People's Republic of Bangladesh
Dhaka Electricity Supply Company Ltd (DESCO)
Dhaka Power Distribution Company Ltd (DPDC)

People's Republic of Bangladesh

Special Assistance for Project Implementation on Dhaka Underground Substation Construction Project

Final Report

February 2019

Japan International Cooperation Agency (JICA)

TEPCO Power Grid, Incorporated
Tokyo Electric Power Services Co., Ltd.

BD
CR(3)
18-004

Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Word
BPDB	Bangladesh Power Development Board
CEGIS	Center for Environmental and Geographic Information Services
CNG	Compressed Natural Gas
DESCO	Dhaka Electricity Supply Company Ltd
DMS	Dhaka Metropolitan Area
DNCC	Dhaka North City Corporation
DSCC	Dhaka South City Corporation
DOE	Department of Environment
DPDC	Dhaka Power Distribution Company Ltd
ECA	Environmental Conservation Act
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EIA	Environment Impact Assessment
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
FAR	Floor Area Ratio
FS	Feasibility Study
GDP	Gross Domestic Product
GIT	Gas Insulated Transformer
GTr	Grounding Transformer
JICA	Japan International Cooperation Agency
MH	Machine Hatch
MOU	Memorandum of Understanding
NOC	No Objection Certificates
O&M	Operation and Maintenance
PGCB	Power Grid Company of Bangladesh Ltd
PIU	Project Implementation Unit
RAJUK	Rajdhani Unnayan Kartripakkha
RC	Reinforced Concrete
SAPI	Special Assistance for Project Implementation
SPT	Standard Penetration Test
SS	Substation
T&D	Transmission and Distribution
TEPCO	Tokyo Electric Power Company
TEPCO PG	TEPCO Power Grid, Inc.
TEPSCO	Tokyo Electric Power Services Co., Ltd.
UG	Underground
UGSS	Underground Substation
UGTL	Underground Transmission Line

Chapter 0. Executive Summary: SAPI on UGSS Construction Project

0.1 Objective

The objective of the "Special Assistance for Project Implementation" (hereinafter "SAPI") for Dhaka Underground Substation Construction Project is to provide assistance to both companies to implement the project comprising the following components:

[Component-1]: Construction of two (2) underground substations (hereinafter "UGSS"), Gulshan substation for Dhaka Electric Supply Company Ltd (DESCO) and Kawranbazar substation for Dhaka Power Distribution Company (DPDC), including cooling system
[Component-2]: Construction of underground tunnels and vertical shafts for underground transmission and distribution lines
[Component-3]: Installation of electric equipment in UGSS
[Component-4]: Installation of underground transmission lines - 3km for Gulshan substation and 2km for Kawranbazar substation
[Component-5]: Installation of distribution lines
[Component-6]: Engineering services for the above components

0.2 Works and Accomplishments

The JICA Team, a joint venture formed by TEPCO Power Grid and TEPSCO, conducted the following works for promoting the project implementation based on the technical examination, design and layout of the UGSS components defined in the "Data Collection Survey on Underground Substation in Dhaka in People's Republic of Bangladesh" performed in 2016/17.

- Examination of the changes requested and made in the project components, and progress of execution agencies' work after the completion of the Data Collection Survey in March 2017 and the loan agreement signed in July 2017, including development of whole project plan, appointment of design consultants for the superstructure design, and necessary regulatory registrations and applications.
- Review of the superstructure design developed by the superstructure architect to co-ordinate designs between UGSS and its architecture.
- Detailed study of the transmission line construction design including on-site survey of the transmission line routes from source substations to the UGSSs.
- Identification of regulatory registrations and applications required for the UGSS construction, and their procedures, lead-times, and necessary documents as part of the entire building construction project on the UGSS plot.
- Detailed study on the UGSS components based on the updated civil engineering information, and design co-ordination with superstructure.
- Review and updates of the environmental management plan and monitoring plan based on the results of the above technical examination, anticipation of cumulative environmental impacts caused by the UGSS and superstructure, and examination of their management measures.

- Identification of gaps between the designs updated during this SAPI and the pre-conditions based on which the Engineering Service Consultant shall perform, and the issues the ES Consultant shall follow up

The JICA Team engaged Mott MacDonald Bangladesh & Singapore, which has a strong background and track record in large-scale building project design in all Asian countries, to further examine UGSS design and construction, and make the dialog with the superstructure architects more fruitful. The Team also commissioned the Center for Environment and Geographical Information Services (CEGIS) to conduct local environmental and social survey, and underground cable route survey, which has strong experience in Bangladesh's regulatory processes and geographical surveys in large-scale construction projects in the country.

Accomplishments during the SAPI are summarized in the two tables below. The important issues which the ES Consultant shall follow up are also described there.

Table 0-1 SAPI's Contribution to DESCO Gulshan Project

	Studies done during the Data Collection Survey in 2016/17, and outstanding issues	Studies done during the SAPI	Concerns, necessary actions and decisions which shall be made by the Clients and Engineering Service Consultancies
Regulatory process for necessary approvals Regulations and Design Codes applicable to UGSS	Regulatory Studies were planned to be done after the L/A. Necessity of building construction permission was identified, but not examined in detail. Applicable firefighting design and building code were not examined because of limited entry to Bangladesh due to the terrorism attack in July 2018.	Regulatory procedure for the building construction permission was investigated, including corresponding NOCs from relevant authorities, and their lead-time. BNBC's design standards for mechanical ventilation system in UGSS were examined, and SAPI developed a preliminary design for MV system in Gulshan UGSS based on individual ducting system, which could be streamlined if waived. BNBC's design requirements for firefighting system suggest following major components for UGSS: 1. Smoke detectors 2. Water sprinkler system 3. Thermal detector if alarm activates fire extinguisher 4. Flame detectors and specialized water-mist spray system for transformers 5. Sprinkler system for common places, such as corridors and toilet facilities BNBC requires double emergency elevators, which should be supplied from emergency generator system, if the depth of underground structure exceeds 9 meters.	Project Schedule must be reviewed based on the whole project schedule, and necessary regulatory procedures to acquire the construction permission. Underground substation design may be revised based on the statutory requirements, and relevant design codes and standards agreed with the authorities. If necessary, DESCO must seek design waivers to establish UGSS's design practices. M&E system for UGSS building design must be finalized in ES consultancy to satisfy relevant codes. In particular, mechanical ventilation system, and therefore the total project cost, can be streamlined by using Japanese common corridor system for air supply. Dimensions of the emergency elevators, their elevator pits, and emergency power supply scheme must be coordinated with the superstructure.
Construction conditions, constraints in plot usage.	Sheet pile method was selected due to the depth of the proposed UGSS, and necessary machinery is planned to be imported. The excavated soil is to be transported at night time, while excavation can be also done at the side during night time.	The JICA Team confirmed that D-wall system or sheet-pile system can be applied at the Gulshan site based on the study done by Mott MacDonald through interviews with local construction companies. UGSS Building's set-back from the border was examined, confirming that a distance of 3 meters from the borders must be secured in the UGSS layout for now to allow construction machinery to be safely installed for the earth-retaining work.	On-site geographical surveys and verification of neighboring buildings must be done to develop a proposed standard excavation method for bidding document FS. Availability of the construction machinery, and necessary import procedures must be confirmed. Regardless of the method applied (D-wall or sheet-piling), quality requirements, methodology, on-site

		The UGSS layout was revised accordingly. The proposed setback, which is 3 meters, was confirmed for the enough clearance for the soil retaining work and excavation work. The layout was developed based on the 3m setback. The possible maximum depth of the UGSS, estimated at 27m, in case of BNBC MV system regardless of earth retaining system (D-wall or sheet-pile).	workspace planning, and monitoring plan must be studied to avoid any fatal consequences regarding the land excavation.
Electric Design for UGSS	Feasibility of Gas Insulated Transformers for the project was examined through Japanese manufacturer interviews.	For the co-ordination with superstructure design, the UGSS layouts were revised to secure sufficient equipment space for available GITs and GISs, by setting maximum dimensions and weight of the equipment among the variations confirmed via interviews. In particular, one OEM's two tank GIT may require further fine-tuning of the transformer room, along with shutters, mechanical ventilation system, fire protection system, and power cable connections. The winding scheme for GITs was discussed to seek further streamlining in UGSS's footprint and its depth. SAPI finalized the winding scheme as delta-Y connection, which was originally requested by DESCO & DPDC, and the dimensions of GIT became 10% more than conventional GITs.	During the ES study, ES consultant may want to request further studies by GIT and GIS manufacturers. After the selection of manufacturers for each SS component, the Contractor that is going to design the final UGSS building must adjust the layout according to the actual dimensions.
Mechanical and Electrical Design for UGSS Building	Basic design was done based on Japanese Building Standard and interviews with BNBC. Detailed Studies for the UGSS Building Design are planned to be done after the L/A.	Per BNBC's requirements for fire-alarms, firefighting systems, water sprinkler systems and mechanical ventilation systems, preliminary designs for ducting and space provisions for the firefighting system were incorporated in the layout so that the maximum depth and column grid can be verified. To assess the maximum depth anticipated for the UGSS building, current BNBC design standards were referred to in order to design the individual ducting system inside UGSS.	Streamlining of M&E system applicable for UGSS must be sought to define a new technical standard for firefighting and ventilation systems specific to UGSSs in Bangladesh, as GIT is inflammable, and most of the UGSS compartments can be regarded as inhabitable except for during maintenance work. As an example of technical requirements that may not applicable, BNBC requires sprinkler systems all the way to the corridor, and a flame detector for the transformer, which may not operate properly

			because GIT does not create flames even in a malfunction. The ventilation ducting system must be designed using the following three variations for pre-consultation and negotiation on the waiver with RAJUK's technical officers. 1. The maximum depth of UGSS building must be determined along with the ducting system, complying with BNBC standards. 2. Japanese common-air intake system using corridor must be introduced to streamline the project, and its cost. 3. In some extreme cases, localized cooling system may be introduced to optimize the project cost with optimized UGSS depth.
Equipment Layout of Underground Substation	Cooling system scheme and design for the GIT were not completely verified with manufacturers, and space provisions were given in the proposed layout without the consideration of superstructure design, which was not available. Also, GIT's heat dissipation was not finalized with manufacturers, so TEPCO PG's standard value was applied. Duct system and fire extinguishing system were not considered in the layout, and some space provisions were made. All these design reviews are to be done after L/A, and after creating superstructure design.	The UGSS layouts were finalized and submitted to DESCO and 37 Bridge for revision of superstructure after the co-ordination with superstructure, location of cooling system, and studies on ventilation ducts and firefighting system based on the applicable laws and regulations. In particular, necessary structures for lifting heavy equipment onto the machine hatch, ground-level workspaces for UGSS equipment replacement & installation, and location of ventilation openings and UGSS access were coordinated during technical discussion with 37 Bridge. Also, the UGSS layout incorporates the necessary boundary setbacks to cater for sheet-piling or D-wall installation during soil excavation.	Building M&E design, and firefighting design must be finalized based on BNBC's standards and applicable technical waivers negotiated with authorities. The proposed water-cooling system must also be well harmonized into the superstructure design to avoid any adverse impacts on the surrounding environment. In particular, the application of GIS must be well explained to streamline necessary building facilities for UGSS building. The revised superstructure design must be shared soon among stakeholders for further review and successive simulations to verify that its structural design complies with BNBC and common high-rise building standards in Asian countries. Necessary accessories and facilities below ground for the superstructure, such as sewage tanks, elevator pits, hook for UGSS, and necessary ceiling clearance above the machine hatch, must be

