SPECIFICATIONS
(New)

Attachment No. 1 for
Addendum No. 2

SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Precast architectural concrete units.
2. Accessories.

B. Related Requirements:

1. Division 01 Sections related to sustainability requirements, as applicable.
2. Section 055000 "Metal Fabrications" for kickers and other miscellaneous steel shapes.
3. Section 085113 "Aluminum Windows" for windows set into architectural precast concrete units.

1.3 DEFINITIONS

A. Design Reference Sample: Sample of approved architectural precast concrete color, finish, and texture preapproved by Engineer.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail fabrication and installation of architectural precast concrete units.
2. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate details at building corners.
5. Indicate separate face and backup mixture locations and thicknesses.

6. Indicate type, size, and length of welded connections by AWS standard symbols. Detail loose and cast-in hardware and connections.
7. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
8. Indicate locations, extent, and treatment of dry joints if two-stage casting is proposed.
9. Include plans and elevations showing unit locations, dimensions, erection sequences, and bracing plans for special conditions.
10. Indicate location of each architectural precast concrete unit by same identification mark placed on panel.
11. Indicate relationship of architectural precast concrete units to adjacent materials.
12. Indicate locations, type, dimensions, and details of facing units, including corner units, special shapes, joint treatment, and anchors.
13. Indicate multiple wythe connection details.
14. Coordinate and indicate openings and inserts required by other trades.
15. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and indicate modified areas on Shop Drawings. Do not adversely affect the appearance, durability, or strength of units.

C. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 300 by 300 by 50 mm.

   a. Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.
   b. Grout Samples for Verification: Showing color and texture of joint treatment.

D. Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a minimum of two sample panels approximately 1.5 sq. m in area for review by Engineer. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

   1. Locate panels where indicated or, if not indicated, as directed by Engineer.
   2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
   3. After acceptance of repair technique, maintain one sample panel at manufacturer's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.
   4. Demolish and remove sample panels when directed.

E. Range Samples: After sample panel approval and before fabricating architectural precast concrete units, produce a minimum of three sets of samples, approximately 1.5 sq. m in area, representing anticipated range of each color and texture on Project's units. Maintain one set of range samples at Project site and remaining sets at manufacturer's plant as color and texture approval reference.

F. Delegated Design Submittals: For architectural precast concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Show governing panel types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.

G. Sustainable Design Submittals:

1. All related Product Data as detailed in Division 01 Sections related to sustainability requirements, as applicable.
2. Regional Materials: Verify concrete is manufactured within (160 km) of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within (160 km) of Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Manufacturer to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and employers, and other information specified.

B. Coordination Drawings: Provide locations, setting diagrams, templates, instructions, and directions, as required, for furnishing and installation of loose connection hardware and anchorage items to be embedded in or attached to other construction.

C. Welding certificates.

D. Material Test Reports: For each of the following items, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Aggregates.
2. Cementitious materials.
3. Reinforcing materials and prestressing tendons.
4. Admixtures.
5. Bearing pads.
6. Structural-steel shapes and hollow structural sections.
7. Thin-brick units and accessories.
8. Stone anchors.
9. Insulation.

E. Preconstruction Test Reports: For mockups.

F. Source Quality-Control Reports: For aggregate cementitious materials.

G. Qualification Statements: For fabricatorand testing agency.

H. Field quality-control and special inspection reports.

1.7 CLOSEOUT SUBMITTALS

A. General Contractor/Construction Manager Project Survey: Complete the survey form, providing feedback of the certified precast producer's performance in accordance with PCI's Architectural Certification Program. Submit to PCI as directed on form; provide a copy to Engineer.

1.8 QUALITY ASSURANCE

A. Product shall demonstrate compliance with sustainability targets and requirements specified in Division 01 Sections related to sustainability requirements, as applicable.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E329 or ASTM C1077 for testing indicated, and in accordance with ISO/IEC 17020, ISO/IEC 17011 and ISO/IEC 17025 requirements acceptable to Engineer and authorities having jurisdiction, and that has the experience and capability to satisfactorily conduct the testing indicated. Testing agency shall have a valid ISO/IEC 17025 certification.

C. Quality System: Provide the products of a manufacturer who holds valid ISO 9001 certification.

D. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated at time of bidding as a PCI-certified plant for Category AD or designated as an APA-certified plant for production of architectural precast concrete products.
2. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116 and PCI MNL 135.

E. Certified Installer Qualifications: A precast concrete erector qualified and designated by local authorities having jurisdiction approvedPCI's Certificate of Compliance to erect Category S2 (Complex Structural Systems) for load-bearing members.

F. Installer Qualifications: A precast concrete erector who has retained a "PCI-Certified Field Auditor" to conduct a field audit of a project in same category as this Project and who can produce an Erectors' Post-Audit Declaration.

G. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

H. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.4/D1.4M.
3. AWS D1.6/D1.6M.

1.9 MOCKUPS

A. Build mockups to set quality standards for materials and execution and for preconstruction testing.

1. After sample panel approval, build mockup as indicated on Drawings, complete with anchors, connections, flashings, and joint fillers.

    a. Build preconstruction testing mockup at testing agency facility.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Employer specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Preconstruction Testing Mockup: Provide a full-size mockup of architectural precast concrete indicated on Drawings for preconstruction testing.

1. Build preconstruction testing mockup as indicated on Drawings including and architectural precast concrete complete with anchors, connections, flashings, and joint fillers.
2. Build preconstruction testing mockup at testing agency facility.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on mockups.

1. Provide test specimens and assemblies representative of proposed materials and construction.
2. Perform preconstruction testing in accordance with ASTM C1354/C1354M or ASTM E488/E488M, modified as follows:

    a. Anchorage Tests: Test 300-mm square samples for each combination of stone variety, orientation of cut, finish, and anchor type proposed for use on Project. Test for shear and tensile strength of anchorage system.

1.11 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.

B. Support units during shipment on nonstaining shock-absorbing material.

C. Store units with adequate dunnage and bracing, and protect units to prevent contact with soil, prevent staining, and prevent cracking, distortion, warping, or other physical damage.

D. Place stored units so identification marks are clearly visible, and units can be inspected.

E. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

F. Lift and support units only at designated points indicated on Shop Drawings.

1.13 LOCAL REGULATIONS AND CODES

A. Comply with applicable requirements of the local codes and regulations of authorities having jurisdiction.

1. Comply with the functionality and serviceability requirements listed in the local fire code and in the life safety and fire strategy report, as accepted and approved by local authorities having jurisdiction.
2. Obtain necessary approvals from authorities having jurisdiction.
3. Verify applicable performances whenever relevant equivalent counterparts to applicable standards are substituted, and submit a comprehensive comparative matrix of equivalency between specified standard and proposed counterpart for Engineer’s approval.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fabricators: Subject to compliance with project requirements.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design architectural precast concrete units.

B. Design Standards: Comply with ACI 318M and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated:

1. Wind Loads: calculated in compliance with the structural Engineer’s Documentation, Specification and Drawings for Wind loads.
2. Seismic loads: calculated in compliance with the structural Engineer’s Documentation, Specification and Drawings for Seismic loads.

C. Calculated Fire-Test-Response Characteristics: Provide architectural precast concrete units with fire-resistance rating indicated as calculated in accordance with PCI 124, "Design for Fire Resistance of Precast Prestressed Concrete," and acceptable to authorities having jurisdiction.

D. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Loads: As indicated.
2. Design precast concrete units and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements as follows:

    a. Upward and downward movement of 19 mm.

3. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 26 deg C.
4. Fire-Resistance Rating: Select material and minimum thicknesses to provide 1-hour fire rating.
5. Stone Facing Anchorage: Provide anchors, as determined through preconstruction testing, in numbers, types, and locations required to satisfy specified performance criteria.
6. Window-Washing System: Design precast units supporting window-washing system indicated to resist pull-out and horizontal shear forces transmitted from window-washing equipment.
7. Vehicular Impact Loads: Design spandrel beams acting as vehicular barriers for passenger cars to resist a single 26.7 kN load applied horizontally in any direction to the spandrel beam, with anchorages or attachments capable of transferring this load to the structure. Design spandrel beams assuming the load to act at a height of 457 or 686 mm above the floor or ramp surface, whichever is more severe, on an area not to exceed 0.0929 sq. m.

2.3 PRECAST ARCHITECTURAL CONCRETE UNITS

A. Provide unit types as indicated on Drawings.

B. Source Limitations: Obtain precast architectural concrete units from single fabricator.

2.4 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that provides continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

B. Form Liners: Units of face design, texture, arrangement, and configuration indicated to match those used for precast concrete design reference sample. Provide solid backing and supports to keep form liners in place during concrete placement.

1. Face Pattern: Smooth.

C. Form-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

D. Surface Retarder: Chemical-set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

2.5 REINFORCING MATERIALS

A. For concrete reinforcement materials and workmanship, refer to section 032000 "Concrete reinforcing".

B. Reinforcing Bars: ASTM A615/A615M, Grade 420, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

D. Galvanized Reinforcing Bars: ASTM A615/A615M, Grade 420, deformed bars, with ASTM A767/A767M, Class II zinc coating and chromate treatment. Galvanize after fabrication and bending.

E. Supports: Suspend reinforcement from back of mold. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place may only be used if they are not visible in the finished face.

2.6 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A416/A416M, Grade 1860, uncoated, seven-wire, low-relaxation strand.

1. Coat unbonded post-tensioning strand with post-tensioning coating and sheath with polypropylene tendon sheathing in compliance with ACI 423.7. Include anchorage devices and coupler assemblies.

B. Post-Tensioning Bars: ASTM A722/A722M, uncoated high-strength steel bars.

2.7 CONCRETE MATERIALS

A. For cast in place concrete materials and workmanship, refer to section 033000 "cast in place concrete".

B. Regional Materials: Verify concrete is manufactured within (160 km) of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within (160 km) of Project site.

C. Portland Cement: ASTM C150/C150M, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, use gray cement, of same type, brand, and mill source.

a. Standard gray cement is acceptable for use where not exposed to view.

D. Supplementary Cementitious Materials:

1. Fly Ash: ASTM C618, Class C or F, with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C618, Class N.
3. Silica Fume: ASTM C1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C989/C989M, Grade 100 or 120.

E. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C33/C33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match approved finish sample.

a. Gradation: Uniformly graded.

2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate; to match approved finish sample.

F. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C330/C330M, with absorption of less than 11 percent.

G. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.

H. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117 and ASTM C1602/C1602M.

I. Air-Entraining Admixture: ASTM C260/C260M, certified by manufacturer to be compatible with other required admixtures.

J. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

1. Water-Reducing Admixtures: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. Water-Reducing and -Accelerating Admixture: ASTM C494/C494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and - Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing Admixture: ASTM C1017/C1017M, Type I.
8. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

9. Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

2.8 STEEL CONNECTION MATERIALS

A. Carbon Steel Shapes and Plates: ASTM A36/A36M.

B. Carbon Steel-Headed Studs: ASTM A108, Grades 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or Type B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.

C. Carbon Steel Plate: ASTM A283/A283M, Grade C.

D. Malleable Iron Castings: ASTM A47/A47M, Grade 32510 or Grade 35028.

E. Carbon Steel Castings: ASTM A27/A27M, Grade 415-205.

F. High-Strength, Low-Alloy Structural Steel: ASTM A572/A572M.

G. Carbon Steel Structural Tubing: ASTM A500/A500M, Grade B or Grade C.

H. Wrought Carbon Steel Bars: ASTM A675/A675M, Grade 450.

I. Deformed-Steel Wire or Bar Anchors: ASTM A1064/A1064M or ASTM A706/A706M.

J. Carbon Steel Bolts and Studs: ASTM A307, Grade A, or ASTM F1554, Grade 36; carbon steel, hex-head bolts and studs; carbon steel nuts, ASTM A563M; and flat, unhardened steel washers, ASTM F844.

K. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325M, Type 1, heavy-hex steel structural bolts; ASTM A563M, Class 10S heavy-hex carbon steel nuts; and ASTM F436/F436M, Type 1, hardened carbon steel washers.

L. Zinc-Coated Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process in accordance with ASTM A123/A123M or ASTM A153/A153M.

1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent, or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with MIL-P-21035B or SSPC-Paint 20.

M. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, in accordance with requirements in SSPC-SP 3, and shop-apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in SSPC-Paint 25 in accordance with SSPC-PA 1.

N. Welding Electrodes: Comply with AWS standards.

2.9 ACCESSORIES

A. Bearing Pads: Provide one of the following for architectural precast concrete units as recommended by precast fabricator for application:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D2240, minimum tensile strength 15.5 MPa, ASTM D412.
2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer; Type A durometer hardness of 70 to 90, ASTM D2240; capable of supporting a compressive stress of 20.7 MPa with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; Type A durometer hardness of 80 to 100, ASTM D2240; in compliance with AASHTO LRFDBDS, Division II, Section 18.10.2; or with MIL-C-882E.
4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

B. Reglets Specified Elsewhere: Specified in Section 076200 "Sheet Metal Flashing and Trim."

C. Reglets: PVC extrusions, Stainless steel, Type 302 or Type 304, felt or fiber filled, or with face opening of slots covered.

D. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install architectural precast concrete units.

2.10 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Use a single design mixture for units with more than one major face or edge exposed.
2. Where only one face of unit is exposed, use either a single design mixture or separate mixtures for face and backup.

B. Limit use of fly ash and ground granulated blast-furnace slag to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.

C. Design mixtures may be prepared by a qualified independent testing agency approved by Engineer or by qualified precast plant personnel at architectural precast concrete fabricator's option.

D. Limit water-soluble chloride ions to maximum percentage by weight of cement, including cementitious additives, as specified under Section 033000 'Cast -in-place Concrete" permitted by ACI 318 or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.

E. Normal-Weight Concrete Mixtures: Proportion full-depth mixture by either laboratory trial batch or field test data methods in accordance with ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength on Cylinder (28 Days): 35 MPa minimum.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Minimum Cementitious Content: 380 kg/m3

F. Water Absorption: Six percent by weight or 14 percent by volume, tested in accordance with ASTM C642, except for boiling requirement.

G. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch method in accordance with ACI 213R and ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

1. Compressive Strength on Cylinder (28 Days): 35 MPa.
2. Unit Weight: Calculated equilibrium unit weight of 1842 kg/cu. m, plus or minus 48 kg/cu. m, in accordance with ASTM C567/C567M.

H. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

I. When included in design mixtures, add other admixtures to concrete mixtures in accordance with manufacturer's written instructions.

2.11 FABRICATION OF MOLDS

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Form joints are not permitted on faces exposed to view in the finished Project.
2. Edge and Corner Treatment: Uniformly chamfered.

2.12 FABRICATION OF STONE FACING

A. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of 19 mm from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned in accordance with established relationships and indicated tolerances.

1. Stone to Precast Anchorages: Provide anchors in numbers, types, and locations required to satisfy specified performance criteria, but not more than 600 mm o.c. around perimeter of stone facing panels with a minimum of four anchors per panel.

B. Fill anchor holes with epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone.

1. Install minimum 0.15-mm thick polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.
2. Install 3-mm polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

2.13 FABRICATION OF PRECAST ARCHITECTURAL CONCRETE

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage in accordance with AWS D1.1/D1.1M and AWS C5.4.

B. Furnish loose hardware items, including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units, as indicated on the Drawings.

D. Cast-in openings larger than 250 mm in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.

2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strands to maintain at least 19-mm minimum concrete cover. Increase cover requirements for reinforcing steel to 38 mm when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.

1. Delay detensioning or post-tensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

H. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Place face mixture to a minimum thickness after consolidation of the greater of 25 mm or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

J. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

1. Place backup concrete mixture to ensure bond with face-mixture concrete.

K. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.

1. Place self-consolidating concrete without vibration in accordance with PCI TR-6. Ensure adequate bond between face and backup concrete, if used.

L. Comply with PCI MNL 117,ACI 305 and ACI 306 for hot concrete placement.

M. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that does not show in finished structure.

N. Cure concrete, in accordance with PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

O. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs comply with requirements in PCI MNL 117 and Engineer's approval.

2.14 FABRICATION TOLERANCES

A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

B. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with the following product tolerances:

1. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:

    a. 3 m or under, plus or minus 3 mm.
    b. 3 to 6 m, plus 3 mm, minus 5 mm.
    c. 6 to 12 m, plus or minus 6 mm.
    d. Greater Than 6 m: Each additional 3 m, plus or minus 1.6 mm.
    e. Greater Than 12 m: Each additional 3 m, plus or minus 1.6 mm.

2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:

    a. 3 m or under, plus or minus 6 mm.
    b. 3 to 6 m, plus 6 mm, minus 10 mm.
    c. 6 to 12 m, plus or minus 10 mm.
    d. Greater Than 6 m: Each additional 3 m, plus or minus 3 mm.
    e. Greater Than 12 m: Each additional 3 m, plus or minus 3 mm.

3. Rib Thickness: Plus or minus 3 mm.
4. Rib to Edge of Flange: Plus or minus 3 mm.
5. Distance between Ribs: Plus or minus 3 mm.
6. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 3 mm/1830 mm or 13 mm total, whichever is greater.
7. Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 19 mm.
8. Dimensions of Haunches: Plus or minus 6 mm.
9. Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 3 mm.

10. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 6 mm.
11. Bowing: Plus or minus L/360, maximum 25 mm.
12. Local Smoothness: 6 mm/3 m.
13. Warping: 1.6 mm/300 mm from nearest adjacent corner.

C. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.

1. Weld Plates: Plus or minus 25 mm.
2. Tipping and Flushness of Plates: Plus or minus 6 mm.
3. Dimensions of Architectural Features and Rustications: Plus or minus 3 mm.
4. Inserts: Plus or minus 13 mm.
5. Handling Devices: Plus or minus 75 mm.
6. Reinforcing Steel and Welded-Wire Reinforcement: Plus or minus 6 mm where position has structural implications or affects concrete cover; otherwise, plus or minus 13 mm.
7. Reinforcing Steel Extending out of Member: Plus or minus 13 mm.
8. Prestressing Reinforcement: Plus or minus 6 mm, perpendicular to panel; plus or minus 25 mm, parallel to panel.
9. Location of Rustication Joints: Plus or minus 3 mm.
10. Location of Opening within Panel: Plus or minus 6 mm.
11. Location of Flashing Reglets: Plus or minus 6 mm.
12. Location of Flashing Reglets at Edge of Panel: Plus or minus 3 mm.
13. Reglets for Glazing Gaskets: Plus or minus 3 mm.
14. Electrical Outlets, Hose Bibs: Plus or minus 13 mm.
15. Location of Bearing Surface from End of Member: Plus or minus 6 mm.
16. Allowable Rotation of Plate, Channel Inserts, and Electrical Boxes: Two-degree rotation or 6 mm maximum, measured at perimeter of insert.
17. Position of Sleeve: Plus or minus 13 mm.
18. Location of Window-Washer Track or Buttons: Plus or minus 3 mm.

D. Thin-Brick-Faced Architectural Precast Concrete Units: Restrict the following misalignments to 2 percent of number of thin bricks in a unit.

1. Alignment of Mortar Joints:

    a. Jog in Alignment: 3 mm.
    b. Alignment with Panel Centerline: Plus or minus 3 mm.

2. Variation in Width of Exposed Mortar Joints: Plus or minus 3 mm.
3. Tipping of Individual Thin Bricks from Panel Plane of Exposed Thin-Brick Surface: Plus 0 mm; minus 6 mm less than or equal to depth of form liner joint.
4. Exposed Thin-Brick Surface Parallel to Primary Control Surface of Panel: Plus 6 mm; minus 3 mm.
5. Individual Thin-Brick Step in Face from Panel Plane of Exposed Thin-Brick Surface: Plus 0 mm; minus 6 mm less than or equal to depth of form liner joint.

2.15 FINISHES

A. Exposed faces to be free of joint marks, grain, and other obvious defects. Corners, including false joints to be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved mockups and as follows:

1. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
2. As-Cast Surface Finish: Provide surfaces to match approved sample for acceptable surface, air voids, sand streaks, and honeycomb.
3. Textured-Surface Finish: Impart by form liners or inserts.
4. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
5. Exposed-Aggregate Finish: Use chemical retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
6. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
7. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
8. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
9. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
10. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
11. Thin-Brick or Terra Cotta Facing: See "Clay Facing Materials" Article.
12. Stone Facing: See "Stone Facing Materials" Article.

B. Finish exposed top surfaces of architectural precast concrete units to match face-surface finish.

C. Finish unexposed surfaces of architectural precast concrete units with as-cast finish.

2.16 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete in accordance with PCI MNL 117 requirements. If using self-consolidating concrete, the requirements of ACI 237R are to be followed; also test and inspect in accordance with PCI TR-6, ASTM C1610/C1610M, ASTM C1611/C1611M, ASTM C1621/C1621M, and ASTM C1712.

B. Engage an independent testing agency approved by the Engineer, to evaluate precast architectural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

C. Factory Tests: Test and inspect precast architectural concrete by a qualified testing agency.

D. Strength of precast concrete units is considered deficient if units fail to comply with ACI 318 requirements and Section 033000 "Cast -in-place Concrete" for concrete strength.

E. Testing: Fabricator will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength in accordance with ASTM C42/C42M and ACI 318M, in compliance with Section 033000 "Cast -in-place Concrete".

1. A minimum of three representative cores to be taken from units of suspect strength, from locations directed by Engineer.
2. Test cores in an air-dry condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to Engineer, Contractor, and precast concrete fabricator. Test reports include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

F. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

G. Defective Units: Discard and replace recast architectural concrete units that do not comply with acceptability requirements in PCI MNL 117, including concrete strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Engineer's approval. Engineer reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive loads from precast concrete units.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PRECAST ARCHITECTURAL CONCRETE UNITS

A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.

B. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

1. Install temporary steel or plastic spacing shims as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
4. Unless otherwise indicated, maintain uniform joint widths of 20 mm.

C. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Welds not specified to be continuous fillet welds use no less than the minimum fillet as specified by AWS.
3. Clean weld-affected metal surfaces with chipping hammer followed by brushing, and apply a minimum 0.1-mm thick coat of galvanized repair paint to galvanized surfaces in accordance with ASTM A780/A780M.
4. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

E. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:

    a. Turn-of-Nut: In accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
    b. Calibrated Wrench: In accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
    c. Twist-off Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.
    d. Direct-Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.

3. For slip-critical connections, use method and inspection procedure approved by Engineer and coordinated with inspection agency.

F. Grouting or Dry Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Erect architectural precast concrete units level, plumb, square, and in alignment, without exceeding the following noncumulative erection tolerances:

1. Plan Location from Building Grid Datum: Plus or minus 13 mm.
2. Plan Location from Centerline of Steel: Plus or minus 13 mm.
3. Top Elevation from Nominal Top Elevation: As follows:

    a. Exposed Individual Panel: Plus or minus 6 mm.
    b. Nonexposed Individual Panel: Plus or minus 13 mm.

4. Support Elevation from Nominal Support Elevation: As follows:

    a. Maximum Low: 13 mm.
    b. Maximum High: 6 mm.

5. Maximum Plumb Variation over the Lesser of Height of Structure or 30 m: 25 mm.
6. Maximum Jog in Alignment of Matching Edges: 6 mm.

    a. Exposed Panel Relative to Adjacent Panel: 6 mm.
    b. Nonexposed Panel Relative to Adjacent Panel: 13 mm.

7. Joint Taper in 3 m: 6 mm.
8. Maximum Jog in Alignment of Matching Faces: 6 mm.
9. Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 6 mm.
10. Opening Height between Spandrels: Plus or minus 6 mm.

3.4 REPAIR

A. Repair architectural precast concrete units if permitted by Engineer. Engineer reserves the right to reject repaired units that do not comply with requirements.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 6 m.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint in accordance with ASTM A780/A780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Erection of loadbearing precast concrete members.
2. Visually inspect field welds and test in accordance with ASTM E165/E165M or to ASTM E709 and ASTM E1444/E1444M.
3. High-strength bolted connections are subject to inspections.

C. Prepare test and inspection reports.

D. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, to be performed to determine compliance of replaced or additional work with specified requirements.

3.6 CLEANING

A. Clean surfaces of precast concrete units exposed to view.

B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, in accordance with precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034500

SECTION 055313 - BAR GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Grating frames and supports.

B. Related Requirements:

1. Division 01 section "Product Requirements" for requirements regarding submittals and substitutions of architectural products.
2. Division 01 Sections related to sustainability requirements, as applicable.
3. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
4. Section 055119 "Metal Grating Stairs" for grating treads and landings of steel-framed stairs.
5. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Clips and anchorage devices for gratings.
2. Paint products.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including manufacturers' published load tables] analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. All related Product Data as detailed in Division 01 Sections related to sustainability requirements, as applicable.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Welding certificates.

E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Product shall demonstrate compliance with sustainability targets and requirements specified in Division 01 Sections related to sustainability requirements, as applicable.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E329 or ASTM E699 for testing indicated, and in accordance with ISO/IEC 17020, ISO/IEC 17011 and ISO/IEC 17025 requirements acceptable to Engineer and authorities having jurisdiction, and that has the experience and capability to satisfactorily conduct the testing indicated. Testing agency shall have a valid ISO/IEC 17025 certification

C. Quality System: Provide the products of a manufacturer who holds valid ISO 9001 certification.

D. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

E. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.6/D1.6M.

F. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

B. Manufacturer Qualifications: A firm experienced in manufacturing "Bar Grating" and components similar to those required for this Project and with a record of successful in-service performance.

1.7 WARRANTY

A. Full System Warranty: Provide full system warranty in which Manufacturer and Installer are jointly and severally responsible and agree to repair or replace without limitations all or any parts of the components of Bar Gratings that fail(s) in materials or workmanship within specified warranty period. Failure includes, but not limited to:

1. Structural failures.
2. Faulty operation of movable parts and accessories.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

B. Warranty shall also include installation and finishing that may be required due to repair or replacement of Bar Gratings.

1. Warranty Period: 10 year(s) from date of Substantial Completion.

1.8 LOCAL REGULATIONS AND CODES

A. Comply with applicable requirements of the local codes and regulations of authorities having jurisdiction.

1. Comply with the functionality and serviceability requirements listed in the local fire code and in the life safety and fire strategy report, as accepted and approved by local authorities having jurisdiction.
2. Obtain necessary approvals from authorities having jurisdiction.
3. Verify applicable performances whenever relevant equivalent counterparts to applicable standards are substituted, and submit a comprehensive comparative matrix of equivalency between specified standard and proposed counterpart for Engineer’s approval.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of 6.00 kN/sq. m or concentrated load of 8.90 kN, whichever produces the greater stress.
2. Floors for Heavy Manufacturing: Uniform load of 11.97 kN/sq. m or concentrated load of 13.40 kN, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of 2.87 kN/sq. m.
4. Walkways and Elevated Platforms Used as Exits: Uniform load of 4.79 kN/sq. m.
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 11.97 kN/sq. m or concentrated load of 35.60 kN, whichever produces the greater stress.
6. Limit deflection to L/360 or 6.4 mm, whichever is less.

C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7, in compliance with Structural specifications, drawings and documents.

1. Component Importance Factor: 1.5.

2.2 METAL BAR GRATINGS

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531 and NAAMM MBG 532.

B. Pressure-Locked Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.

1. Bearing Bar Spacing: As indicated on drawings.
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 51 mm o.c.
5. Grating Mark P-11-4 (1 x 3/16) STEEL: 25-by-4.8-mm bearing bars at 18 mm o.c., and crossbars at 102 mm o.c.
6. Grating Mark P-15-4 (1-1/4 x 1/8) STEEL: 32-by-3.2-mm bearing bars at 24 mm o.c., and crossbars at 102 mm o.c.
7. Grating Mark P-19-4 (1-1/2 x 3/16) STEEL: 38-by-4.8-mm bearing bars at 30 mm o.c., and crossbars at 102 mm o.c.
8. Grating Mark: As indicated.
9. Traffic Surface: As indicated.
10. Steel Finish: Hot-dip galvanized with a coating weight of not less than 550 g/sq. m of coated surface.

2.3 GRATING FRAMES AND SUPPORTS

A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.

2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 600 mm o.c. and provide minimum anchor units in the form of steel straps 32 mm wide by 6 mm thick by 200 mm long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.
2. Interior, where indicated.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ISO 898-1, Property Class 4.6; with hex nuts, ASTM A563M, and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; ISO 3506-1 for bolts and ASTM F836M for nuts, Alloy Group A4.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563M, and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: Torque-controlled expansion or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group A4 stainless steel bolts, ISO 3506-1, and nuts, ASTM F836M.

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099611 "High-Performance Coatings."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

D. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.

E. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 205.

F. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 230, with Z275 coating.

G. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, Type 316L.

H. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 316L.

2.7 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1 mm unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
2. Fabricate toeplates for attaching in the field.
3. Toeplate Height: 100 mm unless otherwise indicated.

G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
2. Provide no fewer than four saddle clips for each grating section containing rectangular bearing bars 4.8 mm or less in thickness and spaced 24 mm or more o.c., with each clip designed and fabricated to fit over two bearing bars.
3. Provide no fewer than four weld lugs for each grating section containing rectangular bearing bars 4.8 mm or less in thickness and spaced less than 24 mm o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
4. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
5. Furnish threaded bolts with nuts and washers for securing grating to supports.
6. Furnish self-drilling fasteners with washers for securing grating to supports.
7. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

I. Do not notch bearing bars at supports to maintain elevation.

2.8 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings, frames, and supports not indicated to be galvanized unless otherwise indicated.

1. Shop prime with primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" unless primers specified in Section 099611 "High-Performance Coatings" are indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099611 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: With a heavy coat of bituminous paint, coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals.

