherwise specified, meet unconfined compressive strength per ASTM D 1633, method A, of 300 to 500 psi at seven (7) days, using samples vacuum saturated according to ASTM C 593.
4. If project documents require pulverized pavement to be used without stabilizer, submit target gradation using all common soil sieves and source acceptance testing demonstrating compliance with section 2.3C and following:
   a. CBR (ASTM D 1883): 70%, minimum, with a 10 lb. surcharge.
   b. Plastic Index (ASTM D 4318): 6, max.

B. Stabilizer Selection: Select and use aggregate stabilizers based on application and mix design results.

C. Pulverized Pavement Material Requirements

1. Pulverize existing pavement to the following gradation, ASTM C 136

Sieve	Percent Passing by Weight
3”	100
2”	< 95
No. 4	> 55

2. For pulverized materials with PI>20, demonstrate ability to intimately mix stabilizer with the pulverized material that will produce a reasonably homogeneous and continuous stabilized matrix.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Pulverizing Machine: Capable of cutting to the required depth, pulverizing, and sizing the material.

B. Blending Machine: Capable of mixing stabilizer and pulverized material to a reasonably homogeneous and continuous stabilized matrix.

3.2 PREPARATION

A. Identify location of all buried utilities.

B. Notify neighborhood of day and time of operation.

C. Implement traffic control plan requirements in Section 01 55 26.

D. Install Invert Covers, Section 01 71 13.

E. Lower Street Fixtures.

F. Determine need for stabilizer.

3.3 CONSTRUCTION

A. Pulverize asphalt pavement and untreated base course to depth specified by contract documents.

B. Control dust, Section 01 57 00.

C. If necessary for grade control, remove amount of pulverized material as shown on plans, or as directed by ENGINEER. If CONTRACTOR is directed to remove poor materials situated below the pulverized materials, push the pulverized material to the side, remove underlying material as directed, and push pulverized material back to original location.

1. If it is necessary to remove material below pulverized product to meet specified grade, **method of payment is determined by ENGINEER.**

D. Prior to adding stabilizer, verify that the moisture content of the UNSTABILIZED material is between minus 1% and plus 3% of design moisture content.

E. Add stabilizer over pulverized material and pulverize a second time.

1. For powdered stabilizers, use a shroud to prevent dust clouds or add powdered stabilizer in slurry form. Replace shroud with slurry form if placed stabilizer produced dust clouds prior to pulverization.

F. Shape, grade, compact, and finish. Complete all finishing operations within four (4) hours of application of stabilizer.

G. Moist-cure stabilized material for seven (7) days with either continuous water spray or asphalt tack coat at a minimum residual application rate of 0.06 gallons per square yard. Apply in a manner that achieves >99% coverage.

H. Pre-crack trated surface between 24 and 48 hous after final compaction.

1. Roll treated surface with 2 to 3 passes (1 pass is down and back) of a 12 ton, minimum, vibratory roller at maximum amplitude at walking speed.

3.4 FIELD QUALITY CONTROL

A. Gradation:Test gradation twice daily, and after visual changes in type of material being processed (i.e., change from granular to clay).

1. If No. 200 sieve material changes by more than 10% of total sample weight, revise mix design to accommodate.

B. Compaction:

1. Ninety-eight (98) percent or greater density with stabilizer relative to a standard proctor density (without stabilizer), Section 31 23 26. Use the following procedures:

a. Maintain moisture content between minus 1% and plus 3% of optimum moisture content, ASTM D 558. Test 1 time per every 2 hours of processing, minimum, and immediately after a precipitation event.

b. Nuclear gage, direct transmission procedure, ASTM D 2922.

3.5 REPAIR

A. Repair surface irregularities.

B. Seal cracks in cured stabilized material.

3.6 **OPENING TO TRAFFIC**

A. Completed portions of pulverized pavement can be opened to low-speed traffic and to construction equipment, provided the curing material or moist curing operations are not impaired and provided the pulverized material is sufficiently stable to withstand marring or permanent deformation.

B. Open to all traffic after the pulverized material has received a curing compound or a subsequent overlay surface, or is sufficiently stable to withstand marring or permanent deformation it may be opened to all traffic.

END OF SECTION

SECTION 32 12 03
ASPHALT BINDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. An asphalt-based cement that is produced from petroleum residue either with or without the addition of non-particulate, non-fibrous organic modifiers.

B. Requirements for accepting non-complying Asphalt Binders.

1.2 REFERENCES

A. **ASTM Standards**:

D113 Ductility of Bituminous Materials.

D977 Emulsified Asphalt.

D2026 Cutback Asphalt (Slow-Curing Type).

D2027 Cutback Asphalt (Medium-Curing Type).

D2028 Cutback Asphalt (Rapid-Curing Type).

D2397 Cationic Emulsified Asphalt.

D3381 Viscosity-Graded Asphalt Cement for Use in Pavement Construction.

D4552 Classifying Hot-Mix Recycling Agents.

D5710 Trinidad Lake Modified Asphalt.

D6373 Performance Graded Asphalt Binder.

1.3 SUBMITTALS

A. Submit bill of lading for each shipment of Asphalt Binder from vendor. Identify the following:

1. Source of product (manufacturer);
2. Type and grade of asphalt, and
3. Type and amount of additives in the product.

1.4 QUALITY ASSURANCE

A. Reject Asphalt Binders that are not uniform in appearance and consistency or foams at hot mixing temperature.

B. Do not use storage containers contaminated with other types or grades of petroleum products.

C. Do not use petroleum product that does not comply with contract requirements.

1.5 ACCEPTANCE

A. **General**:

1. Acceptance is by Lot. One (1) Lot is one (1) day production.
2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation. Section 01 29 00
3. Dispute resolution, Section 01 35 10.

B. **Performance Graded Asphalt Binder (PGAB):** Sub-lot size is 20,000 gallons. Collect sub-lot Samples randomly from oil storage unit.

1. Meet limits published in Section 209 of UDOT's "Manual of Instruction, Part 8 Materials". Pay reductions are as follows:

a. If none of the critical properties are outside rejection limit a composite pay adjustment of 25 percent or less is allowed.

b. If one or more of the critical properties falls outside the rejection limit or if a composite pay adjustment is more than 25 percent, Asphalt Binder will be rejected.

C. **Asphalt Cement (AC) Binder**: Sub-lot size is 20,000 gallons. Collect sub-lot Samples randomly from oil storage unit.

1. Ductility: Meet this section's requirements, or

2. Viscosity or Penetration: Meet graphics published in Section 955 of UDOT's "Manual of Instructions, Part 8 Materials":

a. Lot may be accepted using the published graphics. If pay adjustment exceeds 30 percent, reject Asphalt Binder, or

b. If allowed to remain after placement, pay adjustment will be 50 percent.

D. **Cut-back Binder**: Meet this section's requirements for ductility.

E. **Trinidad Lake Modified Asphalt**: Supplier's certificate for ASTM compliance.

F. **Emulsified Asphalt**: Supplier's certificate for ASTM compliance.

G. **Recycle Asphalt**: Identity of source (asphalt cement or tar products).

H. **Crack Patch**: Meet material requirements in Section 32 01 17.

PART 2 PRODUCTS

2.1 PERFORMANCE GRADE ASPHALT BINDER (PGAB)

A. Petroleum asphalt that complies with ASTM D6373. Blending binder with polymers, crumb rubber, or natural bitumens is CONTRACTOR's choice.

2.2 ASPHALT CEMENT (AC)

A. Petroleum asphalt that complies with Table 2 of ASTM D3381 except as follows:

1. Replace ductility, ASTM D113, at 77 deg F (25 deg. C) with ductility at 39.2 deg F (4 deg. C). Use the following values.

- AC-5: greater than 25.
- AC-10: greater than 15.
- AC-20: greater than 5.

2. Delete the loss on heating requirement on residue from "Thin-Film Oven Test".

B. AC-5 Latex Additive: Anionic emulsion of butadiene-styrene low-temperature copolymer consisting of two (2) percent by weight (solids basis), stabilized with fatty-acid soap for storage stability.

2.3 TRINIDAD LAKE MODIFIED ASPHALT (TLA)

A. Petroleum asphalt that complies with ASTM D5710 (a blend of natural bitumens).

2.4 SLOW CURE CUT-BACK ASPHALT (SC)

A. Petroleum asphalt that complies with ASTM D2026 (fluxed with a light oil) except if penetration of residue is more than 200 and its ductility at 77 deg. F (25 deg. C) is less than 100 cm., the material will be acceptable if the ductility at 59 deg F (15 deg. C) is greater than 100.

2.5 MEDIUM CURE CUT-BACK ASPHALT (MC)

A. Petroleum asphalt that complies with ASTM D2027 (fluxed or blended with a kerosene type solvent, non-foaming when heated to application temperature) except if penetration of residue is more than 200 and its ductility at 77 deg F (25 deg. C) is less than 100 cm., the material will be acceptable if the ductility at 59 deg F (15 deg. C) is greater than 100.

2.6 RAPID CURE CUT-BACK ASPHALT (RC)

A. Petroleum that complies with ASTM D2028 asphalt (fluxed or blended with a naphtha solvent, non-foaming when heated to application temperature).

2.7 EMULSIFIED ASPHALT

A. Petroleum asphalt uniformly emulsified with water, homogeneous throughout, and when stored, shows no separation within 30 days after delivery. Frozen emulsions not accepted:

1. Anionic, ASTM D977 (breaks by evaporation).
2. Cationic, ASTM D2397 (breaks chemically).

2.8 **RECYCLE ASPHALT (RA)**

A. Petroleum asphalt that complies with ASTM D4552 (homogeneous, free-flowing at pumping temperature made from maltene fractions of asphalt cement for surface revitalization or from tar products to make Pavements resistant to fuel spillage:

1. RA-1, RA-5, RA-25 or RA-75 for recycling RAP aggregate when less than 30 percent virgin aggregate is added.
2. RA-250 or RA-500 when more than 30 percent virgin aggregate is added to RAP.

2.9 **WARM-MIX ASPHALT (WMA)**

A. Performance grade Asphalt Binder or asphalt cement binder blended with a wax, foam, chemical, or organic additive.

PART 3 EXECUTION

3.1 **INSTALLATION**

A. Prime coat, Section 32 12 13.19.

B. Tack coat, Section 32 12 13.13.

C. Plant mix paving, Section 32 12 16.13.

D. Road mix paving, Section 32 12 16.19.

E. Slurry seal coating, Section 32 01 13.61.

F. Crack sealing, Section 32 01 17.

END OF SECTION

SECTION 32 12 05
BITUMINOUS CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Composition of a bituminous concrete mix.

B. For placement of a bituminous concrete mix, refer to Section 32 12 16.13.

1.2 REFERENCES

A. **AASHTO Standards**:

M323 Superpave Volumetric Mix Design, Single User Digital Publication

R18 Standard Recommended Practice for Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories

R30 Mixture Conditioning of Hot-Mix Asphalt (HMA)

T324 Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA)

B. Asphalt Institute Standards:

SP-2 SUPERPAVE Mix Design Series No. 2

C. **ASTM Standards**:

C29 Unit Weight and Voids in Aggregate.

C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

C117 Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing.

C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

C136 Standard Method for Sieve Analysis of Fine and Coarse Aggregate.

C142 Clay Lumps and Friable Particles in Aggregates.

D75 Sampling Aggregates.

D140 Sampling Bituminous Materials.

D242 Mineral Filler for Bituminous Paving Mixtures.

D979 Sampling Bituminous Paving Mixtures.

D995 Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.

D2419 Sand Equivalent Value of Soils and Fine Aggregate.

D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.

D3666 Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.

D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

D4552 Classifying Hot-Mix Recycling Agents.

D4791 Flat or Elongated Particles in Coarse Aggregate.

T283 Effect of Moisture on Asphalt Concrete Paving Mixtures (Lottman Test).

D5444 Mechanical Size Analysis of Extracted Aggregate.

D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate.

D6307 Determining Asphalt Content of Hot-Mix Asphalt by Ignition Method.

D6373 Performance Graded Asphalt Binder.

1.3 **DEFINITIONS**

A. Mix Designator: An alphanumeric code that identifies binder grade, aggregate grade, and compaction level for a bituminous concrete mix. For example, in PG64-34, SP-1/2, 75Nd:

1. Binder grade (PG64-34): The alpha portion represents Performance Graded Asphalt Binder. The numberical portion represents the grade of the binder.

2. Aggregate gradation (SP-1/2): The alpha portion represents Superpave mix. The numerical portion represents the nominal maximum sieve size.aggregate gradation.

3. Compaction level (75Nd): This is the compaction level using Superpave mix design process.

B. Bituminous Binder: A graded bituminous cement composed of any of several viscous or solid mixtures of hydrocarbons and their nitrogen and sulfur derivatives, whose combined properties meet a defined standard.

1. Virgin Asphalt Binder: A refined or manufactured bituminous cement known as performance graded asphalt binder (PG or PGAB).

2. Recycled Asphalt Binder: A bituminous cement contained in recycled asphalt pavement known as performance graded asphalt binder (PG or PGAB).

C. Binder Grades:

1. Virgin Binder Grade: The grade of asphalt binder received from binder supplier and added to the mix.

2. RAP Binder Grade: The grade of recycled asphalt binder contained in recycled asphalt pavement.

3. Resultant Binder Grade: The resultant grade of binder in the mix based on blending of virgin binder and RAP binder grades.

4. Design Binder Grade: The required grade of binder for the pavement based on environmental conditions, also the virgin asphalt binder specified when using 15% or less RAP.

D. **Mean of Deviations**: Defined in Section 32 11 23.

E. **Nominal Maximum Size**: One sieve size larger than first sieve size retaining more than 10 percent of the Sample. One hundred percent of the aggregate might be able to pass through the nominal maximum size sieve but not more than 10 percent will be retained on that sieve. The maximum size sieve will be one (1) sieve size larger than the nominal maximum size.

F. **RAP**: Acronym for reclaimed asphalt pavement. A granular product recovered from a bituminous pavement containing aggregate and an Asphalt Binder.

G. Quality Control: Sampling, testing and inspection efforts performed by the Contractor to control the mix production and placement operations. Locations, times, practices and personnel (other than Lab AMRL Accreditation and minimum requirements in Article 3.3) are the contractor's decision.

1. Requirements for Quality Control that may/will be used in acceptance decisions will be defined by the Owner in Section 32 12 05S - Project Specific Surfacing Requirements.

H. Owner Verification Testing: Sampling, testing and inspection efforts, and personnel/laboratory qualifications that are utilized by the Owner to verify compliance of the mix production and placement with specifications. Locations, times, practices and personnel are at the Owner's decision.

I. Road Class: Road Class as identified in Section 32 12 05S – Project Specific Surfacing Requirements, or as defined in section 32 01 31 Pavement Smoothness if not in 32 12 05S.

J. Warm Mix Asphalt (WMA) is defined as asphalt produced with a maximum production temperature (Fahrenheit):

1. PG58 > 270 degrees

2. PG64 > 280 degrees

3. PG70 > 290 degrees

4. PG76 > 300 degrees

1.4 **SUBMITTALS**

A. **General**:

1. Pre-approved Mix Design: Submit name and address of Supplier.

2. Allow ENGINEER 10 days to evaluate mixing equipment and mix design submittals.

3. Once a mix design is accepted, a new mix design submittal is required if the following occurs.

a. Asphalt Binder grade is changed.

b. Aggregate source is changed. When this occurs, submit a physical properties report on the proposed aggregates.

B. **Quality Assurance**:

1. Independent Laboratory: Submit names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM D3666. And follows Section 01 45 00 requirements.

2. Mix Production Equipment: Submit verification by an individual acceptable to ENGINEER, that plant equipment complies with requirements of ASTM D995.

3. Testing Report: If requested by ENGINEER, submit a report of source and field quality control testing performed by CONTRACTOR and Suppliers.

4. Testing Report: If identified by Section 32 12 05S – Project Specific Surfacing Requirements, submit Quality Control data to the Engineer within 3 working days after completion of each day of paving or prior to the start of the next paving day, whichever is sooner.

5. Plant Production Report: If identified by Section 32 12 05S – Project Specific Surfacing Requirements, submit daily plant production records to the Engineer within 1 working day after completion of each day of paving and prior to the start of the next paving day.

a. Plant report must include weights of all individual aggregates, bitumens, water and other additives incorporated in mix, including RAP, lime, mineral filler, fiber or other additives.

C. **Mix Design:** Submit the following.

1. Valid mix design.

a. Mix designs dated from the previous paving season (calendar year) are invalid unless accompanied by a letter from the Asphalt Supplier certifiying that the mix design is still valid for the current paving season.

b. Mix designs dated prior to the previous paving season are invalid.

c. Mix designs are invalid if aggregate source or binder grade are changed.

d. Invalidated mix designs must be revalidated for volumetric properties (minimum 4 pucks, ± 0.2% from targets), or a replaced with a new mix design.

2. Virgin Binder source and grade, and Resultant Binder grade.

3. Optimum compaction temperature at the project site.

4. Theoretical maximum specific gravity.

5. Compaction density at design target air voids.

6. Target Grading Curve for aggregate.

7. Binder target percentage.

8. Dust to binder ratio.

9. Voids in the mineral aggregate (VMA).

10. Voids filled with Asphalt (Bituminous Binder), also known as VFA.

11. Hamburg Wheel Tracker results, if required

12. Percentages of 1) mineral filler, 2) anti-strip (if required), 3) reclaimed bituminous (asphalt) pavement (RAP), 4) recycle agent in the mix, and 5) virgin aggregate.

13. Aggregate physical properties (this section article 2.2). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than two (2) calendar years from the date of submission.

D. Warm Mix Asphalt (WMA) – Mix Design

1. WMA must be produced using an approved additive. Approved additives must be evaluated and published on the National Transportation Product Evaluation Program (NTPEP)

a. Chemical additive dosage shall be declared on the mix design. Production target dosage shall be a minimum and maximum percentage of weight of total binder (RAP + Virgin AC) per manufacturer recommendations.

b. Existing aspalt mix designs can be modified to WMA provided that all standard asphalt specifications continue to be met.

c. New volumetric mix design verifications shall be completed with the additive in the mix.

d. When adding a warm mix chemical to an existing approved mix design the contractor must provide documentation that the mix still meets APWA specifications.

e. The binder supplier shall confirm compatibility between their binder and the maximum dosage of additive to be used.

1.5 **MATERIALS QUALITY**

A. Do not change aggregate source or binder grade until ENGINEER accepts new grades and new or revalidated mix design.

B. HMA Mixing Plant: Capable of meeting ASTM D995 requirements or use UDOT Qualified Plant.

1.6 **ACCEPTANCE**

A. **General**:

1. Acceptance is by Lot. One (1) Lot is one (1) days' production.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation, Section 01 29 00.

3. If test results are not within this section's limits, options include correction of production procedures or production of an alternate mix design acceptable to ENGINEER.

4. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements in Section 01 35 10 are met.

B. **Mix Sampling and Testing**:

1. Sub-lot size is 500 tons or part thereof.

2. Sampling Protocol: ASTM D3665 and ASTM D979. Collect at least one (1) random Sample per sub-lot from behind paver and before compaction. For placements with a design thickness of 2 inches or less, samples may be taken at the plant. Any sample collected because of non-uniform appearance shall not be used in determining a pay factor for the Lot.

a. Sampling binder, ASTM D140. At owner's request, take 1 qt sample and provide to owner's representative.

3. Testing Protocol (Performed by Owner's Verification Testing Organization):

a. Project Less than 1000 tons – At Owner's discretion, mix samples will be compacted in the laboratory and tested for:

1) Binder content, ASTM D6307.

2) Aggregate gradation, ASTM D5444.

3) Maximum Specific Gravity (Rice), ASTM D2041

b. Project greater than 1000 tons - Mix samples will be compacted in the laboratory and tested for:

1) Air voids, ASTM D3203.

2) Voids in the mineral aggregate, AI MS 2.

3) Binder content, ASTM D6307.

4) Aggregate gradation, ASTM D5444.

5) Maximum Specific Gravity (Rice), ASTM D2041

4. Reporting: The Owner or the Owner's Verification Testing organization will provide the contractor with acceptance results within 3 working days after completion of each day of paving, or prior to the start of the next paving day, whichever is sooner.

C. Lot Acceptance: A Lot is acceptable if binder content and aggregate gradation test average deviations are within pay factor 1.00 limits in Table 1 and no sub-lot devation exceeds 0.85 pay factor limit.

D. Un-Accepted Lots (Contracts Issued by Someone Other Than The Ultimate Owner of The Pavement): Provide recommended corrective measures based on Engineering Analysis, described below, based on durability and serviceability relative to the specified product requirements, including expected performance compared to design life. The ultimate owner of the pavement or a representative of such will review and either approve corrective measures or provide basis for rejection.

E. Un-Accepted Lots (Contracts Issued by The Ultimate Owner of The Pavement): At the Engineer's discretion, a lot with an average deviation that does not meet 1.00 pay factor and does not have a sub-lot test deviation greater than pay factor 0.85 limits may be accepted with a pay factor in accordance with Table 1.

1. Lots with a pay factor lower than 0.85 or with a sub-lot with a test deviation greater than the pay factor 0.85 limits, and with Engineer and Contractor concurrence, are subject to an Engineering Analysis.

