

SECTION 01100 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: The "EXTENSION OF BISSARIYEH SEWAGE NETWORK" project comprises the construction, completion and maintenance during the defects liability period of a sewage network located in Bissariyeh, Saida, South Lebanon.
- B. Scope of Works consist of the construction, completion and maintenance during the defects liability period of the sewage network.
 - 1. The Work includes structural and mechanical disciplines as defined in the drawings.

1.3 CONTRACT

- A. Project will be constructed under the conditions of contract stated in the tender documents.
 - 1. Name of Contract: "EXTENSION OF BISSARIYEH SEWAGE NETWORK".

1.4 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
 - 1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 - 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for

clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

- a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01100

SECTION 01140 - WORK RESTRICTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 USE OF PREMISES

- A. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
 - 1. Limits: Confine constructions operations to area indicated on drawings.
 - 2. Owner Occupancy: Allow for Owner occupancy of site.
 - 3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.3 OCCUPANCY REQUIREMENTS

- A. Partial Owner Occupancy: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.
 - 1. Engineer will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before Owner occupancy.
 - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
 - 3. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will provide, operate, and maintain mechanical and electrical systems serving occupied portions of building, works or facilities.
 - 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building, works or facilities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01140

SECTION 01310 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Conservation.
 - 3. Coordination Drawings.
 - 4. Administrative and supervisory personnel.
 - 5. Project meetings.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Construction Progress Documentation" for preparing and submitting the Contractor's Construction Schedule.
 - 2. Division 1 Section "Execution Requirements" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Division 1 Section "Closeout Procedures" for coordinating Contract closeout.

1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid

conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
 2. Installation and removal of temporary facilities and controls.
 3. Delivery and processing of submittals.
 4. Progress meetings.
 5. Pre-installation conferences.
 6. Project closeout activities.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Indicate relationship of components shown on separate Shop Drawings.
 2. Indicate required installation sequences.
- B. Staff Names: Within the bid documents (at tender stage), submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

1.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1.6 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within 3 days of the meeting.

- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner Construction Manager and Engineer, but no later than 14 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Construction Manager Engineer, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing.
 - d. Designation of responsible personnel.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for processing Applications for Payment.
 - g. Distribution of the Contract Documents.
 - h. Submittal procedures.
 - i. Preparation of Record Documents.
 - j. Use of the premises.
 - k. Responsibility for temporary facilities and controls.
 - l. Parking availability.
 - m. Office, work, and storage areas.
 - n. Equipment deliveries and priorities.
 - o. First aid.
 - p. Security.
 - q. Progress cleaning.
 - r. Working hours.
- C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer and Construction Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related Change Orders.
 - d. Purchases.
 - e. Deliveries.
 - f. Submittals.
 - g. Review of mockups.
 - h. Possible conflicts.
 - i. Compatibility problems.
 - j. Time schedules.
 - k. Weather limitations.
 - l. Manufacturer's written recommendations.

- m. Warranty requirements.
 - n. Compatibility of materials.
 - o. Acceptability of substrates.
 - p. Temporary facilities and controls.
 - q. Space and access limitations.
 - r. Regulations of authorities having jurisdiction.
 - s. Testing and inspecting requirements.
 - t. Required performance results.
 - u. Protection of construction and personnel.
 - 3. Record significant conference discussions, agreements, and disagreements.
 - 4. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at **weekly** intervals. Coordinate dates of meetings with preparation of payment requests.
- 1. Attendees: In addition to representatives of Owner Construction Manager and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Change Orders.
 - 14) Documentation of information for payment requests.
 - 3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.

- a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01310

SECTION 01320 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Preliminary Construction Schedule.
 - 2. Contractor's Construction Schedule.
 - 3. Submittals Schedule.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Field condition reports.
 - 7. Special reports.
 - 8. Construction photographs.
- B. Related Sections include the following:
 - 1. Division 1 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
 - 2. Division 1 Section "Submittal Procedures" for submitting schedules and reports.
 - 3. Division 1 Section "Quality Requirements" for submitting a schedule of tests and inspections.
 - 4. Division 1 Section "Closeout Procedures" for submitting photographic negatives as Project Record Documents at Project closeout.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 - 2. Predecessor activity is an activity that must be completed before a given activity can be started.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.

- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time belongs to Owner.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- G. Major Area: A story of construction, a separate building, or a similar significant construction element.
- H. Milestone: A key or critical point in time for reference or measurement.
- I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

1.4 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
 - 1. Scheduled date for first submittal.
 - 2. Specification Section number and title.
 - 3. Submittal category (action or informational).
 - 4. Name of subcontractor.
 - 5. Description of the Work covered.
 - 6. Scheduled date for Engineer's final release or approval.
- C. Preliminary Construction Schedule: Submit two printed copies; one a single sheet of reproducible media, and one a print.
- D. Preliminary Network Diagram: Submit two printed copies; one a single sheet of reproducible media, and one a print; large enough to show entire network for entire construction period.
- E. Contractor's Construction Schedule: Submit two printed copies of initial schedule, one a reproducible print and one a blue- or black-line print, large enough to show entire schedule for entire construction period.
 - 1. Submit an electronic copy of schedule, using software indicated, on a CD labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- F. CPM Reports: Concurrent with CPM schedule, submit three printed copies of each of the following computer-generated reports. Format for each activity in reports shall contain

activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Total Float Report: List of all activities sorted in ascending order of total float.
 4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.
- G. Construction Photographs: Submit two prints of each photographic view within seven days of taking photographs.
1. Format: **8-by-10-inch (203-by-254-mm)** smooth-surface matte prints on single-weight commercial-grade stock, mounted on linen or card stock to allow a **1-inch-(25-mm-)** wide margin and enclosed back to back in clear plastic sleeves that are punched for standard 3-ring binder.
 2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Engineer
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 3. Negatives: Submit a complete set of photographic negatives in protective envelopes with each submittal of prints as a Project Record Document. Identify date photographs were taken.
- H. Daily Construction Reports: Submit **two** copies at **weekly** intervals.
- I. Material Location Reports: Submit **two** copies at **weekly** intervals.
- J. Field Condition Reports: Submit **two** copies at time of discovery of differing conditions.
- K. Special Reports: Submit **two** copies at time of unusual event.

1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting.
- B. Photographer Qualifications: An individual of established reputation who has been regularly engaged as a professional photographer for not less than three years.
- C. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing work stages area separations interim milestones and partial Owner occupancy.
4. Review delivery dates for Owner-furnished products.
5. Review schedule for work of Owner's separate contracts.
6. Review time required for review of submittals and resubmittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for completion and startup procedures.
9. Review and finalize list of construction activities to be included in schedule.
10. Review submittal requirements and procedures.
11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from parties involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.
- C. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities including temporary lighting.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 (Twenty) days, unless specifically allowed by Engineer.
 - 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 - 4. Startup and Testing Time: Include not less than 3 days for startup and testing.
 - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
 - 1. Phasing: Arrange list of activities on schedule by phase.
 - 2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 - 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 - 4. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 - 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.

- d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
 - 6. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Permanent space enclosure.
 - c. Completion of mechanical installation.
 - d. Completion of electrical installation.
 - e. Substantial Completion.
 - E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, interim milestones indicated, Substantial Completion, and Final Completion.
 - F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
 - 1. Refer to Division 1 Section "Payment Procedures" for cost reporting and payment procedures.
 - G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.
 - H. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.
 - 1. Primavera (Original Copy) latest version (at year of installation).
 - 2. Microsoft Project (Original Copy) latest version (at year of installation).
- 2.3 PRELIMINARY CONSTRUCTION SCHEDULE
- A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within **seven** days of date established for **the Notice to Proceed**.
 - B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first **60** days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within **30** days of date established for [the Notice to Proceed](#). Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 - 1. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in **10** percent increments within time bar.

2.5 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Preliminary Network Diagram: Submit diagram within **14** days of date established for [the Notice to Proceed](#). Outline significant construction activities for the first **60** days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than **30** days after date established for [the Notice to Proceed](#).
 - 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 4. Use "one workday" as the unit of time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.
 - 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Purchase of materials.
 - c. Delivery.
 - d. Fabrication.
 - e. Installation.
 - 2. Processing: Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 - 3. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

- a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
- E. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:
 - 1. Contractor or subcontractor and the Work or activity.
 - 2. Description of activity.
 - 3. Principal events of activity.
 - 4. Immediate preceding and succeeding activities.
 - 5. Early and late start dates.
 - 6. Early and late finish dates.
 - 7. Activity duration in workdays.
 - 8. Total float or slack time.
 - 9. Average size of workforce.
 - 10. Dollar value of activity (coordinated with the Schedule of Values).
- F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 - 1. Identification of activities that have changed.
 - 2. Changes in early and late start dates.
 - 3. Changes in early and late finish dates.
 - 4. Changes in activity durations in workdays.
 - 5. Changes in the critical path.
 - 6. Changes in total float or slack time.
 - 7. Changes in the Contract Time.
- G. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
 - 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 - 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 - 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 - 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts **one week** before each regularly scheduled progress meeting.

2.6 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 - 1. List of subcontractors at Project site.
 - 2. List of separate contractors at Project site.
 - 3. Approximate count of personnel at Project site.
 - 4. High and low temperatures and general weather conditions.
 - 5. Accidents.

6. Meetings and significant decisions.
 7. Unusual events (refer to special reports).
 8. Stoppages, delays, shortages, and losses.
 9. Meter readings and similar recordings.
 10. Emergency procedures.
 11. Orders and requests of authorities having jurisdiction.
 12. Change Orders received and implemented.
 13. Construction Change Directives received.
 14. Services connected and disconnected.
 15. Equipment or system tests and startups.
 16. Partial Completions and occupancies.
 17. Substantial Completions authorized.
- B. Material Location Reports: At **monthly** intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.7 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At **monthly** intervals, update schedule to reflect actual construction progress and activities. Issue schedule **one week** before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate Actual Completion percentage for each activity.
- C. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

3.2 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified commercial photographer to take construction photographs.
- B. Photographic Camera: Digital: 8 mega pixels, 4 Gb memory stick with SD card pro-duo.
- C. Contractor shall submit soft and hard copy of all photographs taken for the project.
- D. Date: Unless otherwise indicated, date and time shall be included on each photograph as it is being taken so date and time are integral to photograph.
- E. Preconstruction Photographs: Before starting construction, take **four** color photographs of Project site and surrounding properties from different vantage points, as directed by Engineer. Show existing conditions adjacent to property.
- F. Periodic Construction Photographs: Take **four color** photographs monthly, coinciding with cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.
1. Field Office Prints: Retain one set of prints of periodic photographs in field office at Project site, available at all times for reference. Identify photographs the same as for those submitted to Engineer.
- G. Final Completion Construction Photographs: Take **eight** color photographs after date of Substantial Completion for submission as Project Record Documents. **Engineer** will direct photographer for desired vantage points.

END OF SECTION 01320

SECTION 01330 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.
- B. Related Sections include the following:
 - 1. Division 1 Section "Project Management and Coordination" for submitting Coordination Drawings.
 - 2. Division 1 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule and the Submittals Schedule and construction photographs.
 - 3. Division 1 Section "Quality Requirements" for submitting test and inspection reports and Delegated-Design Submittals and for erecting mockups.
 - 4. Division 1 Section "Closeout Procedures" for submitting warranties Project Record Documents and operation and maintenance manuals.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's approval. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURES

- A. General: Electronic copies (.pdf only) of Drawings of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.
- B. Contractor shall submit soft and hard copies of shop drawings which shall be prepared based on the NCS format. Number of copies shall be 3 hard copies and 1 soft copy for each drawing.
- C. All submitted shop drawings shall have at least a 40% enhancement or additional details then that of the Architect's / Engineer's, reflecting types of material already submitted for approval and approved by the Architect / Engineer and reflecting all necessary equipment if any or else the submitted shop drawing shall not be considered as complete.
- D. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- E. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- F. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.
1. Initial Review: Allow 21 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Concurrent Review: Where concurrent review of submittals by Engineer's consultants, Owner, or other parties is required, allow 28 days for initial review of each submittal.
 3. If intermediate submittal is necessary, process it in same manner as initial submittal.
 4. Allow 21 days for processing each resubmittal.
 5. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- G. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 4 by 5 inches (100 by 125 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Unique identifier, including revision number.
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Other necessary identification.
- H. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.
- I. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
 2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.
- J. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return submittals, without review, received from sources other than Contractor.
1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
 2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
 3. Transmittal Form: Before the commencement of any works on the site, submit a form for the Engineer for his review and approval.
 4. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.
 - b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Submittal and transmittal distribution record.
 - i. Remarks.
 - j. Signature of transmitter.
- K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- L. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
1. Number of Copies: Submit copies of each submittal, as follows, unless otherwise indicated:
 - a. Initial Submittal: Submit a preliminary single copy of each submittal where selection of options, color, pattern, texture, or similar characteristics is required. Engineer, will return submittal with options selected.
 - b. Final Submittal: Submit **three** copies, unless copies are required for operation and maintenance manuals. Submit **five** copies where copies are required for operation and maintenance manuals. Engineer will retain **two** copies;

remainder will be returned. Mark up and retain one returned copy as a Project Record Document.

- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operating and maintenance manuals.
 - k. Compliance with recognized trade association standards.
 - l. Compliance with recognized testing agency standards.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
 4. Number of Copies: Submit **three** blue- or black-line prints of each submittal, unless prints are required for operation and maintenance manuals. Submit **five** prints where prints are required for operation and maintenance manuals. Engineer will retain **two**

prints; remainder will be returned. Mark up and retain one returned print as a Project Record Drawing.

- D. Coordination Drawings: Comply with requirements in Division 1 Section "Project Management and Coordination."
- E. Samples: Prepare physical units of materials or products, including the following:
1. Comply with requirements in Division 1 Section "Quality Requirements" for mockups.
 2. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 3. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 4. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Engineer's sample where so indicated. Attach label on unexposed side that includes the following:
 - a. Generic description of Sample.
 - b. Product name or name of manufacturer.
 - c. Sample source.
 5. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:
 - a. Size limitations.
 - b. Compliance with recognized standards.
 - c. Availability.
 - d. Delivery time.
 6. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
 - a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least **three** sets of paired units that show approximate limits of the variations.
 - b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
 7. Number of Samples for Initial Selection: Submit **one** full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
 8. Number of Samples for Verification: Submit **three** sets of Samples. Engineer will retain **two** Sample sets; remainder will be returned. **Mark up and retain one returned Sample set as a Project Record Sample.**

- a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 9. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 - F. Product Schedule or List: Prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Type of product. Include unique identifier for each product.
 - 2. Number and name of room or space.
 - 3. Location within room or space.
 - G. Delegated-Design Submittal: Comply with requirements in Division 1 Section "Quality Requirements."
 - H. Contractor's Construction Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation" for Construction Manager's action.
 - I. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation."
 - J. Application for Payment: Comply with requirements in Division 1 Section "Payment Procedures."
 - K. Schedule of Values: Comply with requirements in Division 1 Section "Payment Procedures."
 - L. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- 2.2 INFORMATIONAL SUBMITTALS
- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 - 1. Number of Copies: Submit **two** copies of each submittal, unless otherwise indicated. Engineer will not return copies.
 - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall

- be signed by an officer or other individual authorized to sign documents on behalf of that entity.
3. Test and Inspection Reports: Comply with requirements in Division 1 Section "Quality Requirements."
- B. Contractor's Construction Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation."
- C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- D. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.
- G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
- H. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.
- I. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
- J. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.
- K. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- L. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.
- M. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

- N. **Research/Evaluation Reports:** Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
1. Name of evaluation organization.
 2. Date of evaluation.
 3. Time period when report is in effect.
 4. Product and manufacturers' names.
 5. Description of product.
 6. Test procedures and results.
 7. Limitations of use.
- O. **Maintenance Data:** Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section "[Closeout Procedures, Operation and Maintenance Data.](#)"
- P. **Manufacturer's Instructions:** Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
1. Preparation of substrates.
 2. Required substrate tolerances.
 3. Sequence of installation or erection.
 4. Required installation tolerances.
 5. Required adjustments.
 6. Recommendations for cleaning and protection.
- Q. **Manufacturer's Field Reports:** Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- R. **Insurance Certificates and Bonds:** Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- S. **Construction Photographs:** Comply with requirements in Division 1 Section "[Construction Progress Documentation, Photographic Documentation.](#)"
- T. **Monthly Progress Report:** Report shall include the following:
1. Schedule of planning with updates and current situation at the date of report preparation.
 2. Updated Cashflow.
 3. Submittals log.
 4. Construction Progress Photographs.

5. Daily Reports
6. Variation Orders.
7. Payment Certificates.
8. List of problems faced on site.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 1. Approved
 2. Approved as Noted
 3. Conditionally Approved
 4. Rejected – Resubmit
 5. Revise Resubmit
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 01330

SECTION 01400 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections include the following:
 - 1. Division 1 Section "Allowances" for testing and inspecting allowances.
 - 2. Division 1 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 3. Division 1 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
 - 4. Divisions 2 through 16 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. Mockups: Full-size, physical example assemblies to illustrate finishes and materials. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review

construction, coordination, testing, or operation; they are not Samples. **Mockups establish the standard by which the Work will be judged.**

- D. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.4 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

1.5 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

- B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

- C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

- D. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.

11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- E. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.
- G. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed. (Provide Kite Mark Label for products under the British Standards BS, and UL label for product under the American Standards.)
- H. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.
1. Contractor responsibilities include the following:

- a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.
 - d. When testing is complete, remove assemblies; do not reuse materials on Project.
 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by Engineer.
 2. Notify Engineer 4 days in advance of dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Engineer's approval of mockups before starting work, fabrication, or construction.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Demolish and remove mockups when directed, unless otherwise indicated.

1.7 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.
 2. Payment for these services will be made from testing and inspecting allowances.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum.
- B. Contractor Responsibilities: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.
1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ the same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Special Tests and Inspections: Contractor will engage a testing agency to conduct special tests and inspections required by authorities having jurisdiction.
1. Testing agency will notify Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 2. Testing agency will submit a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.
 3. Testing agency will submit a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 4. Testing agency will interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 5. Testing agency will retest and reinspect corrected work.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
 5. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field-curing of test samples.

5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 30 days of date established for the Notice to Proceed.
1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 ACCEPTABLE TESTING AGENCIES

- A. UL (Underwriters Laboratories), Warnock Hersey, Kite Mark or other agencies approved by the UNDP Engineer.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.
 2. Comply with the Contract Document requirements for Division 1 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01400

SECTION 01420 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Installer": Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- J. "Experienced": When used with an entity, "experienced" means having successfully completed a minimum of **five** previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

- K. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.
- C. Conflicting Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Engineer for a decision before proceeding.
1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.
- D. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01420

SECTION 01500 - TEMPORARY FACILITIES AND CONTROLS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities.
- B. Temporary utilities include, but are not limited to, the following:
 - 1. Sewers and drainage.
 - 2. Water service and distribution.
 - 3. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.
 - 4. Electric power service.
 - 5. Lighting.
 - 6. Telephone service.
- C. Support facilities include, but are not limited to, the following:
 - 1. Temporary roads and paving.
 - 2. Dewatering facilities and drains.
 - 3. Project identification and temporary signs.
 - 4. Waste disposal facilities.
 - 5. Field offices.
 - 6. Storage and fabrication sheds.
 - 7. Lifts and hoists.
 - 8. Temporary stairs.
 - 9. Construction aids and miscellaneous services and facilities.
- D. Security and protection facilities include, but are not limited to, the following:
 - 1. Environmental protection.
 - 2. Stormwater control.
 - 3. Tree and plant protection.
 - 4. Site enclosure fence.
 - 5. Security enclosure and lockup.
 - 6. Barricades, warning signs, and lights.
 - 7. Temporary enclosures.
 - 8. Fire protection.
- E. Related Sections include the following:
 - 1. Division 1 Section "Submittal Procedures" for procedures for submitting copies of implementation and termination schedule and utility reports.
 - 2. Division 1 Section "Execution Requirements" for progress cleaning requirements.

1.3 DEFINITIONS

- A. Permanent Enclosure: As determined by Engineer, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

1.4 USE CHARGES

- A. General: Cost or use charges for temporary facilities are not chargeable to Owner or Engineer and shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the following:
 - 1. Owner's construction forces.
 - 2. Occupants of Project.
 - 3. Engineer.
 - 4. Testing agencies.
 - 5. Personnel of authorities having jurisdiction.
- B. Sewer Service: Pay sewer service use charges for sewer usage, by all parties engaged in construction, at Project site.
- C. Water Service: Pay water service use charges, whether metered or otherwise, for water used by all entities engaged in construction activities at Project site.
- D. Electric Power Service: Pay electric power service use charges, whether metered or otherwise, for electricity used by all entities engaged in construction activities at Project site.

1.5 SUBMITTALS

- A. Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
- B. Implementation and Termination Schedule: Within 15 days of date established for submittal of Contractor's Construction Schedule, submit a schedule indicating implementation and termination of each temporary utility.

1.6 QUALITY ASSURANCE

- A. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
 - 1. UTrade Jurisdictions: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.
 - 2. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.7 PROJECT CONDITIONS

- A. Temporary Utilities: At earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.
 - 1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.
- B. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
 - 1. Keep temporary services and facilities clean and neat.
 - 2. Relocate temporary services and facilities as required by progress of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
 - 2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate to support loads and to withstand exposure to traffic during construction period. Locate temporary roads and paved areas **within construction limits indicated** on Drawings.
 - 1. Provide a reasonably level, graded, well-drained subgrade of satisfactory soil material, compacted to not less than 95 percent of maximum dry density in the top **6 inches (150 mm)**.
 - 2. Provide gravel paving course of subbase material not less than **3 inches (75 mm)** thick; roller compacted to a level, smooth, dense surface.
 - 3. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Traffic Controls: Provide temporary traffic controls at junction of temporary roads with public roads. Include warning signs for public traffic and "STOP" signs for entrance onto public roads. Comply with requirements of authorities having jurisdiction.

- D. Dewatering Facilities and Drains: Comply with requirements in applicable Division 2 Sections for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual Sections. Where feasible, use same facilities. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining property nor endanger permanent Work or temporary facilities.
 2. Before connection and operation of permanent drainage piping system, provide temporary drainage where roofing or similar waterproof deck construction is completed.
 3. Remove snow and ice as required to minimize accumulations.
- E. Project Identification and Temporary Signs: Prepare Project identification and other signs in sizes indicated. Install signs where indicated to inform public and persons seeking entrance to Project. Do not permit installation of unauthorized signs.
1. Engage an experienced sign painter to apply graphics for Project identification signs. Comply with details indicated.
 2. Prepare temporary signs to provide directional information to construction personnel and visitors.
 3. Construct signs of exterior-type Grade B-B high-density concrete form overlay plywood in sizes and thicknesses indicated. Support on posts or framing of preservative-treated wood or steel.
 4. Paint sign panel and applied graphics with exterior-grade alkyd gloss enamel over exterior primer.
- F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste. Comply with Division 1 Section "Execution Requirements" for progress cleaning requirements.
1. If required by authorities having jurisdiction, provide separate containers, clearly labeled, for each type of waste material to be deposited.
 2. Develop a waste management plan for Work performed on Project. Indicate types of waste materials Project will produce and estimate quantities of each type. Provide detailed information for on-site waste storage and separation of recyclable materials. Provide information on destination of each type of waste material and means to be used to dispose of all waste materials.
- G. Janitorial Services: Provide janitorial services on a daily basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms, and similar areas.
- H. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility services. Sheds may be open shelters or fully enclosed spaces within building or elsewhere on-site.
1. Construct framing, sheathing, and siding using fire-retardant-treated lumber and plywood.
 2. Paint exposed lumber and plywood with exterior-grade acrylic-latex emulsion over exterior primer.
- I. Lifts and Hoists: Provide facilities for hoisting materials and personnel. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near Project site.
- B. Stormwater Control: Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of stormwater from heavy rains.
- C. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from construction damage. Protect tree root systems from damage, flooding, and erosion.
- D. Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest-control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Engage this pest-control service to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
- E. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- F. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.
 - 1. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch-(16-mm-) thick exterior plywood.
- G. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
 - 1. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.
 - a. Field Offices: Class A stored-pressure water-type extinguishers.
 - b. Other Locations: Class ABC dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.
 - c. Locate fire extinguishers where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
 - 2. Store combustible materials in containers in fire-safe locations.
 - 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for firefighting. Prohibit smoking in hazardous fire-exposure areas.
 - 4. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

5. Permanent Fire Protection: At earliest feasible date in each area of Project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
6. Develop and supervise an overall fire-prevention and first-aid fire-protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
7. Provide hoses for fire protection of sufficient length to reach construction areas. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.4 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
 2. Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
- D. Temporary Facility Changeover: Except for using permanent fire protection as soon as available, do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- E. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are the property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements in Division 1 Section "Closeout Procedures."

END OF SECTION 01500

SECTION 01600 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. Related Sections include the following:
 - 1. Division 1 Section "References" for applicable industry standards for products specified.
 - 2. Division 1 Section "Closeout Procedures" for submitting warranties for contract closeout.
 - 3. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, **except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise.** Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
- E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.4 SUBMITTALS

- A. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
 - 1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
 - 2. Form: Tabulate information for each product under the following column headings:
 - a. Specification Section number and title.
 - b. Generic name used in the Contract Documents.
 - c. Proprietary name, model number, and similar designations.
 - d. Manufacturer's name and address.
 - e. Supplier's name and address.
 - f. Installer's name and address.
 - g. Projected delivery date or time span of delivery period.
 - h. Identification of items that require early submittal approval for scheduled delivery date.
 - 3. Initial Submittal: Within 7 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
 - a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.
 - 4. Completed List: Within 30 days after date of commencement of the Work, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
 - 5. Engineer's Action: Engineer will respond in writing to Contractor within 10 days of receipt of completed product list. Engineer's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Engineer's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.
- B. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use form approved by Engineer.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified material or product cannot be provided.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and

- separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners.
 - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
 - i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
 - j. Cost information, including a proposal of change, if any, in the Contract Sum.
 - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
 - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 10 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
- a. Form of Acceptance: Change Order.
 - b. Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.
- C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 1 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
 5. Store products to allow for inspection and measurement of quantity or counting of units.
 6. Store materials in a manner that will not endanger Project structure.
 7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 9. Protect stored products from damage.
- B. Storage: Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures: Procedures for product selection include the following:

1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.
3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Product Substitutions" Article.
8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Products" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches satisfactorily.
 - a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on "substitutions" for selection of a matching product.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
 - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.
11. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Engineer will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.
- B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 2. Requested substitution does not require extensive revisions to the Contract Documents.
 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 4. Substitution request is fully documented and properly submitted.
 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. Requested substitution is compatible with other portions of the Work.
 8. Requested substitution has been coordinated with other portions of the Work.
 9. Requested substitution provides specified warranty.

10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2.3 COMPARABLE PRODUCTS

- A. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01600

SECTION 01700 - EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. General installation of products.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.
- B. Related Sections include the following:
 - 1. Division 1 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
 - 2. Division 1 Section "Submittal Procedures" for submitting surveys.
 - 3. Division 1 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
 - 4. Division 1 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 SUBMITTALS

- A. Qualification Data: For **land surveyor, professional engineer** to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- B. Certificates: Submit certificate signed by **land surveyor** certifying that location and elevation of improvements comply with requirements.
- C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- D. Certified Surveys: Submit **two** copies signed by **land surveyor**.
- E. Final Property Survey: Submit **10** copies showing the Work performed and record survey data.

1.4 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. All installers of material shall be “Experienced” with a history in the execution of similar work with no less than five years experience in the field involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
 - 1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to **local utility** and **Owner** that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than **two** days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.
- C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.
 - 4. Check the location, level and plumb, of every major element as the Work progresses.
 - 5. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
 - 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of **two** permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
 - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 - 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 4. Maintain minimum headroom clearance of 8 feet (2.4 m) in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
 2. Allow for building movement, including thermal expansion and contraction.
- G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

- D. **Installed Work:** Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. **Concealed Spaces:** Remove debris from concealed spaces before enclosing the space.
- F. **Exposed Surfaces:** Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. **Cutting and Patching:** Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
 - 1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
- H. **Waste Disposal:** Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- I. **During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.**
- J. **Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.**
- K. **Limiting Exposures:** Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

- A. **Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.**
- B. **Adjust operating components for proper operation without binding. Adjust equipment for proper operation.**
- C. **Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.**
- D. **Manufacturer's Field Service:** If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 1 Section "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. **Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.**
- B. **Comply with manufacturer's written instructions for temperature and relative humidity.**

3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 1 Section "Cutting and Patching."
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01700

SECTION 01731 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. Related Sections include the following:
 - 1. Divisions 2 through 16 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
 - a. Requirements in this Section apply to mechanical and electrical installations. Refer to Divisions 15 and 16 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

1.3 DEFINITIONS

- A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
 - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - 2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - 3. Products: List products to be used and firms or entities that will perform the Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
 - 6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.

7. Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections of these Specifications.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.

- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to **avoid** interruption of services to occupied areas.

3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

END OF SECTION 01731

SECTION 01770 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
 2. Project Record Documents.
 3. Operation and maintenance manuals.
 4. Warranties.
 5. Instruction of Owner's personnel.
 6. Final cleaning.
- B. Related Sections include the following:
1. Division 1 Section "Construction Progress Documentation" for submitting Final Completion construction photographs and negatives.
 2. Division 1 Section "Execution Requirements" for progress cleaning of Project site.
 3. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 4. Divisions 2 through 16 Sections for specific closeout and special cleaning requirements for products of those Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Advise Owner of pending insurance changeover requirements.
 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs (with CD copies), damage or settlement surveys, property surveys, and similar final record information.
 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

8. Complete startup testing of systems.
9. Submit test/adjust/balance records.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. [Submit demonstration and training videotapes.](#)

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit [three](#) copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction

including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Page number.

1.6 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
 1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Note related Change Orders, Record Drawings, and [Product Data](#), where applicable.
- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, Record Drawings, and [Record Specifications](#), where applicable.
- E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data:
 - a. Emergency instructions and procedures.
 - b. System, subsystem, and equipment descriptions, including operating standards.
 - c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
 - d. Description of controls and sequence of operations.
 - e. Piping diagrams.
 2. Maintenance Data:
 - a. Manufacturer's information, including list of spare parts.
 - b. Name, address, and telephone number of Installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

1.8 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (115-by-280-mm) paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Provide instructors experienced in operation and maintenance procedures.
 - 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 - 3. Schedule training with Owner, through Engineer with at least seven days' advance notice.
 - 4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.
- B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual

Specification Sections. For each training module, develop a learning objective and teaching outline. Include instruction for the following:

1. System design and operational philosophy.
2. Review of documentation.
3. Operations.
4. Adjustments.
5. Troubleshooting.
6. Maintenance.
7. Repair.

3.2 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

- 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment, [elevator equipment](#), and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01770

SECTION 01781 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Sections include the following:
 - 1. Division 1 Section "Closeout Procedures" for general closeout procedures and maintenance manual requirements.
 - 2. Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Divisions 2 through 16 Sections for specific requirements for Project Record Documents of products in those Sections.

1.3 SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit **one** set of marked-up Record Prints.
- B. Record Specifications: Submit **one copy** of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit **one copy** of each Product Data submittal.
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in the manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue- or black-line white prints **and one soft copy** of the Contract Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Engineer's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 7. All "Approved as Noted" shop drawings have to be corrected and submitted with the "As-Built" drawings.
- B. Record Transparencies: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Engineer. When authorized, prepare a full set of corrected transparencies of the Contract Drawings and Shop Drawings.
1. Incorporate changes and additional information previously marked on Record Prints. Erase, redraw, and add details and notations where applicable.
 2. Refer instances of uncertainty to Engineer for resolution.
 3. Print the Contract Drawings and Shop Drawings for use as Record Transparencies. Engineer will make the Contract Drawings available to Contractor's print shop.
- C. Record CAD Drawings: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Engineer. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:

1. Format: Same CAD program, version, and operating system as the original Contract Drawings.
 2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Engineer for resolution.
 4. Engineer will furnish Contractor one set of CAD Drawings of the Contract Drawings for use in recording information.
 - a. Engineer makes no representations as to the accuracy or completeness of CAD Drawings as they relate to the Contract Drawings.
 - b. CAD Software Program: The Contract Drawings are available in .pdf format.
- D. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing Record Drawings where Engineer determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 2. Consult with Engineer for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- E. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Record Transparencies: Organize into unbound sets matching Record Prints. Place transparencies in durable tube-type drawing containers with end caps. Mark end cap of each container with identification. If container does not include a complete set, identify Drawings included.
 3. Record CAD Drawings: Organize CAD information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each CAD file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Engineer.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.

3. Record the name of the manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Drawings, and Product Data where applicable.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, Record Drawings, and Product Data where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

END OF SECTION 01781

DIVISION 2

SITEWORK TABLE OF

CONTENTS

Section No.	Title
02200	EARTHWORKS
02210	COMPACTION AND TESTING OF EARTHWORK
02220	STRUCTURAL EXCAVATION AND BACKFILL
02221	TRENCHING, BACKFILLING, COMPACTION AND GENERAL GRADING
02230	AGGREGATE OR GRANULAR SUBBASE
02232	AGGREGATE BASE COURSE
02510	WATER SUPPLY/ PIPES AND FITTINGS
02513	PAVEMENTS - ASPHALTIC CONCRETE
02720	STORMWATER DRAINAGE
02726	MANHOLE COVERS AND FRAMES
02730	SANITARY SEWERAGE

SECTION 02200

EARTHWORKS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavating, transporting, placing, spreading, moisture-conditioning and compaction of all types of earth or rock materials.

1.02 RELATED SECTIONS

- A. Section 01400 Quality Requirements
- B. Section 01500 Temporary Facilities and Controls.
- C. Section 02210 Compaction and Testing of Earthwork.
- D. Section 02220 Structural Excavation and Backfill.
- E. Section 02221 Trenching, Backfilling, Compaction and General Grading.
- F. Section 02230 Aggregate Granular Sub-base.
- G. Section 02232 Aggregate Base Course.
- H. Section 03300 Cast-in-Place Concrete.

1.03 REFERENCES

- A. ASTM D 422 Standard Test Method for Particle Size Analysis of Soils.
- B. ASTM D 4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- C. ASTM D 3282 Standard Classification of Soils and Soil Aggregate Mixture for Highway Construction Purpose.
- D. ASHTO M 145 Classification of Soil and Soil Aggregate Mixtures for Highway Construction Purposes.

1.04 SUBMITTALS

- A. Comply with Section 01310.
- B. Submit Method Statement, with the following documents to the Engineer for information and approval.
 - 1. a. Excavation Plan including setting out and marking of existing utilities.
 - b. Filling Plan
 - c. Control of Water Plan
 - d. Equipment to be used

- e. Supervision and Control procedures
- 2. Quality Control Programme.
- 3. Weekly and Monthly Quality Control Reports.
- 4. Analysis Reports of the results of testing as required in Section 02210.

1.05 QUALITY ASSURANCE

- A. Propose a programme for inspection and testing by an approved Independent Testing Laboratory, so as to achieve the specified quality.
- B. Maintain a qualified representative on-site during all earthwork operations.
- C. Weekly Quality Control Report: Present the Engineer with a Quality Control Report at weekly intervals summarising the following:
 - 1. Daily Inspection Reports.
 - 2. Material Delivery Records.
 - 3. Test Results (from previous weeks samples).
 - 4. Samples taken this week and amount of work represented by each individual sample.
 - 5. Quality Control Performance.
- D. Monthly Quality Control Report: Present the Engineer with a Quality Control Report at monthly intervals summarising the following:
 - 1. Weekly Quality Control Reports.
 - 2. Control Charts (showing previous 60 days plotted test results/control measurements, etc.)
 - 3. Proposed Quality Control Programme improvements.
 - 4. Revisions to frequency of testing.
 - 5. Work for which acceptance is requested.

The monthly Quality Control Report shall be approved by the Engineer before being admissible as a contract record.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Satisfactory soil materials for backfilling and fill are defined as those belonging to soil classification group A1-a and A1-b in accordance with ASTM D 3282 or AASHTO M145-87 and the maximum particle size shall be 80 mm.

- B. Obtain suitable fill material either from processed, waste products of rock crushing and screening plants, or borrowed (excavated or dredged) from approved natural soil deposits.
- C. Unsuitable fill material shall include but not be limited to the following:
 - 1. Material not meeting the requirements specified in paragraphs 2.01 A and 2.01 B.
 - 2. Material from Sabkha areas.
 - 3. Perishable and organic materials.
 - 4. Materials containing scrap, debris and garbage.
- D. Fill material shall be from one or more of the sources listed below:
 - 1. Suitable material from required excavations within the site of the work covered under this Contract. This shall be the primary source of fill material.
 - 2. Borrow areas designated by the Engineer.
 - 3. Borrow areas provided by the Contractor and approved by the Engineer.
 - 4. Commercial sources approved by the Engineer.
- E. Designation or approval of a borrow area does not mean that all material within that area is suitable fill material. Only suitable soils from such areas shall be placed in the Works and any unsuitable materials in lenses, layers or other types of inclusions in these areas shall be carefully removed and discarded. Ensure that materials obtained from borrow areas comply with the requirements of the specification.
- F. Supply all water required for construction including dust control, moisture-conditioning of fill material during compaction and any other of his needs.