			continuously discussed to be accommodated in the superstructure's final design.
Superstructure Design	Details of the superstructure and its usage were not determined. Thus, a 13-storied building with 15kN/m2 floor loadings were assumed for UGSS layouts with DESCO's consent, and column grid was determined according to Japanese standards.	Introduction of water-cooling system, and cooling fan on the 5th floor of the superstructure was discussed, it was and agreed to incorporate these in the revised superstructure design. Column Grid and UGSS building parts to be integrated in the superstructure building were discussed and agreed. Some of the columns were not arranged in a straight line from UGSS to superstructure, and transposition may be necessary on the ground floor. This structural verification must be done by 37 Bridge after development of the revised superstructure design.	The superstructure design must be reviewed and finalized by 37 Bridge for further study on the transposition and coordination of earth retaining structure for entire project site. O&M of the cooling system, cost sharing and construction procedure must be developed based on 37 Bridge's superstructure design and construction scheduling. Proper noise prevention measures must be applied for the elevated cooling fans on superstructure's floor level. Heat dissipation from the cooling system may be simulated at the request of DESCO.
Transmission line and its installation method	Transmission line routes were preliminary determined based on interview with DESCO, assuming limited number of buried objects and direct burial of power cables. Underground tunnel facilities were proposed only for the surroundings of UGSS.	To properly install increased number of transmission and distribution power cables within the limited space around UGSS, and to avoid significant adverse impact on the traffic and public activities, basic design for the underground tunnel was developed along with the power cable arrangement at the connection to UGSS. Test boring and test excavation were originally planned, but the less invasive method of GPR was employed to conduct the investigation on buried objects before and within the national election period. The investigation indicated quite a lot of buried objects around the UGSS.	Detailed investigation on buried objects must be done first to identify who will be responsible for the relocation of the objects. DESCO must develop the load evacuation plan considering the expected load increase, and network available to be switched over to. If any buried objects are not removable during the construction of tunnels, the protection method and construction method must be duly studied and agreed by the authorities concerned. Along the transmission route to Rampura substation, power cable conduit system or piping system may be applicable for the physically constrained portion in DESCO's implementation.
Project Scheduling, Cost estimation	In the data collection survey, the construction work plan considered necessary midnight work cost increments, and temporary work for better cost estimation. Cost	Project Schedule was revised to capture the delay in the appointment of ES for further revision among stakeholders including DESCO, ES consultancy, 37 Bridge, and JICA.	Construction schedule for UGSS building and UG tunnel facilities around UGSS, and vertical shafts requires detailed project schedule coordination to share common workspaces.

	information for equipment was derived from DESCO's similar outdoor/indoor substation projects, except for GIT with Y-delta wiring scheme. Project Scheduling was developed based on similar Japanese construction work, and interviews with Bangladesh developers.		By considering aforementioned schedule co-ordination and delays in ES consultant appointments, their consequent design work, and the delay in superstructure design development, entire project design must be re-negotiated with all stakeholders to create realistic and safer construction work procedures. Project Cost breakdown must be updated and reviewed based on the introduction of water-cooling system, GIT's detailed specifications (delta-Y), increased cost for BNBC standard designs for ventilation ducting system and firefighting facilities.
Review and updates of Environmental Management Plan and Monitoring Plan	At the timing of Data Collection Survey 2016/17, there were unforeseen adverse impacts as the layout, design or technical specifications of the project were not yet finalized.	The JICA Team reviewed and updated the Environmental Management Plan. The unforeseen area has been narrowed down as the technical examination made progress to the extent possible during SAPI. The following issues are among the highlights: ・ Environmental impacts such as noise during operation period are foreseen more clearly, since layout of each facility, such as cooling units and their numbers, has almost been finalized. Mitigation measures for such impacts are clearer accordingly. ・ Waste management plan has become more concrete based on the practices and actual cases in the similar construction sites of Bangladesh. Mitigation measures for water pollution and soil contamination were also examined accordingly. ・ Underground cable route has been technically examined during SAPI, which enabled prediction of social impacts at each part of ROW. ・ Present condition of structures surrounding the substation site is observed. Taking into consideration which construction equipment, technology and method are applied to this project, the JICA Team proposed a 3-meter setback from the boundary to avoid impact on them.	・ Prior to the completion of bidding documents for EPC contractors, further examination of environmental management plan shall be required, including safety management, which reaches international level. ・ Technical coordination with superstructure may require further changes/alterations in the layout, design or technical specifications, and EMP shall be reviewed and updated accordingly.

		In parallel with the above, a rough sketch of environmental management plan and monitoring plan for superstructure has been drawn.	

(Source: The JICA Team)

Table 0-2 SAPI's Contribution to DPDC Kawranbazar Project

	Studies done during the Data Collection Survey in 2016/17, and outstanding issues	Studies done during the SAPI	Concerns, necessary actions and decisions which shall be made by the Clients and Engineering Service Consultancies
Regulatory process for necessary approvals Regulations and Design Codes applicable to UGSS	Regulatory Studies are planned to be done after the L/A. Necessity of building construction permission was identified, but not examined in detail. Applicable firefighting design and building code were not examined because of limited entry to Bangladesh due to the terrorism attack in July 2018.	Regulatory procedure for the building construction permission was investigated including corresponding NOCs from relevant authorities, and their lead-time. Regarding the height restriction applicable to the upper building, discussions and confirmations were made between the Civil Aviation Authority and DPDC, accompanied by the SAPI team. Necessary lead-time for building construction permission was summarized according to the interview with Mott MacDoanld and local architect. BNBC requires double emergency elevators, which should be supplied from emergency generator system, if the depth of underground structure exceeds 9 meters.	Project Schedule must be reviewed based on the whole project schedule, and necessary regulatory procedures to acquire the construction permission. Deregulation regarding the height of the upper building in the aerial law requires DPDC assistance for smooth implementation of the whole project. If necessary, support requests to JICA etc. should also be considered.
Construction conditions, constraints in plot usage.	Sheet pile method was selected due to the depth of the proposed UGSS, and necessary machinery is planned to be imported. The excavated soil is to be transported at night time, while excavation can be done at the side during night time. Land use was considered by using part of BPDB site as temporary plant, with surplus soil, rebar work,	In preparation for the design collaboration with the upper building, the layout of the UGSS was examined based on the largest expected equipment outline, reflecting the results of interviews with three manufacturers. When the largest product was selected, more detailed design adjustments were required. After discussing the changes to the layout at FS with DPDC, the latest proposal has changed the column positions. When using the anticipated equipment carrying size, it is possible to transport it by borrowing part of the BPDB site.	Continued examination is necessary to borrow part of BPDB site per the size of the equipment to be carried in. In the future, if it becomes possible to acquire green space in the south, there is a possibility of review from the preconditions, including the UGSS layout.

	cable tunnel and large equipment access road construction site.		
Electric Design for UGSS	Feasibility of Gas Insulated Transformers for the project was examined through the Japanese manufacturer interviews.	For the co-ordination with superstructure design, the UGSS layouts were revised to secure enough equipment space for available GITs and GISs, by setting maximum dimensions and weight of the equipment among the variations confirmed via interviews. In particular one manufacturer's two tank GIT may require further fine-tuning of the transformer room along with shutters, mechanical ventilation system, fire protection system, and power cable connections. The winding scheme for GITs was discussed to seek further streamlining in UGSS's footprint and its depth. SAPI finalized the winding scheme as delta-Y connection, which was originally requested by DESCO & DPDC, and the dimensions of GIT became 10% more than the conventional GITs.	During the ES study, ES consultant may want to request further studies by GIT and GIS manufacturers. After the selection of manufacturers for each SS component, the Contractor that is going to design the final UGSS building must adjust the layout according to the actual dimensions.
Equipment Layout for Underground Substation	Cooling system scheme and design for the GIT was not completely verified with manufacturers, and space provisions were given in the proposed layout without consideration of superstructure design, which was not available. Also, GIT's heat dissipation was not finalized with manufacturers, so TEPCO PG's standard values were applied. Dust system and fire extinguishing system were not considered in the layout, and some space provisions were made.	Based on laws and regulations survey, the standards for firefighting equipment and ventilation equipment required for UGSS layout in FS were checked. Consultation with DPDC was conducted and the direction of demands for deregulation of facility design was examined. Based on the newly proposed substation site conditions, by reducing the existing substation to about half and making it a larger UGSS layout, it was able to deal with the reduction of BPDB sites.	Careful consideration should be given to the precise site that can be secured for the UGSS site after remodeling the existing substation, considering civil engineering construction methods. In design collaboration with the upper building structure, detailed examination of the position of the common pillars and the arrangement of the cooling facilities is necessary. Considering the equipment and site conditions and other factors, the SAPI team strongly urges the cooling equipment to be located above the ground. Building M&E design, and firefighting design must be finalized based on BNBC's standards and applicable technical waivers negotiated with authorities. The proposed water cooling system must also be well harmonized into the superstructure

	All these design reviews are to be done after L/A, and after creating superstructure design.		design to avoid any adverse impacts on the surrounding environment. In particular, the application of GIS must be well explained to streamline necessary building facilities for UGSS building. Necessary accessories and facilities below ground for the superstructure, such as sewage pan, elevator pits, hook for UGSS, and necessary ceiling clearance above the machine hatch, must be continuously discussed to be accommodated in the superstructure final design.
Superstructure Design	Details of the superstructure and its usage were not determined. Thus, a 13 storied building with 15kN/m2 floor loadings was assumed for UGSS layout with DPDC's consent, and column grid was determined according to Japanese standards.	The design conditions of the upper building structure were presented adjusting the design rationalization to install a cooling facility above ground. A design review of the upper building structure was carried out considering the structure of UGSS and construction work. Its influence was reflected in the pillar span and upper buildings.	It is necessary to continue consultation on the load conditions of the upper building and reflect this in the UGSS structure design. Regarding the cooling facilities, continued consultation with the upper building design consultant, a3, is necessary to determine the size of the air intake/exhaust and the maintenance method. It is also necessary to consider countermeasures for noise from the cooling facility.
Transmission line and its installation method	For the FS, the power cable route was examined via interview with DPDC. The team was informed that there were no underground objects, and it was assumed that the power cable could be embedded directly.	As a result of the GPR route survey conducted, it was confirmed that there were many buried objects in the underground area. It is necessary to carry out removal/relocation of these buried items by switching distribution line routes, and to conduct an examination of construction methods for constructing the underground tunnel. The road width is very narrow, especially for DPDC. Taking these conditions into consideration, DPDC was informed of the necessity of urgent relocation of the existing buried distribution lines.	When designing the cable tunnel, it is necessary to continue with the request to DPDC to relocate the existing buried objects and consider the protection method for those which cannot be relocated. As for cable protection, it is necessary to consider hanging protection, temporary duct protection etc. as adopted in Japan. As for the narrow spots, it is necessary to consider adopting the pipeline system, and the SAPI team proposed to DPDC to construct it separately from this project.
Project Scheduling, Cost estimation	In the data collection survey, construction work plan considered necessary midnight work cost	By considering the delay in appointments for ES consultancy and superstructure architect, entire project schedule must be	Since UGSS access road and cable tunnel are planned to be at the same place, it is necessary to carefully adjust the construction procedure.