3.2 INSTALLATION OF METAL BAR GRATINGS

A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum 0.05-mm dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055313

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-core flush wood doors with plastic-laminate-faces.
2. Hollow-core flush wood veneer-faced doors for transparent finish.
3. Fire-rated wood door frames.
4. Factory finishing flush wood doors and frames.
5. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Division 01 Sections related to sustainability requirements, as applicable.
2. Section 064023 "Interior Architectural Woodwork" for wood door frames.
3. Section 064216 "Flush Wood Paneling" for requirements for veneers from the same flitches for both flush wood doors and flush wood paneling.
4. Section 088000 "Glazing" for glass view panels in flush wood doors.
5. Section 099113 "Exterior Painting" Section 099123 "Interior Painting" for field finishing doors.

1.3 DEFINITIONS

A. Fire Resisting Door: A door which has been constructed in such a manner that when installed in an assembly and tested, it will pass NFPA 252 or 10C, and can be rated as resisting fire for the specified duration. A fire resisting door must have been tested and carry the identifying label of an approved independent testing and inspection agency or laboratory, confirming its fire resistance rating.

B. Fire Door Assembly: The door frame, door leaf, all hardware and accessories and vision lites all labeled and tested.

C. Smoke Door: A fire resisting door which, in addition to having intumescent seals to seal hot smoke, also has approved quality draught seals to seal cold smoke, installed in accordance with NFPA 105 “Installation of Smoke-Control Door Assemblies”. A smoke door must have been tested and carry the identifying label of an approved independent testing and inspection agency or laboratory, confirming its rating.

D. Direction of Opening: on Architectural Drawings, the indications for direction of opening are as follows:

1. Sliding doors are indicated by an arrow indicating the direction of slide.
2. Hinged or pivoting doors are indicated by a dotted triangle, the vertex of which indicates the hinge or pivot side.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Door louvers.
5. Door trim for openings.
6. Door frame construction.
7. Factory-machining criteria.
8. Factory- finishing specifications.

B. Sustainable Design Submittals:

1. All related Product Data as detailed in Division 01 Sections related to sustainability requirements, as applicable.
2. Regional Materials: Manufacture wood doors within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.
3. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
4. Chain-of-Custody Qualification Data: For manufacturer and vendor.
5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door and frame location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Dimensions and locations of mortises and holes for hardware.

7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory finished and application requirements.
10. Apply AWI Quality Certification Program label to Shop Drawings acceptable to authorities having jurisdiction.

D. Samples for Initial Selection: For plastic-laminate door faces factory-finished doors and factory-finished door frames.

E. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 200 by 250 mm, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
2. Plastic laminate, 150 mm square, for each color, texture, and pattern selected.
3. Polymer edging, in manufacturer's standard colors.
4. Corner sections of doors, approximately 200 by 250 mm, with door faces and edges representing actual materials to be used.

    a. Provide Samples for each species of veneer and solid lumber required.
    b. Provide Samples for each color, texture, and pattern of plastic laminate required.
    c. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.

5. Louver blade and frame sections, 150 mm long, for each material and finish specified.
6. Frames for light openings, 150 mm long, for each material, type, and finish required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector, acceptable to local authorities having jurisdiction.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of Fire and Egress Door Assembly Inspector certificate acceptable to authorities having jurisdiction.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

D. Vendor Qualifications: A vendor that is certified for chain of custody by certification body acceptable to authorities having jurisdiction.

E. Mockups: Before installing flush wood doors and frames, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location indicated or, if not indicated, as directed by Engineer.
2. Build mockups as shown on Drawings.
3. Build mockups for each type of wood doors and frames, hardware, and anchorage system components.
4. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
5. Obtain Engineer's approval of mockups before fabricating custom steel doors and frames.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 CLOSEOUT SUBMITTALS

A. Special warranties.

B. Quality Standard Compliance Certificates: certification program acceptable to authorities having jurisdiction. AWI Quality Certification Program certificates.

C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.8 QUALITY ASSURANCE

A. Product shall demonstrate compliance with sustainability targets and requirements specified in Division 01 Sections related to sustainability requirements, as applicable.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E329 or ASTM E699 for testing indicated, and in accordance with ISO/IEC 17020, ISO/IEC 17011 and ISO/IEC 17025 requirements acceptable to Engineer and authorities having jurisdiction, and that has the experience and capability to satisfactorily conduct the testing indicated. Testing agency shall have a valid ISO/IEC 17025 certification.

C. Quality System: Provide the products of a manufacturer who holds valid ISO 9001 certification.

D. Source Limitations: Obtain flush wood doors from single source from single manufacturer.

E. Installer, fabricator Qualifications: For Fire-Resistance Rated door assemblies, fabricator shall be experienced in the application of systems similar in complexity to those specified, and acceptable to or licensed by the product manufacturer, satisfying the requirements of and approved**.**

F. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

G. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

H. Manufacturer's Certification: Licensed participant in certification program acceptable to authorities having jurisdiction..

I. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with qualifications set forth in NFPA 80, Section 5.2.3.1 shall be acceptable to authorities having jurisdiction

J. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies complies with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and shall be acceptable to authorities having jurisdiction

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in cardboard cartons, and wrap bundles of doors in plastic sheeting.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.10 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
2. Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 16 and 32 deg C and relative humidity between 17 and 50 percent during remainder of construction period.

1.11 WARRANTY

A. Special Warranty: Provide complete warranty in which Manufacturer, Contractor and Installer are jointly and severally liable and agree agrees to repair or replace doors and frames that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Delamination of veneer.
b. Warping (bow, cup, or twist) more than 6.4 mm in a 1067-by-2134-mm section.

c. Telegraphing of core construction in face veneers exceeding 0.25 mm in a 76.2-mm span.

2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors and frames.
3. Warranty shall also include all hardware.
4. Warranty Period for Solid-Core Exterior Doors: Five years from date of Substantial Completion.
5. Warranty Period for Solid-Core Interior Doors: Life of installation.
6. Warranty Period for Hollow-Core Interior Doors: Two year(s) from date of Substantial Completion.

1.12 LOCAL REGULATIONS AND CODES

A. Comply with applicable requirements of the local codes and regulations of authorities having jurisdiction.

1. Comply with the functionality and serviceability requirements listed in the local fire code and in the life safety and fire strategy report, as accepted and approved by local authorities having jurisdiction.
2. Obtain necessary approvals from authorities having jurisdiction.
3. Verify applicable performances whenever relevant equivalent counterparts to applicable standards are substituted, and submit a comprehensive comparative matrix of equivalency between specified standard and proposed counterpart for Engineer's approval.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain flush wood doors indicated to be blueprint matched with paneling and wood paneling from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Wood Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Temperature-Rise Limit: Where indicated on Drawings, provide doors that have a maximum transmitted temperature end point of not more than 250 deg C above ambient after 30 minutes of standard fire-test exposure.

B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.3 FLUSH WOOD DOORS AND FRAMES, GENERAL

A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.

1. Provide labels and certificates from AWI certification program indicating that doors and frames comply with requirements of grades specified.

    a. This project has been registered with certification program acceptable to authorities having jurisdiction AWI as AWI Quality Certification Program Number.
    b. Contractor shall register the Work under this Section with the certification program acceptable to authorities having jurisdiction.

2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

B. Regional Materials: Manufacture wood doors within (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within (160 km) of Project site.

C. Certified Wood: Certify wood doors as "FSC Pure" or "FSC Mixed Credit" in accordance with FSC STD-01-001 and FSC STD-40-004.

D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

2.4 SOLID-CORE FLUSH WOOD DOORS WITH PLASTIC-LAMINATE FACES

A. Interior Doors, Solid Core:

1. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty Standard Duty.
2. Performance Grade by Location:

    a. ANSI/WDMA I.S. 1A Extra Heavy Duty: public toilets janitor's closets assembly spaces exits and where indicated on Drawings.
    b. ANSI/WDMA I.S. 1A Standard Duty: Closets (not including janitor's closets) and private toilets and where indicated on Drawings.

3. ANSI/WDMA I.S. 1A Grade: Premium.

4. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS.
5. Colors, Patterns, and Finishes: As selected by Engineer from laminate manufacturer's full range of products.
6. Exposed Vertical and Top Edges: Hardwood edges for staining to match faces.

    a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
    b. Fire-Rated Pairs of Doors:

        1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
        2) Provide formed-steel edges and astragals with intumescent seals.

            a) Finish steel edges and astragals with baked enamel same color as doors.
            b) Finish steel edges and astragals to match door hardware (locksets or exit devices).

    c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

        1) Screw-Holding Capability: 2440 N in accordance with WDMA T.M. 10.

7. Core for Non-Fire-Rated Doors:

    a. ANSI A208.1, Grade LD-1 particleboard.

        1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware. follows:

            a) (125-mm) bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
            b) (125-mm) midrail blocking, in doors indicated to have exit devices.

        2) Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087100 "Door Hardware."

    b. Glued wood stave.
    c. WDMA I.S. 10 structural composite lumber.

        1) Screw Withdrawal, Door Face: 2440 N.
        2) Screw Withdrawal, Vertical Door Edge: 2440 N.

    d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.

8. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

    a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware. follows:

        1) (125-mm) bottom-rail blocking, in doors indicated to have protection plates.
        2) (125-mm) midrail blocking, in doors indicated to have armor plates.
        3) 114-by-250-mm lock blocks, in doors indicated to have exit devices.

9. Construction:

    a. Three plies, hot-pressed or cold-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before faces are applied.
    b. Five plies, hot-pressed or cold-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before faces and crossbands are applied.

2.5 HOLLOW-CORE FLUSH WOOD DOORS FOR OPAQUE FINISH

A. Interior Doors, Hollow Core:

1. Performance Grade: WDMA ANSI/I.S. 1A Standard Duty.
2. ANSI/WDMA I.S. 1A Grade: Premium.
3. Faces: Hardboard or MDF.

    a. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).
    b. MDF Faces: ANSI A208.2, Grade 150 or Grade 160.

4. Exposed Vertical and Top Edges: Any closed-grain hardwood.
5. Construction: Standard hollow core.

    a. Blocking: Provide wood blocking with minimum dimensions as follows: (125-by-460-mm) lock blocks at both stiles.
    b. (125-mm) top- and bottom-rail blocking.
    c. (250-mm) top- and bottom-rail blocking.
    d. (64-mm) midrail blocking.

2.6 HOLLOW-CORE FLUSH WOOD PLASTIC-LAMINATE-FACED DOORS

A. Interior Doors, Hollow-Core Plastic-Laminate-Faced:

1. Performance Grade: ANSI/WDMA I.S. 1A Standard Duty.
2. ANSI/WDMA I.S. 1A Grade: Premium.
3. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS.
4. Colors, Patterns, and Finishes: As selected by Engineer from laminate manufacturer's full range of products.

5. Exposed Vertical and Top Edges: Plastic laminate that matches faces, applied before faces.

    a. Polymer Edging Color: Same color as faces.

6. Construction: Standard hollow core.

    a. Blocking: Provide wood blocking with minimum dimensions as follows:(125-by-460-mm) lock blocks at both stiles.
    b. (125-mm) top- and bottom-rail blocking.
    c. (250-mm) top- and bottom-rail blocking.
    d. (64-mm) midrail blocking.

2.7 FIRE-RATED WOOD DOOR FRAMES

A. Interior Frames:

1. ANSI/WDMA I.S. 1A Grade: Premium.
2. Wood Species and Cut: Match species and cut indicated for wood doors unless otherwise indicated.
3. Cut: Plain sliced/plain sawn.
4. Wood Moisture Content: 4 to 9 percent.
5. Profile: As indicated on Drawings.
6. Construction: Solid lumber, fire-retardant particleboard, or fire-retardant medium density fiberboard (MDF) with veneered exposed surfaces and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated on Drawings.

2.8 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Manufacturer's standard shape.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated on Drawings. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

C. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 1.2-mm- thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated on Drawings.

D. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.

1. Wood Species: Same species as door faces.

2. Profile: Flat.

E. Metal Louvers:

1. Blade Type: as indicated on drawings..
2. Metal and Finish:

a. Hot-dip galvanized steel, 1.0 mm thick, with baked-enamel- or powder-coated finish.

F. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.

1. Metal and Finish: Hot-dip galvanized steel, 1.0 mm thick, with baked-enamel- or powder-coated finish.

2.9 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.

1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
2. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

1. Locate hardware to comply with DHI-WDHS-3.
2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Transom and Side Panels:

1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
2. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
3. Fabricate door and transom panels with full-width, solid-lumber meeting rails.
4. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
3. Louvers: Factory install louvers in prepared openings.

E. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before factory finishing.

1. Flash top of outswinging doors with manufacturer's standard metal flashing.

2.10 FACTORY PRIMING

A. Doors for Opaque Finish: Factory prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in Section 099113 "Exterior Painting." Section 099123" Interior Painting."

2.11 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.
3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Factory finish doors that are indicated on Drawings to receive transparent finish.

D. Factory finish doors where indicated in schedules or on Drawings as factory finished.

E. Transparent Finish:

1. ANSI/WDMA I.S. 1A Grade: Premium.
2. Finish: ANSI/WDMA I.S. 1A TR-4 Conversion Varnish.
3. Finish: ANSI/WDMA I.S. 1A TR-6 Catalyzed Polyurethane.
4. Finish: ANSI/WDMA I.S. 1A TR-8 UV Cured Acrylated Polyester/Urethane
5. Staining: As selected by Engineer from manufacturer's full range.
6. Sheen: Satin.

F. Opaque Finish:

1. ANSI/WDMA I.S. 1A Grade: Premium.
2. Finish: ANSI/WDMA I.S. 1A OP-4 Conversion Varnish.
3. Finish: ANSI/WDMA I.S. 1A OP-6 Catalyzed Polyurethane.
4. Color: As selected by Engineer from manufacturer's full range.
5. Sheen: Gloss.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Install frames level, plumb, true, and straight.

1. Shim as required with concealed shims. Install level and plumb to a tolerance of 3.2 mm in 2400 mm.
2. Anchor frames to anchors or blocking built in or directly attached to substrates.
    a. Secure with countersunk, concealed fasteners and blind nailing.
    b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
        1) For factory-finished items, use filler matching finish of items being installed.
3. Install fire-rated doors and frames in accordance with NFPA 80.
4. Install smoke- and draft-control doors in accordance with NFPA 105.

D. Job-Fitted Doors:

1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
    a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
2. Machine doors for hardware.
3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
4. Clearances:
    a. Provide 3.2 mm at heads, jambs, and between pairs of doors.
    b. Provide 3.2 mm from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.

c. Where threshold is shown or scheduled, provide 6.4 mm from bottom of door to top of threshold unless otherwise indicated.
d. Comply with NFPA 80 for fire-rated doors.

5. Bevel non-fire-rated doors 3-1/2 degrees at lock and hinge edges.
6. Bevel fire-rated doors 3-1/2 degrees at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Engineer.

B. Inspections:

1. Provide inspection of installed Work through Certification Program, certifying that wood doors and frames, including installation, comply with requirements of AWI/AWMCA/WI's "Architectural Woodwork Standards" for the specified grade.
2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
3. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Glazed aluminum curtain wall systems:

a. Conventionally glazed.

B. Related Requirements but not necessarily limited to:

1. Division 01 Sections related to sustainability requirements, as applicable.
2. Division 01 Section 014339 "Mockups" for preconstruction laboratory mockup testing.
3. Division 07 Section “Penetration Firestopping" for firestop systems field installed with glazed aluminum curtain-wall systems.
4. Division 07 Section 078443 "Joint Firestopping" perimeter fire-containment systems field installed with glazed aluminum curtain walls.
5. Division 07 Section 079200 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
6. Division 07 Section "Thermal Insulation" for insulation materials field installed with glazed aluminum curtain-wall systems.
7. Division 08 Section 088000 "Glazing" for curtain wall glazing.

1.3 DEFINITIONS

A. Direction of Opening: on Architectural Drawings the indications for direction of opening are as follows:

1. Fixed windows are indicated by letter “F”
2. Sliding windows are indicated by an arrow indicating the direction of slide.
3. Casement or pivoting windows are indicated by a dotted triangle, the vertex of which indicates the hinge or pivot side.

B. Manufacturer: the curtain wall system manufacturer.

C. Fabricator: the fabricator of curtain wall joinery components based on system provided by manufacturer.

D. Installer: The Installer of curtain wall joinery components.

E. Testing Laboratory: an independent testing laboratory and agency acceptable to authorities having jurisdiction, approved by the Engineer to carry out the testing required in this specification.

1.4 SYSTEM DESCRIPTION

A. General: Provide curtain wall system that has the following capabilities based on preconstruction testing:

1. That forms a complete integrated and functional system that is fit to the purpose and produced by an international manufacturer having not less than fifteen (15) years documented experience in that field.
2. Withstands loads and thermal and structural movement requirements indicated without failure. Failure includes the following:

    a. Air infiltration and water penetration exceeding specified limits.
    b. Members transferring stresses, including those caused by thermal and structural movement, to glazing units.

B. Glazing is physically and thermally isolated from framing members.

C. Glazing-to-glazing joints accommodate thermal and mechanical movements of glazing and system, prevent glazing-to-glazing contact, and maintain required edge clearances.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. All related Product Data as detailed in Division 01 Sections related to sustainability requirements, as applicable.
2. All above grade opaque wall surfaces, including shading elements shall be selected with light colors to ensure that the equivalent SRI exceeds the minimum SRI value of 29 as required by ASHRAE 189.1
3. Acoustical control for the curtain wall assembly shall ensure that compliance with ASHRAE 189.1 Table 8.3.3.2 is maintained. All penetrations through and fenestrations within sound rated assemblies shall be sealed in accordance with ASTM C919 and installed as per manufacturer’s recommendations, noting that all construction of acoustical items shall be visually inspected by an approved agency.

4. Product Data: For sealants, indicating VOC content.
5. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
6. Regional Materials: Manufacture products within (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within (160 km) of Project site.
7. Environmental Product Declaration: For each product.
8. Health Product Declaration: For each product.
9. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings General: Submit newly prepared information, drawn to accurate scale for the project in consideration. Do not reproduce Contract Documents or copy standard printed information as the basis of Shop Drawings. Contract Drawings are not intended to be used as shop drawings.

1. Include the following information on Shop Drawings:

    a. Dimensions
    b. Identification of products and materials included
    c. Compliance with specified standards
    d. Notation of co-ordination requirements
    e. Notation of dimensions established by field measurement.

2. Submit Co-ordination Drawings where required for integration of different construction elements. Show construction sequences and relationships of separate components where necessary to avoid conflicts in utilisation of the space available.
3. Highlight, encircle or otherwise indicate deviations from the Contract Documents on the Shop Drawings.
4. Do not permit Shop Drawing copies without an appropriate final stamp or other marking indicating the action taken by the Engineer to be used in connection with construction.
5. Initial Submittal: submit as per Contract Requirements.
6. Final Submittal: submit as per Contract Requirements.

D. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.
    f. Perimeter fire barriers and fire stops.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

E. Samples for Initial Selection: For units with factory-applied color finishes.

F. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

G. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from300-mm lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

H. Delegated-Design Submittal: For glazed aluminum curtain walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Mockup Testing Submittals:

1. Testing Program: Developed specifically for Project.
2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.

B. Qualification Data:

1. For qualified Manufacturer and Installer and laboratory mockup testing agency and field testing agency.
2. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

C. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

D. Product Test Reports: For glazed aluminum curtain walls along with perimeter joints and fire stopping, for tests performed by a qualified testing agency acceptable to authorities having jurisdiction.

E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranties: For special warranties.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.9 QUALITY ASSURANCE

A. Product shall demonstrate compliance with sustainability targets and requirements specified in Division 01 Sections related to sustainability requirements, as applicable.

B. Quality System: Provide the products of a manufacturer who holds valid ISO 9001 certification.

C. Manufacturer Qualifications: A firm experienced in manufacturing glazed curtain wall systems similar to those indicated for the specified Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units, with at least fifteen (15) years of documented experience. Manufacturer to demonstrate that he has successfully completed, installed and commissioned- a minimum of five (5) previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

D. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project, installer shall have a minimum of fifteen (15) years of documented experience in the field, and shall have successfully completed a minimum of (5) years projects similar in nature.

E. Laboratory testing curtain wall assembly tests shall ensure that the test specimen is duplicated as per intended final installation specifications, including but not limited to dimensions, thicknesses, sealants and the like. Laboratories shall ensure that curtain wall assembly tests are not over engineered purely to pass test criteria.

F. Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and shall have a valid ISO/IEC 17025 certification and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

G. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated, and in accordance with ISO/IEC 17020, ISO/IEC 17011 and ISO/IEC 17025 requirements acceptable to Engineer and authorities having jurisdiction, and that has the experience and capability to satisfactorily conduct the testing indicated. Testing agency shall have a valid ISO/IEC 17025 certification.

H. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Engineer, except with Engineer's approval. If changes are proposed, submit comprehensive explanatory data to Engineer for review.

I. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of structural-sealant-glazed curtain wall assemblies.

1.10 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area indicated by Engineer.
2. Testing shall be performed on mockups in accordance with requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on laboratory mockups.

1. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
2. Size and Configuration: As indicated on Drawings.
3. Notify Engineer seven days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested.

B. Preconstruction Laboratory Mockup Testing: Test preconstruction laboratory mockups according to requirements in "Performance Requirements" Article. Perform the following tests in the following order:

1. Structural, 50 percent: ASTM E330/E330M at 50 percent of positive test load.
2. Air Leakage: ASTM E283.
3. Water Penetration under Static Pressure: ASTM E331.
4. Water Penetration under Dynamic Pressure: AAMA 501.1.
5. Interstory Drift, 100 percent: AAMA 501.4 at 100 percent of design displacement. Repeat the following:

a. Air Leakage: ASTM E283.
b. Water Penetration under Static Pressure: ASTM E331.

6. Vertical Interstory Movement: AAMA 501.7 at 100 percent of design displacement. Repeat the following:

    a. Air Leakage: ASTM E283.
    b. Water Penetration under Static Pressure: ASTM E331.

7. Thermal Cycling: AAMA 501.5. Repeat the following:

    a. Air Leakage: ASTM E283.
    b. Water Penetration under Static Pressure: ASTM E331.

8. Structural, 100 percent: ASTM E330/E330M at 100 percent of positive and negative test loads. Repeat the following:

    a. Air Leakage: ASTM E283.
    b. Water Penetration under Static Pressure: ASTM E331.
    c. Water Penetration under Dynamic Pressure: AAMA 501.1.

9. Structural, 150 percent: ASTM E330/E330M at 150 percent of positive and negative test loads.
10. Interstory Drift, 150 percent: AAMA 501.4 at 150 percent of design displacement.

C. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.

1. Compatibility: Test materials or components using ASTM C1087.
2. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.
3. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
6. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.12 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.13 WARRANTY

A. Full Assembly Warranty: Provide a full assembly warranty in which Manufacturer, Fabricator and Installer and jointly and severally responsible agree to repair or replace without limitations, all components of glazed aluminum curtain wall system assembly that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including, but not limited to, excessive deflection.
    b. Noise or vibration created by wind and thermal and structural movements.
    c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    d. Water penetration through fixed glazing and framing areas.
    e. Failure of operating components.

2. Warranty Period: [10] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of [baked enamel] [powder coat] [organic finishes] within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

1.14 LOCAL REGULATIONS AND CODES

A. Comply with applicable requirements of the local codes and regulations of authorities having jurisdiction.

1. Comply with the functionality and serviceability requirements listed in the local life safety and fire strategy report, as accepted and approved by local authorities having jurisdiction.
2. Obtain necessary approvals from authorities having jurisdiction.
3. Verify applicable performances whenever relevant equivalent counterparts to applicable standards are substituted, and submit a comprehensive comparative matrix of equivalency between specified standard and proposed counterpart for Engineer's approval.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed aluminum curtain walls.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.
    e. Failure of operating units.

3. Bitumen, bituminous products and flammable agents including but not limited to anti-corrosion or water-proofing coatings shall not be applied on primary substrates, either on metals or concrete because they propagate building envelope fires.
4. Curtain wall perimeter joints and fire stopping shall comply with local Fire and Life Safety code requirements.
5. Cavity fire barrier bands shall be provided in concealed cavities between façade and primary substrate, at every slab.
6. Fire Breaks shall be provided vertically on exterior façade.

C. Structural Loads:

1. Wind Loads: calculated in accordance with the structural Engineer's Documentation, and Reports.
2. Seismic loads: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 structural Engineer's Documentation, and Reports.
3. Periodic Maintenance-Equipment Loads: As indicated on Drawings.
4. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to4.1 m and to 1/240 of clear span plus6.35 mm for spans of greater than4.1 m.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than3.2 mm.

    a. Operable Units: Provide a minimum1.6-mm clearance between framing members and operable units.

3. Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.

E. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 300 Pa.

G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 300 Pa.
2. Maximum Water Leakage: In accordance with AAMA 501.1 No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.

H. Interstory Drift: Accommodate design displacement of adjacent stories indicated.

1. Design Displacement: As indicatedby Engineer and in compliance with structural drawings and report.
2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement and 1.5 times the design displacement.

I. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7 will be calculated based on structural Engineer's Documentation, Specification and Drawings.

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement and 1.5 times the design displacement.
2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.7 at design displacement and 1.5 times the design displacement.

J. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

   a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 1.65 W/sq. m x K as determined in accordance with NFRC 100.

2. Solar Heat Gain Coefficient (SHGC):

   a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.22 as determined in accordance with NFRC 200.

3. Air Leakage:

   a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.30 L/s per sq. m at a static-air-pressure differential of when tested in accordance with ASTM E283.

4. Condensation Resistance Factor (CRF):

   a. Fixed Glazing and Framing Areas: CRF for the system of not less than 29 as determined in accordance with AAMA 1503

K. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:

1. Outdoor-Indoor Transmission Class: Minimum 26, in compliance with the requirements indicated in the acoustic report and drawings.Sound Transmission Class: Minimum 31 , in compliance with the requirements indicated in the acoustic report and drawings.

L. Where indicated to resist forced attack and in compliance with the requirements indicated in the security report and drawings, glazed aluminum curtain wall assemblies shall comply with BS EN 1627 for security rating RCI, and shall meet the requirements of PAS24. When tested to LPS 1175, glazed aluminum curtain wall assemblies shall achieve a minimum SR2 grade, unless otherwise indicated in the security report and drawings.

M. Windborne-Debris Impact Resistance: Pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 and requirements of authorities having jurisdiction.

1. Large-Missile Test: For glazing located within 9.1 m of grade.
2. Small-Missile Test: For glazing located between9.1 m and 18.2 m above grade.

N. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 67 deg C, ambient; 100 deg C, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

    a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 82 deg C.
    b. Low Exterior Ambient-Air Temperature: minus 18 deg C.

O. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

P. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 SOURCE LIMITATIONS

A. Obtain all components of curtain-wall system and storefront system, including framing spandrel panels entrances sun control and accessories, from single manufacturer.

2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides.
3. Glazing Plane: Front.
4. Finish: High performance powder coating.
5. System: Unitized system.
6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
7. Steel Reinforcement: As required by manufacturer.

B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

1. Include snap-on aluminum trim that conceals fasteners.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Insulated Spandrel Panels:

1. Comply with Section 074213.19 "Insulated Metal Wall Panels."
2. Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.

a. Overall Panel Thickness: As indicated.
b. Exterior Skin: Aluminum.

1) Thickness: Manufacturer's standard for finish and texture indicated.
2) Finish: Match framing system.
3) Texture: Smooth.
4) Backing Sheet: 3.2-mm-thick, tempered hardboard.

c. Interior Skin: Manufacturer's standard galvanized-steel sheet.

1) Thickness: Manufacturer's standard for finish and texture indicated.
2) Finish: Matching curtain-wall framing.
3) Texture: Smooth.
4) Backing Sheet: 3.2-mm-thick, tempered hardboard.

d. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
e. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 or less.

2.4 SUN CONTROL

A. Sunshades: Assemblies consisting of manufacturer's standard outrigger brackets, louvers, and fascia, designed for attachment to curtain wall with mechanical fasteners.

1. Orientation: Horizontal or Vertical.
2. Projection from Wall: As indicated on Drawings.
3. Outriggers: Straight with square edges.
4. Louvers:

    a. Number: Three louvers per unit.
    b. Shape: Planar .
    c. Width: As indicated on Drawings .
    d. Mounting Angle: 25 degrees.

5. Fasciae: Rectangular.
6. Finish: Match adjacent glazed aluminum curtain wall.
7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
8. Steel Reinforcement: As required by manufacturer.

2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: ASTM C509 or ASTM C864. Manufacturer's standard.

1. Color: Black.

C. Glazing Sealants: As recommended by manufacturer.

1. Verify sealant has a VOC content of 250 g/L or less.
2. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes into contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.

1. Color: As selected by Engineer from manufacturer's full range of colors.

E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.

1. Color: Match structural sealant.

2.6 INSULATED SPANDREL PANELS

A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.

1. Overall Panel Thickness: As indicated on drawings.
2. Exterior Skin: Hot-dip galvanized steel sheet.

    a. Thickness: 2 mm.
    b. Finish: Matching framing coating system.
    c. Texture: Smooth.

3. Interior Skin: Hot-dip galvanized steel sheet.

    a. Thickness: 2 mm.
    b. Finish: Matching curtain-wall framing coating.
    c. Texture: Smooth.

4. Thermal Insulation Core: Manufacturer's standard, mineral wool-insulation board.
5. Surface-Burning Characteristics: For exposed interior surfaces of panels, when tested according to ASTM E84 as follows:

    a. Flame-Spread Index: 5 or less.
    b. Smoke-Developed Index: 50 or less.

2.7 SHADOW BOX

A. Insulated shadow box construction: 25 mm Internal glass unit (IGU) with minimum 50mm airspace behind glazing, 3 mm minimum thick powder coated aluminum sheet, 75 mm minimum thickness foil-faced semi rigid mineral wool insulation with 2 mm galvanized sheet back pan.