PART 3 EXECUTION

3.01 GENERAL

- A. Before the surface of any part of the work site is disturbed or the works thereon are commenced observe and record levels and locations of such points over it as are agreed with the Engineer. Excavation or filling shall not commence until prior approval of the Engineer has been obtained.

3.02 CONTROL OF WATER

- A. Keep all work well drained at all times and ensure that all work is carried out in the dry in accordance with the "Method Statement" for the control of water as prepared and recommended by the Contractor and approved by the Engineer.
- B. Construct, operate and maintain all temporary dams, watercourses and other works of all kinds including pumping sets, wellpoint installations and relief well systems that may be necessary to exclude water from the work place or ensure stability of excavations while

construction is in progress. Such temporary works and plant shall include spare units kept ready for immediate use in case of breakdowns, and shall not be removed without the approval of the Engineer. Design pumping units for drainage sumps, well-point installations and relief well systems specifically for the type of service required.

- C. Whenever, in the opinion of the Engineer the methods to control water are inadequate, the Engineer reserves the right to direct to install, operate and maintain wellpoint systems and relief well systems, notwithstanding any previous acceptance of such methods. No payment shall be made for water control systems installed, operated and maintained at the direction of the Engineer and its cost shall be considered to be included in the Contract Price.
- D. Make provision for the discharge or removal from the work of all water and waste products howsoever arising and provide suitable temporary pipes, flumes or channels, using methods of disposal approved by the Engineer.
- E. Keep all excavations free from water during the complete course of construction of the Works.

3.03 EXCAVATION

- A. Carry excavation to the lines, levels and profiles shown on the Contract Drawings or to such other lines, levels and profiles as the Engineer may direct or approve.
- B. For purposes of payment, the work is not classified according to the materials to be excavated, and unit price for the work shall cover excavation of all types of soil and rock, whether water bearing or not, to the lines and levels indicated.
- C. Do not commence blasting without the prior approval of the Engineer and the necessary permits from the concerned authorities.
- D. Transport and place excavated materials suitable for fill. Compact and grade in requisite quantities in fill and backfill areas within the limits of the work. Use any quantity surplus to these requirements as detailed in paragraph 3.07, Disposal of Surplus Materials.
- E. Haul away excavated material unsuitable for filling to spoil areas, dumped and graded, all as approved by the Engineer. Obtain permission for dumping areas and necessary authorization from the Municipality. No claims for additional payment will be entertained for travel distances to or from the authorized dumping areas.
- F. In materials other than rock, carry out the whole or part of the last stage (at least 150 mm) of excavation, manually immediately before placing the covering material. Protect the final surface from all disturbance and flooding until the covering materials are placed.

3.04 EXCAVATION NEAR EXISTING UTILITIES

- A. Proposed or existing utilities in the vicinity of the work are shown on Contract Drawings. However, the completeness and accuracy of this information is not guaranteed and any deviation or omission on the Contract Drawings do not relieve the Contractor from his responsibility for ensuring that the existing utilities are accurately located and fully protected from damage throughout the period of the Contract. Do not commence excavation until the Engineer has approved the setting out and marking of existing underground utilities.
- B. Prior to commencement of excavation, determine the number and location of underground

utilities in the immediate proximity of the work. Whenever necessary, excavate test pits to determine the exact locations of existing utilities. Make such explorations sufficiently in advance of construction to enable the Engineer to approve any modifications, to be made to any pipeline, structure or conflicting utility. Obtain the Engineer's permission before commencing any test pits and fence, mark and protect them as required. Excavate and refill test pits by hand tools. Complete refilling and compaction as soon as practicable.

- C. As excavations approach existing pipes, conduits, cables or other underground facilities, discontinue excavation by machinery and use hand tools. Provide pillars, hangers, tie-backs shores, or any other supports and protection required for the existing utilities to prevent damage during operations.
- D. Notwithstanding the foregoing provisions, when damage to existing utilities results during the contract execution then repair such damage without delay or reinstate it by other agency as directed by the Engineer, without any extra cost.
- E. When damage to existing utilities causes disruption to the schedule of work readjust the schedule, methods of working and resources so that critical dates in the schedule for the completion of the Contract are not affected.
- F. Bear all costs involved in any realignment or relocation of utilities.

3.05 EXCESS EXCAVATION

- A. Excess excavation means excavation outside the lines, levels and profiles and working spaces allowed by the standard methods of measurement, as shown on the Contract Drawings or as directed or approved by the Engineer. Remove and dispose of all material resulting from excess excavation and make good the same with fill compacted as specified herein or with concrete when required by the Engineer, at no extra cost.
- B. When the soil material in any part of such excavated surface as is required to be covered becomes puddled, soft or loose before any material is placed over or against it, remove such damaged, softened or loosened material and excavate further to material acceptable to the Engineer. Such further excavation is considered to be excess excavation.

3.06 ADDITIONAL EXCAVATION

- A. Upon completion of excavation to specified levels, limits or depths, inspect and review the exposed ground in accordance with Quality Control Programme. Carry out any further excavation as instructed by the Engineer. Refill such further excavation to the specified levels, limits or depths with suitable fill material compacted as specified in the relevant sections of these specifications or with concrete as instructed by the Engineer.

3.07 DISPOSAL OF SURPLUS MATERIAL

- A. Do not remove from the site or dispose off surplus excavated material from site except as directed or approved by the Engineer.
- B. Use surplus excavated material suitable for fill to replace other materials unacceptable as fill within the work site, or for other purposes in locations determined by the Engineer without additional payment.
- C. Haul away surplus excavated materials not required for purposes specified above to spoil

areas, dump and grade, all as approved by the Engineer, without any additional payment for the same.

3.08 FILL

A. General:

1. Do not fill material until the surface of the subsoil to receive the fill is cleaned, prepared as specified, and free of standing or running water, and approved by the Engineer.

B. Methods:

1. Utilise only such methods for placement and compaction of the fill for which prior approval from the Engineer is given.
2. Place and compact all fill in an orderly manner using equipment maintained in first class operating condition. Fill and level ruts in the surface of any layer prior to compaction.
3. Compact in layers as specified for different kinds of fill. Refer to Section 02210.
4. Operate vibratory rollers while compacting within the manufacturer's recommended frequency range for the type of material being compacted and at the optimum operating frequency.

3.09 DUST AND NOISE CONTROL

A. Comply with Section 01500.

B. Use all means necessary to control dust on and near the work and on and near all borrow areas.

C. Moisture thoroughly all surfaces as required to prevent dust being a nuisance or a hazard to the public and concurrent performance of other work on the site.

END OF SECTION 02200

SECTION 02210

COMPACTION AND TESTING OF EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Compaction and testing of general fill, done either by hydraulic or dry haul, for mass earthwork and embankments, structural fill in areas of embankments, berms and buildings, backfill for structural and foundation excavation and subgrades.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements
- C. Section 02200 Earthwork
- D. Section 02220 Structural Excavation and Backfill
- E. Section 02221 Trenching, Backfilling, Compaction and General Grading

1.03 REFERENCES

- A. ASTM D 1556 Test Methods for Density of Soil in place by the Sand-Cone Method.
- B. ASTM D 1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10 lb. (4.54 kg) Rammer and 18 in. (457 mm) Drop.
- C. ASTM D 422 Test Method for Particle Analysis of Soils.
- D. ASTM D 2167 Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- E. ASTM D 4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
- F. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.

1.04 SUBMITTALS

- A. Comply with Sections 01330.
- B. Method Statement describing the proposed procedures for placing of fill or backfill materials and their compaction in respect of equipment to be used, moisture conditioning of fill, layer thickness and number of passes as well as the testing procedures.
- C. Field and Laboratory Test Results on a monthly basis, and on hand for inspection at any time by the Engineer. Sign all the test results for acceptance of accuracy.

1.05 QUALITY ASSURANCE

- A. Propose a programme for inspection and testing by an approved Independent Testing Laboratory, to achieve the specified quality.
- B. Maintain a qualified representative on site during compaction and testing operations.

PART 2 PRODUCTS

2.01 DEFINITIONS OF FILL MATERIALS

- A. Structural Fill:

All types of fill material placed to support all structural elements and or piping, both vertically and horizontally. The limits of the structural fill are defined on the drawings.

- B. General Fill:

All mass earthwork, including earth embankments, placed primarily for the purpose of elevating ground levels.

- C. Cohesive Material:

All fine-grained soils such as clayey or silty soils which exhibit cohesion properties. Additionally for purposes of this specification, coarse-grained soils containing 12 % or more fines that pass through No. 200 sieve, are also included in this category.

- D. Cohesionless Material:

Cohesionless material includes all relatively free-draining granular material such as sands or gravels which contain less than 12 % of fines that will pass through No. 200 sieve.

2.02 DEFINITION OF TERMS

- A. Field Density:

Mass of dry solids in kilograms per cubic metre of in-place fill, as determined by standard test procedures referenced in this specification.

- B. Laboratory Density:

Maximum mass of dry solids possible, in kilograms per cubic metre of fill, as determined by standard test procedures referenced in this specification.

- C. Relative Compaction:

Density expressed as a percentage of the laboratory density to the nearest one percent (1%).

- D. Relative Density:

Measurement of the state of compaction of a soil with respect to the loosest and the densest state which can be achieved for it by the laboratory procedures described in ASTM D 4254.

Its value in percent is determined as a measure of compaction in case of free draining cohesionless soils which do not exhibit a well defined density - moisture content relationship when determined in accordance with ASTM D 1557.

PART 3 EXECUTION

3.01 COMPACTION REQUIREMENTS

A. Compaction of Cohesive Fill Materials:

Compact all cohesive fill materials with moisture content within 2% of the optimum moisture content as determined by ASTM D 1557, using Method D, unless otherwise specified, at least to the minimum percentages of the maximum dry density from the same test specified.

B. Compaction of Cohesionless Fill Materials:

Compact all cohesionless fill materials using towed vibratory equipment. Do not use self propelled vibratory equipment without prior approval of the Engineer. Where such equipment is proposed a demonstration of the equipment is required before approval is granted. Cohesionless fill material to be compacted to at least the minimum specified relative densities, as determined according to ASTM D 4254, in case a well-defined density vs. moisture curve cannot be determined according to ASTM D 1557.

C. The following are the minimum requirements for compaction of cohesive and cohesionless fill materials for both general and structural fill as Table 3-1.

Table 3-1

MINIMUM COMPACTION REQUIREMENTS

Type of Fill	Type of Fill Material	Minimum Relative Compaction (% of Max. Dry Density per ASTM D 1557 (D))	Minimum Relative Density in percent, as per ASTM D 4254
General fill	Cohesive	90	-
	Cohesionless	90	70
Structure	Cohesive	95	-
	Cohesionless	95	74

D. Make a trial at the start of the Work, by placing a volume of fill requiring a series of ten (10) compaction tests in accordance with Table 3-2. Present the results and get it approved by the Engineer before the placement of additional fill material. Upon approval, the compaction procedure to be applied to all work of a like nature. Any change in fill materials, subsoil conditions or environment require this approval process to be repeated.

Test the fill in a manner which will give representative results for the whole area. From each set, no more than one test result is permitted to fall below the minimum relative compaction

requirement of Table 3-1.

If more than one test result falls below the minimum relative compaction requirements of Table 3-1, test on the volume of fill represented by the ten (10) consecutive test results to be repeated until the whole volume of the fill meets the requirements of this specification.

3.02 TESTING REQUIREMENTS

A. Frequency of Compaction Tests:

Make a minimum of ten (10) field compaction tests for each of the fill parameters specified in Table 3-2. The Engineer to make the choice of volume, area or length of fill as a basis for compaction testing and this choice to be such as will result in the greater frequency of testing.

Table 3-2

LIMITING PARAMETERS OF FILL FOR A SET OF 10 COMPACTION RESULTS

Type of Fill	Area of Fill in m ²	Vol. of fill in m ³	Length of Fill in m
General	50,000	100,000	1,500
Structural	5,000	10,000	150

B. Testing Requirements for Cohesive Materials:

The maximum dry density and optimum moisture content to be determined for cohesive fill materials in accordance with ASTM D 1557, Method D, at least once for every ten (10) field compaction determinations, and also for every change in soil type and/or borrow source.

C. Testing Requirements for Cohesionless Materials:

Determine the minimum and maximum densities for cohesionless fill materials in accordance with ASTM D 4253 and ASTM D 4254 respectively at least once for every change in soil type and or borrow source.

D. Field Density Testing:

Conduct field density testing so as to be representative of the density of the entire thickness of the layer of fill being tested by doing each test half way between the bottom and the top of every layer less than 500 mm in thickness or at the midpoint of each 500 mm depth or part thereof, for thicker layers. Tests conducted on the surface to be permitted only in the case of layers less than 300 mm thick.

END OF SECTION 02210

SECTION 02220

STRUCTURAL EXCAVATION AND BACKFILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavating for building foundations.
- B. Excavating for slabs-on-grade, paving and landscaping.
- C. Excavating for site structures.
- D. Site filling and backfilling.

1.02 RELATED SECTIONS

- A. Section 01400 Quality Requirements
- B. Section 02200 Earthworks
- C. Section 02210 Compaction and Testing of Earthworks
- D. Section 02221 Trenching, Backfilling, Compaction and General Grading
- E. Section 02230 Aggregate or Granular Sub-base
- F. Section 02232 Aggregate Base Course

1.03 REFERENCES

- A. American Society for Testing and Materials. ASTM D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

ASTM D 2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

ASTM D 2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

ASTM D 2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

ASTM D 3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.04 PROJECT / SITE CONDITIONS

- A. If existing utility lines not described in Contract Documents are encountered, inform Engineer before proceeding.

1.05 SUBMITTALS

- A. At least 14 days prior to commencing any excavation and earthworks operation, submit the following for the Engineer's information and approval:

1. Method Statement:

This will include proposals for:

- a) Extent of excavation work.
- b) Disposal of the excavated materials in areas approved by the Owner and Municipality.
- c) Treatment of subgrade prior to filling or subsequent construction of structures.
- d) Placing and compaction of fill material around structures or in embankments with references for identification of layers.
- e) Record Sheets for definition of the area of works, the sequence of operations, confirmation of compliance with specification of each stage of the Permanent Works and its acceptance by the Engineer.

2. Proposal for dust and noise control.

1.06 QUALITY ASSURANCE

- A. Furnish quality assurance, inspection and material testing programme for review and acceptance of the Engineer.
- B. Verify to ensure that survey bench marks and intended elevations for the Works are as indicated.

PART 2 PRODUCTS

2.01 GENERAL

- A. All goods and products covered by these specifications shall be procured, when available, from an in-Kingdom manufacturer. Procurement of all goods and products manufactured out-of-Kingdom must be approved by the Engineer prior to placing procurement order.

2.02 MATERIALS

- A. Well graded material conforming to ASTM D 2487 free from debris, organic material, brick, lime, concrete and other material which would prevent adequate performance of backfill.
- B. Suitable Unclassified Structural Backfill material from natural sources to comprise cohesionless material, as defined in Section 02210. The water soluble salt content of representative samples of the backfill not to exceed 1% prior to placement.

The maximum stone size in suitable fill material not to exceed 50 mm unless proved otherwise to the satisfaction of the Engineer, that the equipment used can compact layers containing large stone to the required levels of compaction. Stones size not to exceed one third of the layer thickness.

- C. Use lean concrete as mass Structural Backfill material in accordance with Section 03300 Cast in Place Concrete.
- D. Supply potable water required for construction, including dust control, moisture conditioning of fill material during compaction, and such other needs.

2.03 CLASSIFICATION OF STRUCTURAL EXCAVATION AND BACKFILL

- A. Where an excavation is made to a level below that of structural foundations or loadbearing elements and the excavation is subsequently backfilled to foundation levels, classify the excavation as Mass Structural Excavation and the backfill as Mass Structural Backfill.
- B. Consider all structural excavation and backfill except that described in paragraph 2.03A as Unclassified Structural Excavation and Unclassified Structural Backfill.

PART 3 EXECUTION

3.01 GENERAL

- A. Before the surface of any part of the work site is disturbed, or the works thereon are commenced, record levels of such part in the manner agreed with the Engineer. Do not commence excavation or filling without prior approval of the Engineer.
- B. When pipes, conduits, culverts or ducts are required within road embankment areas, the embankment either be constructed and essentially completed in advance of such work, or to a height at least 600 mm or higher above the top of the pipe, conduit, culvert or duct prior to excavation.

3.02 CONTROL OF WATER

- A. Carry out excavations and earthworks in the dry condition by controlling the flow of water entering the excavation from any source, in accordance with the proposals made in the Method Statement and as accepted by the Engineer.
- B. Do not permit water flow to cross any excavated or fill surfaces which are liable to cause erosion.
- C. Construct and maintain any temporary works such as dams, sumps, watercourses etc. as are necessary to contain or control the inflow of storm or ground water. Any pumping plant and equipment (including that for well point dewatering systems or well relief systems) necessary for removal of water from the Works to include standby units for use in the event of an emergency or breakdown. Remove plant and equipment for control of water only after receipt of the Engineers approval.
- D. The Engineer reserves the right to direct to install, operate and maintain wellpoint systems and relief well systems whenever the methods used to control water are inadequate, notwithstanding any previous acceptance by the Engineer of such methods.

- E. Discharge all water and waste products from the site of work and provide all suitable temporary piping, flumes or channels as may be required. The methods for disposal to be in accordance with the approved Method Statement.

3.03 EXCAVATION

- A. Obtain any relevant excavation permits as required, from the appropriate authority having jurisdiction prior to commencing work.
- B. Before any excavation or earthworks is commenced, survey the site of the excavation or earthworks in a manner and to the extent required by the Engineer. Prepare drawings recording the survey and submit for Engineer's acceptance.
- C. Finish all excavated surfaces shall be finished neatly to the lines and levels shown on the Drawings unless such lines and levels are shown as nominal.

When such lines and levels are stated to be nominal, the final lines and levels will be instructed by the Engineer to take into account the conditions of the ground exposed as the excavation nears the nominal lines and levels shown on the Drawings. Carry out the excavation in more than one stage in order to arrive at the final lines and levels.

In material other than rock, leave the surface not less than 150 mm above its final level until Permanent Works construction starts.

- D. Materials to be excavated are not specifically classified, and the work to include excavation of all types of soil and rock, whether water bearing or not, to the lines and levels indicated.
- E. Excavated surfaces which will remain permanently exposed on completion of the Permanent Works to be cleared of all loose material, pieces of rock, debris, rubbish and the like and left neat and tidy.
- F. Measures to be taken for the safety and care of the Works to include:
 - 1. Excavate and remove the sides of excavations which are not positively supported to slopes which will remain stable.
 - 2. The sides of excavations which are not cut to a stable slope to be properly and adequately supported to the extent necessary to ensure stability during the period of construction of the Permanent Works and backfill the excavation unless otherwise indicated on the Drawings.
 - 3. Do not place materials, plant or other load close to any excavation.
 - 4. Remove or otherwise secure by barriers, nets or other means any material which might fall and thereby cause damage to the Permanent Works or injure any person.
- G. Install and subsequently remove all necessary sheeting, timbering, strutting, shoring and the like to secure the excavations, to prevent any movement of adjacent ground and to ensure the safety of workmen and damage to structures, buildings, streets, sewers, drains, walls, services or any other related activity.

- H. At the site of excavation, classify the excavated material as suitable for fill or not. Unsuitable material shall be hauled away to such spoil areas as have been approved by the Engineer. Material suitable for fill to be transported directly to, and placed in fill areas within the limits of the Permanent Works or transported to approved stockpile areas for later use.
- I. Mass Structural Excavation:
 - 1. Where mass structural excavation is made to a level below or close to the ground water table, the ground water table to be lowered using approved methods to a depth of at least 300 mm below the excavation level or to such greater depth as is necessary for the operation of construction equipment within the excavation.
- J. Unclassified Structural Excavation:
 - 1. When excavating to specified levels for the foundation of a structure or to specified lateral limits for the face of a structure required to abut undisturbed ground, do not excavate the last 150 mm until immediately before commencing the construction of the structure. In case the excavation done is deeper than 150 mm from the specified level or more than 150 mm from the lateral limits before commencing the constructional work, excavate a minimum 150 mm of material immediately before commencing the construction of the structure where required by the Engineer. This additional excavation shall be held to be excess Structural Excavation, and has to be replaced by compacted structural backfill or concrete as directed by the Engineer.
 - 2. Before commencement of any construction work remove all loose material from the excavation to ensure that the work rests on a solid and clean foundation or abuts against solid ground.

3.04 EXCAVATION NEAR EXISTING UTILITIES

- A. Confirm the location of the proposed or existing utilities in the vicinity of the Work. The completeness and accuracy of the information shown on contract drawings has to be verified and deviations incorporated in shop drawings. Ensure sure that existing utilities are fully protected from damage throughout the period of the Contract.
- B. Prior to commencement of excavation, determine the number and location of underground utilities in the immediate proximity of the work.

Whenever necessary, excavate test pits to determine the exact locations of existing utilities. Explorations to be done sufficiently in advance of construction to enable the Owner and the Engineer to approve modifications, to be made to any pipeline, structure or conflicting utility.

Obtain permission from the Owner and the Engineer before commencing any test pits and shall fence, mark and protect them as required by the Owner and the Engineer. Excavate test pits and refill by hand tools. Refilling and compaction to be completed as soon as practicable after the necessary information has been obtained.

- C. Adequately protect all surface and underground utilities affected by the construction operations, and provide all necessary supports, hangers, shoring tie-backs or other protection as may be required for this purpose.

- D. Notwithstanding the foregoing provisions, if damage to existing utilities result from the construction operations, such damage to be repaired without delay as determined by the Engineer at no extra cost.
- E. When damage to existing utilities causes disruption to the schedule of work by delaying work in the area of such damage, readjust schedule, method of working and resources so that critical dates in the schedule for the completion of the Contract are not affected.
- F. When an existing utility comes within the limits of or crosses the excavation necessitating its removal, realign, change or remove the utility and rebuild in accordance with the Engineer's direction and the requirements of this specifications and make good to the original conditions.

Dismantle and preserve carefully the materials used in the existing utility and use only those approved by the Engineer in the reconstruction Works.

Dispose of unusable materials from any such existing works at approved disposal sites.

Supply any additional materials required on approval by the Engineer.

Relocation of water, power and telephone services as well as sewer services shall be carried out under the approval of the concerned department. Obtain necessary approvals and permits and pay the necessary costs thereof.

- G. Where it is necessary to interrupt water service in an area during the relocation or replacement of an existing water main, advise the Engineer at least 48 hours in advance of the intention to shut off the system. Where the water system will be out of service for more than 24 hours, provide temporary service by means of surface lines or other facilities satisfactory to the Engineer. In all cases obtain first a permit.
- H. Following completion of the relocation or replacement of a watermain or any portion thereof, test the line, flush and chlorinate according to relevant clause of the specifications and to the approval of the Engineer to ensure that the relocated or replaced section of the pipe is comparable in quality to other portions of the system. Supply labor, materials and temporary plugs, valves, fittings or other appurtenances as required for the testing flushing and chlorination at no extra cost.

3.05 EXCESS EXCAVATION

- A. Excess excavation means excavation outside the lines, levels and profiles shown on the Contract Drawings or as directed or approved by the Engineer. Remove and dispose of all material resulting from excess excavation and make good excess excavation with fill compacted as specified herein or concrete as may be required by the Engineer, at no extra cost.
- B. When during the progress of the Work but subsequent to the acceptance of an excavation the material forming the bottom of an excavation becomes puddled, soft or loose remove such damaged, softened or loosened material and excavate further to material acceptable to the Engineer. Such further excavation is deemed to be excess excavation.

3.06 ADDITIONAL EXCAVATION

- A. Completion of excavation to specified levels, limits or depths shall constitute "hold points". Inspect the exposed ground and review in accordance with the Quality Control Programme. Carry out any further excavation as may be required by the Engineer. Such further excavation to be refilled to the specified levels, limits or depths with suitable fill material compacted as specified.

3.07 DISPOSAL OF SURPLUS MATERIAL

- A. Do not remove the surplus excavated material from the work site or dispose off except as directed or approved by the Engineer.
- B. Surplus excavated materials suitable for fill to be used to replace other materials unacceptable as fill or be neatly deposited and graded so as to widen fill areas or uniformly flatten slopes within the work site, or be neatly deposited for other purposes in locations determined by the Engineer within 5 kilometers of the work site, all as directed or approved by the Engineer and without any additional cost.
- C. Surplus excavated materials not required or deposited as specified above to be hauled away and dumped in spoil areas approved by the Engineer at no extra cost.

3.08 BACKFILL AND FILL

- A. General: Fill to be any suitable material compactable to the degree specified. Submit to the Engineer details and such samples as the Engineer may require of the fill proposed to be used in the Permanent Works together with the results of such tests required to show that the fill complies with the Specification.

Material for fill shall not contain boulders having a height when placed of more than two thirds of the compacted thickness of the layer being placed, nor shall it contain lumps of more than this height which are too hard to be broken down during compaction.

Fill material which fails to comply with the specification to be disposed of to spoil.

- B. Do not place any fill material until the surface of the subsoil to receive fill is cleaned and prepared, as specified in Paragraph 3.08 C, is free of standing or running water and has been accepted by the Engineer. Backfill and fill materials to be placed in layers not greater than 200 mm loose depth for materials compacted by heavy equipment, and 100 mm loose depth for material compacted by hand-operated tampers, unless written approval has been given by the Engineer for greater depths of fill.
 - 1. Use only those methods for placement and compaction of fill proposed in the Method Statement and approved by the Engineer. When fill in depths greater than those specified in clause 3.08 B is proposed, demonstrate successfully by means of compaction trials that the equipment is capable of achieving the required degree of compaction at all depths throughout the layer thickness. The Engineer, when satisfied, may then give written approval.
 - 2. Place the fill in uniform layers across the full width and length of the area to be filled to build-up the area evenly and compact it as soon as practicable after deposition. Do not mix materials of differing characteristics in any one layer and each layer to be free from lenses and pockets of such material.

3. Place the fill to a sufficiently even surface with enough camber to shed surface water and avoid ponding.
4. Direct constructional traffic over the fill in such a manner that damage to compacted layers is minimised. Remedy any such damage as instructed by the Engineer. When the traffic is required to be routed across completed fill areas, take the necessary measures including the placing of further temporary fill to prevent damage to the permanent fill by such traffic.
5. Where fill is to be placed in trenches, pits and other places the sides of which are supported, withdraw those supports which are to be removed as far as practicable ahead of the layer of fill to be compacted and fill all voids left by the supports with fully compacted material
6. Deposit fill material without causing segregation.
7. When fill material deposited but not fully compacted reaches a moisture content by wetting or by drying at which it cannot be compacted in accordance with the specification, take action subject to the agreement of the Engineer to render the material suitable. Such action may include:
 - a) removing the material and replacing it with suitable material;
 - b) adjusting the moisture content by appropriate mechanical or chemical methods including the addition of water in the case of dry material.
 - c) ceasing work on the material until it again becomes suitable.
8. At all times while compacting, operate vibratory rollers within the manufacturer's recommended frequency range for the type of material being compacted and at the optimum operating frequency.

C. Preparation of Subsoil:

1. After clearing, grubbing, and the removal of all unsuitable material, level the surface of the subsoil to receive fill, moisture-condition as required, and compact so that the upper 300 mm of the compacted soil material has the same relative compaction as specified in Section 02210 for the type of fill to be subsequently placed.
2. When road embankments are to be constructed and compacted on natural or previously constructed fill slopes, cut such slopes for a minimum of 2 meters horizontally as the work is brought up in layers. Material thus cut out, when found suitable as fill material, be compacted along with the new road embankment material. Material cut out but is unsuitable for fill material to be disposed of as specified herein.

D. Compaction and Testing of Earthworks:

1. Compaction and testing requirements for earthworks forming part of the Permanent Works shall be in accordance with Section 02210. Unless otherwise shown on the Contract Drawings, there are no specific relative compaction requirements for temporary fill placed for surcharge loading purposes. The field density testing requirements for such temporary surcharge are the same specified for General Fill in Section 02210.

3.09 UNCLASSIFIED STRUCTURAL BACKFILL

- A. Prior to placement of unclassified structural backfill, all concrete placement and all construction to be completed below the elevation of the finished grades and accepted by the Engineer. Remove all formwork, trash and debris from the excavation, and the area to be free of standing or running water.
- B. Arrange the timing and rate of placing of backfill material around or upon any completed or partially completed structure in such a way that no part of the work is over stressed, weakened, damaged or endangered. In particular, commence the placing of backfill materials against the walls of structures only after the walls and floor have been completed and have attained their full specified strength. Backfill materials against walls restrained by structural elements located above or below finished grade level not to be placed until such structural elements have been installed and, if made of concrete, have attained their full specified strength and have had the temporary supports removed.

Do not backfill until the concrete surfaces against which it is to be placed have received their protective treatment.

- C. Each layer of backfill material to be so placed as to maintain adequate drainage and to prevent accumulation of water.
- D. Place the unclassified structural backfill in uniform layers by bringing up uniformly on all sides of the structure being backfilled. Within 1.5 meters of the sides of a structure, place the backfill in layers not exceeding 150 mm in uncompacted thickness and compacting backfill using lightweight vibratory compactors. Do not use compaction equipment or methods that transmit excessive pressures to the structure.
- E. Compaction and testing of unclassified structural backfill to be as specified in Section 02210 except where other specific compaction requirements are specifically indicated on the Contract Drawings.
- F. Compaction of unclassified structural backfill by ponding or jetting is not permitted unless recommended by the Contractor and specifically approved in advance by the Engineer.
- G. Maintain the level of tolerances as specified under Clause 3.11.

3.10 SUPPORTING EXCAVATIONS

- A. Provide adequate supports to the sides and ends of all excavations so as to make them safe and to prevent the occurrence of falls or runs from any portion of the ground outside the excavation or settlement or damage to structures adjacent to the excavation. Install additional shoring as directed by the Engineer, where in the opinion of the Engineer, sufficient or proper shoring has not been provided. Neither compliance with such directives, nor failure of the Engineer to make such directives, relieve the responsibility for adequate support. When any excavation gives way damaging adjacent structures, carry out the necessary repairs at no extra cost.

3.11 TOLERANCES

- A. General: Finished excavation and fill for Permanent Works to be to the lines, levels and profiles shown on the Contract Drawings with the tolerances specified herein.

- B. Tolerances for Fill (except fill for road embankment):
1. General Fill: ± 100 mm.
 2. Fill to be covered with concrete in foundations or linings, or drainage or filter layers of artificial or selected natural materials, or any layer of other material: +0 mm, -75 mm.
 3. The surface tolerance requirements:
 - a. Tolerances along the top edge of any slope steeper than 1 vertical to 30 horizontal not to concentrate rainfall run-off to particular points where it could cause erosion of the slope.
 - b. Slopes steeper than 1 vertical to 30 horizontal not to vary by more than 10% of the specified slope inclination at any point on the slope.
- C. Tolerances for Road Excavation and Road Embankment Fill:
1. No point on excavation slopes to vary from the plane of the design slope by more than 100 mm measured at right angles to the slope except for excavation in rock where points not to vary by more than 500 mm.
 2. No portion of the excavation slope to encroach on the roadbed.
 3. Do not vary any point on the completed embankment slope within 1.0 metre below shoulder grade from the plane of the design slope by more than 100 mm measured at right angles to the slope. Slopes more than 1.0 metre below shoulder grade not to vary from the plane of the design slope by more than 200 mm measured at right angles to the slope.
 4. Do not vary any point on the completed median and side slopes which are on 1 vertical to 6 horizontal or flatter slopes, whether in excavation or embankment, from the plane of the design slope by more than 60 mm measured at right angles to the slope. Flow lines within medians to be graded to drain and not to vary more than 30 mm from the required grade line.

3.12 SETTLEMENT PERIOD

- A. Where a settlement period is shown on the Contract Drawings or otherwise specified, construct the permanent fill to full height and to the other limits shown or specified and shall remain in place for the required settlement period before commencing construction of foundations or placing other layers of materials on the fill surface.
- B. Where a settlement period for a surcharged permanent fill is shown on the Contract Drawings or otherwise specified, construct the surcharge fill to the height and to the limits shown or specified. The surcharge fill to remain in place until the end of the settlement period shown or specified.

3.13 DUST AND NOISE CONTROL

- A. Use all means necessary to control dust on and near the Work and on and near all borrow

areas.

- B. Thoroughly moisten all surfaces as required to prevent dust being a nuisance or a hazard to the public and affect the performance of other work on the site.
- C. Take adequate precautions to control noise during the works. Carry out the work only between the period from 07.00 hours to 19.00 hours Saturday to Thursday inclusive. Agree Ramadan working hours with KJO.

END OF SECTION 02220

SECTION 02221

TRENCHING, BACKFILLING, COMPACTION AND GENERAL GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation, dewatering and backfilling with compaction of trenches for pipes, conduits, channels and pits for structures associated with them.
- B. General grading comprising all excavation and fill for preliminary grading of the whole site and the final grading of all land outside the areas of road construction and building structures.
- C. Preparation of subgrade for equipment bases.
- D. Control and removal of surface and subsurface water regardless of its source and character, providing and maintaining access roads to borrow areas and all other associated work.

1.02 RELATED SECTIONS

- A. Section 02200 Earthwork.
- B. Section 02210 Compaction and Testing of Earthwork.
- C. Section 02220 Structural Excavation and Backfill.

1.03 REFERENCES

- A. ASTM D 1556 Test Method for Density of Soil in Place by the Sand-Cone Method.
- B. ASTM D 1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 kg) Rammer and 18 in (457 mm) Drop.
- C. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.
- D. ASTM D 2167 Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- E. ASTM D 3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
- F. ASTM C 136 Sieve or Screen Analysis of Fine and Coarse Aggregates.
- G. ASTM D 421 Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
- H. ASTM D 4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils.

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| I. | ASTM D 1140 | Amount of Material in Soils Finer than the No. 200 Sieve. |
| J. | ASTM D 2217 | Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants. |
| K. | ASTM D 2419 | Sand Equivalent Value of Soils and Fine Aggregates. |
| L. | AASHTO T 224 | Correction for Coarse Particles in the Soil Compaction Test. |
| M. | ASTM D 1883 | Bearing Ratios of Laboratory - Compacted Soils |

1.05 QUALITY ASSURANCE

- A. Perform work in compliance with applicable requirements of the safety codes, regulations and standards.
- B. Furnish samples and perform all tests and quality control required for the proper execution of the work under the supervision and to the satisfaction of the Engineer.
- C. Tests for proposed soil material:
 - 1. Test soil materials proposed for use in the work for ascertaining their suitability to the satisfaction of the Engineer.
 - 2. Provide one dry density versus moisture content curve, and one relative density test if applicable, for each type of soil encountered in subgrade, fills and backfills. Determine densities in accordance with ASTM D 1557: Method D and ASTM D 4254, as applicable.
 - 3. Determine the physical and mechanical properties and suitability of materials for subgrade, fills and backfills.
 - 4. Tests on proposed soil for backfill: Perform and report to the Engineer the following samples and tests for the proposed subgrade soil, fill and backfill:
 - a. ASTM C 136 Sieve or Screen Analysis of Fine and Coarse Aggregates.
 - b. ASTM D 421 Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
 - c. ASTM D 4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - d. ASTM D 1140 Amount of Material in Soils Finer than the No. 200 Sieve.
 - e. ASTM D 1557 Moisture Density Relations of Soils using 10 lb (4.5 kg) Rammer and 18 inch (457 mm) Drop, Method D.
 - f. ASTM D 2217 Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
 - g. ASTM D 2419 Sand Equivalent Value of Soils and Fine Aggregates.
 - h. ASTM D 1556 Test for Density of Soil in Place by Sand Cone Method.
 - i. AASHTO T224 Correction for Coarse Particles in the Soil Compaction Test.
 - j. ASTM D 1883 Bearing Ratios of Laboratory - Compacted Soils
 - k. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.

1.06 JOB CONDITIONS

A. Existing utilities

1. Where required at perimeter interfaces and diversions, expose existing underground utilities by careful hand excavation. If utilities are to remain in place, provide supports and protection from damage during construction operations.
2. Co-operate with Owner in keeping respective services and facilities in operation, and repair utilities damaged by Contractor to the satisfaction of the Engineer and Owner at Contractor's expense. Alternatively, at Owner's option, provide access for Owner-executed repairs to utilities damaged by Contractor. Costs of Owner – executed repairs to utilities damaged by the Contractor shall be borne by the Contractor.

B. Examination of substrate:

Examine the substrate and the conditions under which the work is to be performed and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

PART 2 PRODUCTS

2.01 DEFINITIONS

A. Satisfactory soil materials:

1. Satisfactory soil materials for backfilling and fill are defined as those belonging to soil classification groups, sub groups A-1, A-2-4, A-2-5 and A-3 in accordance with ASTM D 3282.
2. Soils of classification group A-2 not having a CBR value in excess of 30 and any other materials having this deficiency, shall not be used for the top 150 mm layer comprising the subgrade.