	increment, and temporary work for better cost estimation. Cost information for equipment was derived from DPDC's similar outdoor/indoor substation projects, except for GIT with Y-delta wiring scheme. Project Scheduling was developed based on similar Japanese construction work, and interviews with Bangladesh developers.	re-scheduled after the meeting with appointed consultants and the client.	The whole schedule must be established while negotiating with the relevant parties concerning the remodeling of the existing substation, setting the cable tunnel, construction of UGSS and so on. Project Cost breakdown must be updated and reviewed based on the introduction of water cooling system, GIT's detailed specifications (delta-Y), and increased cost for BNBC standard designs for ventilation ducting system and firefighting facilities.
Review and updates of Environmental Management Plan and Monitoring Plan	At the time of Data Collection Survey 2016/17, there were unforeseen adverse impacts as the layout, design, or technical specifications of the project were not yet finalized.	The JICA Team reviewed and updated the Environmental Management Plan. The unforeseen areas have been narrowed down as the technical examination made progress to the extent possible during SAPI. The following issues are among the highlights: ・ Environmental impacts such as noise during operation period are foreseen more clearly, since layout of each facility, such as cooling units and their numbers, has almost been finalized. Mitigation measures for such impacts are clearer accordingly. ・ Present conditions of structures surrounding the substation site are observed. Taking into consideration which construction equipment, technology and method are applied to this project, the JICA Team proposed a 3-meter setback from the boundary to avoid impact on them. ・ Waste management plan has become more concrete based on the practices and actual cases in the similar construction sites of Bangladesh. Mitigation measures for water pollution and soil contamination were also examined accordingly. ・ The numbers of affected people due to the temporary requisition of surrounding area are now anticipated more and the requisition period is longer than anticipated in 2016/17, as the UGSS layout and transportation plan have been updated. The JICA Team	・ Mitigation measures for social impacts shall be further examined when DPDC finalizes site area and layout of the project. ・ Prior to the completion of bidding documents for EPC contractors, further examination of environmental management plan shall be required, including safety management, which reaches international level. ・ Technical coordination with superstructure may require further changes/alterations in the layout, design or technical specifications, and EMP shall be reviewed and updated accordingly.

		reminded DPDC of the necessity to mitigate social adverse impacts such as losses of livelihood means, as stipulated in the JICA Guidelines for Environmental and Social Considerations 2010. ・ Present condition of structures surrounding the substation site is observed. Taking into consideration which construction equipment, technology and method are applied to this project, the JICA Team proposed a 3-meter setback from the boundary to avoid impact on them. It was planned to draw a rough sketch of environmental management plan and monitoring plan for superstructure, which has not been done yet due to the delay in DPDC's selecting the architects. The JICA Team reminded DPDC of the necessity to allocate budget and human resources to obtain the DOE clearance for the superstructure.	

(Source: The JICA Team)

0.3 Composition of this report

As SAPI finishes its assigned work in February 2019, this final report was developed to organize the necessary information and studies done so far in order for them to be properly transferred to the next ES Consultants. This final report consists of three volumes. The first summarizes the entirety of the SAPI work records and studies applicable to both UGSS projects, such as information on the necessary regulatory procedures and their lead-times. The second and third were specifically developed for DESCO's Gulshan UGSS and DPDC's Kawranbazar UGSS respectively. These volumes share common chapter items for easier reference. Each project-specific volume also proposes the outstanding work and necessary actions to be addressed soon by the appointed Engineering Service Consultant and its Client. Possible JICA support was also summarized for reference.

Based on this final report, knowledge regarding the projects' details and SAPI's studies were transferred to the ES Consultants in February 2019 to determine the necessary immediate actions to be taken, and the necessity of revision of the entire project schedule after the development of the overall projects' design, including the superstructures.

0.4 Constraints

Although the SAPI was begun based on the initial on-site study plan as agreed by JICA during the contract, the JICA Team had to conduct its study incorporating changes, and the content of technical support and its timings during every visit to cover the uncontrollable changes in DESCO and DPDC's project scopes and project implementation schedules. The uncontrollable changes which SAPI encountered and the Team's responses are summarized as below:

(1) Delay in procurement of ES Consultants

Although the appointments of ES Consultants were planned to be completed in August 2018 in the original schedule, DESCO is concluding the contract with their nominated firms at the end of February 2019, while DPDC is aiming for March. As a result, the JICA Team explained its study results with the ES firms in the middle of February 2019.

(2) Delay in procurement of superstructure architects

Appointment of the local architect for DPDC's superstructure design was delayed. DESCO procured the architect team in May 2018 as in the original schedule, whereas DPDC did so in Dec 2018. As of the end of January 2019, no draft for the superstructure for DPDC's project was developed or shared with the JICA Team.

(3) Longer period spent for revision of DESCO's superstructure design

The superstructure design for DESCO's project could not be revised in the SAPI period after the agreement of necessary changes in the draft design between the JICA Team and the architectural firm, 37 Bridge, because of uncertainties in superstructure designs identified by DESCO, PGCB, and 37 Bridge.

As of the end of January 2019, no draft for the revised design of the superstructure for DESCO's project was developed or shared with the Team. Also, the loading conditions for UGSS buildings, which must be based on the revised superstructure design, were not reported to the Team, so the structural design of the UGSS could not be finalized.

(4) Changes in the pre-conditions for DPDC's project

The Team conducted additional technical examination based on the changes in the pre-conditions proposed by DPDC:

- Additional studies were requested by DPDC as preparation when BPDB and DPDC disagreed on the usage of BPDB's plot as part of the entire project plot, since the negotiation on usage had remained unfinalized for a long time.

- As a solution to enlarge the UGSS footprint, preparation work for the existing substation was reviewed by DPDC and the Team based on feasible load evacuation for the current distribution lines, and the relocation of substation components in the existing in-house substation.
- DPDC indicated the possibility of additional land acquisition in the backyard of the plot.
- The height of the superstructure has been discussed between DPDC and corresponding authorities, since the regulation requires a lower building height for the flight path of the Bangladesh air-force. DPDC requested the appointed superstructure architect to design its superstructure without BPDB's land and with a reduced height limit.

The JICA Team developed more than 10 variations of UGSS layout studies in the SAPI period for feasible UGSS design in the reduced area that also considered setbacks so as not to impact the surrounding buildings. Even in the minimized UGSS layout, BPDB's land may be necessary to cater for temporary large equipment transportation depending on the actual size of the equipment and the transportation vehicles used, and the project may need to acquire permission for this temporary use during construction and replacement of the UGSS components. The above variations did not consider the additional land acquisition in the plot backyard as available land at this time due to uncertainties.

(5) Cancellation of test boring and test excavation on the transmission line routes

Test boring and test excavation on the transmission line routes were not permitted by the authorities to avoid adverse impacts on traffic caused by public works before and during the National Election conducted on 30 Decemberember 2018. SAPI instead employed a Ground Penetrating Radar (GPR) survey as a non-destructive method with a shorter survey time. The GPR identified many buried objects around the proposed UGSS plots, and even analyzed the types of buried object to allow Engineering Services to specify detailed allocation for the additional test boring and sampling for transmission line route selection.

(6) Postponement of technical discussions with the related authorities

The JICA Team originally intended to organize some technical discussions with the related authorities to acquire necessary clarifications and possibly some fundamental agreements on regulatory waivers on applicable design requirements for UGSS buildings.

DESCO held the kick-off meeting with RAJUK in July 2018 to explain DESCO's UGSS and its superstructure project based on the direction from DESCO requesting 37 Bridge to act as the counterpoint to RAJUK after developing the whole conceptual project design to better understand the project and outcome. With delegations from DESCO, RAJUK and 37 Bridge, the Team held a preliminary technical discussion during their Japan technical visit in August 2018 on the applicable designs for firefighting equipment for UGSS buildings. However, as is often the case in Bangladesh that the detailed design discussion, and negotiation for the specific design requirements are finally held after the completion of all government procedures for building permit, they had not been organized as of January 2019.

DPDC had not held any meeting with RAJUK or specific design discussions with the rest government organizations yet due to the delay in procuring their superstructure architects.

Under such circumstances, the Team had series of specific and detailed design discussion with Mott MacDonald to prepare design coordination with superstructure construction based on the technical standards for accompanying facilities as stipulated in the BNBC.

0.5 Immediate actions and future tasks

It took considerable time for the JICA Team to spend for revising the layout and design of UGSS due to the above uncontrollable changes in the project conditions and design coordination with the superstructure architects. The SAPI period and its TOR did not allow the Team to spend time for promoting the government procedures to obtain the building permit, coordination among relevant government organizations, or reconsideration of the project implementation schedule. The Team, however, worked hard on each and every detail of UGSS design, and developed technical requirements of UGSS to the superstructure.

At the completion of the SAPI service, the following are observed by the JICA Team as major challenges that DESCO and DPDC are currently facing in order to implement the UGSS projects:

(1) Early commencement of Engineering Services and revision of the project implementation schedule

As of February 2018, the appointment of the Engineering Service Consultancy has been delayed in both UGSS projects, and development (DPDC) or revision (DESCO) of superstructure design, which is crucial for the building construction approval application, is also behind the original schedule developed in the last Data Collection Survey.

The DESCO project needs the integration of UGSS design features for the superstructure portion, and for the JICA Team, and DESCO's utilization plan for the superstructure. The necessary UGSS components of the superstructure have already been discussed among DESCO and 37 Bridge, and expected loadings and column grids to be shared were also finalized. However, the revised superstructure design and corresponding diagrams and illustrations have not yet been finalized, due mainly to the plan for PGCB's UGSS usage being undecided, and the necessary revision of the superstructure's setback requirements in order to consider the actual construction work. Though the setback issue was examined by the Team with Mott MacDonald, the loading for the UGSS building has not been given during SAPI because of the delay in the superstructure design, so the UGSS building design has been somewhat delayed because of the lack of structural calculations, and building structure design evaluation has not been finalized. In addition, the GPR survey revealed many buried objects around the UGSS plot where the underground tunnel facilities are to be constructed to cater for the increased number of power cables for the transmission and distribution system, and a detailed load evacuation plan and identification of buried objects and their owners must be done immediately. These challenges have quite a large impact on the implementation of the UGSS project, and significant delays may occur if they are not properly solved in a timely manner.

The DPDC project has not yet developed any superstructure design based on the available plot proposed by DPDC. The two superstructure architects appointed to this design are currently designing the draft based on the SAPI team's technical input for the technical and structural requirements of UGSS components installed above ground, and design co-ordination between the UGSS and superstructure is crucial. Considering the delay in ES Consultant appointment and superstructure design development, at least half a year delay in the project implementation is anticipated as of now, and there is a concern that ES Consultant's work volume can be increased more than the amount agreed in the contract.

It is thus necessary to let start the Engineering Services and revise the project implementation schedule at earliest.

(2) Stronger project implementation arrangements

Considering the current outstanding work for both projects, an increase in the number of the Project Implementation Unit (PIU) members and provision of training, such as on-site visits to UGSS, will be necessary. The PIU for DESCO's project was organized after the approval for their DPP in July 2018. During the SAPI period, DESCO added one dedicated member and replaced the Project Director. This new Project Director and member were not included in the Japan visit, so supplemental opportunities for them to carry out on-site visits to UGSS will be quite helpful to ensure smooth project implementation. The PIU for DPDC has already been formed, and the Project

Director and dedicated members have also been appointed. They worked to close the contract with the candidate ES Consultants during the SAPI.