Table 1 – Pay Factors

Criteria	Pay Factor	Range of Mean of Deviations of Tests Results in Percentage Points from Binder and Gradation Targets			
		500 Tons	1,000 Tons	1,500 Tons	≥ 2,000 Tons
Binder Content	1.00	0.0 – 0.46	0.0 – 0.41	0.0 – 0.38	0.0 – 0.35
	0.95	0.47 – 0.58	0.42 – 0.52	0.39 – 0.58	0.36 – 0.52
	0.90	0.59 – 0.64	0.53 – 0.56	0.59 – 0.64	0.53 – 0.56
	0.85	0.65 – 0.69	0.57 – 0.61	0.65 – 0.69	0.57 – 0.61
Nominal Sieve	1.00	0.0 – 6.3	0.0 – 5.6	0.0 – 5.3	0.0 – 5.0
	0.95	6.4 – 7.9	5.7 – 7.0	5.4 – 7.9	5.1 – 7.0
	0.90	8.0 – 8.7	7.1 – 7.7	8.0 – 8.7	7.1 – 7.7
	0.85	8.8 – 9.5	7.8 – 8.4	8.8 – 9.5	7.8 – 8.4
No. 8 Sieve	1.00	0.0 – 4.8	0.0 – 4.3	0.0 – 4.0	0.0 – 3.8
	0.95	4.9 – 6.0	4.4 – 5.3	4.1 – 5.0	3.9 – 4.3
	0.90	6.1 – 6.6	5.4 – 5.8	5.1 – 5.6	4.4 – 4.8
	0.85	6.7 – 7.2	5.9 – 6.4	5.7 – 6.2	4.9 – 5.4
No. 50 Sieve	1.00	0.0 – 3.8	0.0 – 3.3	0.0 – 3.0	0.0 – 2.8
	0.95	3.9 – 5.0	3.4 – 4.3	3.1 – 4.0	2.9 – 3.3
	0.90	5.1 – 5.6	4.4 – 4.8	4.1 – 4.6	3.4 – 3.8
	0.85	5.7 – 6.2	4.9 – 5.4	4.7 – 5.2	3.9 – 4.4
No. 200 Sieve	1.00	0.0 – 2.0	0.0 – 1.8	0.0 – 1.8	0.0 – 1.8
	0.95	2.1 – 2.4	1.9 – 2.2	1.9 – 2.2	1.9 – 2.2
	0.90	2.5 – 2.7	2.3 – 2.4	2.3 – 2.4	2.3 – 2.4
	0.85	2.8 – 3.0	2.5 – 2.6	2.5 – 2.6	2.5 – 2.6

NOTES
(a) Test binder content using a burn-off oven, ASTM D6307.
(b) Determine aggregate gradation by extraction, ASTM D5444.

F. Engineering Analysis:

1. Submit an Engineering Analysis, performed and stamped by a Utah Registered Professional Engineer or Mix Supplier QC Manager with commensurate experience in materials and pavements performance, for approval within one week of receipt of test results or at least one working day (M-F) before performing any work that may prevent the evaluation, correction, or removal of the lot in question.

2. The engineering analysis shall include the following:

a. Reasons for disputing the acceptance or verification test results.

b. The Contractor's project quality control test results, including any split sample test results.

1) Test results must be from a UDOT qualified laboratory using UDOT qualified technicians, or results must be verified and certified (stamped) by a Utah Registered Professional Engineer.

2) Include all supporting test data and calculations for reported values.

c. Successful laboratory correlation information when required by material specification.

d. Statistical analysis or identification of potential outliers.

e. Procedures or issues leading to disputed acceptance test results.

f. Impact of results on pavement performance and recommended cost adjustment to impacted materials based on impact to pavement performance.

G. **Installation**: See Section 32 12 16.13 acceptance requirements.

PART 2 PRODUCTS

2.1 BINDER

A. Performance Graded Asphalt Binder (PGAB): See ASTM D6373.

1. Use the following minimum virgin mix binder grades unless otherwise specified.

Table 2 – Minimum Virgin Binder Grade		
	Elevation	
Road Class	Above 4000 Feet	Below 4000 Feet
Class I & II	PG 58-28 (≤ 15% RAP) PG 64-34 (>15% RAP) (a)	PG 64-22 (≤ 15% RAP) PG 58-28 (>15% RAP)
Class III	PG 64-34 (a) (Up to 30% RAP)	PG 70-28 (≤ 15% RAP) PG 64-34 (>15% RAP)
a. Blending chart limitations for mixes exceeding 15% RAP must meet -28 for low end PG temperatures.		

2. Adjust virgin binder grade to accommodate RAP contents in excess of 15% as identified in Table 2. Do not use grades lower than xx-34. Use M323 Appendix X1 Blending chart to determine acceptable RAP content up to maximum allowed based on virgin binder grade selected or additives incorporated. Submit RAP binder grading and blending charts with mix design.

3. Use of Virgin Binder Grades exceeding the minimums, i.e. grades with ranges encompass greater temperature ranges than required for virgin binder, is acceptable.

2.2 **AGGREGATE**

A. Crushed stone, crushed gravel,slag, sand, or combination.

B. Use Table 3 to determine suitability of aggregate source.

Table 3 – Aggregate Physical Properties				
		Standard	Road Class	
			I & II	III
Coarse Aggregate				
Angularity, percent, minimum	One Fractured face	D5821	90	95
	Two Fractured faces		90	90
Wear (hardness or toughness), percent, maximum		C131	35	35
Flats or elongates (3:1 length to width), percent, maximum		D4791	--	20
Fine Aggregate				
Angularity (uncompacted void content), percent, minimum		T304	40	45
Sand equivalent, percent, minimum		D2419	45	60
Plastic limit, maximum		D4318	0	0
Blended Physical Properties				
Dry-rodded Unit Weight, lb/ft^3, minimum		C29	75	75
Weight Loss (Soundness), percent, maximum		C88	16	16
Friable particles, percent, maximum		C142	2	2

NOTES

(a) Coase aggregate is material retained on No. 4 sieve.

(b) Fine aggregate is material passing No. 4 sieve.

(c) Angularity is determined by weight.

(d) Wear of aggregate may have higher values if aggregate source is known to have higher values.

(e) Sand equivalent is waived for RAP aggregate but applies to the remainder of the aggregate blend.

(f) Plastic limit, passing No. 40 sieve. Aggregate is non-plastic even when filler material is added to the aggregate.

(g) Weight loss, using sodium sulfate.

(h) Friable particles are clay lumps, shale, wood, mica, coal passing the No. 4 sieve, and other deleterious materials.

(i) Road class as identified in project documents and as defined in Section 32 01 31

2.3 **ADDITIVES**

A. Mineral Filler: ASTM D242.

B. Recycle Agent: ASTM D4552.

C. Anti-strip Agent: Heat stable cement slurry, lime slurry, or chemical liquid.

D. RAP: Free of detrimental quantities of deleterious materials.

1. Use RAP Content as requirements of Table 2.

2. Determine RAP binder content by chemical extraction.2.4 **MIX DESIGN**

A. **Preparation**:

1. Get the Mix Designator and the Road Class from the OWNER, ENGINEER, or bid documents.

2. Use paragraph 1.4C to determine submittal requirements.

B. **Aggregate Gradation:** See Table 4. The Target Gradation Curve for the specified aggregate grade must lie within the Master Grading Band limits. The target grading band limits for the Target Grading Curve are the appropriate grading limits for pay factor 1.00 in Table 1. The target grading band limits are allowed to extend outside of the Master Grading Band limits.

Table 4 - Master Grading Bands - Superpave Mix Design		
Sieve	**Gradation Limits of Target Gradation**	
	SP-1/2	**SP-3/8**
3/4 inch	100	–
1/2 inch	90.0 – 100	100
3/8 inch	< 90.0	90.0 – 100
No. 4	–	< 90.0
No. 8	28.0 – 58.0	32.0 – 67.0
No. 200	2.0 – 10.0	2.0 – 10.0

NOTES

(a) Gradation is expressed in percent passing by weight per ASTM C136. Percentage of fines passing No. 200 sieve determined by washing per ASTM C117.

(b) The numerical portion of the grade designator (1/2, 3/8) represents the ***nominal maximum*** sieve size. Comparable ***maximum*** mix designs would be one sieve size larger, i.e. ½" nominal (superpave) maximum is comparable to ¾" maximum (Marshall).

C. Design Parameters: Determined by AI MS-2.

Table 5 - Mix Design Parameters	
Compaction Level (a)	Asphalt Institute SP-2
Road Class I/II	50Nd
Road Class III	75Nd
Design Air Void Target, percent (b)	3.5
Voids in Mineral Aggregate (VMA) relative to nominal sieve size grading and calculated using Gsb(dry), percent, minimum	ASTM D3203
Class II and III: SP-1/2	14.2
Class I: SP-3/8	15.2
RAP specific gravity for calculations	Gsb (dry) by chemical extraction
Dust to Binder Ratio, maximum	1.6
Tensile Strength Ratio (moisture sensitivity), minimum (a,c)	AASHTO T283
Road Class I (e)	80% or HWT
Rutting (Hamburg Rut Test) (a,d)	AASHTO T324
Road Class II	15 mm/10,000 passes
Road Class III	10 mm/20,000 passes

NOTES

(a) Road Class as identified in project documents and as defined in Section 32 01 31.

(b) Design Density Target: ASTM D2041. Percent of maximum theoretical specific gravity.

(c) Tensile Strength Ratio (moisture sensitivity): Use one cycle of Freeze-thaw conditioning. Compact test specimen to seven (7) percent plus or minus one (1) percent air voids. Applicable to Road Class I only.

(d) With testing performed at temperatures representing the specified binder grade in the Hamburg rut test, the average rut depth of two (2) mix design test samples is less than the amount shown for the respective Road Classes.

(e) Lottman not required if passing Hamburg Wheel Tracker

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Mixing Plant: ASTM D995. Provide.

1. Positive means to determine the moisture content of aggregate.
2. Positive means to sample all material components.
3. Sensors to measure the temperature of the mix at discharge.
4. Ability to maintain discharge temperature of mix.
5. Capability of maintaining plus or minus five (5) percent tolerance on component percentages in final mix.
6. **Ability to document control efforts.** 3.2 **INSTALLATION**

A. Pavement placement, Section 32 12 16.13.

B. Pavement restoration, Section 33 05 25

3.3 **QUALITY CONTROL**

Perform the following:

A. For all projects, test temperature of mix placed in the transport vehicle at the production plant.

1. Reject mixes exceeding the limits identified in the mix design.

B. For projects requiring testing, collect mix samples randomly from the plant (from truck or hot-drop) or the field (windrow or behind paver), ASTM D3665.

1. Sampling bituminous paving mixture, ASTM D979, minimum one sample per sub-lot.

C. If Quality Control is required by Section 32 12 05S – Project Specific Surfacing Requirements or project documents, submit Quality Control data to the Engineer. Submit data within 3 working days after completion of each day of paving or prior to the start of the next paving day, whichever is sooner.

D. For projects less than 500 tons, if identified as required by Section 32 12 05S – Project Specific Surfacing Requirements, provide one of the following:

1. Plant Report; or
2. Test results for binder content and combined gradation of mix

E. For projects between 500 and 1500 tons, provide the following:

1. Combined aggregate gradation in the mix, ASTM D5444.
2. Binder content in the mix, ASTM D6307.
3. Maximum Specific Gravity (Rice), ASTM D2041.

F. For projects greated than 1500 tons, provide the following:

1. Combined aggregate gradation in the mix, ASTM D5444.
2. Binder content in the mix, ASTM D6307.
3. Air voids, ASTM D3203.
4. Voids in the mineral aggregate, AI MS 2.
5. Maximum Specific Gravity (Rice), ASTM D2041.

G. Warm Mix Testing: When rutting or moisture susceptibility tests are required on warm mix produced at temperatures below 275 deg F, condition the warm mix material before testing for two (2) hours at design mixing temperature plus or minus five (5) deg F per AASHTO R30 (short term aging). The material may be cooled to room temperature before conditioning.

END OF SECTION

SECTION 32 12 13.13
TACK COAT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Application of asphaltic material to existing bituminous concrete or Portland cement concrete surfaces before placing an bituminous concrete pavement.

1.2 SUBMITTALS

A. Certificate showing asphaltic material complies with Section 32 12 03:

1. Identify water/asphalt dilution ratio.
2. Identify tack coat application rate.

B. Identify asphalt material recommended by fabric manufacturer.

1.3 WEATHER

A. Apply tack coat only when air and roadbed temperatures in the shade are greater than 40 deg F Temperature restrictions may be waived only with ENGINEER's concurrence.

B. Do not apply tack coat during rain, fog, dust, or other unsuitable weather. Do not apply coat to wet surfaces.

1.4 NOTICE

A. Send written notice to residents or business owners 24 hours before applying coat.

PART 2 PRODUCTS

2.1 ASPHALT MATERIAL

A. Select from the following:

1. Emulsified Asphalt: Grade MS-1, SS-1 or SS-1h, Section 32 12 03.
2. Cationic Emulsified Asphalt: Grade CSS-1 or CSS-1h, Section 32 12 03.
3. Rapid Cure Cutback Asphalt: Grade RC-70, Section 32 12 03.

PART 3 EXECUTION

3.1 PREPARATION

A. Select and advise ENGINEER of the type of tack material to be used.

B. Clean surface to be treated free of dust and other foreign material. If flushed, allow surface to dry. If leaves from trees, blow clean.

C. Provide safe pedestrian access across tack coat.

D. Prevent pedestrians, vehicles, pets, etc., access to tack surfaces.

3.2 APPLICATION

A. General:

1. Triple coverage by spray bar required. Stop application if any nozzle is not working properly.
2. Apply tack only to area covered with bituminous concrete in the same day.

B. Application Rate: Typically as follows:

1. Emulsions, 0.05 to 0.15 gallons per square yard.
2. Cutback, CONTRACTOR's choice.

C. Tack for Fabric Application: Comply with manufacturer's recommendation. If none, then as follows:

1. Dry pavement surface, 0.20 to 0.30 gallons per square yard. Within street intersections, on steep grades and in zones where vehicle speed changes are commonplace reduce application rate to no less than 0.20 gallons per square yard.

2. Heavy duty fabrics, 0.30 to 0.40 gallons per square yard.

3.3 PROTECTION

A. Protect all surfaces exposed to public view from being spattered or marred. Remove any spattering, over-coating, or marring.

B. Do not discharge bituminous material into borrow pits or gutters.

3.4 OPENING TO TRAFFIC AND MAINTENANCE

A. Do not permit traffic to travel over the tacked surface until bituminous tack coat has cured or is not picked up by traffic.

B. If detours cannot be provided, restrict operations to a width suitable at least for one-way traffic over the remaining portion of the road.

C. If one-way traffic is provided, control traffic appropriately.

END OF SECTION

SECTION 32 12 13.19
PRIME COAT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Application of liquid asphalt to aggregate base before placing bituminous concrete or Portland cement concrete pavement.

B. Placing sand on areas that are over-primed.

1.2 SUBMITTALS

A. Certificate showing asphaltic material complies with Section 32 12 03.

1.3 WEATHER

A. Apply prime coat only when air and roadbed temperatures in the shade are greater than 40 deg F Temperature restrictions may be waived only with ENGINEER's knowledge.

B. Do not apply prime coat during rain, fog, dust, or other unsuitable weather.

PART 2 PRODUCTS

2.1 ASPHALT MATERIAL

A. Select from the following:

1. Slow Cure Cutback Asphalt: Grade SC-70, or SC-250, Section 32 12 03.
2. Medium Cure Cutback Asphalt: Grade MC-30, MC-70, or MC-250, Section 32 12 03.
3. Rapid Cure Cutback Asphalt: Grade RC-1, RC-2, or RC-250, Section 32 12 03.

2.2 SAND

A. Clean natural aggregate passing the No. 4 sieve and retained on the No. 200 Sieve.

PART 3 EXECUTION

3.1 PREPARATION

A. If aggregate base course to be primed contains an appreciable amount of loose material or is excessively dusty; moisten, blade, roll, and recompact to make the surface dense.

B. Do not start priming until all free surface moisture has disappeared.

C. Notify residents and business owners 24 hours before applying prime coat.

D. Provide pedestrian access across prime coat if required.

3.2 APPLICATION

A. If pavement surface is to be applied over loosely bonded surface, apply prime coat at 0.10 to 0.50 gallons per square yard to penetrate and seal. Do not flood surface.

B. Cure and dry as long as necessary to attain penetration and evaporation of volatile.

C. Blot over-primed surface with a light, uniform layer of sand.

D. Prime under-primed areas with additional asphalt.

3.3 PROTECTION

A. Protect all structures, including curb, gutter, sidewalks, guardrails and guide posts from being spattered or marred. Remove any spattering, over-coating, or marring at no additional cost to OWNER.

B. Do not discharge bituminous material into borrow pits or gutters.

C. Prevent tracking of prime coat onto adjacent surfaces.

3.4 **OPENING TO TRAFFIC AND MAINTENANCE**

A. Do not permit traffic to travel over freshly primed surface until prime coat has cured. If detours cannot be provided, restrict operations to a width suitable at least for one-way traffic over the remaining portion of the road. If one-way traffic is provided, control traffic by flagging or pilot car operation.

B. After prime coat application, leave work area undisturbed. If prime coat is tacky or tends to pick up under traffic after four (4) hours, blot excess prime coat with blotter sand. Prime coats can be opened to traffic after blotting.

C. Clean and maintain primed surfaces until surface pavement course is placed. Maintenance includes spreading any necessary additional blotter material, replacing all portions of prime coat that have been destroyed, and patching any break in primed surfaces.

END OF SECTION

SECTION 32 12 16.13
PLANT-MIX BITUMINOUS PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Place a bituminous concrete pavement base course, leveling course, surface course, overlay course, or an inlay course.

1.2 REFERENCES

A. **APWA (Utah) Standards:**

Plan 761 Speed Bump.

Plan 762 Speed Table.

B. **AASHTO Standards**:

R9 Acceptance Sampling Plans for Highway Construction.

TP68 Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method.

T324 Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA).

C. **ASTM Standards**:

D979 Sampling Bituminous Paving Mixtures.

D1188 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.

D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.

D2725 Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.

D2950 Density of Bituminous Concrete In Place by Nuclear Method.

D3549 Thickness or Height of Compacted Bituminous Paving Mixture Specimens.

D3665 Random Sampling of Construction Materials.

D5361 Sampling Compacted Bituminous Mixtures for Laboratory Testing.

D6927 Marshall Stability and flow of Bituminous Mixtures.

1.3 DEFINITIONS

A. Lot: Defined in Section 01 35 10.

B. Must Grind: Defined in Section 32 01 31.

C. Road Class: Defined in Section 32 01 31

D. Sample: Defined in Section 01 35 10.

1.4 SUBMITTALS

A. Bituminous Concrete Mix Design, Section 32 12 05

B. Before Delivery: Submit 48 hours before delivery:

1. Materials Quality Data, this section Article 1.5
2. Traffic control plan, Section 01 55 26.
3. Manufacturer's certificate of compliance for paving geotextiles. (Refer to Section 31 05 19).
4. Certification of profilograph and profilograph operator.
5. Cold weather paving plan.

C. At Delivery: For each batch delivered to site provide a paper or electronic (e-ticket) delivery ticket with the following:

1. Date and project description.

2. Producer and plant.
3. Name of contractor.
4. Serial number of ticket.
5. Mix identification number or code.
6. Truck number and time dispatched.
7. Weight of mix delivered.

D. After Placement:

1. Quality Control Test Report: If required by Section 32 12 05S, submit density and thickness Quality Control data to the Engineer within 3 working days after completion of each day of paving or prior to the start of the next paving day, whichever is sooner.

2. After Placement: Before final payment submit summary report describing profile deviation and profile roughness. Section 32 01 31

1.5 **MATERIALS QUALITY**

A. Do not change aggregate source or binder grade until ENGINEER accepts new source and new mix design.

B. Perform Quality Control efforts identified in article 3.8.

C. Reject product and work that does not meet requirements of this Section.

D. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.

E. Foreman of paving crew has completed at least three (3) projects of similar size and nature.

F. For all equipment and hand tools used to mix, haul, and place the bituminous concrete, use a release agent that does not dissolve asphalt and is acceptable to ENGINEER.

1.6 **WEATHER**

A. Temperature:

1. April 15 to October 15: Place pavement when air temperature in the shade and the roadway surface temperature are above 50 deg F. The ENGINEER determines may provide written approval if it is acceptable to place outside of this temperature limit.

2. Before April 15 and After October 15: Provide a Cold Weather Paving Plan. ENGINEER must accept the plan before proceeding. Include the following details.

a. Haul details.
b. Placement details.
c. Compaction aids used in production.
d. Coordination procedure for acceptance testing.

B. Moisture: Do not place on frozen base, during adverse climatic conditions such as precipitation, or when roadway surface is wet or icy.

1.7 **NOTICE**

A. Follow Laws and Regulations concerning when and to whom notices are to be given. Send written notice at least three (3) days before start of paving.

B. Indicate paving time and when new surface can be used.

C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

D. Should work not occur on specified day, send a new notice.

1.8 **OWNER VERIFICATION TESTING AND ACCEPTANCE**

A. **General**:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00.

3. Dispute resolution, Section 01 35 10.

4. Opening a paved surface to traffic does not constitute acceptance.

5. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. **Mix Material**: Accepted as specified for bituminous concrete , Section 32 12 05, or rubberized asphalt concrete, Section 32 12 08.