B. Unsatisfactory soil materials:

1. Unsatisfactory soil materials for back fill and fill are those described in ASTM D 3282 as belonging to soil classification groups A-2-6, A-2-7, A-4, A-5, A-6 and A-7, peat and other highly organic soils, unless otherwise acceptable to the Engineers.

2.02 MATERIALS

A. Backfill and fill materials:

1. Provide satisfactory soil materials for backfill and fill, free of clay, rock or boulders larger than 100 mm in any dimension, debris, garbage, vegetation and other deleterious matter and use excavated or borrow material which has been sampled, tested and approved as satisfactory soil material.
2. Material excavated from borrow pits selected and approved by the Engineer, for

which the rights to procure material have been obtained from the Owners. Pay all royalties and all expenses of excavating handling, hauling, and placing the material.

PART 3 EXCAVATION

3.01 EXCAVATION

A. General:

Excavation consists of the removal of all materials encountered above the required grade elevations, setting aside satisfactory soil materials for reuse in backfilling (in trenches, around structures) and filling (for general grading and other purposes) and disposal of unsatisfactory and excess material.

B. Classification of excavations:

All excavation shall be done on an unclassified basis. No consideration will be given to the nature of the materials, including that of rock, and all excavation will be designated as common excavation. No separate compensation shall be made for rock encountered in the excavation, the additional cost resulting therefrom shall be allowed for in the contract prices for common excavation.

C. Unauthorised excavation:

Unauthorised excavation consists of removal of materials beyond indicated elevations or lateral limits without the specific direction of the Engineer. Unauthorised excavation shall be replaced by backfilling and compacting as specified for authorised excavations unless otherwise directed by the Engineer.

D. Additional excavation:

When excavation has reached the required trench bottom or grade elevations, notify the Engineer for the inspection of conditions. If unsuitable bearing materials are encountered at these elevations, carry excavations deeper and replace the excavated material, as directed by the Engineer, at no additional cost to the Owner.

E. Stability of excavation:

1. Slope the sides of excavation to the angle of repose of the in -situ material excavated, or provide shores, timbering, struts and sheeting, as required, and brace where sloping is not possible either because of space restrictions or is to be avoided because of the trenching requirements described later.
2. Maintain sides slopes of excavations in a safe condition until completion of backfilling.
3. Take prior precautions to prevent slides or cave-ins in excavation.

F. Dewatering:

1. Prevent surface water and subsurface or ground water from flowing into excavations and flooding the work site and surrounding area.

2. If water is encountered in excavation, it shall be removed without allowing it to accumulate, in order to prevent soil changes detrimental to the stability of subgrades. Provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components necessary to convey the water away from the site.
3. Drain the water from excavations and rainwater to collecting or run-off areas. Trench excavations for utilities shall not be used as temporary drainage ditches.

G. Material storage:

1. Stockpile excavated materials classified as satisfactory soil material in approved locations, until required for backfill or fill, and place, grade and shape stockpiles for proper drainage.
2. Retain materials required for the work and locate them at sufficient distance from the edge of excavations, even though such excavations may be sheeted and braced, to prevent such material falling or sliding into the excavations and to prevent cave-ins.

H. Excavation for trenches and utility structures:

1. Comply with the following instructions in execution of this work:
 - a. Excavate as far as possible to a uniform width and as close as possible to such width as is just sufficient to provide all the working room required for the particular item to be installed. In case of a pipe, excavation from a point at least 300 mm above its crown to the trench bottom shall be to a uniform width, which is the minimum necessary to provide adequate working space on its sides and is approved by the Engineer as the maximum permissible width for this part of the trench.
 - b. Make good any excavation in excess of the above-mentioned maximum allowable trench width for a pipe, with plain concrete utilizing formwork to achieve the approved trench width below a point at least 300 mm above its crown.
 - c. In materials other than rock, leave at least the last 150 mm, both vertically and horizontally, to such final surface on or against which some materials shall be placed, to be excavated only at such short time before the placing of covering materials, as approved by the Engineer. Carry out the whole or part of this last stage of excavation, as required, manually and protect the final surface from all disturbance and flooding until the covering materials are placed.
 - d. For foundations of underground structures, i.e. manholes, chambers, and for channels and drains, on materials other than rock, excavate by hand for a depth of at least 50 mm to final grade and elevation. Trim and compact bottoms to the required lines and grades to leave a solid base to receive the structure, and take care not to disturb the bottom of the excavation until it is covered by concrete.
 - e. Excavate trenches to the depth indicated or required. Carry the depth of trenches for pipes to below the invert elevations as required for pipe bedding or other supports.
 - f. Where rock is encountered in trench excavation carry the excavation to at

- least 150 mm below the pipe and back fill and compact with granular bedding material.
 - g. Grade bottoms of trenches as indicated. In case of trenches for pipes to be supported on granular material, fill and compact to the pipe support level, shaping the bedding surface to fit the lower portion of the pipe and making notches in the bedding under pipe bells, sleeves, flanges or other protuberances at joints and intersections, to allow joints to be properly made and to provide solid bearing for the entire length of the pipe. If concrete surround or cradle is to be provided, hold pipe with joints ready firmly in position by concrete blocks and carefully place concrete, working it thoroughly under the pipe to provide a solid and uniform bedding.
 - h. Do not backfill until tests and inspections have been made and backfilling is authorized by the Engineer. Use care in backfilling to avoid damage to structures and or displacements of pipe systems.
2. Trenches shall not remain open for more than 5 days (120 hours), which shall be counted from the completion of excavation to the start of backfilling.

3.02 COMPACTION

A. General:

Control soil compaction during construction, as to provide at least the minimum percentage of density or the minimum relative density, if applicable, specified for each area classification.

B. Density requirements:

1. Soil compaction for backfill in trenches around associated structures, for subgrade below equipment bases and for fill elsewhere shall not be less than the percentages of maximum dry density given below in sub-para (a) and (b) for soils which exhibit a well defined density- moisture relationship determined in accordance with ASTM D 1557, Method D, and not less than the relative densities in percent values given in the same sub-para determined in accordance with ASTM D 4254, for soils which do not exhibit a well-defined moisture- density relationship.
 - a. Under road ways or shoulders and under equipment bases:
 - i) The top 300 mm comprising the subgrade: 100 % of maximum dry density, or 78 % relative density if required in case of cohesionless soils.
 - ii) Other layers of backfill and fill: 95 % of maximum dry density, or 74 % relative density if required for cohesionless soils.
 - b. Under paved areas other than roadways or shoulders:
 - i) The top 300 mm comprising the subgrade: 95 % of maximum dry density, or 74 % relative density if required for cohesionless soils.
 - ii) Other layers of back fill and fill: 90 % of maximum dry density, or 70 % relative density if required for cohesionless soils.

C. Moisture control:

1. Where the moisture content of a layer of the subgrade or other soil must be increased before compaction, water shall be applied uniformly to its surface and in such a manner that free water is prevented from appearing on the surface during the compaction operation.
2. Soil which is too wet to permit compaction to specified density shall either be removed and replaced, or scarified and dried.
3. Soil material, which has been removed because it is too wet to permit compaction may be stockpiled or spread in approved locations and permitted to dry. Drying shall be assisted by harrowing or pulverising, until the moisture content is reduced to a satisfactory value as determined by moisture-density relation tests.
4. Moisture in soil being compacted shall be uniform and maintained within + or - 3% of the optimum moisture content as determined by ASTM D 1557 or, if required in case of cohesionless soils, by field trials, unless directed or approved otherwise by the Engineer. Sand may be compacted dry only if this method is approved by the Engineer and the required field density is consistently achieved.

3.03 BACKFILL AND FILL

A. General

1. Backfill consists of the placement in the excavations, of specified soil materials in layers to the required grade elevations and compaction to densities specified for areas in each classification listed above in para 3.02.
2. Fill consists of the placement over the ground surface, of specified soil materials in layers to the required elevations and compaction to densities specified for each area classification listed above in para 3.02.
3. The layers of soil materials shall be 200 mm maximum loose thickness in each case, unless directed or approved otherwise by the Engineer.

B. Backfill and fill materials

1. Provide satisfactory soil materials for backfill and fill, free of clay, rock or boulders larger than 50 mm in any direction, debris, garbage, vegetable matter, and other deleterious matter.
2. Only such excavated or borrow material shall be used in fills and backfills, as have been sampled, tested and approved by the Engineer.

C. Requirements prior to backfill placement

1. Backfill as promptly as the work permits, but not until completion of the following:
 - a. Approval by the Engineer of construction below the finished grade.
 - b. Inspection, testing, approval and recording of locations of underground utilities.
 - c. Removal of concrete formwork, except that approved to be left in place.
 - d. Removal of shoring and bracing, except that required to remain, and backfilling of voids with satisfactory materials.

- e. Cut-off of temporary sheet piling driven below bottom of structures if required to be left in place. Otherwise their removal in a manner to prevent settlement of the structures or utilities.
 - f. Removal of trash and debris.
 - 2. Supports and bracing designated as permanent, and temporary bracing installed to provide horizontal support to walls, shall be left in place during backfill.
- D. Preparation of surfaces to receive backfill and fill
 - 1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface or excavation bottom, prior to placement of backfills and fills.
 - 2. When the soil below the surface of existing ground or excavation bottom has a density less than that required for its area classification, it shall be broken up, pulverised, moisture-conditioned to the optimum moisture content, and compacted to such depth and density as are required by the Engineer.
- E. Placement and compaction
 - 1. Place backfill and fill materials in layers not more than 200 mm in loose depth unless otherwise directed or approved by the Engineer. Before compaction, each layer shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and compacted to the required density for each area classification. Backfill or fill material shall not be placed on surfaces that contain excessive moisture preventing achievement of the specified degree of compaction.
 - 2. Trenches: Provide satisfactory soil containing no rocks or boulders greater than 100 mm in size and other deleterious material. Pipe embedment material shall be as specified in the pipe utilities sections or drawings.
 - 3. Around structures: Care shall be taken to prevent wedging action of the backfill against structures by raising the material uniformly around the structure to approximately the same elevation in each lift.

3.04 GRADING

- A. General
 - 1. Uniformly grade all areas of the project site as well as the adjacent transition areas. Make the finished ground surface smooth within the specified tolerances and compact it, providing uniform slopes between points where elevations are shown or between such points and existing grades.
 - 2. Tolerances for grading shall be as follows:
 - a. In level, + or – 50 mm from specified levels.
 - b. In surface finish, less than 30 mm beneath a 3 m straight edge.

3.05 FIELD QUALITY CONTROL

A. Quality control testing during construction

Take the following measures for this purpose:

1. Inspect and perform all testing and retesting to ensure that all the works conform to the specified requirements in respect of evenness of surface, field density and load bearing capacity.
2. Inspect and ensure that all subgrades and fill layers conform to the specified requirements and obtain Engineer's approval before further construction is performed thereon.
3. Perform field density tests, in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method) as applicable, with the following frequencies:
 - a. At least one field density test of foundation subgrade for each equipment base.
 - b. At least one field density test for every 50 m of trench backfill for each 1.5 m lift or part thereof.
 - c. All soil characteristic tests at locations selected at the rate of 1 location for 10 field density test locations
4. Where field density tests are not practicable or load bearing capacity is to be determined under carriageway and equipment base construction, perform plate bearing tests.
5. If, in the opinion of the Engineer based on reports or inspection, the subgrade, backfills or fills which have been placed are below the specified density, provide additional compaction and testing until satisfactory results are obtained.

3.06 MAINTENANCE

A. Protection of graded areas:

Protect newly graded areas from traffic and erosion, and keep them free of trash and debris. Repair and re-establish grades in settled, eroded and rutted areas, to the specified tolerances.

3.07 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Transport acceptable excess excavated material to designated soil storage areas, located within a radius of 10 km from the work site, for stockpiling, and spread/grade it as directed by the Engineer.
- B. Transport unsatisfactory excavated material, trash and debris to an approved municipal site for dumping, spread and grade as required.

END OF SECTION 02221

SECTION 02230

AGGREGATE OR GRANULAR SUBBASE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate or granular subbase as shown on the drawings.

1.02 RELATED SECTIONS

- A. Section 01400 Quality Requirements.
- B. Section 02210 Compaction and Testing of Earthworks.
- C. Section 02232 Aggregate Base Course.
- D. Section 02513 Pavements – Asphaltic Concrete.

1.03 REFERENCES

- A. General Specifications for Roads and Bridge Construction, Ministry of Communications, the Kingdom of Saudi Arabia with the applicable addenda and circulars.
- B. Materials and Research Department Manual of Materials and Tests (MRDTM) and all current letters issued by Ministry of Communications.
- C. American Association of State Highway and Transportation Officials:
 - 1. AASHTO M 147 Standard Specification for Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses.
 - 2. AASHTO T 180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10 lb) Rammer and a 457 mm (18 in) Drop.
- D. American Society for Testing and Materials
 - 1. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).
 - 3. ASTM D 1556 Standard Test Method for Density of Soil in Place by the Sand Cone Method.
 - 4. ASTM D 1557 Standard Test method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³).

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| 5. | ASTM D 2167 | Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method. |
| 6. | ASTM D 2487 | Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System). |
| 7. | ASTM D 2922 | Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). |
| 8. | ASTM D 3017 | Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth). |
| 9. | ASTM D 4318 | Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. |

1.04 SUBMITTALS

- A. Comply with provisions of section 01300.
- B. Formulate Job Mix Formula (JMF) with pertinent test data and results and submit for approval at least 30 days before producing subbase mixture.
- C. Furnish the source and gradation of the aggregate for each mix.
- D. Type of plant to be used for mixing each mix.

1.05 QUALITY REQUIREMENT

- A. Determine the location, suitability and quality of materials available for the construction of the aggregate/granular base from a single source throughout the work.
- B. Examine the substrata and the condition under which the aggregate/granular subbase is to be laid and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
- C. Compaction testing and field quality control shall be conducted by an Independent Testing Laboratory as per Section 01410.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregate used for aggregate subbase to be free from vegetation matter and other deleterious substances and, when compacted under watering and rolling, form a firm, stable subbase. Coarse aggregate to be crushed stone, crushed slag, or crushed gravel. Fine aggregate, material passing the 4.75 mm (No. 44) sieve, to consist of natural or crushed sand and fine material particles.
- B. Furnish, produce, stockpile, blend and mix all necessary materials using such equipment and procedures as will produce specified aggregate subbase.

- C. Aggregate to conform to one of the following grading and quality requirements on the road bed after all blending and mixing and spreading and before compacting, when tested in accordance with ASTM C 136.

AGGREGATE SUBBASES GRADATION REQUIREMENTS

Sieve Sizes	Grading I	Grading II
62.5 mm (2½ inch)	100	-
50 mm (2 inch)	90-100	100
37.5 mm (1½ inch)	-	90-100
25 mm (1 inch)	-	55-85
19 mm (¾ inch)	-	50-80
9.5 mm (3/8 inch)	-	40-70
4.75 mm (No. 4)	35-70	30-60
2.54mm (No. 10)	-	20-50
0.425 mm (No. 40)	-	10-30
0.075 mm (No. 200)	0-15	0-15

QUALITY REQUIREMENTS	
Sand Equivalent	25 min.
Plasticity Index	6 max.
Abrasion Loss	50 max.
California Bearing Ratio (CBR)	50 min.

- D. When the aggregate (coarse, fine, supplemental fine) is separated into two (2) or more sizes, provide the information consisting of gradations for all individual sizes, the proportions of each individual size to be used, and the mathematically combined gradation for each mix to be furnished as per requirements shown above and show the percentage passing each of the specified sieve sizes.
- E. Provide the Engineer access to the materials sampling and testing operations at all times. The combined aggregate, including mineral additives, shall conform to the approved job mix formula grading within the following tolerances:

9.75 mm (3/8") and larger sieves,	± 11 percentage points
4.75 mm (No. 4) sieve,	± 10 percentage points
2.36 mm (No. 8) sieve,	± 9 percentage points
0.300 mm (No. 50) sieve,	± 8 percentage points
0.075 mm (No. 200) sieve,	± 8 percentage points

- F. Do not begin production of aggregate subbase mixes until the Engineer has given written acceptance of the Job Mix Formula.
- G. Acceptance of the JMF by the Engineer does not relieve the obligation to produce aggregate base mixes to all specified requirements.
- H. When there is change in the source of aggregate, furnish a new job mix design proposal and samples of materials, as described above.

2.02 EQUIPMENT

- A. Furnish all necessary equipment for production, stockpiling and hauling aggregate, preparing the subgrade and placing, compacting, finishing and maintaining the aggregate subbase according to the minimum type and number outlined in the detailed Program of Work as approved by the Engineer.

Perform blending, mixing aggregates and adjusting the moisture content as required for compaction in a central mixing plant or on the grade by means that insure uniformity.

Place and spread the blended and mixed aggregates to the width and thickness specified.

PART 3 EXECUTION

3.01 QUALITY CONTROL PROCEDURES

- A. Test the aggregate furnished for subbase to control the quality. Forward copies of all test results to the Engineer at the end of each working day. The Engineer shall have access to the testing laboratory at all times and the right to obtain samples of the materials at any point during construction. When requested by the Engineer, obtain aggregate subbase materials and prepare duplicate samples by quartering. Deliver one (1) sample to the Engineer and test the duplicate sample.
- B. Perform the following minimum types and number of tests:
 - 1. Gradation, sand equivalent and plasticity index – One (1) test each per two thousand (2000) cm of aggregates produced but not less than one (1) test per production day.
 - 2. Abrasion Loss – One (1) test for the first, second and third five hundred (500) cubic meters of aggregate produced and one (1) test for each twenty five hundred (2,500) cubic meters thereafter.
 - 3. CBR Value – One (1) test for each five thousand (5,000) cubic meters placed.
- C. When test data indicate that the aggregate subbase does not conform to specified

requirements, take effective action to correct production methods to assure that subbase aggregate will conform to all specified requirements. Such action to include halting production, changing the sources of aggregate supply, altering amount of aggregate scalped and rejected, increasing degree of crushing, and revising blending and handling methods. Such material if already placed, shall be removed and modified or replaced to produce material conforming to the specified requirements.

3.02 SURFACE PREPARATION

- A. The surface to receive aggregate subbase immediately prior to spreading aggregate subbase, to conform to specified compaction and elevation tolerances and to be free of loose or extraneous material.
- B. Correct any deviation from specified elevation and compaction in the surface to receive aggregate subbase.
- C. When surfaces to receive aggregate subbase are lower than specified, fill the low areas with aggregate subbase. The volume of aggregate subbase so placed not to be measured for payment under any item listed in the Bill of Quantities.

3.03 PLACING AND SPREADING

- A. Aggregate for subbase, immediately prior to spreading to be uniform mixtures free from pockets and streaks of coarse or fine material and be deposited on the subgrade in uniform layers using approved equipment.
- B. Shape the layers of aggregate subbase to such thickness that, after watering and compacting, the completed subbase layer conform to the required width, grade and thickness within the tolerances specified in Paragraph 3.05 "Finishing".
- C. Handle the material avoiding segregation. Remix the segregated materials until uniform. The water can either be added in the borrow pit or on a mixing platform or on the grade.
- D. Where the subbase thickness is twenty (20) centimeters or less, the aggregate subbase may be spread and compacted in one (1) layer. Where the required thickness is more than twenty (20) cm, spread the aggregate subbase in two (2) or more layers of approximately equal thickness.

3.04 COMPACTING

- A. Each layer of subbase material, after being shaped to the required lines and cross section, to be compacted to a uniform density with no individual test being less than ninety-five percent (95%) of the maximum dry unit weight. Each of lot of subbase material to have a percent relative compaction of not less than ninety-nine percent (99%) of the maximum dry unit weight. Water or dry the subbase as may be necessary to obtain a moisture content suitable for compaction. Material which has dried prior to final compaction or which has dried and decompacted subsequent to final compaction to be watered and recompactd using equipment and procedures approved by the Engineer. When found impossible to return the material to its original or specified condition with respect to compaction, thickness, and surface tolerances, remove the material and reconstruct the course on a reapproved subgrade.
- B. When there are delays in constructing the remaining pavement structure over a granular course, verify the compaction of the granular course and deficient areas corrected or

replaced to the satisfaction of the Engineer.

- C. Plan the work and handle the various operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. In case placing of succeeding layers of material is delayed, apply additional water to prevent ravelling or excessive drying.
- D. Compact the material by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass. Continue rolling until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density. The final rolling of the completed course to be done with a self-propelled roller as approved by the Engineer. Rolling to be accompanied by sufficient blading, in a manner approved by the Engineer, to insure a smooth surface, free from ruts or ridges and having the proper section and crown. When additional water is required, add it in the amount and manner approved by the Engineer. Construct the initial layers of material to a uniform grade and cross section, compact and obtain approval from the Engineer prior to the delivery of materials for a succeeding layer.
- E. Prior to placing a succeeding layer of granular material, moist the surface of the underlayer sufficiently, to insure bond between the layers. Blade/dress the edges and edge slopes of the base course to conform to the lines and dimensions shown on the plans, and present straight, neat and workmanlike lines and slopes as free of loose material as practicable.
- F. Any areas inaccessible to normal compaction equipment to be compacted by means of portable mechanical tampers until satisfactory compaction is obtained. When the last layer is to be trimmed to final grade by an automatic grading machine, construct it approximately one (1) to three (3) centimeters above grade, so that the grading machine cuts continually. After the final pass of the grading machine, wet and roll the subbase.

3.05 FINISHING

- A. Place all subbase material, trim and finish in a neat and workmanlike manner in compliance with the lines, grades and typical cross sections shown on the plans within the tolerances listed below. Check the cross section of the finished subbase in the presence of the Engineer at maximum intervals of twenty-five (25) meters and at intermediate points as directed by the Engineer. The deviation of the elevation of the surface above the design elevation to be not more than twenty (20) millimeters. Deviations above the design elevation not result in the diminished thickness of any subsequent pavement course. Compensate the deviation of the elevation below the design elevation by additional thickness of the subsequent pavement layer. Furnish all devices necessary to check the surface, such as stringlines, straightedges, etc., and the manpower necessary to handle the task.

3.06 MAINTENANCE AND PROTECTION

- A. Following construction of the subbase course blade, broom, and otherwise maintain the course, keeping it free from raveling and other defects that result in lost density until such time as the next element of the pavement structure is placed. Apply water at such time and in such quantities as directed by the Engineer. The Engineer has full authority to suspend all other work on the project to insure the proper maintenance of previously compacted material.
- B. The Engineer shall determine when the surface of the subbase is in the proper condition to permit the placement of aggregate subbase course or the bituminous primer and/or surfacing

to be applied. Continue to maintain the surface of the base course, including the application of necessary water, until such time as the bituminous primer or the subsequent layer is applied.

3.07 COMPACTION TEST TRIALS

- A. When directed by the Engineer prior to the commencement of subbase compaction operations, construct compaction trial lengths, not to exceed one (1) km.
 - 1. The materials used in the trials to be that approved for use as aggregate subbase and the equipment be that according to the approved detailed Program of Work.
 - 2. The object of these trials is to determine the adequacy of the equipment, the loose depth measurements necessary to result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.
- B. Proceed with aggregate subbase work only after the methods and procedures established in the compaction trial has been approved by the Engineer.

END OF SECTION 02230

SECTION 02232

AGGREGATE BASE COURSE

PART 1 GENERAL

1.01 SECTIONS INCLUDES

- A. Provision, spreading and compaction of materials of aggregate base course for roads in accordance with the specifications and in conformity with grade, lines and thickness shown on the drawings, including setting out of controls and furnishing of all plant, machinery, tools, equipment, guides, templates and labor.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements.
- C. Section 02210 Compaction and Testing of Earthwork.
- D. Section 02230 Granular Sub-base.
- E. Section 02513 Pavements – Asphaltic Concrete.

1.03 REFERENCES

- A. General Specifications for Roads and Bridge construction, Ministry of Communications, in Kingdom of Saudi Arabia.
- B. Ministry of Communications circular No. 2403 dated 24.05.1407 H, with other applicable circulars and addenda to General Specifications.
- C. American Society for Testing and Materials – ASTM.
 - 1. ASTM C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 2. ASTM C 136 Sieve Analysis of Fine and Coarse Aggregate.
 - 3. ASTM D 1196 Standard Method for Non-Repetitive Static Plate Load Tests of Soil and Flexible Pavement Components, for Use in Evaluation and Design of Airport, and Highway Pavements.
 - 4. ASTM D 4318 Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - 5. ASTM D 1883 Test Method for CBR (California Bearing Ratio) of Laboratory – Compacted Soils.

1.04 SUBMITTALS

- A. Comply with Section 01300.
- B. Propose Job Mix Formula (JMF) with pertinent test data and results at least 30 days before producing aggregate base mixtures.
- C. The source and gradation of the aggregate for each mix.
- D. Type of plant to be used for mixing each mix.

1.05 QUALITY REQUIREMENTS

- A. Determine the location, suitability and quantity of materials available for the supply of the aggregate base course from a single source throughout the work.
- B. Examine the substrate and the condition under which the aggregate base is to be laid, and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.
- C. Compaction test and field quality control shall be conducted by Independent Testing Laboratory as per Section 01410.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: The aggregate to be hard durable crushed stone or gravel, clean and free from excessive flat, elongated, soft or disintegrated pieces as well as organic matter or other deleterious substances, and be in a readily compatible conditions by watering and rolling to form a firm and stable base course. Any fine aggregate added to obtain the desired gradation shall be screenings obtained from crushing of stone, gravel or slag.
- B. Crushed stone aggregate not to contain more than eight (8) percent by weight flat, elongated, soft, or disintegrated pieces. Aggregate retained on the 2.36mm (No. 8) sieve to consist of stone particles of which at least ninety percent (90%), by weight, to have minimum two (2) mechanically fractured faces.
- C. Obtain the specified gradation by crushing, screening and blending processes, as necessary. Furnish stockpile, blend and mix all necessary materials using equipment and procedures to produce the specified aggregate base.
- D. If additional fine material, in excess of that already present in the base course material, is necessary for correcting the gradation properties for satisfactory bonding of the base material, or for adjusting the material characteristics of the fraction passing the 0.425mm (No. 4) sieve, blend the additional material uniformly and mix with the crushed aggregates. Such mixing shall take place at the crusher, at an approved stationary proportioning and mixing plant or on a travelling plant. Reworking of the base course material in place to obtain the specified requirements is not permitted. The additional fine material obtained from crushing stones, gravel, or slag, to comply with the specified gradation of the final mixture.

- E. Aggregate shall conform to one of the following grading and quality requirements on the road bed after all blending and mixing and spreading and before compacting when tested in accordance with ASTM C 136.

AGGREGATE BASES GRADING REQUIREMENTS

Sieve Sizes	PERCENTAGE PASSING		
	Grading I	Grading II	Grading III
50 mm (2 inch)	100	-	-
37.5 mm (1½ inch)	-	100	-
25 mm (1 inch)	55-85	70-95	100
19 mm (¾ inch)	50-80	55-85	70-100
4.75 mm (No. 4)	30-60	30-60	35-65
0.425 mm (No. 40)	10-25	10-25	15-25
0.075 mm (No. 200)	3-10	3-10	3-10
The fraction passing the No. 200 sieve shall not exceed ½ the fraction passing the 0.425mm (No. 40) sieve.			

QUALITY REQUIREMENTS	
Sodium Sulphate Soundness & Loss	12 max.
Abrasion Loss	45 max.
Sand Equivalent	45 min.
Liquid Limit	25 max
Plasticity Index	6 max.
California Bearing Ratio Grading I	100 min.
California Bearing Ratio Grading II	80 min.
California Bearing Ratio Grading III	65 min.

- F. If the aggregate (coarse, fine, supplemental fine) is separated into two (2) or more sizes, provide information consisting gradation and proportion of each individual size to be used, and the mathematically combined gradation for each mix. Such combined gradation meet the applicable grading requirements shown above and the percentage passing each of the specified sieve sizes.

- G. Provide the Engineer access to the materials sampling and testing operations at all times. The combined aggregate, including mineral additives, shall conform to the approved JMF grading within the following tolerances:
- | | |
|-----------------------------------|-----------------------|
| 9.75 mm (3/8") and larger sieves, | ± 9 percentage points |
| 4.75 mm (No. 4) sieve, | ± 8 percentage points |
| 2.36 mm (No. 8) sieve, | ± 7 percentage points |
| 0.300 mm (No. 50) sieve, | ± 6 percentage points |
| 0.075 mm (No. 200) sieve, | ± 4 percentage points |
- H. Do not begin production of aggregate base mixes until the Engineer has given written acceptance of the JMF.
- I. Acceptance of the JMF by the Engineer does not relieve obligation to produce aggregate base mixes conforming to all specified requirements.
- J. When the source of aggregate require change due to any reason, furnish a new job mix design proposal and samples of materials, as described above.

2.02 EQUIPMENT

- A. Furnish all necessary equipment for production, stockpiling, moisture conditioning, and hauling aggregate, preparing the surface on which the aggregate base will be placed, and placing, spreading, compacting, finishing and maintaining the aggregate base in accordance with the minimum type and number outlined in the Contractor's Program of Work as approved by the Engineer. Perform blending and mixing aggregates and adjusting the moisture content as required for compaction in a central mixing plant.

Place and spread the blended and mixed aggregates to the width and thickness specified using approved mechanical spreading equipment. Do not use motor graders for spreading.

PART 3 EXECUTION

3.01 QUALITY CONTROL PROCEDURES

- A. Carry out all the tests required to control quality of aggregate base course and furnish copies of all test results to the Engineer at the end of each working day. Provide the Engineer access to the Contractor's testing laboratory at all times and the Engineer to have right to obtain samples of the materials at any point during construction. When requested by the Engineer, deliver sample aggregate base materials and prepare duplicate samples, by quartering. One (1) sample to the Engineer and test the duplicate sample.
- B. Perform the following minimum types and number of tests:
1. Gradation, sand equivalent and plasticity index – One (1) test each per one thousand (1,000) cubic meters of aggregates produced but no less than one (1) test per production day.
 2. Abrasion Loss – One (1) test for first, second and third five hundred (500) cubic meters of aggregate produced and one (1) test for each twenty five hundred (500) cubic meters thereafter.

3. Percent Crushed Faces – One (1) test for each five hundred (500) cubic meters of aggregate produced.
 4. CBR Value – One (1) test for each five thousand (5,000) cubic meters.
- C. When test data indicate that the aggregate base does not conform to specified requirements, take effective action to correct production methods to assure that the materials produced will conform to all specified requirements. Action taken shall include halting production, changing the sources of aggregate supply, altering amount of aggregate scalped and rejected, increasing degree of crushing, and revising blending and handling methods.

3.02 PREPARATION AND MAINTENANCE

- A. Prepare the subgrade or subbase surface and maintain it true to cross section, grade and density. The surface of the subgrade or subbase, immediately prior to receiving the aggregate base to conform to the specified cross section, grade and density and be free of any loose or extraneous material. All subgrade or subbase protection, maintenance or repair work is considered subsidiary to items in the Bill of Quantities.

3.03 MIXING

- A. Mix the aggregate and the water thoroughly in a twin shaft pugmill type mixer, unless another type of mixer is approved. The amount of water added to the aggregate to be an amount to produce the mixture with a satisfactory moisture content for compaction to the specified in-place density. Control the rate of flow of the water to the pugmill by valves or other devices which can be easily reset to change the rate of flow if desired. Equip the water supply system with a positive cut-off control to stop the flow of water simultaneously with any stoppage in the flow of aggregate into the pugmill.

3.04 TRANSPORTING

- A. Transport the plant-mixed material suitably to deliver the mix to the project without loss or segregation. Cover truck load with a heavy canvas sheet to reduce the loss of moisture in transit whenever the time between loading the work and spreading the moisture exceeds thirty (30) minutes.

3.05 PLACING AND SPREADING

- A. Place the mixture on the existing roadway, approved subgrade or approved subbase, in a uniform layer or layers not exceeding fifteen (15) centimeters in compacted depth. Where the required thickness is greater than fifteen (15) centimeters, place the material in layers of equal thickness. On using heavy duty vibratory compaction equipment approved by the Engineer, the maximum compacted layer thickness could be twenty (20) centimeters.
1. Take compaction samples from the entire layer including the lower part of the increased thickness.
 2. The coarse aggregate on the top of the Aggregate Base layers are not damaged or crushed.

Engineer will rescind approval for the increased thickness more than fifteen percent (15%) of the subsequent field density tests taken on the thicker layer initially fail, necessitating retesting after additional compaction.

- B. Place the mixture course on the roadbed to the required width and uncompacted thickness as follows:
 - 1. Through an approved self-propelled spreading machine.
 - 2. In a sized windrow from which a paving machine or travel plant will pick-up and spread the aggregate base.
- C. To protect the underlayer and to allow proper drainage, begin the spreading of the base course material along the centerline on stretches with a crowned section or on the high side of stretches with a one-way slope.
- D. Handle the material properly to avoid segregation. If the approved spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be eliminated easily or prevented by adjustment to the spreading operation, discontinue the use of such approved spreader and replace it. Remove all segregated material and replace it with well-graded material. Do not do skin patching. Do only minor surface manipulation and watering to achieve the required surface tolerances during the compaction process.
- E. No hauling or placement of material will be permitted when, in the judgement of the Engineer, the weather or road conditions are such that hauling operations will cause rutting of the road surface or cause contamination of the subbase or base course material. Wet the subgrade or previous layer before placing the mixture to get good bond between the layers. Place and shape the mixture by power equipment to the lines, elevations, cross sections, depths and density specified in the following subsections.

3.06 COMPACTING

- A. Compact each layer of aggregate base material, after being shaped to the required lines and cross section, to a uniform density with no individual test being less than ninety-five percent (95%) of the maximum dry unit weight. The relative compaction for each lot of base material to be not less than one hundred percent (100%) of the maximum dry unit weight. Water/dry the aggregate base as necessary to obtain a moisture content suitable for compaction. Water and re-compact using equipment and approved procedures any material/surfaces which has dried prior to final compaction or which has dried and decompacted subsequent to final compaction. Failure to return the material to its original or specified condition with respect to compaction, thickness, and surfaces tolerances, remove the material and reconstruct the course on a reapproved subgrade.
- B. When there are delays in constructing the remaining pavement structure over a granular course, the compaction of the granular course shall be reverified and deficient areas corrected or replaced to the satisfaction of the Engineer.
- C. Plan the work and handle the various operations so that the least amount of water will be lost by evaporation from uncompleted surfaces.
- D. Compact the material by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass. Rolling to continue until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density. Do not roll the base course when the underlayer is soft or yielding or when rolling causes undulation of the base course. The final rolling of the completed course to be done with a self-propelled roller as approved by the

Engineer. Accompany the rolling by sufficient blading, in a manner approved by the Engineer, to insure a smooth surface, free from ruts or ridges and having the proper section and crown. Add additional water when required, the amount and manner as approved by the Engineer. Construct initial layers of material to a uniform grade and cross section and compact. Take Engineer's approval prior to the delivery of materials for a succeeding layer.

- E. Prior to placing a succeeding layer of granular material, moist sufficiently the surface of the underlayer to insure bond between the layers. Blade/dress the edges and edge slopes of the base course to conform to the lines and dimensions shown on the plans, and present straight, neat and workmanlike lines and slopes as free of loose material as practicable.
- F. Use portable mechanical tampers in areas inaccessible to normal compaction equipment until satisfactory compaction is obtained. When the final layer is to be trimmed to required grade by an automatic grading machine, lay this layer approximately one (1) to three (3) centimeters above grade, so that the grading machine cuts continually. After the final pass of the grading machine, wet and roll the base. Use the excess material removed by the grading machine in shoulders, islands, or other areas for which aggregate base is specified, but not under roadway pavement.

3.07 FINISHING

- A. Place, trim and finish all aggregate base material in a neat and workmanlike manner in compliance with the lines, grades and typical cross sections shown on the plans or staked by the Engineer.

Accomplish grade control by means of grade stakes, steel pins or forms, placed in lanes parallel to the centerline of the road and at intervals sufficiently close to permit placing of string lines or straightedges for checking purposes.

3.08 MAINTENANCE AND PROTECTION

- A. Following construction of the aggregate base course, blade, broom and otherwise maintain the compacted course, keeping it free from raveling and other defects that result in lost density until such time as the next element of the pavement structure is placed. Apply water at such times and in such quantities as directed by the Engineer, and the Engineer has full authority to suspend all other work on the project to insure the proper maintenance of previously compacted material.
- B. Repair any damage to the base course, or any layer thereof, caused from routing of construction or other equipment over completed stretches as approved by the Engineer.
- C. The Engineer to determine when the surface of the base course is in the proper condition to permit the bituminous prime and surfacing to be applied. Continue to maintain the surface of the base course, including the application of necessary water, until such time as the bituminous prime and surfacing is applied.

3.09 COMPACTION TEST TRIALS

- A. When directed by the Engineer, prior to the commencement of aggregate base compaction operations, construct compaction test trial lengths, not to exceed one (1) kilometer. The materials used in the trials to be that approved as aggregate base and the equipment as approved under detailed Program of Work.

The object of these trials is to determine the adequacy of the equipment, the loose depth measurements necessary to result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.