(3) Design optimization of building facilities for GIS UGSS

Soon after the development of whole project design, including UGSS and its superstructure, DESCO and DPDC have to initiate pre-consultation with the corresponding authorities to identify applicable design standards for the entire project. SAPI's UGSS study concluded that the UGSS building facilities, such as the fire-alarm and firefighting system and mechanical ventilation system, must be designed in an optimized way to minimize the total building dimensions (especially depth), to maintain the project cost within the planned amount. However, the current Building Code applicable to underground facilities of a building imposes more stricter design standards, and requires more components, some of which may not necessary for underground substations which have reduced fire risk due to the use of gas insulated switchgears and transformers. It is strongly requested that DESCO and DPDC jointly establish design standards applicable to UGSS buildings, and seek further design streamlining compared to the standard BNBC codes for reasonable M&E facility design.

It is strongly requested for JICA to consider their continuous monitoring and support to keep the entire project on track, such as advices on the project framework from JICA's viewpoint (esp. decision making, project cost monitoring, and scheduling), support for regulatory clarification & negotiation for building design and construction by encouraging relevant authorities, and proposing appropriate ways and timings for negotiation, and technical assistance for PGCB's UGSS FS if requested.

Chapter 1. Report of SAPI Activities, contributions, and outstanding tasks

1.1 Background of Special Assistance for Project Implementation

Bangladesh, with its firm GDP growth of approximately six percent per annum, has been confronting a growing power demand. The country forecasts that it will need to expand generation capacity by 11,000MW or more in the upcoming seven years, and the existing electricity system needs further facility development in the areas of substations, and the transmission and distribution network in order to meet the sharp demand increase as forecasted for the near future.

The strong demand is prominent in the capital city, Dhaka. The load demand in 2015 reached its peak at 880MW in the northern part, and 1,470MW in the southern part. 2030 demands are anticipated to be 4,550MW and 6,843MW respectively. As the heart of country's economy and industry, Dhaka has been accommodating large-scale economic activities in recent years and there has been a rush to construct high-rise office buildings. Reinforcement of power supply facilities is an immediate and urgent need in Dhaka, requiring expansion of maximum SS capacity from 1,708MWA in 2015 to 9,618MWA in 2030 in the north, and from 1,838MWA to 8,554MWA in the south.

Rapid growth in population and economic activities, and urbanization has made it difficult to find and acquire sufficient areas of land on surfaces suitable for newly constructing or reinforcing the existing substation facilities and transmission and distribution network in the Dhaka Metropolitan Area (DMA). Such work is also highly costly.

(Source: The JICA Team)

Figure 1-1 Pictures of Dhaka City

Given the abovementioned situation, a Loan Agreement for the Dhaka Underground Substation Construction Project at Gulshan under Dhaka Electric Supply Company Ltd (DESCO) and at Kawranbazar under Dhaka Power Distribution Company (DPDC) (hereinafter "the UGSS Project") was signed in June 2017 in order to secure facilities to meet the increasing power demand in Dhaka. The following are the expected components of the UGSS Project.

[Component-1]: Construction of two (2) underground substations (hereinafter "UGSS"), Gulshan substation for DESCO and Kawranbazar substation for DPDC, including cooling system

[Component-2]: Construction of underground tunnels and vertical shafts for underground transmission and distribution lines

[Component-3]: Installation of electric equipment in UGSS

[Component-4]: Installation of underground transmission lines - 3km for Gulshan substation and 2km for Kawranbazar substation

[Component-5]: Installation of distribution lines

[Component-6]: Engineering services for the above components

JICA decided to commission a technical team comprised of Tokyo Electric Power Company Power Grid (TEPCO PG) and Tokyo Electric Power Services Co., Ltd. (TEPSCO) (hereinafter "the JICA Team") to extend a consultancy service called "Special Assistance for Project Implementation (hereinafter "SAPI") on the UGSS Project.

The main purpose of SAPI is to assist both DESCO and DPDC promote their project implementation through working on design issue, solving bottlenecks, and etc. at pre-construction stage before the appointment of Engineering Service Consultancies. For instance, it is likely that the UGSS Project will be faced with the following situations, which may cause delay in the implementation schedule and make it longer than planned, and SAPI will tackle on such anticipated challenges ahead.

- It is the first experience for both companies of implementing design coordination with a superstructure and UGSS. Hence, either the design house for the superstructure or the engineers for the UGSS might have to re-design their portion for compatibility between the superstructure and underground structure. Eventually, the entire construction schedule might be delayed.

- Construction approval for both superstructure and UGSS might be an obstacle to smooth progress of the UGSS Project. Since it is also the first experience of securing construction approval for both structures, both parties, Rajdhani Unnayan Kartripakkha (hereinafter "RAJUK") as regulator and DESCO/DPDC as applicants, might not be able to carry out accurate evaluations for construction approval including structural calculations, special designs for UGSS (such as fire prevention design and evacuation route) and so on. Eventually, the entire construction schedule might be delayed because re-calculation might be required.

1.2 Objective of SAPI

The objective of the SAPI is to provide assistance to both companies for the UGSS Project through the following works:

- Assist with design coordination for superstructure and UGSS
- Advise on development of underground transmission and distribution network
- Advise on developing technical requirements for UGSS
- Advise on obtaining construction approval for both UGSS
- Advise on designing ground floor for UGSS O&M space

The JICA Team will provide in future an Engineering Service Consultant with designs updated through this SAPI.

1.3 Tasks and Works in SAPI

The survey's target covers DESCO's and DPDC's supply areas, which cover Dhaka. The survey is comprised of three major tasks:

Investigation of the current laws and regulations applicable to UGSS and discussion on design policy with both companies as Task-1,

Review of draft designs for superstructures as Task-2, and

Knowledge transfer to Engineering Service Consultant as Task-3. The following Table shows major works under the said three tasks in this survey.

Table 1-1 Major Works in SAPI

1.	**First Visit to Bangladesh, Work in Japan (May 2018)**
1.1.	Safety briefing in JICA Bangladesh Office
1.2.	Kickoff Meeting with relevant counterparts and JICA Bangladesh Office
1.3.	Technical discussion on superstructure design with relevant counterparts
1.4.	Study on the current status of the UGSS Project through discussion and on-site survey
1.5.	Study on the current status of power source substation development
1.6.	Study on the current laws and regulations for construction of UGSS and superstructure
1.7.	Study on the current status of power source line projects and load evacuation plans via development of distribution network
1.8.	Contracts with local consultants
2.	**Second Visit to Bangladesh, Work in Japan (from June to July 2018)**
2.1.	Safety briefing in JICA Bangladesh Office and reporting of progress
2.2.	(Continued) Technical discussion on superstructure design with relevant counterparts
2.3.	(Continued) Study on the current status of the UGSS Project through discussion and on-site survey
2.4.	Confirmation on DESCO/DPDC to develop distribution network plan for load evacuation
2.5.	Study on layout compatibility between superstructure and underground structure
2.6.	Revision of the UGSS layouts produced in Data Collection Survey on Underground Substation in Dhaka in People's Republic of Bangladesh (hereinafter "the Data Collection Survey"), according to superstructure designs
2.7.	Revision of equipment specifications
2.8.	Study and data collection on social and environmental issues for construction of superstructure and UGSS
3.	**Third Visit to Bangladesh, Work in Japan (August 2018)**
3.1.	Safety briefing in JICA Bangladesh Office
3.2.	Reporting of progress to relevant counterparts and JICA Bangladesh Office, according to Monitoring Sheet
3.3.	Development of entire schedule for the UGSS Project, according to revised issues
3.4.	Review of superstructure designs
3.5.	(Continued) Interview with authority for construction approval and request of waiver
3.6.	(Continued) Revision of the UGSS layouts produced in the Data Collection Survey, according to superstructure designs
3.7.	(Continued) Revision of equipment specifications
3.8.	Review social and environmental impacts caused by the construction of substructures and superstructures, and their cumulative impacts, and analyze data and information collected from relevant government authorities
4.	**Fourth Visit to Bangladesh, Work in Japan (September 2018)**
4.1.	Safety briefing in JICA Bangladesh Office and reporting of progress
4.2.	(Continued) Review of superstructure designs
4.3.	(Continued) Study on layout compatibility between superstructure and underground structure
4.4.	Monitoring of DESCO and DPDC's progress on application for construction approval (with

assistance if necessary)

5. Fifth Visit to Bangladesh, Work in Japan (October 2018)

5.1. Safety briefing in JICA Bangladesh Office and reporting of progress
5.2. Development of, and agreement on, Monitoring Summary
5.3. (Continued) Study on layout compatibility between superstructure and underground structure
5.4. (Continued) Monitoring of DESCO and DPDC's progress on application for construction approval (with assistance if necessary)

6. Sixth Visit to Bangladesh, Work in Japan (November-December 2018)

6.1. Safety briefing in JICA Bangladesh Office and reporting of progress
6.2. Reporting of progress to relevant counterparts and JICA Bangladesh Office, according to Monitoring Summary
6.3. (Continued) Study on layout compatibility between superstructure and underground structure
6.4. (Continued) Monitoring of DESCO and DPDC's progress on application for construction approval (with assistance if necessary)

7. Seventh Visit to Bangladesh, Work in Japan (January-February 2019)

7.1. Safety briefing in JICA Bangladesh Office and reporting of progress
7.2. Reporting of progress to relevant counterparts and JICA Bangladesh Office, according to Final Report
7.3. (Continued) Study on layout compatibility between superstructure and underground structure
7.4. Assistance to develop more appropriate content for the relevant laws and regulations on construction of UGSS and superstructure
7.5. Development of entire schedule for the UGSS Project, according to revised issues
7.6. Review social and environmental impacts caused by the construction of substructures and superstructures, and their cumulative impacts, and analyze data and information collected from relevant government authorities