2.8 OPERABLE UNITS

A. Venting Windows: Comply with Division 08 Section "Aluminum Windows."

B. Doors: Comply with Division 08 Section "Sliding Automatic Entrances."

2.9 MATERIALS

A. Sheet and Plate: ASTM B209M.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221M.

C. Structural Profiles: ASTM B308/B308M.

D. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

E. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

G. Perimeter Fire-Containment Systems (Safing Insulation): Shall be as specified in Division 07 Section "Joint Firestopping Systems" and in section 072100 "Thermal Insulation."

H. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

I. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.10 Regional Materials: Manufacture products within (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within (160 km) of Project site. ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 25.4 mm that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for0.762-mm thickness per coat.

2.11 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
6. Provisions for safety railings mounted on interior face of mullions.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
8. Components curved to indicated radii.

D. Thermally Improved Construction: Fabricate aluminum curtain wall with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal and metal-to-concrete contact.

1. Provide thermal-break construction that has been in use for not less than five years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
3. Provide hardware with low conductivity or nonmetallic material for hardware bridging thermal breaks at frame or vent sash.
4. Provide thermal Isolator pads of 2mm thick to prevent metal-to-metal and metal-to-concrete contact of 2mm.

E. Fabricate components to resist water penetration as follows:

1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

F. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.

G. Factory-Assembled Frame Units:

1. Rigidly secure nonmovement joints.

2. Prepare surfaces that are in contact with structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
3. Seal joints watertight unless otherwise indicated.
4. Install glazing to comply with requirements in Section 088000 "Glazing."
5. Install structural glazing.

    a. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
    b. Set glazing with proper orientation so that coatings face exterior or interior as specified.
    c. Apply structural silicone sealant to completely fill cavity, in accordance with sealant manufacturers written instructions with the framing and glazing in a fully supported position.
    d. Brace or stiffen framing and glazing in such a manner to prevent undue stresses on the glass edge seal and structural joints or movement of the glazing, until sealant is fully cured in accordance with manufacturer's recommendations.
    e. After structural sealant has completely cured, insert backer rod between lites of glass as recommended by sealant manufacturer.
    f. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.
    g. Clean and protect glass as indicated in Section 088000 "Glazing."
    h. Retain bracing or stiffening until erected to prevent racking of units during transportation and erection.

H. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.12 ALUMINUM FINISHES

A. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 50 percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: As selected by Engineer from manufacturer's full range.

B. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: As selected by Engineer from manufacturer's full range.

C. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

2. Color and Gloss: As selected by Engineer from manufacturer's full range.

D. Superior Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: As selected by Engineer from manufacturer's full range.

E. Superior Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: As selected by Engineer from manufacturer's full range.

F. Powder Polyester Coating (PEF)

1. Powder Polyester Coating (PEF): Approved type to meet the requirements of AAMA 2603 consisting of powder particles of resinous material and additives to improve performance. Coating shall pass Qualicoat class 1 standard test and shall pass 1 year Florida test (45˚ south). The coating is to be electrostatically sprayed on the object to produce a hard, durable coating with a minimum dry film thickness of 0.06 mm, medium gloss.

    a. To AAMA 2603
    b. Qualicoat Class: 1
    c. Pencil Hardness, ASTM D-3363: H minimum
    d. Salt Spray Resistance, ASTM B117: 1500 hours
    e. Humidity Resistance, ASTM D2247: 1500 hours
    f. Dry Film Thickness, ASTM D1400: 1.0 mil +/- 0.2 mil
    g. Florida Test Exposure: 1 year
    h. Minimum Thickness: 60 microns
    i. Surface Finish: Matt.
    j. Color: As selected by Engineer from manufacturer's full range of colors.

G. Super Durable Polyester Powder Coating (PE-SDF)

1. Super Durable Polyester Powder Coating (PE-SDF): For aluminum alloy extrusions and components, to be of an approved type to meet the requirements of AAMA 2604 consisting of powder particles of Isophthalic acid based resinous material and additives to improve performance. Coating shall pass Qualicoat class 2 standard test and shall pass 5 years Florida test (45˚ South). Provide certificates to prove test results.
2. Applicator Qualifications: Coating manufacturer's approved and certified Applicator, who is equipped, trained and approved for application of coatings required for this Project, and is approved to provide warranty specified in this Section.
3. The coating is to be electrostatically sprayed on the object to produce a hard, durable coating:

    a. For steel components:

        1) Standard: To BS EN 13438.

2) GSB: Certificate: Class A.

b. Visual inspection after powder coating: Significant surface viewing distances to be as specified in the relevant Standard, unless specified otherwise.
c. Colour and gloss levels: To conform with approved samples.
d. Qualicoat Class: 2
e. Florida Test Exposure: 5 years
f. Minimum Thickness: 60 microns
g. Surface finish: Matt

4. Adhesion to EN ISO 2409 (2 mm): Cross-cut rating Gt0 (100 % adhesion)
5. Impact resistance to ASTM D2794 (impactor diameter 15.9 mm) need to pass 2.5 Nm without detachment after tape pull test.
6. Flexibility to EN ISO 1519: shall pass 12 mm cylindrical Mandrel bend test without cracking.
7. Film hardness EN ISO 2815 :Indentation resistance according to Buchholz: > 80
8. Mortar resistance EN 12206-1: The mortar must be easy to remove without leaving any residues.
9. Neutral salt spray resistance ASTM B117: No blistering or loss of gloss after 3000 hours
10. Natural weathering test to ISO 2810 (South Florida, 27 ºN): No chalking, excellent gloss retention and color stability after 36 months exposure (angle of 5 º to South).
11. Warranty: 20 years
12. Flame spread index ASTM E84: Class 1 or A
13. Smoke development ASTM E84: Class 1 or A

H. High-Performance Powder (PVF3): Manufacturer's standard 1-coat, thermocured system consisting of specially formulated fluoropolymer powder. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions. The Coating shall be Qualicoat class 3 and shall pass 10 years Florida test (45˚ South).

1. Qualicoat Class: 3
2. Florida Test Exposure: 10 years
3. Surface finish: Low to medium gloss level
4. Minimum dry film: 60 microns
5. Color: As selected by Engineer from manufacturer's full range.
6. Warranty: 30 years

2.13 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

B. Testing Agency: Engage Employer’s approved qualified testing agency to evaluate the glazed aluminum curtain wall manufacturer’s quality-control and testing methods.

C. Factory Tests: Test and inspect assembled glazed aluminum curtain wall systems, by a qualified testing agency.

D. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

E. Complete assembly will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

G. Seal joints watertight unless otherwise indicated.

H. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with non-flammable coating material.

I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF OPERABLE UNITS

A. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

3.4 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.5 INSTALLATION OF STRUCTURAL GLAZING

A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

B. Set glazing into framing in accordance with sealant manufacturer's and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.

C. Set glazing with proper orientation, so that coatings face exterior or interior as specified.

D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.

E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer's and framing manufacturer's written instructions and in compliance with local codes.

F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.

G. Allow structural sealant to cure in accordance with manufacturer's recommendations.

H. Clean and protect glass as indicated in Section 088000 "Glazing."

3.6 INSTALLATION OF WEATHERSEAL SEALANT

A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass, as recommended by sealant manufacturer.

B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.7 ERECTION TOLERANCES

A. Install glazed aluminum curtain walls to comply with the following maximum tolerances:

1. Plumb: 3.2 mm in 3 m;6.35 mm in 12.2 m.
2. Level: 3.2 mm in 6 m;6.35 mm in 12.2 m.

3. Alignment:

    a. Where surfaces abut in line or are separated by reveal or protruding element up to12.7 mm wide, limit offset from true alignment to1.6 mm.
    b. Where surfaces are separated by reveal or protruding element from12.7 to 25.4 mm wide, limit offset from true alignment to3.2 mm.
    c. Where surfaces are separated by reveal or protruding element of25.4 mm wide or more, limit offset from true alignment to6 mm.

4. Location: Limit variation from plane to3.2 mm in 3.6 m;12.7 mm over total length.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform tests and inspections.

B. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.

C. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Engineer shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.

    a. Perform a minimum of two tests in areas as directed by Engineer.
    b. Perform tests in each test area as directed by Engineer. Perform at least three tests, prior to 10, 35, and 70 percent completion.

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than0.45 L/s per sq. m at a static-air-pressure differential of75 Pa.

    a. Perform a minimum of two tests in areas as directed by Engineer.
    b. Perform tests in each test area as directed by Engineer. Perform at least three tests, prior to 10, 35, and 70 percent completion.

3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than300 Pa, and shall not evidence water penetration.

D. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

1. Test a minimum of two areas on each building facade.
2. Repair installation areas damaged by testing.

E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 084413

SECTION 107113 - EXTERIOR SUN CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fabrication and erection of Exterior Sun Control Devices, louvers and fins, as shown on drawings including shop drawings, schedules, notes, and details showing size and location of members, typical connections, and types of metal required.

B. Related Sections include the following:

1. Division 01 Section "Product Requirements" for requirements regarding submittals and substitutions of architectural products.
2. Division 01 Sections related to Sustainability Requirements as applicable.
3. Division 05 Section 055000 "Metal Fabrication"

1.3 SUBMITTALS

A. Samples: Submit one sample minimum 650 mm long of each material to be utilized at each Sunshade with specified finish.

B. Sustainable Design Submittals:

1. All related Product Data as detailed in Division 01 Sections related to sustainability requirements, as applicable.

C. Test Reports; two copies of applicable testing reports.

D. Engineering Calculations for approval by the engineer. These calculations to include: Dead Loads, Live Load, Wind Loads, Temperature range and Seismic Zone

E. Shop drawings prepared under supervision of a licensed Structural Engineer, including:

1. Complete details and schedules for fabrication and assembly of structural members, procedures, and diagrams.
2. Anchorage, details and connections for all the component parts.
3. Calculations related to wind load and seismic action.

F. Specifications; three of each manufacturer's published specifications to evidence compliance with these specifications.

G. No fabrication work is to commence prior to approval by the Engineer of submittals.

H. Paint: Submit manufacturer's protective coating system proposed to ensure life expectancy of not less than twenty years without maintenance, taking into consideration climatic conditions.

I. Warranty: provide written warrantee for stability and serviceability of completed Exterior Sun Control Devices me for a minimum period of five years. All products shall be free of defective materials or workmanship for a period of one year from date of installation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency acceptable to authorities having jurisdcition or by manufacturer and witnessed by a qualified testing agency, for each type of exterior sun control devices, louver and fins, and showing compliance with performance requirements specified.

B. Windborne-debris-impact-resistance test reports.

C. Sample Warranties: For full system warranties.

1.5 QUALITY ASSURANCE

A. Product shall demonstrate compliance with sustainability targets and requirements specified in Division 01 Sections related to sustainability requirements, as applicable.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E329 or ASTM E699 for testing indicated, and in accordance with ISO/IEC 17020, ISO/IEC 17011 and ISO/IEC 17025 requirements acceptable to Engineer and authorities having jurisdiction, and that has the experience and capability to satisfactorily conduct the testing indicated. Testing agency shall have a valid ISO/IEC 17025 certification.

C. Quality System: Provide the products of a manufacturer who holds valid ISO 9001 certification.

D. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2, "Structural Welding Code--Aluminum."
2. AWS D1.6, "Structural Welding Code--Stainless Steel."
3. Certify that each welder has satisfactorily passed AWS qualification tests or equivalent certification acceptable to authorities having jurisdiction for welding processes involved and, if pertinent, has undergone re-certification.

E. Quality Control: Submit for approval a method statement of the system of quality control to be used in fabrication and erection, complying with ASTM and AWS including proposed welding procedure. An approved quality control engineer is to be assigned for the complete duration of the work to ensure proper performance.

F. Manufacturer's Qualifications

1. The manufacturer shall have not less than ten (10) years experience in manufacturing Exterior Sun Control Devices structures for projects of equivalent size and complexity as required by these contract Exterior Sun Control Devices ocuments.
2. The Exterior Sun Control Devices shall be designed, engineered and fabricated by a single entity.
3. The manufacturer must certify in writing that materials have been tested in accordance with a certified quality assurance program and that the manufacturer has supervised all elements of fabrication necessary for the manufacture of the Exterior Sun Control Devices and that all materials have proven to be satisfactory for the use intended by these contract documents.

G. Installer's Qualifications

1. The installer shall submit evidence of skill and not less than five (5) years specialized experience with this product.
2. The installer shall be trained by the manufacturer.

H. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup for type(s) of louvers indicated, in location(s) shown on Drawings.
2. Build mockup in building envelope wall in locations as determined by Engineer.
3. Modify mockup construction and perform additional tests as required to achieve specified minimum acceptable results.
4. Approved mockups may become part of the completed Work.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For Exterior sun control devices, louvers and fins to include in operation and maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. All members and connectors must be wrapped or packed, delivered and stored in unopened factory containers to avoid damage to the finish.

C. Store materials to permit easy access for inspection and identification. Keep members off ground by using pallets, platforms, or other supports. Protect members and packaged materials from erosion and deterioration. If bolts and nuts become dry or rusty, clean and relubricate before use.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 WARRANTY

A. Full System Warranty: Provide full system warranty in which Manufacturer, Contractor and Installer are jointly and severally responsible and agree to repair or replace without limitations, all or any part of the Exterior Sun Control Devices,Louvers and fins specified in this section which fails or becomes defective in materials or workmanship within specified warranty period.

1. All Exterior Sun Control Devices,Louvers and fins are guaranteed to be of good material and workmanship and free from defects that render it unserviceable for the use for which it is intended.
2. Warranty shall also include:

    a. Installation and finishing that may be required due to repair or replacement of defective metal framing.
    b. Metal, sealants, insulation, fasteners, and all other components of metal framing specified in this section.

3. Failure includes, but is not limited to:

    a. Deterioration in metal framing materials and coatings; other than due to normal ageing and weathering; and any defects in sealants, fixings, coverings and other components of the work.
    b. Failure of operating components.

4. Warranty Period: five (5) years Total Warranty from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

1.10 LOCAL REGULATIONS AND CODES

A. Comply with applicable requirements of the local codes and regulations of authorities having jurisdiction.

1. Comply with the functionality and serviceability requirements listed in the local life safety and fire strategy report, as accepted and approved by local authorities having jurisdiction.
2. Obtain necessary approvals from authorities having jurisdiction.
3. Verify applicable performances whenever relevant equivalent counterparts to applicable standards are substituted, and submit a comprehensive comparative matrix of equivalency between specified standard and proposed counterpart for Engineer’s approval.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE REQUIREMENTS

A. System: The system is composed of aluminium sections and fittings.

B. Structural performance: Design, engineer, fabricate, and install the prefabricated Exterior Sun Control Devices, louvers and fins in accordance with the drawings and specifications requirements, to withstand the following loads as a minimum:

1. Live load: as determined by structural engineer.
2. Dead load: to be determined by manufacturer and is to include weight of the complete system assembly.
3. Basic wind speed: calculated in accordance with the structural Engineer's Documentation, Specification and Drawings for Wind report.
4. Horizontal and uplift wind loads / coefficients: Refer to structural Engineer's Documentation, Specification and Drawings.
5. Seismic Forces: calculated in accordance with the structural Engineer's Documentation, and Reports.
6. Temperature variation: plus or minus 25 deg. C from a median temperature of 27 deg. C.

C. Unacceptable conditions: Excessive deflection, noise or vibration created by any of the afore mentioned loads or a combination thereof.

2.2 FABRICATION

A. Provide all structural members, member connectors, fasteners and accessories required for a complete installation of the Exterior Sun Control Devices, louvers and fins as indicated in approved shop drawings. Design, engineering and fabrication of Exterior Sun Control Devices, louvers and fins, is to be by one source. Outsourcing, subcontracting or joint ventures to achieve a single source are not acceptable

B. Code each part for easy identification. Cross reference coding to shop and erection drawings and to shipping lists.

2.3 COMPONENTS AND MATERIALS

A. Aluminum Extrusions: ASTM B211, Alloy 6063-T5.

B. Fasteners: Fasteners shall be stainless steel. Provide types, gauges and lengths to suit unit installation conditions.

C. Anchors and Inserts: Use stainless steel anchors and inserts for installation and elsewhere as required for corrosion resistance. Use stainless steel expansion bolt devices for drill-in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

D. Bolts: all bolts shall be of Standard Dimensions as designated by the design loads given in the structural analysis. Bolts shall meet the requirements of either ASTM A-307 or A-449 as required by design and structural analysis.

1. Use of A-325 or A-490 bolts shall conform to the requirements of AISC specifications latest edition.

2.4 FABRICATION, GENERAL

A. Provide fixed Sunshades and accessories of design, material, sizes, depth, arrangement, and thickness as indicated or as required for optimal performance with respect to strength; durability; and uniform appearance.

B. Include supports, anchorage, and accessories required for complete assembly

2.5 SUNSHADE CONSTRUCTION

A. Components: All blades components shall be 6063-T5 aluminum alloy.

B. Supports: All Supports shall be stainless steel type 316. Thicknesses to be as required by calculation and approved shop drawings.

C. All bolts shall be stainless steel S304

2.6 ALUMINUM FINISH

A. General: Comply with NAAMM AMP 500-06 "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products assembly. Protect finishes on exposed surfaces prior to shipment. Remove scratches and blemishes from exposed surfaces which will be visible after completing finishing process.

B. Powder Polyester Coating (PEF)

1. Powder Polyester Coating (PEF): Approved type to meet the requirements of AAMA 2603 consisting of powder particles of resinous material and additives to improve performance. Coating shall pass Qualicoat class 1 standard test and shall pass 1 year Florida test (45degree south). The coating is to be electrostatically sprayed on the object to produce a hard, durable coating with a minimum dry film thickness of 0.06 mm, medium gloss.

a. To AAMA 2603
b. Qualicoat Class: 1
c. Pencil Hardness, ASTM D-3363: H minimum
d. Salt Spray Resistance, ASTM B117: 1500 hours
e. Humidity Resistance, ASTM D2247: 1500 hours
f. Dry Film Thickness, ASTM D1400: 1.0 mil plus or minus 0.2 mil
g. Florida Test Exposure: 1 year
h. Minimum Thickness: 60 microns
i. Surface Finish: Matt.

j. Color: As selected by Engineer from manufacturer's full range of colors.

C. SUPER DURABLE POLYESTER POWDER COATING (PE-SDF)

1. Super Durable Polyester Powder Coating (PE-SDF): For aluminum alloy extrusions and components, to be of an approved type to meet the requirements of AAMA 2604 consisting of powder particles of Isophthalic acid based resinous material and additives to improve performance. Coating shall pass Qualicoat class 2 standard test and shall pass 5 years Florida test (45degree South). Provide certificates to prove test results.
2. Applicator Qualifications: Coating manufacturer's approved and certified Applicator who is equipped, trained and approved for application of coatings required for this Project, and is approved to provide warranty specified in this Section.
3. The coating is to be electrostatically sprayed on the object to produce a hard, durable coating:

   a. For steel components:

      1) Standard: To BS EN 13438.
      2) GSB: Certificate: Class A.

   b. Visual inspection after powder coating: Significant surface viewing distances to be as specified in the relevant Standard, unless specified otherwise.
   c. Colour and gloss levels: To conform with approved samples.
   d. Qualicoat Class: 2
   e. Florida Test Exposure: 5 years
   f. Minimum Thickness: 60 microns
   g. Surface finish: Matt

4. Adhesion to EN ISO 2409 (2 mm): Cross-cut rating Gt0 (100 percent adhesion)
5. Impact resistance to ASTM D2794 (impactor diameter 15.9 mm) need to pass 2.5 Nm without detachment after tape pull test.
6. Flexibility to EN ISO 1519: shall pass 12 mm cylindrical Mandrel bend test without cracking.
7. Film hardness EN ISO 2815 :Indentation resistance according to Buchholz: > 80
8. Mortar resistance EN 12206-1: The mortar must be easy to remove without leaving any residues.
9. Neutral salt spray resistance ASTM B117: No blistering or loss of gloss after 3000 hours
10. Natural weathering test to ISO 2810 (South Florida, 27 degreeN): No chalking, excellent gloss retention and colour stability after 36 months exposure (angle of 5 degree to South).
11. Warranty: 20 years
12. Flame spread index ASTM E 84: Class 1 or A
13. Smoke development ASTM E 84: Class 1 or A

D. High-Performance Powder (PVF3): Manufacturer's standard 1-coat, thermocured system consisting of specially formulated fluoropolymer powder. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions. The Coating shall be Qualicoat class 3 and shall pass 10 years Florida test (45degree South).

1. Qualicoat Class: 3

2. Florida Test Exposure: 10 years
3. Surface finish: Low to medium gloss level
4. Minimum dry film: 60 microns
5. Color: As selected by Engineer from manufacturer's full range.
6. Warranty: 30 years

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage Employer's approved qualified testing agency to evaluate the Exterior Sun Control Devices manufacturer's quality-control and testing methods.

B. Testing: Test and inspect exterior sun control devices according to authorities having jurisdiction.

C. Factory Tests: Test and inspect assembled Exterior Sun Control Devices, by a qualified testing agency.

D. Engage Employer's approved qualified testing and inspecting agency to perform factory quality control testing and inspection including but not limited to, pre-fabrication meeting, in-process assembly, and final inspections.

E. Complete assembly will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The erector shall examine the Exterior Sun Control Devices supports, work area and conditions under which the work is to be installed prior to assembly and erection. If the supports, area or condition are unsatisfactory, erection shall not proceed until satisfactory corrections have been made.

3.2 INSTALLATION

A. Installation shall be accomplished by a fully trained installer authorized by and approved by the Engineer.

B. Connectors and members shall be assembled into their final configuration either from scaffolding staged at the final location or assembled in a temporary location and hoisted into the final position.

C. All framing work shall be true to line, level and plumb, with uniform joints.

D. Adequate care shall be taken during the installation sequences to insure members are not positioned by force or erected in such a manner that cause secondary stresses.

E. Tightening of bolts shall be accomplished correctly in order that all members rest flush on the flat surfaces of the connector.

F. Adequate temporary bracing and supports shall be provided to insure the Exterior Sun Control Devices stability during installation.

G. Completed Exterior Sun Control Devices shall comply with approved installation tolerances and shop drawing requirements.

H. Comply with manufacturer's instructions and recommendations for installation of the work..

I. Verify dimensions of supporting structure at the site by accurate field measurements so that the work will be accurately designed, fabricated and fitted to the structure.

J. Anchor Sunscreen to building substructure as indicated on architectural drawings.

K. Installation Tolerances:

1. Variation from level: +/- 3 mm maximum in any column to column space or 6.5 Mtr runs, non-cumulative.
2. Offsets in end-to-end or edge-to-edge alignment of consecutive members 1.5 mm

L. Corners: Miter sun control fascia assembly at outside corner as shown on drawings.

M. Cut and trim component parts during erection only with the approval of the Engineer and in accordance with the manufacturer’s printed instructions. Restore finish completely. Remove and replace members where cutting and trimming has impaired the strength or appearance of the assembly as directed.

N. Do not erect warped, bowed, deformed or otherwise damaged or defaced members. Remove and replace any members damaged in the erection process as directed.

3.3 CLEAN-UP

A. Upon completion of this section of work, remove all protective wraps, leave all work and work areas clean and in satisfactory condition. Clean and/or repair any litter or damage due to Exterior Sun Control Devices erection.

B. Touch-Up Paints: Immediately after assembly, apply air dry touch-up paint to members whose finish was damaged during material handling and/or erection of the Exterior Sun Control Devices.

3.4 PROTECTION

A. During erection and until inspection, it shall be the responsibility of the Exterior Sun Control Devices installer to protect the Exterior Sun Control Devices from damage.

B. The installer shall remove all bent or distorted members and replace with new, undamaged members.

C. Upon completion and inspection it shall be the responsibility of the general contractor to protect the Exterior Sun Control Devices from damage during the remainder of construction on the project and until Employer acceptance.

3.5 INSPECTION

A. The completed Exterior Sun Control Devices structure shall undergo a full and complete final inspection to certify that it was erected in accordance with approved erection drawings and these contract documents.

END OF SECTION 107113

ITEM 407 PILING

407.1 DESCRIPTION

This work shall consist of performing all operations in connection with furnishing, driving, cutting off and load testing of piles to obtain the specified bearing value complete in place and strictly in accordance with these Specifications and as shown on the Drawings.

The Contractor shall furnish the precast piles in accordance with an itemized list, which will be provided by the Engineer, showing the number and lengths of all piles. When cast-in-place concrete piles are specified on the Drawings, the Engineer will not furnish the Contractor, an itemized list showing the number and length of piles. When test piles and load tests are required in conformance with sub-items 407.3.8 and 407.3.9 respectively, the data obtained from such test loads will be used in conjunction with other available subsoil information to determine the number and lengths of piles to be furnished. The Engineer will not prepare the itemized list of piles for any portion of the foundation area until all loading tests representative of that portion have been completed.

The contractor shall provide an outline of his proposed method for constructing large diameter pile when submitting his tender; the proposed method of boring being stated.

Not less than two weeks before the contractor proposes to commence piling, detailed proposal for the piling shall be delivered to the Engineer. These proposals shall include full details of materials, equipment and method to be used in the construction of piles.

If it is proposed to use bentonite slurry, this shall also be described.

Work on piling shall not commence until the contractor's proposals have been approved by the Engineer and communicated to the contractor.

The requirements herein are minimum. Strict compliance with these requirements will not relieve the Contractor of the responsibility for adopting whatever additional provisions may be necessary to ensure the successful completion of the work.

The kind and type of piles shall be as shown on the Drawings and/or as specified. No alternate types or kinds of piling shall be used, except with the written approval of the Engineer each time.

407.2 MATERIAL REQUIREMENTS

407.2.1 Types of Piles

a. Untreated Timber Piles

Untreated timber piles shall conform to the requirements of AASHTO M 168.

b. Treated Timber Piles

Treated timber piles shall conform to the requirements of AASHTO M 133 and M 168. Unless otherwise called for on the drawings, the timber piles shall be treated with creosote according to the Standard AWPA PI of the American Wood-Preservers Association.

c. Reinforced Concrete Cylindrical Piles

Diameter of reinforced concrete piles shall be as shown on the Drawings and may or may not have permanent lining, as shown on the drawing.

Reinforcing Steel shall conform to the requirements under Item 404 - Steel Reinforcement.

Concrete shall meet all the requirements for specified Class as provided under Item 401 and shall be of Class-D unless otherwise specified.

d. Structural Steel Piles

Structural steel piles shall be rolled steel sections of the type, weight and shape called for on the Drawings. The piles shall be structural steel conforming to the requirements of ASTM A 7 and ASTM A 36, except that steel produced by the Acid-Bessemer process shall not be used.

The steel piles shall be coated with red lead paint conforming to AASHTO M 72 as instructed by the Engineer, unless otherwise specified.

e. Precast Concrete Piles

Concrete for piles shall meet all the requirements for the specified class as provided under Item 401 - Concrete. The concrete shall be of Class-D1 unless otherwise specified.

Reinforcing Steel shall conform to the requirements under Item 404 - Steel Reinforcement.

Prestressed concrete piles shall conform to Item 405 - Prestressed Concrete Structures.

Precast piles shall be made in accordance with the Drawings, and reinforcement shall be placed accurately and secured rigidly in such manner as to ensure its proper location in the completed pile. The concrete cover as measured to the outside face of ties or spirals shall not be less than five (5) cm.

The piles shall be cast separately or, if alternate piles are cast in a tier, the intermediate piles shall not be cast until four (4) days after the adjacent piles have been poured. Piles cast in tiers shall be separated by tar paper or other suitable separating materials. The concrete in each pile shall be placed continuously. The completed piles shall be free from stone pockets, porous spots, or other defects, and shall be straight and true to the form specified. The forms shall be true to line and built of metal, plywood, or dressed lumber. A two and half (2.5) cm chamfer strip shall be formed on all edges. Forms shall be watertight and shall not be removed within twenty four (24) hours after the concrete is placed. Piles shall be given a surface finish according to Item 401.3.7 - Concrete Surface Finishing.

Piles shall be cured in accordance with the requirements of Item 401.3.8 (e) - Curing Precast Concrete Piles.

Piles shall not be moved until the tests indicate a compressive strength of eighty (80) percent of the design twenty eight (28) days compressive strength and they shall not be transported or driven until the tests indicate a compressive strength equal to the design twenty eight (28) days compressive strength.

When concrete piles are lifted or moved, they shall be supported at the points shown on the Drawings or, if not so shown, as instructed by the Engineer.

407.2.2 Pile Shoes

Pile shoes when required shall be of the design as called for on the Drawings or by the Engineer.

407.2.3 Pile Splices

Materials for pile splices, when splicing is allowed, shall be of the same quality and characteristics as the materials used for the pile itself and shall follow the requirements given on the Drawings unless otherwise directed by the Engineer.

407.3 CONSTRUCTION REQUIREMENTS

407.3.1 Driven Piles

a. Location and Site Preparation

Piles shall be used where indicated on the Drawings or as directed by the Engineer.

All excavations for the foundation in which the piles are to be driven shall be completed before the driving is begun, unless otherwise specified or approved by the Engineer. After driving is completed, all loose and displaced materials shall be removed from around the piles by hand excavation, leaving clean solid surfaces to receive the concrete for foundations.

b. Determination of Pile Length

The criteria for pile length and bearing capacity will be determined by the Engineer according to the results from test piles and load tests. The piles shall be driven to such depths, that the bearing loads indicated on the Drawings are obtained.

The criterion for pile length may be one of the following:

1) Piles in sand and gravel shall be driven to a bearing value determined by use for the pile driving formula or as decided by the Engineer.