- B. Proceed with aggregate base Work only after the methods and procedures established in the compaction trial has been accepted by the Engineer.

3.10 SURFACE TOLERANCES

Evaluate for compliance the surface layer of the aggregate base with the following surface tolerances:

1. Check the cross section of the finished aggregate base surface in the presence of the Engineer at maximum intervals of twenty-five (25) meters and at immediate points as directed by the Engineer. The deviation of the elevation of the surface above or below the design elevation not to be more than ten (10) millimeters. Deviations above the design elevation shall not result in the diminished thickness of any subsequent pavement course. Compensate isolated deviations below the design elevation by additional thickness of the subsequent pavement layer.
2. Check the surface with a four (4) meter straightedge in all areas of apparent roughness as directed by the Engineer. The finished surface of the base course not to deviate from the straightedge between any two (2) contact point more than ten (10) millimeters when the straightedge is placed parallel to centerline or twelve (12) millimeters when the straightedge is placed perpendicular to centerline. Furnish all devices necessary to check the surface, such as stringlines, straightedges etc. and the necessary to handle the task.

END OF SECTION 02232

SECTION 02510 - WATER SUPPLY/ PIPES AND FITTINGS

PART 1 – GENERAL

1.1 RELATED WORK

- A. Division 15 - Mechanical

1.2 SYSTEM DESCRIPTION

- A. This section covers the general piping and fittings supply and installation required for the works.

1.3 REFERENCES

- A. Reference Standards

The latest edition of the following standards:

1. American Society for Testing and Materials (ASTM):
 - a. ASTM A53B Welded and Seamless Steel Pipe for Ordinary Use, Specification for Black and Hot Dipped Zinc Coated.
2. American National Standards Institute (ANSI): Standards as specified herein.

1.4 SUBMITTALS

- A. Product Data

Descriptive literature for each of the actual proposed material to be used including:

1. Operating Pressure Ranges.
2. Pressure Losses.
3. Fluid Flows.
4. Test Reports.
5. Certificates of approval.

- B. Shop Drawings

Shop drawings for each of the proposed systems shall includes following:

1. Working or manufacturing drawings.
2. Calculations.
3. Installations details
4. Connections to other services.
5. Accessories available indicating those included.
6. System diagrams.

1.5 QUALITY ASSURANCE

- A. Submit welder certificated signed by the Contractor certifying that welders comply with the technical requirements.

1.6 WORK INCLUDED ELSEWHERE

- A. Soil, Waste, and Roof Drainage Piping Systems.
- B. Sections related to External Site Utilities.

PART 2 – PRODUCTS

2.1 PIPES

- A. Service Schedule

<u>Service</u>	<u>Piping Class</u>
- Domestic cold water supply underground outside the building.	Multilayer
- Domestic cold water supply inside the building.	GSP
- Domestic hot water supply and return inside the building.	GSP
Service	Piping Class
- Fire Protection water supply pipes.	BSP
- Drainage and vent pipes above ground	UPVC

- Sanitary sewer under building structure	UPVC
- Sanitary sewer under ground and outside building.	UPVC
- Sanitary sewer under Roads.	UPVC
- Storm drain above ground	UPVC
- Storm drain under building structure	UPVC
- Laboratory waste Piping	HDPE
- Laboratory under bench waste piping	HDPE
- Gas	BSP
- Fuel Oil	BSP
- Drainage pipe from CSSD, Laundry	UPVC
- Chilled Water	BSP
- A/C Condensate drain	PPVC
- Refrigerant	CUP type 3
- Medical gas	CUP type 2
- Vacuum & Medical Compressed air	CUP type 2

B. Sizes

1. Unless otherwise specified steel pipe work of 65 mm nominal bore and over shall be welded joints, while 50 mm nominal bore and below the pipe work shall be screwed joints.

2.2 PIPING MATERIALS

A. UPVC Pressure Piping

1. Pipe work:

- a. The pipe work and fittings shall be U.P.V.C. in accordance with EN 1452, suitable for pressure pipes (10 bars).
- b. Fittings shall be in accordance with EN 1452.
- c. The pipe work and fittings shall be installed strictly in accordance with the manufacturers recommendations, copies, of technical instructions on the laying of U.P.V.C. pipe work shall be obtained from the manufacturer's Technical Service Department before work proceeds.
- d. When jointing pipe work the spigot and socket ends shall be supported clear of the ground to prevent dirt deposits on the joint, solvent or lubricant. Only solvent and lubricant made by the manufacturer of the pipe shall be used.
- e. When making flanged joints the correct flanges and seal rings shall be used with seal gasket set square between mating flange and all bolts secured evenly.
- f. Where solvent joints are used a mechanical joint incorporating a seal ring shall be incorporated where necessary to allow for thermal movement.
- g. Test pressure shall be applied to the system after a period of not less than 24 hours.
- h. Where joints are to be made between dissimilar materials a proper purpose made flanged adapter shall be used.
- i. No attempt shall be made to alter or manufacture U.P.V.C. fillings on site.
- j. All underground UPVC pipes shall be encased with reinforced concrete 150mm thick.
- k. All exposed UPVC pipes in false ceiling areas should be acoustic type.

2. Mechanical Joints:

- a. When making a mechanical joint a check shall be made to ensure that the depth of entry mark is indicated on every spigot before insertion into the socket, so that the spigot enters the socket within 13/25 mm of the socket.
- b. The spigot end of the pipe shall be chamfered to half the wall thickness and made with suitable hand tools provided by the manufacturer.
- c. When making a mechanical joint care shall be taken ensure that the seal ring is not misplaced.
- d. Due allowance shall be made for the control of thermal movement.

-
- e. Solvent Joints:
 - f. When making a solvent joint the spigot and sockets shall be wiped clean and thoroughly degreased with cleaner to remove oil, grease, etc, after which the spigot and socket shall have solvent adhesive applied.
 - g. The sockets and spigots shall be assembled as quickly as possible after applying the adhesive and within forty seconds after which it shall be held together for up to five minutes.
 - h. Special care shall be taken to prevent dirt and rubbish entering the open ends of pipes during erection. Wrought iron screwed caps or plugs, or plastic covers only shall be used. Wood, rag or paper plugs shall not be used. Failure to comply with this instruction shall mean that the Engineer shall have the right to order the pipe work to be dismantled for as far as considered necessary and the pipe work to be cleaned internally. Such work shall be carried out by the Contractor and all cost shall be borne by the Contractor.
 - i. The Contractor is reminded that the valve fitted to the open end of disconnected pipes is not considered satisfactory to prevent the entry of rubbish. The open end shall be capped, plugged or crimped.

B. Polypropylene pipes (PPR)

- 1. PPR pipes shall be high density, rigid type, working at 6 bars pressure at 90° C, according to DIN 16892/93.
- 2. Pipes shall be welded by an approved special electric welding process.
- 3. All tees, branches, reducers, shall be welded in the same manner of pipes.
- 4. PPR are allowed to be used for heating and domestic cold and hot water pipes, inside apartments, under tiles and inside walls.
- 5. Approved manufacturer: Coestherm or approved equal.

C. High density polyethylene pipes (HDPE)

- 1. HDPE pipe (high density polyethylene pipe), should be without any lubricant and conform to French norm NFT 54072 (polyethylene 5).
- 2. HDPE pipe should be specified by a blue sign for potable water network (public water), in order to be sure of the quality of the water (without odors). The storage of HDPE pipe shouldn't be in an exposed area to the sun and high temperature.
- 3. The thermo fusion should be executed by mirror or electrical collars.
- 4. Approved manufacturer: Future Pipe or approved equal.

D. Multi-Layer Pipes

- 1. Multi-layer pipes shall be of the longitudinally lap-welded aluminum with the inner and outer layers made of cross-linked polyethylene tightly bonded the aluminum by means of adhesives.
- 2. Multi-layer composite pipe shall be approved by DVGW for potable water.
- 3. Multi-layer pipes are allowed to be used for domestic cold & hot water supply 3 application and for potable water.
- 4. Multilayer pipe shall be similar to unipipe or approved equal.
- 5. Multi-layer pipes shall be of the diffusion type 5 layers composite pipes, with a longitudinally overlapped welded aluminum with the inner and outer layers made of cross-linked polyethylene tightly bonded to the aluminum by means of adhesives:
- 6. Permanent load up to : max. 95 °C/10 bars
- 7. Peak load : max. 110 °C/10 bars
- 8. Pipe roughness : 0.0004 mm
- 9. Thermal conductivity : 0.40 w (mk)
- 10. Thermal expansion coefficient : 25 x 10⁻⁶ m/mk

11. All fittings shall be nickel-plated brass type pipes and pipe fittings shall be to Din 1988. Fittings shall be manufactured by the same pipe manufacturer.

E. Copper Pipes (CUP) Type 2

CUP shall be to BS 2871 Part 1 table X or table Y Copper Water Tube.

Table X tubes shall be used within the building and Table Y tubes for underground installation.

Cup shall be suitable for jointing with compression fitting joints.

Fittings shall be to BS 864 Part 2 - type A brass.

CUP are allowed to be used for Medical gas piping and/or as specifically mentioned in the schedule of pipe materials.

All copper tubes shall be marked with the manufacturer's name or trade mark and tube type, at intervals not to exceed 500mm.

All fittings shall be marked in accordance with the applicable standard and must be marked with the manufacturer's name or trade mark.

F. Copper Pipes (CUP) Type 3

Copper pipes shall be of the seamless hard drawn tubing type K or L to ASTM B88. Tubing, to be used, shall have been cleaned by the manufacturer and the open ends capped to preserve cleanliness.

Cup shall be designed, constructed and installed in compliance with ASA B9.1 and ASA B35.5 (safety code for Mechanical Refrigeration).

CUP shall be suitable for solder jointing with forged or wrought copper fittings.

Cast fittings should not be used because they might be porous and allow the refrigerant to leak. Surfaces to be soldered shall be cleaned bright. The joints shall be given a thin coating of approved soldering flux and the tubing end inserted into the fitting as far as possible.

Heating and finishing of the joint shall be done in accordance with the recommendations of the manufacturer of the fittings. During the heating, the pipe and fittings must be kept full of an inert gas N or CO2 to prevent formation of scale.

The solder metal to be used shall be a non-ferrous metal or alloy having a melting point below 800°F (427°C) and below that of the metal being joined, an accepted solder is Sil-Fos to make copper to copper joints.

When solenoid valves are being installed, the coil should be removed, and no heat shall be applied near the bulb of the expansion valve.

CUP are allowed to be used to carry refrigerants 12, 22, and 500 only and/or as specifically mentioned in the schedule of pipe materials.

G. Galvanized Steel Piping

1. Welded and seamless galvanized steel pipes shall be schedule 40 to ASTM A53 grade B. Pipes shall be cold drawn for sizes up to 50mm diameter and hot drawn for larger sizes. Hot drawn pipes to have wall thickness along the total length of the pipe.
2. All fittings elbows, tees, unions, etc. to be of same quality and weight of pipe, as specified below.
3. All pipes to be identified by logo, size, thickness, material and heat number.
4. Pipe wall thickness and weight should be as follows:

Pipe size (inch)	Pipe size (mm)	Wall thickness (mm)	Weight per m
(1/2)	16	2.77	1.27
(3/4)	20	2.87	1.69
(1)	25	3.38	2.50
(1 1/4)	32	3.56	3.39
(1 1/2)	40	3.68	4.05
(2)	50	3.91	5.44
(2 1/2)	65	5.16	8.63
(3)	80	5.49	11.3

(4)	110	6.02	16.07
(5)	125	6.55	21.77
(6)	160	7.11	28.26
(8)	200	8.18	42.55
(10)	250	9.27	60.30

H. Black Steel Piping

1. Black steel pipes shall be seamless schedule 40 to ASTM A106 grade B
2. Fittings shall be threaded up to 2" (50mm) diameter and welded for 2 1/2" (65mm) diameter and above. Pipes shall be cold drawn for sizes up to 50mm diameter and hot drawn for larger sizes. Hot drawn pipes to have wall thickness along the total length of the pipe.
3. All fittings elbows, tees, unions, etc. to be of same quality and weight of pipe, as specified below
4. End of pipes for 2" (50mm) shall be plain, straight cut and cupped ends. 2 1/2" (65mm) diameter and above pipe shall have beveled ends.
5. All pipes to be identified by logo, size, thickness, material and heat number.

I. Galvanized & Black Steel Fittings

1. Pipe Fittings, welded
 - a. Black steel fittings from 2 1/2 " (65mm) and larger to be steel butt-welded fittings, material ASTM A234 grade WPB, ANSI B16.9 beveled ends.
 - b. Recommended content of impurities: S=15 to 20/1000 P=15 to 20/1000
 - c. Logo, material, thickness and heat number must be hot stamped on each piece of fittings.
 - d. All pieces of fittings to be coated with anti-rust paint.
2. Pipe Fittings, Black malleable iron
 - a. Black malleable iron fittings conform to: 6681 GR B30.06 or ASTM A197
 - b. Black malleable iron fittings up to 2" (50mm) to be screwed conform to BS 143 having taper external threads and taper internal jointing threads conform to BS21 filling to have a full clear bore and high factor of safety over stated working pressures.
 - c. All female outlets to have banded reinforcement.
 - d. All unions to have preferably spherical seat.
 - e. Each piece of malleable iron filling has to be factory tested either by pressure or hydrostatically.
3. Pipe iron malleable iron galvanized
 - a. Same as black malleable iron fittings but hot-drip Zinc coated.
 - b. Coating conforms to BS 729 and ASTM 153 minimum coating 600g/m².
 - c. Galvanized fittings to be used up to 6".
4. Steel flanges
 - a. Black forged steel flanges to conform to ASTM A105.
 - b. Type of flange slip-on (S/O), spirally grooved to match gasket flanges to be fully machined after normalizing heat treatment.
 - c. Flanges to be drilled according to the matching equipment or valves:
 S/O, PN10 as per BS 4504 TABLE 10/5
 S/O, PN16 as per BS 4504 TABLE 16/5
 Screwed bars, PN16 as per BS 4504 TABLE 16/4
 Blind, PN16 as per BS 4504 TABLE 16/8C
 S/O, ASA 150, ANSI B16.5, RF.

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- d. Screwed bars, PN16 as per BS4504 TABLE 16/4 hot-drip galvanized or galvanized plating.
 - 5. Gaskets
 - a. Casketing materials to be non asbestos to ANSO B16.21 dimensions to match corresponding flanges as per equipment and valves scope.
 - b. Gasket to be cut from compressed sheet jointing, thickness of sheets 1.6 to 2.5 mm depending from sizes.
 - 6. Stud Bolts, Bolts and Nuts
 - a. Alloy Carbon steel stud bolt and nuts of size below 7/5"(22mm) shall be hot forged according to ASTM A193 GRB7, from size 7/8 and above, cold forged according to ASTM A194 GR2H.

J. Cast Iron Pipes (CIP)

1. Cast Iron Pipes and Fittings.

- a. The systems shall be designed and installed in accordance with BS 5572, BS 8301 and the relevant sections of the building regulations.
- b. Soil, vent and rainwater pipe work of nominal diameters, 50mm to 300mm shall be installed using light weight cast iron socketless soil and fittings conforming to a British Board Agrément Certificate and meet with pr EN877
- c. pipes shall be coated as follows :

Above ground soil, vent and rainwater pipe work (inclusive of products embedded in concrete)

Pipes Externally - One coat of red water based paint. Giving an average thickness of 40 microns.

Pipes Internally - A black epoxy tar lining, a minimum thickness of 120 microns. This comprises two solvent based components of epoxy resin and tar pitch to give internal protection and anti-corrosive features.

Fittings shall be protected internally and externally with a single coat of red powder epoxy resin electro statically applied. This gives an average thickness of 70 microns with a minimum thickness of 40 microns.

Couplings / Brackets (Ductile Iron) Protected with a red based semi-gloss paint, average thickness of 40 microns.

Below ground – drain pipe work

Pipes Externally - One coat of red water based paint. Giving an average thickness of 40 microns.

Pipes Internally - A black epoxy tar lining, a minimum thickness of 120 microns. This comprises two solvent based components of epoxy resin and tar pitch to give internal protection and anti-corrosive features.

Fittings shall be protected internally and externally with a single coat of red powder epoxy resin electro statically applied. This gives an average thickness of 70 microns with a minimum thickness of 40 microns.

Couplings / Brackets All stainless steel (or ductile iron protected with a red based semi-gloss paint, average thickness of 40 microns).

Additional anti-corrosive wrapping will be required with either Polyethylene sleeving in accordance with ISO 8180 or Adhesive tapes, e.g. "long Maflowrap", or "Densotape", or similar. *

(Or optional all stainless steel couplings)

Where pipes are cut on site, ends shall be cut clean and square with burrs removed. All cut ends shall be made good/re-coated strictly in accordance with manufacturers' recommendations.

All pipes and fittings shall be jointed by means of all stainless steel couplings, including set screws and nuts, or optional ductile iron couplings. The couplings shall incorporate a synthetic EPDM rubber gasket as standard or Nitrile to special order. Earth continuity shall be provided for.

Joints to cast iron drain and to other materials shall be made using standard couplings or step couplings as described in clause (e), or traditional joint connectors.

2.3 PIPE FITTINGS AND SPECIALTIES

A. General

1. Refer to individual piping system sections for required pipe fillings and specialties not covered herein.
2. Pipes shall be joined via the Victual grooved coupling style.
3. All ground components shall be of one manufacturer and conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9.

B. Elbows, Tees, Reducers

1. These fittings shall comply with ASTM and ANSI B16 as described in relevant sections of specifications. The wall thickness shall at least be as specified for the straight pipes.
2. All fittings shall be factory made.
3. Unless otherwise stated, elbows shall be long radius bends with a radius of 1.5 times the nominal size, and shall be smooth and not made of welded segments.
4. Tees up to and including an outside diameter of 323.9mm shall be of the pressed type.
5. Unless otherwise specified, reducers shall be made with a length $L = 3(D-d)$, where L is the construction length, D the outer diameter of the large end and d that of the small end. Unless otherwise stated, the wall thickness of a reducer shall be the same as that of the adjacent large straight pipe.

C. Carbon Steel Pipes Couplings & Fittings

1. Pipe Jointing Method: Pipes shall be joined via the Victual grooved coupling Style 07 Zero Flex Rigid coupling with Angle Pad Design. Victual Style 77 or 75 shall be used where system flexibility is required, at pumps and mechanical equipment to reduce vibration, noise and to accommodate for thermal expansion and contraction. All couplings shall be cast of ductile iron conforming to ASTM A-395, Grade 65-45-15 or malleable iron conforming to ASTM A-47 Grade 32510. Housings shall be red or orange enamel coated or hot dip galvanized.
2. Gaskets: Shall be Grade "E" EPDM compound (green color-coded) conforming to ASTM D-2000, UL listed classified to ANSI/NSF 61 for water supply systems. All gaskets shall be selected as per manufacturer's recommendation according to service application. Gaskets must be manufactured by the same source for couplings and fittings to secure compatibility.

3. Grooved Fittings and Coating: Shall be Victual fittings cast of ductile iron conforming to ASTM A-395, Grade 65-45-15 with grooved ends, malleable iron conforming to ASTM A-47 Grade 32510, forged steel to ASTM A-234. Fittings shall be alkynde enamel painted; hot dip galvanized to ASTM A-153.
4. Branch Outlets - Hole Cut Pipe: Hole cut branch outlets shall be Victual style 920, 920N Mechanical T branch connections with locating collar emerging into the hole. Gaskets shall be Grade E standard pressure responsive gasket.
5. Flange Adapter: Vic-Flange® Adapter Style 741 2"-24" (DN50-DN600), for connection to ANSI class 125/150 flanged components. Cast of ductile iron conforming to ASTM A-536, Grade 65-45-12. Vic-Flange® Adapter Style 743 2"-12" (DN50-DN300), for connection to ANSI class 250/300 flanged components. Cast of ductile iron conforming to ASTM A-536, Grade 65-45-12.

D. Fire Fighting Couplings & Fittings

1. Pipe Jointing Method: Pipes shall be joined via the Victaulic grooved Style 005 Rigid Firelock Coupling with Angle Pad Design for pressures up to 300psi. Style 07 Zero Flex Design shall be used for pressure ratings above 300psi. Victaulic Style 77 or 75 shall be used where system flexibility is required, at pumps and mechanical equipment to reduce vibration and noise. All couplings shall be cast of ductile iron conforming to ASTM A-395, Grade 65-45-15 or malleable iron conforming to ASTM A-47 Grade 32510. Housings shall be red or orange enamel coated or hot dip galvanized.
2. Gaskets: Shall be Grade "E" EPDM Type 'A' compound (violet color coded) conforming to ASTM D-2000, UL listed classified to ANSI/NSF 61 for water supply systems and Flush Seal gaskets for dry service. All gaskets shall be selected as per manufacturer's recommendation according to service application. Gaskets must be manufactured by the same source for couplings and fittings to secure compatibility.
3. Grooved Fittings and Coating: Shall be cast of ductile iron conforming to ASTM A-395, Grade 65-45-15 or ASTM A-563, Grade 65-45-12 with grooved ends for direct connection into the grooved piping system. Fittings shall be orange or red enamel coated or hot dip galvanized.
4. Branch Outlets - Hole Cut Pipe: Hole cut branch outlets shall be Victaulic style 920, 920N, or 922 sprinkler T and branch connections with locating collar emerging into the hole. Gaskets shall be Grade E standard pressure responsive gasket. Branches shall have a machine cut hole at a predetermined position, on the centerline of the pipe, of a size to receive the housing collar, in accordance with Victaulic specifications using Victaulic Hole Cut Machines.

2.4 HANGERS AND SUPPORTS

A. Mechanical Installation System

1. All installation material used for supporting and fixing mechanical pipe systems should be of a Pre-engineered modern flexible type that gives a tested and reliable supporting solution without the need for welding, drilling or subsequent galvanizing for corrosion protection.
2. The system should provide for easy access and disassembly for future maintenance, and shall be product of well known manufacturer such as SILKA or approved equal.
3. The Contractor should provide shop drawings and load calculations to verify the suitability of the system for critical load applications as per the engineer's requirement.
4. The system should consist of the following components:
 - a. C-channels should be used as the main item for supporting pipe and duct and runs and structures. C-channel should be made in accordance with British Standards of width 41 mm, and height of channel shall be selected according to load calculation, made of cold rolled steel strip of thickness 2.5 mm steel grade ST32-2 as per DIN 10025. The

steel is Sendzimir galvanized to a thickness of 20 microns. The channel inward side should include fine serrations that insure strong friction hold of the assemble nuts and accessories. The channel inward side should be slotted for greater flexibility and should include longitudinal swaging to increase rigidity and stiffness. Double channels connected with tubular rivets shall be used where greater strength and stiffness is required. Supporting distance and calculation of pipe loads for pipe nuts should be verified by channel design in accordance with manufacturer recommendations.

- b. C-channel accessories as recommended by the channel manufacturer should be used for assembly of various channel structures as appropriate for the application. These accessories include fixing nuts with serration, angles, brackets and pipe ring saddles.
- c. Pipe Ring Clamps : Galvanized, pre-engineered pipe ring clamps should be used for fixing all pipes to channel system or directly to the concrete structure. The contractor should verify that the pipe supported weight does not exceed the recommended maximum load of the clamp as provided by the manufacturer. The clamps should consist of two half rings suitably connected with welded on connection nut for fixing the clamp to the threaded rod. The rings for all piping systems should provided with a pre-fitted rubber inlay with suitable temperature resistance characteristics for the application.
- d. For PVC installation requirement refer to section 15405.
- e. Threaded Rods used should be manufactured as per DIN 976 of Steel Grade 4.6, galvanized and used to support pipe duct ring clamps onto the C-channel or directly to concrete anchors depending on the application. The threaded rods, nuts and flat washers used should have a clean thread and flawless galvanized condition.
- f. Concrete Anchors: Internally threaded Anchors used for fixing threaded rods and pipe clamps should be made from galvanized steel, anchors should have a flared end for accurate setting flush with the surface, and should have an intelligent expansion selection that adapts to suit strength of the base material. Concrete stud anchors should be used for fixing C-channels to the concrete suitable for through in-place fattening with reliable fixing. All Concrete anchors used should be provided with full load characteristics and used in accordance with manufacturer recommendations with regards to application and setting details. Concrete Anchors should also be fire rated to verify that they can withstand the required loads within the fire integrity limits of the supporting building structure.
- g. For riser pipes, Anchor Fixed Point Clamps should be used to support the weight of the riser pipe . Fixed Point Clamps should be used in location as recommended by supporting system manufacturer and approved by the Engineer.

B. Pipe Hangers, Upper Attachments

1. Individual or continuous preset concrete inserts.
2. Beam clamps and anchor bolts may be used for steel construction.
3. self-drilling expansion shells for 75 mm pipe and smaller may be used in existing concrete structures. See special details for larger piping.

E. Hanger Rods

1. Galvanized solid steel, all thread rods, with lock nuts (10mm dia. Per pipe)
2. For trapez supports submit calculation for threaded hanger rod diameter with at least 8 times load factor.

C. Pipe Hangers, Lower Attachments

1. Lower attachments for individual runs of pipe shall be as follows, unless indicated otherwise:
 - a. steel piping up to 125 mm: steel clevis;
 - b. steel piping 150 mm and larger, not subject to thermal expansion: steel clevis;
 - c. steel piping 150 mm and larger, subject to thermal expansion:
 - d. pipe roller support;

- e. copper tubing, all sizes: copper-plated steel clevis, except where hanger is installed around the outside of insulation, not in contact with pipe, where steel clevis hangers may be used;
- f. cast iron pipe, all sizes: steel clevis.

F. Vertical Pipe Supports

1. At intermediate floors use extension pipe clamps.
2. At top of risers, use hangers as specified above.
3. At base of risers, use stiff-leg pipe support immediately adjacent to elbow. For cast iron soil or storm riser use solid concrete block.

G. Trapeze Hangers

1. Where numerous pipes are run in parallel to one another, they may be supported from a trapeze type hanger arrangement. Rollers supports shall be used to support each run of piping on trapeze hangers to permit independent movement of individual pipes.
2. Piping supports shall consist of channels, fittings, pipe brackets, pipe rollers, pipe clamps, post bases, stud nuts, etc., as required to properly support and hang piping.

H. Stiff-legs or Stanchions

1. Stiff-legs or two-leg stanchion supports shall be provided in cases where support from overhead structure is not possible. Pipe rollers shall be provided for pipe rigidly supported from floor.

I. Alignment Guides

1. Guides to be constructed with steel base and T-bar with teflon or graphite plates bounded to the steel components to allow minimum static friction and self-lubrication for unlimited movement. Units shall be factory painted. Guide base shall be welded to the pipe; like F & S "unislide", Elcen, or equal.

J. Flexible Ball Joints

1. units shall carbon steel construction, screwed, flanged, or welded connection as required, suitable for temperatures of 274 degrees C and pressure of 8.3 MPa; provide for 15 degrees angular flex and 360 degrees rotation.

K. Anti-Vibration Suspension Hangers

1. Combination type, shall have a double-deflection neoprene element in series with a steel coil spring; deflection of 8 mm; steel coil spring shall be selected from a 25 mm static deflection series with a minimum additional travel of 12 mm; spring diameter shall be large enough to permit 15 degree angular misalignment of the rod connecting the hanger to the upper attachment without rubbing the hanger box.

L. Spacing of Pipe Supports

1. Spacing Support Schedule:
 - a. The maximum spacing for pipe supports shall be as follows:

NOMINAL	HORIZONTAL (m)			VERTICAL (m)		
BORE mm	STEEL	COPPER	UPVC CPVC	STEEL	COPPER	UPVC CPVC
10-12	-	1.0	-	-	1.2	-
15	1.8	1.2	0.8	2.5	1.8	0.8
20-32	2.4	1.8	0.8	2.5	2.4	1.0
40-50	2.4	2.4	1.0	2.5	2.5	1.5
65-80	2.5	2.5	1.2	2.5	2.5	1.7

100 & above	2.5	2.5	1.2	2.5	2.5	1.7
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b. Hangers and supports shall in no case be less than one (1) hanger per, 2.5m.

2. The spacing of pipe group supports shall be based on the smallest nominal bore pipe using the hanger, in accordance with the spacing support schedule above. Alternatively intermediate supports can be given to a particular pipe, if conditions permit.

2.5 PASSIVE FIRE PREVENTION SYSTEM

- A. All openings through fire rated walls, ceilings and floors due to penetrations of mechanical installations as well as those due to construction joints, should be sealed with fire rated products suitable for the specific application as specified hereunder. All material selected shall be UL listed.
- B. The product shall be capable of stopping the passage of fire, air and water through wall, floor and ceiling penetrating, cladding and expansion joints. The product shall exhibit the minimum designed fire resistant properties.
- C. The products shall be obtained from an approved, established and proven firm and qualities shall be applied strictly in accordance with the written instructions of the manufacturer and to the approval of the Engineer.
- D. The recommended treatments for various applications shall be as follows:
 1. Metal pipe and duct crossings: the annular space around the pipe shall be packed with UL listed fire rated from backing material and the ends shall be filled and sealed with fire rated Elastic sealant according to manufacturer data. The size of the circular opening shall be maintained as the barest minimum as recommended by the mastic manufacturer.
 2. Non-metal pipe and conduit crossings less than 50 mm in diameter : The annular space around the pipe shall be packed with fire rated foam as backing material. The ends should then be filled and sealed with intumescent, graphite based, fire rated mastic with expansion pressure of minimum 6 bar. The circular opening shall be maintained strictly as the barest minimum recommended by the mastic manufacturer. For pipes/conduits more than 50mm in diameter, the pipe/conduit shall be wrapped with a fire rated, intumescent, graphite, based, fire rated wrap and applied strictly according to the manufacturer specifications, all UL Listed.

2.6 PIPE SLEEVES

- A. General
 1. Sleeves for all pipes passing through floors, walls, partitions, (except where floors and walls are a part of fire-rated assembly) concrete beams, girders, and any other building construction shall be provided in types as described below, and of adequate diameter to allow minimum of 19mm clearance all around between sleeve and pipe. When pipe is insulated, insulation shall pass continuously through sleeve with 19 mm clearance between insulation and sleeve.
 2. Pipes passing through fire-rated walls, partitions, or floor shall be sealed, smoke-tight, with a fire proof compound. Insulation shall not pass through the sleeve as specified above. Fill inner space with Rockwool insulation with fire rated compound up to the rating of the wall.
 3. Allow 50 mm of steel sleeve above F.F.L, and flush with walls.
- B. Pipe Sleeves Material
 1. Galvanized Schedule 40 steel pipe when installed in:
 - a. Concrete or masonry walls and concrete bases.

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- b. Beams with poured concrete fireproofing.
 - c. Concrete floors and mechanical equipment room floors.
 - d. Concrete floors with metal under deck (tack weld to deck).
 2. 18-Gage Galvanized steel when installed in:
 - a. Plaster or dry wall.
 - b. Air plenums.

2.7 FLASHING

- A. Steel Flashing: 26 gauge (0.50) galvanized steel.
- B. Lead Flashing: 24.5 kg/m² (5lb/sq.ft.) sheet lead for waterproofing, 5kg/m² (1 lb/sq.ft.) sheet lead to sound proofing.
- C. Safes: 24.5 kg/m² (5lb/sq.ft.) sheet lead or 0.20 mm (8mil) thick neoprene.
- D. Caps: Steel, 22 gauge (0.80 mm) minimum, 16 gauge (1.50 mm) at fire resistance structures.

2.8 SEALANTS

- A. Sealant for Pipe Sleeves
 1. All sealants materials shall be a single compounds, primerless, non- sagging type in neutral color.
 2. Polysulfide: one part, gun grade.
 3. Acrylic Latex: one part, gun grade, paintable, with a temperature range from -17 to +82 degrees C.
 4. Butyl: one part, gun grade, suitable for both horizontal and vertical joints.
 5. Fire rating compound similar to wall rating and as described under paragraph 2.05 of this section.

2.9 COMPENSATORS

- A. General
 1. All compensators shall be selected for the function it is to perform and the suitability for the fluid type; pressure and temperature to be conveyed.
 2. The compensator shall be the same size bore as the pipework it shall be connected to, and shall have flanged connections for ease of maintenance.
- B. Compensators
 1. The compensator shall absorb movement under strict guiding in an axial direction only. No side thrusts can be permitted.
 2. The stainless steel convolutions of the number required to accommodate the determined movement shall be protected internally and externally by a heavy mild steel sleeve for physical protection against damage.
 3. The compensator shall be capable of a working pressure of 2.5 MPa and a temperature range of -15 to 4000c.
 4. Large expansion compensators capable of up to 200mm shall be considered to keep the number of compensators to a minimum.
 5. It shall be suitable for LPHW, chilled water, HWS in long straight runs such as crawlways and service tunnels.

2.10 THERMAL EXPANSION FIXED POINT SYSTEM

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- A. Where metal pipes are subject to thermal expansion, particular attention should be given and pipe runs should be studied and designed to compensate for the expansion forces and reduce the stress on the pipes and supporting system.
 - B. The constructor should provide sufficient shop drawings and load calculations to verify the suitability of the system for critical thermal applications run as per the engineers requirement. Allowance for free thermal expansion distance at pipe bends should be marked.
 - C. The following components should be used to control thermal expansion:
 - 1. Slide guides: Use side and Roll Connectors with integrated sliding components on all pipe runs subject to high thermal movement. The guide should be used in accordance with manufacturer load limits and movement limits. The slides should be resistant to operating temperatures of the supported pipes.
 - 2. Anchor fixed Point Pipe Clamps : Where necessary and according to the thermal study, use fixed point for a flexible and reliable fixing system against axial thermal expansion forces. The anchor points should be used strictly in accordance with the manufacturer recommendations and loading characteristics and in accordance with the calculated expansion forces provided by the thermal study.
 - 3. Expansion compensators : For critical application and if expansion movement cannot be taken up by free movement of the pipe bends, expansion compensators or bellows of the axial and/or angular type should be used in conjunction with the fixed anchor points and in accordance with the thermal study. Expansion compensators should be used in accordance with manufacturer recommendations.

2.11 ACCESSORIES

A. Safety or Relief Valves

- 1. The relief valves shall be set to a maximum of 0.3 bar above the working pressure of the line in which they are fitted or as indicated on drawings. Safety and relief valves shall be suitable for the operating condition of the system.
- 2. They shall be of the totally enclosed spring loaded type with padlock.
- 3. Safety valves and relief valves shall have a full bore discharge connection. Where any low point occurs in the discharge run, it shall be fitted with a 22 mm size copper waste pipe carried clear of the insulation for drainage. The discharge and waste pipes shall be run to visible safe positions to be agreed..
- 4. Relief valves shall be ASME approved and labeled, size, capacity and setting as indicated.

B. Temperature and Pressure Test Pugs

- 1. Provide temperature and pressure test plugs as described in Section 15990.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. General

- 1. Installation instructions contained in this Section pertain to most systems. For specific requirements for installation of each system, refer to individual system specification sections.

B. Piping Installation Generalities

- 1. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, etc. unless other wise indicated. Under slab piping shall be kept to the absolute minimum.
- 2. Install all piping free of sags or bends and with ample space between piping to permit proper installation.

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3. Install piping at right angles or parallel to building walls. Diagonal or bent piping will not be permitted.
 4. Install piping tight to slabs, beams, joints etc. where possible and such that any removable ceiling panels may be removed for access above ceilings.
 5. Protect all piping from entrance of dirt or other foreign materials during the construction period. At the completion of the project, all dirt and foreign matter in piping shall be removed completely.
 6. Piping passing through exterior building walls shall be caulked whether tight.
 7. Provide drain lines from all relief valves and condensate pans and run drain line full size to the nearest floor or equipment drain.
 8. All water piping shall have draining points at all low points. For mains, risers and branch lines there shall be at least a 20 mm drain valve with a threaded hose connection for other points a 15 mm drain valve and hose and hose connection shall be provided.
 9. Water piping shall be securely anchored to insure proper direction of expansion and contraction.
 10. Expansion loops or expansion joints shall be provided as indicated and required, and shall be cold sprung.
 11. Verify existing grades, inverts, and topographic conditions prior to any trenching, excavation, or installations.
 12. Horizontal piping shall slope uniformly without sags or humps to provide for complete drainage of systems and elimination of air.
 13. Piping shall be cut accurately to measurements established at the site, worked into place without springing or forcing, and shall clear all windows, doors and other openings.
 14. Cutting or other weakening of building structure to facilitate piping installation is not permitted, install to permit free expansion and contraction without damage.
 15. Swing joints at runouts to equipment and risers. Provide expansion loops at all other points for flexible piping systems.
 16. Drain piping from pump glands, relief valves, condensate drain pan etc. to spill over open sight drains, or other acceptable discharge points terminating drain line with plain end (unthreaded) pipe.
 17. Provide necessary temporary connections, valves, oversize flushing connections, pumps, etc. as required to properly clean and test systems.
 18. coordinate piping installations with ductwork, structure, lighting, electrical conduit and all other materials and equipment.
 19. use flexible pipe connectors for all inlet and discharge final connections to pumps (except in line pumps) and other vibration producing equipment.
 20. Provide flanges on all valves, apparatus, and equipment having 50 mm and larger connections.
 21. Reduction in pipe sizes except in drainage pipe, shall be made using eccentric reducer couplings installed with the level side up on water piping and level side down on steam and condensate piping.
 22. Provide unions adjacent to each valve at the final connection to each piece of equipment of plumbing fixture having 50 mm and smaller connections and where otherwise indicated.
 23. Wherever wells are installed in piping for thermometers, pressure gages, probes, etc., pipe size shall be increased by one pipe diameter to accommodate same.
 24. Provide air chambers at the top of all hot and cold domestic risers, at the end of each water header in utility spaces, at the end of each branch line, and at the top of all branches to fixtures. Provide shock absorbers at each solenoid valve or piece of equipment that has a quick closing type valve. Air chambers shall be a minimum of two pipe sizes larger than the terminating pipe and shall be equipped with an accessible drain valve and air recharging petcock or installed at least 600 mm above fixture to permit recharging by draining air chamber.