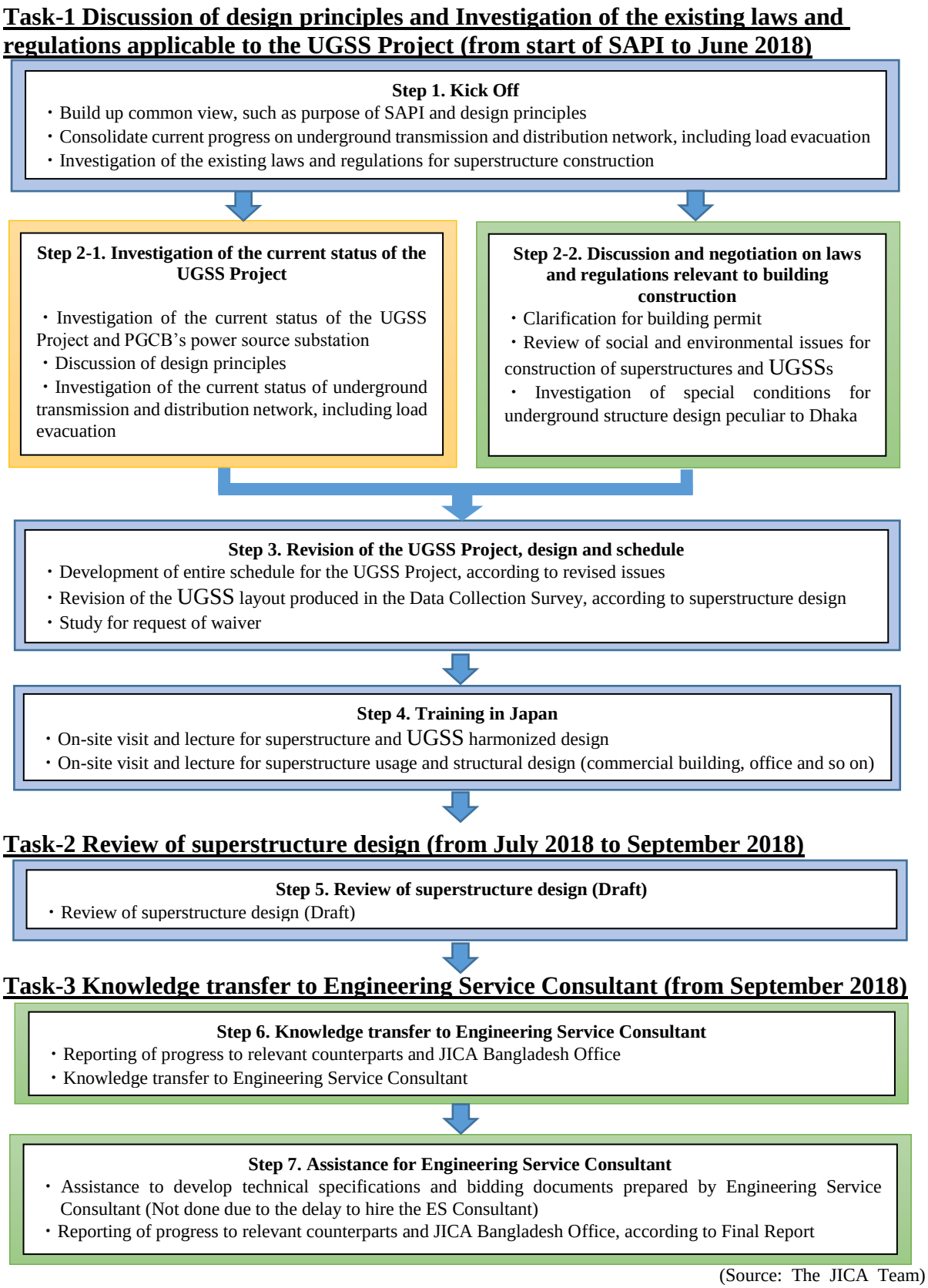
8. Training in Japan (August 2018)

8.1. On-site visit and lecture for superstructure and UGSS harmonized design
8.2. On-site visit and lecture for superstructure usage and structural design (commercial building, office and so on)
8.3. Factory visit for Gas Insulated Transformer and Gas Insulated Switchgear and discussion
8.4. On-site visit for coordinated design regarding water prevention, drainage and fire prevention
8.5. On-site visit and lecture for work constraints and equipment transportation in UGSS
8.6. On-site visit and lecture for underground space and underground tunnel structure and installation locations
8.7. On-site visit to UGSS on other company's property

(Source: The JICA Team)

1.4 Work Procedure

The following chart shows the project's work procedure.



(Source: The JICA Team)

Figure 1-2 Flowchart for SAPI Procedure

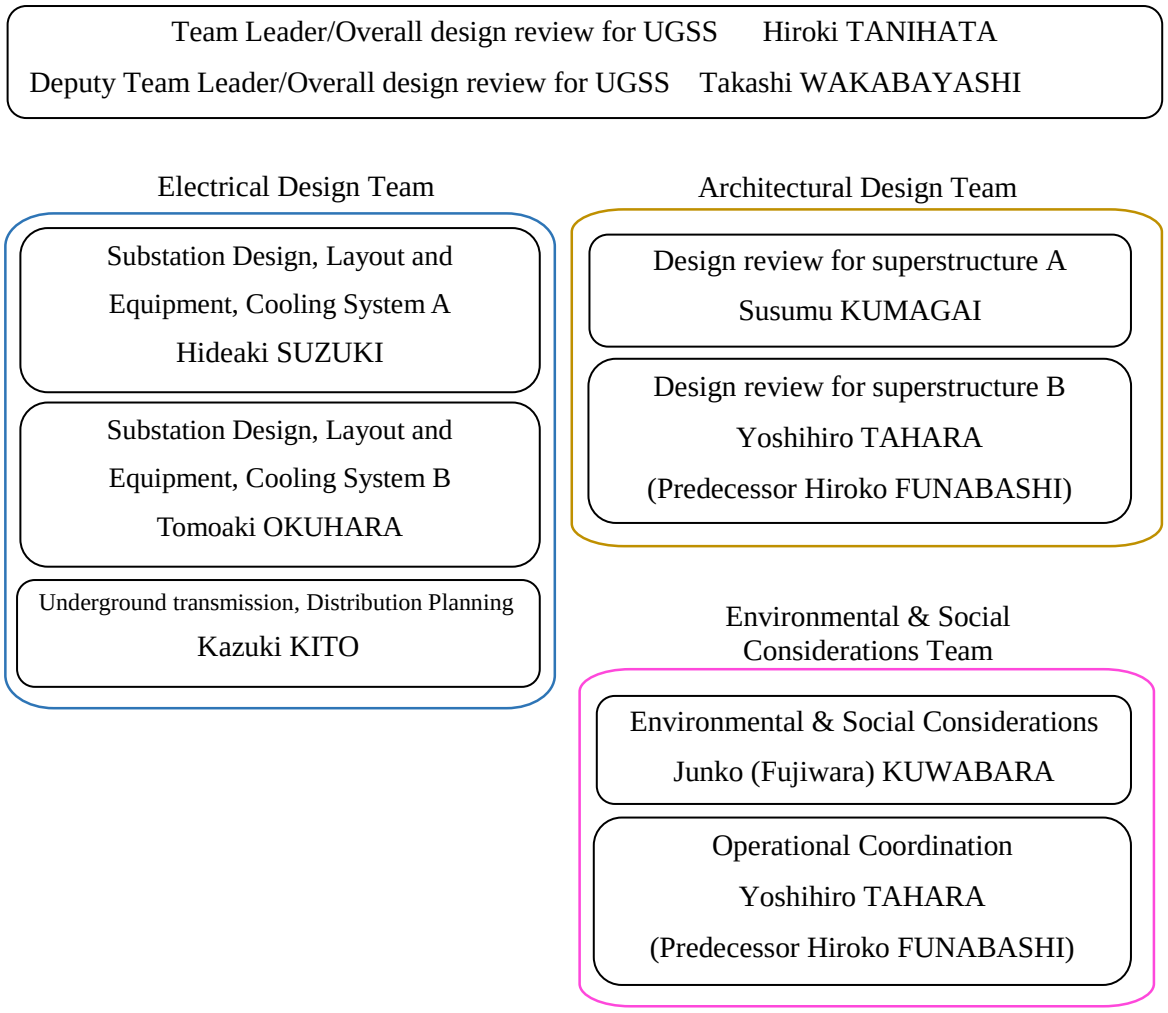
The above flowchart has been prepared based on the current forecast for project progress. The actual plan will be fixed according to the progress of SAPI, such as the progress on superstructure design and the timing of hiring the Engineering Service Consultant.

This project started on April 26, 2018, with the development of a Work Plan for JICA and relevant agencies. The monitoring sheet was developed in August 2018, and the Monitoring Summary report was submitted in December. And Final Report is issued on February 2019.

1.5 The JICA Team

1.5.1 Composition of the JICA Team

The JICA Team consists of the three groups as follows, Electrical design, Architectural design, and Environmental & Social Considerations Team.



(Source: The JICA Team)

Figure 1-3 Composition of the JICA Team

1.5.2 Work Responsibilities for this Project

Detailed work responsibilities are as follows.

(1) Network Planning

- Confirm the current construction status of power source substations for the UGSS Project
- Confirm the current status of distribution line reconstruction planning for load evacuation from existing substations to other substations
- Development of overall project schedule based on the expected progress of all tasks, such as transmission, distribution, construction approval and environmental issues

(2) Substation Facility Planning

- Compatibility check for design coordination between superstructure and UGSS
- Review and revision of the UGSS layout designed in the Data Collection Survey, according to superstructure design
- Obtain substation specifications planned by DESCO and DPDC
- Monitor and supervise local consultants commissioned by the JICA Team
- Knowledge transfer to Engineering Service Consultant
- Assistance to develop technical specifications and bidding documents

(3) Underground Facility Planning

- Confirm the current status of transmission lines from transmission substation to UGSS
- Monitor and supervise local surveys commissioned by the JICA Team
- Assistance for DESCO/DPDC to develop distribution network plan for load evacuation
- Knowledge transfer to Engineering Service Consultant
- Assistance to develop technical specifications and bidding documents

(4) Design Coordination with Superstructure

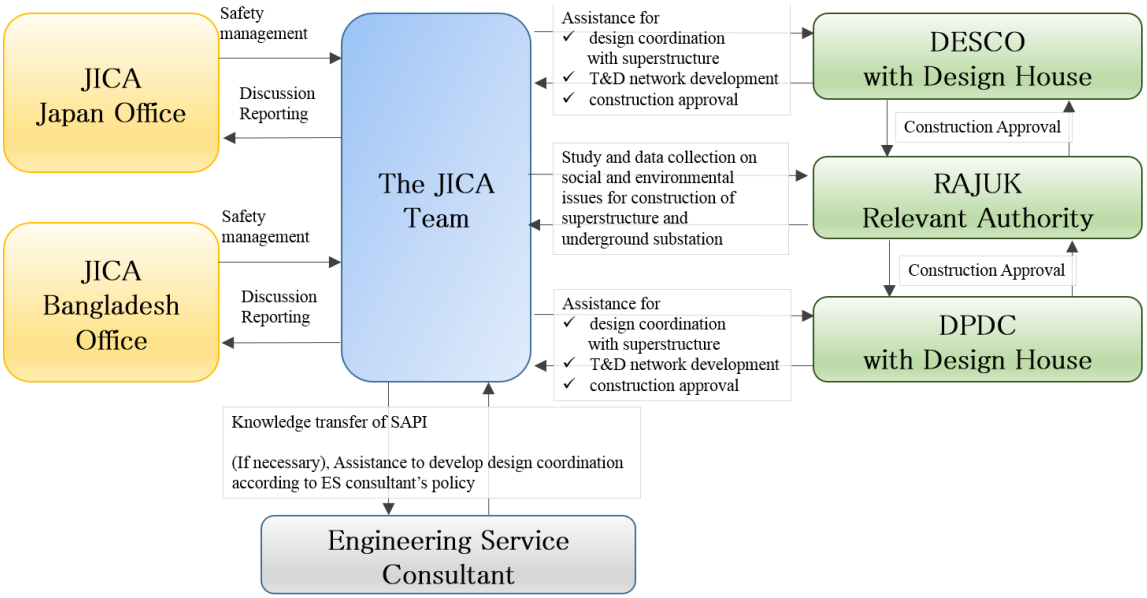
- Obtain Bangladeshi construction standards and laws/regulations on construction of substations
- Monitor and supervise local surveys commissioned by the JICA Team
- Compatibility check for design coordination between superstructure and UGSS
- Interview with authority for construction approval and request of waiver
- Development of overall schedule for the UGSS Project, according to revised issues
- Review and revision of the UGSS layout designed in the Data Collection Survey, according to superstructure design
- Review of superstructure design
- Knowledge transfer to Engineering Service Consultant
- Assistance to develop technical specifications and bidding documents

(5) Environmental and Social Considerations

- Update and analyze of relevant laws and regulations
- Hold discussions and consultations with DESCO/DPDC and other relevant government organizations such as RAJUK and DOE
- Update anticipated environmental and social impacts caused by the UGSS Project, and environmental management and monitoring plan
- Examine anticipated impacts caused by the superstructure construction, cumulative impacts (if any), mitigation measures, and environmental management and monitoring plan
- Confirm the current implementation progress of the environmental monitoring plan (EMP)
- Monitor and supervise the progress of local surveys commissioned by the JICA Team
- Reflect environmental and social considerations in layout, design and other areas of the construction work
- Draw up recommendations for the Engineering Service Consultant

1.6 Coordination with Relevant Counterparts

The UGSS Project is a pioneer in constructing UGSS in Bangladesh. The JICA Team will provide a series of consultancy services through close coordination with DESCO/DPDC, design houses, RAJUK and relevant counterparts.