C. **Mix Temperature at Site:**

1. Reject mixes in the transport material exceeding the limits identified in the mix design.

a. Use calibrated temperature probes for rejection of mix. Use temperature guns for quick approximate temperature readings only.

2. Dispose of cold mix in paver hopper as thin spread underlay.

D. **Grade, Cross Slope**: Perform minimum one grade and one cross-slope check per sub-lot.

E. Compaction: Options for acceptance are 1) core density, 2) non-destructive test density, or 3) control strip density with visual observation. Use core density unless specified elsewhere. A Lot is acceptable if density test averages are within pay factor 1.00 limits and no test is below Lowest Test limit. For remediated sublots, include remediated sub-lot tests in Lot evaluation.

1. Un-Accepted Lots: At the Engineer's discretion, a lot with an average deviation that does not meet 1.00 pay factor and does not have an individual test deviation greater than pay factor 0.80 allowed limits may be accepted with a pay factor in accordance with Table 1.

a. Lots with a mat pay factor lower than 0.80 or with a sub-lot with a test deviation greater than the pay factor 0.80 limits, and with Engineer and Contractor concurrence, are subject to an Engineering Analysis.

Table 1 – Compaction Pay Factors

Pay Factor	Mat Density, in Percent Relative to ASTM D2041 (a)		Joint Density, in Percent Relative to ASTM D2041 (a) (d)	
	Average	Lowest Test	Average	Lowest Test
0.80	More than 98.0	–	More than 98.0	–
1.00	**93.0 to 98.0**	**90.0 or greater**	**91.0 to 98.0**	**89.0 or greater**
0.90	93.0 to 98.0	Less than 90.0	91.0 to 98.0	Less than 89.0
0.80	Less than 93.0	90.0 or greater	Less than 91.0	89.0 or greater
Eng. Analysis	Less than 93.0	Less than 90.0	Less than 91.0	Less than 89.0

Notes:
(a) For overlay design thicknesses of less than 2.0", mat density targets are reduced by 1% and no joint density cores are taken.
(b) Difference based on actual sublot mat density and sublot core density values.
(c) Report and calculate all density values to 0.1%.
(d) A paving Joint is defined as a longitudinal seam between two adjacent passes of asphalt placed during the project, and where the initial pass cools below 180 deg F prior to placement of the adjacent pass. Do not take Joint cores where the "Joint" is comprised of existing asphalt or concrete. Use 6" diameter cores for joint density determination.

2. Core Density: This method compares the average density of cores extracted from a pavement surface to maximum theoretical density. Contractor to take cores in the presence of and immediately deliver to the Engineer or Engineer's representative.

a. Mat Lot Size: One (1) day production.

b. Mat Sampling Protocol: Use ASTM D3665 to randomly select in each sub-lot at least one (1) surface test location. Samples are full depth or overlay depth in overlay construction.

1) Projects less than 500 Tons: Use 10 sublots and non-destructive tests. Coring may be used for dispute resolution.

2) Projects between 500 and 1000 Tons: Use 4 equal sublots.

3) Projects between 1000 and 1500 Tons: Use 6 equal sublots

4) Projects greater than 1500 Tons: Use 8 equal sublots.

c. Joint Sampling Protocol: Use ASTM D3665 to randomly select a total of three (3) longitudinal joint test locations for each joint. Samples are full depth or overlay depth in overlay construction.

1) Use 6" diameter cores, centered within 1 inch of center of joint.

2) Do not core projects smaller than 250 Tons.

d. Testing Protocol: ASTM D2726 for core density and ASTM D2041 (Rice) for maximum theoretical density.

3. **Non-Destructive Density Testing by Electronic Gage**:

a. Lot Size: One (1) day production, with sublots as defined in Article 1.8.E 2 Core Density.

b. Mat Sampling Protocol: Use ASTM D3665 to randomly select in each sub-lot at least two (2) surface test locations.

c. Testing Protocol: ASTM D2950 (nuclear gauge) or AASHTO TP68 (non-nuclear gauge) and ASTM D2041 (Rice) for maximum theoretical density. A non-destructive test is the average of two (2) test samples at each test location with a minimum 90 degree offset between test samples using mix correlated gauges. Use minimum 60 second count with Nuclear Gauge.

4. **Compaction Dispute Resolution**:

a. Submit an Engineering Analysis for approval within one week of receipt of test results or at least 24 hours before performing any work that may prevent the evaluation, correction, or removal of the lot in question.

b. Include information, engineering analysis, statistical analysis, and test results related to the dispute.

1). Reasons for disputing the acceptance or verification test results.

2). The Contractor's project quality control test results, including any split sample test results.

a) Test results must be from a UDOT qualified laboratory using UDOT qualified technicians, or results must be verified and certified (stamped) by a Utah Registered Professional Engineer.

b) Include all supporting test data and calculations for reported values.

3). Successful laboratory correlation information when required by material specification.

4). Statistical analysis or identification of potential outliers.

5). Procedures or issues leading to disputed acceptance test results.

6). Provide recommended corrective measures or adjusted pay factor based on engineering evaluation based on durability and serviceability relative to the specified product requirements, including expected performance compared to design life.

F. **Thickness**: A Lot is acceptable if average of test deficiencies, applied to the **total design thickness**, exceeds design thickness or is within pay factor 1.00 limits; and no sublot or individual test below 0.90 pay factor.

1. Un-Accepted Lots: At the Engineer's discretion, a lot with an average deviation that does not meet 1.00 pay factor and does not have a sub-lot test deviation greater than pay factor 0.90 allowed limits may be accepted with a pay factor in accordance with Table 2.

a. Lots with a pay factor lower than 0.90 or with a sub-lot with a test deviation greater than the pay factor 0.90 limits, and with Engineer and Contractor concurrence, are subject to an Engineering Analysis.

Table 2 – Thickness Pay Factor

Pay Factors	Deficiency Limits, in Inches
1.00	0.00 to 0.25
0.90	0.25 to 0.375
Remediate	>0.375

2. Lot Size: One (1) day production with 1,000 square yard sub-lots or part thereof.

3. Sampling Protocol: Use ASTM D3665 to randomly select at least one surface test location and one longitudinal joint test location in each sub-lot. Samples are full depth. Overlay construction measured only on overlay portion of core sample. Use one of the following methods for thickness determination:

a. Measurement of Density Cores

b. Probe of uncooled mix – perform between intermediate and final rolling operations.

c. Ground Penetrating Radar (not applicable to overlay applications).

1) Perform GPR evaluation by scanning and recording depth for full-width of the pavement at one random location for each sublot. Engineer will mark locations for scans. Measure HMA thickness every 6 inches on the

recorded scan. Calculate the average thickness, and the percentage of the thickness below each of the tolerance levels described in Article 1.8 F 5.

4. **Testing Protocol:** ASTM D3549:

a. Minimum Specified Thickness (Cores or Probes): A Lot specified to have minimum thickness will be accepted if all sub-lot measurements meet or exceed minimum.

1) Cores not meeting full payment will be provided to the Contractor for verification of measurements.

2) If thickness is deficient, additional material may be placed over the deficient thickness if rotomilling is utilized for edge tie-in; placement matches this section's thickness tolerance; surface continues to drain; and roughness tolerance is met.

b. Actual Specified Thickness (Cores or Probes): A Lot specified to have actual thickness is acceptable if any sub-lot measurement does not exceed deficiency limits for thickness pay factor 1.00.

c. A lot is accepted for thickness based on GPR evaluation when:

1) The average thickness of all scans is not more than ¼ inch less than the total thickness specified.

2) No individual scan shows a deficient thickness of more than ⅜ inch for more than 5% of any scan.

5. Thickness Dispute Resolution:

a. CONTRACTOR:

1) Hire an Independent Testing Agency, Section 01 45 00, or perform in the presence of Engineer (or their representative)

2) Coring Option:

i. Take two (2) additional cores midway between deficient acceptance test locations, and midway between a deficient test location and the next adjacent acceptable test location.

ii. Patch core holes.

3) Ground Penetrating Radar (GPR) Option:

i. Use GPR to determine extents of deficient area.

4) Conduct testing at no additional cost to OWNER.

b. ENGINEER:

1) Graph deficient areas by plotting new cores and original cores, or GRP results, to define deficient areas assuming the following.

a) The graph represents the thickness of the pavement.

b) Thicknesses vary linearly along the pavement length from core depth to core depth.

c) The pavement is a constant depth in the transverse direction.

2) Accept Lot at full pay if new information shows minimum of 95% of sub-lot area is in compliance, or

3) Accept Lot at pay reduction using new test information, or

4) Reject Lot.

c. REJECT LOTS:

1) Remediate reject thickness lots by adding additional thickness of bituminous concrete, adhering to all requirements of Sections 32 12 05 and 32 1216.13.

2) Utilize rotomilling as necessary to achieve proper cross-slope and elevations in relation to existing curb and gutter.

6. **Excess Thickness**: For projects paid by the ton, payment will be made for excess tonnage for thickness up to ½" over design thickness. Additional tonnage for thickness above ½" will be paid at a 50% pay factor.

G. Profile Roughness and Profile Deviation: Section 32 01 31

1.9 **WARRANTY**

A. Joints at Street Fixtures and Portland Cement Concrete Flat Work: If wider than 1/2 inch before end of the correction period seal joints with asphalt rubber or rubberized asphalt; Section 32 01 17.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bituminous concrete, Section 32 12 05.

B. Rubberized asphalt concrete, Section 32 12 08.

C. Tack coat, Section 32 12 13.13.

D. Prime coat, Section 32 12 13.19.

E. Paving geotextile, Section 31 05 19.

F. Paving geogrid, Section 31 05 21.

G. Warm Mix Asphalt (WMA), Section 32 12 05

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Paver Machine: Use track equipment when operating on fabrics, geogrids or pavement mats hotter than 180 deg F

B. Compactors: Steel wheel static or vibratory. Use pneumatic tire roller for intermediate rolling only.

3.2 PREPARATION

A. General:

1. Locate and preserve utilities Section 01 31 13. Contact utility companies and other agencies, for dangerous concentration of combustible, flammable, or explosive matter.

2. Lower Street Fixtures if paving machine is not capable of passing over the fixtures.

3. Remove vegetation from cracks, edges and joints. Sweep surface clean. Blow cracks clean. Remove leaves.

4. Fill cracks and fix Potholes, Section 32 01 17.

5. Stabilize Portland cement concrete subgrade slabs.

B. Traffic Control:

1. Implement notification and traffic control plan requirements, Section 01 55 26. Do not proceed without certified flaggers.

2. Apply temporary lane marking tape or paint after layout has been verified with ENGINEER.

C. Aggregate Base Course:

1. Verify base course is placed to grade, compacted and dampened.

2. If indicated, follow Section 31 31 19 requirements for herbicide treatment or Section 32 12 13.19 for prime coat applications.

3.3 PROTECTION

A. Trees, Plants, Ground Cover:

1. Protect trees, plants and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.

B. Protect all structures, including curb, gutter, sidewalks, guard rails and guide posts from physical damage. Remove spatter, over-coat, or mar.

C. Do not discharge bituminous materials into borrow pits or gutters.

D. Protect hot pavement from traffic until cool enough not to become marred.

E. Remove saw-cut dust immediately. Protect neighborhood, storm drains and down-stream fish habitat.

3.4 TEMPORARY SURFACING

A. Place, roll, maintain, remove and dispose of temporary Pavement surfaces.

B. In sidewalk areas construct temporary pavements at least 1 inch thick and in all other areas at least two (2) inches thick. At major intersections and other critical locations a greater thickness may be required.

3.5 LINE AND GRADE CONTROL

A. Provide necessary survey stakes for horizontal and vertical control.

B. Furnish, place, and maintain supports, wire devices, and materials as required to provide continuous line and grade reference controls for placing pavement, matching existing pavement surfaces, etc.

C. **Speed Bump or Speed Table:** Provide line and grade as shown in the Drawings or APWA Plan 761 or 762.

3.6 FABRIC PLACEMENT

A. Section 31 05 19.

3.7 PAVEMENT PLACEMENT

A. General:

1. Barricade off or eliminate fall off edges.
2. Provide continuous forward paver movement so temperature 10 feet behind paver is as follows:
   a. Warm Mix Placement: 200 deg F minimum.
   b. Hot Mix Placement:

Table 3 – Minimum Pavement Temperature in Degrees F.

Air Temperature Deg F	Compacted Mat Thickness					
	3/4"	1"	1-1/2"	2"	3"	4"+
45 – 50	–	–	–	–	280	265
50 - 59	–	–	–	280	270	255
60 - 69	–	–	285	275	265	250
70 - 79	285	285	280	270	265	250
80 - 89	280	275	270	265	260	250
90 +	275	270	265	260	250	250

B. Overlays or Subsequent Lifts:

1. Allow new base pavement or new inlay pavement to cure (harden) before placing overlays.
2. Apply tack coat per Section 32 12 13.13 if inlay or sub-base Pavement surface is dirty or older than 24 hours.

C. Irregular Areas: Handwork is acceptable if specified grade, slope, compaction and smoothness are achieved.

D. Compaction:

1. Test mix placement until a compaction pattern is acceptable to CONTRACTOR. Continue random quality control testing.
2. Do not over compact or under compact.
3. Complete compaction before the following temperature are reached:
   a. 180 deg F for hot mixes.
   b. 140 deg F for warm mixes.

E. Joints:

1. Construct joints to industry standards for texture, density and smoothness.
2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new pavements, or between successive day's work.
3. Offset longitudinal joints a minimum of 12 inches in succeeding courses and at least six (6) feet transversely to avoid a vertical joint through more than one course. In the top course restrict longitudinal joint to 1 foot either side of lane lines.

4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges before making another pass with paver if mix has cooled to 90 deg F

3.8 QUALITY CONTROL

A. For projects less than 500 tons, perform Quality Control as identified below if identified as required by section 32 12 05s or project documents. For projects greater than or equal to 500 tons, perform Quality Control as identified below.

B. Compaction

1. Use trained and experienced Density Technicians

a. Use technicians trained in the aspects of gauge operation and offsets, rolling patterns, mat temperature maintenance.

b. Use technicians that have controlled a minimum of 3 previous projects under the supervision of a UDOT TTQP certified (current certifications that cover sampling, density and field asphalt properties) technician.

2. Develop Rolling Pattern for achieving density using gauges (nuclear or non-nuclear) correlated to mix being supplied.

3. Perform systematic testing to verify full lot placement (length, width and joints) is in conformance with density requirements.

4. Do not substitute owner Quality Assurance activities for Quality Control. Owner QA activities may be used to correlate Quality Control activities and devices.

C. Thickness

1. Perform systematic depth determinations throughout each sublot. Determinations may be made on compacted mix, or on uncompacted mix with appropriate adjustment for compaction.

2. Perform a minimum of two depth determinations for each edge of paving pass and for center of paving pass for each sublot.

D. Submit Quality Control Documentation to Engineer within 72 hours of placement of Lot, or prior to any subsequent overlay, whichever is sooner.

3.8 TOLERANCES

A. Lift Thickness: If not indicated, meet the following tolerances.

Table 4 – Lift Thickness Tolerance (a)

Mix	Minimum	Maximum
Bituminous Concrete	2.5 times *nominal* aggregate size	4.0 inches (b)

NOTES
(a) Thickness is measured after compaction.
(b) Maximum lift thickness may be exceeded if contractor can demonstrate ability to achieve consistent compaction from top to bottom of lift without breaking down aggregate. Determine compaction consistency by cutting a minimum of 3 random cores in half vertically and testing top and bottom half of cores. If density range between top half and bottom half of each core is equal to or less than 1%, compaction consistency is verified. If range exceeds 1%, placement must adhere to Maximum lift thickness requirement.

B. Smoothness:

1. Parallel to Centerline: Section 32 01 31.

2. Cross Slope: 1/4 inch in 10 feet except at cross section grade breaks.

3.9 SURFACE REPAIR

A. Repair ride disturbing or unsafe butt joints. Repair expense is at no additional cost to OWNER.

B. If pavement smoothness is deficient, follow Section 32 01 31 repair requirements.

C. Corrective Action for Profile Deviations ("Must Grinds"): Grinding is acceptable. See Section 32 01 26. Apply a fog seal over grind areas. See Section 32 01 13.50. If depressions cannot be corrected by grinding, remove and replace.

D. Corrective Action for Profile Roughness Index: Grinding is acceptable. Re-profile corrected segments to verify ride index meets tolerance. Apply a fog seal over grind areas. See Section 32 01 13.50.

E. When thickness is deficient, place additional material over deficient areas. DO NOT skin patch. Mill for inlay if necessary.

F. Defective Joints, Seams, Edges: Repair.

G. Unacceptable Paving: Remove and replace.

3.10 **OPENING TO TRAFFIC**

A. Temperature of pavement surface is not more than 180 deg F

3.11 Pavement Placement – Warm Mix Asphalt (WMA)

A. Additives may be introduced by way of terminally blending at the binder supplier's facility or by way of in-line injection at the asphalt mix producer's facility as described below:

1. Terminal Blend

a.) WMA additive shall be metered into each bulk load of asphalt at the rate prescribed in the asphalt mix design.

b.) WMA product name and dosage shall be listed on the Bill of Lading (BOL).

c. The additive temperature must be stored and pumped per the manufacturer's recommendations.

2. In-line Asphalt Plant Injection

a.) Ensure that the additive metering equipment is calibrated and tied into asphalt plant's computer system so that flow rates can be continuously monitored by the plant operator.

b.) Ensure that metering systems can vary the amount of additive being introduced and interlock the additive pump system with the asphalt plant's computer system so that flow is automatically controlled by the plant's production rate. Do not allow the additive rate to go outside of the manufacture's recommendations.

c.) Provide calibration protocol and frequency within the contractor's QC Plan.

d.) Ensure that the additive equipment stops flow, or if a control or equipment failure occurs, the computer system immediately notifies the plant operator, and all asphalt production is stopped until the system is repaired and checked.

e.) Upon request, the contractor shall produce proof that an approved warm mix additive was purchased for the awarded project.

B. WMA Dispute Resolution

1. APWA and the CONTRACTOR shall use calibrated temperature probes at the same time at the asphalt plan to to determine temperature.

END OF SECTION

SECTION 32 12 16.18

RECYCLE BITUMINOUS PAVEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Make a base, leveling, or surface course using an existing bituminous concrete that is in-place.

B. Mix design requirements.

1.2 REFERENCES

A. **ASTM Standards**:

D2950 Density of Bituminous Concrete In Place by Nuclear Method.

D3549 Thickness or Height of Compacted Bituminous Paving Mixture Specimens.

1.3 DEFINITIONS

A. **RAP**: Acronym for reclaimed asphalt pavement. Refer to Section 32 12 05.

B. **RAC**: Acronym for recycled asphalt concrete. A bituminous mix product consisting of RAP or ROSP, new aggregates and Binder or Binder with a recycle rejuvenating agent, the mixture of which creates a new bituminous concrete.

C. **ROSP**: Acronym for reclaimed Oil Sand pavement. Refer to Section 32 12 05.

1.4 SUBMITTALS

A. Before commencing work of this Section, submit:

1. Traffic control plan, Section 01 55 26.
2. A list of equipment to be used.
3. Type of Binder to be used, Section 32 12 03.

B. RAC Mix Design: Determine conditions and properties of existing materials. Identify recycling agent and submit the following data as applicable:

1. If RAP or ROSP is 15 percent or less of the RAC, submit a mix design formula if Supplier does not have a mix design formula at the plant. The formula shall be based on current test data.
2. If RAP or ROSP added to the RAC is over 15 percent, submit a mix design formula.

C. RAC Delivery Tickets, Section 32 12 16.19.

1.5 QUALITY ASSURANCE

A. Section 32 12 16.13.

1.6 WEATHER

A. Section 32 12 16.13.

1.7 NOTICE

A. Section 32 12 16.13.

1.8 ACCEPTANCE

A. Section 32 12 16.13.

PART 2 PRODUCTS

2.1 MATERIAL

A. Recycle asphalt (RA), Section 32 12 03.

B. Tack coat, Section 32 12 13.13.

C. Paving geotextile, Section 31 05 19.

D. Paving geogrid, Section 31 05 21.

E. RAP OR ROSP: Free of detrimental quantities of deleterious materials. Graded (on a non-dried basis) as follows.

Sieve Size	Percent Passing by Weight
1–1/2"	100
1"	90

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Laydown Machine: Provide track equipment when operating on fabrics or geogrid, otherwise type of equipment is CONTRACTOR's choice.

B. Compactors: Steel wheeled static or vibratory.

3.2 PREPARATION

A. General:

1. Locate and preserve utilities, Section 31 23 16. **Contact utility companies and other agencies, for dangerous concentration of combustible, flammable, or explosive matter.**

2. Lower Street Fixtures if pavement recycler machine is not capable of releasing pavement-cutting mechanism to protect fixtures.

3. Remove plant materials from cracks, edges and joints. Sweep surface clean. Blow cracks clean.

4. Stabilize concrete subgrade slabs.

5. Apply tack coat, Section 32 12 13.13.

6. Verify surfaces are dry.

B. Trees, Plants, Ground Cover:

1. Protect trees, plants and other ground cover from damage.

2. Prune trees, Section 32 01 93 to allow equipment passage underneath. Repair tree damage at no additional cost to OWNER.