25. Use fittings for all changes in direction and all branch connections and take - off from mains. Changes in direction and branch connection in welded piping shall conform to Section 15051 Welding.
26. Connect dissimilar piping material using dielectric unions or insulating flanges.

C. Hangers & Supports

1. Approved hangers and stiff leg supports shall be installed in quantity and size as required to carry the weight of pipe, contents, and insulation and shall be arranged to prevent vibration transmission to the building and allow for pipe movement.
2. Support on pipework requiring a vapor barrier shall be installed on the outside of the insulation. Approved material shall be provided between the pipe and the support to give adequate support and thermal isolation. The vapor barrier will cover the chock.
3. Hangers spacing shall be as per clause 2.04 K of this section.
4. Hangers shall be supplied with lock nuts in sufficient number and location to lock all rod adjustments permanently at the adjusted height. Two lock nuts shall be used unless the nut tightens against a threaded socket. Minimum rod diameters shall be as follows:

NOMINAL PIPE SIZE	ROD DIAMETER
12 mm through 50mm	9 mm
60 mm and 75 mm	12 mm
100 mm and 125 mm	15 mm
150 mm	19 mm
200 mm through 250 mm	22 mm
300 mm	25 mm

5. Location of hangers shall be coordinated with light fixtures as shown on reflected plans. Piping shall not be supported from ductwork, duct supports, or other piping. Hanger rods shall not penetrate ductwork.
6. Provide all necessary supplementary steel for support and attachment of hangers, and pipe , and duct supports in shafts and between building structural members.
7. Piping at pumps, tanks, etc., shall be supported independently so that pipe weight will not be supported by equipment. Each piece of pipework system shall be supported so that no stress shall be imposed on equipment connections or flexible joints to equipment.
8. Provide anchors, guides, and bracing as indicated to prevent lateral movement
9. Where an excessive number of fittings or accessories are installed between hangers, provide additional hangers or adequate support.
10. Rods for trapeze hangers supporting several pipes shall be sized for the equivalent load.
11. Hangers rods shall be attached to structural members of the building.
12. Provide additional hangers or anchoring devices necessary for support of piping at corners, tops of risers, etc.
13. Anchors shall consist of rigid members clamped or welded to the pipe to prevent pipe movement at that point. Attach anchors to structural members of the building.

D. Joints

1. Any leaking joints shall be completely disassembled and remade with new materials.
2. Caulked joints in drainage piping shall be made using spun oakum to within 25 mm of hub and the remaining space filled with poured pure pig lead and swigged.
3. Ends of all copper tubing and the interior of the cup of the fitting shall be thoroughly cleaned and polished prior to the application of the flux and solder. The flux shall not be used as a substitute for proper joint preparation.
4. All pipe shall be carefully reamed. Threaded pipe shall have full length clean cut threads.

5. All sockets and pipe ends of PVC shall be cleaned and solvent cement applied for full circumferential cover.

E. Pipework Expansion

1. The contractor shall supply and fix expansion devices, anchors and guides to adequately allow for the expansion and contraction of the pipework. The minimum number considered necessary are shown on the contract drawings.
2. Whenever possible, such as brunch take-offs, natural expansion shall be used with the configuration of the pipework system.
3. Pipe work expansion shall be carefully controlled to prevent damage to the pipework system, equipment, structure, etc.
4. Special consideration shall be given to LTHW and hot water services.
5. Cold water pipework generally where installed in the services building main services duct, equipment rooms and other areas where relatively high ambient temperatures may occur , and where movement cannot be absorbed naturally, shall incorporate flanged joints of the type which allow expansion, contraction and some measure of lateral movement. These joints shall be a mechanical pipe coupling consisting of a center sleeve, and flanges wedge shaped rubber sealing rings and nuts and bolts. The main components shall be constructed from high quality malleable or cast iron for sizes up to 80 mm diameter and steel above this size. All nuts and bolts shall be galvanized . Sealing rings shall be suitable for the liquid type, temperature and pressure range. Sizes up to 345 mm diameter shall be supplied preassembled. Larger sizes shall be supplied unfitted for ease of handling. Coupling shall allow for a setting regularity of -‘ 6° up to 600 mm + 5° for 600 mm to 750 mm and 4° for 750 to 900 m. Each coupling shall allow for a repeated maximum pipe movement of 9.5 mm and sufficient couplings shall be installed on this basis.
6. All expansion devices shall be suitable insulated to prevent accident to personnel, but does not restrict the movement of the pipework
7. All expansion devices and natural expansion pipework systems shall be installed with 50 % cold draw of the total movement.
8. Anchor points shall be provided as shown on the drawings. The anchor shall be capable of resisting the maximum stresses that be applied. The contractor shall ensure that the structure, that the anchor is attached to, shall also be capable of withstanding the same stresses.
9. The method of anchoring the pipework to a secured point shall be:
 - a. Mild Steel - Welding
 - b. Cast iron - Two wrought iron stirrups acting as clamps, bolted, with sufficient thread for tightening, to a secured cast iron chair
 - c. Copper - A wide copper strap, undersized to give sufficient grip, when bolted together around the pipe shall be attracted to the secured point.
10. Care shall be taken when installing and positioning guides to ensure that the amount of free play in the pipeline is kept to an absolute minimum and that the resulting thrust of expansion is taken up in the designed manner. Means for lubrication shall be provided where necessary, inforced PTFE in order to allow reduced frictional resistance to movement. Guides and skid supports shall be provided in accordance with the manufacturers recommendations and shall form part of the submission.

3.2 VIBRATION CONTROL

A. General

1. All vibrating equipment connected to the pipework system shall be isolated to eliminate transmission of noise and vibration.

B. Noise Criteria

1. Each piece of mechanical equipment selected shall be evaluated for quietness. Particular care shall be taken to evaluate acoustical performance as well as mechanical function. Sound pressure level within spaces shall not exceed the NC curves indicated.

C. Piping Insulations

1. All piping 63 mm and larger specified with vibration isolation shall have anti - vibration hangers . Static deflections as follows:
 - a. First three hangers away from any spring isolated piece of equipment shall have hangers with same static deflection as equipment isolators.
 - b. All others shall have 25 mm static deflection.
2. All piping 50 mm and smaller shall have isolators as follows:
 - a. First three hangers away from any spring isolated piece of equipment shall have hangers with same static deflection as equipment isolators.
 - b. For insulated piping outside equipment rooms isolators are not required.
 - c. Install temporary anchors as required to permit readjustment of springs in risers and to fix direction of pipe movement and final operating deflection of springs
 - d. Provide permanent limit stops to prevent excessive vertical motion in risers in event system is drained and to prevent excessive lateral motion.

3.3 ACCESSIBILITY

- A. Locate all equipment that must be serviced, or maintained, in fully accessible positions. Minor deviations from the drawings may be allowed for better accessibility at written approval.
- B. Allow ample space for removal of parts that may require replacement or service in the future.
- C. Extend all grease fittings to an accessible location.

3.4 MECHANICAL CUTTING AND PATCHING

- A. Contractor shall be responsible for all culling, fitting, or patching of his work which may be required to make its several parts come together properly and fit it to receive, or be received, by work of other trades. Cutting of structural members shall not be done without written approval.
- B. Any cost caused by defective or ill-timed work shall be borne by the contractor, as determined by the Engineer. Contractor shall not endanger any work, persons, or construction by cuffing, digging or otherwise.
- C. Place sleeves through all walls , floors, and ceilings during the initial construction where it is necessary for piping to go through. When this is not done, do all cutting and patching required for the installation of the work. Any damage caused to the building by this cutting and patching, shall be corrected at no additional cost.
- D. Patching of all openings for new installations and all openings resulting from the removal or relocation of any installations shall be done by craftsmen skilled in the particular trade effected, with materials of like type adjoining openings.

END OF SECTION 02510

SECTION 02513

PAVEMENTS - ASPHALTIC CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Asphalt Concrete Wearing Course.
- B. Asphalt Concrete Leveling Course.
- C. Asphalt Concrete Base Course.
- D. Tack Coat.
- E. Prime Coat.

1.02 RELATED SECTIONS

- A. Section 01400 Quality Requirements
- B. Section 02200 Earthwork.
- C. Section 02210 Compaction and Testing of Earthwork.
- D. Section 02220 Structural Excavation and Backfill.
- E. Section 02230 Aggregate or Granular Subbase.
- F. Section 02232 Aggregate Base Course.

1.03 REFERENCES

- A. ASTM C 136 Sieve Analysis of Fine and Coarse Aggregate.
- B. ASTM D 5 Test for Penetration of Bituminous Materials.
- C. ASTM D 113 Test Method for Ductility of Bituminous Materials.
- D. ASTM D 242 Mineral Filler for Bituminous Paving Mixtures.
- E. ASTM D 979 Sampling of Bituminous Paving Mixtures.
- F. ASTM D 1188 Bulk Specific Gravity of Compacted Bituminous Mixtures using Marshall Apparatus.
- G. ASTM D 1559 Resistance to Plastic Flow of Bituminous Mixtures.
- H. ASTM D 2172 Quantitative Extraction of Bitumen from Bituminous Paving.
- I. ASTM D 3202 Percent Air Voids in Compacted Dense and Open Bituminous Paving

Mixtures.

- J. ASTM D 3549 Thickness of Height of Compacted Bituminous Paving Mixtures.
- K. ASTM D 4791 Standard Test Method for Flat or Elongated Particles in Coarse Aggregate.
- L. General Specifications for Road and Bridge Construction of Ministry of Communication, with applicable Addenda and Circulars. (M.O.C.).
- M. Materials and Research Department Manual of Materials and Test (MRDTM) Ministry of Communication, K.S.A.
- N. Asphalt Institute Manual MS 2.

1.04 SUBMITTALS

- A. Comply with Section 01330.
- B. Mix Design of proposed asphalt concrete mixture.
- C. Copies of test results from tests conducted to assure compliance to contract document requirements.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bituminous material
 - 1. Provide 4.0 to 7.0% of the total mix by weight penetration grade 60-70 asphalt cement as bituminous material for base course, leveling course or wearing course complying to requirements of M.O.C. as shown in the following table.

Test	AASHTO Test Method	Penetration Grade 60-70	
		Min.	Max.
Penetration at 25 °C (77 °F) 100 g, 5 sec.	T49	60	70
Penetration Ratio, percent minimum (Note 1)		25	25
Viscosity at 135 °C Kinematic (min)	T201	170	---
Flash point Cleveland Open Cup °F	T48	450	---
Ductility at 25 °C (77 °F) 5 cm per min, cm.	T51	100	---
Solubility in trichloroethylene percent	T44	99	---
Thin film oven test, 1/8 in. (3.2 mm), 163 °C (325 °F) 5 hours.			
Lost on bending percent of original		---	0.8
Penetration, of residue, percent of original		54	---
Ductility of residue at 25°C (77°F), 5cm per min. cm.		50	---
Spot Test (when and as specified with):	T102		
Standard naphtha solvent		Negative	
Naphtha-xylene solvent, percent xylene		Negative	
Heptane-xylene solvent, percent xylene		Negative	

Note 1: Penetration Ratio =
$$\frac{\text{Penetration at 4°C, 200 gms, 60 seconds}}{\text{Penetration at 25°C, 100 gms, 5 second}}$$

2. Determine the optimum ratio between bituminous material and filler such that the bituminous material-filler mixture will reach its softening point within the temperature range of 75-90 °C, when tested in accordance with MRDTM 406 (Circular No. 2401, paragraphs 3 and 6, as amended). In particular, the softening point shall be not less than 85 °C for heavy traffic and not less than 75 °C for medium or low traffic.

B. Aggregate

1. Provide aggregates of hard durable particles or fragments free from decomposed materials, organic materials and other deleterious substances not containing more than one percent (1.0%) by weight particles having a specific gravity below 1.95.
2. Provide coarse aggregate of crushed stone, crushed slag or crushed gravel retained on a 4.75 mm (No. 4) sieve and containing no more than ten percent (10%) thin or elongated particles which have a maximum dimension more than five (5) times the minimum dimension as determined in accordance with ASTM D 4791.
3. Provide Fine aggregate material passing the 4.75 mm (no. 4) sieve and produced from crushed stone, crushed slag or crushed gravel or manufactured sand. Natural sand may not be used without the prior written approval of the Engineer. When approved, the quantity of natural sand in the aggregate not to exceed fifteen percent (15%) of the weight passing the 4.75 mm (no. 4) sieve and the quantity of dune sand not more than fifty percent (50%) of the weight of natural sand authorized by the Engineer. Pay particular attention to the proper control of aggregate and especially to that of natural sand.
4. Provide supplemental fine aggregate mineral filler passing the 0.600 mm (No. 30) sieve, including dust from the dust collection system. When furnished as supplemental fine aggregate, mineral filler, at the time of use, to be dry, free flowing, without lumps or agglomerations and conform to the requirements of AASHTO M-17.
5. Prior to the addition of bituminous material conform that the combined aggregate meets the gradation and quality requirements as in Table 1 and Table 2 respectively:
 - a. The grading limits specified are based on materials of uniform specific gravity and shall be adjusted by the Engineer to compensate for any variations in specific gravity of the individual sizes. The Engineer may vary the gradings on the basis of Marshall Tests to obtain optimum stability and life of the completed Bituminous Concrete Pavement.
 - b. The gradation of the job mix materials shall be towards the coarse end of the specification.
 - c. Aggregate gradation for heavy traffic must avoid the area defined by the following equation:

$$P = \frac{d^{0.45}}{d_{\max}} \pm T$$

Where P = Percent passing

d = Sieve opening in mm

d_{\max} = The smallest sieve opening which is not allowed to retain any material (max size aggregate)

T = Vertical distance from the 0.45 power curve in %

The value of T are as follows:

For 19 mm nominal size:

d^{mm}	2.36	2.0	1.18	0.6	.425	.30
T (%)	± 0	± 1	± 3	± 2	± 1	± 0

For greater than 19 mm nominal size

d^{mm}	4.75	2.36	2.0	1.18	0.60	0.425	0.30
T (%)	± 0	± 2.0	± 2.5	± 3.0	± 2.0	± 1.0	± 0

AGGREGATE GRADING REQUIREMENTS – MRDTM 419

Table 1

BITUMINOUS BASE COURSE

Sieve Size	Grading I 32 mm Nominal Maximum	Grading II 22 mm Nominal Maximum	Grading III 19 mm Nominal Maximum
37.5mm (1½ inch)	100		
25.0 mm (1 inch)	75 – 90	100	100
19.0 mm (¾ inch)	65 – 80	75 – 90	90 – 100
12.5 mm (½ inch)	55 – 70	65 – 80	78 – 93
9.5 mm (3/8 inch)	45 – 60	55 – 65	57 – 72
4.75 mm (No. 4)	31 – 46	35 – 60	43 – 58
2.00 mm (No. 10)	18 – 33	20 – 35	28 – 43
0.425 mm (No. 40)	5 – 18	7 – 20	13 – 28
0.180 mm (No. 80)	3 – 13	5 – 25	–
0.075 mm (No. 200)	2 – 9	3 – 7	3 – 7

BITUMINOUS WEARING COURSE

Sieve Size	Grading I 16 mm Nominal Maximum	Grading II 12.5 mm Nominal Maximum	Grading III 9.5 mm Nominal Maximum
19.0 mm (¾ inch)	100	100	
12.5 mm (½ inch)	75 – 90	90 – 100	100
9.5 mm (3/8 inch)	64 – 79	78 – 83	90 – 100
4.75 mm (No. 4)	41 – 56	46 – 60	54 – 68
2.00 mm (No. 10)	23 – 37	30 – 42	32 – 46
0.425 mm (No. 40)	7 – 20	14 – 25	14 – 25
0.180 mm (No. 80)	5 – 13	8 – 16	8 – 16
0.075 mm (No. 200)	3 – 8	3 – 7	3 – 7

Table 2
QUALITY REQUIREMENTS

	Bituminous Wearing Course			Bituminous Base Course		
	Class A*	Class B*	Class C*	Class A*	Class B*	Class C*
Sodium Sulfate Soundness Loss, MRDTM 311-66 Percent Max	10	10	10	10	10	10
Abrasion Loss, MRDTM 309 – Percent, Max.	40	40	40	40	40	40
Clay and Friable Particles, MRDTM 312, Percent Max.	0.25	0.25	0.25	0.25	0.25	0.25
Sand Equivalent, MRDTM 313 – Percent, Min.	45	45	45	45	45	45
1) 75 Blow Marshall, MRDTM 410**						
Stability – Kg. Min.	1000	750	500	1000	750	500
Flow – mm	2-4	2-4	2-4	2-4	2-4	2-4
Voids in Mineral Aggregate – Percent, min.	Varies with Nominal Maximum Size per MS-2***					
Voids in Mix – Percent	4-6	4-6	3-5	5-7	5-7	5-7
Bituminous Material – Percent of Total Weight	4.0-6.0	4.0-6.0	4.0-6.0	3.0-6.0	3.0-6.0	3.0-6.0
Retained Strength – Percent, Min.	75	75	75	70	70	70
2) Hveem, ASTM D 1560 –						
Stabilimeter, minimum	40	37	35	37	35	33
Voids in mix – percent	4-6	4-6	3-5	5-7	5-7	5-7
Filler/Bituminous Material Softening Point All Mixtures	0.62 minimum					
Filler/Bituminous Material Ratio All Mixtures	Between 0.5 and 1.5					

* Aggregate particles retained on the 2.36 mm (No. 8) sieve shall have the following minimum percentage by weight, and have two (2) faces with mechanical fracture:

Class A Base and Wearing Course - 90%
Class B Base and Wearing Course - 65%
Class C Base and Wearing Course - 25%

Each fractured face shall have a minimum dimension from edge across the fractured face which is not less than one-third (1/3) the maximum dimension of the aggregate particle.

** The maximum loss of Marshall Stability by submerging specimens in water at 60 °C for 24 hours as compared to stability measured after submersion in water at 60 °C for 30 to 40 minutes shall not exceed 25%, for each asphalt concrete mix designation.

*** Asphalt Institute Manual MS-2.

C. Mineral Fillers

1. Provide mineral fillers of either Portland cement, blended hydraulic cement or lime conforming to the following requirements:

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Lime, Type N or S	ASTM C 207

2. When required, use the amount of mineral filler between one and two percent (1.0 and 2.0%) of the weight of aggregate, with the exact amount to be stated in the Job Mix Formula.

D. Medium and Rapid Curing Liquid Asphalts (MC & RC) for Tack Coat and Prime Coat.

Conform to the specification for medium curing MC-70 or MC 250 and Rapid Curing RC-70 used as prime coat and tack coat respectively as below:

Tests	AASHTO Test Method	Prime Coat MC-70		Prime Coat MC-250		Tack Coat RC-70	
	.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60 °C (140 °F) – centistokes	T 201	70	140	250	500	70	140
Flash Point (Tag, open-cup), °C (F)	T 79	38 (100)	---	66 (150)	---	---	---
Water Percent	T 55	----	0.2	----	0.2	---	0.2
Distillation Test: Distillate percentage by volume of total distillate to 360 °C (680 °F)	T 78	---		---		10	---
To 190 °C (374 °F)		---	---	---	---	---	---
To 225 °C (680 °F)		0	20	0	10	50	---
To 260 °C (680 °F)		20	60	15	55	70	---
To 315 °C (680 °F)		65	90	60	87	85	---
Residue from distillation to 360 °C (680 °F) volume percentage of sample by difference		55	---	67	---	55	---
Tests on residue from distillation: Absolute viscosity at 60 °C (140 °F) poises	T 202/T49	300 (T49)	1200	300	1200	600 (T-202)	2400
Ductility 5 cm/min at 25 °C (77 °C)	T 51	100	---	100	---	100	---
Solubility in Trichloroethylene, percent	T 44	99.0	---	99.0	---	99.0	---
Spot test with:							
Standard naphtha	T 102	Negative		Negative		Negative	
Naphtha-xylene solvent, - percent xylene	T 102	Negative		Negative		Negative	
Heptane-xylene solvent, - percent xylene	T 102	Negative		Negative		Negative	

2.02 JOB MIX DESIGN

- A. Formulate and propose job mix formula and submit to the Engineer for approval at least 30 days before producing bituminous concrete mixture.
- B. Sample mixes and trial areas will be required to confirm the suitability of the proposal to achieve compliance with the specification, and authorisation will be given by the Engineer in writing when a satisfactory method has been established and successful trials have been concluded.
- C. Use hot-bin aggregate for the final job mix formula. Develop preliminary job mixes using stockpiled aggregate, to demonstrate their suitability for the intended purpose.
- D. Establish and submit the mix with single percentages for the coarse aggregate, fine aggregate, mineral filler, the amount of asphalt cement, the temperature of mix leaving the mixer and the temperature of mix delivered on the road. Confirm this Job Mix Formula to the following range of tolerances.

Maximum Variations of Aggregate Fractions, Asphalt Content and Mix Temperatures

Passing Sieve No. 4 and larger sieves	±5.0%
Passing Sieve No. 10	±4.0%
Passing Sieve No. 40	±3.0%
Passing Sieve No. 80	±2.0%
Passing Sieve No. 200	±1.5%
Asphalt content	±0.4%
Temperature at mix discharge (145 °C minimum) 145-163 °C	
Temperature at laying	140-163 °C

- E. When unsatisfactory results make it necessary or on proposing a new source of material, the Engineer may ask for establishment of a new Job Mix Formula before the new material is used.

2.03 MIXING

- A. Dry and heat the aggregate for the mixture to the required temperature. Properly adjust the flames used for drying and heating to avoid damage to the aggregate and to avoid soot on the aggregate.
- B. First mix the dried aggregate in the mixer, in the amount of each fraction of aggregates required to meet the job-mix formula, followed by the necessary amount of filler, and mix for at least 10 seconds before the specified amount of bituminous material is added.
- C. Mix the material until a complete and uniform coating of the particles throughout the aggregate is secured. Wet mixing time will be approved by the Engineer for each type of plant and the aggregate used.
- D. Produce the mixture as closely as practicable to the highest temperature limit which will produce a workable mix within the specified temperature range.

2.04 MIXING PLANT

- A. Use the asphalt mixing plant for heating, proportioning and mixing the aggregates and asphalt cement either of the batch type or continuous mixing type, capable of producing a uniform mixture in the quantities required within the job-mix tolerance specified previously.
- B. Provide the plant with an accurate mechanical means for feeding the mineral aggregate at a uniform temperature. The feeder or feeders shall be capable of delivering in precise proportions the aggregate or aggregates required. When more than one cold feed elevator is used, each shall be fed as a separate unit and the individual controls shall be integrated with an overall master control.
- C. Use drier or driers capable of drying and heating all aggregate to the required temperatures with positive control of the temperature through the progress of all operations. Design driers so that aggregates will be agitated continuously during the process of heating.
- D. Provide plant screens capable of screening all aggregates to the specified proportions and with normal capacities in excess of the full capacity of the mixer. The dried aggregate shall be metered to the pugmill from the storage bins in a manner which will result in constantly uniform mixture complying with the job mix formula as specified.
- E. Provide tanks used for storage of asphalt cement with a device for controlled heating of the material temperature between 135 °C and 163 °C (225 °F and 325 °F). Accomplish heating so that no flame shall come in contact with the heating tank. Provide a circulating system of adequate size to insure proper and continuous circulation between the storage tank and mixer during the entire operating period. Keep when possible, the discharge end of the circulating pipeline below the surface of the asphalt in the tank while the pump is in operation. The storage tank to have a sufficient capacity to hold enough asphalt for at least one day's operation.
- F. Size the bins for storage of dry aggregate to ensure continuous operation at rated capacity. Maintain and equip the bins so that the flow of dried aggregate to the mixer is uniform and will result in the specified mixture.
- G. Provide means to obtain the required percentage of asphalt in the mix within the tolerances specified, either by weighing or measuring volumetrically. Where the quantity of asphalt is controlled by volumetric metering, make provision to check the weight of the asphalt delivered through the meter. Provide steam jacketing or other insulation to maintain the specified temperature of asphalt in pipelines, meters, weigh buckets, spray bars, flow lines or other containers.
- H. Install an armoured thermometer of adequate range in the asphalt feed line at a location near the discharge valve at the mixer unit.
- I. Equip the plant with an approved thermometric instrument having an accuracy of 2.5 °C (5 °F) placed at the discharge chute of the drier to register automatically or indicate the temperature of heated aggregate. Use thermometric instrument sensitive to a rate of temperature change not less than 10°F (5°C) per minute. The Engineer may require the Contractor to test any thermometric equipment at any stage of the work, and has the authority to direct the repair or replacement of any equipment found to be inaccurate or undependable.
- J. Provide the plant with a dust collector, designed to waste or return to the hot elevator by

mechanical means all or part of the material collected. Approval of Engineer for the quantity of dust to be returned must be obtained. Provide the plant with a mixer cover and such additional housing as may be necessary to properly control the dust.

- K. Provide and maintain adequate and safe stairways to the mixer platform and guarded ladders to other plant units. Guard and protect all gears, pulleys, chains, and other dangerous moving parts. Provide ample and unobstructed space for the operator on the mixing platform. Maintain clear and unobstructed passage at all times in and around the truck loading space. Provide ladder or platform at the truck loading space to permit safe inspection of the mix as it is delivered to the truck.

PART 3 EXECUTION

3.01 TRANSPORTATION, LAYING AND COMPACTION OF ASPHALT SURFACING

A. Preparation of Surface:

Before laying the bituminous concrete surface course, check the base course to ensure that the surface is within the specified tolerance and is in all respects fit for laying the pavement then spray the bituminous prime coat on the surface as specified below.

1. Application of prime coat

- a. Apply cut back bitumen MC 70 or MC 250 at the rate of 0.5 to 1.5 litres/m² for prime coat.
- b. Apply the prime coat only when the existing surface is dry or slightly damp and do not proceed when rain is imminent unless approved by the Engineer. The base-course on which it is to be applied shall be clean to the satisfaction of the Engineer.
- c. Apply the cut-back asphalt prime coat by a pressure distributor to obtain uniform distribution at all points. Spread back disposable protective covering such as thick paper or polythene from the end of each application to cover the existing surfaces. Start and stop the flow through the nozzles on the disposable protective covering so that all nozzles are operating properly on the entire length being treated. While applying the prime coat, protect the surfaces of all adjacent structures and objects so as to prevent their being spattered or marred. Do not allow any bituminous material to discharge into a ditch or stream.

Do not commence laying of the bituminous course until the prime coat has been absorbed by the surface and approved by the Engineer.

2. Application of tack coat

Apply tack coat between the basecourse and wearing course or between two lifts of any of these courses. It shall be Rapid Curing Cut-Back Bitumen RC-70 applied at a rate of 0.10 to 0.15 litres/m² or as directed by the Engineer. Omit the tack coat if approved by the Engineer, when the previous course or lift is less than 48 hours old. During application of the tack coat, protect the surfaces of all adjacent structures and objects to prevent their being spattered or marred.

B. Transportation of Asphalt

Transport the mixture from the mixing plant to the laying plant in metal lined lorries, which are to be sheeted for protection from the weather, or such other vehicles as may be approved by the Engineer. Do not send the loads out so late in the day as to prevent completion of the spreading and compaction during daylight hours unless otherwise approved by the Engineer. Deliver the mixture at a temperature between 135 °C and 163 °C (275 °F and 325 °F). No segregation of the material or excess loss of heat shall be allowed to occur during transport.

C. Laying of Asphaltic Concrete

Lay the asphaltic concrete by paving machine in layers as shown on the Drawings. The machine must be capable of producing a level and even running surface and must correct for any irregularities in the base. Provide paving machines capable of feeding material from the hopper across the full width of the screed.

1. Joints

- a. Offset longitudinal joints for each course thirty (30) centimeters from the joint in the immediate underlying course. Offset transverse joints a minimum of sixty (60) centimeters from the joint of the immediate underlying course.
- b. Locate longitudinal joints within fifteen (15) centimeters of the centerline of the roadway or within fifteen (15) centimeters of the centerline of a lane and to the minimum practical numbers. Form longitudinal joints by lapping the screed over the first layer placed, crowding a ridge of bituminous material at the joint and crimping the ridge of material into the joint by a compaction roller while the material is hot.
- c. Form the transverse joints by cutting back the first layer placed to the full depth of the layer, removing and wasting the material, spreading new bituminous material in sufficient quantity to create a compacted thickness equal to the thickness of the first layer. Cross roll the joint with one coverage and the joint checked with a straight edge not less than four (4) meters in length. Remove the high points and sags filled with additional bituminous material and the joint rolled a second time. Check the joint again with a straight edge, humps and sags adjusted as necessary, and rolled until the joint is complete and compacted as specified.
- d. Tack coat all contact surfaces, where bituminous concrete mixtures are placed against concrete or stone curb and gutter, bridge abutments, retaining walls, drainage facilities, a cold pavement joint or metal surface.

2. Compaction

- a. Compact the mix thoroughly after spreading by rolling. Unless lower temperatures are ordered by the Engineer, spread all courses of bituminous concrete pavement and perform the initial coverage or perform breakdown compaction when the temperature of the mixture is not less than one hundred forty degrees Celsius (140 °C). Complete all rolling before the temperature of the mixture drops below ninety degrees Celsius (90 °C).
- b. Roll longitudinal joints first, then begin rolling at the lower edge and

proceed towards the highest portion, except when compacting layers that are thicker than nine (9) centimeters. Begin compaction of layers more than nine (9) centimeters in thickness in the middle and proceed alternately towards each edge. When the roller is within sixty (60) centimeters of either edge proceed by lapping the uncompacted mixture by not more than thirty (30) centimeters per coverage.

- c. A coverage consists of one pass of the roller over any portion of the layer being placed.
- d. Carry out the initial "breakdown" rolling by three wheeled rollers with a weight between 4.4 and 6.5 kg per mm width of rear wheel. Proceed the rollers onto fresh material with rear or driven wheels leading. When the rollers are reversed at the end of pass, place the steering wheels on compacted material and do not displace the mix by their movement while changing direction. After the initial rolling, achieve compaction by pneumatic tired rollers, which are self propelled having a weight between 15 and 30 tonne, and tyre pressure which can be varied between 0.05 and 0.08 kg/mm². After the pneumatic tyre rolling, give a final finish by tandem roller.
- e. Overlap each pass of the roller by the preceding one by half the width of the roller wheel. Slightly vary lengths of alternate passes of the roller, maintain rolling speed about 3km per hour, and the number of passes about 5 or 6 over the same area. Keep the roller wheels clean and smooth and take care to ensure that the mixture does not adhere to the wheels, spraying a little water on them when required for this purpose. Commence rolling as soon as the freshly spread mix bears the weight of the roller without any undue movement or displacement and on no account allow the rollers to stand on the finished surface until it has thoroughly cooled. Immediately following initial rolling, check the surface with a straight edge to ensure that it meets with the tolerance requirements. Correct minor variations by rolling, but adjust larger imperfections by adding or taking away mix while it is still hot and workable.
- f. Provide sufficient compaction equipment and continue compaction until each lot of bituminous concrete pavement is compacted to an in-place density within the following range when compared to the theoretical maximum density determined from ASTM D 2041:

Bituminous Concrete Base Course	-	92 to 95
Bituminous Concrete Leveling Course	-	92 to 95
Bituminous Concrete Wearing Course	-	91 to 94

3.02 TESTING OF ASPHALT SURFACE MATERIALS

- A. Carry out the tests scheduled below as directed by the Engineer. Take at least one sample for each day's paving.
 - 1. Uncompacted Asphalt Concrete Mix:
 - a. Sampling ASTM D 979
 - b. Asphalt cement content ASTM D 2172

- | | | |
|----|--|--------------------------|
| c. | Sieve analysis of extracted mineral matter | ASTM D 313
ASTM C 136 |
| d. | Penetration of recovered asphalt cement | ASTM D 5 |
| e. | Ductility of recovered asphalt cement | ASTM D 113 |
| f. | Marshall stability and flow | ASTM D 1559 |

2. Compacted Asphalt Concrete Mix:

- | | | |
|----|---|-------------|
| a. | Bulk density | ASTM D 1188 |
| b. | Marshall stability and flow | ASTM D 1559 |
| c. | Thickness or height of compacted mix (coring) | ASTM D 3549 |
| d. | Air voids in compacted mix | ASTM D 3203 |

- B. Cut sample as directed by the Engineer from the previous day's paving. Supply and compact new material in the voids left by the sampling.
- C. Conduct daily testing of the bituminous mixture to ensure compliance with the approved job-mix formula and submit copies of the test results to the Engineer.

3.03 TOLERANCES

- A. Test the surface by a 3 metre straight edge applied both parallel and at right angles to the centreline of the road. Designate an employee to use the straight edge under the direction of the Engineer in checking all surfaces. The variation of the surface from the testing edge of the straight edge between any two contacts with the surface shall not exceed 3 mm.
- B. Place within the following surface tolerances and flush with top of castings, pads and other surface items at required elevations to provide continuous smooth surface.

<u>Grade</u>	<u>Max. Deviation in 3 metres</u>
1% and less	3 mm
Greater than 1%	6 mm

END OF SECTION 02513

SECTION 02720
STORM WATER DRAINAGE SYSTEM

PART 1 GENERAL

1.01 SCOPE OF SECTION

- A. Work Included: This Section covers the furnishing, installation and testing of the storm water drainage systems which may include the piped storm water drainage collection on and disposal.

1.02 APPLICABLE CODES AND STANDARDS

- A. The following Codes and Standards are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referenced codes and standards and are submitted for the Engineer's review in advance of their use.

British Standards (BS):

BS: 2494	-	Elastomeric seals for Joints in Pipework and Pipelines
BS: 5481	-	Unplasticised PVC Pipe and Fittings for Gravity Sewers
BS: 5955	-	Code of Practice for Installation of unplasticised PVC Pipework (Part 6) for Gravity Drains and Sewers
BS: 6367	-	Code of Practice for Drainage of Roof and Paved Areas.
BS: 8301	-	Building Drainage
BS: 8005	-	Sewerage

1.03 SUBMITTALS

- A. Prior to commencing work, the Contractor shall submit the following to the Engineer for review and approval.
- B. Method Statement: Detailing the method and form of construction it is proposed to use to meet the requirements of the Specifications and Drawings and the types of pipes, fittings and accessories with the measures proposed for stockpiling and storage after delivery, and prior to installation.

- C. Manufacturer's Test Certificates and/or certificates of compliance with the specification for all materials, pipes, fittings and accessories it is proposed to incorporate at the Permanent Works.
- D. Manufacturer's catalogues showing the data and schedules of parts for the pipes fittings and accessories to facilitate assembly and disassembly.
- E. Shop Drawings at a scale not smaller than 1:100 showing layout of drainage including all invert levels crossover levels cover levels setting out of terminal fittings, etc. Detail drawings at a scale of 1:20 of assembly procedures, joint details etc.
- F. Samples of materials and fittings as required by the Engineer.
- G. Manufacturer's recommended Specification for transporting, handling, loading and unloading, stock piling and storage of materials.

1.04 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15000.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All goods and products covered in these Specifications shall be procured, when available, from an in-Kingdom manufacturer. Procurement of all goods and products shall have the prior approval of the Engineer.

2.02 PIPEWORK

- A. All pipework shall be the sizes indicated on the Drawing and shall be as specified in Section 02750 Underground Piping.

2.03 PRODUCT STORAGE AND HANDLING

- A. All products shall be delivered in manufacturer's original protective packaging.
- B. All products shall be inspected at time of delivery for damage and for compliance with Specifications.
- C. Any products that are found to be damaged or not in accordance with the Specifications shall immediately be repaired or removed from the site and replaced. Repairs shall not be undertaken before the Engineer has approved the Contractor's proposed action.
- D. All products shall be handled and stored as recommended by the Manufacturer to prevent damage and deterioration.
- E. The Contractor shall supply handling equipment such as lifting beams, reinforced canvas slings, protective padding, struts, cradles, etc., required to handle the products without damaging hardware or linings and coatings.
- F. Each pipe unit shall be site stored, stacked and handled into the final location in such manner, and by such means, that affords its total protection from damage. The

Manufacturer's recommendations shall be taken as the minimum requirement.