(Source: The JICA Team)

Figure 1-4 Coordination with Relevant Counterparts in SAPI

1.7 Training in Japan

1.7.1 Summary of the training in Japan

(1) Objective

The objective of the study tour is to deepen understanding of advanced Japanese technology for UGSSs and their superstructures, and methodologies for construction approval applications, structure design and so on. The study tour includes several lectures and site visits to 4 UGSSs, 3 electric equipment factories (of 2 manufacturers), and TEPCO's Training Center. The lecture series and site visit program were designed to achieve the following objectives, which are crucial for all experts delegated to implement the Gulshan UGSS project and Kawran Bazar Project.

- Examine real underground substation designs owned by TEPCO Power Grid
- Identify technical differences between conventional substations and UGSS
- Learn necessary functions and corresponding designs for UGSS's sub- and superstructure
- Study particular technical features of GIS (Gas Insulated Switchgear) and GIT (Gas Insulated Transformer), including technical specifications applicable to UGSS design, and manufacturers' quality management in their factories
- Study methods of construction and operation for UGSS

(2) Duration

August 6, 2018 to August 17, 2018 (14 days)

(3) Schedule

The schedule for the study tour is shown in Table 1-2.

(4) Delegates

12 persons (DESCO, DPDC, PGCB, RAJUK, 37BRIDGE)

The list of delegates is shown in Table 1-3.

Table 1-2 Schedule for Training in Japan

Date		Time	Schedule	Plan						Accommodation
				Transport	Departure time	Origin	Transit	Arrival time	Destnation	
5-Aug	Sun	13:35 ～ 17:00	Flight （Dhaka → Bangkok）	Flight No.TG322	13:35	Dhaka		17:00	Bangkok	
		22:45 ～ 6:55	Flight （Bangkok → Haneda）	Flight No.TG682	22:45	Bangkok				
6-Aug	Mon		Flight （Bangkok → Haneda）					6:55	Haneda	[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
		13:00 ～ 13:30	Orientation @JICA	Summary of the training tour in Japan						
		13:30 ～ 14:00	Courtesy visit to JICA	Meeting with JICA executives						
		14:00 ～ 15:00	Transfer	by Bus						
		15:00 ～ 16:00	Orientation (Kick-off) @TEPCO	Kick-off Meeting introducing overview of TEPCO						
		16:30 ～ 17:00	Courtesy visit to TEPCO	Meeting with TEPCO executives						
7-Aug	Tue	9:00 ～ 14:30	Transfer (Lunch)	by Bullet Train (Shinkansen) & Bus						[Kansai] 100 Minami Ekimae-cho Himeji-shi Hyogo 670-0962 Japan
		14:30 ～ 16:00	Visit to Factory	Mitsubishi Electric (Itami Factory)						
		16:00 ～ 16:30	Discussion with Manufacturer	Mitsubishi Electric (Itami Factory)						
8-Aug	Wed	9:00 ～ 11:30	Visit to Factory	Mitsubishi Electric (Ako Factory)						[Kansai] 100 Minami Ekimae-cho Himeji-shi Hyogo 670-0962 Japan
		11:30 ～ 12:00	Discussion with Manufacturer	Mitsubishi Electric (Ako Factory)						
		12:00 ～ 14:00	Transfer (Lunch)	by Bus						
		14:00 ～ 16:00	Site Visit	Himeji Castle						
9-Aug	Thu	9:00 ～ 12:00	Transfer	by Bullet Train (Shinkansen) & Bus						[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
		13:00 ～ 16:00	Visit to UGSS Construction Site	"Koishikawa Substation"						
10-Aug	Fri	9:30 ～ 12:00	Visit to Factory	Toshiba (Hamakawasaki Factory)						[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
		13:00 ～ 16:00	Discussion with Manufacturer	Toshiba (Hamakawasaki Factory)						
11-Aug	Sat									[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
12-Aug	Sun									[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
13-Aug	Mon	9:00 ～ 11:30	Lecture	Underground Tunnel, Space underground						[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
		11:30 ～ 13:00	Transfer (Lunch)	by Bus						
		13:00 ～ 16:00	Visit to UGSS Site	Ultra high voltage substation "Shin-Toyosu Substation"						
14-Aug	Tue	9:00 ～ 11:00	Lecture	Work restrictions in underground substation, Transportation for heavy equipment						[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
		11:00 ～ 13:30	Transfer (Lunch)	by Bus						
		13:30 ～ 16:00	Visit to UGSS Site	Distribution substation "Nakaokachimachi Substation"						
15-Aug	Wed	9:30 ～ 12:00	Lecture	Coordination and design collaboration between UGSS and superstructure, UGSS on other company's land						[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
		12:00 ～ 14:00	Transfer (Lunch)	by Bus						
		14:00 ～ 16:00	Visit to UGSS Site	Example for building not owned by TEPCO "Higashi-Uchisaiwaicho Substation"						
16-Aug	Thu	9:00 ～ 11:00	Lecture	Design for disaster prevention						[Tokyo] Tokyo Prince Hotel 3-3-1 Shiba-koen, Minato-ku Tokyo, 105-8560, Japan
		11:00 ～ 14:00	Transfer (Lunch)	by Bus						
		14:00 ～ 16:00	Visit to Training Center	Overview of TEPCO Training Center, Facility Tour						
17-Aug	Fri	9:00 ～ 11:00	Wrap-up Meeting							-
		13:00 ～ 16:00	Spare Time							
18-Aug	Sat	0:20 ～ 4:50	Flight （Haneda → Bangkok）	Flight No.TG661	0:20	Haneda		4:50	Bangkok	
		10:35 ～ 12:10	Flight （Bangkok → Dhaka）	Flight No.TG321	10:35	Bangkok		12:10	Dhaka	

(Source: The JICA Team)

Table 1-3 List of Delegates

No.	Name		Organization	Position
1	Mr.	Bikash Dewan	Dhaka Power Distribution Company Limietd (DPDC)	Managing Director
2	Mr.	Md Ramiz Uddin Sarker	Dhaka Power Distribution Company Limietd (DPDC)	Executive Director (Engineering)
3	Mr.	S M Shahidul Islam	Dhaka Power Distribution Company Limietd (DPDC)	Chief Engineer, P & D and PD, UGSS Project
4	Mr.	Md Mehedi Hasan	Dhaka Power Distribution Company Limietd (DPDC)	Executive Engineer (Addl. Charge), Project Planing and Deputy Project Director
5	Mr.	Md Zahirul Karim	Dhaka Power Distribution Company Limietd (DPDC)	Executive Engineer, DPSD, Design Circle
6	Mr.	Jagodish Chandra Mandol	Dhaka Electric Supply Company Limited (DESCO)	Executive Director (Engineering)
7	Mr.	Zulfiquar Tahmid	Dhaka Electric Supply Company Limited (DESCO)	Chief Engineer (P&D), Current Charge & Project Director, Dhaka Underground Substation Construction Project-Gulshan
8	Mr.	Md Moinuddin Khan	Dhaka Electric Supply Company Limited (DESCO)	Executive Engineer (Grid & Protection) - Substation & network Expert
9	Mr.	Abu Sadat Muhammad Sayem Bin Sayeed	Dhaka Electric Supply Company Limited (DESCO)	Sub-divisional Engineer (D&MP) - (Civil, Structural & Geo technical Expert)
10	Mr.	Md Faysal Kabir	37BRIDGE (Hired by DESCO)	Architect, Team Leader
11	Mr.	A.S.M Shahriar Haque	Power Grid Company of Bangladesh Limited (PGCB)	Assistant Engineer
12	Mr.	Mohammad Nazmus Sakib Jamali	Rajdhani Unnayan Kartripakkha(RAJUK)	Executive Engineer (Eletcrical)

(Source: The JICA Team)

1.7.2 Summary of the Lectures

A summary of the lectures is shown below.

(1) Lecture #1 Design of Underground Power Cable Facilities
Date：August 13, 2018 9:00 – 11:00
Agenda: Underground Tunnel and Underground Power Cable design
Lecturers: Mr. Imamura, Mr. Matsui, Mr. Imamura, Mr. Kito, Mr. Wakabayashi
Content:
- Introduction to Power Cable network and tunnel facilities in TEPCO
- Discussion on specifications for the projects' power cables and bending radius
- Design and construction methods for underground facilities
- Necessity of water sealing devices between UGSS and UG tunnels
- Design of power cable inlets, and piping arrangement

(2) Lecture #2 Underground Substation design for equipment installation and transportation
Date: August 14, 2018 9:00 – 11:00
Agenda: Work restrictions in underground substations, Transportation for heavy equipment
Lecturers: Mr. Suzuki, Mr. Mogami, Mr. Wakabayashi, Mr. Kumagai, Mr. Takada
Content:
- Procedures for heavy equipment transportation and installation in UGSS
- Design requirements for superstructure for the installation work
- Machine hatches and anchors necessary in UGSS rooms
- Transportation planning for heavy machine parts

(3) Lecture #3 Necessary Designs for UGSS and its superstructure
Date: August 15, 2018 9:30 – 12:00
Agenda: Features of and design coordination between UGSS and superstructure, UGSS on other company's land
Lecturers: Mr. Suzuki, Mr. Wakabayashi, Mr. Kumagai, Mr. Takada
Content:
- Anti-flooding design, waterproofing of the superstructure
- Ventilation system design
- Firefighting facility design specifications
- Electricity supply design

(4) Lecture #4: Discussion on promoting underground distribution network in Tokyo
Date：August 16, 2018 9:00 – 11:00
Agenda: Discussion on promoting underground distribution network in Tokyo
Lecturers: Mr. Kawamura, Mr. Saito, and Mr. Imabeppu of TEPCO Town Planning
Content:
- Regulatory scheme for promoting underground network in Tokyo Metropolitan area
- Design of multi-purpose underground network facilities (telecom + power utility)
- Cost sharing between authorities and private utilities
- Examples of underground network designs

1.7.3 Summary of the Site Visits

A summary of the site visits is shown below.