C. Traffic Control:

1. Control pedestrian and vehicular traffic, Section 01 55 26.

2. Protect pavement from traffic until mixture has cooled enough not to become marked.

3. Apply temporary lane marking tape or paint after layout has been verified with ENGINEER.

D. Milling, Section 32 01 16.71

3.3 PLACING RAC

A. Hot-laid RAC, Section 32 12 16.13

B. Cold-laid RAC, Section 32 12 16.19

C. Mix and blend milled aggregate, recycling asphalt, virgin asphalt and virgin aggregate per mix design.

3.4 TOLERANCES

A. Compaction, lift thickness, grade, cross slope, Section 32 12 16.19

B. Complete compaction of RAC within five (5) minutes of placing RAC and before its temperature drops below 200 deg F

3.5 PROTECTION AND REPAIR

A. Section 32 12 16.19.

END OF SECTION

SECTION 32 12 16.19

COLD-MIX BITUMINOUS PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Construct a bituminous concrete pavement base course, leveling course, or surface course by placing a bitumen cement over an in-place aggregate and mixing and compacting the product in-place.

B. Bituminous concrete material is not specified in this section. Refer to Section 32 12 05.

1.2 REFERENCES

A. **ASTM Standards**:

D1461 Moisture or Volatile Distillates in Bituminous Paving Mixtures.

D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.

D2170 Kinematic Viscosity of Asphalts (Bitumens).

D2399 Selection of Cutback Asphalts.

D3628 Selection and Use of Emulsified Asphalts.

D5581 Resistance to Plastic flow of Bituminous Mixtures Using Marshall Apparatus (6 inch-Diameter Specimen).

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. Laboratory mix design, Section 32 12 05.

C. Batch Delivery Tickets: Submit ticket for each batch delivered to the work site. Include information specified in Section 32 12 16.13.

1.4 WEATHER

A. Section 32 12 16.13.

1.5 NOTICE

A. Section 32 12 16.13

1.6 ACCEPTANCE

A. Section 32 12 16.13.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bituminous Binder: Emulsified asphalt or medium curing cutback asphalt, Section 32 12 03. If type is not indicated CONTRACTOR is to select the material recommended in the following ASTM standards.

1. Emulsified asphalt, ASTM D3628.
2. Cutback asphalt, ASTM D2399.

B. Aggregate, Section 32 12 05: Use an aggregate containing not more than two (2) percent moisture. If more, dry before applying bituminous product. An exception may be made for unusually porous material, when laboratory tests indicate excess moisture will not produce an unstable mix.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Lay-down Machine: Use track equipment when operating on fabrics or geogrid.

B. Compactors: Steel wheeled static or vibratory. Use a pneumatic tire roller for intermediate rolling only.

3.2 PREPARATION

A. Trees, Plants, Ground Cover:

1. Protect trees, plants and other ground cover from damage.

2. Prune trees, Section 32 01 93 to allow equipment passage underneath. Repair tree damage at no additional cost to the OWNER.

B. Traffic Control:

1. Provide worker and public safety, Section 01 55 26.

2. Apply temporary lane marking tape or paint after layout has been verified with ENGINEER.

3.3 PREPARATION OF AGGREGATE

A. On unpaved surfaces, prime coat whole roadway surface receiving cold-mix application, Section 32 12 13.19.

B. Place aggregate on the prepared base in a uniform windrow or windrows.

C. Notify ENGINEER 48 hours in advance of applying bituminous material to permit check of aggregate with respect to volume, moisture content, unit weight, and proper amount of bituminous material to be used.

3.4 PROPORTIONING AND MIXING

A. Unless specified otherwise, method of mixing may be traveling mixer method, stationary mixer method, or blade mixing method.

B. Traveling Mixer Method:

1. Accomplish mixing by means of mixer that will thoroughly blend aggregate and bitumen. Use metering devices that will accurately introduce required quantity of bitumen during the mixing process. Produce a satisfactory mixture that is uniform in appearance, texture and bitumen content, free from pockets of segregated aggregates.

2. When necessary, supplement travel plant mixing with blade mixing to obtain desired degree of aeration of mix. Continue mixing until not more than 50 percent of original volatiles present in the bituminous material remain in the mix, ASTM D1461.

C. Blade Mixing Method:

1. Spread and windrow aggregate on the prepared base, after that, uniformly apply bituminous material over the aggregate.

2. Apply bituminous material in two (2) or more applications over a section of definite limits. Limit amount of bitumen spread in any 1 application to 0.50 gallon per square yard. Exercise care to avoid overlapping of spreads onto adjoining sections. Immediately after each application, partially mix the bituminous material with the aggregate.

3. After the last application of bituminous material and partial mixing, windrow the entire mass of bitumen and aggregate and mix by blading material from side to side of roadway. Blade to produce a satisfactory mixture that is uniform in appearance, texture, and bitumen content, and free from pockets of segregated aggregates and continue until not more than 50 percent of original volatiles present in the bitumen remain in the mix, ASTM D1461. While mixing, take care to avoid cutting into underlying base course or contaminating the bituminous mixture with earth or other foreign matter.

D. Stationary Mixing Method:

1. Dry aggregate to optimum moisture content before mixing. Use same application of bituminous material and mixing as required for traveling mixer.

2. After mixing, haul and place mix on the roadway surface in windrows. All requirements as to uniformity, percent of volatiles, and textures are as required for traveling mixer that may require supplemental blade mixing.

3.5 TEMPERATURE CONTROL

A. Maintain temperature range of cold road mix material at time of application so viscosity will be between 50 and 200 centistokes, ASTM D2170.

3.6 **PLACING PAVEMENT MIXTURE**

A. When mixing has been completed, spread mixture in such a manner that the finished surface conforms to the elevations, grades, and cross-sections indicated.

B. At the end of each day's work or when the work is interrupted by adverse weather conditions, blade all loose material into a windrow, whether mixing is completed or not. Do not leave material spread on the roadbed overnight.

3.7 **TOLERANCES**

A. Section 32 12 16.13.

3.8 **PROTECTION AND REPAIR**

A. Section 32 12 16.13.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Place Portland cement concrete in a base course, surface course, overlay course, or an inlay course.

B. This specification does not apply to concrete flat work.

1.2 REFERENCES

A. **ACI Standards**:

305 Hot Weather Concreting.

306 Cold Weather Concreting.

318 Building Code Requirements for Reinforced Concrete.

B. **APWA (Utah) Standards**:

Plan 261 Concrete pavement joints.

Plan 761 Speed bump.

Plan 762 Speed table.

Plan 880 Bus stop pad.

C. **ASTM Standards**:

A307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

C39 Compressive Strength of Cylindrical Concrete Specimens.

C78 Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).

C94 Ready-Mixed Concrete.

C174 Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.

C231 Air Content of Freshly Mixed Concrete by the Pressure Method.

C1315 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

D3665 Random Sampling of Construction Materials.

D5249 Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement and Asphalt Joints.

E950 Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference.

E1274 Measuring Pavement Roughness Using a Profilograph.

D. **DOT Standards**:

1. Publication No. HIF-07-004: Integrated Materials and Construction Practices for Concrete Pavement.

1.3 DEFINITIONS

A. Must Grind: Defined in Section 32 01 31.

B. Road Class: Defined in Section 32 01 31

1.4 SUBMITTALS

A. **Before delivery**: Submit 48 hours before delivery:

1. Traffic control plan, Section 01 55 26.

2. Joint layout plan.

3. Concrete placement plan. Identify items such as but not limited to grade control system, placement start and stop timing, hydration control during cold conditions (ACI 306), hot and windy conditions (ACI 305), timing for

evaporation retarder application, timing for curing agent application, floating restrictions, concrete saw-cut timing, header joints.

4. Curing plan. Describe method to prevent excessive concrete temperatures and water evaporation that could impair strength or serviceability of concrete. Refer to ACI 305.

5. Evaporation Retarder Data Sheet. Identify product components, application, and manufacturer's recommendations.

6. Proof of finisher's ACI certification.

7. Make and model name of paving machine, grade trimmer, and gang drill mechanism.

8. Pre-approved concrete mix design or supplier's mix number, Section 03 30 04.

9. Certification of profilograph calibration and profilograph operator.

10. Manufacturer's recommended installation procedures for joint sealing material which, when accepted by ENGINEER, will become the basis for accepting or rejecting actual installation procedures used in the Work.

B. **At Delivery**: Submit batch ticket, Section 03 30 10.

C. **After Placement**: Before final payment submit summary report describing profile deviation and profile roughness. See Section 32 01 31 requirements.

1.5 **QUALITY ASSURANCE**

A. Do not change concrete supplier until ENGINEER accepts new source and new mix design.

B. Reject product that does not meet requirements of Section 03 30 04.

C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.

D. Foreman of paving crew has completed at least three (3) projects of similar size and nature.

E. Lead finishing mechanic is ACI certified.

F. Follow state of practice for quality assurance as published in FHWA Publication No. HIF-07-004.

G. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR its Suppliers.

1.6 **WEATHER**

A. Hot weather, ACI 305. Set retarding admixture may be used if allowed in mix design. Discontinue placement if ambient air temperature exceeds 100 deg F in the shade.

B. Cold weather, ACI 306 Accelerating admixtures may be used if allowed in mix design. Provide weather protection until 90 percent of design compressive strength is achieved. When removing heat, limit temperature changes next to concrete surface to 20 deg F per 12 hours until the concrete surface temperature reaches ambient:

1. Use of admixtures or curing agent will not relax cold weather placement and cure requirements.

2. Do not use chemical additives to prevent freezing.

3. Prevent loss of moisture during protection.

1.7 **NOTICE**

A. Follow Laws and Regulations concerning when and to whom notices are to be given. Send written notice at least three (3) days before start of paving.

B. Indicate paving time and when new surface can be used.

C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

D. Should work not occur on specified day, send a new notice.

1.8 **ACCEPTANCE**

A. **General**:

1. Acceptance is by Lot. Lot size is one day production and as listed below.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation, Section 01 29 00.

3. Dispute resolution, Section 01 35 10 and Section 03 30 05.

4. Opening a paved surface to traffic does not constitute acceptance.

5. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements in Section 01 35 10 are met.

B. **Temperature, Slump, Air**:

1. Lot size is one (1) random batch.

2. Testing Frequency: Section 03 30 05.

3. Reject non-complying batches until two (2) consecutive batches are compliant then continue in random batch testing for acceptance.

Table 1 – Strength Pay Factor

Criteria	Pay Factor	PSI Below 28 day Compressive Strength	Lot Size, in Square Yards
Compression (ASTM C39)	0.98	1 to 100	500
	0.94	101 to 200	
	0.88	201 to 300	
	0.80	301 to 400	
	Reject	Greater than 400	
Flexure (ASTM C78)	0.95	1 to 29	750
	0.85	30 to 60	
	Reject	Greater than 60	

1. Strength Dispute Resolution:

a) CONTRACTOR:

1) Hire an Independent Testing Agency, Section 01 45 00.

2) Follow Section 03 30 05 requirements.

3) Conduct testing at no additional cost to OWNER. Retesting must be completed within 40 calendar days after placement.

b) ENGINEER:

1) Accept lot at full pay if average strength of three (3) cores from the defective lot is greater than or equal to 85 percent of compressive strength (f_c'), and if no single strength retest is less than 75 percent of f_c'.

2) Use original cylinder compressive strengths for pay factor determination if any of above criteria are not met.

D. **Placement**: Section 03 30 10.

1. Verify grade, cross slope, finish, and dimensions.

2. No standing water in curb and gutter.

3. Curing membrane applied at twice coverage rate recommended by curing membrane Supplier.

E. **Thickness**: A Lot is acceptable if test deficiencies are within pay factor 1.00 limits. At ENGINEER's discretion, a lot with greater sub-lot deficiencies may be accepted if pay is adjusted using one of the following applicable pay factors or accepted at 50 percent pay if a sub-lot is in Reject.

Table 2 – Thickness Pay Factor		
Pay Factors	**Deficiency Limits, in Inches**	
	Residential street	**Non-residential street**
1.00	0.00 to 0.25	0 to 1/8
0.90	0.26 to 0.50	1/8 to 1/4
0.75	--	1/4 to 1/2
0.70	0.51 to 0.75	--
0.60	--	1/2 to 3/4
0.50	0.76 to 1.00	--
Reject	Greater than 1.00	Greater than 3/4

1. Lot Size: 1,000 square yards or part thereof.
2. Sampling Protocol: Use ASTM D3665 to randomly select at least one (1) test location in each lot. Collect two (2) samples at each test location. Samples are full depth. Patch core holes.
3. Testing Protocol: ASTM C174.
4. Thickness Dispute Resolution:
   a. CONTRACTOR:
      1) Hire an Independent Testing Agency, Section 01 45 00.
      2) Take two (2) additional cores midway between deficient acceptance test locations, and midway between a deficient test location and the next adjacent acceptable test location.
      3) Patch core holes.
      4) Conduct testing at no additional cost to OWNER.
   b. ENGINEER:
      1) Graph deficient areas by plotting new cores and original cores to define deficient areas assuming the following.
         a) The graph represents the thickness of the pavement.
         b) Thicknesses vary linearly along the pavement length from core depth to core depth.
         c) The pavement is a constant depth in the transverse direction.
      2) Pay Factor: The pay factor will be calculated over the Lot's deficient area or over areas extending into adjacent Lots.
      3) Accept lot at full pay if new information shows compliance, or
      4) Accept Lot at pay reduction using new test information, or
      5) Reject Lot.

F. **Profile Roughness and Profile Deviation**: Verify tolerances required in Section 32 01 31.

PART 2 PRODUCTS

2.1 CONCRETE

A. Compression Design: Class 4000, Section 03 30 04. Slump per mix design.

B. Flexure Design:

1. Strength: 650 psi, ASTM C78.
2. Cement Content: 6.5 bags.
3. Water cement Ratio: 0.44 maximum by weight (before pozzolan exchange), ACI 318.
4. Entrained Air: Five (5) to seven (7) percent, ASTM C231 (pressure).

5. Slump per accepted mix design.

2.2 **EVAPORATION RETARDER**

A. Water based spray-on liquid that forms a mono-molecular film over the plastic concrete surface.

2.3 **CONCRETE CURING COMPOUND**

A. Type II Class A or B (white pigmented) liquid membrane forming compound, ASTM C1315.

2.4 **JOINT MATERIALS**

A. Section 32 13 73.

1. Expansion Joint Filler: F1 sheet.
2. Contraction Joint Filler (Backer Rod): Type 1 round, ASTM D5249.
3. Contraction Joint Sealer: HAS1, HAS4, or CAS6.

2.5 **STEEL REINFORCEMENT**

A. Section 03 20 00.

B. Tie Bar: Grade 60 or higher deformed billet steel bars galvanized, or epoxy coated.

C. Dowel Bar: Grade 60 or higher billet steel bar, galvainzed, or epoxy coated with plastic expansion cap on one (1) end.

D. Chair and Basket Assemblies: Plastic chairs. Galvanized or epoxy coated grade 60 billet steel bar basket assemblies.

E. Hook Bolts: Galvanized ASTM A307, grade A steel, nuts, and shaft internally and externally threaded.

2.6 **BOND BREAKER**

A. Wax based compound.

2.7 **EPOXY ADHESIVE GROUT**

A. Two components, Section 03 61 00.

2.8 **EVAPORATIVE REDUCER**

A. Water-based mono-molecular polymer liquid at application rates recommended by manufacturer. **DO NOT use as a finishing aid**.

PART 3 EXECUTION

3.1 **CONSTRUCTION EQUIPMENT**

A. **Mixing plant**: ASTM C94, Option C:

1. Use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.
2. Mixing time must exceed 80 seconds after adding air entrainment admixture.

B. **Cylinder Storage Device**: A container at the work site that maintains an interior temperature of 60 to 80 deg F. equipped with an automatic 7-days temperature recorder, accurate within 2-degrees and having a permanent recording feature. A 24 hours test run may be required. Cease concrete operation when storage capacity of storage device is reached.

C. **Concrete Hauling Vehicle**:

1. Truck mixer: Not allowed if ready mix product can be provided. If allowed:
   a. Fill drum no more than 63 percent of the gross drum volume and no less than 2-cubic yards is occupied.
   b. Use drum manufacturer's recommended mixing speed (between 12 and 18 rpm)
   c. Driver of vehicle has and follows Supplier's manual of standard operational procedures.
2. Truck Agitator: Do not fill drum greater than 80 percent of the gross drum volume. Use drum manufacturer's recommended agitating speed (between 2 – 6 rpm).

3. Dump truck. End dump or side dump is acceptable. Air content must be controlled at the mixing plant.

D. **Trimmer**: A self-propelled unit to strike off and shape surface of road base material so future placement of concrete pavement meets specified thickness. The trimmer uses the same line and grade control assembly or system that the paving machine uses.

E. **Slip Form Paving Machine**:

1. Capable of providing one pass between crown line and back of curb unless specified otherwise.
2. Self Propelled with two or four tracks
3. Steering and elevation controlled from reference string lines.
4. Paving width up to 50 feet (depending upon model and attachments).
5. Weight 2,000 pounds per foot of paving lane width.
6. Continuous auger, hydraulic plow-pans, or conveyor system to distribute concrete in front of the screed.
7. Variable speed internal vibrators.
8. Capable of consolidating mats up to 15 inches thick.
9. Various finishing attachments.

F. **Fixed Form Paving Machine:**

1. Capable of providing one pass between crown line and lip of gutter.
2. Ride on forms or on self-propelled wheels.
3. Steering and elevation controlled by fixed forms.
4. Various paving width.
5. Weight about 1,000 pounds per foot of paving width.
6. Suspended screw auger to spread concrete in front of screed or roller.
7. Has one or two vibrators that move transversely in front of the screed. May also use fixed vibrators near the form edges.
8. Capable of consolidating amts up to 10 inches thick.

G. **Vibrating Screed**:

1. Capable of providing one pass between crown line and lip of gutter.
2. Various paving width.
3. Elevation controlled by fixed forms or string-line.

H. **Finishing and Texturing Equipment**.

1. Machine float may be attached to paver.
2. Texturing equipment acceptable to ENGINEER.
3. Curing compound application device with a fully atomizing type power spray and a wind protection hood.

I. **Straight Edge**: 10 to 20 feet long hand-operated. Successive straightedge checks should overlap by one-half the length of the straightedge.

J. **Profilograph**:

1. Capable of producing results required by ASTM E950 and ASTM E1274.
2. Set profilograph readings with corresponding project survey stationing, or as a minimum, correlate equipment station 0+00 with a specific project station number. ENGINEER to select.

3.2 PREPARATION

A. **General**:

1. Locate and preserve utilities, Section 01 31 13. Contact utility companies and other agencies, for dangerous concentration of combustible, flammable, or explosive matter.
2. Lower Street Fixtures if paving machine is not capable of passing over fixtures.
3. Coat surface of Street Fixtures with oil to prevent bond with concrete pavement.

4. Remove sand, leaves and other objectionable materials before placing paving course.
5. Notify ENGINEER at least 24 hours before commencement of concreting operations.

B. **Traffic Control**:

1. Implement notification and traffic control plan requirements, Section 01 55 26. Do not proceed without certified flaggers.
2. Apply temporary lane marking tape or paint after layout has been verified with ENGINEER.

C. **Aggregate Base Course**:

1. Verify base course is placed to grade, compacted, and dampened.
2. If indicated, follow Section 31 31 19 requirements for herbicide treatment or Section 32 12 13.19 for prime coat requirement.

D. **Cement Treated or Lean Concrete Base**:

1. Aggregate Subgrade: Moisten surface but do not place concrete over standing water.
2. Concrete Subgrade:
   a. Remove loose material from surface of cement treated or lean concrete base course immediately before placing concrete surface course.
   b. Apply a double coat of bond breaker before placing surface concrete.

3.3 PROTECTION

A. Protect placed concrete, Section 03 30 10 and as follows:

1. Do not allow steel wheel rollers or steel wheel vehicles on the concrete Pavement. Keep traffic and construction equipment off at least 10 days after concrete placement or until 100 percent of the design strength has been achieved and verified by either:
   a) Maturity meter.
   b) Concrete cylinders.
2. If construction traffic is permitted, keep Pavement clean. Remove surface stains and spillage of materials as they occur.
3. Remove saw-cut dust immediately. Protect neighborhood, storm drains and down-stream fish habitat.

B. Trees, Plants, Ground Cover:

1. Protect trees, plants, and other ground cover from damage.
2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.

3.4 LAYOUT OF WORK

1. Construction survey requirements. Section 01 71 23.
2. **Speed Bump or Speed Table:** Provide layout with line and grade as shown in the Drawings or APWA Plan 761 or 762.
3. **Bus Stop Pad:** Install as shown in the Drawings or APWA Plan 880.

3.5 LINE AND GRADE CONTROL

A. **General**:

1. Furnish, place, and maintain forms, supports, wire devices, and materials as required for providing continuous line and grade control.
2. Use survey staking. Distances between line and grade control points are as follows:
   a. 25 feet maximum on tangent sections.
   b. 10 feet maximum on vertical curve high points and low points, and on horizontal curves from PC to PT points.
3. Provide additional grade control at high points, low points,
4. Check line and grade control immediately before paving operation.

5. Use the same grade control system to control the paver and the grade trimmer.

B. **Slip Form Paving**. Equip machinery with a control system that automatically controls concrete placement to the specified longitudinal grades and transverse cross slopes.

C. **Formed Paving.** Section 03 11 00. Keep forms free from warps, bends, kinks, and equal in depth to the specified pavement edge. Tightly join formed sections and stop paving operation if the side forms to not meet or hold the following line and grade:

1. Top of forms not more than 1/4 inch from true grade.
2. Vertical face on longitudinal axis not more than 1/4 inch from true line.