2) Piles in clay shall be driven to the depth ordered by the Engineer. However, the bearing value shall be controlled by the appropriate pile driving formula if called for by the Engineer.

3) Piles shall be driven to refusal on rock or hard layer when so ordered by the Engineer.

The contractor shall be responsible for correct pile lengths and bearing capacities according to the criteria given by the Engineer.

c. Pile Driving

All piles shall be driven accurately to the vertical or the batter as shown on the drawings. Each pile shall, after driving, be within fifteen (15) cm from the theoretical location underneath the pile cap or underneath the superstructure in the case of pile bents. All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again.

Piles shall be used only in places where a minimum penetration of three (3) meters in firm materials, or five (5) meters in soft materials, can be obtained. Where a soft stratum overlies a hard stratum, the piles shall penetrate to hard material upto a sufficient distance to fix the ends rigidly.

All pile driving equipment is subject to the Engineer's approval. The Contractor is responsible for sufficient weight and efficiency of the hammers to drive the piles down to the required depth and bearing capacity. Hammers shall be gravity hammers, single acting steam or pneumatic hammers or diesel hammers. Gravity hammers shall not weigh less than sixty (60) percent of the combined weight of the pile and driving head and not less than 2,000 Kg. The fall shall be adjusted so as to avoid injury to the pile and shall in no case exceed one (1) m for timber and steel piles and one half (0.5) M for concrete piles unless otherwise specified or approved by the Engineer. The plant and equipment furnished for steam

hammers shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The boiler or pressure tank shall be equipped with an accurate pressure gauge and another gauge shall be supplied at the hammer intake to determine the drop in pressure between the gauge and the hammer. When diesel hammers are used, they shall be calibrated with test piling and/or test loads in accordance with Item 407.3.9.

Water jets shall be used only when permitted in writing by the Engineer. When water jets are used, the number of jets and the nozzle volume and pressure shall be sufficient to erode the material adjacent to the pile freely. The jets shall be shut off at a depth not less than three (3) M before final tip elevation is reached, and the piles driven solely by hammer to final penetration as required by the Engineer.

Piles shall be supported in line and position with leads while being driven. Pile driving leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and shall be held in position by guys or steel braces to ensure rigid lateral support to the pile during driving. The leads shall be of sufficient length to make the use of a follower unnecessary, and shall be so designed as to permit proper placing of batter piles. The driving of piles with followers shall be avoided if practicable and shall be done only under written permission from the Engineer.

The method used in driving piles shall not subject them to excessive and undue abuse producing crushing and spalling of the concrete, injurious splitting and brooming of the wood, or deformation of the steel. Manipulation of piles to force them into proper position, if considered by the Engineer to be excessive, will not be permitted.

The pile tops shall be protected by driving heads, caps or cushions in accordance with the recommendations from the manufacturer of the pile hammer and to the satisfaction of the Engineer. The driving head shall be provided to maintain the axis of the pile in line with the axis of the hammer and provide a driving surface normal to the pile.

Full-length piles shall be used where practicable. Splicing of piles when permitted shall be in accordance with the provisions of Item 407.3.5. All piles shall be continuously driven unless otherwise allowed by the Engineer.

d. Pile Driving Formulae

Pile driving formulas may be used to determine the number of blows of hammer per unit of pile penetration needed to obtain the specified bearing capacity for piles driven in the sub-soils at the site. Piles shall be driven to a final resistance as indicated on the plans determined by the following formula:

For drop hammer

Q_{all} = WH/[6(S+2.5)]

For single-acting steam or air hammers and for diesel Hammers having unrestricted rebound of rams.

Q_{all} = WH/[6(S+0.25)] (Use when driven weights are smaller than striking weights)

Q_{all} = WH/[6{S+0.25(WD/WS)}] (Use when driven weights are larger than striking weights)

For double-acting steam or air hammers and diesel hammers having enclosed rams

Q_{all} = E/[6(S+0.25)] (Use when driven weights are smaller than striking weights).

Q_{all} = E/[6{S+0.25(WD/WS)}] (Use when driven weights are larger than striking weights)

In the above formulas:

Q_{all} = Allowable pile load in Kilograms.

W = Weight of striking parts of hammer in Kilograms.

H = The height of fall in centimeters for steam, and air hammers, and the observed average height of fall in centimeters, of blows used to determine penetration for diesel hammers with unrestricted rebound of hammer.

S = Average net penetration per blow in centimeters for the last 10 to 20 blows of steam, air, or diesel hammer; or for the last 15 centimeters of driving for a drop hammer.

E = The actual energy delivered by hammer per blow in Kilogram - centimeter.

WD = Driven weights in Kilograms

Note: Ratio of driven weights to striking weights should not exceed three.

WS = Weight of striking parts in Kilograms.

Modifications of basic pile driving formula:

a) For piles driven to and seated in rock as high capacity end-bearing piles: Drive to refusal (approximately four (4) to five (5) blows for the last 0.625 centimeters of driving). Re-drive open end pipe piles repeatedly until resistance for refusal is reached within two and half (2.5) centimeters of additional penetration.

b) For piles driven through stiff compressible materials unsuitable for pile bearing to an underlying bearing stratum:

Add blows attained before reaching bearing stratum to required blows attained in bearing stratum.

c) For piles into limited thin bearing stratum:

Drive to predetermined tip elevation, and determine allowable load by load test.

The bearing power as determined by the appropriate formula in the foregoing list will be considered effective only when it is less than the crushing strength of the pile. Other recognized formula for determining pile bearing power may be used when given in special specification. However, it shall be understood that the relative merits and reliability of any of the pile formula can be judged only on the basis of comparisons with the results of load tests.

407.3.2 **Cast-in-Place Piles**

Piles, cast-in-place, shall consist of one of the types either shown on the drawing and/or as specified. The term shaft wherever used in this section, shall mean either piles or shafts.

a. Working Drawings

At least 4 weeks before work on shafts is to begin, the Contractor shall submit to the Engineer for review and approval, an installation plan for the construction of drilled shafts. The submittal shall include the following:

i. List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, sampling equipment, tremies or concrete pumps, casing etc.
ii. Details of overall construction operation sequence and the sequence of shaft construction in bents or groups.
iii. Details of shaft excavation methods.
iv. When slurry is required, details of the method proposed to mix, circulate and desand slurry.
v. Details of methods to clean the shaft excavation.
vi. Details of reinforcement placement including support and centralization methods.
vii. Details of concrete placement, curing and protection.
viii. Details of any required load tests.
ix. Other information shown on the plans or requested by the Engineer.

The Contractor shall not start the construction of drilled shafts for which working drawings are required until such drawings have been approved by the Engineer. Such approval will not relieve the Contractor of responsibility for results obtained by use of these drawings or any of his other responsibilities under the contract.

b. Fabrication of Permanent Lining

If shown on the drawings, the contractor shall provide a permanent lining suitably formed of ten (10) mm minimum thickness mild steel plate complying with B.S. 4360. The plates shall be cut and rolled to the inner diameter not less than the nominal diameter of the pile or such larger diameter as to allow the requisite pile diameter hole in the unlined length of pile. The rolled plates shall be connected by full penetration butt welds generally complying with B.S. 5133. No more than three (3) longitudinal seam welds shall be employed in any one cross-section and such welds shall be staggered in position in the cross-section between one length and the next. The dimensional accuracy of the lining shall be as stated on the drawings.

In the case of steel shells or pipes, after being driven and prior to placing reinforcing steel and concrete therein, the steel shells or pipes shall be examined for collapse or reduced diameter at any point. Any shell or pipe, which is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value will be rejected. Rejected shells or pipes shall be removed and replaced, or a new shell or pipe shall be driven adjacent to the rejected one. Rejected shells or pipes, which can not be removed, shall be filled with lean concrete by the Contractor at his expense.

c. Piles Cast in Drill-Borehole

i) Boring Procedure

The method and equipment of boring generally either the dry method, wet method, temporary casing method or permanent casing method shall be one which maintains stability, verticality or batter (as shown on the Drawing) of the wall and base of borehole by the use of temporary casing and/or bentonite slurry.

All holes shall be drilled to the tip elevation shown on the Drawings, unless otherwise specified or approved by the Engineer. Rejected boreholes shall be filled with lean concrete by contractor at his expense.

The method shall be such that allows soil samples to be taken and in site soil test, (if required) to be carried out during or ahead of boring operations. The method/procedure used in execution of borehole and other operations shall not be such as to cause vibrations resulting in damage to completed or partially completed piles or to adjacent structures, services or other property. The procedure shall not be such as to cause harmful loosening or softening of soil outside the pile that

has to be filled with concrete. The equipment used for execution of borehole shall be adequate to ensure that each pile penetrates to the required founding level.

- **Use of Casing**

  Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is poured. Casing, if used in drilling operations shall be removed from the hole as concrete is poured unless otherwise specified. The bottom of the casing shall be maintained not less than fifty (50) cm below the top of the concrete during withdrawal and pouring operations unless otherwise permitted by the Engineer. Separation of the concrete during withdrawal operations shall be avoided.

- **Reinforcement**

  Reinforcement if called for shall conform to the requirements under item 404. The steel shells/pipes shall be of sufficient strength and rigidity to permit driving to the required bearing value or depth without injury. The steel may be either cylindrical or tapered, step tapered or a combination, plain, circular or fluted. All types shall conform to the corresponding ASTM standards. The minimum average tensile strength of steel shall be 3500 Kg/sq.cm (50,000 psi).

When called for on the Drawings or by the Engineer, the steel shells/pipes shall be factory coated on both interior or exterior surfaces by red lead paint conforming to AASHTO M-72 or as stated in the special specifications. The coating shall not cause any hindrance while assembling the pile section during welding operations.

ii) Temporary Casing Method

The temporary casing of appropriate diameter for locating the pile and piloting the borehole shall be pitched at the exact locations as given on the drawings to ensure that the casing when sunk is within the specified tolerances. The casing shall be sunk to sufficient depth by approved

methods. The depth shall be at least sufficient to prevent the ingress of alluvium or other loose materials into the bore when executed below the bottom level of the casing. In addition, the depth shall be such as the contractor considers necessary for the stability of the casing and/or temporary works system during construction in general and for the following conditions and operations in particular during all conditions of river current which may occur during the period of works:

a: Open temporary casing to ensure against blow-in of soil.

b: Concreting of the pile, until temporary casing is extracted.

- **Safety of Casing**

  The contractor shall take all such measures and provide such strengthening and bracing as is necessary and to the approval of the engineer to ensure that the temporary casing is not disturbed, overturned, over-stressed or under-eroded in any condition of temporary casing shall be such that it will not disturb the freshly cast concrete and/or permanent lining and/or reinforcement.

  Where the use of temporary casing is approved for the purpose of maintaining the stability and over-rapid withdrawal of the boring tools which could lead to excessive removal of soil and water and disturbance of the surrounding ground and when boring through any permeable stratum (including silt), the water level in the boring shall be maintained between one (1) meter and two (2) meters above the external water level, unless the engineer directs otherwise.

  The temporary casings shall be free from significant distortion and of uniform cross sections throughout each continuous length. During concreting they shall be free from encrusted concrete or any internal projections which might prevent the proper formation of the piles.

Permanent Casing Method

The permanent casing construction method shall be used when required by the plans. This method consists of driving or drilling a casing to a prescribed depth before excavation begins. If full penetration cannot be attained, the Engineer may require either excavation of material within the embedded portion of the casing or excavation of a pilot hole ahead of the casing until the casing reaches the desired penetration. In some cases, over-reaming to the outside diameter of the casing may be required in order to advance the casing.

The casing shall be continuous between the elevations shown on the plans. Unless shown on the plans, the use of temporary casing in lieu of or in addition to the permanent casing shall not be used except when authorized by the Engineer in writing.

After the installation of the casing and the excavation of the shaft is complete, the casing shall be cutoff at the prescribed elevation and the reinforcing steel and shaft concrete placed within the portion of the casing left in place.

iii) Bentonite Slurry

Where the use of bentonite slurry is approved for the purpose of maintaining the stability of the walls and base of bore, the contractor's proposals in accordance with (sub clause vi) hereof shall include details of the slurry. These shall include inter-alia:

a. The source of the bentonite
b. The constitution of the slurry.
c. Specific gravity, viscosity, sheer strength and PH value of slurry.

d. The methods of mixing, storing, placing, removal and recirculating the slurry, and
e. The provision of stand-by equipment.

Tests shall be carried out to ensure that the proposed constitution of the slurry is compatible with the ground water. Proposals for the constitution and physical properties of the slurry shall include average, minimum and maximum values. The specific gravity of the slurry shall not be less than one and three hundredth (1.03) in any case at any time. The contractor shall use additives where necessary to ensure the satisfactory functioning of the slurry.

Manufacturers Certificate

A manufacturer's certificate showing the properties of the bentonite powder shall be delivered to the Engineer for each consignment delivered to site. Independent tests shall be carried out at laboratory approved by the Engineer on samples of bentonite frequently.

Tests on Bentonite Slurry

The Contractor shall carry out tests during the course of the piling to check the physical properties of the bentonite slurry in the works. These tests shall include, inter-alia, density, viscosity, shear strength and PH tests. The test apparatus and test methods shall be those given in "Recommended Practice" Standard by American Petroleum Institute, New York City, 1957, reference API RP29, Section- I, II and VI.

The frequency of tests shall be that which the Contractor considers necessary to ensure that the bentonite slurry is in accordance with his proposals and as such other times as the Engineer may direct.

Should the physical properties of any bentonite slurry deviate outside the agreed limits, such slurry shall be replaced, irrespective of the number of time it has been used by new bentonite slurry of correct physical properties.

Adequate time shall be allowed for proper hydration to take place, consistent with the method of mixing, before using slurry in the works.

Precautions

The Contractor shall control the bentonite slurry so that it does not cause a nuisance either on the site or adjacent waterways or other areas. After use it shall be disposed in a manner to the approval of the Engineer.

The level of the slurry in the bentonite shall be maintained so that the internal fluid pressure always exceeds the external water pressure.

If chiseling is used when boring through hard strata or to overcome obstructions, the stability of the excavation shall be maintained by methods acceptable to the Engineer.

iv) Excavation From Boreholes

The soil and debris from inside the pile boreholes shall be removed by bucket, augur or circulating bentonite slurry provided that no jetting at the

foot of the borehole shall be permitted. Methods of excavation, which in the opinion of the Engineer may damage the permanent lining of the pile, shall not be employed.

Should the excavation reveal any soil stratum below the bottom of a pile which is, in the opinion of the Engineer, unsuitable for supporting the loads that will be imposed on it, the Contractor shall remove all such sub soil stratum to the satisfaction of the Engineer and shall lengthen the pile if necessary and cost of any such lengthening shall be paid as per this contract.

Excavation shall be carried out as rapidly as possible in order to reduce to a minimum the time in which any strata are exposed to the atmosphere, bentonite slurry or water. In any case, a pile shall not remain unfilled with concrete for period exceeding eighteen (18) hours after completion of borehole.

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The materials from pile excavation shall be disposed so that the same does not interfere with any part of the permanent works of this project, in neat and workmanlike manner.

v) Samples and Tests

The Contractor shall take soil samples as given below or as directed by the Engineer to the designed tip elevation of the pile and shall carry out insitu Standard Penetration tests within, and ahead of borehole on the line of vertical axis of the pile at these locations after one and half (1.5) meter interval. The costs of tests and collection of samples shall be deemed to be included in the unit rates quoted by the Contractor. Each disturbed sample shall, as far as possible, be truly representative of the grading of insitu soil at the point from which it is taken, without contamination by other material. It shall be approximately five (5) Kg in weight and shall be placed in a strong air tight container immediately after its removal from the sampler. The container shall be sealed as soon as the sample has been placed in and shall be taken to the site laboratory for grading, moisture content and Atterberg Limits tests.

The apparatus and procedure for the Standard Penetration Test shall be in accordance with the provisions of ASTM D 1586 Penetration Test and split-barrel sampling of soils and/or ASTM D 1587 thin-walled sampling of soils, (except insofar as any such provisions may conflict with other requirements of the contract).

vi) Limitations of Boring Sequence

Piles shall be constructed in such a manner and sequence as to ensure that no damage is sustained by piles already constructed in adjacent positions. The Contractor shall submit to the Engineer for his approval a programme showing sequence of construction of various piles.

vii) Tolerances

Following construction tolerances shall maintained

a. The drilled shaft shall be within 3 inches of the plan position in the horizontal plane at the plan elevation for the top of the shaft.
b. The vertical alignment of the shaft excavation shall not very from the plan alignment by more than 1/4 inch per foot of depth.
c. After all the shaft concrete is placed, the top of the reinforcing steel cage shall be no more than 6 inches above and no more than 3 inches below plan position.
d. When casing is used, its outside diameter shall not be less than the shaft diameter shown on the plans. When casing is not used, the minimum diameter of the drilled shaft shall be the diameter shown on the plans for diameters 24 inches or less, and not more than 1 inch less than the diameter shown on the plants for diameters greater than 24 inches.
e. The bearing area of bells shall be excavated to the plan bearing area as a minimum. All other plan dimensions shown for the bells may be varied, when approved, to accommodate the equipment used.
f. The top elevation of the shaft shall be within 1 inch of the plan top of shaft elevation.
g. The bottom of the shaft excavation shall be normal to the axis of the shaft within 3/4 inch per foot of shaft diameter.

viii) Inspection

After the borehole has reached its final stipulated positions, after the samples have been taken out, as required by the Engineer, and the borehole has been completely cleaned of all loose matter and otherwise made ready to receive the reinforcement and thereafter the concrete, the contractor shall so inform the Engineer.

The Engineer shall inspect the soil samples and test results thereon, check the elevation of the bottom of the borehole and the amount and direction, if any, by which the top of the casing is out of position, or out-

of-plumb having satisfied himself on these and on any other points which he may consider relevant shall sign permission authorizing the Contractor to proceed with the placing of the reinforcement. The Contractor shall under no circumstances proceed with the placing of reinforcement or with the subsequent concreting without having first obtained the authority signed separately for each and every borehole by the Engineer.

ix) Pile Reinforcement

The reinforcement for each pile shall be assembled and securely tied by means of binding wire and by welded reinforcement rings of twenty five (25) mm diameter bar as shown on the drawings, in such a manner as to form a rigid cage.

The required concrete cover to the reinforcement shall be maintained by suitable spacers securely attached to the reinforcement and of sufficient strength to resist damage during handling of the reinforcement cage into the pile. The distance between the spacers shall be such that the required cover is maintained throughout and that there is no displacement of the reinforcement cage in the course of the concreting operation.

Should the Contractor prefer to lower the reinforcement cage assembly into the borehole in sections, he may do so provided the same lapping requirements as for assembly on the ground are followed, namely, the longitudinal reinforcement shall be lapped as shown on the drawings and the spiral reinforcement shall be doubled over the lap zones. Spacers maintaining concrete cover shall be located immediately below and above the laps at 4 points spaced around the cage.

407.3.3 Concreting of Piles

In general, item 401 of the General Specifications shall be followed, however, the following particular requirements shall be observed.

i) Materials

Compressive strength of concrete in piles shall be of class A_3 as prescribed in Item 401, except if otherwise indicated.

Suitable retarder, plasticiser may be added as approved by the Engineer.

The Contractor shall submit the detailed proposed additive for approval, which shall be approved after laboratory trial mix results. The dosing of retarders shall ensure initial setting time of not less than five (5) hours corresponding to the ambient temperature at which the concreting is proposed to be carried out.

ii) Commencement of Concreting

Prior to placing any concrete

a. Any heavy contaminated bentonite slurry, which could impair the free flow of concrete from the tremie pipe, shall be removed.

b. Any loose or soft material/water soil shall be removed from the bottom of the bore by methods acceptable to the Engineer.

The Contractor shall not proceed with the concreting of the pile until the Engineer gives specific permit to do so after satisfying himself of the:

- Adequacy of the Contractors equipment and arrangement.
- Proficiency of his personnel.
- Cleanliness of the borehole.

Contractor shall have a suitable lighting arrangements at all times for inspecting the entire length of the shells, pipe or hole before placing the reinforcing steel or concrete.

Prior to the concreting a pile, sample of slurry shall be taken from the base of the borehole using an approved sampling device and its specific gravity shall be determined.

iii) Placing of Concrete

The tremie shall be of not less than two hundred and fifty (250) mm diameter made of water-tight construction. The means of supporting the tremie shall be such as to permit the free movement of the discharge end in the concrete in the pile. The tremie pipe shall be fitted with travelling plug, which shall be placed at the top of the pipe before charging the tremie pipe with concrete as barrier between the concrete and water or bentonite slurry, so as to prevent water or bentonite slurry entering the tube and mixing with the concrete. The tremie shall be carefully lowered into the borehole so that the end of the tube shall rest at about one hundred and fifty (150) mm above the bottom of the borehole, with reinforcement in the borehole, and the hopper end of the tremie tube shall be filled with concrete as aforesaid. It shall be slightly raised so that when the concrete reaches the bottom it flows out of the lower end of the tube, and fills the bottom of the borehole. Thereafter, the rate of withdrawal of the tremie shall be gradual so as to ensure the end of the tremie pipe is always one and half (1.5) meters below the top of the concrete in the borehole. An allowance shall be made for the top five hundred (500) mm of concrete in borehole during concreting being unsatisfactory. When the next batch is placed in the hopper the tremie shall be slightly raised but not out of the concrete at the bottom, until the batch discharges to the bottom of the upper. This operation shall be controlled by calculating the volume of concrete required to fill one linear meter of pile and then by measuring the rate of withdrawal of the tube corresponding to the volume of the batch in the hopper. The flow shall then the retarded by lowering the tube. The depth of the concrete in borehole shall be measured at intervals to keep a constant check that the tremie pipe bottom is immersed in concrete.

Concreting in each pile shall be carried out in a continuous operation without stoppages until the pile has been completed.

If the bottom of the tremie pipe ceases to be immersed in the body of the concrete in the pile and the seal is broken, concreting shall cease immediately and such remedial measures as the Engineer may accept or direct shall be carried out. The Contractor shall take precautions to ensure that the concrete is free of voids and shall prevent the entry of water and/or collapse of soil into concrete. If any soil or other deleterious or extraneous materials fall into any pile excavation prior to or during concreting, it shall be removed immediately.

Concreting shall continue until the concrete has reached an elevation five hundred (500) mm higher than the designated pile cut off level shown on the drawings, or as otherwise directed by the Engineer.

The concrete shall be placed in one continuous operation from tip of cut-off elevation and shall be carried out in such a manner as to avoid segregation. The method of placing the concrete and the consistency (slump) shall conform to the requirements of Item 401 or to the satisfaction of the Engineer.

No shell or pipe shall be filled with concrete until all adjacent shells, pipes or piles within a radius of three (3) M or five (5) times the pile diameter, whichever is greater, have been driven to the required resistance.

After a shell or pipe has been filled with concrete, no pile shall be driven within seven (7) meters thereof until at least seven (7) days have elapsed.

407.3.4 Withdrawal of Temporary Casing

If the method of construction involves partial withdrawal of temporary casing as concreting proceeds, a sufficient head of concrete shall be maintained above the bottom of the temporary casing to ensure that no voids are formed within the pile and to prevent the entry of ground water and to prevent the collapse of soil into the concrete.

If such entry or collapse should occur, the temporary casing shall be re-driven before the concrete has set and all defective concrete shall be removed or the construction of the pile shall be abandoned, in which case the provision of the clause herein which refers to "Defective Piles" shall apply.

The withdrawal of the temporary casing shall be carried out before the adjacent concrete has taken its initial set.

The method and timing of withdrawal must be such as to ensure that the space between the pile and the surrounding ground shall be filled with concrete.

407.3.5 Splicing of Piles

Splicing of piles, when permitted by the Engineer, shall be made as shown on the Drawings or as specified with materials having same quality and characteristic as for materials used for the pile itself.

i) Precast Concrete Piles

For precast concrete piles, the splicing shall be done according to one of the following methods unless otherwise specified.

1) Using prefabricated joints mounted in the forms and cast together with the pile sections and joined together as specified by the manufacturer and approved by the Engineer. The joints shall be of the design and type as shown on the Drawings.

2) By cutting away the concrete at the end of the pile, leaving the reinforcement steel exposed for a length of forty (40) times steel bar diameters. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement of the same

size as that used in the pile shall be welded to the projecting steel and the necessary formwork shall be placed, care being taken to prevent leakage along the pile. The concrete shall be of the same quality as that used in the pile. Just prior to placing concrete, the top of the pile shall be wetted thoroughly and covered with a thin coating of neat cement, or other suitable bonding material to the satisfaction of the Engineer. The forms shall remain in place not less than seven (7) days. The pile shall not be driven until the 28-days design strength is reached.

3) Any other method shown on the Drawings or approved by the Engineer.

ii) Steel Piles, Shells or pipes

For steel piles shells and pipe, the splicing shall be as under:

If the ordered length of the steel pile, pipe, or shell is insufficient to obtain the specified bearing value, an extension of same cross-section shall be spliced to it. Unless otherwise shown on the Drawings, splices shall be made by butt-welding the entire cross-section to form an integral pile using the electric arc method. The sections connected shall be properly aligned so that the axis of the pile will be straight. Piles bent or otherwise injured shall be rejected.

407.3.6 Cutting of Piles

Tops of piles shall be embedded in the concrete footing as shown on the drawings.

Concrete piles shall, when approved by the Engineer, be cut off at such a level that at least five (5) cm of undamaged pile can be embedded in the structure above. If a pile is damaged below this level, the Contractor shall repair the pile to the satisfaction of the Engineer. The longitudinal reinforcement of the piles shall be embedded in the structure above to a length equal to at least (40) times the diameter of the main reinforcing bars. The distance from the side of any pile to the nearest edge of the footing shall not be less than twenty (20) cm.

When the cut-off elevation for a precast concrete pile, steel shell, pipe or for a cast-in-place concrete pile is below the elevation of the bottom of the pile cap, the pile may be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete construction according to Item 401, if approved by the Engineer.

Cut-offs of structural steel piles shall be made at right angles to the axis of the pile. The cuts shall be made in clean, straight lines and any irregularity due to cutting or burning shall be leveled off with deposits of weld metal prior to placing bearing caps.

407.3.7 Defective Piles

Any pile delivered with defects such as damaged during driving or cast insitu, placed out of its proper location, incapable or partially capable of permanently carrying the load which it is intended to carry, driven below the elevation fixed by the Drawing or by the Engineer, due to the immature setting of the concrete in the pile or due to caving/collapse of the borehole fully or partially, or due to any cause of which Engineer shall be sole judge to determine shall be corrected at the contractor's expense by one of the following methods approved by the Engineer:-

a) The pile shall be withdrawn and replaced by a new and when necessary, by longer pile.

b) A second pile shall be driven or cast adjacent to the defective pile.

c) The pile shall be spliced or built up as otherwise provided herein or the underside of the footing lowered to properly imbed the pile.

The contractor shall undertake such additional tests/works as the Engineer may specify to provide additional foundations to supplement the defective piles and so modify the structure to be supported as to ensure that load will be transferred safely to the additional foundations of existing pile. The contractor shall be responsible for the cost of such additional functions and tests and/or of the extra work carried out in such modification to the structure.

A concrete pile shall be considered defective if it has a visible crack or cracks, extending around the four sides of the pile, or any defect, which, in the opinion of the Engineer affects the strength, or life of the pile.

When a new pile is driven or cast to replace a rejected one, the Contractor, at his expense, shall enlarge the footing as deemed necessary by the Engineer.

407.3.8 Test Piles

Test piles which are shown on the Drawings or ordered by the Engineer shall conform to the requirements for piling as specified and shall be so located that they may be cut-off and become a part of the completed structure.

Test piles to be load tested in accordance with Item 407.3.9 shall be driven in locations determined by the Engineer. These piles shall not be utilized in the structure unless otherwise directed.

Test piles driven by the Contractor for his own use in determining the lengths of piles to be furnished may be so located and they may be cut-off and become a part of the completed structure provided that such test piles conform to the requirement for piling in these specifications.

Any pile, which after serving its purpose as a test pile is found unsatisfactory for utilization in the structure, shall be removed if so ordered by the Engineer, or if approved by the Engineer it shall be cut-off below the ground line and footings, but such approval does not in any way relieve the Contractor of his responsibilities.

Test piles shall generally be driven with the same equipment that is to be used for driving foundation piles. When required, the ground shall be excavated to the elevation of the bottom of the footing before the test pile is driven.

When diesel hammers are to be used for driving end bearing piles, or friction piles where the bearing capacity shall be checked by pile driving formulas, the Contractor shall in advance carry out test piling or load tests to determine the energy developed by the hammer. The Contractor may elect one of the following methods for the calibration:

a) By test driving the same type of piles successively with diesel hammer and gravity or single acting hammer, or by driving two different piles with diesel hammer and gravity or single acting hammer respectively.

b) By driving test piles to a depth determined by the Engineer and load testing the same piles in accordance with Item 407.3.9.

c) Calibration tests shall be made at least at two different sites until the results are satisfactory to the Engineer.

Calibration of diesel hammers may not be required if the hammer has been previously calibrated under soil conditions and for the same size and type of pile, provided that the calibration data is accepted by the Engineer.

407.3.9 Load Tests

A load test shall consist of the application of a load equal to a minimum of 2 times the specified bearing capacity or as otherwise provided for herein or as directed by the Engineer. Load tests shall be made where specified and/or where called for by the Engineer. Unless otherwise permitted by the Engineer, the load tests shall be completed before the remaining piles in the same structure are driven or cast.