(1) Courtesy visits to JICA and TEPCO
Date: August 6, 2018 13:00 – 17:00
Theme: Meeting with JICA and TEPCO executives
Counterparts: Mr. Kitazawa and Ms. Uematsu (JICA HQ, South Asia Division 4)
Mr. Imai (Executive director of TEPCO Power Grid)
Mr. Ohishi (General Manager of TEPCO Power Grid)
Mr. Wakabayashi, Mr. Suzuki, Mr. Kumagai, and others
Agenda
- Greetings from JICA Representatives
- Greetings from TEPCO executives
- Orientation for the Japan visit

(2) Factory Visit (Mitsubishi Electric Corporation, Itami Factory)
Date: August 7, 2018 13:00 – 17:00
Theme: Factory Visit for Gas insulated switchgear
Lecturers: Mr. Nakano, Mr. Umeda, Mr. Maeda, Mr. Yoshida, Mr. Yanai, Mr. Mori and others (Mitsubishi Itami Works)
Mr. Suzuki, Mr. Kumagai, and Mr. Tahara
Agenda
- Quality control at Japanese GIS manufacturers
- Manufacturing Process
- Equipment Specifications for underground substations

(3) Factory Visit (Mitsubishi Electric Corporation, Ako Factory)
Date: August 8, 2018 9:00 – 12:00
Theme: Factory visit to Gas Insulated Transformer Factory
Lecturers: Ms. Takeuchi, Mr. Ueda, Mr. Kondo, Mr. Miyamoto, and others (Mitsubishi Ako Works)
Mr. Suzuki, Mr. Kumagai, Mr. Wakabayashi, and Mr. Tahara
Agenda
- Manufacturing Process, comparison of conventional oil and GIT designs
- Equipment Specifications for underground substations
- Cooling system for UGSS, gas blowers and radiator system

(4) Factory Visit (Toshiba Corporation, Hamakawasaki Factory)
Date: August 10, 2018 9:30 – 15:00
Theme: GIT, GIS, LA Factory
Lecturers: Mr. Abe, Mr. Bannai (Toshiba works)
Mr. Inoue, Mr. Sato, Mr. Okuhara, and others.
Agenda:
- Manufacturing Process, comparison of conventional oil and GIT designs
- Equipment Specifications for underground substations (GIS and GIT)
- Cooling system for UGSS, gas blowers and radiator system

(5) Site Visit: UGSS construction site under town renovation
Date：August 9, 2018
Location：new "Koishikawa Substation"
Lecturers：Mr. Kumagai, Mr. Okuhara, Mr. Suzuki， Mr. Wakabayashi, Ms. Fujiwara
Feature: UGSS under construction：66/6.6kV(20MVA)×OIT：
3units（plan）replacement of existing indoor-substation

Agenda:

- New underground substation constructed as a part of town re-development project
- Excavation method and earth-retaining wall design
- building structure design for sub- and super-structure, column grid design
- workers' safety management

(6) UGSS Site Visit: 500kV Shin Toyosu Substation
Date: August 13, 2018 14:00 – 16:30
Theme: Extra high voltage substation, "Shin-Toyosu Substation"
Lecturers: Mr. Kouno, Mr. Matsui, Mr. Ogawa, Mr. Imamura, Mr. Kito
Equipment specifications: 500/257kV (300MVA)×OIT: 2 units
275/66kV (90MVA)×GIT: 2 units
Agenda

- Underground power cable system and its tunnel design
- Power Cable installation in UGSS
- Ventilation system and machine hatch design
- Equipment selection (275kV GIT, and GIS)

(7) UGSS Site Visit: Naka-Okachimachi UGSS
Date: August 14, 2018 14:00 – 15:30
Theme: Distribution substation, "Nakaokachimachi Substation"
Lecturers: Mr. Ohhata, Mr. Wakabayashi, Mr. Suzuki, Mr. Okuhara, Mr. Inoue, Mr. Kito
Equipment specifications: 66/6.6kV (30MVA)×GIT: 3 units, 66kV GIS and 6.6kV SIS
Agenda

- Compact design for distribution substation
- Ventilation facility design and air circulation inside UGSS
- Firefighting system design for distribution substation
- Streamlined design of control system and control room

(8) UGSS Site Visit: Higashi Uchisaiwaicho UGSS
Date: August 15, 2018 14:00 – 16:00
Theme: Example of building not owned by TEPCO, "Higashi Uchisaiwaicho Substation"
Lecturers: Mr. Miyazaki, Mr. Yamamoto (Ginza control center), Mr. Wakabayashi, Mr. Suzuki
Equipment specifications: 275/66kV (90MVA)×GIT: 3 units, 66/6.6kV GIT (30MVA) 2 units
Agenda:

- Design of 275kV UGSS with 22 storied superstructure
- 275kV GIS design anti-vibration system
- 66kV GIS design with metal structure and power cable arrangement
- Corridor design used as ventilation port of UGSS
- Ventilation fan installation

(9) Visit: TEPCO Power Grid's Training Center
Date: August 16, 2018 14:00 – 16:30
Agenda: Overview of TEPCO Training Center, Facility Tour
Lecturers: Mr. Inoue. Mr. Kito, and Mr. Tahara
Facility: Standardized model of distribution substation and distribution network components
Agenda:

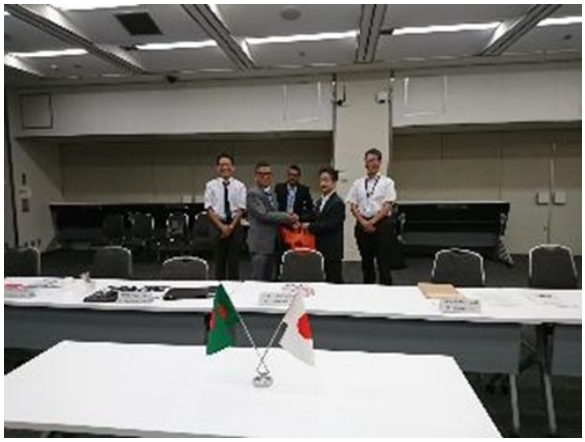
- Cut-model of distribution system components
- Standardized facility mock-up of underground distribution network
- Distribution substation model for training

1.7.4 Outcome

All delegates completed the whole lecture series and gained technical and operational knowledge crucial for the implementation of underground substation construction project planned. During the lectures and site visits, lecturers and delegates discussed thoroughly the designs and technical specifications particular to the two underground substation projects in Dhaka using SAPI's UGSS layout drafts.

(Source: The JICA Team)

Courtesy Visit to JICA



(Source: The JICA Team)

Courtesy Visit to TEPCO

(Source: The JICA Team)

Factory Visit (Mitsubishi)

(Source: The JICA Team)

Factory Visit (Toshiba)

(Source: The JICA Team)

UGSS Construction Site Visit

(Source: The JICA Team)

UGSS Site Visit

(Source: The JICA Team)

Visit to TEPCO's Training Center

(Source: The JICA Team)

Lecture

Figure 1-5 Pictures of Japan Training

Chapter 2. Building Permit/Construction Approval Process (Common)

2.1 Outline of Existing Building Permit/Construction Approval Process

Collection of information for underground structure and superstructure:

The JICA Team has investigated the applicable laws, rules, codes and regulations with regard to the Building Permit and/or Construction Approval for the superstructure building and the underground structure building. The information has been obtained through the JICA Team's sub-consultant and DESCO's local architect for the Superstructure (the JICA Team has not been informed about any appointment for DPDC's local architect for the Superstructure yet). However, approval and permit applications for both projects would be expected to follow the same procedure in principle.

Applicable Laws, Rules, Codes and Regulations:

It is understood that the following standards are currently being used for building design, and building permit/construction approvals in Bangladesh.

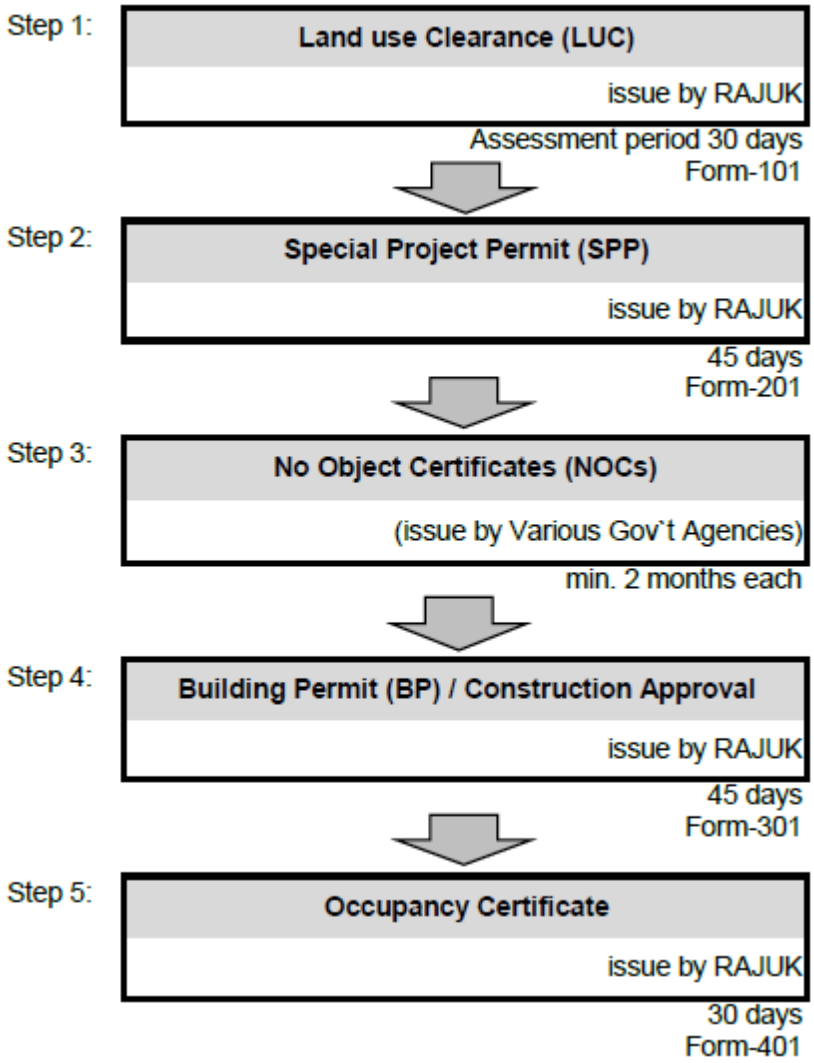
(1) Building Construction Act, 1952 (Act No. II of 1953)
(2) Bangladesh National Building Code 2006 (Amended 2014)
(3) Dhaka Metropolitan Building (Construction, Development, Conservation and Removal) Rules 2008, (so-called "RAJUK Rules 2008")
(4) Town Improvement Act, 1953
(5) Environmental Conservation Act, 1995
(6) Environmental Conservation Rules, 1997
(7) The Building Construction Rules, 1996
(8) Bangladesh Civil Aviation Authority Act, 2017
(9) Water Supply & Sewerage Authority Act, 1996
(10) Dhaka Water Supply & Sewerage Authority Rules, 2011
(11) Bangladesh Gas Act, 2010
(12) Gas Distribution Rules, 2014
(13) Dhaka Transport Coordination Authority Act, 2012
(14) Fire Prevention and Extinction Act, 2003
(15) Local Government (City Corporation) Act, 2009

2.2 Necessary Permits/Approvals and Application Procedures

The following approvals and permits need to be obtained from RAJUK and other related government authorities for the building construction work and for the use of the completed building. There are basically five steps.

Step 1: Land Use Clearance (LUC) from RAJUK
Step 2: Special Project Permit (SPP) from RAJUK
Step 3: No Objection Certificates (NOCs) from various gov't agencies
Step 4: Building Permit (BP) from RAJUK
Step 5: Occupancy Certificate (OC) from RAJUK

The application procedure is shown in the following flow chart. Except for Step 3, NOCs, the assessment periods shown are only the nominal periods after the application has been duly received by RAJUK. In order for the application documents to be duly received, unofficial preliminary meetings with RAJUK are normally required, but the time needed for these is not included in these nominal periods.