3.6 REINFORCEMENT PLACEMENT

A. Section 03 20 00.

B. Use smooth dowel in expansion joints.

C. Interrupt reinforcement placement at expansion joints.

D. Keep load transfer bars and dowels in vertical center of concrete and perpendicular to the joint during concrete placement.

E. Position mats on bar chair supports and properly tie before concrete is poured. Keep mats clean, free from rust, flat, and free of distortions. Straighten bends, kinks, and other irregularities or replace units before concrete placement. Provide at least two (2) inch overlap to adjacent mats.

F. DO NOT place the end of a dowel or tie bar within 18 inches of any joint

3.7 JOINTS

A. **General**:

1. Lay our joints as shown in the Drawings or APWA Plan 261.
2. Review joint layout with ENGINEER.
3. Do not allow edge slump when placing tie-bars or by over-working edge of slab.
4. If CONTRACTOR chooses to open the roadway to construction or public traffic before final sawing and sealing, install backer rod in the initial (green) cut to prevent entrance of incompressibles.

B. **Contraction Joints (Crack Control Joint):**

1. Joint spacing measured in feet not to exceed twice the slab thickness measured in inches or 15 feet maximum.
2. Joint depth = T/3. T is depth of concrete slab in inches.
3. Use of a mechanical control joint-void former in lieu of saw cutting or tooling is acceptable.
4. Make transverse joints align with end at curb and gutter joints.
5. Leave forms in place until paving operations are resumed on the other side of the joint.
6. Keep a minimum of 3 working power saws on site when concrete operations are underway. Saw all joints before uncontrolled shrinkage cracking takes place. Do not tear or ravel concrete during sawing.

C. **Expansion Joints**:

1. Joint Filler Type:
   a. Place joint filler vertical in position, in straight lines. Secure fillers to formwork or other to prevent movement. When butted together, do not leave voids or gaps between filler units.
   b. Set joint fillers full depth if no joint sealant is specified. Recess joint fillers if backer rods and joint sealant are specified.
2. Dowel Bar Type:
   a. Provide expansion cap on end of dowel bar.
   b. If a deformed bar is used in an expansion joint, provide sleeve for movement.

D. **Header Joints (Transverse Construction Joints) in Slip Form Paving:** Extend concrete paving placement an addition 5-feet at the end of a day of work or at an interruption for a bridge, intersection, or leave-out. When hardened, saw cut and remove the five feet to create the header. Install dowels into the hardened concrete and continue concrete placement.

E. **Volunteer Crack Joint**:

1. If a volunteer crack joint falls within 5-feet of the location of proposed contraction joint, omit the contraction joint.

2. Rout volunteer crack joints to a depth of ¼-slab thickness or as shown in the Drawings or APWA Plan 261 Detail 1. Clean and fill crack joint with backer rod and joint sealant.

3. If a volunteer crack joint develops within 2-feet of expansion or construction joints, replace panel. Use saw cuts and tie-bars or dowels in cut planes.

F. **Joint Sealing**: Section 32 13 73.

3.8 **PLACEMENT**

A. Section 03 30 10.

B. Do not place concrete until concrete subbase and surface course forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time of concrete placement. Do not place concrete around manholes or other structures until they are at required finish elevation and cross slope.

C. At the beginning of concrete placement:

1. Test slump and air. If corrections are necessary, placement may proceed after 2-subsequent and consecutive batches pass testing.

2. Tempering, not allowed unless Section 03 30 10 requirements are followed or mix design makes allowance for water addition.

3. Admixtures (such as for air entrainment) not allowed unless specified elsewhere.

D. **Any delay more than 15 minutes from placing to start of finishing operations is cause for stopping placement work**.

E. Prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.

F. Do not place concrete in a longitudinal section until test specimens from the adjacent lane have attained a compressive strength of 2,500 psi as determined by maturity meter or cast cylinders.

G. Deposit and spread concrete in a continuous operation between transverse joints. If interrupted for more than ½-hour, place a construction joint.

H. Place the concrete to the full width of the pavement in a single construction operation unless indicated otherwise.

3.9 **SCREEDING AND FLOATING**

A. Strike-off, consolidate, and provide a smooth surface by screeding

B. After screeding, test slab for trueness with a straight edge. Distribute concrete as required to remove surface irregularities.

C. Apply an evaporation retarder immediately after screeding (or after floating if floating is required). Apply retarder BEFORE bleed water has vanished. **Do not use the retarder as a finishing aid**.

D. Use floating hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture. Refloat repaired areas to provide a continuous smooth finish.

3.10 **FINISHING**

A. Section 03 35 00.

B. DO NOT use steel finishing equipment (floats, trowels, etc.).

C. **Any delay more than 30 minutes for completing the finishing operation is cause for stopping concrete placing to correct difficulties**.

D. Round edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool. Eliminate tool marks.

E. Surface Texture: After floating when excess moisture or surface sheen has disappeared:

1. For speed less than 45 mph: Apply 1/16-inch-deep burlap drag, turf drag, or broom.

2. For speeds 45 mph and greater: Apply 1/8-inch-deep groove placed 80 degrees to center line and randomly spaced between 3/8 and 1-1/2-inches.

F. Do not remove forms for at least 24 hours after concrete has been placed. After form removal, clean ends of joints and patch any minor honeycombed areas. Remove and replace areas or sections with major defects.

3.11 **CURE**

A. Section 03 39 00.

B. Immediately after floating and texturing as the water sheen of the surface is disappearing, apply curing agent in 2- directions for total white coverage on all exposed surfaces.

C. Apply agent at 2-times the rate recommended by the compound manufacturer. Applying curing agent too late (after concrete dampness has disappeared) may cause work rejection by ENGINEER.

D. Eliminate thermal shock of concrete by keeping cure temperature close to ground and air temperature.

3.12 **TOLERANCES**

A. **Slab Thickness**: Not more than ¼-inch deficient.

B. **Smoothness**:

1. Parallel to Centerline: Section 32 01 31.
2. Cross Slope: ¼-inch in 10 feet except at cross section grade breaks.

C. **Dowel Bar**:

1. Maximum allowable skew is 0.375 inches per 12 inches (3 percent) in the horizontal and vertical planes.
2. Embedment is 6-inches minimum.
3. Position in slab is center plus or minus 1/2 inch.

3.13 **REPAIR**

A. General: Section 03 30 10. All expenses are at no additional cost to OWNER.

B. Corrective Action for Profile Deviations (“Must Grinds”): Grinding per Section 32 01 26 is acceptable after concrete cure. Apply a water repelling product, Section 07 19 00 over grind surfaces. If depressions cannot be corrected by grinding, remove and replace.

C. Corrective Action for Profile Roughness Index: Grinding is acceptable. Re-profile corrected segments to verify ride index meets tolerance. Apply a water repelling product, Section 07 19 00 over grind areas.

D. Corrective Action for Cracks: Consider repair options published in guidelines by the American Concrete Pavement Association (ACPA). Do not begin corrective work until ENGINEER agrees with repair option. Drill test cores when necessary to determine magnitude. Fill holes with Portland cement concrete bonded to pavement with epoxy adhesive.

3.14 **OPENING TO TRAFFIC**

A. Not less than 3,000 psi compressive or 400 psi flexure strength.

END OF SECTION

SECTION 32 13 73
CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Joints and joint sealants in horizontal concrete sidewalks, curb, gutter and roadway Pavement surfaces.

1.2 REFERENCES

A. **ASTM Standards**:

C920 Elastomeric Joint Sealants.

D545 Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types).

D994 Preformed Expansion Joint Filler for Concrete (Bituminous Type).

D1190 Concrete Joint Sealer, Hot-Poured Elastic Type.

D1191 Testing Concrete Joint Sealers.

D1751 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

D1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

D1851 Concrete Joint Sealers, Cold-Application Type.

D2240 Rubber Property - Durometer Hardness.

D2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.

D3405 Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements.

D3406 Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.

D3407 Testing Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements.

D3408 Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements.

D3542 Preformed Polychloroprene Elastomeric Joint Seals for Bridges.

D3569 Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant-Type for Portland Cement Concrete Pavements.

D3575 Flexible Cellular Materials Made from Olefin Polymers.

D3581 Joint Sealant, Hot-Poured, Jet-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements.

D3582 Testing Joint Sealant, Hot-Poured, Jet-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements.

D3583 Joint Sealant, Hot-Applied, Elastomeric Type, for Portland Cement Concrete Pavements, or Joint Sealant, Hot Applied, Elastomeric, Jet Fuel Resistant Type, for Portland Cement Concrete Pavements.

D5249 Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement and Asphalt Joints.

D5893 Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

B. **FS Standards**:

SS-S-200 Sealants, Joint, Two Component, Jet-Fuel Resistant, Cold-Applied, for Portland Cement Concrete Pavement.

1.3 SYSTEM PERFORMANCES

A. Pavement joints include longitudinal and transverse expansion joints, contraction joints, construction joints, and crack control joints.

B. Provide joint sealants that maintain watertight and airtight continuous seals.

1.4 **SUBMITTALS**

A. Manufacturer's certification that product was manufactured, tested and supplied meeting source quality control requirements specified herein, together with a report of the test results and the date each test was completed.

B. Manufacturer's instruction for joint preparation, type of cleaning and installation.

C. Manufacturer's product data and samples for each joint sealant product required.

D. Safety data sheets.

1.5 **QUALITY ASSURANCE**

A. Installation of joint systems are to follow manufacturer’s published directions.

B. For cold applied joint sealant installation, use installers approved by joint sealant supplier.

C. Obtain joint sealing materials from a single manufacturer for each different product required.

1.6 **DELIVERY, STORAGE, AND HANDLING**

A. Deliver materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants, or other causes.

PART 2 PRODUCTS

2.1 **GENERAL**

A. Compatibility: Provide joint fillers, sealant backings, sealants, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2.2 **JOINT VOID - FORMER**

A. Plastic with a water stop.

B. 1/4 depth of concrete structural section.

2.3 **JOINT FILLER - SHEET TYPE**

A. **F-1**: Bituminous (asphalt or tar) mastic, ASTM D994. Formed and encased between two (2) layers of bituminous saturated felt or two (2) layers of glass-fiber felt.

B. **F-2**: Cane or other cellulosic fiber, ASTM D1751. Saturated with asphalt.

C. **F-3**: Granulated cork, ASTM D1751. In an Asphalt Binder; encased between two (2) layers of asphalt saturated felt or two (2) layers of glass-fiber felt.

D. **F-4**: Sponge rubber fully compressible, ASTM C1752. With resiliency recovery rate of 90 percent minimum.

E. **F-5**: Cork, ASTM C1752. Impregnated and bound with asphalt, compressible with resiliency recovery rate of 90 percent if not compressed more than 50 percent of original thickness.

F. **F-6**: Plastic foam (for cold-applied sealants only). Preformed, compressible, resilient, non-waxing, non-extruding strips of flexible, non-gassing plastic foam; non-absorbent to water and gas; 30 pounds per cubic foot density maximum, And of size and shape to control sealant depth and performance.

2.4 **JOINT FILLER - BACKER ROD, TAPE, POURED FILL TYPE**

A. Backer material, ASTM D5249 for cold-applied and hot-applied joint sealant in Portland cement concrete or bituminous concrete pavements joints:

1. Type 1: Round rods.
2. Type 2: Sheets or strips, laminated or skived.
3. Type 3: Poured fills that completely fills pavement joint.

2.5 **JOINT SEALANT - GENERAL**

A. Color of exposed joint sealant indicated, or if not, as selected from manufacturer's standard colors.

2.6 **JOINT SEALANT – HOT APPLIED**

A. **HAS-1**: Asphalt base type, ASTM D3405.

B. **HAS-2**: Thermoplastic type, ASTM D3581. Jet-fuel resistant without rubber unless indicated otherwise.

C. **HAS-3**: Elastic type, ASTM D1190.

D. **HAS-4**: Elastomeric type, ASTM D3406. One component, for Portland cement concrete pavements.

E. **HAS-5**: Elastomeric type, ASTM D3569. One component, jet-fuel resistant, for Portland cement concrete pavements.

2.7 **JOINT SEALANT – COLD APPLIED**

A. **CAS-1**: Elastomeric type, ASTM C920. Chemically curing, for vehicular or pedestrian use, and types of construction other than highway and airfield pavements and bridges and joint substrates indicated; Type S or M; Grade P or NS; Class 25; Use T, NT, M and O:

1. Self leveling.
2. Shore A Hardness, ASTM D2240: 40 plus or minus 5.
3. Final cure: Four (4) days maximum.
4. Service range: -10 to 150 deg F

B. **CAS-2**: Mastic type, ASTM D1851. Single or multiple component; for joints having a minimum width of 1/2 inch.

C. **CAS-3**: Coal-tar modified urethane, FS SS-S-200. One part, jet fuel resistant; Type H.

D. **CAS-4**: Elastomeric preformed polychloroprene type with lubricant adhesive and indicated movement ratio:

1. For concrete pavement seal, ASTM D2628.
2. For concrete bridge seals, ASTM D3542.

E. **CAS-5**: Silicone type, ASTM D5893. Single component, non-sag or self leveling, chemically curing sealant based on polymers of polysiloxane structure intended for use in Portland cement concrete pavements.

F. **CAS-6**: Asphalt base meeting ASTM D3405.

G. **CAS-7**: Olefin polymer, ASTM D3575 as follows:

1. Tensile elongation 255 percent plus or minus 20 percent, Suffix T.
2. Tensile strength 115 psi minimum, Suffix T
3. Density 2.9 plus or minus three (3) lbs/cubic foot, Suffix W, Method A
4. Water absorption 0.025 lbs/square foot maximum, Suffix L.

2.8 **SOURCE QUALITY CONTROL**

A. Preformed Expansion Joint Fillers: Non-extruding and resilient types, ASTM D545.

B. Hot-Applied Joint Sealants:

1. Elastic type used in concrete pavements, bridges, other structures, ASTM D1191.
2. Bituminous type for Portland cement concrete and bituminous concrete pavements, ASTM D3407.
3. Elastomeric type for hydraulic concrete pavement, ASTM D3408.

C. Jet-Fuel-Resistant Joint Sealant: Hot applied, ASTM D3582 and ASTM D3583.

D. Cold-Applied Mastic Joint Sealant: Cold applied, ASTM D1851.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Remove oil, grease, wax, form-release-agents, curing compounds, bitumens, laitance and old chalking material by sandblast, or water blast as recommended by manufacturer of sealant. Maximum sand blast angle, 25 degrees plus or minus five (5) degrees.

B. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants.

C. Remove frost and moisture in concrete joint substrates before commencing sealing.

D. Install bond breaker tape where needed or required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.

3.2 **JOINT SEALING**

A. General:

1. Install sealants in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides.

2. Except as otherwise indicated, fill sealant rabbet flush with surface.

3. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

B. Depths: Saw cut joints if necessary to provide the required sealant thickness and depth. Install sealant to depths indicated or, if not indicated, as recommended by sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:

1. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.

2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/4 inch deep.

3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints full depth.

C. Spillage: Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.

D. Heating: Do not use overheated hot-applied sealants.

E. Edges: Unless indicated otherwise, recess exposed edges of gasket and exposed joint fillers slightly behind adjoining surfaces so compressed units will not protrude from joints.

3.3 **CURING AND CLEANING**

A. Cure sealants and caulking compounds per manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses. Use methods and cleaning materials approved by manufacturers of joint sealant and of products in which joints occur.

C. Remove protective coating and oil from metals with solvent recommended by the sealant manufacturer.

3.4 **PROTECTION**

A. Protect joint sealant during and after curing period from contact with contaminating substances or from damage resulting from deterioration or damage at time of substantial completion.

B. If damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealant immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work at no additional cost to OWNER.

END OF SECTION

SECTION 32 16 13
DRIVEWAY, SIDEWALK, CURB, GUTTER

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Concrete flat work such as waterways, waterway transition structures, sidewalks, curb, gutters, Driveway Approaches, etc.

1.2 REFERENCES

A. **APWA (Utah) Standards**:

Plan 205 Curb and gutter.

Plan 206 Curb and gutter dowel tie-in.

Plan 209 Curbs.

Plan 211 Waterway.

Plan 213 Waterway transition structure.

Plan 215 Dip driveway approach.

Plan 216 Mountable curb driveway approach.

Plan 221 Flare driveway approach.

Plan 222 Saw-cut driveway approach.

Plan 225 Open driveway approach.

Plan 229 Bridge driveway approach.

Plan 231 Sidewalk.

Plan 232 Patterned concrete.

Plan 235 Curb cut assembly.

Plan 237 Islands and median.

Plan 238 Detectable warning surface.

Plan 251 Bituminous concrete pavement tie-in.

Plan 252 Curb and gutter replacement without pavement tie-in.

B. **ASTM Standards**:

A36 Structural Steel.

C39 Compressive Strength of Cylindrical Concrete Specimens.

C172 Sampling Freshly Mixed Concrete.

1.3 DEFINITIONS

A. **Driveway**: A paved or unpaved vehicular thoroughfare outside of but connected to a public road right-of-way or highway right-of-way.

B. **Driveway Approach**: A paved or unpaved vehicular thoroughfare connecting a public road or highway to a Driveway.

1.4 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. Concrete mix design, Section 03 30 04.

C. Batch ticket, Section 03 30 10.

1.5 **QUALITY ASSURANCE**

A. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.

1.6 **NOTICE**

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least two (2) days before work starts.

B. Indicate when concrete work will take place and when driveway approach can be used.

C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

D. Should work not occur on specified day, send a new notice.

1.7 **ACCEPTANCE**

A. **General**:

1. Acceptance is by lot. One lot is one day production.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation, Section 01 29 00.

3. Dispute resolution, Section 01 35 10 and Section 03 30 05.

B. **Concrete Mix**:

1. Testing Frequency: Section 03 30 05. Sample per ASTM C172.

2. Temperature, Slump, Air: Lot size is 1 random batch. Reject non-complying batches until two (2) consecutive batches are compliant then proceed in random batch testing for acceptance.

3. Strength: Lot size is 50 cubic yards. At ENGINEER's discretion and ASTM C39, a lot with deficient sub-lot strength may be accepted if pay is adjusted using one of the following applicable pay factors, or accepted at 50 percent pay if a sub-lot is in Reject.

Pay Factor	PSI Below 28 days Compressive Strength
0.98	1 to 100
0.94	101 to 200
0.88	201 to 300
0.80	301 to 400
Reject	Greater than 400

C. **Placement**, Section 03 30 10:

1. Verify line, grade, cross slope, finish, and dimensions.

2. No standing water in curb and gutter.

3. Membrane curing compound applied for total coverage at two (2) times manufacturer's recommended rate in two (2) directions after finishing and texturing.

PART 2 PRODUCTS

2.1 **MATERIALS**

A. Concrete Mix:

1. Class 4000 cast-in-place, Section 03 30 04.

2. Slump range per mix design.

B. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel, Section 03 20 00, deformed.

C. Expansion Joint Filler: F1 sheet 1/2 inch thick, Section 32 13 73.

D. Contraction Joint Filler (Backer Rod): Closed cell, Type 1 round, Section 32 13 73.

E. Contraction Joint Sealer: HAS1 or HAS4 hot applied, Section 32 13 73.

F. Curing Compound: Membrane forming compound, Section 03 39 00.

G. Plate Steel: Galvanized Steel, ASTM A36, Section 05 05 10.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Slip Form Machines:

1. Placement must produce required cross-section, line, grade, finish, and jointing as specified for formed concrete.

2. If results are not acceptable, remove and replace work with formed concrete.

3.2 PREPARATION

A. Implement notification and traffic control plan requirements, Section 01 55 26.

B. Examine surfaces scheduled to receive concrete formwork for defects.

C. Do not start work until defects are corrected.

D. Check slopes on each side of the work to ensure drainage. Failure to check and verify will result in CONTRACTOR repairing any drainage deficiencies at no additional cost to OWNER.

3.3 CONCRETE PLACEMENT

A.**Preparation:**

1. Make sure base course is uniformly damp at tie of concrete placememt.

2. Obtain ENGINEER's review of base course and forms before placing concrete.

3. Do not segregate the mix.

B. **Placement:** Section 03 30 10. Time between end of placement and beginning of finishing is less than 15 minutes.

1. Curb, Gutter, Waterway. Waterway Transition Structure: Place as shown in the Drawings or APWA Plans 205, 209, 211, 213 as applicable.

2. Driveway Approach: Place as shown in the Drawings or APWA Plans 221, 222, 225, 229 as applicable.

3. Sidewalk Crosswalk: Place as shown in the Drawings or APWA Plans 231, 232 as applicable.

4. Curb Cut Assembly: Place as shown in the Drawings or APWA Plans 235, 236, 238 as applicable.

5. Islands and Median: Place as shown in the Drawings or APWA Plan 237.

C. **Consolidate Concrete:** Use vibrator or other acceptable method. Prevent dislocation of inserts.

3.4 CONTRACTION JOINTS

A. Section 32 13 73.

B. Geometrics:

1. Tooled Joints (Score Lines):

a. Depth = T/4. T is the depth of the concrete slab in inches.

b. Top radius = 1/2 inch.

2. Saw Cut Joints: Saw joints before uncontrolled shrinkage cracking occurs. Do not tear or ravel concrete during sawing.