Load tests shall be made by methods approved by the Engineer. The Contractor shall submit to the Engineer detailed plans of the loading system and apparatus he intends to use at least three (3) weeks in advance. The apparatus shall be so constructed as to allow the various increments of the load to be placed gradually without causing vibration to the test piles. Tension anchor piles if used, shall be of a design and driven to a depth satisfactory to the Engineer. Steel shells or piles whose walls are not of adequate strength to withstand the test loading when empty, shall have the required reinforcement and concrete placed before loading. The load test shall not be started until the concrete has attained a minimum compressive strength of ninety five (95) percent of the design twenty eight (28) days compressive strength. If he so elects, the Contractor may use high early strength cement in the concrete of the load test pile and the tension piles.

Suitable approved apparatus for determining accurately the load on the pile and the settlement of the pile under each increment of load shall be supplied by the Contractor. The apparatus shall have a working capacity of three times the design load for the pile being tested. Reference points for measurement of pile settlement shall be sufficiently away from the test pile to preclude all possibility of disturbance.

All pile load settlements shall be measured by adequate devices, such as gauges, and shall be checked by means of an Engineer's level. Increment of deflection shall be read just after each load increment is applied and at 15-minute intervals thereafter. The safe allowable load shall be considered as 50 percent of the load which, after 48 hours of continuous application, has caused not more than 6 mm of permanent settlement, measured at the top of the pile.

The first load to be applied to the test pile shall be 50%, of the pile design load and the first increment shall be up to the pile design load by applying additional loads in three equal increments. A minimum period of 2 hours shall intervene between the application of each increment, except that no increment shall be added until a settlement of less than one tenth (0.1) mm is observed for a 15-minute interval under the previously applied increment. If there is a question as to whether the test pile will support the test load, the load increments shall be reduced by fifty (50) percent, at the direction of the Engineer, in order that a more closely controlled failure curve may be plotted. The full test load shall remain on the test pile not less than forty eight (48) hours. The full test load shall then be removed and the permanent settlement read.

When directed by the Engineer load tests shall then be continued beyond the double design load in 10-ton increments to failure or a maximum of three (3) times the design load.

The pile may be considered to have failed when the total permanent settlement exceeds (6) mm.

407.3.10 **Backfilling Empty Boring**

When each pile has been cast, the empty bores remaining shall not be back-filled unless required by the construction procedures and activities following the completion of piling work.

407.3.11 **Pile Records**

The Contractor shall keep records of the piles driven or installed. A copy of the record shall be given to the Engineer within two (2) days after each pile is driven. The record form to be used shall be approved by the Engineer. The pile records shall give full information on the following:

Driven Piles	Cast-in-Place Piles
Pile type and dimension.	Pile type and nominal dimensions.
Driving equipment, type, weight, reach-and efficiency of hammer etc.	Date of boring commenced, level reached each day and date of casting.
Date of casting (for concrete piles) and driving.	Soil samples taken from pile boring operation and soil test results.
Details of Reinforcement.	Strata and ground water encountered with levels, description shall be in accordance with B.S.C.P. 2001.
Test results on concrete	Length of finished pile and tip elevation
Depth driven & tip elevation.	Dia of borehole.
For gravity and single-acting hammers: the height of drop.	Elevation of the bottom of borehole.
For double acting hammers: the frequency of blows.	Date of placing concrete; theoretical and actual quantities of concrete used in pile.
Final set for last 20 blows for every 10 piles and when the Engineer so requires the penetration along the whole driven depth shall be recorded.	Lengths and diameter of temporary casing and permanent lining and the elevation of the tip of temporary casing and of permanent lining.
Details of any interruption in driving.	Details of Reinforcement.
Level of pile top immediately after driving, and the level when all piles in the group are driven.	Details of penetration during boring operation or driving of steel shell (driving records as for driven piles).
Details of re-driving.	Quality, consistency and other test results on concrete.
Any other relevant information.	Time interval between boring or driving and concreting.
	Any other relevant information.

On completion of the piling for each structure, the Contractor shall deliver to the Engineer a drawing recording the exact location and the final depth (tip elevation) of all piles.

407.3.12 **Confirmatory Boring**

The contractor shall carry out confirmatory boring at bridge site at locations indicated by the Engineer.

Boring shall be carried out with ASTM D 1586 Penetration Test and Split barrel sampling of soil. Additionally, when undisturbed sampling is required, the procedure shall conform to ASTM D 1587, Thin Walled sampling of soil.

Diameter of boreholes shall be twenty (20) centimeters cased through out its length and shall be down to the designated elevation. In-situ standard penetration test shall be carried out at one and half (1.5) meters interval from designated top elevation to the bottom of the hole. Undisturbed samples shall be taken from substratum. If clay is encountered, undisturbed samples will be taken at interval of three (3) meters.

At least two borings are required at each bridge site. The boring shall extend to a depth of at least three (3) meters below the pile tip elevation as indicated in the drawings.

407.4 **MEASUREMENT AND PAYMENT**

407.4.1 **Measurement**

The quantities to be paid for shall be the number of linear meters of piles, completed and accepted, measured from the pile tip elevation to the bottom of pile caps, footings or bottom of concrete superstructure in the case of

pile bents. In case the bottom of pile caps or footing or bottom of pile bent is above N.S.L and method of fabrication is such that the work above N.S.L is done as that of column, the same shall be measured as concrete and steel for column. No allowance shall be made for cut-offs or the required length of concrete or reinforcement steel placed into the concrete structure as called for on the drawings. Any additional pile lengths that may be necessary to suit the Contractor's method of operation or for any other reason shall not be included in the measurements.

For cast-in-situ piles, helical and vertical steel will be measured in Tons. Pile casing where ever provided will be measured in linear meters. Measurement shall be made for permanently placed pile casing s shown on drawings. If the Contractor likes to use temporary casing for the convenience of preparing of boreholes, the same shall not be measured whether left at site or withdrawn after completing the boreholes.

Test piles when ordered by the Engineer, whether or not utilized as service piles in the structure shall not be included in the above measurements. Accepted test piles will be measured separately as the number of linear meters.

- Pile shoes when called for on the Drawings or by the Engineer shall be measured by the number accepted in place.

- Splicing of piles if not shown on the drawings will not be allowed except that the length of reinforcement is to exceed 12 meter in which case the splicing will not be measured or paid directly but the cost thereof shall be considered as included in the unit price for piling.

- Load tests shall be counted as the number of complete and accepted load tests as described in Item 407.3.9.

- Concrete footings or pile caps shall be measured and paid for as provided under Item 400 "Structures". Additional quantities of concrete, reinforcement and formwork caused by incorrect location of piles or additional piles necessary to replace defective piles shall be to the Contractor's expense.

407.4.2 Payment

- The quantities of piling left in place in the accepted structure measured as provided above shall be paid for at the contract unit price per linear meter of piles of the different types listed below and shown in the Bill of Quantities.

- For cost-in-situ piles, rate per linear meter will include all items except for helical and vertical reinforcement, which will be paid as per steel reinforcement item 404.

- For pre cast piles, the cast of steel shall be included in the rate per linear mater.

Pile casing will be paid at the contract unit price per linear meter for pile casing.

Test piles whether or not used in the completed structure or constructed adjacent to structure as per requirements of the contract document shall be paid for at the contract unit price for pile installation.

Load tests shall be paid for at the contract unit price for pile load Tests, either one and half (1.5) times or two (2) times the design load. The unit price for test loading to three (3) times the design load shall include the total load test with all load increments as described in Item 407.3.9.

Payment for tubular steel piles left in place shall include the cost of the concrete core of the specified class of concrete and the steel reinforcement of the said concrete core.

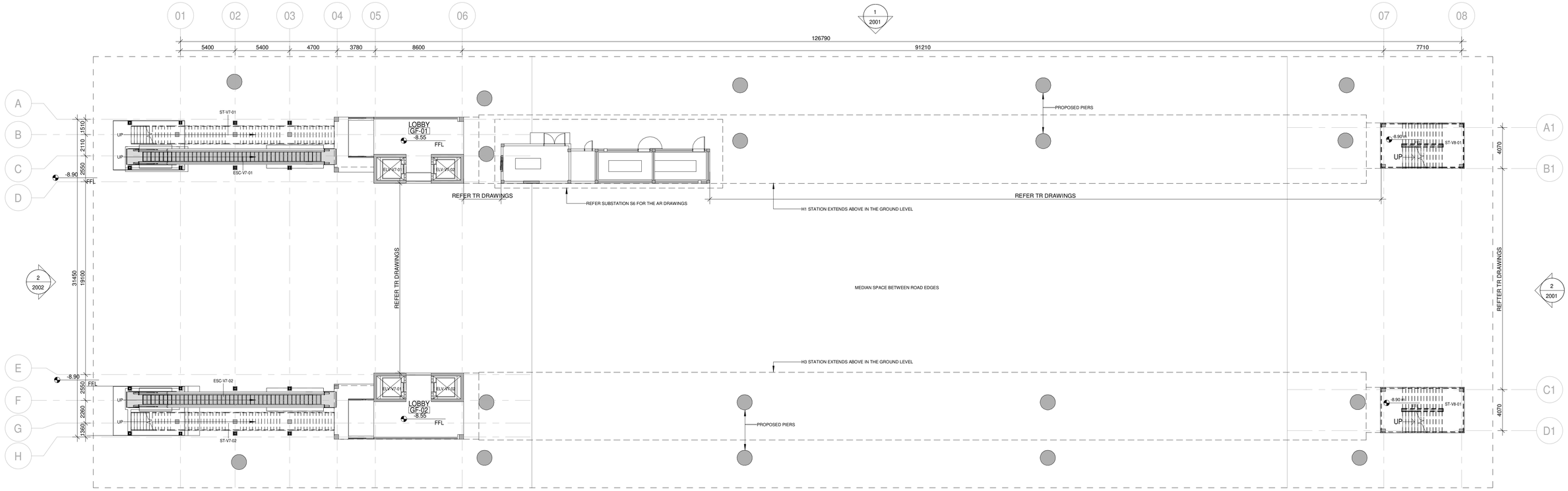
The quantity to be paid for confirmatory boring shall be the number of linear meters of the boring completed and accepted.

Such prices and payment shall be considered full compensation for furnishing all materials, performing standard penetration and all other relevant laboratory tests, labour, equipment, tools, fuel, welding, if needed and other incidental expenses including splicing, caging providing covers etc. necessary to complete the item as directed by the Engineer.

Pay Item No.	Description.	Unit of Measurement
407a	Untreated Timber Piles	M
407b	Treated Timber Piles	M
407c	Precast Concrete Piles type _____	M
407d	Cast-in-place Concrete Piles, type _____	M
407e	Structural Steel Piles, type _____	M
407f	Pile Shoes, type _____	Each
407g	Test Piles, type _____	M
407h	Pile Load Tests to 1.5 times the design load	Each
407i	Pile Load Tests to 2 times the design load.	Each
407j	Pile Load Tests to 3 times the design load.	Each
407k	Confirmatory Boring	M
407l	Permanent Pile Casing, type ____	M
407m	Temporary Pile Casing type ____	M

Drawings (Revised)

Attachment No. 2 for
Addendum No. 2



1 BASEMENT FLOOR PLAN (AT GRADE)

1 : 200

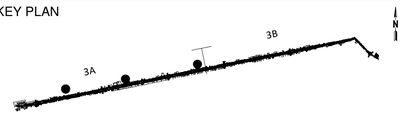
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

FOR LEVEL +-0.00 REFER TO THE BELOW SURVEY LEVEL FOR ROAD FINISH LEVEL AT THE STATION LOCATION ON TR MASTER PLAN.

- FOR (BROOKS CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.011
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- FOR (VITA CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +15.399

THE ESCALATORS SHOWN ARE FOR PROVISIONAL PURPOSES AND FUTURE PLANNING. THE ACTUAL QUANTITY TO BE EXECUTED IS SPECIFIED IN THE BOQ

REV.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
1	07/09/2024	GENERAL REVISION	A.T	M.K	S.A / N.H	M.Y
0	31/07/2024	APPROVED ISSUE	A.T	M.K	S.A / N.H	M.Y

PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

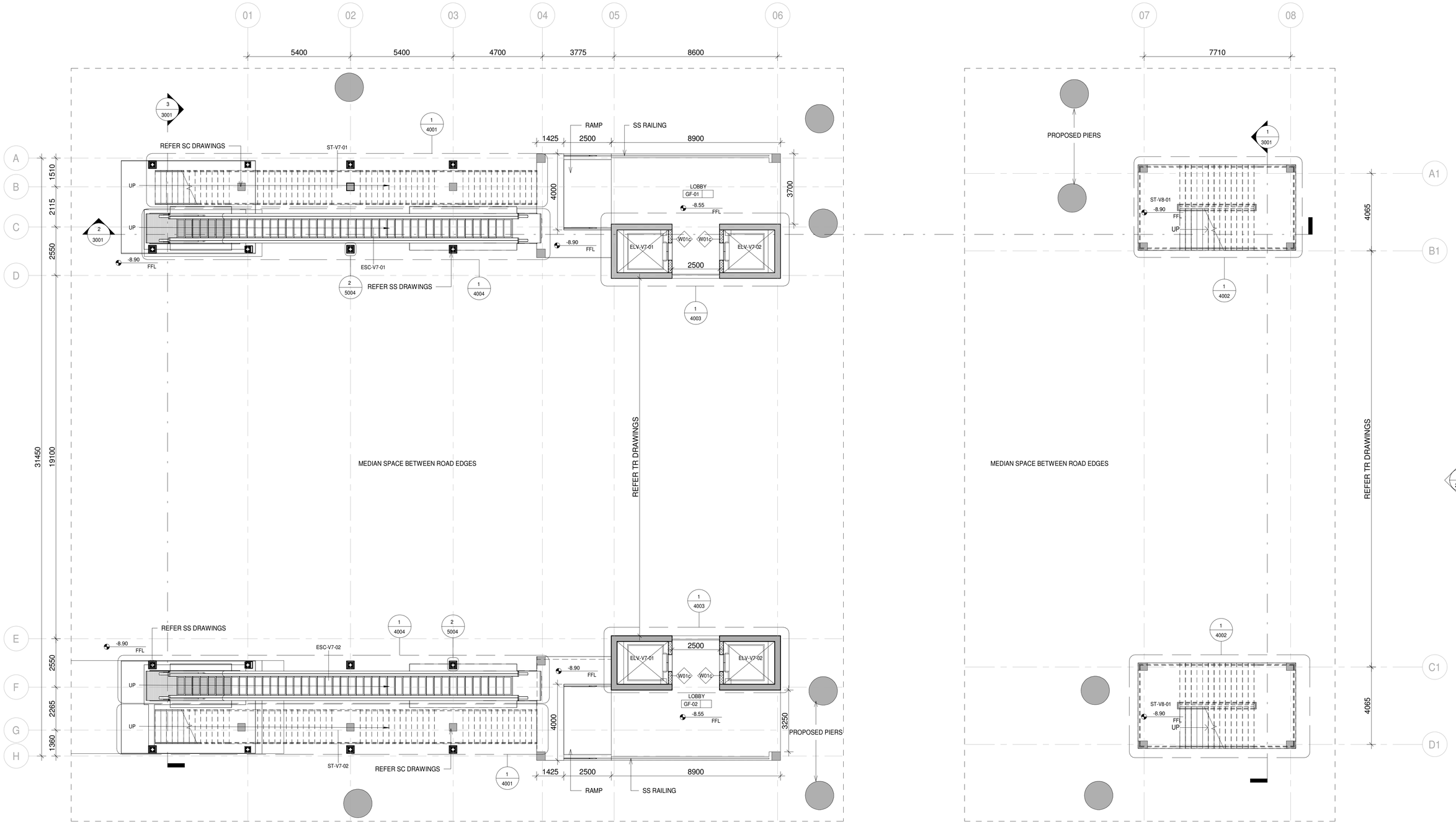
DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
FLOOR PLANS
KEY PLAN - GROUND FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-1001

REVISION
1



1 BASEMENT FLOOR PARTIAL - PLAN (AT GRADE)

1 : 100

TENDER DESIGN
SEPTEMBER 2024

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DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
FLOOR PLANS
GROUND FLOOR PLAN

SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-1002

REVISION
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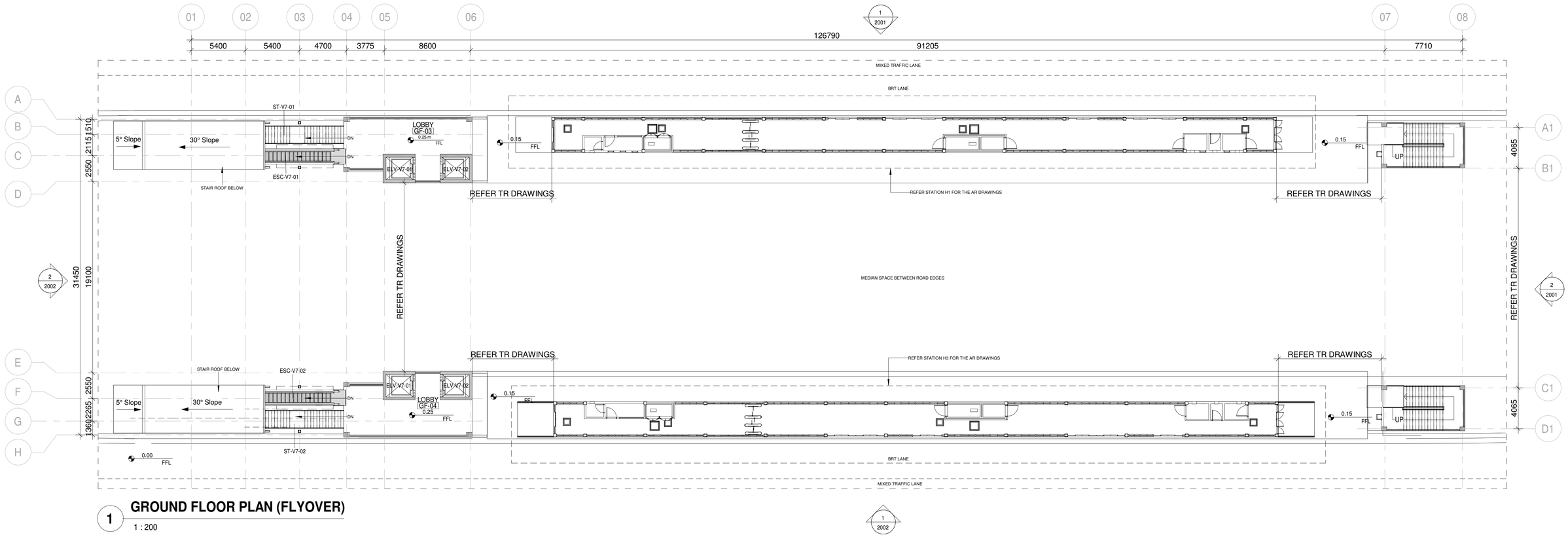

1 GROUND FLOOR PLAN (FLYOVER)

1 : 200

TENDER DESIGN
SEPTEMBER 2024

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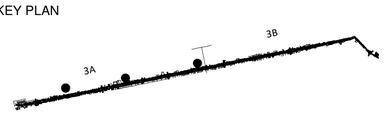

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PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
FLOOR PLANS
KEY PLAN - FIRST FLOOR PLAN

SCALE
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DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-1003

REVISION
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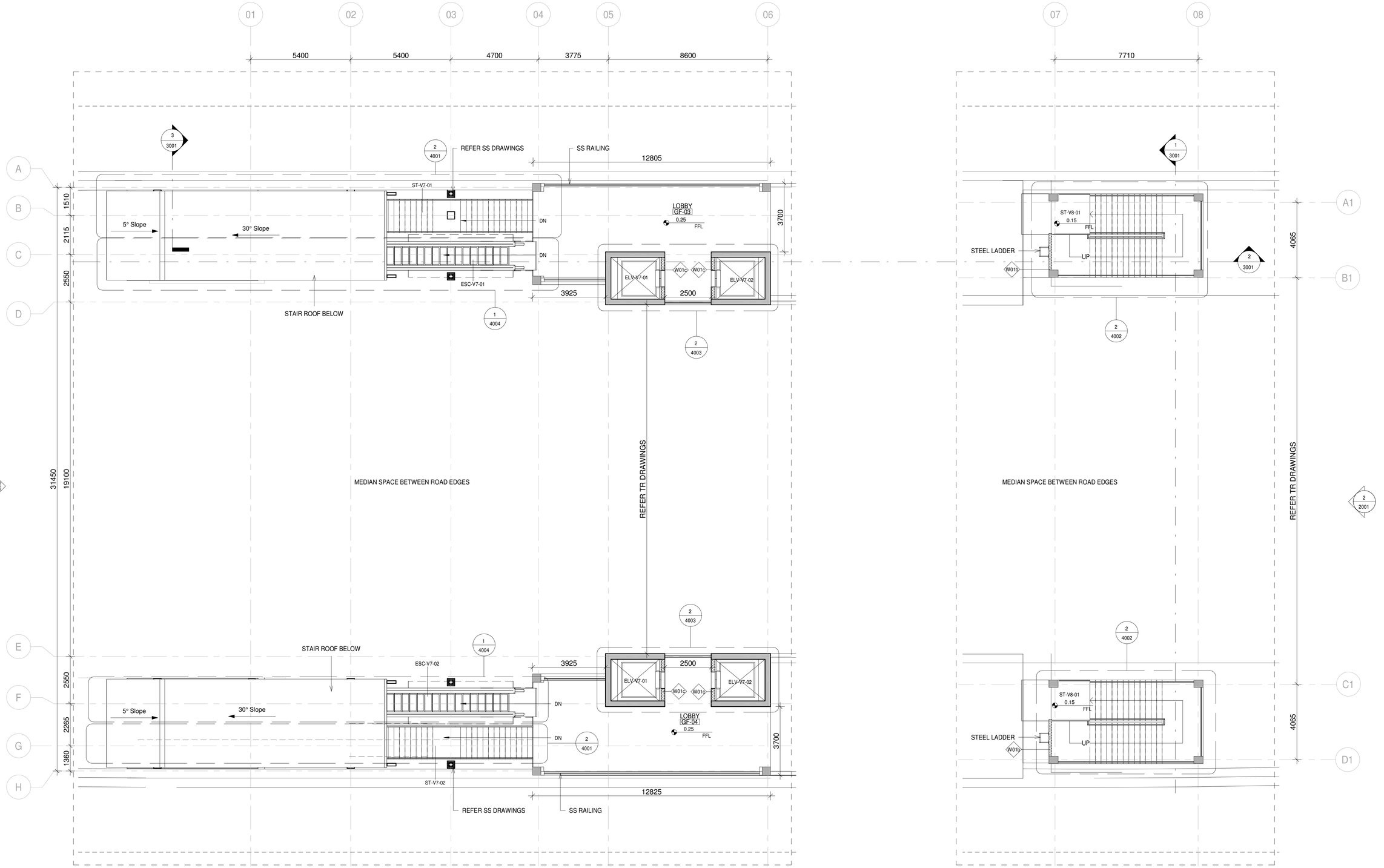

1 GROUND FLOOR PARTIAL - PLAN (FLYOVER)

1 : 100

TENDER DESIGN
SEPTEMBER 2024

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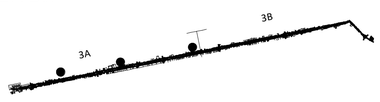

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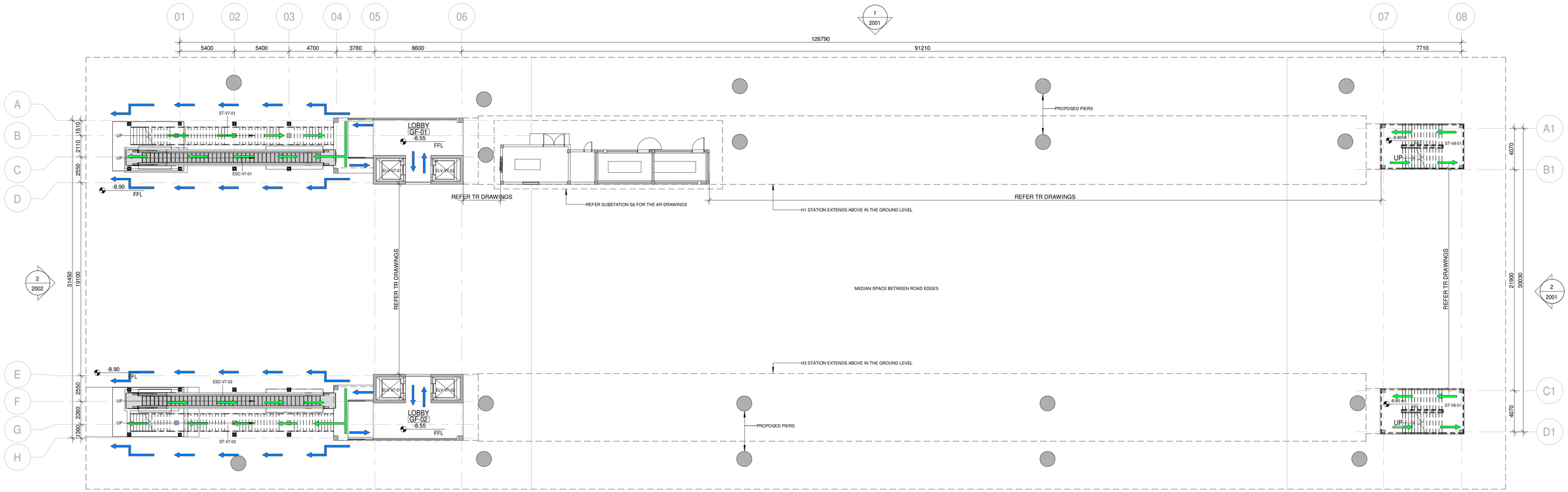
REVISION
1



1 CIRCULATION PLAN - BASEMENT FLOOR PLAN (AT GRADE)

1 : 200

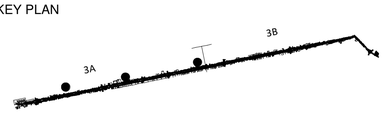
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

- TICKETS POINT
- BUS GATES
- HANDICAP CIRCULATION ON THE ABOVE BRIDGE
- HANDICAP CIRCULATION
- PEDESTRIAN CIRCULATION ON THE ABOVE BRIDGE
- PEDESTRIAN CIRCULATION
- EMERGENCY EXIT

THE ESCALATORS SHOWN ARE FOR PROVISIONAL PURPOSES AND FUTURE PLANNING. THE ACTUAL QUANTITY TO BE EXECUTED IS SPECIFIED IN THE BOQ

REV.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
1	07/09/2024	GENERAL REVISION	A.T	M.K	S.A / N.H	M.Y
0	31/07/2024	APPROVED ISSUE	A.T	M.K	S.A / N.H	M.Y

PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

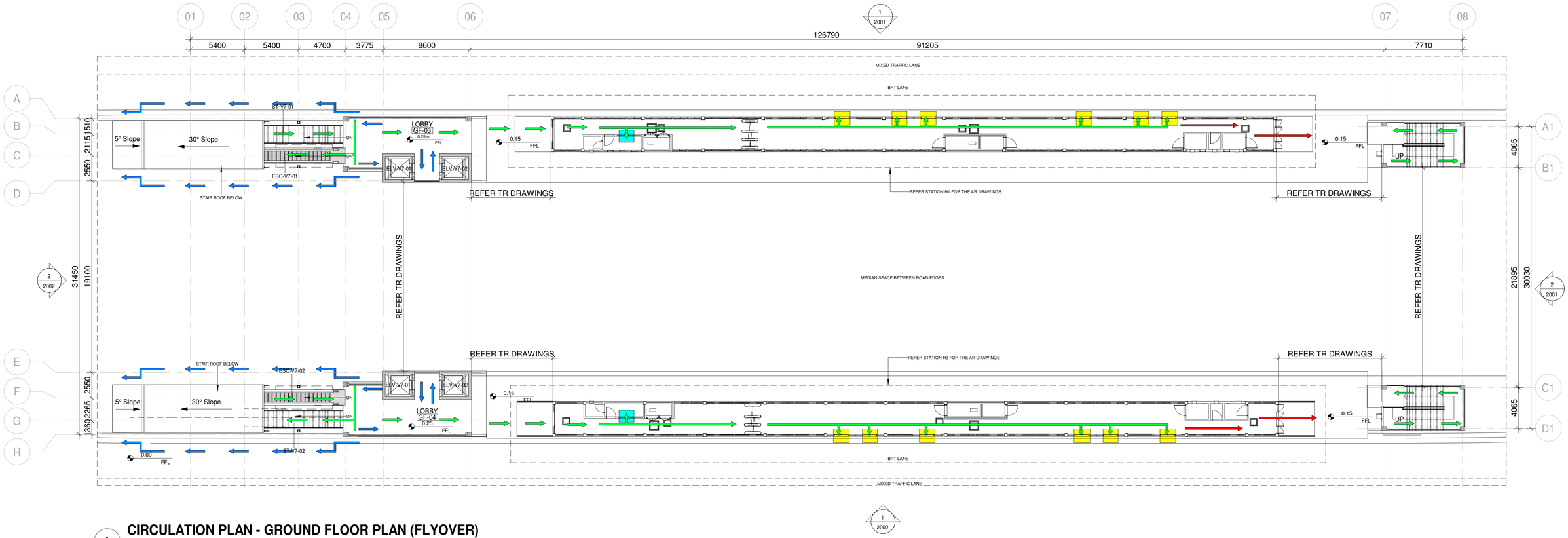
DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
CIRCULATION PLAN
BASEMENT FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-1007

REVISION
1



1 CIRCULATION PLAN - GROUND FLOOR PLAN (FLYOVER)

1 : 200

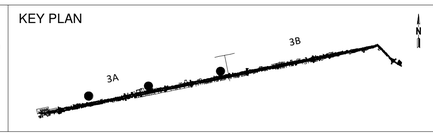
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