- G. Products shall be protected against damage and the ambient conditions both during transport, site storage and immediately up to the time the products are installed. Precautions shall be taken to protect the product from mechanical damage and the effects of sunlight and heat, until the backfilling operations have been completed.
- H. Site stacking of pipework shall be such that the pipework will not deform or be damaged in any way by storage or retrieval.
- I. Full consideration shall be given to safety aspects when locating, planning and constructing pipe stacking areas, and whilst stacking pipes.

PART 3 EXECUTION

3.01 INSPECTION

- A. Immediately prior to installation, the products shall be inspected for damage by the Contractor. Products that are found to be damaged or not in accordance with their respective standards and specifications shall not be incorporated in the Permanent Works, and shall be removed from site. Any remedial measures that the Contractor may propose must have the prior approval of the Engineer before being carried out.

3.02 GENERAL

- A. The installation of the products comprising the storm water system shall be in accordance with the approved Method Statement, Manufacturer's instruction and recommendations, the appropriate standards and/or as directed by the Engineer.
- B. When a pipeline passes through a wall or other structure, less than one pipe length wide the a clear space at least 75mm wide all round the pipe. Adequate means shall be provided to prevent soil from entering this gap.

3.03 TESTING

- A. Contractor shall inform the Engineer sufficiently in advance to give him a reasonable opportunity to attend all tests and inspections.
- B. All sections of installation shall be checked to ensure they are free from obstruction debris before testing.
- C. Obstruction Test - All pipelines having a nominal diameter of less than 300mm shall be tested for obstructions by drawing through each completed length a mandrel 750mm long and having a diameter 10mm less than the actual pipe diameter.
- D. Contractor shall provide clean water, assistance and apparatus for testing and inspection as required.
- E. All lengths of drain shall be tested after laying and jointing but before covering and tested again after completion of backfilling.
- F. A record of all tests shall be kept; a copy of which shall be given to the Engineer.

- G. All lengths of drain, manholes and inspection chambers shall be capable of passing the tests specified. All defects shall be located and remedied without delay and retested as instructed.

3.04 WATER TESTING OF PIPELINES

- A. Temporarily seal low ends of drains and connections.
- B. Fill system with water to produce 1.5m head in a standpipe at high end and not move them 4.0m head at low end.
- C. Allow pipeline to stand for 2 hours for absorption, topping up as necessary.
- D. Measure loss at water by noting the quantity of water needed to maintain the test head for 30 minutes.
- E. Loss of water for drains to be not more than 1 litre per hour per metre diameter per linear metre run.

END OF SECTION 02720

SECTION 02726

MANHOLE COVERS AND FRAMES

PART 1 GENERAL

1.01 SCOPE OF SECTION

- A. This Section covers the furnishing and installation of cast iron manhole covers/gratings and frames as shown on the Drawings and equipment schedule.
- B. The term covers/gratings and frames shall include but shall not be limited to all manholes, handholes, joint boxes, draw pits, valve chambers, water storage tanks access and sump pit covers and frames or gratings and frames.

1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and performance of all operations in connection with the supply and application of sanitary sewerage as specified herein and where referred to on the Drawings.
- B. Co-ordination: The Contractor shall be responsible for the full co-ordination of the work of all trades.

1.03 QUALITY ASSURANCE

- A. The Contractor shall be responsible for the quality of all materials and workmanship.

1.04 APPLICABLE CODES AND STANDARDS

- A. The following Codes and Standards are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they give an equivalent degree of quality as those referenced and are submitted for the Engineer's review and approval in advance of their use.

- 1. British Standards Institution (BS)

- | | | |
|------------|---|---|
| BS EN: 124 | - | Gully tops and Manhole tops for vehicular and pedestrian areas. Design requirements, Type, Testing Marking, Quantity Control. |
| BS: 1452 | - | Grey Iron Casting |
| BS: 3416 | - | Black Bitumen Coating Solution for Cold Application |
| BS: 4164 | - | Coal Tar Based Hot Applied Coating Materials |

1.05 SUBMITTALS

- A. The Contractor shall submit for approval:
 - 1. Manufacturers' catalogues and data detailing all items to be furnished under this Section

2. Certification that the castings comply with the cited Standards.

1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 01500.

1.07 EXTRA MATERIALS

- A. 2 sets of manhole cover lifting and unlocking keys to suit each type to manhole cover.

PART 2 PRODUCTS

2.01 GENERAL

- A. All goods and products covered by these specifications shall be procured, when available, from a local manufacturer. Procurement of all goods and products manufactured out-of-Lebanon must have the prior approval of the Engineer.
- B. Proprietary products considered by the Engineer to meet this specification shall be approved by him based on the Contractor's report and recommendation prior to incorporation into the Permanent Works.
- C. Covers/gratings and frames shall be grey cast iron castings. Grey cast iron shall conform to or exceed the requirements of BS 1452 grade 220.
- D. The bearing surfaces of frames and covers shall be machined to ensure that the covers will seat firmly in the frame without rocking or rattling. For square and rectangular manhole covers, a rubber gasket may be permitted in lieu of machining.
- E. All edges of covers and frames shall be ground smooth.
- F. Unless otherwise specified the castings shall have a priming coat of zinc silicate 75-micron and finish coats of coal tar epoxy each 100 microns thick.

2.02 COVER TYPES

- A. The types of covers/gratings and frames shall be as specified on the Drawings and defined as follows:
 1. Heavy Duty: Covers/gratings and frames capable of bearing wheel loads of 11.5 tonnes and with permanent non-rock features.

Heavy-duty covers/gratings and frames shall be used in all main carriageways and elsewhere as specified on the Drawings.
 2. Medium Duty: Covers/gratings and frames capable of bearing wheel loads up to 5.0 tonnes and with permanent non-rock features.

Medium duty covers/gratings and frames shall be used on all residential roads, walkways, verges and domestic accesses subject to light vehicular traffic only or where specified on the Drawings.

3. Light Duty: Covers/gratings and frames for use in situations inaccessible to motor vehicles.

2.03 SPECIAL REQUIREMENTS

- A. Sealed covers and frames:

Where a sealed cover is specified, the frame shall be provided with a continuous means of retaining a sealing material. Sealing may be of either single or double pattern and the minimum depth of penetration of the cover sealing flanges into the frame shall be 10 mm.

- B. Lockable sealed covers:

The locking shall not nullify the seal. Where locking devices can be rendered ineffective by corrosion, they shall be suitably protected. If the locking device utilises a bolt connection, this shall be of stainless steel.

- C. Inscriptions, manhole cover surfaces (protruding skid prevention pattern), lifting devices, and any provision for gas detection on manhole covers shall be as shown on the Drawings.
- D. Recessed cast iron covers shall receive in-fill material as specified by the manufacturer to meet the required design loads.
- E. Inside buildings, any covers required, shall be airtight and lockable. The covers and frames shall be of galvanized pressed steel construction with the cover recesses filled to match the surrounding floor finishes. These covers shall be detailed and specified on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The Contractor shall install the covers and frames strictly in accordance with the Manufacturer's instructions and recommendations and to the details shown on Drawings and Schedules.
- B. Covers/gratings and frames shall not be subject to any loads until such time the bedding haunching materials have adequately cured.
- C. All covers shall be bedded and levelled to prevent rocking and lateral movement of the frame.
- D. All covers shall be set level with surrounding finishes and square with joints surrounding finishes or with the building.
- E. Where recessed type, infill covers are used in block pavior areas, frame is to be secured to top of manhole with expanding bolts of suitable size.

END OF SECTION 02726

SECTION 02730
SANITARY SEWERAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

The works covered under this contract include the supply, installation, testing, adjusting and putting into operation systems, components of systems, and individual items of equipment, and work related thereto, in accordance with the project Tender Documents. Products not mentioned but obviously necessary to the completion of those works shall be provided.

This section applies to, and is a part of each of the following sections of the specifications as if repeated therein verbatim.

- A. Sanitary sewer pipe.
- B. Sanitary sewer manholes, frames and covers.

1.2 REFERENCES

A. General:

- 1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
- 2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

B. International References:

- 1. ASTM A48 / A48M Standard Specification for Gray Iron Castings.
- 2. ASTM C150 Standard Specification for Portland Cement
- 3. ASTM C 443 Standard Specification for Joints for Concrete Pipe and
Manholes, Using Rubber Gaskets
- 4. ASTM C478 Standard Specification for Precast Reinforced Concrete
Manhole Sections
- 5. ASTM C923 Standard Specification for Resilient Connectors Between
Reinforced Concrete Manhole Structures, Pipes, and Laterals.
- 6. ASTM D1784 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC)
Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC)
Compounds
- 7. ASTM D 2414 Standard Test Method for Carbon Black—Oil Absorption
Number (OAN)
- 8. ASTM D 3034 Standard Specification for Type PSM Poly(Vinyl Chloride)
and (PVC) Sewer Pipe and Fittings

- | | | |
|-----|---------------|---|
| 9. | ASTM D 3212 | Standard Specification for Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals |
| 10. | ASTM F 477 | Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| 11. | AWWA C 601-68 | Standard for Disinfecting Water Mains Designation |

1.3 WORKMANSHIP

- All workmanship required to accomplish the work mentioned hereinafter or shown on related Drawings, shall conform to the highest standards, and as required by the Engineer.
- The Engineer will be the sole judge of the standards required.

1.4 SUBMITTALS

- A. Manufacturer's instructions for installation of pipe and appurtenances.
- C. Construction sequence.
- B. Catalog cuts, samples, manufacturer's data and listing of applicable standards for special, unique or proposed substitute materials if requested by the Engineer.
- D. All precast concrete structures.
- E. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.
- F. Shop Drawings: Indicate manhole locations, elevations, piping sizes, and elevations of penetrations.
- G. Product Data: Provide manhole covers, materials, component construction, features, configuration, and dimensions. Furnish certificate of compliance for all items.
- H. Interior lining data and application procedures.
- I. Test reports.
- J. Project Record Documents.

1.5 SUBSTITUTIONS

- A. Use only materials conforming to these specifications unless permitted otherwise by the Engineer.
- B. Obtain written approval of the engineer for all substitutions prior to use.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to the Engineer and approved for use.

- B. Store materials and handle to avoid damage. Replace any damaged materials. Remove damaged materials from site.

1.7 CONFLICTS

- A. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations and verify clearance for proposed construction.
- B. Complete elements of work which can affect line and grade in advance of sanitary sewer construction unless noted on plans.
- C. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.6 SPECIAL REQUIREMENTS

- A. Stop Work: Stop work and notify the Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.
- B. Conform to municipal and central government requirements.

PART 2 – PRODUCTS

2.1 PIPES AND FITTINGS

- A. Description of Work

The work included under this part shall consist of pipes, fittings and equipment, as hereinafter specified and as shown on the Drawings. Such work shall include, without being limited to the items described in the following clauses of this part.

- B. Arrangement and Alignment

- Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls wherever possible.

- Install pipe groups for plumbing parallel with pipes of other trades.

- Space pipe supports, arrange reducers and Pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low points. However, where obstructions exist, automatic air vents shall be installed at all air pocket points and 1/2" (15 mm) drain gate valves shall be supplied and installed at all low points and riser legs.

- C. Special Requirements for PVC Pipes

- Storage

PVC pipe and fittings shall be stored under cover at all times.

Sun light shall not be permitted to come into contact with the PVC materials at any time, except during installation in trench. The pipes shall be stored on flat level ground free from large or sharp edged stones or objects, and shall be stacked to a maximum height of 1.5m. (or as

recommended by the manufacturer with sockets at alternate ends, and in such a manner as to prevent sagging or bending.

- Pipe Installation

Before installation, the pipe shall be inspected for defects.

Defective, damaged or unsound pipe will be rejected. Deflections from a straight line or grade, between the center lines extended, of any 2 connecting pipes made necessary by vertical curves or horizontal curves or offsets, shall not exceed $12500/D$ mm. per linear meter of pipe, where D represents the nominal internal diameter of the pipe expressed in millimeters. If the alignment requires deflections in excess of these limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth. Except where necessary in making connections with other lines, pipe shall be laid with the bells facing in the direction of laying.

Pipes in trenches-Place each length of pipe with a uniformly distributed bearing for the bottom 0.3 of the pipe on the sand fill in the trench. Excavate recesses to accommodate pipe bells, sleeves, glands or other fittings. Take up and re-lay any pipe that has the grade or joint disturbed after laying. Clean the interior of the pipe of all foreign material before lowering into the trench, and keep clean during laying operations by means of plugs or other acceptable methods.

Plumbing vents exposed to sun light shall be protected by water- base synthetic latex paints.

- Thermal Expansions

When drainage and vent stacks exceed six (6) meters in height, approved expansion joints, restraint fittings and offsets shall be placed on vertical risers and horizontal branches as follows:

- Expansion joints are recommended at alternate floors in all vertical stacks.
- Expansion joints shall be placed in horizontal branches containing two or more vertical risers and exceeding ten (10) meters in length immediately upstream of vertical riser whenever possible.
- An expansion joint, shall be placed below the connection point of a waste pipe to the stack, if this connection is exposed below floor slab, and above the connection point if this connection is above floor slab.
- No expansion joints shall be required in building drain below grade.

- Thermal Expansion Fittings

Approved expansion fittings that utilize rubber-o-rings in a recessed groove may be used to compensate for thermal expansion. The ring slides along the pipe when expansion or contraction occurs. Expansion joints shall be installed by solvent cementing techniques.

D. General Requirements

- Make all changes in size and direction of piping with standard fittings.
- Make all branch connections with tees.
- Use eccentric reducing fittings or eccentric reducing couplings where required by the contract documents or where required to prevent pocketing of liquid or non- condensibles.
- Pipe bending shall not be resorted to except in extreme cases and only after the written approval of the Engineer.
- Piping shall be designed with Loops to take the thermal expansion. Wherever this is not possible for physical reasons, expansion joints with guides shall be used.
- Installation of pipes shall be complete with all cutting, patching and making good of walls, slabs, partitions, etc., due to fixing, supporting and anchoring of pipes.
- Automatic air vents shall be installed at all air pocket locations, and/or at the highest points in the lines.
- Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English or both metric.

E. Connection to Equipment

- Provide flanges or unions at all final connections to equipment and control valves to facilitate dismantling. Arrange connections so that the equipment being served may be removed without disturbing the piping.
- Install all supply piping, pumps and other equipment including gate valves and strainers therein, at line size with the reduction in size being made only at the outlet piping from the control valve at the full size of the tapping in the equipment served.

F. Unions and Flanges

Unions and flanges shall be installed at all equipment inlets and outlets, at all valves inlets or outlets, on all pipe branches and in general, every 15 metres of pipe run.

Unions shall be used on all screwed pipes and shall be of the same quality and service. Flanges, suitable for welding, shall be used on all welded pipes, and shall be all steel construction to ASTM or BS Standards.

Threaded flanges shall be used on all threaded pipes; when flanged valves and equipment are connected to the pipes, flanges shall be of the same quality and service as the pipe served, and shall conform to ASTM or BS Standards.

G. Cleaning of Piping Systems

- Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

- After installation is complete, place temporary screens at connections to all equipment and at automatic control valves where permanent strainers are not provided.
- Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.
- Remove dirt and debris collected at screens, strainers and other points from the system.
- The Contractor shall disinfect water piping before it is placed in service. The Contractor shall furnish all equipment and materials necessary to do the work of disinfecting and shall perform the work in accordance with the procedure outlined in AWWA Standard for Disinfecting Water Mains Designation C 601-68. The dosage shall be such as to produce a chlorine residual for not less than 10 ppm after a contact period of not less than 24 hours. After treatment, the piping shall be flushed with clean water until the residual chlorine content does not exceed 0.2 ppm. During the disinfecting period, care shall be exercised to prevent contamination of water in steel main.

H. Material Tests and Identification

- In addition to the tests required for specific piping systems, the manufacturer shall test all materials as specified prior to delivery.
- Check all materials for defects. Identify all materials with factory applied permanent stampings or markings designating their conformance to specified requirements.

I. Hydrostatic Pressure Tests

Test all piping systems as per the specifications under "Quality Requirements"

2.2 PIPE CLASSES: SANITARY SEWERS 4" - 15": (Gravity)

A. Polyvinyl Chloride Pipe (PVC)

1. Polyvinyl chloride pipes (PVC) shall be of the unplasticized rigid type and of high density and complete homogeneity material PVC pipes-Type 3 shall comply with B.S. 4660-1973 atmospheric pressure rating and tested at maximum static head.
2. PVC pipes socket shall be provided with elastomeric lip sealing ring.
3. PVC pipes-Type 3 are allowed to be used for drainage, sewer and storm water application, under building structures and outside building and/or as specifically mentioned in the schedule or pipe materials.
4. Conform to ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness Solid Wall Pipe SDR 35.
5. PVC plastic in accordance with ASTM D 1784, Cell Classification 12454 B.

6. Integral Bell and spigot type rubber gasket push joint fittings conforming to ASTM D 3212 and ASTM F 477.

B Reinforced Concrete Pipe (RCP) 8" to 21" diameter:

1. Conform to ASTM C76.
2. Class IV, Wall B (Iowa DOT 3000D).
3. All joints to be sealed with rubber gaskets conforming to ASTM C 443.
4. Gasket to be P-4 Profile gasket.
5. Interior pipe barrel and all joint surfaces to be coated with two-component coal-tar epoxy polyamide black paint or approved equal.

2.3 PIPE JOINTS

A. Flanged Pipe Joints

- All flanged joints shall be made up with compressed ring type asbestos gaskets. Gaskets shall be 1.5 mm. thick.
- Bolts for flanges shall be of low carbon steel with hexagonal heads and hard pressed steel hexagon nuts. Bolts shall be to ASTM specifications A 307 or SAE grade 2, with tensile strength of 64000 psi (441.3 Mpa) minimum.
- All bolt holes shall be spot faced. B)

B. Joints Between Dissimilar Materials

- Screwed Pipe to Cast Iron Pipe

Joints between wrought-iron, steel, brass or copper pipe and cast iron pipe shall be made with cast iron spigots screwed to the steel pipe and caulked to the cast iron pipe.

- Copper Tubing to Screwed Pipe Joints

Joints shall be made by the use of brass converter fittings. The joint between the copper pipe and the fitting shall be properly soldered, and the connection between the threaded pipe and the fitting shall be made with a standard pipe size screw joint.

C. Joints Between Dissimilar Metals (Dielectric isolators)

- Make joints between ferrous and non-ferrous screwed piping and equipment by using Teflon or nylon isolating materials in the form of screwed unions.
- Make joints between ferrous and non-ferrous flanged piping and equipment, "Task-Line" insulating gaskets and "Teflon sleeves and washers between flanges, bolts and nuts.
- The entire insulating joint including the dielectric material shall be suitable to withstand

the temperature, pressure and other operating characteristics for the service for which they are used.

2.4 LUBRICANT FOR JOINT GASKETS:

- A. Soap-based only.
- B. DO NOT USE petroleum based lubricant.

2.5. STANDARD MANHOLES:

A. Concrete Manhole sections

1. Manholes shall be constructed of class "b" concrete as shown on the drawings. The base (where required) shall be of precast class "B" reinforced concrete. The shaft shall be constructed of poured reinforced concrete to suit the required depth. The top shall be of class "B" reinforced concrete. An opening suitable to the cover shall be left in the top around which the radial concrete ring is built for proper adjustment of levels.
2. The benching shall be formed in the bottom of manholes in class "B" CONCRETE. "U" channels shall be formed with bottom flush with inside surface of pipes and sides extending the full height of the largest pipe and then sloped back at a minimum fall of 10%. The benching and channels shall be finished with 2 cm thick rendering composed of 1/2 cement/sand mortar, and surface hardened with two coats of sodium silicate solution brushed on. The finished diameter of channels shall be the same as the diameter of pipes entering or leaving the manhole.
3. Joints: Flexible joint rubber ring gasket type, profile gasket or O-ring gasket; conform to ASTM C443.
4. Steps: aluminum or copolymer encapsulated steel reinforcing bar spaced as per detail drawing.
5. The paint for the manhole interior shall be coated tar epoxy resin or approved equivalent.
6. Conform to standard drawings.

B. Pipe connections:

1. Use knockouts or saw cut openings for piping connections. Precast rubber sleeves not to be used.
2. Conform to standard drawings.

C. Frame and cover castings:

1. The Contractor shall finish and set level and the proper grade, a ductile iron frame and cover and grating of the form and dimensions shown on the Drawings. The concrete masonry shall be neatly and accurately brought to the dimensions of the base of the frame. The frames shall be thoroughly embedded in mortar. All covers and frames

shall be fill in type, with double seal class B125 similar to Saint Goban or approved equal.

2. All castings for frames covers, and gratings shall be of ductile iron. All castings shall be made accurately to dimensions and shall be machined to provide even bearing surfaces. Covers and gratings must fit the frames in any position and if found to rattle under traffic shall be replaced. Filling to obtain tight covers will not be permitted. No plugging, burning-in and filling will be allowed. All castings shall be carefully coated inside and out with coal tar pitch varnish of approved quality.
3. Refer also to Section 02726 Manhole Covers and Frames.
4. The words "SANITARY" in Arabic and English shall be cast into the covers.

D. Concrete adjusting rings:

1. Use precast concrete adjusting rings meeting ASTM C478 for any grade adjustment.
2. No bricks, HDPE, or site poured adjusting rings shall be used.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify measurements at site; make necessary field measurements to accurately determine pipe make up lengths or closures.
- B. Examine site conditions to insure that construction operation do not pose hazards to adjacent structures or facilities.

3.2 LINE AND GRADE

- A. Install pipe to line and grade shown on plans. Set field grades to invert of pipes.
- B. Notify the Engineer immediately if discrepancies or irregularities are discovered in line or grade shown by grade takes.
- C. Make detailed measurements as required to construct work to line and grade established by line and grade hubs.
- D. Use one of these methods to determine line and grade, or an alternate approved by Owner:
 1. Batter Boards:
 - a. Set grade points at 1 meter intervals at convenient offset from centerline of pipe.
 - b. Set batter boards as necessary to construct to design line and grade.
 - c. Provide at least three batter boards at the pipe laying area during construction as check on accuracy of grades.

- d. Check line and grade of each pipe length with grade rod and plumb bob.
- 2. Pipe Laser:
 - a. Set laser equipment to proper line and grade from line and grade hubs.
 - b. Check line and grade of laser at 1 meter intervals for first 4 meters and then at 2 meter intervals for each setup.
 - c. Check line and grade of each pipe length.
- 3. Survey Laser:
 - a. Set laser equipment to base elevation.
 - b. Check line and grade of each pipe length with grade rod.

3.3 PIPE INSTALLATION

- A. Provide trench excavation, pipe bedding and backfill.

The laying of pipe underground will require trimming and grading of trench bottoms for pipe and will require backfilling with approved materials and tamping around all pipe to center line of pipes as the pipe laying process to provide protection and stabilization of the piping. Pipe laying work shall be conducted so that trenching operations are not advanced too far ahead of pipe laying operations resulting in excessive length of open trench.

The Contractor shall trim the bottom of all trenches to receive pipe and shall provide finish grade by hand methods. The bottoms of all trenches shall be rounded so that insofar as particular at least one-third of the circumference of the pipe will rest firmly on 20cms undisturbed sand at proper line and grade. Bell holes where required shall be dug to ensure pipe resting for its entire length upon the bottom of the trench. Trenches shall not be excavated below grade by machine.

After pipes have been tested and approved, trenches shall be backfilled with approved materials, carefully deposited in layers not to exceed 15 cms in thickness on both sides and thoroughly and carefully tamped. Backfilling and tamping in layers of 15 cms shall be conducted until a depth of 30 cms has been placed over the sand. No backfill shall be placed in a manner such as to cause injury to the pipe. Where pipe crossing occur, the lower pipe shall be laid first and the backfill thoroughly compacted to the level of the higher pipe before higher pipe is laid. Backfill materials under such conditions shall be earth, approved gravel on concrete as directed.

Where rock is encountered excavation shall conform to applicable provisions.

- B. Begin at highest point in line. Lay groove or bell end pointing upstream unless specifically noted otherwise.
- C. Prepare trench bottom to design line and grade so that only minor movement of pipe is necessary after installation. Use bedding as specified on detail drawing.

- D. Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.
- E. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.
- F. Do not lay pipe in water or on saturated soil or bedding, or allow water to rise in trench around pipe, unless approved by the Engineer.
- G. Lay pipe to design line and grade.
- H. Provide uniform bearing for full pipe barrel length.
 - 1. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
 - 2. Do not block pipe above bedding unless controlled density fill, concrete bedding, or concrete easement is to be used.
- I. Assemble joints as specified by pipe manufacturer.
- J. Install cap at exposed ends of pipe whenever pipe installation is not in progress.
- K. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.
- L. Saw cut ends of pipe at manholes and structures. Do not hammer cut or break pipe.
- M. Correct misalignment, displacement or otherwise defective pipe by removing, relaying or replacing pipe at Contractor's expense.
- N. To connect new pipe to existing manhole, sawcut or hammer out enough manhole wall and base to allow pipe to penetrate 3" past interior wall of manhole at elevation indicated. Sawcut out and pour new invert if elevation requires. Grout around pipe penetration.

3.4 PIPE JOINTING

- A. Joint Cleaning: Clean joint surfaces with wire brush to remove soil or foreign material prior to jointing pipe
- B. Assemble joints in accordance with pipe manufacturer's recommendations.
 - 1. Use equipment that does not apply damaging forces to pipe joints.
 - 2. Use bar and block or internal or external jointing devices or other devices as recommended by pipe manufacturers.
- C. Polyvinyl Chloride Pipe (PVC):
 - 1. Coat rubber gasket and joint with lubricant immediately prior to closing joint..

D. Connections Between Dissimilar Pipes:

1. Use Fernco couplings or equivalent.
2. Where adapters or couplings are not commercially available, the Engineer may authorize use of a reinforced concrete collar as per specs. Authorization for this will be very rare and must be explicitly approved.

3.5 TOLERANCES

- A. Horizontal and vertical alignment of each pipe length of gravity sewer lines shall not vary from design lines and grade by more than 1 % of the inside diameter of the pipe or '1/4 inch, whichever is larger.
- B. Tolerance allowed for gravity sewer lines only if design line and grade is sufficient to prevent backslope when tolerance limits are reached.
- C. Reverse slope on gravity pipe is prohibited. Remove and relay pipe to proper grade.
- D. Horizontal and vertical alignment of force mains shall not vary from design line and grade by more than 3 inches.

3.6 CONFLICTS

- A. Provide temporary support for existing water, gas, telephone, power or other utilities or service that cross trench.
- B. Compact backfill under existing utility crossing as specified in Utility Trench and Backfill. or construct utility line supports where indicated on plans or as directed by the Engineer.

3.7 MANHOLE INSTALLATION

- A. Subgrade Preparation:
 1. Undisturbed soil; Hand grade to accurate elevation.
 2. Disturbed soil; Machine compact to 95 percent of Standard Proctor Density and hand grade to accurate elevation or install stabilization material as directed by the Engineer.
- B. Installation of Poured In Place Base:
 1. Bed base riser section in cement mortar.
 2. Assure proper vertical and horizontal alignment of base riser section.
 3. Invert to be same size as outlet pipe.
 4. Provide smooth, semi-circular invert through manhole. This may be achieved by smoothly forming concrete in a curve to match long radius fitting size, or by bedding proper standard fittings such as wye and 1/8 bends in the concrete and leaving them in place.

5. All water shall drain freely from manhole.
6. Slope floor toward invert.
- C. Grout inside pipe/manhole joint.
- D. Additional Risers: Install additional riser section as required. Lubricate O-rings with soap.
- E. Repair any honeycomb areas or damaged areas as directed by the Engineer.
- F. Install manhole adjustment rings as shown in the manhole detail. Bed each concrete ring with bituminous jointing material in trowelable or rope form.
- G. For cone topped manhole, drill 1/4" hole through neck of eccentric manhole to insert locate wire. Grout full. On flat topped manhole, install locate wire in mortar bed between top two adjustments rings.
- H. Install manhole ring and cover. Adjust accurately to proper grade. Where manhole is to be in a paved area, adjust slope to match finished surface.

3.8 ABANDONING EXISTING MANHOLES

- A. Remove top and walls of structure to a minimum of 35 cm below subgrade in paved areas or 35 cm feet below finish grade in other areas.
- B. Plug all pipes that are to be abandoned leaving structure using flowable mortar.
- C. Fill remaining structure using flowable mortar.
- D. Place compacted earth fill over structure as required for embankment or compacted backfill.

3.9 TESTING AND INSPECTION

- A. General
 1. On completion of the works, the Contractor shall arrange the testing of the works and witnessing of the tests.
 2. Scheduling: The Contractor will complete the tests and will provide the project Engineer with results. The Engineer can witness the tests.
 3. The tests shall comprise the tests as set out in the Uniform Plumbing Code, and described below.
 4. Where the testing is to be carried out in sections the Contractor shall retain on site drawing indicating sections tested and recording dates on which the tests took place duly witnessed.
 5. The Contractor shall be responsible for providing all skilled and unskilled labor necessary to carry out tests and ensure that all supplies and instruments are available.
- B. Roundness testing

1. The Contractor shall test gravity lines for roundness by drawing a 7 1/2% deflected mandrel through the pipe.
2. To be used on PVC and polyethylene pipes.

C Pressure Testing (for projects with over 200' of new sewer piping)

1. Owner shall conduct a low pressure air test per ASTM F1417.
2. To be used on PVC and polyethylene pipes.
3. Determine the test time required. A table of minimum test times for various pipe sizes is shown below.
4. Owner shall plug all openings in the test section.
5. If groundwater is present, air pressure shall be corrected by dividing water height over pipe (ft) by 2.31 and adding this psi to test pressure.
6. Add air until the internal pressure of the line is raised to 4 psig plus groundwater correction. Maintain pressure for 2 minutes to allow temperature equalization.
7. After pressure has stabilized between 3.5 and 4 psig, record pressure and begin timed test.
8. If the pressure drops more than 1.0 psig during the test time, the line has failed. Contractor must resolve failure at their expense.
9. Minimum Test Times

Pipe Size (Inches)	Seconds/100 ft
4	20
6	45
8	75
10	120
12	170

D. Visual Inspection.

1. The Owner and Engineer will check the sewer piping for alignment and grade between manholes or intake structures by means of lamping. If any portion of the sewer system deviates from true line or grade, the Contractor shall be required to correct at the Contractor's expense.
2. To be used on all pipes.

-
3. Manhole and intake structures are to be visually examined for leaks, damage, voids, porous areas, proper seals, and to verify that structure is proper size, to grade and plumb.
 4. Contractor to repair or replace any unacceptable work at no additional cost to Owner. Items that can be repaired in manholes are small visible leaks and tie holes to patch.
- E. Water Flow Inspection.
1. Water shall be supplied at the upstream structure and observed flowing into the adjacent structure downstream. The Engineer shall determine if the functionality of the sewer is acceptable.
- F. Water Head Test (For projects with under 200' of sewer piping).
1. Contractor shall provide a means for the owner to put 15' head of water on the new sewer pipe.
 2. The Engineer shall fill the sewer pipe with water up to 15' above pipe invert and mark fill level.
 3. Water shall not drop more than 6" in 2 hours. Pipe that fails this test shall be inspected by excavation at Contractor's expense to determine cause of leak. Contractor shall repair leak as directed by owner, prior to a re-test
- G. Trench Compaction
1. Utility Trench Excavation and Backfill for compaction testing.

END OF SECTION 33300

DIVISION 3
CONCRETE TABLE OF
CONTENTS

03100	FORMWORK
03200	CONCRETE REINFORCEMENT
03250	CONCRETE ACCESSORIES
03300	CAST IN PLACE CONCRETE
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03455	GLASS FIBRE REINFORCED CONCRETE
03521	LIGHT WEIGHT CONCRETE FILL
03720	CONCRETE REPAIR

SECTION 03100

FORMWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.
- E. Formed concrete surface finishes.
- F. Remedial work to defective surfaces.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 03200 Concrete Reinforcement.
- C. Section 03250 Concrete Accessories.
- D. Section 03300 Cast In Place Concrete.
- E. Section 03355 Exposed Aggregate Concrete Finish.

1.03 REFERENCES

- A. ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials.
- B. ACI 301 Structural Concrete for Buildings.
- C. ACI 318 Building Code Requirements for Reinforced Concrete.
- D. ACI 347 Recommended Practice for Concrete Formwork.
- E. ASTM A 184 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.

1.04 DEFINITIONS

- A. Formwork means the surface against which concrete is placed to form a face, together with all the immediate supports to retain it in position while concrete is placed.
- B. Falsework means the structural elements supporting both the formwork and the concrete until the concrete becomes self supporting.

- C. A formed face is one which has been cast against formwork.
- D. An exposed face is one which will remain visible when construction has been completed.

1.05 DESIGN REQUIREMENTS

- A. Design, engineer and construct formwork, shoring and bracing to conform to code requirements; resultant concrete to conform to required shape, line and dimensions.
- B. Design and construct formwork and falsework such that they support the loads imposed on them by fresh concrete, together with additional stresses from vibrating equipment and construction traffic, so that after the concrete has hardened the formed faces are in the position and have the shape and profile as shown on the drawings within the limits of the dimensional tolerances.
- C. The design of formwork is the responsibility of the Contractor.

1.06 SUBMITTALS FOR REVIEW

- A. Comply with Section 01330.
- B. Submit shop drawings and design calculations showing details of the proposed formwork and falsework for approval of the Engineer.
- C. Shop drawings: Indicate pertinent dimensions, materials, bracing and arrangement of joints and ties.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Construct temporary formwork of timbers, (soft wood plywood, plywood or lumber), metal sheet or other approved material such that concrete produced is of the required finish.
- B. Construct permanent formwork of slabs or blocks of precast concrete, natural stone, brickwork, preformed metal sheets or other approved material. Tighten them by such means as to prevent the leakage of grout from the concrete. Do not use breeze blocks or other porous materials as permanent formwork.
- C. The type and treatment of any lining to the forms be appropriate to the concrete finish required.

2.02 PREFABRICATED FORMS

- A. Provide one or more of the following form types as per manufacturer's standard product and as required by the project, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
 - 1. Preformed steel forms of minimum 16 gauge or 1.5 mm thick.
 - 2. Thermoplastic polystyrene preformed plastic forms.

3. Glass fiber fabric reinforced plastic forms.
4. Pan type: Steel or glass fiber of size and profile required.

2.03 FORMWORK ACCESSORIES

- A. Form Ties: Removable type, galvanized metal or plastic, adjustable length, cone type, with waterproofing washer, free of defects.
- B. Form Release Agent: Colorless mineral oil which do not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete and be one of the following types:
 1. Cream emulsion.
 2. Neat oil with surfactant added.
 3. Chemical release agent.
- C. Corners: Chamfered rigid plastic or wood strip 25 x 25 mm size of maximum possible lengths.
- D. Dovetail Anchor Slot: Galvanized steel, 0.8 mm thick, non-filled, release tape sealed slots, anchors for securing to concrete formwork.
- E. Flashing Reglets: Galvanized steel or rigid PVC, 0.8 mm thick, longest possible lengths, with alignment splines for joints, non-filled, release tape sealed slots, anchors to be secured to concrete formwork.
- F. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sizes as required, of sufficient strength and character to be secured to concrete formwork.
- G. Waterstops: Preformed mineral colloid strips, 9 mm thick, moisture expanding.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Earth forms are not permitted.

3.03 ERECTION

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301 and ACI 347.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads. Props shall be carried to construction which is

sufficiently strong to afford the necessary support without injury to any portion of the structure. This may mean in some cases that they be carried down to the foundations or other suitable bases.

- C. Arrange and assemble formwork to permit dismantling and stripping without shock and disturbance. Do not damage concrete during stripping. Permit removal of remaining principal shores. The responsibility for the safe removal of the props rests with the Contractor.
- D. Align joints and make watertight to prevent leakage of grout from concrete. Keep form joints to a minimum.
- E. All construction joints in formwork shall be tightly secured against previous or hardened concrete to prevent the formation of stepping or ridges in the concrete.
- F. Formwork shall be constructed to provide straight and true angles, arises or edges. Provide chamfer strips on external corners of beams columns and walls.
- G. Formwork panels shall have true angles to permit accurate alignment at the sides and provide a clean line at construction joints in the concrete.
- H. Coordinate this section with other sections of work which require attachment of components to formwork.
- I. When formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.
- J. Fix formwork panels with their joints either vertical or horizontal unless otherwise specified.
- K. Provide formwork to the top surface of concrete where the slope or nature of the Work requires it. Horizontal or inclined formwork to the upper surface of concrete is to be adequately secured against uplift due to the pressure of fresh concrete.

3.04 APPLICATION – FORM RELEASE AGENT

- A. Store and use release agents strictly in accordance with the manufacturer's instructions.
- B. Where the concrete surface is to be permanently exposed use only one agent throughout the entire area.
- C. Where the surface is to receive an applied finish, take care to ensure the compatibility of the release agent with the finish.
- D. Release agents not to come in contact with the reinforcement.

3.05 INSERTS, EMBEDDED PARTS AND OPENINGS

- A. Unless otherwise shown on the drawings or specifically approved, form all openings and holes and cast all inserts and fixings at the time of pouring.
- B. Locate and set in place items which will be cast directly in to concrete. Obtain approval for size, type and position of any hole, insert or fixing required before work proceeds.

- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Position recessed reglets for masonry anchors to the spacing and intervals required.
- E. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- F. Install waterstops in accordance with manufacturer's instructions continuous without displacing reinforcement. Heat seal joints watertight.
- G. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- H. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
- I. Do not drill or cut away any part of the concrete works without the specific approval of the Engineer.
- J. If such drilling or cutting is carried out without approval the affected parts is classed as defective work.

3.06 FORMWORK TIES

- A. Obtain Engineer's approval for the materials and position of any ties passing through the concrete.
- B. Remove a tie so that no part of it is remaining in the concrete.
- C. Place the tie nearer to the finished surface of the concrete more than the specified thickness of cover to reinforcement.
- D. Fill any holes left after the removal of ties with concrete or mortar of approved composition unless otherwise specified.
- E. In waterproof concrete use tie through the concrete of a type with a baffle.

3.07 DEFECTIVE FORMWORK

- A. Where in the opinion of the Engineer any piece of formwork is damaged, deformed, worn or otherwise incapable of producing an acceptable finished concrete surface, he may declare such formwork defective. Repair such formwork to the satisfaction of the Engineer or remove from the site.

3.08 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain out through clean-out ports.

3.09 FINAL PREPARATIONS

- A. Before concrete placing commences, secure all wedges and other adjusting devices against movement during concrete placing and maintain a watch on the formwork during placing to ensure no movement occurs.

3.10 STRIKING OF FORMWORK

- A. Inform and take approval of the Engineer to strike any formwork.
- B. Do not remove forms or bracing until concrete has gained sufficient strength.
- C. Unless otherwise directed, do not apply treatment of any kind, other than that required for curing after removal of the forms until it has been inspected.

3.11 SUBSEQUENT POUR

- A. Do not pour concrete against an existing concrete face until 24 hours of its casting.

3.12 FORMED CONCRETE SURFACE FINISHES

- A. Classes of Finish: Achieve the surface finish on formed concrete surfaces as shown on the Drawings and detailed hereunder.
 - 1. Class F1 Finish
 - a. Provide this finish for surfaces against which backfill or further concrete will be placed.
 - b. Use sawn boards, sheet metal or any other suitable material which will prevent the loss of fine material from the concrete being placed.
 - 2. Class F2 Finish
 - a. Provide this finish for surfaces which are permanently exposed to view but where the highest standard of finish is not required.
 - b. Use form faced with wrought thickened tongue and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets be such that there is no visible deflection under the pressure exerted by the concrete placed against them.
 - c. Provide joints between boards or panels vertical and horizontal unless otherwise directed.
 - d. This finish do not require general filling of surface pitting. Fins, surface discolouration and other minor defects are remedied by methods agreed by the Engineer.
 - 3. Class F3 Finish
 - a. Provide this finish for surfaces permanently exposed to view where good appearance is of special importance.

- b. To achieve this finish, which shall be free of board marks, face the formwork with plywood complying with ACI 301 or equivalent material in large sheets.
- c. Arrange the sheets in an approved uniform pattern. Wherever possible, arrange joints between sheets to coincide with architectural features or changes in direction of the surface. Keep joints between panels vertical and horizontal unless otherwise directed. Provide suitable joints between sheets to maintain accurate alignment in the plane of the sheets.
- d. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish.
- e. Ensure that the surface is protected from rust marks, spillages and stains of all kinds.

4. Class F4 Finish

- a. Provide this finish similar to that required for F3 but use it in places where a first class alignment and a dense surface free from air holes and other defects is required.
- b. Provide a high quality finish for exposed surfaces and be suitable for the application of decorative finishes and in other similar circumstances.
- c. Use this finish for concrete surface to have exposed aggregate finish complying with Section 03355.
- d. Provide this finish with careful selection of materials and the highest quality of workmanship and supervision at all stages.

B. Curved Surfaces

- 1. For curved surfaces where F2, F3 or F4 finishes are called for, build the formwork face with splines cut to make a tight surface and dressed to produce the required finish.
- 2. Alternatively face the single curvature surfaces with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush.
- 3. Ensure that linings shall not bulge, wrinkle or otherwise deform when subjected to temperature and moisture changes.

3.13 DIMENSIONAL TOLERANCES

- A. Erect formwork such that dimensions of concrete construction are within the tolerances quoted in ACI SP-16, ACI 301, ACI 318, ACI 347 and ASTM A184 for accuracy in Building, except where the tolerances given in the Specification are more onerous.
- B. The permissible tolerances on formed concrete surfaces shall not exceed the values given in Table 1.

TABLE 1

Class of Finish	Tolerance in mm – see notes		
	A	B	C
F1	10	10	±25 to ±10
F2	5	10	±15
F3	2	5	±10
F4	Nil *	2	±5

Notes:- The tolerances A, B and C given in Table 1 are defined as follows:

- A - is an abrupt irregularity in the surface due to misalignment or defects in the face of the formwork.
- B - is a gradual deviation from a plane surface as indicated by a straight-edge 3 m long. In case of curved surfaces replace the straight-edge by correctly shaped template.
- C - is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the drawings.
- * Abrupt irregularities are not permitted in F4 finish. Remove by grinding any irregularities which remain after removal of formwork to achieve a transition of 1 in 50 between the surfaces adjacent to the irregularity.

3.14 REMEDIAL WORK TO DEFECTIVE SURFACES

- A. When on stripping any formwork the concrete surface is found to be defective in any way, do not attempt to remedy such defects prior to the Engineer's inspection.
- B. Do not make defective surfaces good by plastering at any stage.
- C. Honeycombed Areas
1. Repair areas of honeycombing which the Engineer agrees by cutting back to sound concrete or to 75 mm whichever is the greater.
 2. In the case of reinforced concrete cut back to at least 25 mm clear distance behind the reinforcement or to 75 mm, whichever is the greater.
 3. Make sides of the cavity at right-angles to the face of the concrete.
 4. After cleaning out with water and compressed air, apply a thin layer of cement grout

on to the concrete surfaces in the cavity and then fill immediately with concrete of the same class as the main body but with aggregate larger than 20 mm nominal size removed.

5. Use form against the cavity along with a lip to enable concrete to be placed. Fill it to a point above the top edge of the cavity.
 6. After seven days remove the lip of concrete and grind the surface.
- D. Grind the surface irregularities which are outside the limits of tolerance set out in Table 1 in the manner and to the extent instructed by the Engineer.

END OF SECTION 03100

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Steel reinforcement for concrete in any part of the Works but excluding prestressing tendons or any other embedded steel.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements.
- D. Section 03100 Concrete Formwork.
- E. Section 03250 Concrete Accessories.
- F. Section 03300 Cast In Place Concrete.
- G. Section 03400 Precast Concrete.
- H. Section 03410 Structural Precast Concrete.

1.03 REFERENCES

- A. CRSI Concrete Reinforcing Steel Institute - Manual of Practice.
- B. CRSI 63 Recommended Practice for Placing Reinforcing Bars.
- C. CRSI 65 Recommended Practice for Placing Bar Supports, Specification and Nomenclature.
- D. ACI 301 Structural Concrete for Buildings.
- E. ACI 318 Building Code Requirements for Reinforced Concrete.
- F. ACI SP 66 American Concrete Institute - Detailing Manual.
- G. ASTM A 184 Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
- H. ASTM A 185 Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
- I. ASTM A 496 Specification for Steel Wire, Deformed, for Concrete Reinforcement.
- J. ASTM A 497 Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement.

- K. ASTM A 615 Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- L. ASTM A 641 Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
- M. ASTM A 767 Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement.
- N. ASTM A 775 Specification for Epoxy-Coated Reinforcing Steel Bars.
- O. ASTM A 884 Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
- P. ASTM A 934 Specification for Epoxy-Coated Pre-Fabricated Reinforcing Bars.
- Q. AWS D 1.4 Structural Welding Code for Reinforcing Steel.
- R. AWS D 12.1 Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction.

1.04 SUBMITTALS FOR REVIEW

- A. Comply with Section 01330.
- B. Submit for Engineer's review all items described in this specification section.
- C. Submit manufacturer's certificate, certifying that the products meet or exceed specified requirements.

1.05 HANDLING AND STORAGE OF MATERIALS

- A. Comply with Section 01600.
- B. Handle epoxy coated bars with the systems having padded contact area.
- C. Use padded bundling bands or use suitable banding (use nylon rope instead of wire rope), to prevent damage to the coating.
- D. Lift all the bundles of coated bars with a strong back, spreader bar, multiple supports or via platform bridge to prevent bar-to-bar abrasion from sags in the bundles of coated bars.
- E. Do not drop or drag bars or bundles.
- F. Store reinforcement of all types on site in padded racks above ground in an approved manner so as to avoid damage to coatings.
- G. Provide reinforcement free from loose scale, rust, oil, grease or any other material that may impair the bond between the concrete and the reinforcement. Remove from site any reinforcement which has damaged the coating or pitted to an extent which, in the opinion of the Engineer, will affect its properties.
- H. Store mild steel reinforcement separately from high yield reinforcement.

1.06 QUALITY ASSURANCE AND TESTS

- A. Comply with Section 01400.
- B. Perform work in accordance with CRSI 63, 65 of ACI 301, ACI SP-66, ACI 318, ASTM A 184 and ASTM A 775.
- C. Provide Engineer with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
- D. The manufacturer's test certificate for ultimate strength, elongation and cold bending together with the chemical analysis of the steel may be called for by the Engineer for any consignment of reinforcing steel direct from the manufacturer. Where steel is obtained from an indirect supplier, the Engineer may require tests in an approved laboratory to prove compliance with the appropriate American Standards.
- E. The frequency of testing shall be as set out in the American Standards. Carry out additional tests as instructed by the Engineer.
- F. Any reinforcement which does not comply with the Specification remove immediately from site.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Bars for reinforcement shall be:-
 - 1. Hot rolled mild steel bars to ASTM A 615.
 - 2. Hot rolled high yield deformed bars to ASTM A 615.
 - 3. Steel fabric to ASTM A 185 plain type, ASTM A 497 welded deformed type, ASTM A 497 deformed type.
 - 4. Reinforcing steel bars, welded wire fabric, and prefabricated reinforcing bars shall be epoxy-coated to ASTM A 775, ASTM A 884 and ASTM A 934.
- B. Deformed bars shall be as defined in ASTM A 615.

2.02 TYING DEVICES

- A. Tying devices shall be:
 - 1. Black annealed mild steel wire of 1.6 mm diameter.
 - 2. Approved rustproof binding wire, or
 - 3. Approved proprietary ties.

2.03 SPACER BLOCKS, CHAIRS, BOLSTERS, BAR SUPPORTS

- A. Use spacer blocks chairs, bolsters, bar supports for ensuring that the correct cover is maintained to the reinforcement.
- B. Provide blocks, chairs, bar supports and bolsters of such materials and design as will be durable and not lead to corrosion of the reinforcement such as plastic and plastic coated steel, or current blocks. These are sized and shaped for strength and support of reinforcement during concrete placement conditions.
- C. Use spacer blocks made from cement, sand and small aggregate not exceeding 50 mm square in section and secure with wire to the reinforcement to ensure that they are not displaced when the concrete is poured. Make these of similar mix proportions and strength as the adjacent concrete.

PART 3 EXECUTION

3.01 CUTTING AND BENDING

- A. Bend reinforcement to the dimensions given in the bar schedules in accordance with latest editions of ASTM A 184, ACI 318 CRSI 63 and CRSI 65 unless otherwise stated.
- B. Do not heat reinforcement before bending.
- C. Do not straighten or re-bend cold worked bars and hot rolled high yield bars once having been bent. Where it is necessary to bend mild steel reinforcement already cast in the concrete, the internal radius of bend shall not be less than twice the diameter of the bar.
- D. After bending, securely tie bars together in bundles or groups and legibly labelled as set out in CRSI 63 and CRSI 65.

3.02 SPLICING AND WELDING

- A. Locate reinforcing splices at point of minimum stress. Review and take instruction for location of splices with Engineer.
- B. Do not weld or splice reinforcement except where required by the Contract or agreed by the Engineer. When welding is employed follow the procedures shall be as set out in AWS D 1.4. Submit details of all welding techniques to be used and such trials made as are required to demonstrate the effect of the welding.

3.03 CLEANING OF REINFORCEMENT

- A. Clean reinforcement free of all loose mill scale, rust, oil, grease, concrete or other harmful matter at the time of concreting.

3.04 PLACEMENT AND FIXING OF REINFORCEMENT

- A. Accurately place all reinforcement with the correct cover and fix securely in the positions as shown on the drawings. Give reasonable notice of the intention to pour to the Engineer and that the reinforcement fixing is complete.

- B. At intersections bind together the reinforcement bars together with tying wire such that loose ends of the wire shall be turned towards the inside of the member.
- C. Supply and fix all chairs required to support the top mat of slab reinforcement or space the mats of all reinforcement adequately. In particular slab chairs must be close enough to prevent the reinforcement being bent or sagging.
- D. Provide the actual concrete cover not less than the required nominal cover minus 5 mm. No metal part of any device used for connecting bars or for maintaining reinforcement in the correct position shall remain within the specified minimum cover. Provide adequate mortar or plastic spacers to ensure the correct cover is achieved. The use of spacer blocks will not generally be permitted against a concrete face which is to be permanently exposed in the finished works.

3.05 PROJECTING REINFORCEMENT

- A. Protect projecting reinforcement without affecting its bond properties ensure that it does not cause rust staining to any part of the Works.

END OF SECTION 03200

SECTION 03250

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Accessories used in cast-in-place concrete construction, including but not limited to the following:
 - 1. Expansion, contraction and construction joints.
 - 2. Waterstops.
 - 3. Joint sealants.
 - 4. Coloured concrete.
 - 5. Floor hardeners.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 02220 Structural Excavation and Backfilling.
- C. Section 02518 Concrete Pavers.
- D. Section 03100 Formwork.
- E. Section 03300 Cast in Place Concrete.
- F. Section 03370 Concrete Curing.

1.03 REFERENCES

- A. ASTM C 494 Specification for Chemical Admixtures for concrete.
- B. ASTM D 1190 Concrete Joint Sealer, Hot-Poured Elastic Type.
- C. ASTM D 1752 Preformed Sponge Rubber or Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.04 DEFINITIONS

- A. Expansion and contraction joints are discontinuities in concrete designed to allow for thermal and other movements in the concrete.
- B. Expansions joints are formed with a gap between two concrete faces to permit subsequent expansion of the concrete. Expansion joints shall be formed in the positions and in accordance with the details shown on the drawings or elsewhere in the Specification.

C. Contraction joints are formed to permit initial contraction of the concrete and may include provision for subsequent filling. Contraction joints shall be either complete contraction joints or partial contraction joints and shall be formed in the positions and in accordance with the details shown on the drawings and elsewhere in the Specification.

D. A construction joint is the surface of contact whenever concrete is to be bonded to other concrete which has hardened.

1.05 SUBMITTALS

A. Comply with Section 01330.

B. Submit all the items described in this specification section with product data, manufacturer's installation instructions indicating procedures and interface required with adjacent work.

1.06 QUALITY ASSURANCE

A. Field Reference Samples:

1. Provide field constructed samples as identified and specified in this Section.
2. Engineer accepted samples will be quality control reference for remainder of Work and considered as minimum quality standards.
3. An Engineer accepted field reference sample may be integrated into the Work.
4. If not integrated into Work, retain accepted samples in-place on site until related Work is completed and accepted.

PART 2 PRODUCTS

2.01 COMPRESSIBLE JOINT FILLER

A. Non-absorbent, closed cell, non-extruding, non bituminous complying to ASTM D 1752.

B. Shall have:-

1. A minimum of 85% recovery after 50% compression.
2. Water absorption not exceeding 1.5% by weight after 72 hours immersion.
3. Density between 37 and 40 kg/m³.

C. Acceptable materials:-

1. Polyethylene foam expansion joint material.
2. Non-bituminous, wood fiber based joint material, Homex by Homasote or equal.
3. Standard or self-expanding cork material, ASTM D 1752.
4. Sponge rubber material, ASTM D 1752.

- D. Manufacturer: Fosroc Jubail 03-362-3875 or approved equal.

2.02 JOINT SEALANTS

- A. Gun grade, long life two part polysulphide sealing compound composed of selected fillers and pigments.
- B. Non-toxic, non-flammable, non-shrinkable and shall have a cyclic movement accommodation of + or - 17% of the mean joint width.
- C. Conforming to ASTM D 1190 non-slumping based on polysulphide rubber cured by the addition of lead dioxide hardener of a strength specified by the manufacturer to suit site conditions.
- D. Applied to a compatible polyethylene backing strip, all in accordance with the manufacturers instructions.
- E. Colour to be approved by the Engineer.
- F. Manufacturer: Forsoc, Jubail, 03-362-3875 - or approved equal.

2.03 BACKING STRIP OR ROD

- A. Closed cell foam, polyethylene compatible with furnished sealant rod, diameter minimum 3 mm larger than width of joint being sealed.

2.04 SLIP MEMBRANE

- A. Proprietary sliding bearing premoulded strip bearing of neoprene rubber with 7 mm minimum thickness reinforced with warpknitted polyester fabric.
- B. Design: Done by the manufacturer of the material.
- C. Installation: As per manufacturer's recommendations, provided at locations recommended by the manufacturer.
- D. Manufacturer: SK Bearings Ltd. Pampis Ford, Cambridge CB2-4HG or approved equal.

2.05 LAMINATED BEARINGS

- A. Elastomeric laminated bearings mechanically interlocked of natural rubber module, layered between metal plates.
- B. Number of layers shall be sufficient to cater for all applied vertical load and required displacement at bearing location (under beams).
- C. Bearings shall be mechanically anchored to the structure and be of precision manufacture with strict quality control and to be of plan size suitable to the connection under consideration.
- D. Manufacturer: CIPEC (France).

2.06 WATERSTOPS

- A. Made of materials which are resistant to chlorides, sulphates or other deleterious substances which may be present in the environment of the Permanent Works.
- B. Extruded from high quality unfilled polyvinylchloride (PVC) compounds and shall not contain any scrap or reclaimed PVC. Waterstops be of the type recommended by the manufacturer for intended use.
- C. Shall have an elongation breaking stress of at least 225% at 25°C, capable of accommodating a transverse movement of at least 10 mm.
- D. Supplied in maximum possible lengths consistent with ease of handling and construction requirements. Junctions between lengths of waterstops to be factory made.
- E. The sizes as per the drawings and of the same profile throughout the project.
- F. Manufacturer: Fosroc, Jubail or approved equal.

2.07 COLORED CONCRETE

- A. Concrete shall comply with Section 03300.
- B. Integral concrete colorant: Admixture conforming to ASTM C 494. Final colors to be selected by the Engineer.
- C. Special Provisions for Colored Concrete:
 - 1. Air-entraining agent must be approved by manufacturer of concrete colorant. Use no other admixtures with colored concrete.
 - 2. Whenever Section 03300 concrete mix requirement conflicts with colorant manufacturer's requirement, colorant manufacturer's requirements govern.

2.08 FLOOR HARDENERS

- A. Abrasion resistant hardener
 - 1. Hardeners containing non-metallic, rust free, emery aggregate with hardness value not less than 9 on Mohs scale.
 - 2. Premixed dry powder, colour as chosen by Engineer.
 - 3. Follow manufacturer's instructions.
- B. Chemical Hardener
 - 1. Factory blended dry powder of Magnesium flourosilicate and zinc flourosilicate.
 - 2. Of non metallic, hard, dense surface resistant to oil and grease.
 - 3. Follow manufacturer's instruction and recommendation for different locations.

- C. Manufacturer: Fosroc, Jubail or approved equal.

PART 3 EXECUTION

3.01 EXPANSION JOINTS

- A. Form expansion joints in concrete structures by means of a closed cell filler board cast between the two adjoining edges of concrete. Provide expansion joints at spacings not exceeding 30 meters or where indicated and detailed on the drawings.
- B. Tape all joints in the filler board to prevent concrete seepage.
- C. Ensure that the expansion joint is not bridged at any point by concrete or any other solid matter that makes the joint ineffective.
- D. At exposed faces of expansion joints cut back the filler board on completion of the structure and seal the joint with an approved sealant and backing rod.

3.02 CONTRACTION JOINTS

- A. Form contraction joints for slabs and walls at locations indicated on the drawings or at suitable locations in the slabs as directed by the Engineer.
- B. Place timber or plastic crack inducer at the bottom of the slab joint and form or cut a surface groove at the top surface immediately above.

3.03 CONSTRUCTION JOINTS

- A. Form construction joints in solid slabs, beams and walls by inserting temporary vertical stopping-off boards against which concrete can be properly compacted. The position at which such joints may be made are to be approved by the Engineer.
- B. Cast the maximum length of concrete not exceeding 10 linear meters in one operation without contraction joints. However, the maximum area of concrete that may be cast in one operation shall not exceed 400 square meters.
- C. Expose aggregate on existing concrete surface with a light power tool over all contact areas, except within 25 mm of permanently exposed faces. Do not carry out this operation until the concrete is in position for more than 24 hours. Remove all loose materials by compressed air and water jet. When instructed by the Engineer thoroughly saturate the face with water and apply a layer of 1:1 slurry of cement and sand immediately prior to the deposition of the fresh concrete.

3.04 WATERSTOPS

- A. Provide waterstops where indicated and detailed on the drawings and at all horizontal and vertical construction, contraction and expansion joints in basement construction whether or not indicated on the drawings.
- B. Supply waterstops in maximum possible lengths consistent with ease of handling and construction requirements.

- C. Supply manufacturer's ready made joints, other than butt joints. Fabricate butt joints on site in accordance with manufacturer's instructions and with equipment supplied for the purpose by the manufacturer to form a continuous network providing a watertight seal along the line of all joints. Test all site made butt joints by an approved means.
- D. Store waterstop material carefully on site to avoid damage and contamination with oil, grease or other pollutants and in cool well ventilated spaces away from direct sunlight.
- E. Protect waterstops which are embedded in one side of a joint for a scheduled period of one month or more, from the sun by a method approved by the Engineer.
- F. Firmly fix waterstops in the formwork so that they cannot be displaced during concreting. Remove formwork around waterstops carefully to avoid damage. When waterstops suffer any damage which cannot be properly repaired insitu, the Engineer may require a section of concrete to be removed and the waterstops replaced.
- G. Place and compact concrete carefully around waterstops to avoid distortion or displacement.

3.05 INTEGRAL COLORED CONCRETE AND FLOOR HARDENERS

- A. Comply with recommendations and Application Instructions and other manufacturer's recommendations for acceptable techniques.
- B. For stamped concrete finish, lay concrete and apply patterns as required by the pattern supplier and applicator.
- C. For acceptance, completed floor areas must be uniform in color and be free from bumps or depressions.

END OF SECTION 03250

SECTION 03300

CAST IN PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cast-in-place concrete for all structural and non-structural use.
- B. Establishes the quality of materials and workmanship and defines how quality is measured for concrete work.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements.
- C. Section 03100 Concrete Formwork.
- D. Section 03200 Concrete Reinforcement.
- E. Section 03250 Concrete Accessories.
- F. Section 03370 Concrete Curing.
- G. Section 07105 Bituminous Membrane Waterproofing.

1.03 REFERENCES

- A. ACI 207.1 Mass Concrete.
- B. ACI 207.2 Effect of Restraint, Volume Change and Reinforcement on Cracking of Mass Concrete.
- C. ACI 207.4 Cooling and Insulating Systems for Mass Concrete.
- D. ACI 211.1 Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- E. ACI 211.2 Selecting Proportions for Structural Lightweight Concrete.
- F. ACI 221 Guide for Use of Normal Weight and Heavyweight Aggregates in Concrete.
- G. ACI 224 Control of Cracking in Concrete Structures.
- H. ACI 224.3 Joints in Concrete Construction.
- I. ACI 301 Structural Concrete for Buildings.
- J. ACI 302 Guide for Concrete Floor and Slab Construction.
- K. ACI 304 Recommended Practice for Measuring, Mixing, Transporting and Placing

Concrete.

- L. ACI 305R Hot Weather Concreting.
- M. ACI 306R Cold Weather Concreting.
- N. ACI 318M Building Code Requirements For Reinforced Concrete.
- O. ASTM C 31 Standard Practice for Making and Curing Test Specimens in the Field.
- P. ASTM C 33 Standard Specifications for Concrete Aggregates.
- Q. ASTM C 40 Standard Specifications for Organic Impurities in Fine Aggregates for Concrete.
- R. ASTM C 42 Standard Specifications for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- S. ASTM C 94 Standard Specifications for Ready-Mixed Concrete.
- T. ASTM C 127 Standard Specifications for Specific Gravity and Absorption of Coarse Aggregate.
- U. ASTM C 128 Standard Specifications for Specific Gravity and Absorption of Fine Aggregate.
- V. ASTM C 136 Standard Specifications for Sieve Analysis of Fine and Coarse Aggregates.
- W. ASTM C 143 Standard Specifications for Slump of Hydraulic Cement Concrete.
- X. ASTM C 150 Standard Specifications for Portland Cement.
- Y. ASTM C 260 Standard Specifications for Air-Entraining Admixture for Concrete.
- Z. ASTM C 470 Standard Specifications for Molds for Forming Concrete Test Cylinders Vertically.
- AA. ASTM C 494 Standard Specifications for Chemical Admixtures for Concrete.
- AB. ASTM C 618 Standard Specifications for Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.04 DEFINITIONS

- A. Structural concrete is any class of concrete which is used in reinforced, prestressed or unreinforced concrete construction subject to stress.
- B. Non-structural concrete is composed of materials complying with this Section but for which no strength requirements are specified and which is used only for filling voids and similar purposes where it is not subjected to significant stresses.
- C. Lightweight concrete screed is non-structural concrete made with light aggregate, but otherwise complying with this specification. Dry density shall not be greater than 1040

kg/m³.

- D. A pour refers to the operation of placing concrete into any mould, bay or formwork etc, and also to the volume which has to be filled. Pours in vertical succession are also referred to as lifts.
- E. Water/Cement ratio is the ratio by weight of the free water in the mix divided by the weight of cement in the mix. Free water is the water in the mix excluding water absorbed by the aggregate.

1.05 SUBMITTALS

- A. Comply with Section 01330.
- B. Full details of all proposed materials to be used for making concrete. Do not place concrete until the Engineer has approved the materials of which it is composed. Do not alter or replace approved materials without the consent of the Engineer.
- C. The proposed name of the Independent Testing Authority complying to the requirements of Section 01410.
- D. Full details of the proposed batching plant, mode of transportation and placing equipment and make arrangements for inspection and certification, prior to the production of concrete complying with the procedure published by the Ready Mix Concrete Manufacturer's Associations.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. The design of the structural concrete members to be in accordance with ACI 318M. Any concrete design carried out to conform to the above standard unless otherwise instructed by the Engineer. The provisions of this standard, unless otherwise stated be held to be incorporated in this Specification.
- C. No variations to the Specification or drawings to be made without approval. Submit details of any reasons for the proposed variations from this Specification, the drawings, and the Engineer's written or drawn instructions for approval.
- D. Comply with the appropriate American Standards and manufacturer's specifications for all materials used. Acquire cement and aggregate from the same source for all work. Mark, document and identify materials so as to ensure that they are used as specified.
- E. Conform to ACI 305R when concreting during hot weather.
- F. Perform all sampling, laboratory and site tests by an Independent Testing Agency/Laboratory complying with section 01400.
- G. Carry out all tests and checks on site in the presence of or as directed by the Engineer and as required by the Specification.
- H. Maintain at the site the following apparatus in good operating condition:

1. Apparatus for assessing workability in accordance with ACI 304.
 2. Apparatus for making concrete cylinders in accordance with ASTM C 470.
 3. A maximum and minimum thermometer close to the works for measuring atmospheric shade temperature.
 4. A wet and dry bulb thermometer for measuring relative humidities.
- I. When the concrete arrived on site does not meet the specified slump or any other test requirements and reached the site beyond the time limit, Engineer has authority to reject the load of concrete. Cart away the rejected concrete out of project site immediately.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement

1. Cement: Ordinary Portland Cement (OPC), complying with ASTM C 150, for all works above ground level. White or coloured cement shall comply with ASTM C 150.
2. Low-heat Portland cement, complying with ASTM C 150, in large concrete sections above ground, where necessary, to reduce temperature development.
3. For work below ground level, use Sulphate Resisting Portland Cement (TYPE V) complying with ASTM C 150.
4. Obtain the cement directly from an approved manufacturer or an approved supplier and deliver either in bulk by purpose built vehicles or in sealed bags. All cement to be free flowing and free of lumps.
5. The total alkali content of the cement expressed as the sodium oxide equivalent not to exceed 0.6% by weight.
6. The tricalcium aluminate (C_3A) content of any cement not to exceed 8% and for sulphate resisting cement 5%.
7. The sulphuric anhydride (SO_3) content to be more than not 2.3%.
8. The heat of hydration not to exceed values listed in ASTM C 150.
9. The initial setting time to be not less than 45 minutes and the final setting time not more than 10 hours.
10. Certificates of cement tests done by the manufacturer will be called for by the Engineer. If such certificate is not made available, or when the Engineer considers that the manufacturer's tests are inadequate, take samples for testing from different consignments as directed by the Engineer. Such samples to be of weight not less than 7 kg and be selected and tested by the Independent Testing Authority complying to the requirements of Section 01410.

11. Storage of Cement

- a. Store bulk cement in weatherproof silos bearing a clear indication of the types of cement contained in them. Do not mix different types of cement in the same silo. Draw down silos frequently to prevent cement caking.
- b. Store cement in bags in a suitable weatherproof structure of which the interior has to be dry and well ventilated at all times. Raise the floor above the surrounding ground level and construct such that no moisture rises through it. Stack closely each delivery of cement in bags but do not stack against an outside wall. Distinguish clearly different types of cement in bags by visible markings and store in separate stacks. Use cement in bags in the order of delivery. Do not use cement from broken bags.
- c. Provide sufficient storage capacity on site to ensure that anticipated programme of work is not interrupted due to lack of cement.

B. Aggregates

1. Conform to the requirements for fine and coarse aggregates in ASTM C 33.
2. Consist of crushed or naturally occurring materials having hard, durable, strong particles. Wash all aggregates with clean water. The use of marine aggregates will not be approved.
3. At least 45 days before concreting operations are due to commence, submit for approval the proposed names of the pits, quarries or manufacturing plants to obtain aggregates, together with evidence showing that the material complies with the requirements of ACI 221.
4. Use fine aggregate of natural sand or of crushed clean hard rock or a mixture of these. Conform to ASTM C 33. In order to achieve an acceptable grading it may be necessary to blend materials from more than one source refer Table 2 for grading requirements.
5. Fine aggregate not to contain excessive quantities of dust, soft or flaky particles, shells, concealed lumps, shale or other contaminations likely to adversely affect the strength or durability of the concrete or to attack the reinforcement.
6. Provide coarse aggregates of naturally occurring crushed rock and not containing harmful materials in sufficient quantity affecting adversely the strength or durability of the concrete or to attack the reinforcement.
7. Supply coarse aggregates in the nominal sizes specified and graded in accordance with ASTM C 33 for single sized aggregates, refer Table 2.
8. Comply aggregates with the mechanical properties in ASTM C 33 and in addition the flakiness index when determined by the sieve method described in ASTM C 136 not exceed 40 for 40 mm aggregates, nor shall it exceed 35 for 20 mm aggregates. In watertight constructions, the coarse aggregates shall not have combined indices for flakiness and elongation exceeding 35, nor the flakiness index exceed 15.
9. The sulphate content (as SO_3) of both the fine and coarse aggregates not to exceed 0.4% by weight. The total sulphate content of all the ingredients in a mix including cement, water and admixtures not to exceed 4.0% of the weight of cement within the mix.
10. The chloride content (as Na Cl) shall not exceed 0.05% by weight. The total chloride

content arising from all ingredients in a mix including cement, water and admixtures not to exceed the following limits expressed as a percentage of the weight of the cement in the mix :-

- a. For prestressed concrete, steam cured concrete or concrete containing sulphate resisting cement : 0.05%.
 - b. For any other reinforced concrete : 0.25% in 95% of all test results providing no result is more than 0.4%.
11. The coarse aggregate when tested shall have a water absorption as defined in ASTM C 33. When the proposed aggregate has an absorption of more than the specified value, demonstrate by trial mixes and tests that the strength and durability of the concrete are not adversely affected and that adequate workability can be maintained during the placing and compacting processes.
 12. Determine the “10% Fines” values, in accordance with ASTM C 33. Where aggregates are to be used for concrete wearing surfaces, the “10% Fines” value to be as specified in ASTM C 33.
 13. The weight loss after the magnesium sulphate soundness test, not to be more than 15% for the fine aggregate and 18% for the coarse aggregate.
 14. Aggregates not to contain any mineral known to have a potential to cause alkali silica, alkali silicate, alkali carbonate or any other damaging chemical reactions between alkalis and aggregates.
 15. The grading of all aggregate, when analysed, to be as per ASTM C 33 for the nominal size of aggregate specified and as given in Tables 1 and 2.
 16. Carry out routine testing of aggregates for compliance with the specification during the period concrete is being produced. The routine tests include but are not limited to grading, silt and clay content, moisture content, check on organic impurities and chloride content. Perform these tests on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to site provided that no set of tests shall represent more than 250 tonnes of coarse aggregate and provided also that the aggregates are of uniform quality.
 17. Delivery and Storage of Aggregates
 - a. Deliver aggregates to site in clean and suitable vehicles. Do not deliver different types or sizes of aggregates in one vehicle.
 - b. Do not store aggregates in contact with the ground and protect against the intrusion of the ground and other foreign matter. Provide a physical partition between the store heaps of fine and coarse aggregates and between separate heaped sizes of coarse aggregate which may have been segregated for mix control. When concreting is not being carried out, cover the store heaps to prevent contamination by wind blown material.
 - c. Remove aggregate from site immediately, which in the opinion of the Engineer are not clean or have become mixed due to defective storage.

C. Water

1. Use clean water free from all harmful matter in suspension or solution and satisfying the recommendations given in ASTM C 94. When directed by the Engineer, carry out tests in accordance with ASTM C 94 to establish compliance with the Specification.

Table 1

Sieve	Percent Passing
9.5 mm	100
4.75 mm	95 to 100
2.36 mm	80 to 100
1.18 mm	50 to 85
600 ìm	25 to 60
300 ìm	10 to 30
150 ìm	2 to 10

Table 2
Grading Requirements for Course Aggregate

Size No.	Nominal Size mm	100 mm	90 mm	75 mm	63 mm	50 mm	37.5 mm	25 mm	19 mm	12.5 mm	9.5 mm	4.75 mm	2. 36 mm	1.18 mm
1	90-37.5	100	90 to 100	-	25 to 60	-	0 to 15	-	0 to 5	-	-	-	-	-
2	63-37.5	-	-	100	90 to 100	35 to 70	0 to 15	-	0 to 5	-	-	-	-	-
3	50-25.0	-	-	-	100	90 to 100	35 to 70	0 to 15	-	0 to 5	-	-	-	-
357	50-4.75	-	-	-	100	90 to 100	-	35 to 70	-	10 to 30	-	0 to 5	-	-
4	37.5-19.0	-	-	-		100	90 to 100	20 to 55	0 to 15	-	0 to 5	-	-	-
467	37.5-4.75	-	-	-		100	90 to 100	-	35 to 70	-	10 to 30	0 to 5	-	-
5	25-12.5	-	-	-			100	90 to 100	20 to 55	0 to 10	0 to 5	-	-	-
56	25.0-9.5	-	-	-			100	90 to 100	40 to 85	10 to 40	0 to 15	0 to 5	-	-
57	25.0-4.75	-	-	-			100	90 to 100	-	25 to 60	-	0 to 10	0 to 5	-
6	19.0-9.5	-	-	-				100	90 to 100	20 to 55	0 to 15	0 to 5	-	-
67	19.0-4.75	-	-	-				100	90 to 100	-	20 to 55	0 to 10	0 to 5	-
7	12.5-4.75	-	-	-				-	100	90 to 100	40 to 70	0 to 15	0 to 5	-
8	9.5-2.36	-	-	-				-		100	85 to 100	10 to 30	0 to 10	0 to 5

2.02 ADMIXTURES

- A. Use suitable admixtures only with the prior written approval of the Engineer. Submit both the proposed dosage and method of use to the Engineer together with the following data:
 - 1. The typical dosage and detrimental effects of underdosage and overdosage.
 - 2. The chemical name(s) of the main active ingredient(s) in the admixture.
 - 3. Whether or not the admixtures contain chlorides and, if so, the chloride content of the admixture expressed as a percentage of equivalent anhydrous calcium chloride by weight of admixture.
 - 4. Whether or not the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage.
- B. Unless otherwise agreed on, comply admixture with one of the following standards:
 - 1. ASTM C 618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
 - 2. ASTM C 260 Air-Entraining Admixtures for Concrete.
 - 3. ASTM C 494 Chemical Admixtures for Concrete.
- C. The use of calcium chloride as an admixture will not be approved.
- D. Pozzolan shall not be used in concrete mixes for construction of elevated slabs.