3. Template Joints: 1/8-to-3/16 inch wide 1/4-depth of slab.

C. Sidewalks.

1. At intervals equal to the width of the sidewalk and transverse to the line of walk.

2. Radial at curbs and walk returns.

3. Place longitudinal joints in walks when width of walk, in feet is greater than two (2) times the walk thickness in inches. (e.g. maximum width of a four (4) inch thick walk before placement of a longitudinal contraction joint is eight (8) feet). Make longitudinal joints parallel to, or concentric with, the lines of the walk.

4. In walk returns make at least one (1) radial joint midway between beginning of curb returns (BCR) and end of curb returns (ECR). Match longitudinal and traverse joints with joints in adjacent walks.

D. Curb, Gutter, Waterway:

1. Place joints at intervals not exceeding 12 feet.

2. At curb radius and walk returns make joints radial.

3. Where integral curb and gutter is adjacent to concrete pavement, align joints with pavement joints where practical.

3.5 **EXPANSION JOINTS**

A. General: Section 32 13 73:

1. ½-inch-wide full depth filler that is flush with concrete surface. Do not place seal over top of joint filler.

B. Sidewalks:

1. Place expansion joints to separate sidewalk from utility poles, hydrants, manhole frames, buildings, and abutting sidewalks.

2. Place expansion joints between sidewalk and back of curb returns and between sidewalk and sidewalk ramps.

3. Do not place expansion joints in sidewalk ramp surfaces.

4. Expansion joints are not required when using slip form method to place concrete except where sidewalk changes direction or where it joins foundation walls or structures.

C. Curb, Gutter, Waterway:

1. Do not place longitudinal joint in drain gutter flowline.

2. Where drain gutter transitions extend beyond curb return, place expansion joints at ends of drain gutter transition.

3. Place expansion joints at beginning of curb radius (BCR) and at end of curb radius (ECR).

D. Curb and Gutter Dowel Tie-in: As shown in the Drawings or APWA Plan 206. Tie-in occurs between new and existing curb and gutter.

E. Slip Form Work: Expansion joints are not required except at BCR or ECR.

F. Driveway Approach: Do not place expansion joints in curb returns.

G. Street Intersection Corner: Place expansion joints at BCR and ECR.

3.6 **FINISH**

A. Section 03 35 00.

B. Round edges exposed to public view to a 1/2 inch radius.

C. Apply broom finish longitudinal to curb and gutter flow-line.

D. Apply broom finish transverse to sidewalk centerline as follows:

1. Fine hair finish where grades are less than six (6) percent.

2. Rough hair finish where grades exceed six (6) percent.

E. Remove form marks or irregularities from finish surfaces.

3.7 **PAVEMENT TIE-IN**

A. As shown in the Drawings or APWA Plan 251 and 252.

3.8 **TOLERANCES**

A. Curb, Gutter, Curb and Gutter: APWA Plan 205, 209, 211, 213.

1. Dimensions: As shown in the Drawings or APWA Plan 215, 216, 221, 225, 229 as applicable.

2. Line: Less than ½-inch variance in 10 feet and not more than 1 inch from true line at any location.

3. Grade: Not more than ¼-inch variance in 10 feet. Flood curb and gutter with water after final set has been reached. Remove and replace any area where ponding is found.

4. Standing Water: None allowed.

B. Sidewalk:

1. Dimensions: As shown in the Drawings or APWA Plan 231.
2. Cross slope: one (1) percent minimum, two (2) percent maximum.
3. Standing Water: None allowed.

C. Driveway Approach: As shown in the Drawings or APWA Plan 215, 216, 221, 225, 229.

D. Patterned Concrete Park Strips and Crosswalks: As shown in the Drawings or APWA Plan 232.

3.9 **CURING**

A. Section 03 39 00.

B. Curing compound: Apply at two (2) times manufacturer's recommended rate. Apply total coverage in two (2) directions after texturing.

C. Eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete slab.

3.10 **PROTECTION AND REPAIRS**

A. General: All expenses are at no additional cost to OWNER.

B. Protection: Section 03 30 10:

1. Protect concrete work from deicing chemicals during the 28 days cure period.
2. Immediately after placement, protect concrete from graffiti or other types of mechanical injury.

C. Repair: Section 03 30 10. Consider also guidelines published by the American Concrete Pavement Association (ACPA). Do not begin corrective work until ENGINEER agrees with repair option:

1. Correct all humps or depressions.
2. Standing Water: Remove and replace any area where ponding is found. If necessary, flood construction to determine ponding extent.
3. Restore surfaces damaged by saw cutting, grinding, or removal operations.

END OF SECTION

SECTION 32 16 14
CURB CUT ASSEMBLY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete flat work for public right-of-way accessibility.

1.2 REFERENCES

A. **APWA (Utah) Standards**:

Plan 235 Corner curb cut assembly.

Plan 236 Tangent curb cut assembly.

Plan 237 Islands and median.

Plan 238 Detectable warning surface.

1.3 DEFINITIONS

A. **Approach**: An Element in a pedestrian access route that connects a sidewalk to a Blended Transition or a Turning Space. It has a Running Slope of 8.33 percent (1:12) maximum, a Cross Slope of five (5) percent (1:20) maximum, and a Running Length to be determined by the ENGINEER.

B. **Blended Transition**: An Element in a pedestrian access route that connects a sidewalk or an Approach to a Crosswalk. It is 4 feet wide minimum and has a Running Slope of 5 percent (1:20) or less. Cross Slope may vary as follows:

1. Five (5) percent maximum at corners with no yield or stop controls.
2. Two (2) percent maximum at corners with yield or stop controls.
3. Street or highway grade at midblock.

C. **Clear Space**: An Element in a pedestrian access route that is located beyond the foot of a Curb Ramp, Turning Space, or Blended Transition and is within the width of the Crosswalk. Its dimensions are 4 feet minimum by 4 feet minimum with a Running Slope of 5 percent (1:20) maximum. Cross Slope may vary as follows:

1. Five (5) percent maximum at corners with no yield or stop controls.
2. Two (2) percent maximum at corners with yield or stop controls.
3. Street or highway grade at midblock.

D. **Counter Slope**: Running Slope of the roadway surface in a Crosswalk (including the pan of the gutter).

E. **Cross Slope**: Grade perpendicular to the direction of pedestrian travel usually expressed in percent.

F. **Cross Width**: Distance perpendicular to the direction of pedestrian travel usually expressed in linear measure.

G. **Crosswalk (or Pedestrian Street Crossing)**:

1. Unmarked: That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the roadway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway. In the absence of a sidewalk on one side of the roadway, that part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line;

2. Marked: Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.

H. **Curb Ramp**: An Element in a pedestrian access route that is 4 feet wide minimum, has a Running Slope from 5 percent (1:20) to 8.33 percent (1:12) maximum and is not required to be more than 15 feet long. Curb ramps are perpendicular to or parallel with a curb. A perpendicular curb ramp abuts or cuts through the curb and its Turning Space is at the top of the ramp. A parallel curb ramp abuts the curb and its Turning Space abuts or cuts through the curb. Cross Slope may vary as follows:

1. Five (5) percent maximum at corners with no yield or stop controls.

2. Two (2) percent maximum at corners with yield or stop controls.
3. Street or highway grade at midblock.

I. **Detectable Warning Surface**: A surface feature of truncated dome material built into the walking surface to advise a pedestrian of an upcoming change from pedestrian to vehicular way.

J. **Element**: An architectural or mechanical component of a building, facility, space, site, or public right-of-way.

K. **Grade Break**: The line where two surface planes with different grades meet flush.

L. **Running Length**: Distance parallel to the direction of pedestrian travel usually expressed in linear measure.

M. **Running Slope**: Grade parallel to the direction of pedestrian travel usually expressed in percent.

N. **Turning Space (or Landing)**: An element in a pedestrian access route that connects an Approach or a sidewalk to a Curb Ramp, a Blended Transition or a Clear Space. It is 4 feet minimum by 4 feet minimum. If constrained on 2 sides, it must be 5 feet minimum in the direction of the Curb Ramp or Blended Transition. It's Running Slope and Cross Slope is 2 percent (1:50) maximum. At midblock Crosswalks without stop control, the Cross Slope is permitted to equal the street or highway grade.

1.4 SUBMITTALS

A. Field quality control 'pass-fail' checklist data.

B. Traffic control plan, Section 01 55 26.

C. Concrete mix design, Section 03 30 04.

D. Batch ticket, Section 03 30 10.

E. Detectable warning surface product data sheet.

1.5 OWNER'S INSTRUCTIONS

A. **Alteration**s: If the direction of water flow in an existing curb and gutter system is not apparent, proceed as follows:

1. Flood curb and gutter system to determine extent of replacement.
2. Flood curb and gutter system after installation to verify drainage.

B. **Steep Slopes**: Prior to placing concrete, allow ENGINEER time to check slopes and dimensions of construction forms.

1.6 ACCEPTANCE

A. Clear Space: Located within Crosswalk, Running Slope, Cross Slope.

B. Flow-line: No standing water, no trip hazard.

C. Detectable Warning Surface:

1. Color contrast, dome geometry, joints between units.
2. Cross Width, Running Length.

D. Curb Cut: Cross Width (appropriate to number of crosswalks served).

E. Turning Space: Running Slope, Cross Slope, dimensions.

F. Curb Ramp: Running Slope, Cross Slope, Cross Width.

G. Blended Transition: Running slope, Cross Slope, Cross Width.

PART 2 PRODUCTS

2.1 CONCRETE

A. Class 4000, Section 03 30 04.

2.2 DETECTABLE WARNING SURFACE

A. Concrete paver, ribbed composite panel, or tile.

B. Properties:

1. Homogenous color.
2. High shear strength domes.
3. Slip resistant, freeze thaw resistant, UV resistant.

PART 3 EXECUTION

3.1 PREPARATION

A. Implement notification and traffic control plan requirements, Section 01 55 26. Provide safe passage for pedestrians and vehicles.

B. Assist visually impaired and wheel chair users.

C. Provide continuous access to fire hydrants.

D. Keep passage ways free of construction materials, trash and debris.

E. Remove graffiti immediately.

3.2 INSTALLATION

A. Layout, APWA Plans 235, 236, 237, and 238.

B. Place concrete, Section 03 30 10.

C. Install Detectable Warning Surface full width of curb cut.

3.3 FIELD QUALITY CONTROL

A. Use the ‘pass-fail’ checklist in Table 1 to verify that the curb cut assembly complies with layout requirements.

3.4 CLEANING AND REPAIR

A. Remove all debris and concrete dust.

B. Clean surrounding handrails, sidewalks, driveways approaches, landscaping, and other objects in vicinity of work.

C. Repair surfaces damaged by saw cutting, grinding, or removal operations at no additional cost to OWNER.

END OF SECTION

Table 1 – Field Quality Control Checklist

Date: _____ Time: _____ (am) (pm) Job No. _____
Job Title: _____
Indicate the intersection corner or adjacent sreet address number:
Intersection: _____, NE NW SE SW
Street Address Number: _____

	Criterion	Pass	Fail
Clear Space			
Located in the width of the Crosswalk	Yes		
Running Slope	≤ 5%		
Proper Crosswalk striping.....	Yes or NA		
Gutter			
Slope (midblock)	Street grade		
Slope (corner without yield or stop control)	≤ 5%		
Slope (corner with yield or stop control) ..	≤ 2%		
Slope (adjacent to a Turning Space)	≤ 2%		
Counter Slope (flow-line to pan lip)	≤ 5%		
Trip hazard at flow-line	No		
Trip hazard at roadway/pan joint	No		
Curb Ramp			
Running Slope	≤ 8.33%		
Blended Transition			
Running Slope	≤ 5%		
Turning Space			
Running Slope (midblock)	Street grade		
Running Slope (corner)	≤ 2%		
Cross Slope	≤ 2%		
Approach			
Running Slope	≤ 8.33%		
Cross Slope	≤ 5%		
Detectable Warning Surface			
Spans curb cut in pedestrian access route	Yes		
Running Length	≥ 24”		
Color contrast	Yes		
Dome dimension and orientation	Yes		
Flare			
Slope (if in pedestrian access route)	≤ 10%		

SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Words, striping, and other pavement markings.

B. One-way or two-way prismatic reflectors.

1.2 REFERENCES

A. **AASHTO Standards**:

MP24 Waterborne White and Yellow Traffic Paints

M237 Epoxy Resin Adhesive for Bonding Traffic Markers to Hardened Concrete.

M247 Glass Beads Used in Traffic Paint.

M248 Ready-Mixed White and Yellow Traffic Paints.

M249 White and Yellow Reflective Thermoplastic Striping Material (Solid Form).

B. **ASTM Standards**:

D638 Tensile Properties of Plastics.

E303 Measuring Surface Frictional Properties Using the British Pendulum Tester.

E1710Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer.

C. **DOT Standards**:

MUTCD Manual on Uniform Traffic Control Devices for Streets and Highways.

1.3 DEFINITIONS

A. **Retroreflective**: Majority of reflected light is directed back to the light source.

1.4 SUBMITTALS

A. Product data for primer to be used for tape applications.

B. Manufacturer's affidavit certifying paint products meet or exceed material requirements of this section.

C. Sample of prismatic reflector to be used along with manufacturer's statement of the reflector's minimum reflective area and specific intensity at the 0.2 degrees observation angle.

D. Manufacturer's recommendation for type of adhesive to be used.

E. Samples of each thermoplastic or preformed plastic pavement markings along with manufacturer's instructions of how the materials are to be applied.

1.5 QUALITY ASSURANCE

A. At the end of the correction period, pavement markings, when applied according to the recommendations of the manufacturer, show a neat, durable marking with no flow or distortion due to temperature if the pavement surface remained stable. The tape shows no appreciable fading, lifting or shrinkage, and no significant tearing, roll back or other sign of poor adhesion.

1.6 WEATHER

A. Apply pavement striping and markings only when pavement surface is dry and air temperature is above 40 deg F during daylight hours.

B. Do not apply pavement striping and markings when rain is anticipated within 12 hours.

PART 2 PRODUCTS

2.1 **GLASS BEADS**

A. AASHTO M247.

2.2 **FILM AND ADHESIVE**

A. **Film**: A pliant polymer with retroreflective glass beads distributed throughout its cross-sectional area and bonded to its top surface. The film is selected and blended to conform to standard white or yellow highway colors and has a minimum thickness of 0.06 inches at pattern height.

1. Skid Resistance: 35 BPN minimum, ASTM E303.

2. Tensile Strength: ASTM D638. Using a Sample size 6 x 1 inch, a temperature between 70 and 80 deg F, and a test jaw speed of 10 to 12 inches per minute, the film has an elongation of 75 percent maximum at break and a strength as follows.

a. Type 1: 150 pounds minimum tensile strength per square inch of cross-section area.

b. Type 2: 40 pounds minimum tensile strength per square inch of cross-section area.

3. Reflectivity: Meet film reflectivity in the following table.

Table 1 - Film Reflectivity

Application	Tensile Strength	Color	
		White	Yellow
Non-residential	Type 1	500	350
Residential	Type 2	300	250

NOTES

(a) Follow ASTM E1710 procedures using 30 meter test distance, an entrance angle of 88.76 degrees, and an observation angle of 1.05 degrees.

(b) Reflectivity is measured in millicandelas per square foot per footcandle (mcd/sf/fc).

B. **Adhesive**:

1. Class 1: Without pre-coated adhesive for applications with surface preparation adhesive recommended by the manufacturer at temperatures of 40 deg F or above and moderate humidity.

2. Class 2: With pre-coated pressure sensitive adhesive with minimum adhesion value of 1.1 pounds per inch width, AASHTO M237

2.3 **PAINT**

A. Acrylic waterborne pavement marking paint, AASHTO MP 24.

B. Thermoplastic, AASHTO M249.

2.4 **PRISMATIC REFLECTORS**

A. Unless indicated otherwise, provide single lens snowplow resistant reflectors of the color indicated:

1. With a cast iron housing and acrylic prismatic reflector.

2. With an overall size not less than nine (9) inches long, five (5) inches wide, and 1-3/4 inch thick with a 7/16 inch maximum projection above its base.

3. With a minimum reflective area of 1.6 square inches per face.

B. Reflector Specific Intensity: Meet intensity in the following table.

Table 2 - Intensity		
Color	Entrance Angle	
	0 Degrees	20 Degrees
White Yellow	3.0 1.8	1.2 0.72
NOTES (a) Intensity measured at 0.2 degree observation angle.		

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Use equipment manufactured for pavement marking. Use workers experienced in operating such equipment.

B. Use equipment capable of applying a strip, or strips with a width tolerance of plus or minus 1/4 inch. Equip machine with an automatic skip control giving a 10 feet long marked segment and a 30 feet long gap within a linear tolerance of six (6) inches over that cycle.

C. If applying glass beads, locate bead applicator directly behind and synchronized with marking applicator.

D. For thermoplastic paint materials, use equipment that is designed to agitate the paint to prevent scorching, discoloration, or excessive high temperatures.

3.2 PREPARATION

A. **General**: DO NOT begin pavement painting and marking operations without ENGINEER's knowledge of such activity.

B. **Repair of Receiving Surface**: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.
2. Crack sealing and crack repairing, Section 32 01 17.
3. Pushing or shoving pavement repair.
   a. Mill damaged area at least three (3) inches below required surface elevation.
   b. Install and compact three (3) inches of bituminous concrete, Section 32 12 16.13. ENGINEER to determine Mix Designator.

C. **Traffic Control**:

1. Implement notification and traffic control plan requirements, Section 01 55 26. Provide safe passage for pedestrians and vehicles. Do not proceed without certified flaggers if work requires.
2. Grind off confusing pavement markings and lane stripes.

D. **Cleaning**: Broom or flush the surface to remove dirt, loose stones, or other foreign material. For better adhesion results clean the surface using high velocity compressed air.

E. **Mark Roadway**: Mark roadway between control points established by ENGINEER. ENGINEER will establish points on tangent at least every 100 feet and at 25 feet long intervals on curves. Maintain the line within 1 inch of the established control points. ENGINEER may also designate other pavement striping locations such as stop bars, crosswalks, zebra striping, etc.

F. **Markings**: Markings that adhere to bituminous concrete or Portland cement concrete by either a pressure sensitive pre-coated adhesive or an epoxy cement shall mold to the pavement contours by traffic action at normal pavement temperatures and shall be ready for traffic immediately after application.

3.3 INSTALLATION - ACRYLIC WATERBORNE PAINT STRIPING

A. Adjust pavement striping machine to apply paint at rate recommended by paint manufacturer. Provide two (2) applications over new pavement (pavement correction period has not expired)

B. Glass Bead Application Rate (Final Application): 8 pounds per gallon of paint.

C. Protect the markings until dry by placing approved guarding or warning device wherever necessary. Remove any markings not authorized or smeared or otherwise damaged, or correct as approved by ENGINEER.

3.4 **INSTALLATION - THERMOPLASTIC PAINT STRIPING**

A. Clean off dirt, glaze, and grease before pre-striping.

B. Pre-stripe the application area with a binder material that will form, when sprayed, a continuous film over pavement surface, and will dry rapidly and mechanically adhere to pavement surface. Install material in varying widths if indicated.

C. At a temperature recommended by the equipment manufacturer, extrude thermoplastic material from equipment that is proven to produce a line 1/8 inch to 3/16 inch thick, continuous, uniform in shape and has clean and sharp dimensions.

D. Do not use material that produces fumes that are toxic, obnoxious, or injurious to persons or property.

E. Apply so finished lines have well-defined edges free of waviness.

F. Glass Bead Application Rate: Six (6) pounds of glass beads to every 100 square feet of marking.

3.5 **INSTALLATION - TAPE STRIPING**

A. Apply pavement marking tape as indicated or directed. ENGINEER will establish control points.

B. Apply tape only on surfaces that are dry and free of oils, grease, dust and dirt, and primed at the rate of approximately 1 quart per 60 feet with an approved primer material.

C. Maintain the line on established control points. Apply intermittent pavement marking tape 24 inches long, spaced approximately 100 feet on tangents, and approximately 25 feet on curves unless otherwise directed. The ENGINEER will designate other pavement striping locations such as stop bars, crosswalks, zebra striping, etc.

D. Press down tape immediately after application until it adheres and conforms to pavement surface.

E. Completely remove all tape on sections where tape conflicts with revised traffic lanes before opening new lanes to traffic.

3.6 **INSTALLATION PAVEMENT MARKING FILMS**

A. Apply before traffic is allowed on freshly paved surface.

B. Unless indicated otherwise, provide Type 1, Class 2, polymer film markings in specified widths and shapes. Provide and layout words and marking symbol configurations per MUTCD requirements and as indicated.

C. When indicated, inlay markings in fresh bituminous concrete pavement with a compaction roller during the paving operation.

D. Apply all markings in accordance with manufacturer's recommendations.

3.7 **INSTALLATION - PRISMATIC REFLECTORS**

A. Install reflectors by cutting pavement and partially filling cut area with epoxy adhesive. Place reflector housing in the adhesive and apply pressure to properly seat. Allow epoxy to completely set before allowing traffic on markers.

B. Install markers so that housing top surface and edges are flush with pavement surface.

3.8 **INSTALLATION - WORDS, SYMBOLS AND OTHER MARKINGS**

A. Wet sandblast existing or temporary pavement markings that may be confusing. Removal of markings by high-pressure water may be used if approved by ENGINEER.