- TICKETS POINT
- BUS GATES
- HANDICAP CIRCULATION ON THE ABOVE BRIDGE
- HANDICAP CIRCULATION
- PEDESTRIAN CIRCULATION ON THE ABOVE BRIDGE
- PEDESTRIAN CIRCULATION
- EMERGENCY EXIT

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0	31/07/2024	APPROVED ISSUE	A.T	M.K	S.A / N.H	M.Y

PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION V7 - V8
CIRCULATION PLAN
GROUND FLOOR PLAN

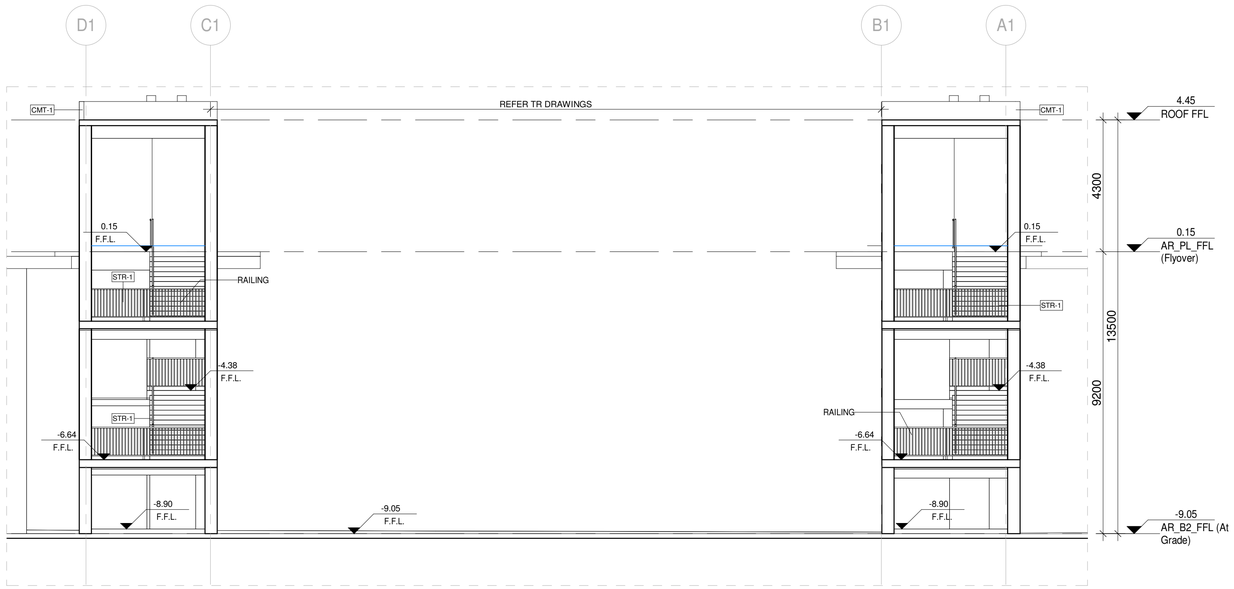
SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-1008

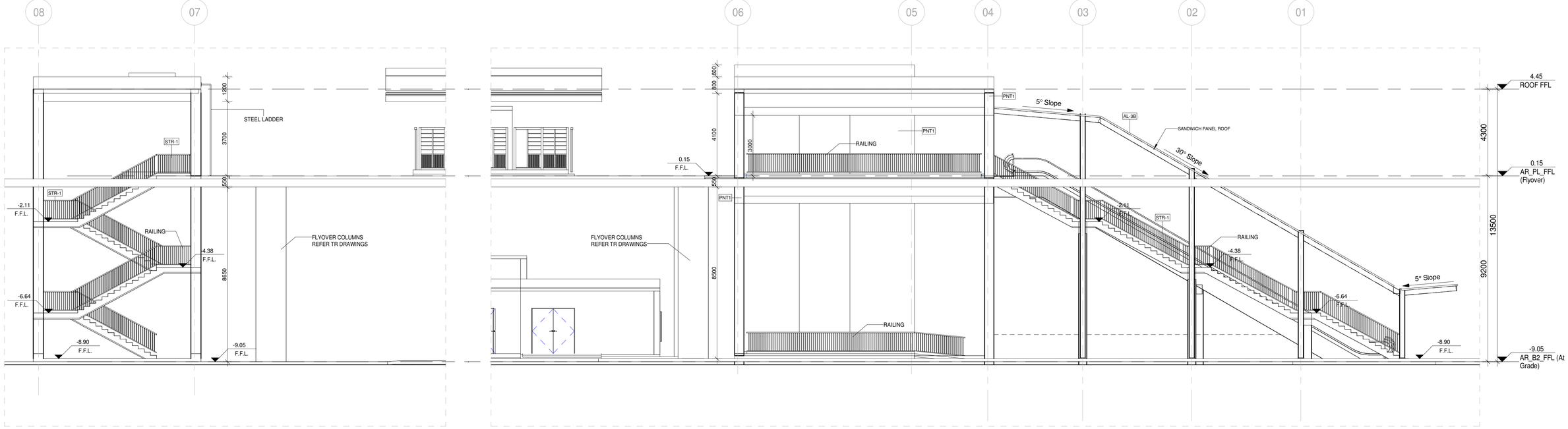
REVISION
1

External Building Material List	
Key Value	Keynote Text
AL-3B	INSULATED METAL ROOF PANEL , WITH PIR THERMAL CORE-COLOR GREY (RAL 7035),SUPPORTED ON SECONDARY STEEL STRUCTURE, FIRE PERFORMANCE IN COMPLIANCE WITH NFPA 285
CMT-1	CONCRETE ROOFING
PNT1	EXTERNAL 20MM PLASTER AND PAINT-COLOR GREY (NCS S 3500-N)
STR-1	STEEL RAILING-COLOR YELLOW (RAL 1021)



2 EAST ELEVATION

1 : 100



1 NORTH ELEVATION

1 : 100

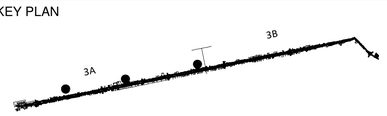
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

FOR LEVEL +-0.00 REFER TO THE BELOW SURVEY LEVEL FOR ROAD FINISH LEVEL AT THE STATION LOCATION ON TR MASTER PLAN:

- FOR (BROOKS CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.011
- FOR (SHAAN CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.3
- FOR (VITA CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +15.399

THE ESCALATORS SHOWN ARE FOR PROVISIONAL PURPOSES AND FUTURE PLANNING. THE ACTUAL QUANTITY TO BE EXECUTED IS SPECIFIED IN THE BOQ

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0	31/07/2024	APPROVED ISSUE	A.T	M.K	S.A / N.H	M.Y

PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

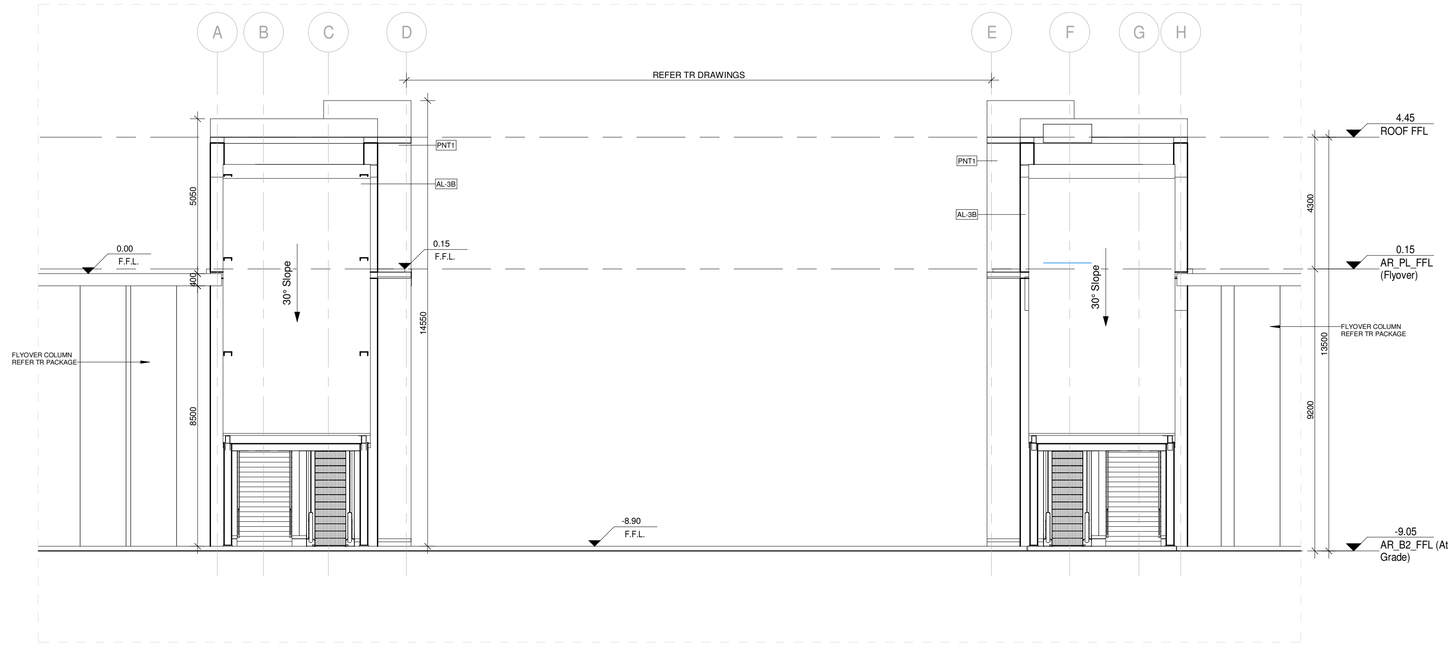
DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
ELEVATIONS
EAST AND NORTH ELEVATIONS

SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-2001

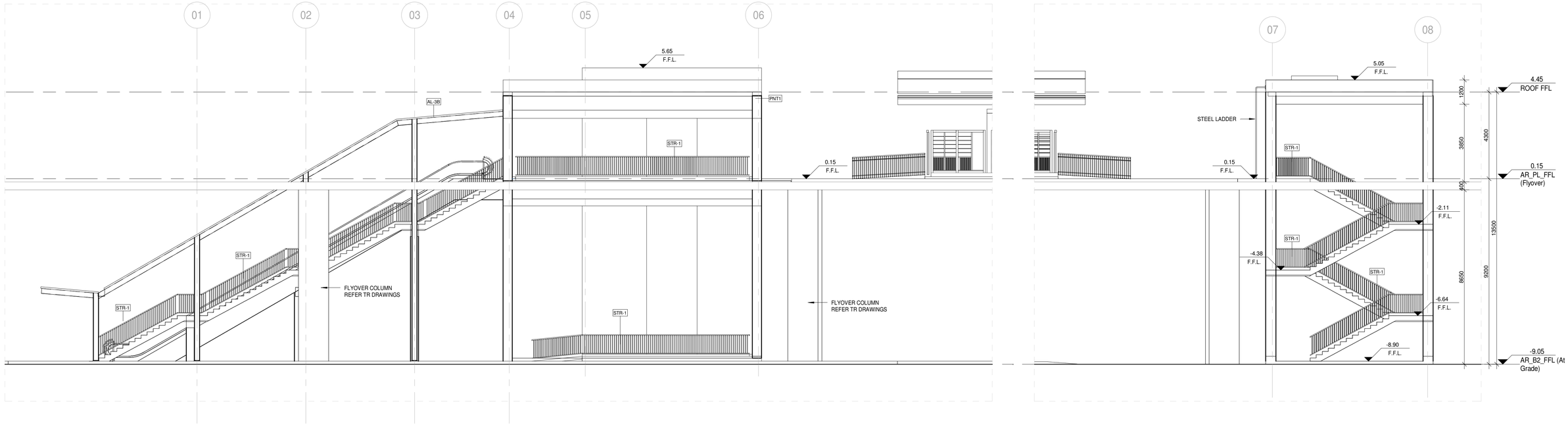
REVISION
1



External Building Material List	
Key Value	Keynote Text
AL-3B	INSULATED METAL ROOF PANEL , WITH PIR THERMAL CORE-COLOR GREY (RAL 7035),SUPPORTED ON SECONDARY STEEL STRUCTURE, FIRE PERFORMANCE IN COMPLIANCE WITH NFPA 285
PNT1	EXTERNAL 20MM PLASTER AND PAINT-COLOR GREY (NCS S 3500-N)
STR-1	STEEL RAILING-COLOR YELLOW (RAL 1021)

2 Elevation 4 - a

1 : 100



1 Elevation 3 - a

1 : 100

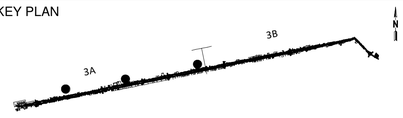
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

FOR LEVEL = 0.00 REFER TO THE BELOW SURVEY LEVEL FOR ROAD FINISH LEVEL AT THE STATION LOCATION ON TR MASTER PLAN:

- FOR (BROOKS CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.011
- FOR (SHAH CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.3
- FOR (VITA CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +15.399

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0	31/07/2024	APPROVED ISSUE	A.T	M.K	S.A / N.H	M.Y

PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
ELEVATIONS
SOUTH AND WEST ELEVATIONS

SCALE
1 : 100

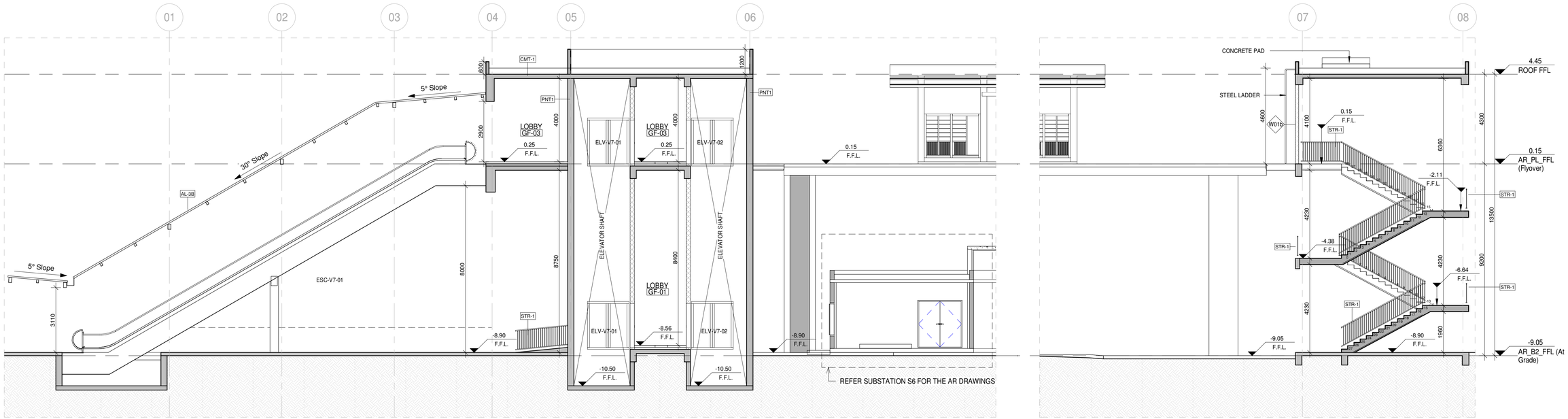
DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-2002

REVISION
1

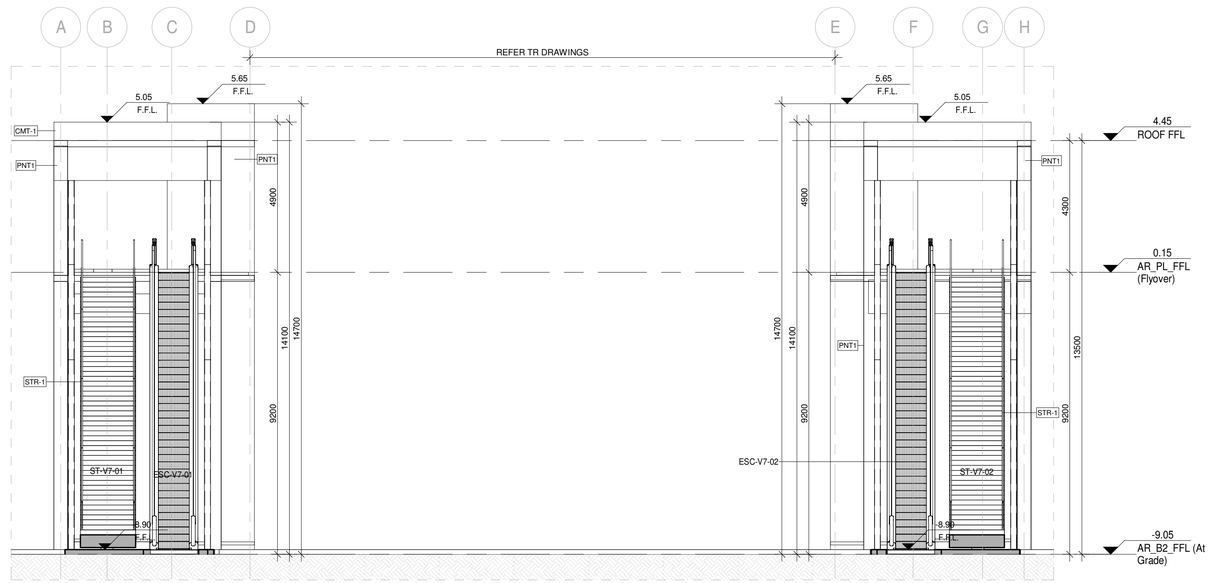
External Building Material List	
Key Value	Keynote Text

AL-3B	INSULATED METAL ROOF PANEL , WITH PIR THERMAL CORE-COLOR GREY (RAL 7035),SUPPORTED ON SECONDARY STEEL STRUCTURE, FIRE PERFORMANCE IN COMPLIANCE WITH NFPA 285
CMT-1	CONCRETE ROOFING
PNT1	EXTERNAL 20MM PLASTER AND PAINT-COLOR GREY (NCS S 3500-N)
STR-1	STEEL RAILING-COLOR YELLOW (RAL 1021)



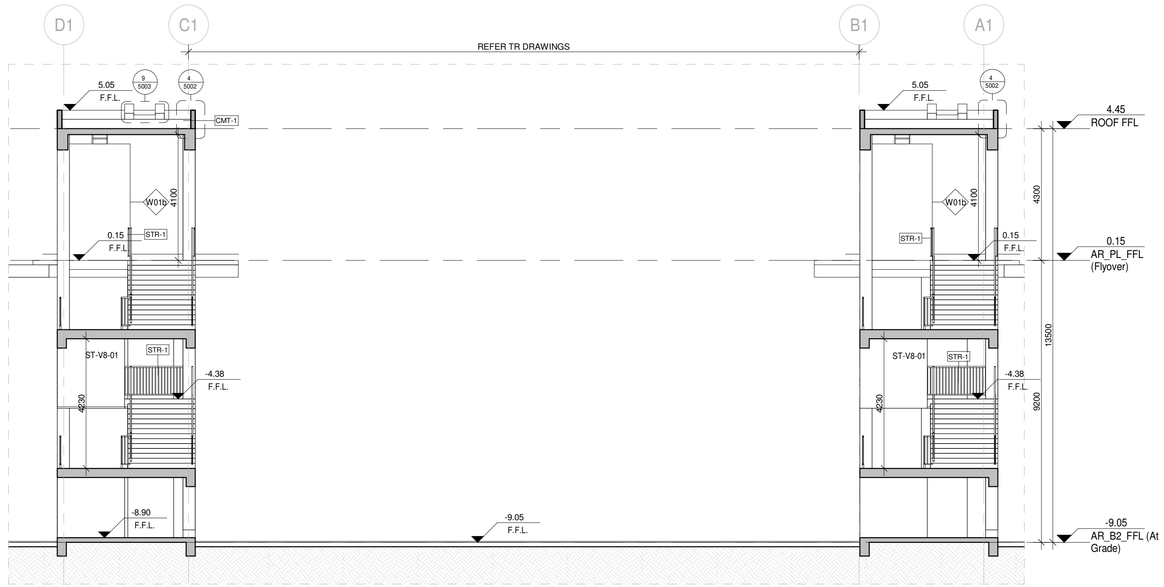
2 SECTION BB'

1 : 100



3 SECTION CC'

1 : 100



1 SECTION AA'

1 : 100

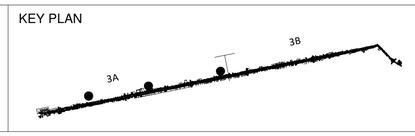
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

FOR LEVEL +-0.00 REFER TO THE BELOW SURVEY LEVEL FOR ROAD FINISH LEVEL AT THE STATION LOCATION ON TR MASTER PLAN:

- FOR (BROOKS CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.011
- FOR (SHAH CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.3
- FOR (VITA CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +15.399

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PROJECT TITLE

KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
SECTIONS
SECTION AA' , BB', CC'

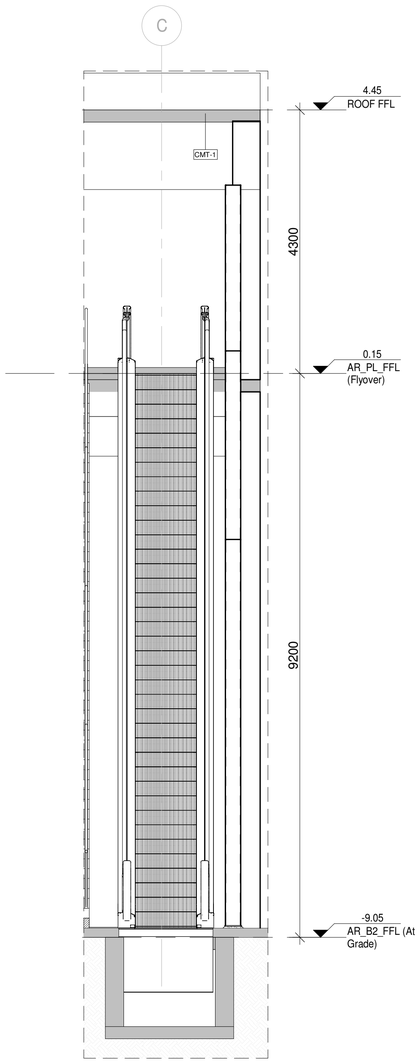
SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-3001

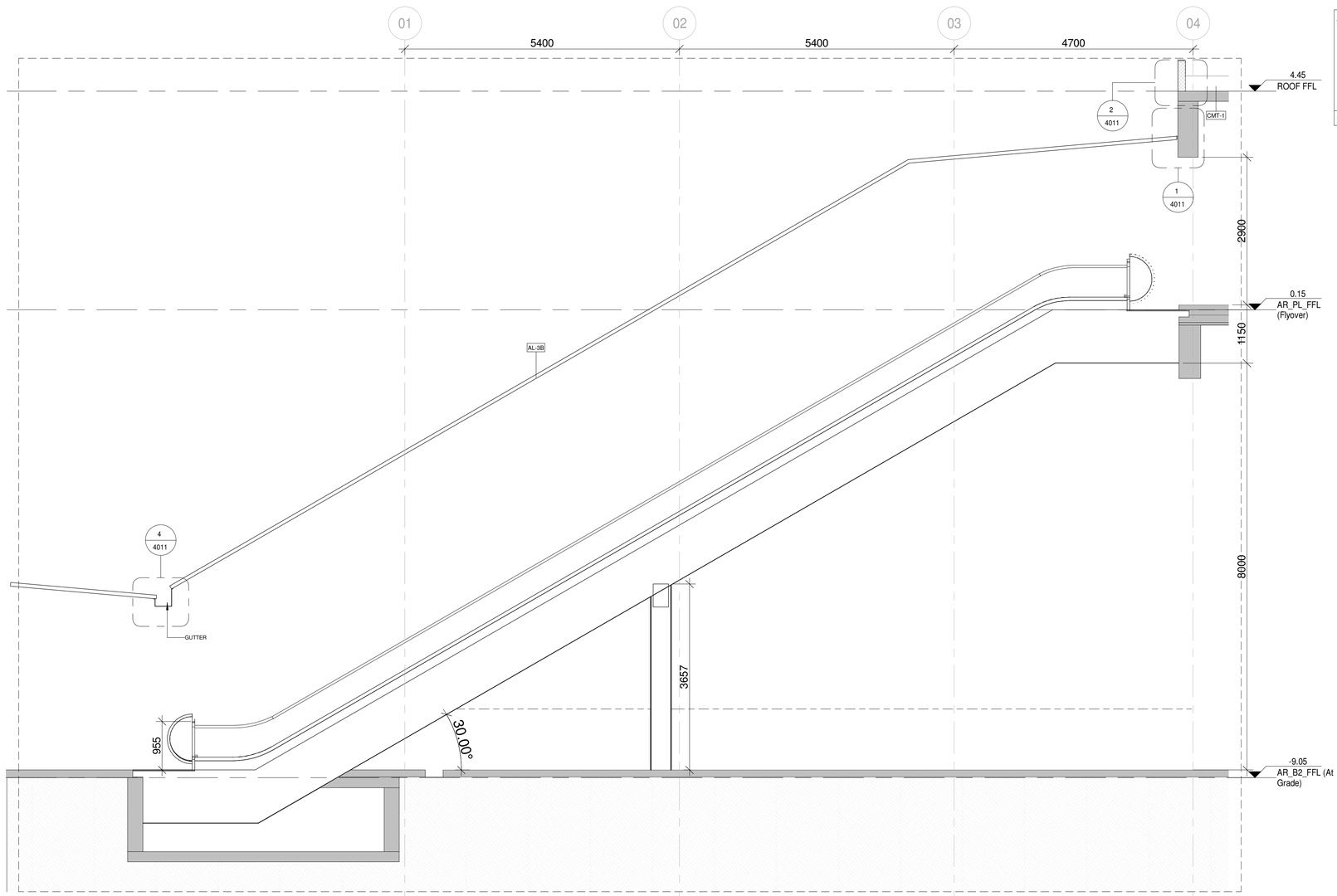
REVISION
1

External Building Material List	
Key Value	Keynote Text
AL-3B	INSULATED METAL ROOF PANEL , WITH PIR THERMAL CORE-COLOR GREY (RAL 7035),SUPPORTED ON SECONDARY STEEL STRUCTURE, FIRE PERFORMANCE IN COMPLIANCE WITH NFPA 285
CMT-1	CONCRETE ROOFING



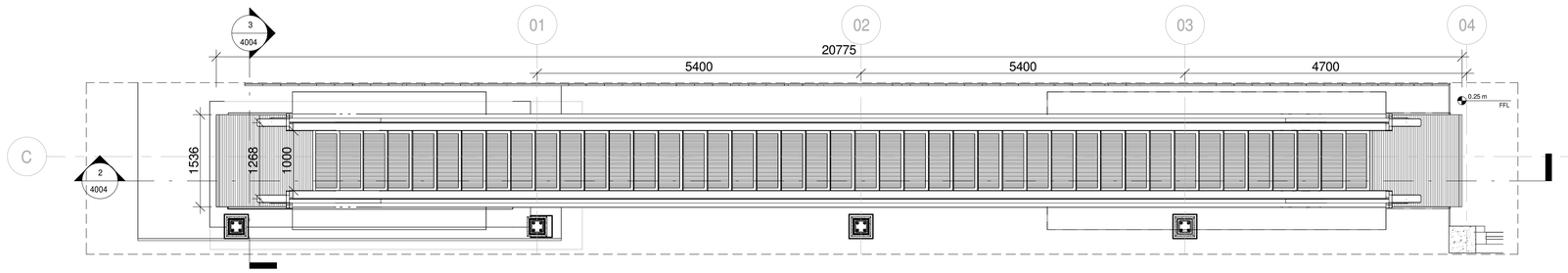
3 ESCALATOR SECTION BB' - ECS - V7 - 01, 02

1 : 50



2 ESCALATOR SECTION AA' - ECS - V7 - 01, 02

1 : 50



1 ESCALATOR GROUND FLOOR PLAN - ECS - V7 - 01, 02

1 : 50

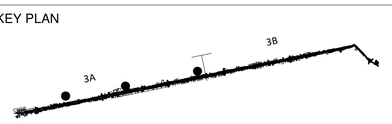
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

FOR LEVEL +-0.00 REFER TO THE BELOW SURVEY LEVEL FOR ROAD FINISH LEVEL AT THE STATION LOCATION ON TR MASTER PLAN:

- FOR (BROOKS CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.011
- FOR (SHAH CHOWRANGI STATION) THE ROAD SURVEY FINISH LEVEL IS +14.3
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PROJECT TITLE

KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V7 - V8
ESCALATOR DETAILS

SCALE
1 : 50

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-4004

REVISION
1

FIRE ZONING LEGEND:

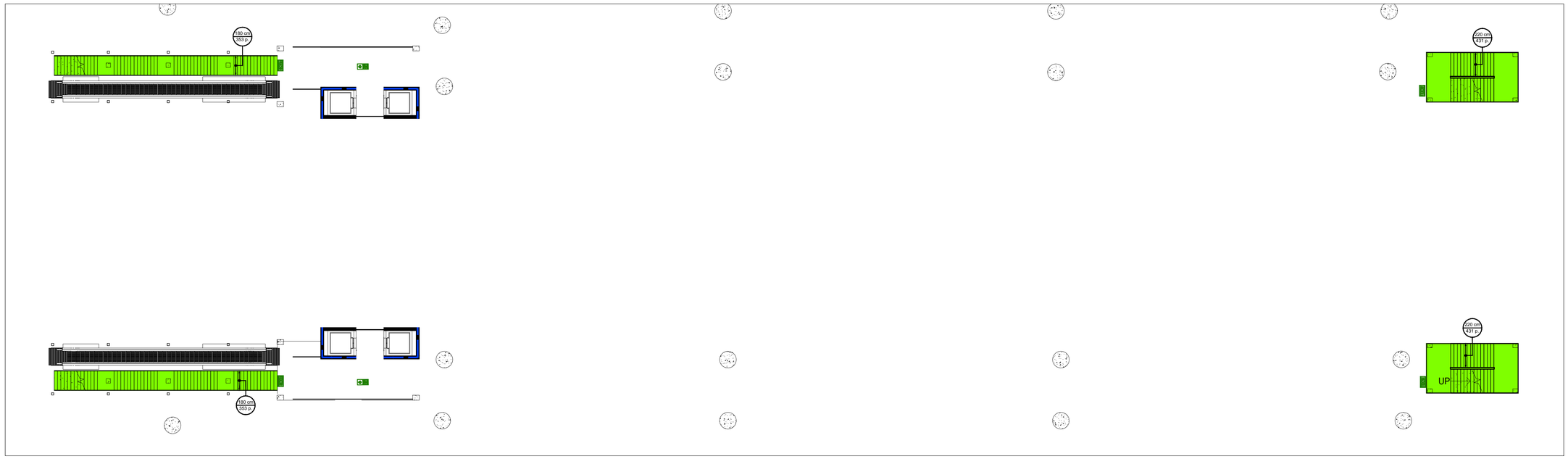
X cm / Y p. — STAIR WIDTH / DISCHARGE –NUMBER OF PERSONS

EXIT

EXIT ACCESS

EXIT STAIRS

1 HOUR FIRE RATED BARRIER



1 FIRE & LIFE SAFETY LAYOUT- BASEMENT FLOOR PLAN

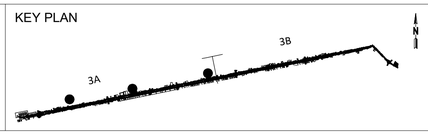
1 : 200

TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN


NOTES AND LEGENDS
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REV.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
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0	31/07/2024	APPROVED ISSUE	N.H	N.H	E.K	N.E

PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V7-V8
FIRE & LIFE SAFETY LAYOUTS
BASEMENT FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-8001

REVISION
1

FIRE ZONING LEGEND:

X cm / Y p. — STAIR WIDTH / DISCHARGE –NUMBER OF PERSONS

EXIT — EXIT

EXIT ACCESS

EXIT STAIRS

1 HOUR FIRE RATED BARRIER

1 FIRE & LIFE SAFETY LAYOUT- GROUND FLOOR PLAN

1 : 200

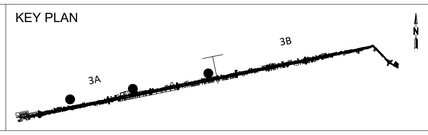
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

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REV.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
1	07/09/2024	GENERAL REVISION	N.H	N.H	E.K	N.E
0	31/07/2024	APPROVED ISSUE	N.H	N.H	E.K	N.E

PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

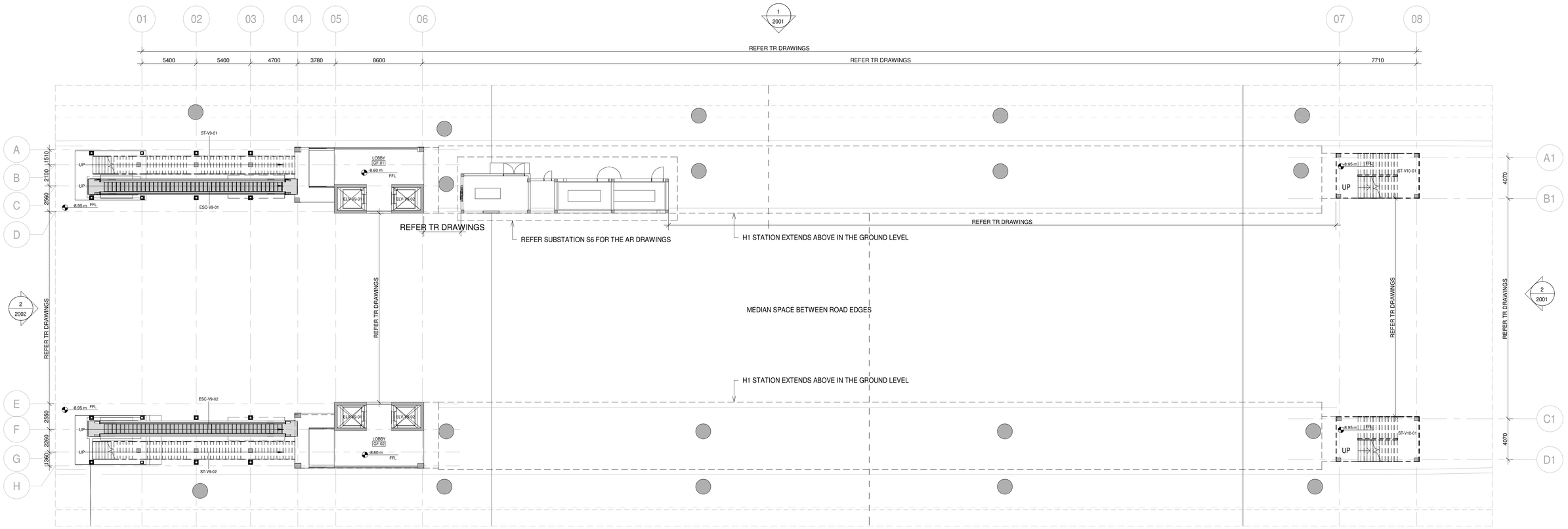
DRAWING TITLE
VERTICAL CIRCULATION - V7-V8
FIRE & LIFE SAFETY LAYOUTS
GROUND FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V7-V8-8002

REVISION
1



1 BASEMENT FLOOR PLAN (AT GRADE)

1 : 200

1
2002

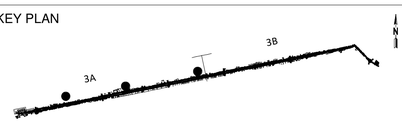
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

FOR LEVEL +-0.00 REFER TO THE BELOW SURVEY LEVEL FOR ROAD FINISH LEVEL AT THE STATION LOCATION ON TR MASTER PLAN:
- FOR (BILAL JUNCTION) THE ROAD SURVEY FINISH LEVEL IS +8.95

THE ESCALATORS SHOWN ARE FOR PROVISIONAL PURPOSES AND FUTURE PLANNING. THE ACTUAL QUANTITY TO BE EXECUTED IS SPECIFIED IN THE BOQ

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PROJECT TITLE

KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

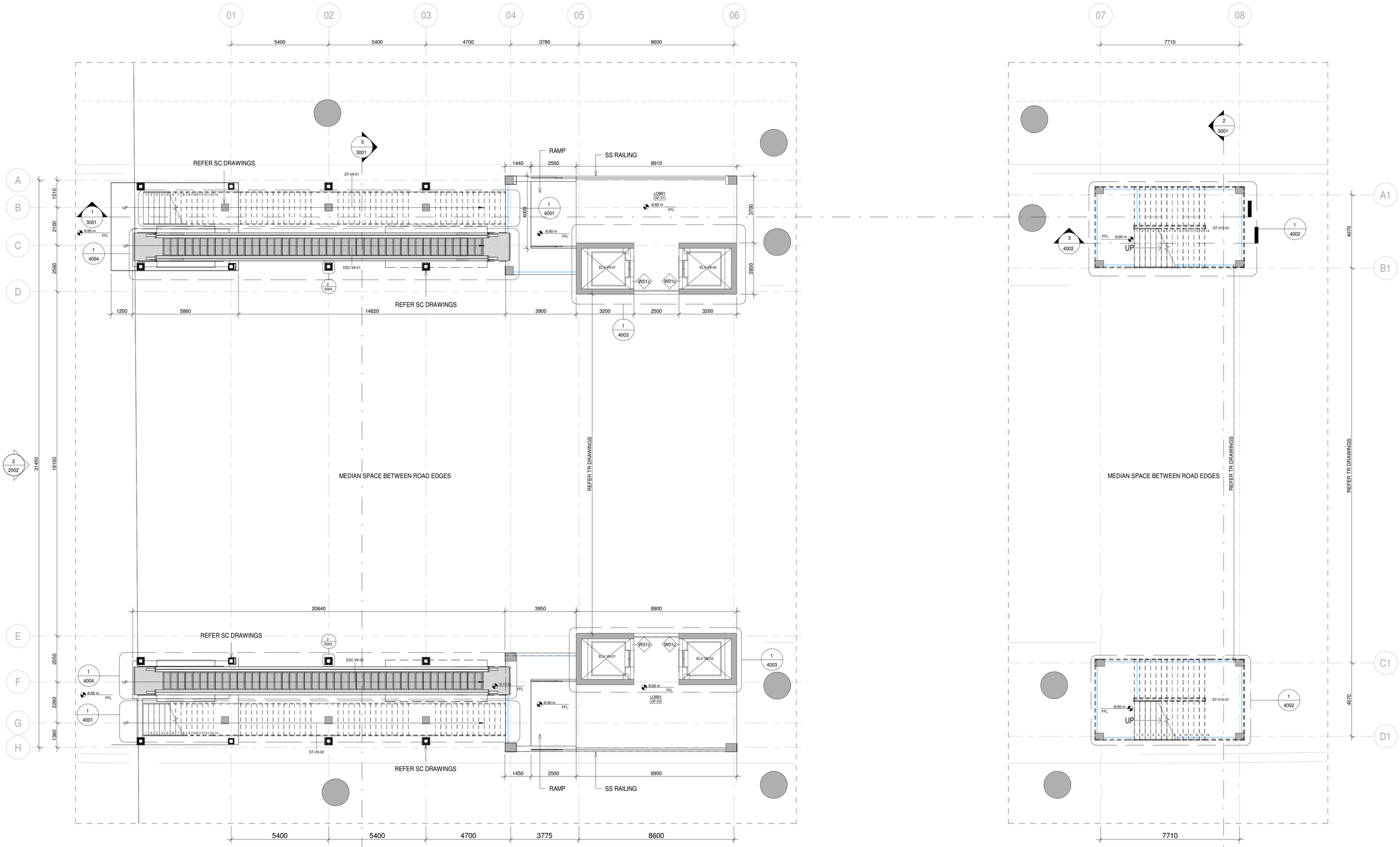
DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
FLOOR PLANS
KEY PLAN - GROUND FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-1001

REVISION
1



1 BASEMENT FLOOR PARTIAL - PLAN (AT GRADE)

1 : 100

TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN

NOTES AND LEGENDS

FOR LEVEL +-0.00 REFER TO THE BELOW SURVEY LEVEL
FOR ROAD FINISH LEVEL AT THE STATION LOCATION ON TR MASTER PLAN:
- FOR (BILAL JUNCTION) THE ROAD SURVEY FINISH LEVEL IS +8.95

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REV.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
1	07/09/2024	GENERAL REVISION	A.T	M.K	S.A / N.H	M.Y
0	31/07/2024	APPROVED ISSUE	A.T	M.K	S.A / N.H	M.Y

PROJECT TITLE

KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

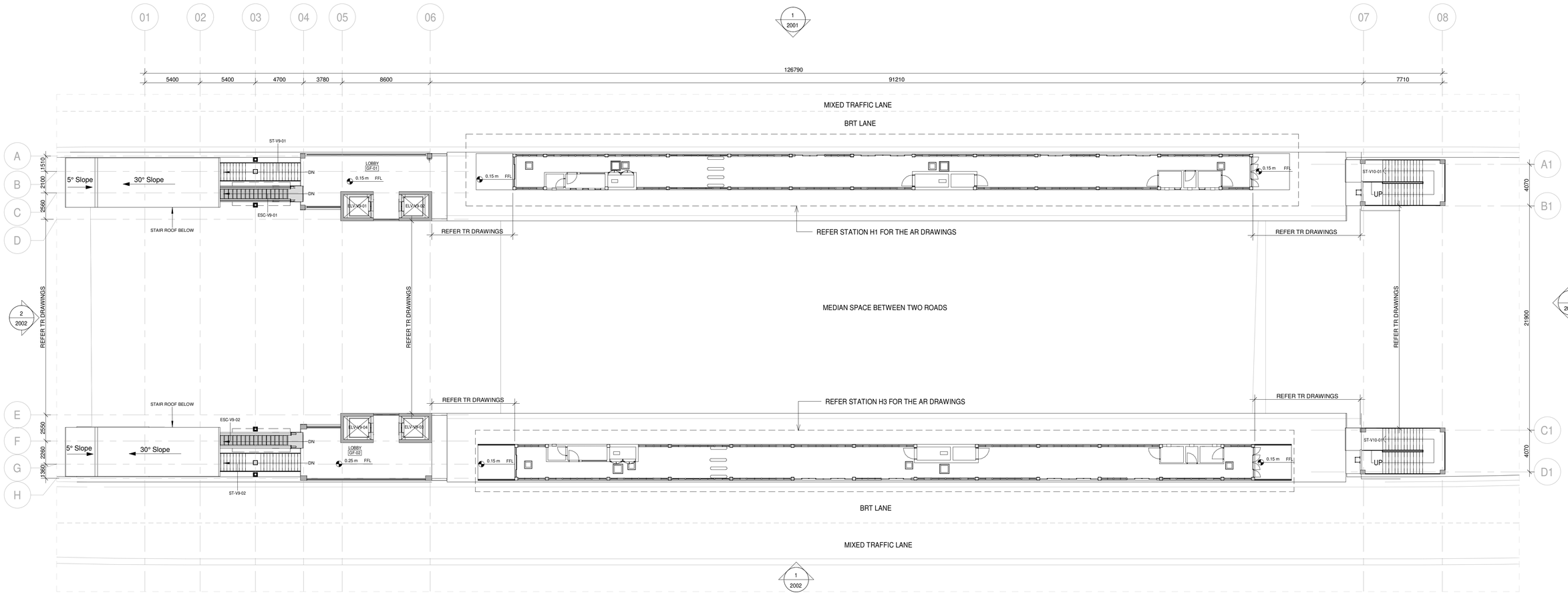
DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
FLOOR PLANS
GROUND FLOOR PLAN

SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-1002

REVISION
1



1 GROUND FLOOR PLAN (FLYOVER)

1 : 200

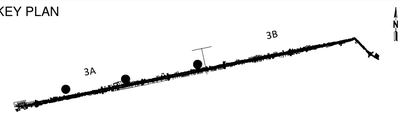
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

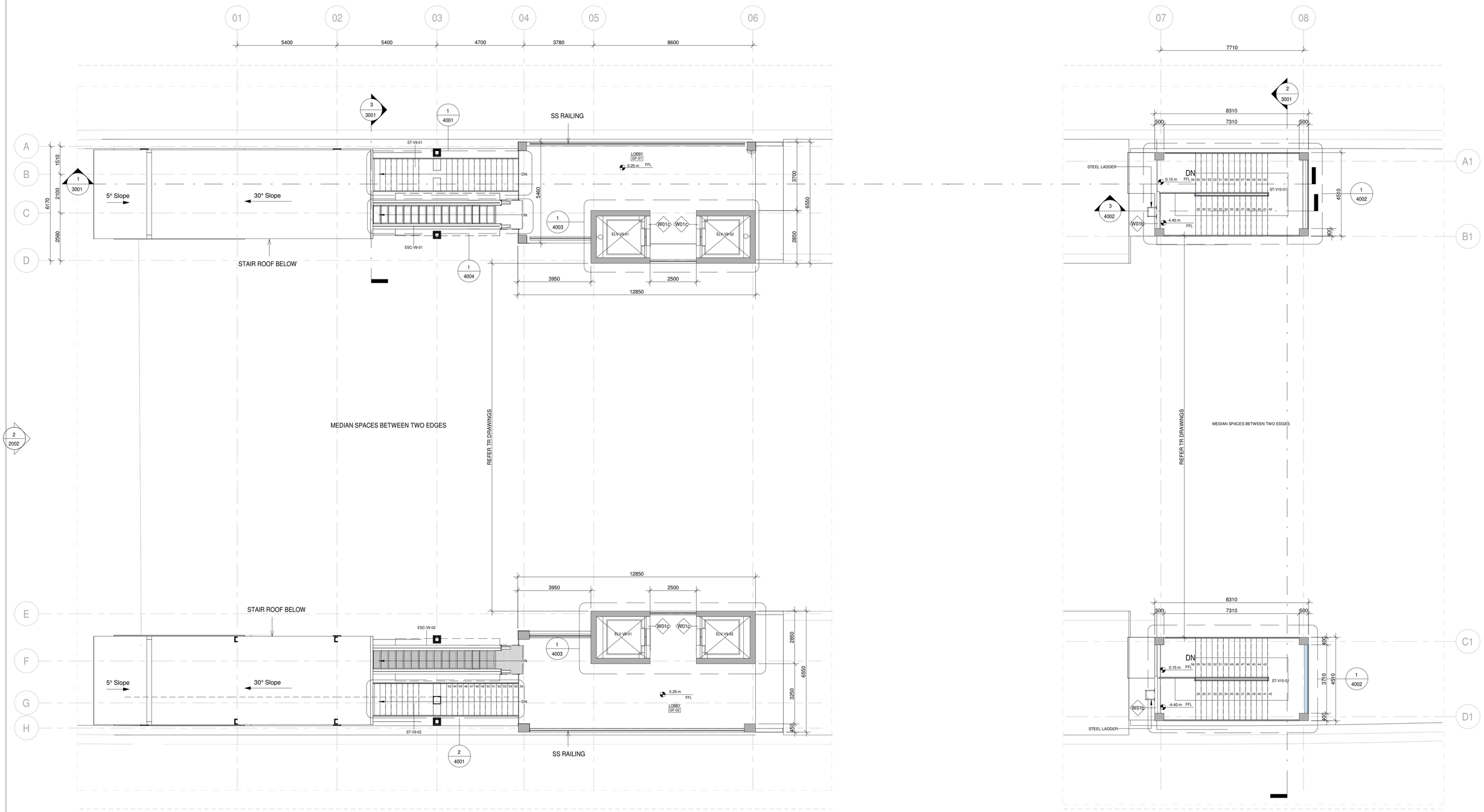
DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
FLOOR PLANS
KEY PLAN - FIRST FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-1003

REVISION
1



1 GROUND FLOOR PARTIAL - PLAN (FLYOVER)

1 : 100

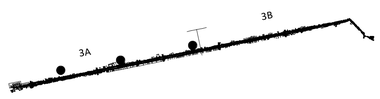
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

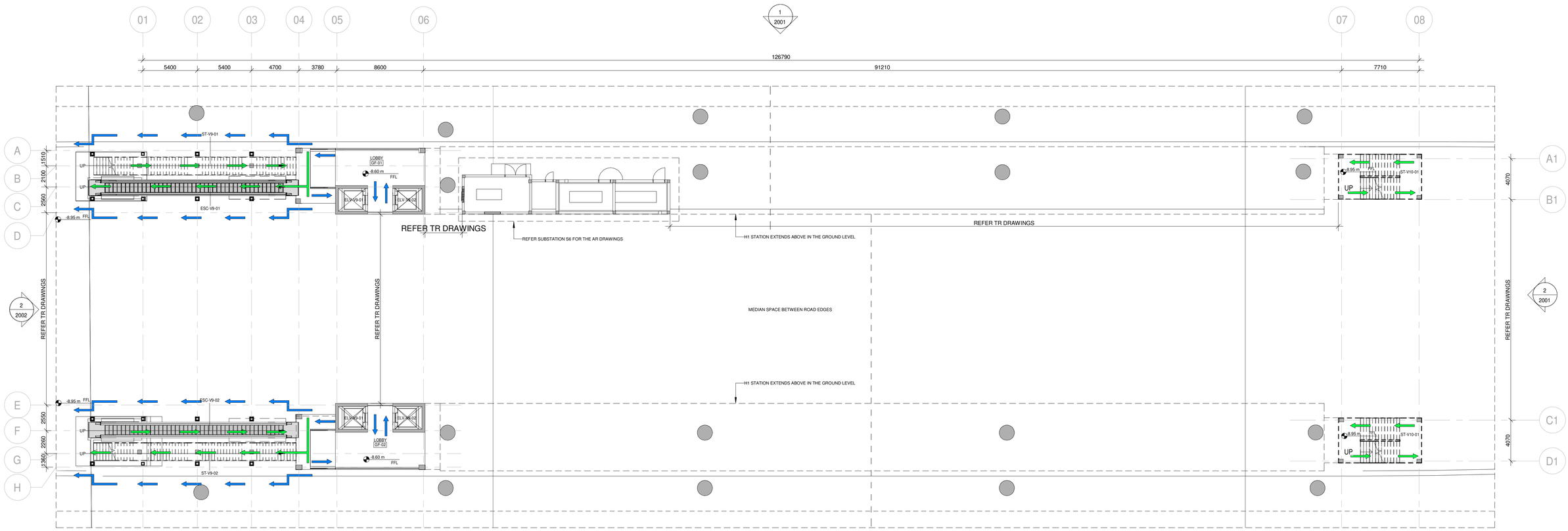
DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
FLOOR PLANS
FIRST FLOOR PLAN

SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-1004

REVISION
1



1 CIRCULATION PLAN - BASEMENT FLOOR PLAN (AT GRADE)

1 : 200

1
2002

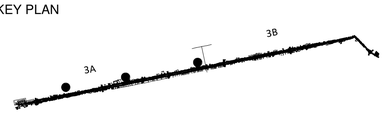
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS
- TICKETS POINT
- BUS GATES
- HANDICAP CIRCULATION ON THE ABOVE BRIDGE
- HANDICAP CIRCULATION
- PEDESTRIAN CIRCULATION ON THE ABOVE BRIDGE
- PEDESTRIAN CIRCULATION
- EMERGENCY EXIT

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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

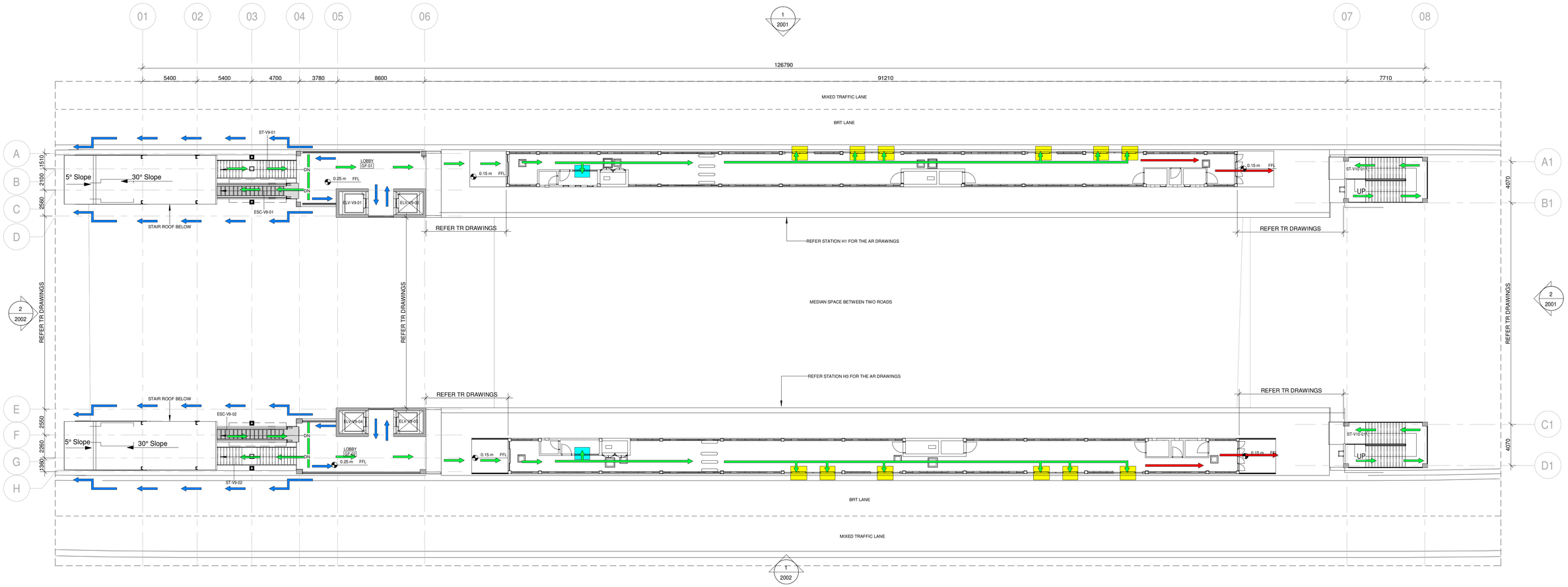
DRAWING TITLE
VERTICAL CIRCULATION V9 - V10
CIRCULATION PLAN
BASEMENT FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-1007

REVISION
1



1 CIRCULATION PLAN - GROUND FLOOR PLAN (FLYOVER)

1 : 200

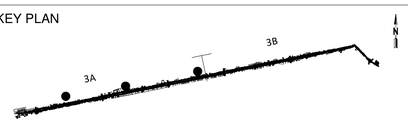
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS
- TICKETS POINT
- BUS GATES
- HANDICAP CIRCULATION ON THE ABOVE BRIDGE
- HANDICAP CIRCULATION
- PEDESTRIAN CIRCULATION ON THE ABOVE BRIDGE
- PEDESTRIAN CIRCULATION
- EMERGENCY EXIT

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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION V9 - V10
CIRCULATION PLAN
GROUND FLOOR PLAN

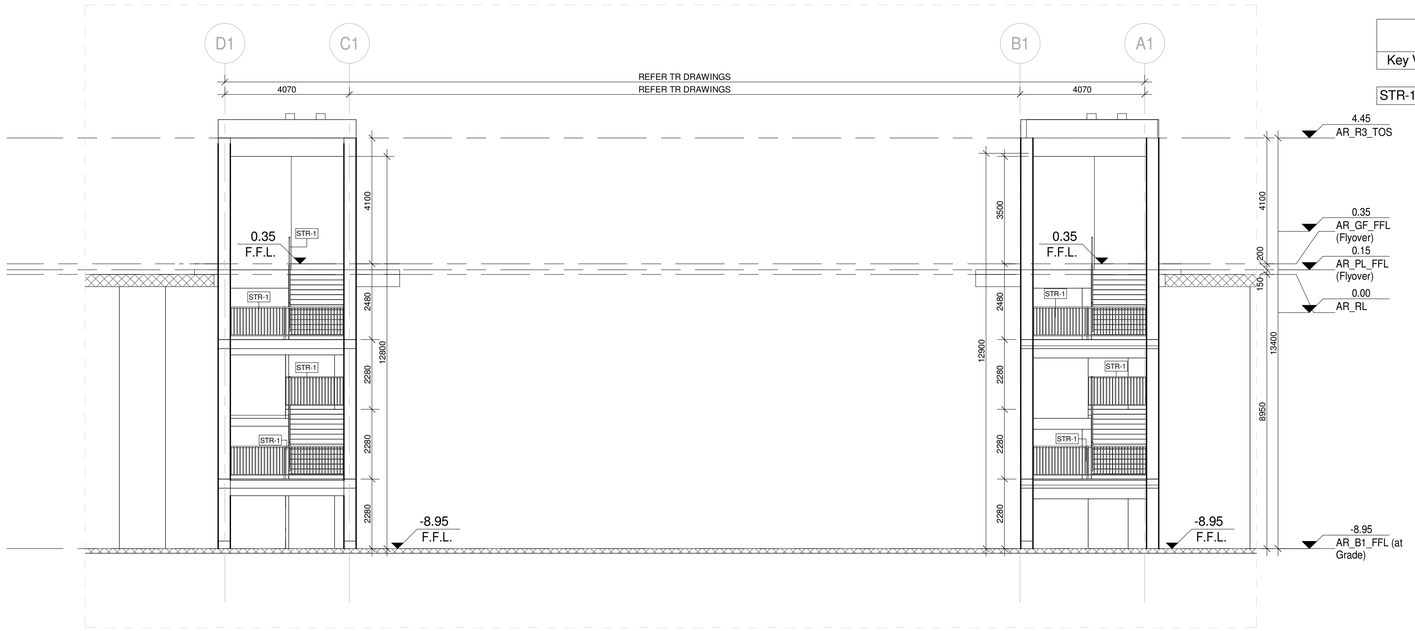
SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-1008