2.03 ACCESSORIES

- A. Plastic Sheeting
 - 1. Use the plastic or polythene sheeting material for placing, where shown, immediately below concrete slabs, foundations, etc., and for other uses as defined elsewhere in the specification of 300 microns nominal thickness and a minimum thickness of 250 microns meeting the requirements of ASTM C 171.
 - 2. The material to be chemically inert and unaffected by subsoil acids and alkalis.
 - 3. Store the sheeting away from the direct rays of sun.
 - 4. Make all joints in the plastic sheeting with jointing tape and minimum laps of 300 mm.
- B. Bituminous Membrane Waterproofing

Where indicated on the drawings, bituminous waterproofing membrane to horizontal and vertical concrete surfaces of basements and other underground structures to conform to Section 07105.
- C. Waterstops

Waterstops: Conforming to the requirements of Section 03250.

2.04 CONCRETE MIX

A. Formulate concrete mix from cement, aggregate and water, all as specified and approved. Do not add other ingredients without prior approval of the Engineer.

B. Design Mixes

1. Design the concrete mixes to the requirement of ACI 318 and ACI 211.1.
2. Design the concrete mix to have at least the required minimum cement content, maximum water/cement ratio, the required average strength, f'_{cr} in accordance with the requirements of ACI 318 outlined in Chapter 5 and as per 2.04C, Table 3.

C. Concrete Classes

Following classes of concrete as shown in Table 3 is to be used in various locations indicated on the drawings. The class of concrete is denoted by the minimum 28 day cylinder strength and the type of cement. The specified compressive strength and other parameters specified are those assumed for the design of the structure and must be achieved in the finished structures.

TABLE 3

Class of Concrete	Minimum Cement Content kg/m ³	Maximum Water Cement Ratios	Nominal Maximum Aggregate size mm	Compressive Strength on cylinder sample(f'_c) N/mm ²
C20/S	300 (Type V)	0.40	20	20
C40/S	400 (Type V)	0.39	20	40
C60/S	400 (Type V)	0.40	20	60
C40	400 (Type II)	0.40	20	40
C50	400 (Type II)	0.40	20	50
C60	400 (TYPE II)	0.40	20	60

D. Use Microsilica for the concrete in the construction of all walls and slabs to all the liquid retaining structures. Provide microflow superplasterizer by Master Builder or approved equal, with the mix containing microsilica additive in accordance with the manufacturer recommendation.

E. Quality Control of Concrete Production (Ready Mix Plant)

1. When a ready mix concrete supplier is used, propose names of suppliers to the Engineer, one of which will be approved. Submit for each proposed supplier, plant and mix results of full scale trial mixes. The average strength obtained in 28 day tests from these trials to exceed the specified cylinder strength by at least the value given in 5.3.2.2 of ACI 318-95. Make sure that the average strength (f'_{cr}) of delivered concrete is equal or exceeds the average

strength (f'_{cr}) of the approved design mixes.

2. Submit standard deviations for each supplier and plant, derived from results tested by an independent agency on a recent construction project of similar size. Make available all the records to the Engineer upon request.
3. When designed mix is proposed, conduct preliminary tests in accordance with Specification and send the results to the Engineer before placing any structural grade concrete. Do not place any structural concrete in the works until the relevant mix is approved by the Engineer. Conduct the preliminary tests at the start of the works on samples of the intended materials to be used for structural concrete grades. Repeat the preliminary tests when there is a change in source of supply and when in the opinion of the Engineer there is sufficient variation from the previously approved sample that new tests are required.
4. Take samples of concrete for each class of concrete in production at each plant and at the point of discharge from the mixer or the ready mix delivery vehicle as instructed by the Engineer and in the presence of a representative of the Engineer, all in accordance with the sampling procedures described in ASTM C 31.
5. Measure the concrete slump of the different classes of concrete in accordance with ASTM C 143.
6. Concrete cylinders shall be 150 mm diameter. Take one set of samples for every 20 cubic meters of concrete placed with a minimum of one set of samples taken every day on which the mix is used. From each sample take three cylinders, one for testing after 7 days of casting and two for testing after 28 days of casting. The average strength of the two cylinders crushed at 28 days shall be referred to as one test result.
7. Provide field cured samples conforming to ASTM C 31 as directed by the Engineer.
8. Concrete shall be deemed to comply with the strength specified when both of the following requirements are met:
 - a. Every arithmetic average of any three consecutive strength tests equals or exceeds the average strength (f'_{cr}) at 28 days, and
 - b. No individual strength test (average of two cylinders) falls below the specified average strength (f'_{cr}) at 28 days by more than 3.5 N/mm^2 .
9. When any strength test of laboratory-cured cylinders falls below specified value (f'_{cr}) by more than 3.5 N/mm^2 or when tests of field-cured cylinders indicate deficiencies in protection and curing, take steps to assure that load-carrying capacity of the structure is not jeopardized.
 - a. When the likelihood of low-strength concrete is confirmed and calculations indicate that load-carrying capacity is significantly reduced, carry out tests on cores drilled from the area in question in accordance with ASTM C 42. In such cases, take three cores for each strength test.
 - b. When concrete in the structure will be dry under service conditions, air dry the cores (temperature 15° to 25°C , relative humidity less than 60%) for 7 days before test and

test them dry. When concrete in the structure will be more than superficially wet under service conditions, immerse cores in water for at least 40 hr and test them wet.

- c. Concrete in an area represented by core tests is considered structurally adequate when the average strength result of three cores is equal to at least 85% of f'_c and where no single core is less than 75% of f'_c . Additional testing of cores extracted from locations represented by erratic core strength results shall be permitted.
 - d. When the above criteria are not met and where the structural adequacy remains in doubt, follow the Engineer's decision for the appropriate action.
10. All cylinders shall be clearly marked with the date of casting and supply accurate records to the Engineer, stating the dates of casting and testing of samples, together with the results of tests and the exact position from where the sample was taken.

E. Mixing Concrete on Site

- 1. Unless otherwise agreed by the Engineer, mix concrete in an approved type of mechanical weigh-batcher. No hand mixing will be allowed.
- 2. Maintain the weighing and water-dispensing mechanisms in good order.
- 3. The weights of cement and each size of aggregate as indicated by the mechanisms employed to be within a tolerance of $\pm 2\%$ of the respective weights per batch agreed by the Engineer. Adjust the weight of the fine and coarse aggregates to allow for the free water contained in the fine and coarse aggregates which are to be determined by approved methods immediately before mixing begins, and further as the Engineer requires.
- 4. Mix the materials until they are uniformly distributed and the mass is of uniform consistency and colour, but in no case mixing time be less than two minutes after all the materials have been added to the drum. The drums on all mixers shall revolve at the speeds recommended by the manufacturer.
- 5. Thoroughly clean the mixers which have been out of use for more than 30 minutes before any fresh concrete is mixed or before changing from one type of cement to another.
- 6. Record the following on delivery notes with each batch delivered:-
 - a. Date and time of arrival.
 - b. Time and place of mixing.
 - c. Registration of truck and depot.
 - d. Time and place of adding water.
 - e. Mix class.
 - f. Cement content.
 - g. Type of cement.
 - h. Details of any approved additives.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Comply with Section 01039.
- B. Verify site conditions.
- C. Verify requirements for concrete cover over reinforcement.
- D. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.02 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.
- B. Prepare construction joints by use of high pressure water jet or other methods approved by the Engineer to remove surface laitance and loose concrete.
- C. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with approved epoxy/non-shrink grout.
- D. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

3.03 TRANSPORTING AND PLACING CONCRETE

- A. Take acceptance of the Engineer for the method of transporting and placing concrete. Transport and place concrete such that contamination, segregation or loss of constituent materials does not occur.
- B. Ensure all formwork and reinforcement placed in the proposed concreting area is clean and free from standing water immediately before placing the concrete.
- C. Place concrete in accordance with ACI 301, ACI 318 and ACI 304.
- D. Notify Engineer minimum 24 hours prior to commencement of operations.
- E. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints are not disturbed during concrete placement.
- F. Install vapor barrier/retarder under interior slabs on grade. Lap joints minimum 150 mm and seal watertight by taping edges and ends.
- G. Repair vapor barrier/retarder damaged during placement of concrete reinforcement by laping over damaged areas minimum 150 mm and sealing it watertight.
- H. Do not place concrete in any part of the works until the Engineer's approval is received. The Engineer shall have the right to reject any concrete which does not meet specified test requirements or time limitations.
 - 1. In case concreting does not start within 24 hours of approval being given, obtain approval

again from the Engineer.

2. Proceed concreting continuously over the area between predetermined expansion, control and construction joints.
 3. Do not place fresh concrete against cast-in-place concrete which has been in position for more than 30 minutes unless construction joint is formed in accordance with this specification.
 4. When cast-in-place concrete has been in place for 4 hours or more no further concrete shall be placed against it for a further 20 hours.
- I. Concrete when deposited shall have a temperature of not less than 5° C and not more than 28° C except with the approval of the Engineer.
 - J. Except in the case of columns or where otherwise agreed by the Engineer, place the concrete in horizontal layers to a compacted depth not exceeding 300 mm and consolidate each before the subsequent layer is placed.
 - K. Except in the case of columns or unless otherwise agreed by the Engineer, do not drop concrete into place from a height exceeding 2 meters. When trunking or chutes are used, keep them clean and used in such a way as to avoid segregation.
 - L. Do not pump concrete through aluminium or alloy conduits. Carry out concreting continuously and do not place concrete on concrete which has sufficiently set to cause the formation of seams or planes of weakness with the section. Where concrete cannot be placed continuously, form construction joints as specified and shown on the drawings or approved by the Engineer.
 - M. Keep the time elapsing between mixing and placing a batch of concrete as short as practicable. The time to be no longer than will permit completion of placing and compaction before the onset of initial set and in any case not longer than one hour from the time the water is added to the mix.

3.04 PLACEMENT OF CONCRETE IN LARGE SECTIONS

- A. Submit proposals for the casting of large concrete sections, where the minimum dimension is greater than 500 mm, which shall include, but not limited to, proposed methods for controlling generated heat of hydration with supporting calculations, temperature monitoring and curing. Comply with the recommendations of ACI 207.1, ACI 207.2, ACI 207.4, ACI 211.1 and ACI 224.3. All proposals are subject to the Engineer's approval.
- B. Monitor the temperature of the concrete in large sections throughout pouring of the complete section by the use of thermocouples. Ensure that the temperature of the concrete does not exceed 70° C and that any temperature differential (center to surface) across the section does not exceed 30° C. Continue temperature monitoring until the temperature in the hottest part of the section is less than 20° C greater than the minimum daily ambient temperature.

3.05 INTERRUPTIONS TO PLACING

- A. 1. When concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and compact

thoroughly the concrete already placed.

2. Complete all the work on the concrete while it is still plastic and do not thereafter disturb until it is hard enough to resist damage.
 3. Plant and materials to comply with this requirement shall be readily available at all times during concrete placing.
 4. The use of high pressure water blast equipment is also recommended immediately following the final set of concrete.
- B. Before concreting is resumed after such an interruption cut out and remove all damaged or uncompacted concrete, feather edges or any other undesirable features and leave a clean sound surface against which the fresh concrete can be placed.
- C. Where it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, compact and thoroughly work the new concrete against the existing concrete so as to eliminate any cold joints.

3.06 PUMPED CONCRETE

- A. Take Engineer's written acceptance at the commencement of the Contract.
- B. Furnish the Engineer with full details of the mix design, the area and volume of concrete to be placed in an operation and the distance over which the concrete is to be pumped.
- C. The foregoing Clause on mix design shall apply equally to a concrete that is designed to be "pumped".

3.07 COMPACTION OF CONCRETE

- A. Compact concrete to produce a dense homogeneous mass with the assistance of mechanical vibrators, keep sufficient mechanical vibrators in serviceable condition on site so that spare equipment is always available in the event of breakdowns.
- B. Mechanical vibrators shall be of the immersion type capable of operating at between 7,000 and 10,000 cycles per minute.
- C. Do not allow vibrator to be operated by workmen who do not have sufficient training in its use.
 1. Insert vertically the tubular part of immersion vibrator into the full depth of the concrete to be vibrated at points 600 mm apart and at least 100 mm away from any formwork.
 2. Keep the vibrators constantly moving whilst in action to prevent segregation.
 3. Vibration shall not be applied directly or through the formwork or reinforcement to sections or layers of concrete which have taken their initial set or to concrete which has ceased to become plastic under vibration.
 4. Stop vibration after the decrease in volume is no longer apparent or before localised areas of grout or laitance are formed.
 5. When the supply of concrete from the mixer is interrupted, the vibrators shall be lifted out

clear from the work.

- D. Take care to ensure that concrete is fully compacted around waterstops and embedded items without distorting, displacing or damaging the waterstops or other items.

3.08 PROTECTION OF FRESH CONCRETE

- A. Protect freshly placed concrete from rainfall and from water running over the surface until it is sufficiently hard to resist damage from this cause.
- B. Do not allow any traffic on any concrete surface until such time as it is hard enough to resist damage by such traffic.
- C. Do not subject concrete placed in the Permanent Works to any structural loading until it has attained at least its minimum average strength as defined in 2.04 C.

3.09 CONCRETING IN HOT WEATHER

- A. On exposed concrete surfaces in high temperatures and strong drying wind conditions, use a curing method which shields the concrete. Apply the curing in position not later than half an hour after final tamping. When the surface exhibits cracking while the concrete is still plastic then retamp it to close the cracks.
- B. Do not mix or place the concrete whilst the shade temperature is above 43° C on a rising thermometer or above 45° C on a falling thermometer. Supply an accurate maximum/ minimum thermometer and hang it in an approved place in the Works site.
- C. Plan the day's concreting in such a manner as to ensure that each bay or panel is completed at a proper construction joint before the temperature rises above the permissible limit.
- D. The temperature of fresh mixed concrete at the point of placement not to exceed 28° C and take all necessary precautions to ensure that the limit is not exceeded. Concrete with a temperature less than 28° C can be produced by combinations of the following methods:
 - 1. Use of sliced, flaked or crushed ice to reduce temperature of mixing water. All ice shall be melted before adding to concrete.
 - 2. Night casting (subject to the prior acceptance of the Engineer).
 - 3. Shading of aggregates.
 - 4. Moistening of aggregates with potable water.
 - 5. Cooling of formwork and reinforcement.
 - 6. Using cement with a temperature of less than 77° C.
 - 7. Use of white or light reflective paints on mixer drums and water storage tanks.
 - 8. Shading of the mixing area.

3.10 FINISHES ON FREE SURFACES

- A. Finish horizontal or nearly horizontal surface which are not cast against formwork to the class shown on the Drawings and detailed hereunder.

1. U1 Finish

- a. Provide U1 finish to all surfaces for which no higher class of finish is called for on the drawings, finishing schedule or instructed by the Engineer.
- b. Level and screed the concrete to produce a uniform plain or ridged surface, surplus concrete being struck off by a straightedge immediately after compaction.

2. U2 Finish

Treat surface as Class U1 finish and after the concrete has hardened sufficiently, floated it by hand or machine sufficient only to produce a uniform surface free from screed marks.

3. U3 Finish

Float surface as for a U2 finish but to the tolerance stated below. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface. Steel-trowel it under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.

4. U4 Finish

The requirement is similar to U3 finish, but the permissible tolerances are smaller.

5. U5 Finish – Brushed Finish

Prepare the concrete surface first as a U2 finish and then lightly brush with a stiff brush over the surface to produce a textured finish. Clean the surface when it is hard set.

B. Surface Tolerances

The permissible tolerances on free surfaces not to exceed the values given in Table 4.

Table 4
Surface Tolerances

Class Of	Tolerance in mm – see Notes		
	A	B	C
U1	Not applicable	10	+20 or –10
U2	Nil	10	+20 or –10
U3	Nil	5	+12.5 or –7.5
U4	Nil	2	+5 or –5
U5	Nil	5	+12.5 or –7.5

Notes:

1. Column A is the maximum allowable value of any sudden change of level in the surface.

2. Column B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three metre long straightedge or correctly shaped template placed on the surface.
3. Column C is the maximum allowable value of the difference in level or position between a straightedge or correctly shaped template placed on the surface and the specified level or position of that surface.
4. Where dimensional tolerances are given on the Drawings or elsewhere in the Specification they shall take precedence over those given in Table 4.

3.11 PROTECTION TO SUBSTRUCTURE

- A. Provide bituminous waterproofing membrane to the underside of slabs and vertical faces of concrete walls in basements and other underground structures where indicated on the drawings. Install Bituminous waterproofing membrane in accordance with the requirements of Section 07105.
- B. Waterstops: Install in accordance with Section 03250.
- C. Except where indicated otherwise on the drawings or agreed by the Engineer, protect all buried concrete surfaces, exposed after the removal of formwork, using two coats of bituminous paint-on material and wrapping all buried surfaces with polyethelene sheet complying with clause 2.03A.

3.12 LIQUID CONTAINING CONSTRUCTION

- A. Test all liquid containing construction to ensure that there is no leakage or damp penetration. Carry out the testing before waterproofing and other finishes are applied to the construction and before back-filling any excavation.
- B. Seal completely all drains and fill the construction with clean water to a predetermined level. Once filled the level is to be recorded at daily intervals for a period of fourteen days or as otherwise directed by the Engineer. Ensure that the level of water is not affected by rainfall or undue evaporation.
- C. When it is apparent from the test results, external inspection or any other source that leakage or damp penetration has occurred, then carry out remedial work to make the construction completely watertight to the Engineers acceptance. Retest the construction until the results are satisfactory.

3.13 DEFECTIVE WORK

- A. Carry out remedial treatment to surfaces as agreed with the Engineer following inspection immediately after removing the formwork.
- B. Any concrete, the surface of which has been treated before being inspected by the Engineer, is liable for rejection.
- C. Any concrete which in the opinion of the Engineer is damaged or is in any way defective due to lack of compliance with any of the foregoing Clauses, or is not true to an acceptable line or level compatible with the requirements of second fixings and finishes, is deemed to be unacceptable and rejected.
- D. Where rejected work has to be cut out or re-built, the operation shall be carried out immediately without any delay.

- E. Propose the extent of the work to be removed and the methods to be used in the removal and replacement of the work for the Engineer's review.
- F. The Engineer's acceptance must be obtained before any cutting of concrete is carried out. If such cutting of concrete is carried out without the Engineer's approval the affected areas shall be classified as defective.

3.14 RECORDS

- A. Temperature: Keep daily record of maximum and minimum outside shade temperatures.
- B. Concreting and Cylinders: Submit weekly to the Engineer a complete record of concreting, giving the date, location, concrete grade cement content, No. of samples taken for testing, and source of supply (when more than one). These records to be set out in such a way that the test cylinder results can be easily referred to the concrete to which they relate.

END OF SECTION 03300

SECTION 03370
CONCRETE CURING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Curing of cast-in-place and precast concrete.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 03300 Cast In Place Concrete.
- C. Section 03355 Exposed Aggregate Concrete Finish.

1.03 REFERENCES

- A. ACI 301 Structural Concrete for Buildings.
- B. ACI 302 Recommended Practice for Concrete Floor and Slab Construction.
- C. ACI 308 Standard Practice for Curing Concrete.
- D. ASTM C 171 Sheet Materials for Curing Concrete.
- E. ASTM C 309 Liquid Membrane-Forming Compounds for Curing Concrete.

1.04 SUBMITTALS

- A. Comply with Section 01330.
- B. Product Data: Provide data on all items specified under this Section.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301 and ACI 302.

PART 2 PRODUCTS

2.01 CURING COMPOUNDS

- A. Use suitable curing compounds only with the written approval of the Engineer. Curing compounds to be in accordance with ASTM C 309. Submit both the proposed dosage and method of application to the Engineer.
- B. Approve the use of the curing compound on surfaces which are to receive a bonded finish only when it is proven beyond doubt that the use of the compound has no detrimental effect on the applied finish.

- C. Curing compounds shall contain a dye to enable the extent of the spread to be seen easily.
- D. Use curing compounds on surfaces exposed to the sky, containing sufficiently finely divided flake aluminium in suspension to produce a complete coverage of the surface with a metallic finish when applied at the rate recommended by the manufacturer.
- E. Curing compounds to become stable and impervious to the evaporation of water from the concrete surface within sixty minutes of application. The material not to react chemically with the concrete, crack, peel or disintegrate within three weeks after application.

2.02 SHEET MATERIALS FOR CURING CONCRETE

- A. Sheet materials for curing concrete shall be in accordance with ASTM C 171.
- B. Polyethylene film shall have a minimum thickness of 0.15 mm or as indicated on the drawings whichever is more.

2.03 WATER

- A. Water used for curing shall be of the same quality as that used for mixing concrete as described in Section 03300.

PART 3 EXECUTION

3.01 GENERAL

- A. Cure surfaces in accordance with the recommendations of ACI 308.
- B. Immediately after compaction and for 7 days thereafter, protect concrete against harmful effects of weather, including rain, rapid temperature changes, and from drying out. The methods of protection used to be subject to the acceptance of the Engineer.
- C. Use such method of curing that it prevents loss of moisture from the concrete. On concrete surfaces which are to be waterproofed, do not use curing compounds. Details of all curing methods to be used are subject to the approval of the Engineer.

3.02 METHODS OF CURING

- A. For formed surfaces: Unless otherwise agreed by the Engineer all formwork to remain in place for at least 48 hours; form when removed within 7 days of casting, cure the exposed concrete surface. Use insulated steel or timber for formwork which remains in place.
- B. In cases where formwork is removed within 7 days of casting, cover the exposed concrete surfaces closely with impermeable sheeting, properly secured to prevent its removal by wind and the development of air spaces beneath it. Alternatively keep the exposed surfaces continuously wet by means of a water spray or by covering with a water absorbent material which is kept wet. Subject to the approval of the Engineer, apply pigmented reflective curing compound immediately to the surface.
- C. For other surfaces the above methods are acceptable subject to the additional requirement that when the area considered is exposed to the effects of sun or wind, provide ponding to a depth of at least 50 mm. Start ponding as soon as possible at the end of concreting, but not

before the concrete can resist surface damage.

- D. When the humidity is less than 50% and the wind speed exceeds 4 m/second, provide shelter to the concrete, during casting and for a period of at least 24 hours after casting. This is in addition to the curing procedures described previously. Formwork left in place is regarded as sheltering.
- E. Limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances as accepted by the Engineer.

END OF SECTION 03370

SECTION 03720
CONCRETE REPAIR

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Methods and materials for the reports of defective concrete surfaces.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 03250 Concrete Accessories.
- C. Section 03300 Cast-In-Place Concrete.
- D. Section 03400 Precast Concrete.

1.03 REFERENCES

- A. ASTM C 33 Specifications for Concrete Aggregates.
- B. ASTM C 150 Portland Cement.
- C. ASTM C 404 Aggregates for Masonry Grouts.
- D. ASTM C 882 Bond Strength of Epoxy Resin Systems Used with Concrete.
- E. ASTM D 638 Test Method for Tensile Properties of Plastics.
- F. ASTM D 695 Compressive Properties of Rigid Plastics.
- G. ASTM D 790 Flexural Properties of Plastics and Electrical Insulating Materials.

1.04 SUBMITTALS

- A. Comply with Section 01300.
- B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.
- C. Manufacturer's Certificate: Certify that specified products shall meet or exceed requirements.

1.05 QUALITY ASSURANCE

- A. Materials Manufacturer: Company specialized in manufacturing the products specified in this Section with minimum three years experience.
- B. Applicator: Company specialized in concrete repair with minimum ten years documented

experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's instructions for storage, shelf life limitations, and handling.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. Epoxy Resin: Two-part epoxy adhesive containing 100% solids, meeting the following minimum characteristics:

Characteristic	Test Method	
1. Bond Strength	ASTM C 882	30 Mpa
2. Tensile Strength	ASTM D 638	45 Mpa
3. Elongation	ASTM D 638	2 % precast at 7 days at 21 °C
4. Flexural Strength	ASTM D 790	45 Mpa
5. Compressive Strength	ASTM D 695	55 MPa

- B. Bonding Agent: Polyvinyl acetate emulsion, dispersed in water while mixing, non-coagulant in mix, water resistant when cured.
- C. Portland Cement: ASTM C 150, Type I color as selected.
- D. Sand: ASTM C 33; C 404; uniformly graded, clean.
- E. Water: Clean and potable.
- F. Cleaning Agent: Commercial muriatic acid.

2.02 MIXING EPOXY MORTARS

- A. Mix epoxy mortars in accordance with manufacturer's instructions for purpose intended.
- B. Mix components in clean equipment or containers. Conform to pot life and workability limits.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means acceptance of substrate.

3.02 PREPARATION

- A. Clean concrete surfaces of dirt, laitance, corrosion, or other contamination; wire brush, rinse surface and allow to dry.
- B. For areas patched with epoxy mortar, remove broken and soft concrete 6 mm deep. Remove corrosion from steel. Clean surfaces mechanically; rinse with water.

3.03 REPAIR WORK

- A. Repair exposed structural, shrinkage, and settlement cracks of concrete by the epoxy injection method.
- B. Repair spalling, fill voids flush with surface, apply surface finish.

3.04 APPLICATION - EPOXY MORTAR

- A. Trowel apply mortar mix. Tamp into place filling voids at spalled areas.
- B. For patching honeycomb, trowel mortar onto the surface, work mortar into honeycomb to bring surface flush with surrounding area. Finish trowelled surface to match surrounding area.
- C. Cover exposed steel reinforcement with epoxy mortar, feather edges to flush surface.

3.05 APPLICATION - CEMENTITIOUS GROUT

- A. Apply coating of bonding agent to concrete surfaces. Provide full surface coverage.
- B. Apply cementitious grout by steel trowel. Tamp into place filling voids at spalled areas. Work mix into honeycomb.
- C. Damp cure cementitious grout for four days.

END OF SECTION 03720

**SECTION 05531
GRATINGS AND FLOOR PLATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed floor gratings / landscaped grating.
- B. Perimeter closure.

1.02 RELATED SECTIONS

- A. Section 09900 - Painting: Field paint finish.

1.03 REFERENCES

- A. ASTM A36/A36M - Structural Steel.
- B. ASTM A123 - Zinc (Hot Galvanized) Coatings on Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip.
- C. ASTM A510 - Wire Rods and Coarse Round Wire, Carbon Steel.
- D. ASTM A510M - Wire Rods and Coarse Round Wire, Carbon Steel Metric.
- E. ASTM A525 - Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process.
- F. ASTM A525M - Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process Metric.
- G. ASTM A569/A569M - Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.
- H. AWS D1.1 - Structural Welding Code.
- I. AWS A2.0 - Standard Welding Symbols.
- J. NAAMM A202.1 - Metal Bar Grating Manual.

1.04 PERFORMANCE REQUIREMENTS

- A. Design Live Pedestrian Load: Uniform load of 4.7 kPa) minimum; concentrated load of 1/330 N) normal duty.
- B. Maximum Allowable Deflection Under Live Load: 1/240 of span; size components for single span.
- A. Maximum Spacing Between Bars: To restrict pedestrian shoe heels. 3/8 inch (9 mm).

1.05 SUBMITTALS FOR REVIEW

- A. Section 01330 - Submittals: Procedures for submittals.

- B. Product Data: Provide span and deflection tables.
- C. Shop Drawings: Indicate details of gratings, plates, component supports, anchorage, openings, perimeter construction details, and tolerances.
- D. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.
- E. Samples: Submit one sample, (300x300 mm) in size illustrating surface finish, color, and texture.

1.06 SUBMITTALS FOR INFORMATION

- A. Section 01330 - Submittals: Procedures for submittals.
- B. Manufacturer's Installation Instructions: Indicate special requirements of perimeter framing, and fixing details.

1.07 QUALITY ASSURANCE

- A. Design gratings under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.08 PROJECT CONDITIONS

- A. Section 01310 - Project Management and Coordination.
- B. Coordinate the Work with placement of frames, tolerances for placed frames openings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. A company specialised in this field with 10 years experience.
- B. Substitutions: Under provisions of Section 01600.

2.02 MATERIALS

- A. Formed Steel For Welding: ASTM A569/A569M ASTM A36/A36M of rectangular shape.
- B. Cross Bars: ASTM A510. ASTM A510M.
- C. Welding Materials: AWS D1.1, AWS D1.2, type required for materials being welded.
- D. Touch-Up Primer for Galvanized Surfaces: Zinc rich as supplied by manufacturer.

2.03 ACCESSORIES

- A. Fasteners and Saddle Clips: Flange Blocks: J-Hooks: Galvanized steel.
- B. Perimeter Closure: Of same material as grating.

2.04 FABRICATION

- A. Grating Type: NAAMM A202.1, Pressure Locked Welded Rivetted Type.
- B. Fabricate grates and plates to sizes indicated.
- C. Bolt joints of intersecting metal sections.
- D. Fabricate support framing for openings.
- E. Top Surface: Serrated. Non-slip. or Raised lug.
- F. Conceal fixing from below.

2.05 FINISHES

- A. Galvanizing: ASTM A525 to G90.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01310 - Coordination and Meetings: Verification of existing conditions before starting work.
- B. Verify that opening sizes and dimensional tolerances are acceptable.
- C. Verify that supports and anchors are correctly positioned.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions.
- B. Place frames in correct position, plumb and level.
- C. Mechanically cut galvanized finish surfaces. Do not flame cut.
- D. Anchor by bolting through saddle clips.
- E. Set perimeter closure flush with top of grating and surrounding construction.
- F. Secure to prevent movement.

3.03 TOLERANCES

- A. Conform to NAAMM A202.1.
- B. Maximum Space Between Adjacent Sections: 3 mm.
- C. Maximum Variation From Top Surface Plane of Adjacent Sections: 3 mm.

3.04 CLEANING

- A. Section 01700 - Contract Closeout: Cleaning installed work.
- B. Clean welds and damaged coatings and apply one two coats of touch-up primer.

END OF SECTION 05531

DIVISION 7

THERMAL AND MOISTURE PROTECTION TABLE

OF CONTENTS

07160	BITUMINOUS, CEMENTATIOUS, EPOXY, DAMPPROOFING AND WATERPROOFING
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SECTION 07160

BITUMINOUS, CEMENTITIOUS, EPOXY, DAMPPROOFING AND WATERPROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

This section includes hot or cold single or multiple coats of asphalt or bitumen or paint or sheet waterproofing and damproofing as shown on the drawings and the requirements of the contract documents including but not limited to the following:-

- A. Cold applied bitumen waterproofing paint, or sheet to concrete and masonry and behind cladding, plaster and ceramic tiles to wet area walls and slabs and at junctions of masonry walls and site concrete.
- B. Protective high build epoxy resin waterproof coating to floors, walls and water tanks.
- C. Applied cementitious waterproofing to swimming pools.
- D. Two component acrylic modified Cementitious coating to stores, plantrooms, gutters and planters where shown.
- E. Below grade damp proofing.
- F. Cavity wall damp proofing.

1.02 SYSTEM DESCRIPTION

- A. Waterproofing System: Application of bituminous paint, sheet and coatings to prevent moisture migration.
- B. Location: Where shown on drawings.
- C. Internal coating to potable water tanks.
- D. Protective coating to floors.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01330.

- B. Product Data: Provide properties of proposed material.
- C. Manufacturer's Installation Instructions: Including any special procedures.
- D. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.06 SUBMITTALS FOR REVIEW

- A. Section 01300 - Submittals, Procedures for Submittals.
- B. Product Data : Provide manufacturers data on materials performance, properties, preparation, areas of application, application, mixing, consumption.
- C. Submit shop drawings for review and approval showing the location, materials, construction details including coordination with and incorporation into the overall construction.

1.07 QUALITY ASSURANCE

- A. Perform work in accordance with manufacturers instructions.
- B. Test material samples in accordance with ANSI/ASTM D449 D450.
- C. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

- A. Applicator: Company specializing in performing the work of this section with minimum five years experience.

1.09 MOCKUP

- A. Provide mockup of waterproofing systems under provisions o section 01400.
- B. Mockup may remain as part of the work.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Maintain conditions recommended by manufacturer.

1.11 WARRANTY

- A. Provide ten year warranty under provisions of Section 01700.
- B. Warranty: Include coverage for waterproofing failing to resist penetration of water.
- C. For warranty repair work, be responsible for removing and replacing materials concealing waterproofing.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials shall be as Tretolastic damp surface primer with 2 coats Tretol 202T bitumen solutions to wall manufactured by Tretol Bid Product Ltd. with Pluvex bitumen sheet manufactured by Ruberoid Building Products Ltd. or other equal and approved equivalent products to walls and floors of wet areas.
- B. Non-toxic solvent high build, protective epoxy resin, as Ceilcote 180 manufactured by "Feb Master Builders" or other equal and approved equivalent products to linings of potable water tanks.
- C. Two component acrylic modified cementitious coating, as Masterseal manufactured by "Feb Master Builders" or other equal and approved equivalent products to floors and skirtings.
- D. Acceptable Manufacturers for Dampproofing:
 - 1. W.R. Grace and Company or equal and approved.
 - 2. Celotex Corporation or equal and approved.
 - 3. FEB Products or equal and approved.
 - 4. Dermabit or equal and approved.
- E. Bituminous Dampproofing for Below Grade Applications (DAMP-1): Fiber reinforced (non-asbestos), solvent-base, non-sag asphaltic coating designed for troweled application and conforming to the following.
 - 1. ASTM D-2822, Type 1.
 - 2. Fed. Spec. SS-C-153C, Type 1, Class A and B.
- F. Bituminous Dampproofing for Cavity Wall Applications (DAMP-2): Fiber reinforced (non-asbestos), solvent-base, semi-mastic asphaltic coating designed for sprayed application and conforming to the following.
 - 1. ASTM D-2823
 - 2. Fed. Specs. SS-A-694D.
- G. Emulsified Bituminous Dampproofing for Below Grade Applications (DAMP-3): Fiber reinforced (non-asbestos), water-base, non-sag asphaltic coating designed for troweled application on damp substrate and conforming to the following.
 - 1. ASTM D-1227, Type 4.
 - 2. Fed. Spec SS-R-1781, Type 1
- I. Emulsified Bituminous Dampproofing for Cavity Wall Application (DAMP-4): Fiber reinforced (non-asbestos), water-base, non-sag asphaltic coating designed for spray application on damp substrate and conforming to the following.

1. ASTM D1227, Type 4.
2. Fed. Spec SS-R-1781, Type 1.
- J. Polyethylene Sheeting: 0.15mm thick, fungi resistant polyethylene sheeting conforming to Voluntary Product Standard PS17-69.
- K. Neoprene Flashing: 1.5mm thick, fungi resistant polyethylene sheeting conforming to Voluntary Product Standard PS17-69.
- L. Flashing Adhesive: As recommended by neoprene flashing manufacturer.
- M. Protection Board: Semi-rigid 12mm by 1200 mm by 2400 mm panels with a blend of asphalt and inorganic mineral filler particles with asphalt-saturated felt and fiberglass met coating.
 1. Acceptable manufacturer and product:
 - a. Celotex Corporation or equal and approved.
 - b. W.R. Meadows, Inc.: PC-2 Protection Course or equal and approved.

2.02 ACCESSORIES

- A. Fillers, flashings as recommended by the manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.
- B. Verify items which penetrate surfaces to receive waterproofing are securely installed.
- C. Flash around all penetration.

3.02 PREPARATION

- A. Protect adjacent surfaces not designated to receive waterproofing.
- B. Clean and prepare surface to receive waterproofing in accordance with manufacturer's instructions.
- C. Do not apply waterproofing to surfaces unacceptable to manufacturer or applicator.
- D. Apply mastic to seal penetrations, small cracks, or minor honeycomb in substrate.

3.03 APPLICATION

- A. Install materials in accordance with the manufacturers instructions and prime surfaces in

accordance with manufacturer's instructions.

- B. Apply to walls in internal wet areas up to height of tiling or stone cladding.
- C. Apply below external double skin masonry walls.
- D. Apply to concrete and blockwork below grade.
- E. Apply to all external concrete and blockwork backings to external cladding.
- F. Apply to under sides of sloping concrete canopies to receive finishes.
- G. Apply where shown on drawings.
- H. Fill depressions, holes, and cracks with a material compatible with the dampproofing.
- I. Provide bituminous dampproofing where indicated as DAMP-1 or DAMP-3 and on exterior side of below grade walls where interior floor slab is below exterior grade.
- J. Expansion and Control Joints in Below Grade Walls:
 - 1. Install joints before application of dampproofing.
 - 2. Prime substrate which is to receive flashing adhesive as recommended by adhesive manufacturer.
 - 3. Install continuous strip of neoprene flashing centered over joint. Roll into adhesive to ensure bond.
 - a. Ensure that center portion of neoprene flashing over joint (25mm from each side of joint center line) is not bonded. Do not stretch flashing over joint.
 - b. Trowel flashing adhesive continuously along each edge of neoprene flashing to provide watertight seal.
 - 4. Terminate under horizontal waterproofing above.
- K. Spray apply bituminous dampproofing where indicated as DAMP-2 or DAMP-4 and on exterior of interior wythe (within the cavity) of masonry cavity walls.
 - 1. Apply dampproofing to obtain a film thickness of not less than 1.5m.

3.04 PROTECTION OF FINISHED WORK

- A. Where applicable protect finished work under provisions of Section 01500.
- B. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION 07160