B. Apply word markings, letters, numerals and symbols with indicated stencils and templates. In the absence of such information all stencils and templates shall be identical to those currently used by OWNER.

3.9 **REPAIR**

A. Before the end of the correction period, renew stripes and markings if original visual effectiveness is reduced by 50 percent.

END OF SECTION

SECTION 33 05 14
UTILITY GRADE ADJUSTMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Raise, lower, or change slope of Street Fixtures.

B. Install Cover Collars.

C. This specification is NOT APPLICABLE to raising and lowering Street Fixtures that withstand internal pressure.

1.2 REFERENCES

A. **APWA (Utah) Standards**.

Plan 273 Frame and cover for monument.

Plan 335 Adjust reinforced concrete dock to grade.

Plan 345 Concrete dock.

Plan 360 Grade ring.

Plan 362 Cover collar for storm drains.

Plan 413 Cover collar for sanitary sewer manhole.

Plan 574 Cover collar for water valve box.

1.3 DEFINITIONS

A. **Box**: A structure such as a valve box, meter box, monument box, fire hydrant box, electrical pull box, cleanout box or other like structure not intended for human entry.

B. **Cover Collar**: A concrete filled annular space between the frame of a Street Fixture and the adjacent pavement surface usually one (1) foot wide.

C. **Extension Ring**: A concrete or metal ring used to adjust surface elevations and surface cross slopes of Street Fixtures covers. Metal rings are used between metal frames and metal covers or grates. Concrete rings are used below metal frames or in the concrete structure below.

D. **Manhole**: A structure designed to permit human entry and working space inside and to confine and control the flow of pipe-conveyed fluids. These structures are collectively referred to as manholes regardless of composition, design, type or depth.

E. **Street Fixture**: The top of existing structures such as but not limited to Manholes, catch basin, sumps, inlets, valve boxes, meter boxes, monument boxes, and similar structure in a thoroughfare surface.

F. **Vault**: A structure intended for human entry containing electrical or telephone facilities or other like utilities.

PART 2 PRODUCTS

2.1 PAVEMENT

A. Bituminous Concrete: Unless indicated otherwise in the Bid Documents or by ENGINEER, provide PG64-22, DM-1/2, 50 blow, product per Section 32 12 05.

B. Concrete: Class 4000 cast-in-place, Section 03 30 04.

2.2 GROUT

A. Portland cement grout, Section 03 61 00.

2.3 EXTENSION RINGS

A. Metal: Class 20 grey iron, arrangement as shown on the Drawings or APWA Plan 273.

B. Concrete: 4000 psi Portland cement, arrangement as shown on the Drawings or APWA Plan 360 Sheet 1.

C. Plastic: Arranged as shown in the Drawings or APWA Plan 360 Sheet 2.

PART 3 EXECUTION

3.1 PREPARATION

A. Determine condition of existing incidental structure. Any item not reported damaged before construction shall be considered unbroken and must be replaced by CONTRACTOR at no additional cost to OWNER.

B. Provide Invert Cover over pipe in cleanout box to prevent gravel, concrete, or debris from entering pipeline.

C. Unless required otherwise, arrange for utility companies to adjust their own structures.

D. Coordinate all adjustments with requirements of affected utility company.

3.2 ADJUST STRUCTURE TO GRADE

A. Restrict excavation around structure to a minimum.

B. After structure adjustment, backfill void around structure and compact before paving or landscaping.

C. Apply mortar to inside and outside of concrete grade rings.

D. If the cone is cracked during construction, restack the manhole with shorter manhole sections and install a new cone at no additional cost to the OWNER.

3.3 ADJUST COVER IN PAVEMENT SURFACE

A. Method A - Metal extension rings:

1. Use rings that lock together.
2. Set frame at desired elevation and cross-slope.
3. Seal joints between pavement and ring, Section 32 01 17.

B. Method B – Concrete extension rings: Adjust frame according to the Drawings or APWA Plan 360.

1. Place concrete grade rings under frame or in structure riser shaft.
2. Set frame at desired elevation and cross-slope.
3. Provide 100 percent concrete support under frame. Do not use wood, bricks, concrete fragments, blocks or particles as support.
4. Grout seams between concrete rings and between frame and concrete rings.

C. Method C – Place Concrete:

1. Set frame at desired elevation and cross-slope.
2. Place concrete and provide 100 percent concrete support under frame.

D. Method D – Concrete Deck: Adjust frame according to the Drawings or APWA Plan 335 or 345.

1. Remove existing concrete deck.
2. Reset steel rebar.
3. Set frame to grade, set forms.
4. Pour concrete. Provide complete concrete support under Street Fixtures.

3.4 INSTALL COVER COLLAR

A. Install collar as shown in Drawings or APWA Plans 362, 413, or 574.

B. Open annular space between pavement and Street Fixtures cover. Unless indicated otherwise, make space 12 inches wide.

C. Set concrete collar to 1/4 inch minimum to 1/2 inch maximum below bituminous concrete pavement surface and 1/4 inch below Portland cement concrete pavement surface.

D. Trowel finish, Section 03 35 00.

3.5 SURFACE FINISHING

A. In new streets or overlays, adjust Street Fixture covers after paving is complete.

B. Restore paved surfaces, Section 33 05 25.

C. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 for turf and grasses.
2. Section 32 93 13 for other ground cover.

D. Repair public and private facilities damaged by CONTRACTOR.

END OF SECTION

SECTION 33 05 20
BACKFILLING TRENCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Backfill materials in trenches and backfilling requirements.

1.2 REFERENCES

A. **APWA (Utah) Standards**:

Plan 381 Trench backfill

Plan 382 Pipe zone backfill

B. **ASTM Standards**:

D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

D1557 Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D4832 Preparation and Testing of Soil-Cement Slurry Test Cylinders.

1.3 DEFINITIONS

A. **Bedding**: That surface of the excavation or portion of the Pipe Zone below the pipe.

B. **Pipe Zone**: That zone in a backfilling operation which supports, and surrounds the pipe barrel, and extends to 1 foot above the top of the pipe barrel.

1.4 SUBMITTALS

A. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material, and
2. Each type of fill to be used.

B. Submit aggregate batch delivery tickets showing name of material source, serial number of ticket, date and truck number, name of Supplier, job name and location, volume or weight. And aggregate classification or Supplier's identification code.

1.5 QUALITY ASSURANCE

A. Do not change material sources, or aggregate without ENGINEER's knowledge.

B. Reject backfill material that does not comply with requirements in this Section.

C. If requested, submit a quality control inspections and testing report describing source and field quality control activities performed by CONTRACTOR and Suppliers.

1.6 STORAGE

A. Safely stockpile backfill materials.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

1.7 SITE CONDITIONS

A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.

B. Control traffic and erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.

C. Reshape and compact damaged structural section to required density.

D. Restore any damaged structure to its original strength and condition.

E. Replace contaminated backfill at no additional cost to OWNER.

1.8 SEQUENCING

A. Coordinate backfilling operation with pipeline commissioning, Section 33 08 00.

1.9 **ACCEPTANCE**

A. General: Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.

B. Material: For material acceptance refer to:

1. Common fill, Section 31 05 13.
2. Aggregate base course, Section 32 11 23.
3. Cement treated fill, Section 31 05 15.

C. Lift Thickness: One test per lot.

D. Compaction: One test per lot. Verify density using nuclear tests, ASTM D2922. Compaction standard and Lot sizes as follows:

Table 1: Compaction Standard and Lot Size

Material	Proctor	Lot Size
Subgrade	Standard	200 linear feet
Common Fill	Standard	200 linear feet per lift 25 square feet of footing area per lift
Aggregate base course	Modified	200 linear feet per lift 25 square feet of footing area per lift

NOTES
(a) Standard proctor, ASTM D698.
(b) Modified proctor, ASTM D1557.
(c) Lift thickness above pipe zone before compaction, 8 inches.

E. Flowable Fill Strength: Lot size is one (1) day production with sub-lots of 50 cubic yards or part thereof. Verify strength using cylinders, ASTM D4832.

F. Grade, Cross Slope: Measured at random locations.

1.10 **WARRANTY**

A. Correct any settlement of Trench backfill or structures built over Trench backfill at no cost to OWNER.

B. Restore structures damaged by settlement at no additional cost to OWNER.

PART 2 PRODUCTS

2.1 **BACKFILL MATERIALS**

A. Common fill, Section 31 05 13. Granular material, CONTRACTOR's choice.

B. Aggregate base course, Section 32 11 23. Untreated base course.

C. Cement treated fill, Section 31 05 15. Use a flowable fill so vibration is not required.

D. Slag or bitumen bearing material NOT ALLOWED in trench.

2.2 **WATER**

A. Make arrangements for sources of water during construction and make arrangements for delivery of water to site.

B. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.

2.3 **GEOTEXTILE FABRIC**

A. Section 31 05 19. Use woven or non-woven stabilization-separation fabric. Select either moderate MARV or high MARV as needed.

2.4 **IDENTIFICATION TAPE**

A. Permanent, bright colored, continuous printed magnetic plastic tape, intended for direct burial service; not less than six (6) inches wide by four (4) mils thick. Tape shall read "**CAUTION: BURIED INSTALLATION BELOW**". Color as follows.

Red	Electric power lines, cables, conduit and lighting cables
Yellow	Gas, oil, steam, petroleum or gaseous materials
Orange	Communications, alarm, signal, cables or conduits
Blue	Potable water
Purple	Reclaimed water, irrigation and slurry lines
Green	Sewer and storm drain lines

PART 3 EXECUTION

3.1 **PREPARATION**

A. Implement traffic control plan requirements, Section 01 55 26.

B. Identify required line, levels, contours, and datum.

C. Stake and flag locations of underground utilities.

D. Verify:

1. Backfill material meets gradation requirements.
2. Foundation walls are braced to support surcharge forces imposed by backfilling operations, areas to be backfilled are free of debris, snow, ice or water.
3. Trench bottom is not frozen.

E. If ground water is in the intended backfill zone, dewater.

3.2 **SUBGRADE**

A. Protect subgrade from desiccation, flooding, and freezing.

B. Before backfilling over Subgrade, get ENGINEER's review of Subgrade surface preparations.

C. If Subgrade is not readily compactable, get ENGINEER's permission to stabilize the subgrade:

1. Excavation for Subgrade stabilization is incidental work, Section 31 23 16.
2. Place geotextile fabric. Place acceptable fill in lifts. Compact.

3.3 **PROTECTION**

A. During installation or repair, plug end of pipe or fitting except when installing next section of pipe or fitting.

B. Movement of construction machinery over Work at any stage of construction is solely at CONTRACTOR's risk.

3.4 **BACKFILLING - GENERAL**

A. Avoid injuring and displacement of conduit, pipe and structures while compacting soil or operating equipment next to pipeline.

B. Place geotextile fabrics; Section 31 05 19.

C. Do not damage corrosion protection on pipe.

D. Repair or replace damaged pipe at no additional cost to OWNER.

E. Withdraw sheathing, shoring, piles, and similar supports as backfilling progresses. Backfill and compact all holes left by removals.

F. Provide sufficient water quality facilities to protect downstream fish and wildlife, and to meet State water quality requirements.

G. Water settling of trench backfill is not permitted. "Jetting" of trench backfill is prohibited.

3.5 BACKFILLING - PIPE ZONE

A. As shown in the Drawings or APWA Plan 382.

B. Maintain uniform foundation along barrel of pipe with sufficient relief for joint connections.

C. Use backfill materials meeting pipe manufacturer's recommendations. Maximum backfill particle size is 3/4 inch for plastic pipe.

D. Do not permit free fall of backfill material that may damage pipe, pipe finish, or pipe alignment.

E. Except where piping must remain exposed for tests, fill pipe zone as soon as possible.

3.6 BACKFILLING -ABOVE PIPE ZONE.

A. As shown in the Drawings or APWA Plan 381.

B. Maximum lift thickness before compaction is eight (8) inches.

C. Fill unauthorized excavations with material acceptable to ENGINEER at no additional cost to OWNER.

D. Do not damage adjacent structures or service lines.

E. Install continuous identification tape directly over buried lines 18 inches below finished grade.

3.7 BACKFILLING - MODIFIED LAYER METHOD

A. At discretion of CONTRACTOR, backfill may be placed in thicker layers than indicated above subject to the following provisions:

1. CONTRACTOR proves the ability of proposed method to achieve specified average compaction density.
2. ENGINEER, on the basis of test results, approves the system in writing.

B. Should CONTRACTOR find it necessary to change the method or any part of it, including the source of material, or the rate of placing the material, obtain approval of ENGINEER, who may require a further trial area.

C. If testing shows a previously approved system is no longer producing the required degree of compaction, make changes to comply.

D. Where vibration effects are creating environmental problems, make changes to eliminate problems.

3.8 TOLERANCES

A. Compaction: Ninety-five (95) percent or greater relative to a standard or modified proctor density, Section 31 23 26.

B. Lift Thickness (before compaction):

1. Eight (8) inches when using riding compaction equipment.
2. Six (6) inches when using hand held compaction equipment.
3. As proven in the modified backfill layer method.

C. Cement Treated Fill: Compressive strength targets are 60 psi in 28 days and 90 psi maximum in 28 days.

3.9 FIELD QUALITY CONTROL

A. Test trench backfilling until a compaction pattern acceptable to CONTRACTOR and ENGINEER is achieved. Continue random quality control compaction testing.

3.10 SURFACE FINISHING

A. Provide temporary paved surfaces where trenches pass through roadways, driveway approaches or sidewalks.

B. Restore paved surfaces, Section 33 05 25.

C. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 for turf and grasses.
2. Section 32 93 13 for other ground cover.

D. Repair public and private facilities damaged by CONTRACTOR.

3.11 CLEANING

A. Remove stockpiles from site when work is complete. Grade site to prevent free standing surface water.

B. Leave borrow areas clean and neat.

END OF SECTION

SECTION 33 05 23.35

TRENCHLESS UTILITY INSTALLATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Boring or jacking pipe or box culvert.

1.2 REFERENCES

A. ASTM Standards:

A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

1.3 SUBMITTALS

A. Details of jacking pit bracing, casing or conduit, and jacking head to be used.

B. Dimensions and support of pilot tunnel (if used).

C. Details of steel rails in pilot tunnel (if used), including true line and grade.

D. Copy of applicable permits from agency having jurisdiction.

1.4 PERFORMANCE REQUIREMENTS

A. Jack conduit to line and grade indicated. Modify jacking operation to correct any deviation. Correct misalignment in line or grade at no additional cost to OWNER.

B. Methods and equipment used in jacking casing or conduit are CONTRACTOR's choice.

C. Use workers experienced in jacking operations.

PART 2 PRODUCTS

2.1 STEEL CASING

A. ASTM A53, Grade B steel pipe for jacking operations, minimum wall thickness of 0.375 inch, minimum yield stress of 42,000 psi. Use a casing with a diameter equal to the outside bell diameter of the pipe plus four (4) inches minimum.

B. Fillet weld joints continuous around casing and reinforce joints to withstand jacking operations.

2.2 CONCRETE PIPE

A. Section 33 05 02. When concrete pipe is to be jacked, use a pipe section designed to support the superimposed loads and the loads that may be placed upon the pipe during jacking operations. Use pipe sections that have a watertight joint.

2.3 SOIL CEMENT

A. Cement treated fill, Section 31 05 15.

B. Grout: Portland cement type, Section 03 61 00.

PART 3 EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities, Section 31 23 16.

3.2 JACKING PROCEDURE

A. When casing is to be jacked through a plastic clay, continue uninterrupted operations until casing has been jacked between specified limits.

B. Equip leading section of casing with a jacking head securely attached to prevent any wobble or variation in alignment during jacking operation.

C. Protect driving end against spalling or other damage, and install sufficient bearing shims to intermediate joints to properly distribute jacking stresses. Remove and replace any section showing signs of failure.

D. No excavation in excess of outer dimensions of conduit being jacked will be allowed unless approved. Avoid any loss of earth outside jacking head.

E. Upon completion of jacking operations, pressure grout voids around outside face of the conduit. Grouting around jacked conduit must be started immediately after jacking operations have finished.

F. During the jacking operation, backpack with soil cement any annular space occurring outside of conduit that could affect any surface structure or facility.

3.3 PILOT TUNNEL

A. Construct tunnel where casing 60 inches or greater inside diameter is to be jacked for a distance greater than 32 feet.

B. Remove supports for tunnels as jacking progresses.

3.4 PIPE SUPPORT IN CASING TUNNEL

A. Unless indicated otherwise, use redwood skids throughout the length of the pipe tied at every pipe diameter length to brace pipe installed in casing to prevent shifting or flotation during backfilling of annular ring between the casing and carrier pipe.

B. Backfill annular ring with Portland cement grout, Section 03 61 00 unless indicated otherwise.

C. Install pipe barrels to rest upon support blocks with the pipe bells clearing the casing invert by at least 1/2 inch.

D. Whenever clay pipe is installed in a casing, use mechanical compression joints.

END OF SECTION

SECTION 33 05 25
PAVEMENT RESTORATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate base restoration.

B. Concrete base restoration.

C. Pavement surface restoration.

1.2 REFERENCES

A. **APWA (Utah) Standards**:

Plan 255 Bituminous pavement T-patch.

Plan 256 Concrete pavement patch.

B. **ACI Standards**:

305 Hot Weather Concreting.

306 Cold Weather Concreting.

C. **ASTM Standards**:

A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

C928 Packaged, Dry, Rapid- Hardening Cementitious Materials for Concrete Repairs.

C1315 Liquid Membrane Forming Compounds Having Special Properties for Curing and Sealing Concrete.

D4 Bitumen Content.

D5 Penetration of Bituminous Materials.

D92 Flash and Fire Points by Cleveland Open Cup.

D95 Water in Petroleum products and Bituminous Materials by Distillation.

D113 Ductility of Bituminous Materials.

D402 Distillation of Cut-Back Asphaltic (Bituminous) Products.

D1664 Coating and Stripping of Bitumen-Aggregate Mixtures.

D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.

D2170 Kinematic Viscosity of Asphalts (Bitumens).

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. Target sieve gradation for aggregate base.

C. Bituminous pavement mix design.

D. Portland cement concrete mix design and data sheets for joint filler board, concrete joint sealer, concrete bond breaker, concrete chemical additives, curing agent, and reinforcement.

1.4 WEATHER

A. Bituminous Pavement Restoration:

1. If air and roadbed temperatures in the shade are less than 40 deg F placement is considered a temporary patch.

2. Remove any temporary patching and provide permanent patch material when temperature exceeds 40 deg F. CONTRACTOR may perform work after cold weather season if authorized in writing by ENGINEER.

B. Portland Cement Concrete Pavement Restoration:

1. Hot weather, ACI 305. Set retarding admixture may be used if allowed in mix design. Discontinue placement if ambient air temperature exceeds 100 deg F. in the shade.

2. Cold weather, ACI 306. Concrete accelerating admixtures may be used if allowed in mix design. Provide weather protection until 90 percent of design compressive strength. When removing heat, limit temperature changes next to concrete surface to 20 deg F. per 12 hours until the concrete surface temperature reaches ambient.
   a. Use of admixtures or curing agent will not relax cold weather placement and cure requirements.
   b. Do not use chemical additives to prevent freezing.
   c. Prevent loss of moisture during protection.

1.5 **ACCEPTANCE**

A. Aggregate Base: Compaction.

B. Concrete Base: Strength.

C. Bituminous Pavement:
1. Compaction.
2. Grade and cross slope of pavement surface.
3. Surface distortion.

D. Concrete Pavement:
1. Reinforcement placement and concrete strength.
2. Grade and cross slope of pavement surface.
3. Surface distortion.

PART 2 PRODUCTS

2.1 **MATERIALS**

A. Aggregate Base: Untreated base course material, Section 32 11 23.

B. Flowable Fill Base: Section 31 05 15.

C. Portland Cement Concrete Base Course: Class 4000, Section 03 30 04.

D. Tack Coat: Grade SS-1, Section 32 12 13.13.

E. Permanent Marking: Tape or paint, Section 32 17 23.

2.2 **BITUMINOUS PAVEMENT**

A. Permanent Warm Weather Bituminous Concrete: PG64-22, DM-1/2, 50 blow, Section 32 12 05 unless indicated elsewhere.

B. Temporary Cold Weather Bituminous Concrete Patching Material: Type MC250, DM-1/2, 50 blow, Section 32 12 05 with hydrated lime or anti-strip agent as indicated in the mix design.

C. Pavement Sealing:
1. Slurry Seal: SS Type II - RS-1, Section 32 01 13.61.
2. Chip Seal: MC-250. CS-A, Section 32 01 13.64.
3. Fog Seal: Section 32 01 13.50.

2.3 **CONCRETE PAVEMENT**

A. Chairs, Bolsters, Bar Supports, Spacers: Section 03 20 00.

B. Bond Breaker: Paraffin wax, lithium grease, or other semi-solid, inert lubricant.

C. Fillers and Sealer: Section 32 13 73:
1. Expansion joint filler, F1 sheet 1/2 inch thick.
2. Contraction joint filler, closed cell Type 1 round backer rod.
3. Contraction joint sealer, HAS1 or HAS4 hot applied.