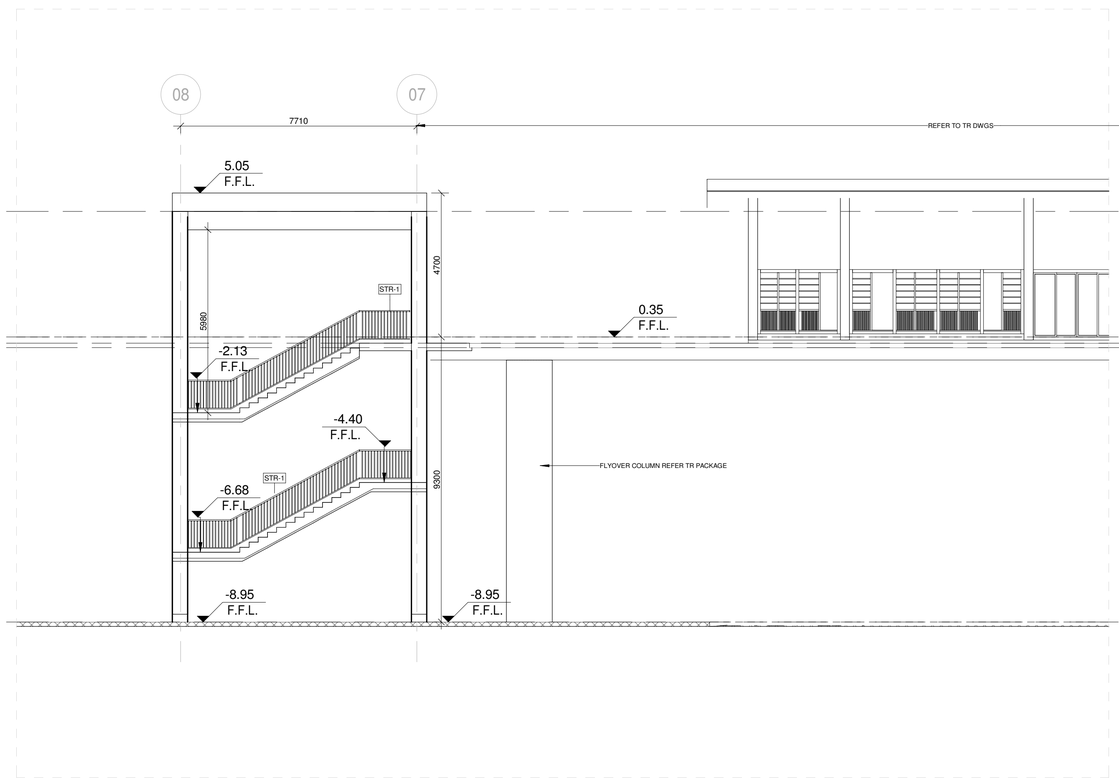
REVISION
1

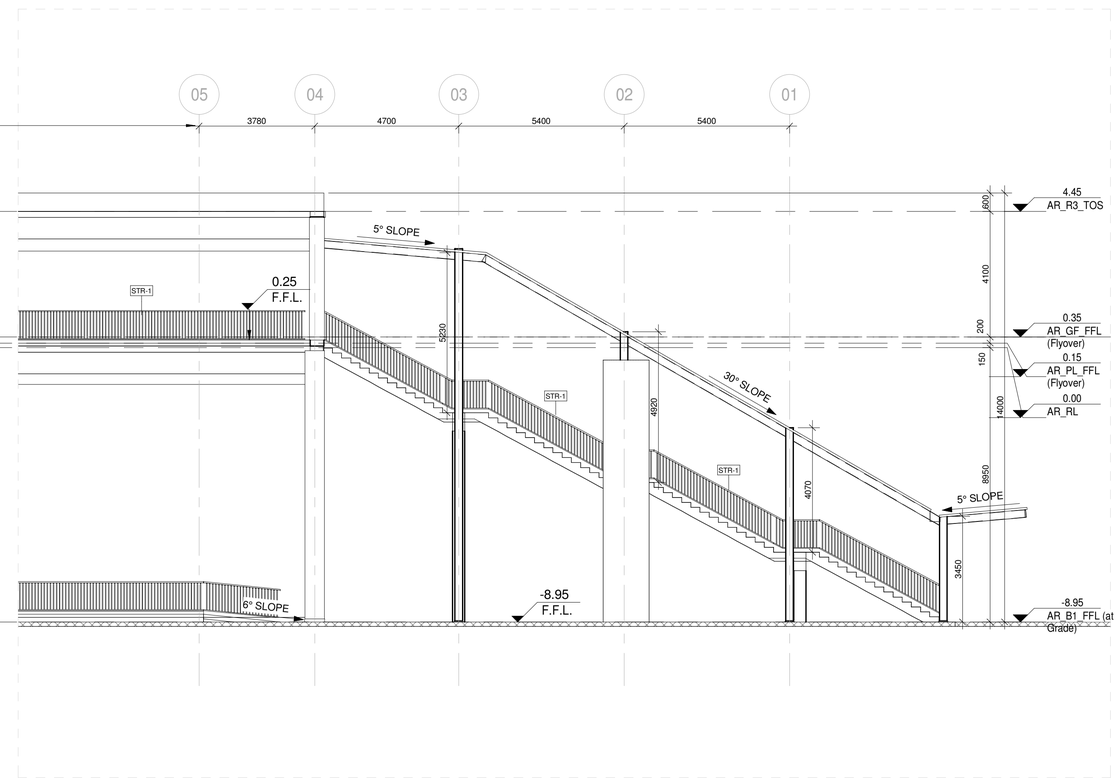
External Building Material List	
Key Value	Keynote Text
STR-1	STEEL RAILING-COLOR YELLOW (RAL 1021)



2 EAST ELEVATION

1 : 100





1 NORTH ELEVATION

1 : 100

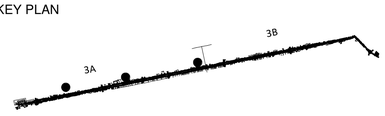
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE (SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
ELEVATIONS
EAST AND NORTH ELEVATIONS

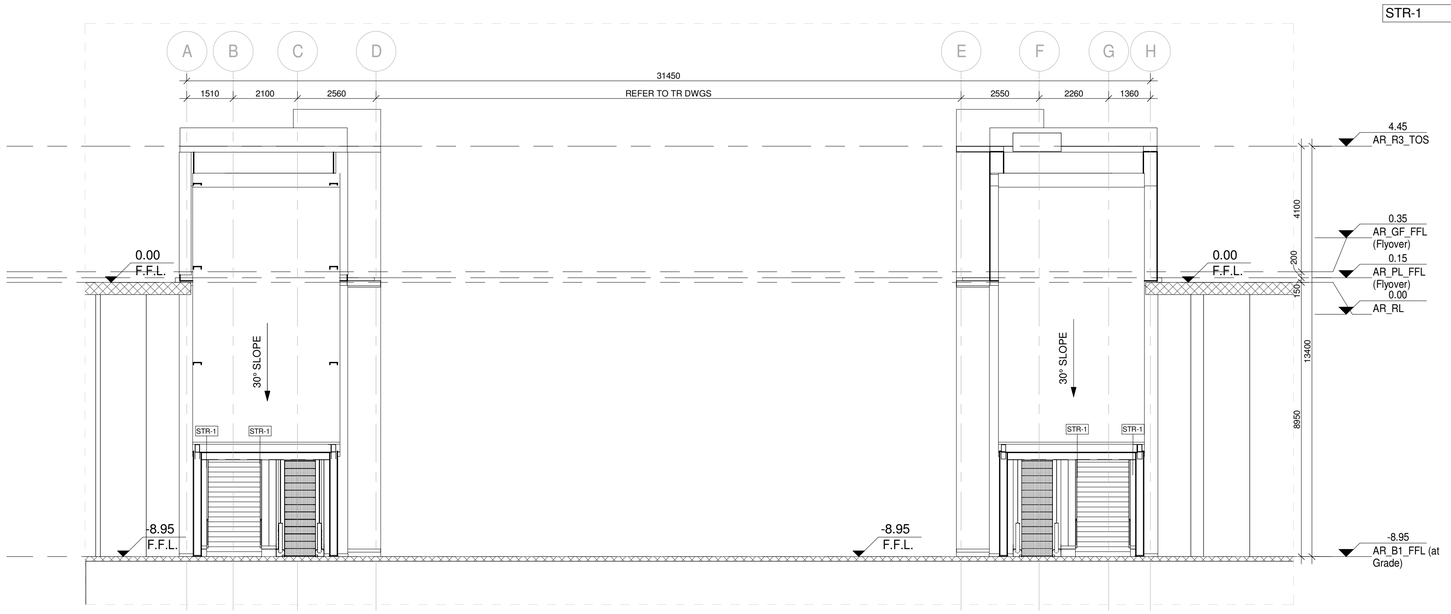
SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-2001

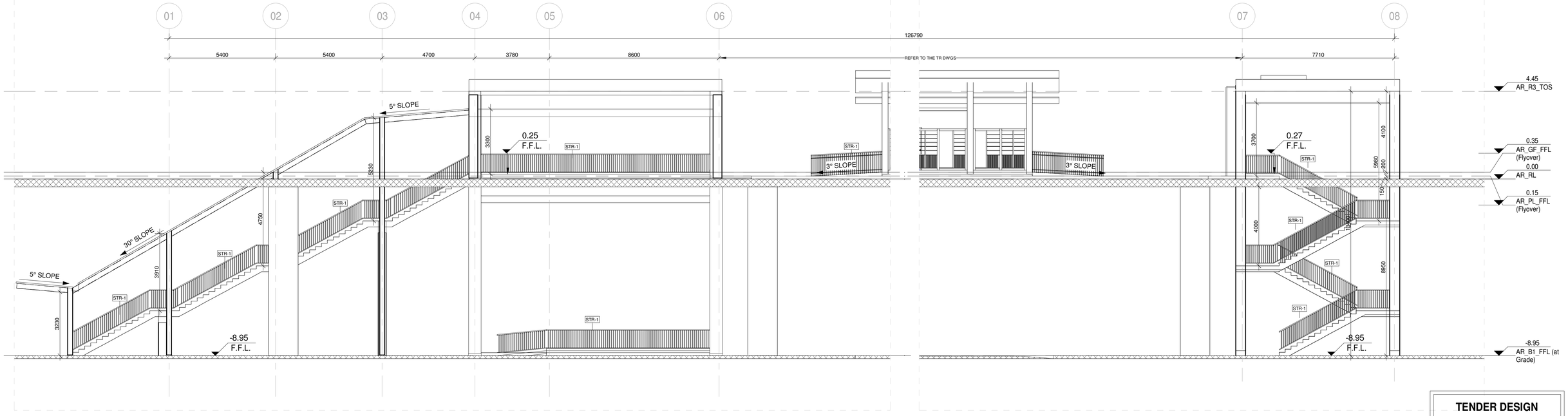
REVISION
1

External Building Material List	
Key Value	Keynote Text
STR-1	STEEL RAILING-COLOR YELLOW (RAL 1021)



2 Elevation 3 - a

1 : 100



1 SOUTH ELEVATION

1 : 100

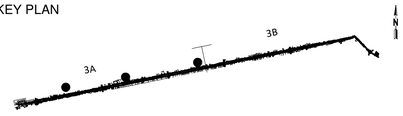
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
ELEVATIONS
SOUTH AND WEST ELEVATIONS

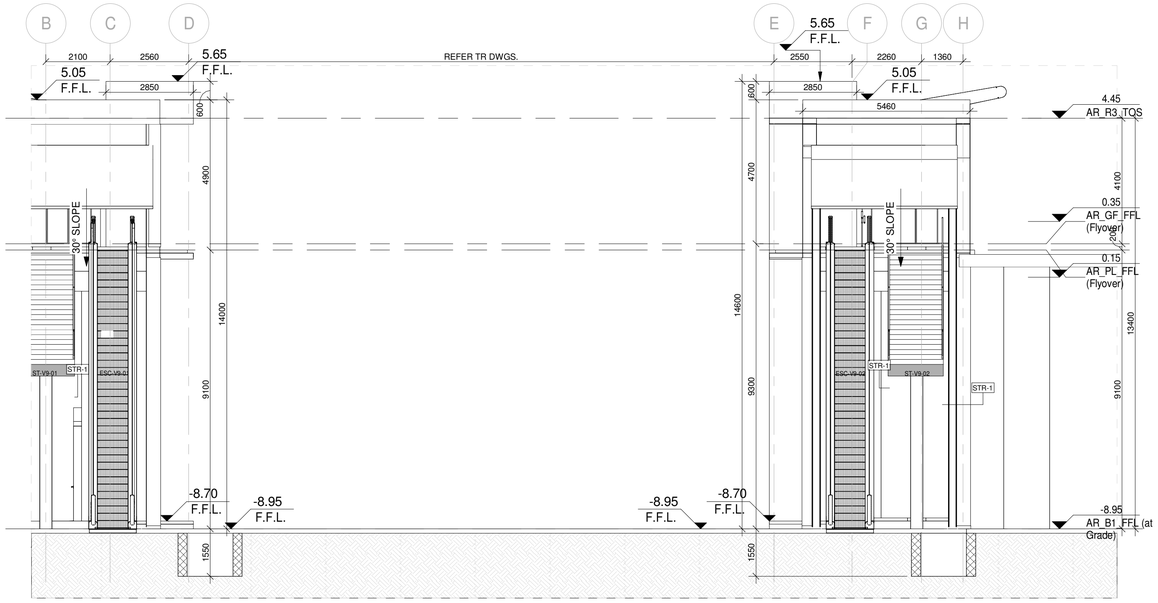
SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-2002

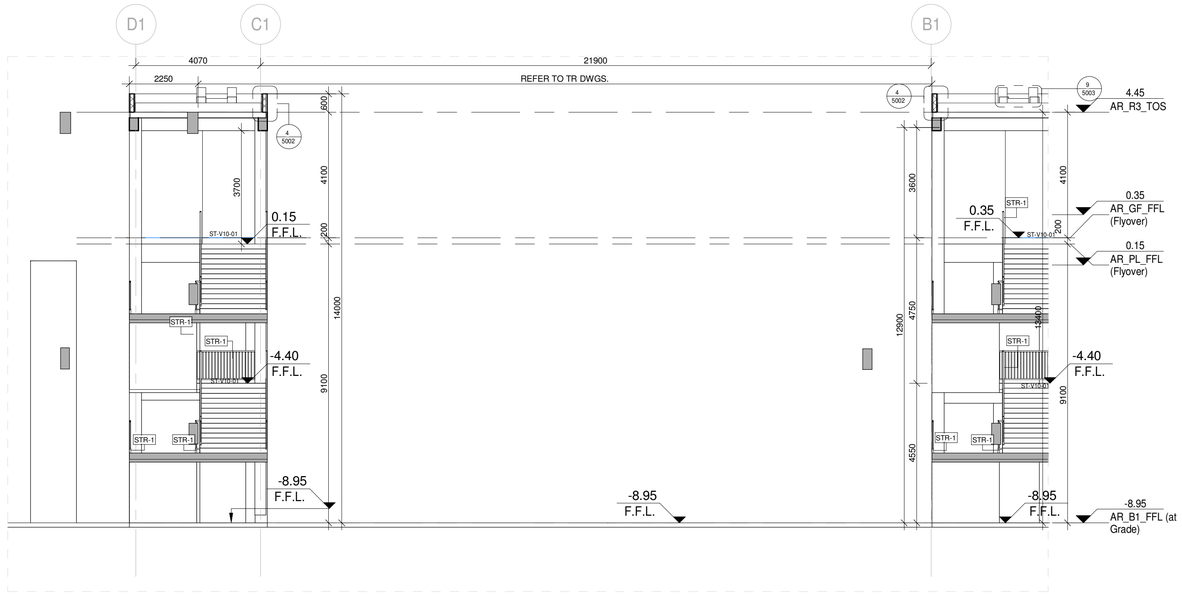
REVISION
1

External Building Material List	
Key Value	Keynote Text
STR-1	STEEL RAILING-COLOR YELLOW (RAL 1021)



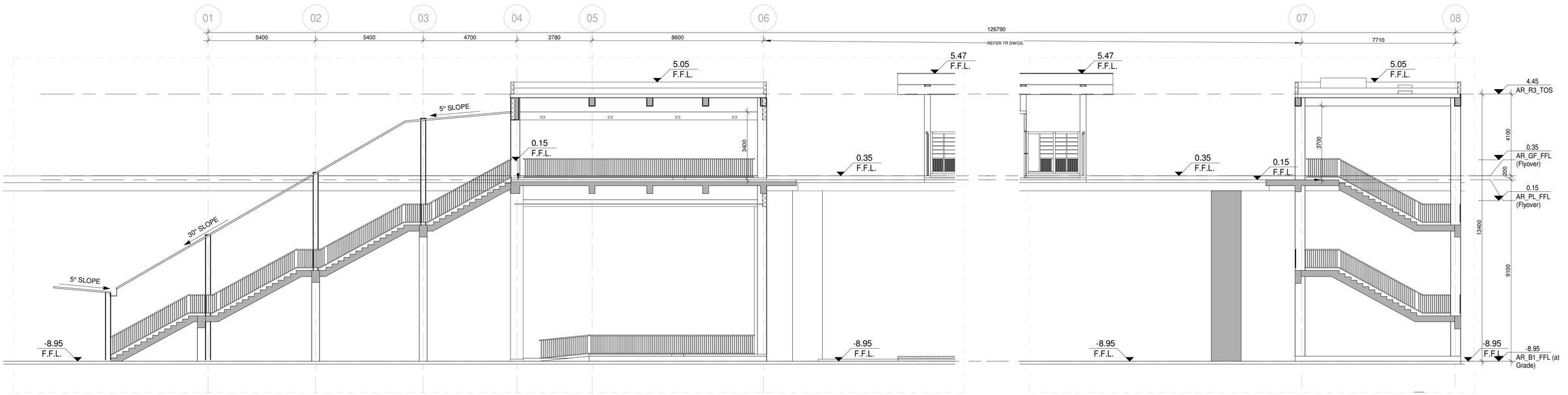
3 SECTION CC'

1 : 100



2 SECTION- BB'

1 : 100



1 SECTION AA'

1 : 100

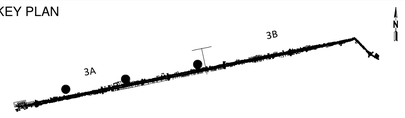
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
SECTIONS
SECTION AA' , BB', CC'

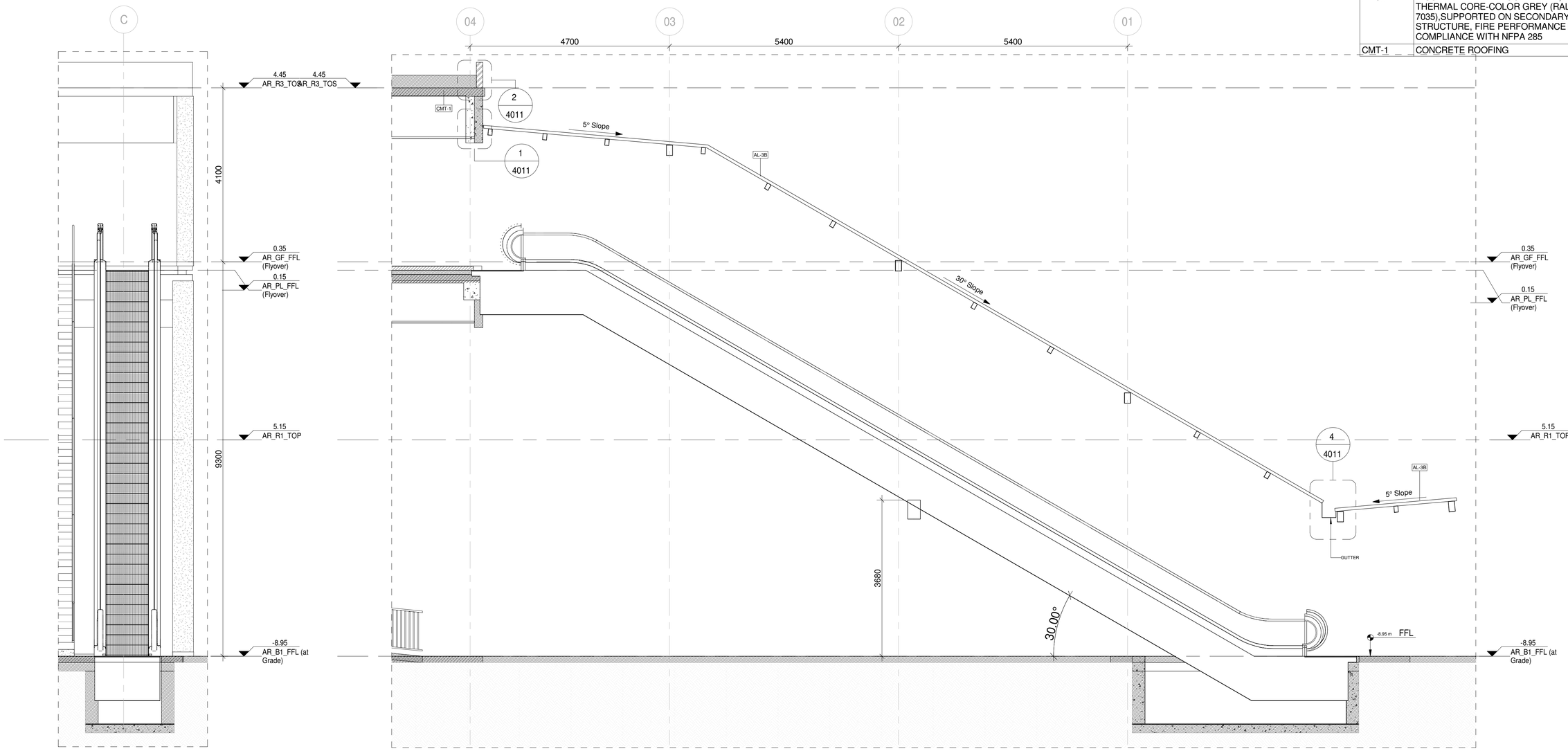
SCALE
1 : 100

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-3001

REVISION
1

External Building Material List	
Key Value	Keynote Text
AL-3B	INSULATED METAL ROOF PANEL , WITH PIR THERMAL CORE-COLOR GREY (RAL 7035),SUPPORTED ON SECONDARY STEEL STRUCTURE, FIRE PERFORMANCE IN COMPLIANCE WITH NFPA 285
CMT-1	CONCRETE ROOFING

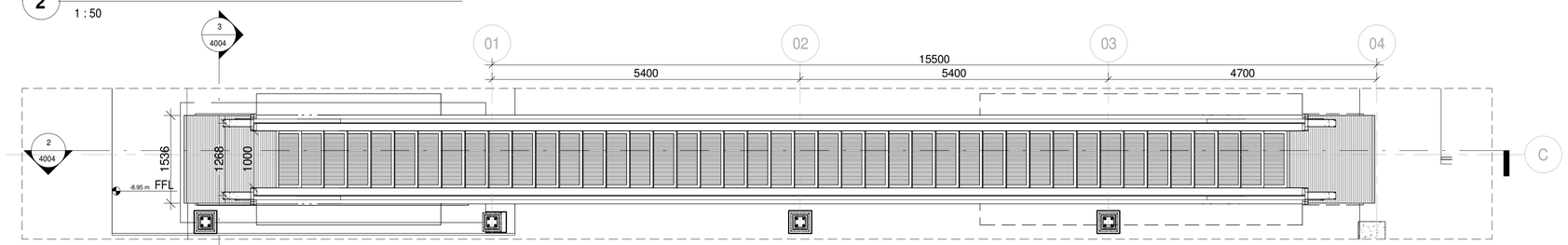


3 ESCALATOR SECTION BB' - ECS - V9 - 01, 02

1 : 50

2 ESCALATOR SECTION AA' - ECS - V9 - 01, 02

1 : 50



1 ESCALATOR GROUND FLOOR PLAN - ECS - V9 - 01, 02

1 : 50

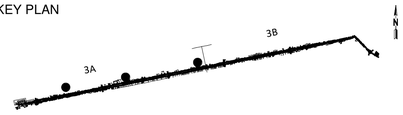
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



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PROJECT TITLE

KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V9 - V10
ESCALATOR DETAILS

SCALE
1 : 50

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-4004

REVISION
1

FIRE ZONING LEGEND:

X cm
Y p.

STAIR WIDTH
DISCHARGE –NUMBER OF PERSONS

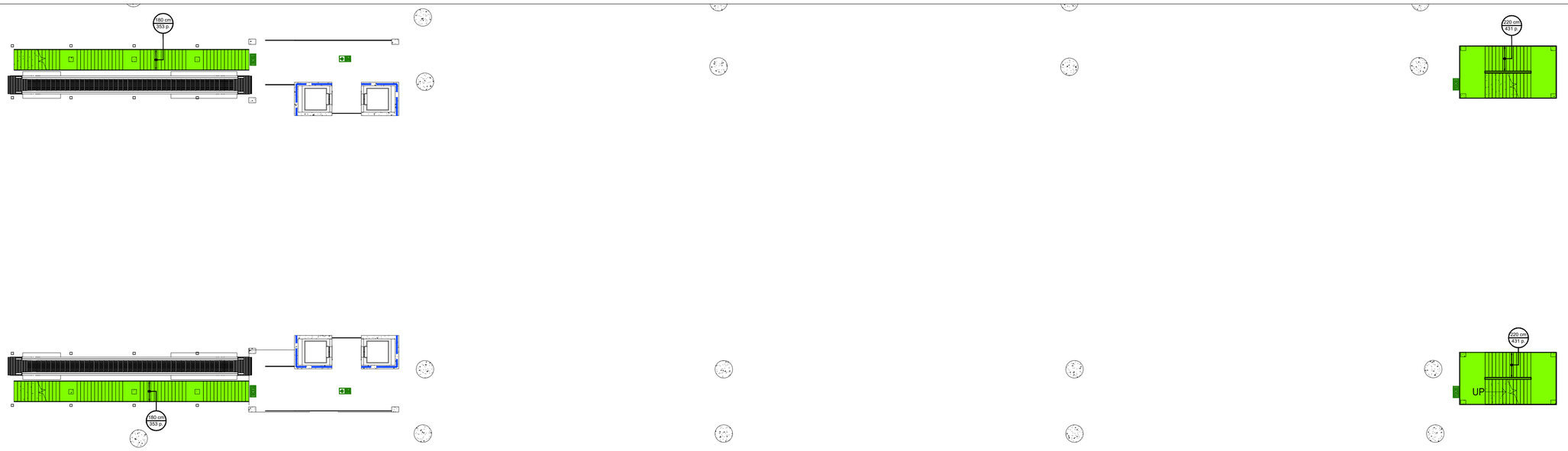
EXIT

EXIT

EXIT ACCESS

EXIT STAIRS

1 HOUR FIRE RATED BARRIER



1 FIRE AND LIFE SAFETY LAYOUT- BASEMENT FLOOR PLAN

1 : 200

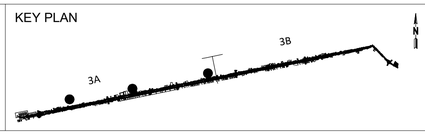
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



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PROJECT TITLE
KARACHI MOBILITY PROJECT - YELLOW BRT LINE
PACKAGE 3A - ROAD CORRIDOR AND BRT INFRASTRUCTURE
(SEGMENT 2)

DRAWING TITLE
VERTICAL CIRCULATION - V9-V10
FIRE & LIFE SAFETY LAYOUTS
BASEMENT FLOOR PLAN

SCALE
1 : 200

DATE
07/09/2024

DRAWING NUMBER
P21161/4309-03-TD-A-V9-V10-8001

REVISION
1

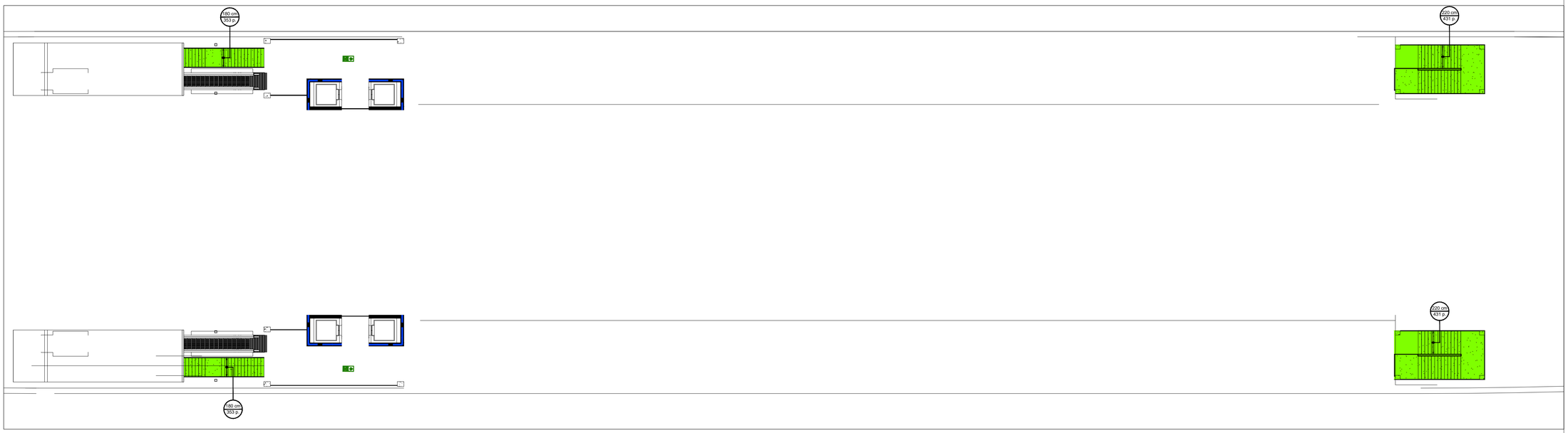
FIRE ZONING LEGEND:

X cm
Y p.

STAIR WIDTH
DISCHARGE –NUMBER OF PERSONS

EXIT
EXIT ACCESS
EXIT STAIRS

1 HOUR FIRE RATED BARRIER



1 FIRE AND LIFE SAFETY LAYOUT- GROUND FLOOR PLAN

1 : 200

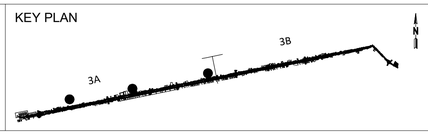
TENDER DESIGN
SEPTEMBER 2024

CLIENT
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT, GOVERNMENT OF SINDH

FUNDING AGENCY
THE WORLD BANK

CONSULTANT
dar
NESPAK

KEY PLAN



NOTES AND LEGENDS

THE ESCALATORS SHOWN ARE FOR PROVISIONAL PURPOSES AND FUTURE PLANNING. THE ACTUAL QUANTITY TO BE EXECUTED IS SPECIFIED IN THE BOQ

REV.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
1	07/09/2024	GENERAL REVISION	N.H	N.H	E.K	N.E
0	31/07/2024	APPROVED ISSUE	N.H	N.H	E.K	N.E

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GROUND FLOOR PLAN

SCALE
1 : 200

DATE
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DRAWING NUMBER
P21161/4309-05-TD-A-V9-V10-8002

REVISION
1