D. Adhesive Grout: Epoxy gel type II; Section 03 61 00.

E. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel, ASTM A615:

1. Dowel Bar: Smooth.
2. Tie Bar: Deformed.
3. Mat: Deformed.

F. Normal Set Concrete: Class 4000, Section 03 30 04. Slump range per mix design.

G. High Early Strength Concrete: Quick set.

1. Slump range per mix design, Section 03 30 04:
2. Concrete compressive strength of 3,000 psi minimum in four (4) hours.
3. Cementitious Material: Rapid hardening or very rapid hardening, ASTM C928.
4. Cement content of mix, per cement manufacturer's recommendations or approved mix design.
5. Non-reactive aggregates in applications subjected to wetting, extended exposure to humid atmosphere, or contact with moist ground.

H. Curing and Sealing Compound: Membrane type, ASTM C1315:

1. Type II Class A or B (white pigmented) for roadway pavement.
2. Clear with red fugitive dye for concrete flat work.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Paver: Use bituminous concrete lay-down machine for final lift if surface restoration is over a trench in the direction of traffic flow or if trench is a wide surface excavation.

3.2 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26.

B. At site, post name, address and telephone number of CONTRACTOR to contact in emergencies.

C. Notify ENGINEER within 24 hours of commencing work of this Section but not less than four (4) hours.

D. Cutting Pavements: Cut full depth and straight, Section 02 41 14. Remove all bonding inhibitors.

3.3 AGGREGATE BASE

A. Match depth of existing aggregate base or at least eight (8) inches thick.

B. Place lifts not exceeding eight (8) inches before compaction. Compact each lift to 95 percent or greater relative to a modified proctor density.

3.4 CONCRETE SUBSTRATE

A. Match existing substrate thickness.

B. Apply concrete bonding compound, Section 03 30 10, to edge of existing concrete.

C. Place concrete, Section 03 30 10.

3.5 BITUMINOUS PAVEMENT RESTORATION

A. Restore aggregate base and bituminous surface as shown in the Drawings or APWA Plan 255 Sheet 1 or Sheet 2.

B. Match existing pavement thickness plus 1 inch, but not less than four (4) inches. Maximum thickness is six (6) inches in residential areas and eight (8) inches in non-residential areas.

C. Clean all vertical surfaces that butt against new patchwork. Provide full coverage spray tack coat. Do not spray tack coat on surfaces exposed to public view. Do not apply tack coat by brush.

D. Place bituminous pavement in lifts not less than three (3) inches after compaction. Compact to 94 percent of ASTM D2041 (Rice density) plus or minus two (2) percent.

E. Match adjacent surface slopes.

F. Use lay-down machine for final lift if trench is in direction of traffic flow.

3.6 CONCRETE PAVEMENT RESTORATION

A. **Full Depth Restoration:**

1. Restore Portland cement concrete pavement and its aggregate base as shown in the drawings or APWA Plan 256 Sheet 1 or Sheet 2.
2. In vertical load bearing joints, clean vertical surfaces and install tie-bars or dowels. Apply concrete bonding compound, Section 03 30 10.
3. Place concrete. Prevent segregation.
4. Match adjacent surface slopes. Match adjacent surface texture.
5. Saw cut contraction joints.

B. **Partial Depth Restoration:**

1. Chip, hydro-blast or saw cut concrete at least one (1) inch below surface to be replaced.
2. Make prepared surface free of frost, ice, mud, water, grease, dirt and other materials that hamper bonding.
3. Install bonding agent per manufacturer's recommendations.
4. Place concrete. Prevent segregation.
5. Match adjacent surface slopes and surface texture.

C. **Cure:**

1. Protect restoration work from hot or cold weather. Immediately after placement and texturing, apply a membrane forming compound.ASTM C1315 and Section 03 39 00. Apply total coverage in two (2) directions.
2. Eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete patch.

D. Traffic: Not allowed on the repaired area until concrete strength is achieved.

3.7 CONCRETE PAVERS

A. Screed bedding with a notched and cambered screed board to achieve a crown between existing pavers. Use graded aggregate, geotextile, and bedding sand, Section 32 14 13.

B. After placement, use a plate-type vibrating compactor to compact pavers. Size compactor to provide at least 5,000 lbf force. Sweep joint sand into the joints and vibrate until joints are full. Remove excess joint sand.

C. Match adjacent surface grades with no more than ¼-inch vertical deviation in 10 feet.

3.8 TOLERANCE

A. 1/4 inch vertical deviation from design elevation in 10 feet.

B. Match adjacent surface slopes.

3.9 PAVEMENT MARKINGS

A. Unless indicated otherwise, repair all damaged Pavement markings with matching material types and installation.

3.10 REPAIR

A. Remove bumps and depressions exceeding ¼-inch vertical deviation in 10 feet.

B. Bituminous Pavement: Repair options include mill-and-inlay, or grinding. Feather edges on bituminous concrete repairs are not allowed. Apply a cationic or anionic tack emulsion to make milled surfaces water resistant.

C. Concrete Pavement: Repair options include grinding, or slab replacement. Apply a water repelling product over surfaces that are ground to make the surfaces water resistant. Repair or replace any slab that cracks, shrinks, or otherwise fails. Do not allow traffic on repaired area until concrete strength is achieved.

END OF SECTION

SECTION 33 31 00
SANITARY SEWERAGE SYSTEMS

PART 1 GENERAL

1.1 **SECTION INCLUDES**

A. Installation of a buried non-pressure sanitary sewer pipe system.

B. Refer to Section 33 11 00 if installation is a pressurized pipe system.

1.2 **REFERENCES**

A **APWA (Utah) Standards**:

Plan 255 Bituminous concrete T-patch

Plan 256 Concrete pavement patch

Plan 381 Trench backfill

Plan 382 Pipe zone backfill

Plan 411 Sanitary sewer manhole

Plan 431 Sewer lateral connection

Plan 432 Sewer lateral relocation.

Plan 433 Pipe drop.

B. **ASTM Standards**:

C478 Precast Reinforced Concrete Manhole Section.

C891 Installation of Underground Precast Concrete Utility Structures.

C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

1.3 **DEFINITIONS**

A. **Non-pressure Pipe System**: Defined in Section 33 41 00.

1.4 **PERFORMANCE REQUIREMENTS**

A. Vertical Cover: Unless indicated otherwise, provide at least two (2) feet of protection cover during construction.

B. Remove any section of pipe already placed that is found to be out of alignment tolerance, defective, or damaged. Relay or replace at no additional cost to OWNER.

1.5 **SUBMITTALS**

A. Product data: Submit manufacturer's technical product data and installation instructions.

B. Commissioning: Provide Section 33 08 00 submittals.

1.6 **SITE CONDITIONS**

A. Minimize neighborhood traffic interruptions. Barricade stockpiles.

B. Provide access to adjacent properties for local traffic and pedestrians, Section 01 31 13.

1.7 **ACCEPTANCE**

A. Each sanitary sewer system component must pass applicable commissioning requirements in Section 33 08 00.

PART 2 PRODUCTS

2.1 **PIPES AND FITTINGS**

A. Provide piping materials and factory fabricated piping products of sizes, types, and classes required.

B. Where not indicated, select product acceptable to ENGINEER and comply with installation requirements.

C. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

2.2 **MORTAR, GROUT AND CONCRETE**

A. Portland cement mortar, Section 04 05 16.

B. Non-shrink grout, Section 03 61 00.

C. Concrete:

1. Cast-in-place: Section 03 30 04.
2. Precast Concrete: Section 03 40 00.

2.3 **MANHOLES**

A. Basin: Concrete floor and walls, or ASTM C478 precast concrete.

B. Steps: None.

C. Top: Concentric cone. Concentric flat slab concrete deck allowed only with ENGINEER's permission.

D. Frame and Cover: Scoriated, asphalt coated, heavy duty, ductile iron Section 05 56 00, with flat top design meeting load rating H-20 and appropriate utility lettering. Shape, size and lifting device as necessary.

E. Pipe Connectors:

1. Precast Bases: Resilient, ASTM C923. Sand mortar grout pipe connections.
2. Cast in Place or Connections to Existing Fixture with Plastic Pipe: Use rubber adapter gasket for precast sections. Grout, Section 03 61 00 for cast in place sections.

F. Joints in Sections: Bituminous mastic gasket-type sealant or otherwise acceptable to ENGINEER.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Verify Trench Excavation is ready to receive work, and dimensions, and elevations are correct. Commencing installation means acceptance of existing conditions.

B. Hand trim excavations to required elevations. Backfill over excavations and compact, Section 31 23 26.

C. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.

D. Clearly identify and promptly set aside defective or damaged pipe.

E. Use pipe cutting tool acceptable to pipe manufacturer.

3.2 **ABANDONED UTILITIES**

A. Use concrete to plug and cap openings in abandoned underground utilities that are to remain in place.

B. Provide closures to withstand hydrostatic or earth pressure that may result after abandoned utilities have been closed.

3.3 **INSTALLATION - PIPE AND FITTINGS**

A. Protect sanitary sewer pipe crossings as shown in the Drawings or APWA Plan 373.

B. Relocate sanitary sewer laterals as shown in the Drawings or APWA Plan 432.

C. Install pipe and fittings as shown in the Drawings or APWA Plan 382 and 433.

D. Place bell or groove end facing upstream.

E. Install gaskets per manufacturer's recommendations.

F. Plug pipeline branches, stubs or other open ends that are not to be immediately connected.

G. Clean interior of pipe of dirt and debris as work progresses.

H. Meet line and grade tolerance in Section 33 08 00. Use a laser device or demonstrate an equivalent method of establishing line and grade.

3.4 **INSTALLATION - JOINTS**

A. Join pipe per manufacturer's recommendation.

B. Join pipe of different sizes at manholes only.

C. Use neoprene couplings with stainless steel bands to make connections between dissimilar pipe, or where standard pipeline joints are impractical.

3.5 INSTALLATION - MANHOLES

A. Install manholes as shown in the Drawings or APWA Plan 411.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Place structures in location indicated.

D. Provide elevations and pipe inverts for inlets and outlets indicated.

E. When structures occur in Pavements, mount frame and cover 1/2 inch below finished surface. Provide a concrete Cover Collar between the frame and bituminous Pavement. Elsewhere set frame and cover three (3) inches above finished grade.

3.6 INSTALLATION - TAP CONNECTIONS-6 INCHES AND SMALLER

A. Install connections as shown in the Drawings or APWA Plan 431.

B. Field cutting into new or existing piping will not be permitted unless written permission is obtained from ENGINEER.

C. Make connections to existing pipe and underground structures, so connections will conform as nearly as practicable to requirements specified for new work.

D. Use commercially manufactured wyes for branch connections. Spring wyes into existing line and encase entire wye, plus six (6) inches overlap, with not less than six (6) inches of concrete.

E. For taps into existing 24 inches or larger piping, or to underground structures, cut opening into unit sufficiently large to allow three (3) inches of concrete to be packed around entering connection. Cut ends of connection passing through pipe or structure wall to conform to shape of and parallel with inside wall, unless otherwise indicated. Grout connection to provide smooth transition inlet into pipe.

3.7 INSTALLATION - TAP CONNECTIONS-LARGER THAN 6 INCHES

A. Not allowed. Where laterals are larger than 6-inches, install a Manhole structure as shown in the Drawings or APWA Plan 411.

3.8 BACKFILLING

A. Trench Backfill: Section 33 05 20. Restor pavement patches as shown in the Drawings or the following.

1. APWA Plan 382 for pipe zone backfill.
2. APWA Plan 381 for trench backfill above pipe zone.

B. Landscape and Structural Backfill: Place backfill per Section 31 23 23. Provide product and placement indicated.

C. Repair public and private facilities damaged by CONTRACTOR.

3.9 SURFACE FINISHING

A. Roadway Trenches and Patches: Restore pavement patches per Section 33 05 25. Provide product and placement indicated in the following standard plans.

1. APWA Plan 255 for bituminous pavement T-patch.
2. APWA Plan 256 for Portland cement concrete pavement patch.

B. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 for turf and grass cover.
2. Section 32 93 13 for other ground cover.

C. Repair public and private facilities damaged by CONTRACTOR.

3.10 COMMISSIONING

A. Before surface finishing, commission pipeline per Section 33 08 00. Provide sizes and types of equipment connections and fittings that match pipe materials when pressure testing system.

B. If paved surfaces must be kept open prior to commissioning, provide temporary paved surfaces.

3.11 CLEANING

A. Remove debris, concrete, or other extraneous material that accumulates in existing pipes or structures.

B. Clean all pipelines after testing. Do not flush sand, gravel, concrete, debris or other materials into existing piping systems.

END OF SECTION

SECTION 33 41 00
DRAINAGE SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Installation of a buried non-pressure pipe system such as a storm drain, a sub-drain, irrigation, etc.

B. If the system is pressurized, refer to Section 33 11 00 or Section 32 84 32 as applicable.

1.2 REFERENCES

A. **APWA (Utah) Standards**:

Plan 255 Bituminous concrete T-patch

Plan 256 Concrete pavement patch

Plan 315 Catch basin (single or double grate)

Plan 317 Curb face inlet box

Plan 322 Curb face outlet box

Plan 323 Pipe outfall

Plan 331 Cleanout box

Plan 341 Precast manhole

Plan 372 Area drain

Plan 373 Concrete pier

Plan 381 Trench backfill

Plan 382 Pipe zone backfill

Plan 611 Curb face inlet – irrigation

Plan 613 Irrigation diversion box

Plan 614 Irrigation diversion box

B. **ASTM Standards**:

C 478 Precast Reinforced Concrete Manhole Section.

C 923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

1.3 DEFINITIONS

A. **Non-pressure Pipe System**: Pipelines with joints that have no leakage after a sustained hydraulic pressure not exceeding 10.8 psi (22 in. Hg) for 10 minutes or a sustained vacuum pressure not exceeding 3 kPa (5 in. Hg) for 10-minutes.

1.4 PERFORMANCE REQUIREMENTS

A. Vertical Cover: Unless indicated otherwise, provide at least two (2) feet of protection cover during construction.

B. Remove any section of pipe already placed that is found to be out of alignment tolerance, defective, or damaged. Relay or replace without additional cost to OWNER.

1.5 SUBMITTALS

A. Product data: Submit manufacturer's technical product data and installation instructions.

B. Commissioning: Provide Section 33 08 00 submittals.

1.6 SITE CONDITIONS

A. Minimize neighborhood traffic interruptions. Barricade stockpiles.

B. Provide access to adjacent properties for local traffic and pedestrians, Section 01 31 13.

1.7 **ACCEPTANCE**

A. Each drainage system component must pass applicable commissioning requirements in Section 33 08 00.

PART 2 PRODUCTS

2.1 **PIPES AND FITTINGS**

A. Provide piping materials and factory fabricated piping products of sizes, types, and classes required.

B. Where not indicated, select product acceptable to ENGINEER and comply with installation requirements.

C. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

2.2 **IN-PLANE WALL DRAINAGE**

A. Drainage Core: Manufacturer's standard three-dimensional non-biodegradable, plastic designed to effectively conduct water to foundation drainage system.

B. Filter Fabric: Manufacturer's standard non-woven geotextile fabric of polypropylene or polyester fibers, or combination.

2.3 **SUB DRAIN FILL MATERIALS**

A. Sewer rock, Section 32 11 23 and geotextile, Section 31 05 19.

2.4 **MORTAR, GROUT AND CONCRETE**

A. Portland cement mortar, Section 04 05 16.

B. Non-shrink grout, Section 03 61 00.

C. Concrete:

1. Cast-in-place: Section 03 30 04.
2. Precast Concrete: Section 03 40 00.

2.5 **MANHOLES**

A. Basin: Concrete floor with cast in place concrete walls or ASTM C478 precast concrete.

B. Steps: None.

C. Top: Concentric cone. Concentric flat slab concrete deck allowed only with ENGINEER's permission.

D. Frame and Cover: Scoriated, asphalt coated, heavy duty, ductile iron Section 05 56 00, with flat top design meeting load rating H-20 and appropriate utility lettering. Shape, size and lifting device as necessary.

E. Pipe Connectors:

1. Precast Bases: Resilient, ASTM C923. Sand mortar grout pipe connections.
2. Cast in Place or Connections to Existing Fixture with Plastic Pipe: Use rubber adapter gasket for precast sections. Grout, Section 03 61 00 for cast in place sections.

F. Joints in Sections: Bituminous mastic gasket-type sealant or otherwise acceptable to ENGINEER.

2.6 **INLETS, CATCH BASINS, CLEANOUTS**

A. Basin: Concrete floor and walls.

B. Pipe Connectors: Resilient, ASTM C923. Sand mortar grout.

C. Frame and Grate:

1. Asphalt coated, heavy duty, cast iron, Section 05 56 00. Shape and size indicated.
2. Galvanized, heavy duty, steel: Sections 05 12 00 and 05 05 10. Shape and size as indicated.

2.7 **OUTFALLS**

A. Cast-in-place or precast concrete with reinforced headwall, apron, and tapered sides. Provide riprap, Section 31 37 00, if indicated.

2.8 **DRAIN PIPE JOINT SCREENS**

A. Heavy mesh burlap, coal-tar saturated felt, 18 to 14 mesh copper screening or synthetic drainage fabric.

B. Plastic or corrosion resistant metal bands.

2.9 **PRECAST BOX**

A. Reinforced class 5000 concrete.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Verify Trench Excavation is ready to receive work, and dimensions, and elevations are correct. Commencing installation means acceptance of existing conditions.

B. Hand trim excavations to required elevations. Backfill over excavations and compact, Section 31 23 26.

C. Remove stones larger than two (2) inches or other hard matter that could damage pipe or impede backfilling or compaction.

D. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.

E. Clearly identify and promptly set aside defective or damaged pipe.

F. Use pipe cutting tool acceptable to pipe manufacturer.

3.2 **ABANDONED UTILITIES**

A. Use concrete to plug and cap open ends of abandoned underground utilities that are to remain in place.

B. Provide closures to withstand hydrostatic or earth pressure that may result after ends of abandoned utilities have been closed.

3.3 **INSTALLATION - PIPE AND FITTINGS**

A. Protect sanitary sewer pope crossings as shown in the Drawings or APWA Plan 373.

B. Place bell or groove end facing upstream.

C. Install gaskets per manufacturer's recommendations.

D. Plug pipeline branches, stubs or other open ends that are not to be immediately connected.

E. Clean interior of pipe of dirt and debris as work progresses.

F. Insulate dissimilar metals from direct contact with each other using neoprene gaskets or asphalt coatings.

G. Meet line and grade tolerance in Section 33 08 00. Use a laser device or demonstrate an equivalent method of establishing line and grade

3.4 I**NSTALLATION - JOINTS**

A. Join pipe per manufacturer's recommendation.

B. Join pipe of different sizes at manholes or cleanouts only.

C. Use neoprene couplings with stainless steel bands to make connections between dissimilar pipe, or where standard pipeline joints are impractical.

3.5 **INSTALLATION - MANHOLES**

A. Install manholes as shown in the Drawings or APWA Plan 341.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Place structures in location indicated.

D. Provide elevations and pipe inverts for inlets and outlets indicated.

E. When structures occur in Pavements, mount frame and cover 1/2 inch below finished surface. Provide a concrete Cover Collar between the frame and bituminous concrete pavement. Elsewhere set frame and cover three (3) inches above finished grade.

3.6 INSTALLATION - INLETS, CATCH BASINS, CLEANOUTS

A. Install inlets, catch basins, or cleanouts as shown in the Drawings or APWA Plans 315, 316, 317, 331, 332 and 611.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Construct with all connecting piping and appurtenances in their final position.

D. Cut all piping parallel to interior surface wall. Grout connection to provide smooth transition inlet into pipe.

3.7 INSTALLATION SUB DRAIN SYSTEMS

A. Install pipe and fittings per manufacturer's requirements.

B. Open Joint Systems: Loosely butt pipe ends. Place 12 inches wide filter fabric around pipe circumference, centered over joint.

C. Mechanical Joint Perforated Pipe System: Place pipe with perforations facing down.

D. Place drainage pipe on bed of sewer rock, Section 31 05 13.

3.8 INSTALLATION - TAP CONNECTIONS

A. Not allowed in storm drain systems. Provide a cleanout or manhole structure.

3.9 INSTALLATION - OUTFALLS

A. Install outfalls as shown in the Drawings or APWA Plans 322 and 323.

3.10 INSTALLATION – DIVERSION BOXES AND AREA DRAINS

A. Install boxes and drains as shown in the Drawings or APWA Plans 613, 614 and 372.

3.11 BACKFILLING

A. Trench Backfill: Section 33 05 20. Place backfill as shown in the Drawings or the following.

1. APWA Plan 382 in the pipe zone.
2. APWA Plan 381 above the pipe zone.

B. Structural Backfill: Section 31 23 23.

3.12 SURFACE FINISHING

A. Roadway Trenches and Patches: Restore pavement patches per Section 33 05 25. Provide product and placement indicated in the following standard plans.

1. APWA Plan 255 for bituminous pavement T-patch.
2. APWA Plan 256 for concrete pavement patch.

B. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 for turf and grass cover.
2. Section 32 93 13 for other ground cover.

C. Repair public and private facilities damaged by CONTRACTOR.

3.13 COMMISSIONING

A. Before surface finishing, commission pipeline per Section 33 08 00. Provide sizes and types of equipment connections and fittings that match pipe materials when pressure testing system.

B. If paved surfaces must be kept open prior to commissioning, provide temporary paved surfaces.

3.14 CLEANING

A. Remove debris, concrete, or other extraneous material that accumulates in existing piping or structures.

B. Clean all pipelines after testing. Do not flush sand, gravel, concrete, debris or other materials into existing piping systems.

END OF SECTION

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