(Source: DESCO's local architect)

Figure 2-1 Flow Chart for obtaining Permits/Approvals

Firstly, in Step 1, Land Use Clearance needs to be obtained. Without this Land Use Clearance, a Special Project Permit and Building Permit cannot be applied for. Land Use Clearance needs to be applied for with site survey drawings etc., which are land-related documents excluding building drawings or FAR. It is understood that the LUC materials will be prepared and submitted by DESCO themselves since this work is not included in DESCO's Architectural contract.

As for Step 2, Special Project Permit, conditions applicable to the different types of special projects are specified as follows:

a). Residential building comprising more than 40 residential units;
b). A project of more than a total of 7,500 m2;
c). A commercial project comprising 5,000 m2 (including FAR) floors;
d). A project directly connected to a national or regional highway or main road;
e). Dangerous industries and industries which cause environmental pollution, including brickfields;
f). Any construction or development within 250 m of a historically important building or area;

g). Any construction or development within 250 m of an area which is naturally beautiful;
h). Any construction or development within 250 m of a riverbank.

The Gulshan UGSS project would fall under the above items b), c) and e). Therefore, it is obviously necessary to submit a Special Project Permit application to RAJUK. It is understood that assistance from the architect and the JICA Team would be needed for DESCO's application, because not only land information but also building drawings (1:1,000 scale) and information (including FAR calculation) etc. would be required.

After clearing Steps 1 and 2, the Building Permit application (Step 4) can be submitted. However, as indicated in Step 3, the Building Permit application documents need to have NOCs (No Objection Certificate) attached, requiring approximately 10 certificates from the different authorities. (This is the case for DESCO's Gulshan UGSS. However, it is considered that the process would be very similar for DPDC's Kawranbazar in terms of NOCs.)

Table 2-1 Assessment period of each authority

No.	Name of Government Authority	Purpose	Assessment Period
1	Civil Aviation Authority of Bangladesh (CAAB)	Height clearance	3 weeks
2	Dhaka Electrical Supply Company Limited (DESCO)	Load clearance	15 days
3	Dhaka Water Supply and Sewerage Authority (Dhaka WASA)		60 days
4	Titas Gas Transmission and Distribution Company Limited		15 days
5	Dhaka Transportation Coordination Authority (DTCA)	Traffic Impact Assessment Report	60 days
6	Bangladesh Fire Service and Civil Defense		30 days
7	Dhaka North City Corporation (DNCC)		7 days
8	Department of Environment (DOE)	Location Clearance Certificate	45 days
		Emvironmental Impact Assessment	30 days
9	Deputy Commissioner (Traffic), Dhaka Metropolitan Police		60 days
10	Ward Commissioner's Office		

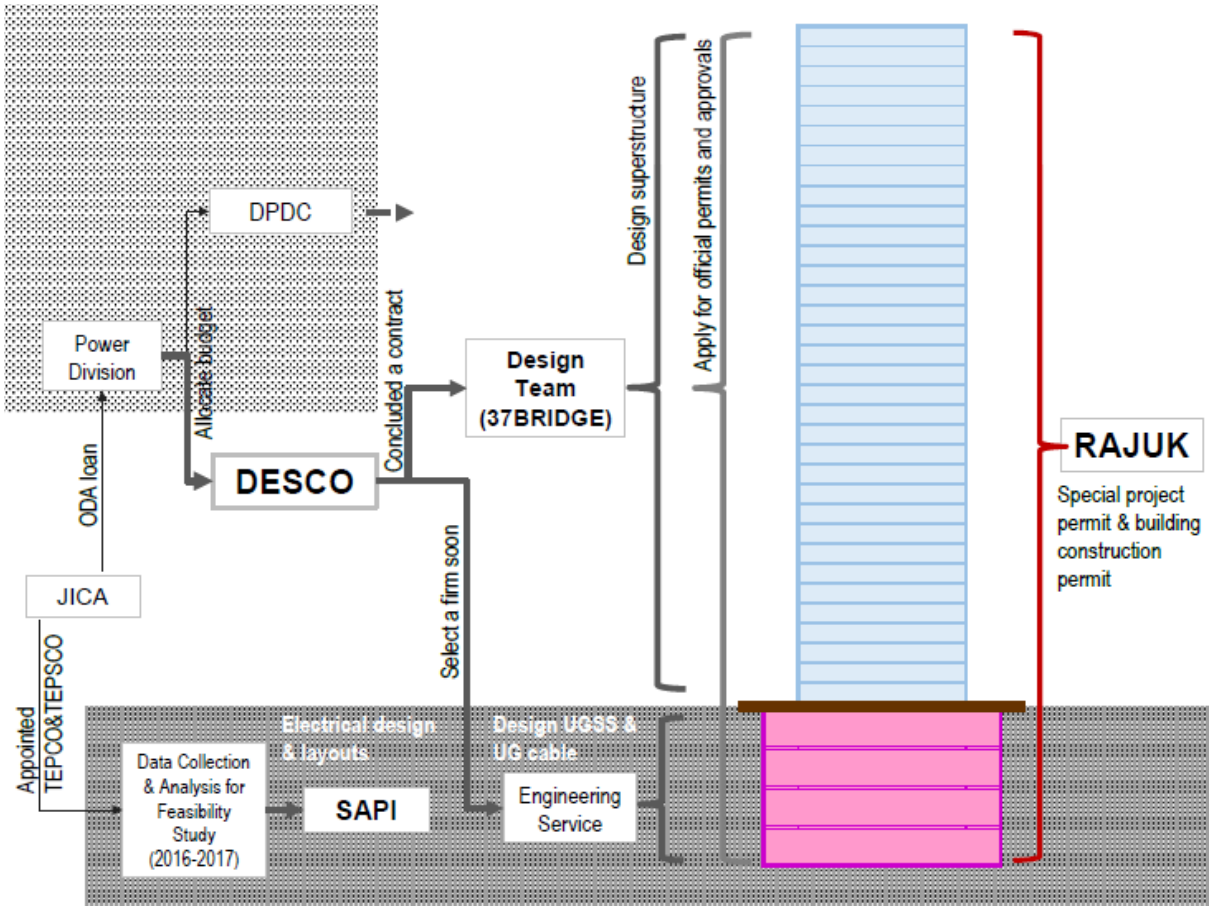
(Source: The JICA Team)

As per the above table, the assessment period is estimated for each NOC. In order to minimize the overall schedule for the permits/approvals, the earliest commencement of preliminary discussions with each authority is essential. In particular, item 5 (DTCA) and item 6 (Fire service etc.) seem to take quite a long time for clarification of the requirements with each authority. Therefore, earliest commencement of discussions with each authority will be recommended.

With regard to Step 5, Occupancy Certificate, upon completion of building construction, either fully or in part, an occupancy certificate has to be obtained in order to occupy/reside in or use the building. The following documents are required to be submitted:

- Completion report;
- As Built Architectural drawings;
- Structural design;
- Design of Building Services.

The following organization chart shows the implications of pre-consultation for RAJUK and other authorities.

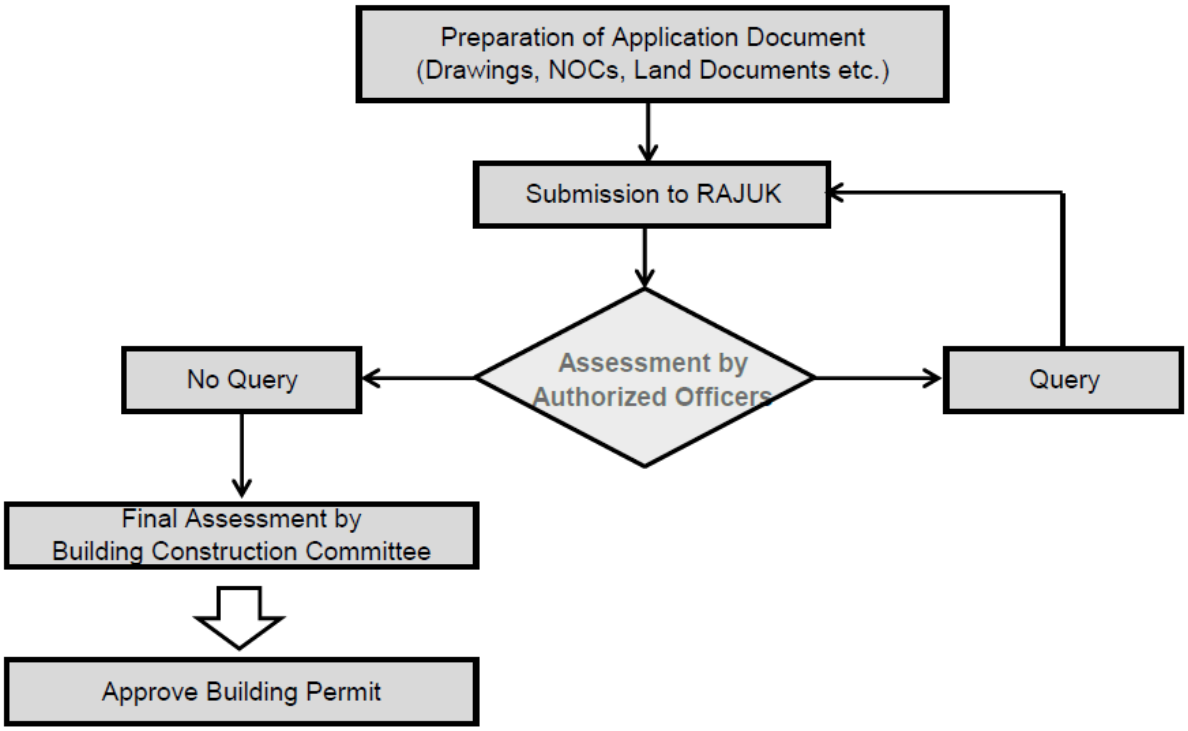


(Source: The JICA Team)

Figure 2-2 Organization Chart for pre-consultation for RAJUK and other authorities

2.3 RAJUK's Assessment Procedure for Building Permit Application

It is understood that RAJUK's assessment procedure from submission of the application documents until approval of the Building Permit would be as per the following flow chart.



(Source: DESCO`s local architect)

Figure 2-3 Flow Chart for Assessment of Building Permit Application

2.4 Recommendations on Construction Approvals for both Superstructure and Underground Substation

This would be the first case of underground substation construction in Bangladesh, and it has been confirmed that there are no adequate laws or regulations in Bangladesh for an entire, comprehensive underground substation. Given this, in order to proceed to the design and approval application, the JICA Team considered at beginning whether it would be possible to compare the differences between the required approval applications in Japan and Bangladesh, then identify the differences. Such different items would then form the necessary and recommended items for RAJUK and other related authorities. However, after collecting the information and analyzing it, the JICA Team realized that the required items and necessary documents in Bangladesh are not detailed enough to compare them with those for the Japanese requirements. Therefore, this approach is not valid anymore. Under these circumstances, the JICA team has found several important items which need to be sorted out through a series of meetings and discussions with the local architect and the local sub-consultant.

The following subjects are still under investigation and review by the JICA Team, local architect and local consultant.

- Building Permit
- Firefighting System
- Ventilation Design
- Underground tunnel

With regard to the Building Permit, the design code in Bangladesh defines that application for it should take place only once, with no further applications for “minor changes” against the approved permit conditions allowed (a practice which is allowed in Japan). If changes/modifications are needed for the approved Building Permit, a new application will be required, thus affecting the project program/schedule. However, DESCO’s local architect mentioned that the approved Building Permit

allows some "allowance range" and changes in the construction work could be approved with the submission of the as-built drawings after completion of the work. However, the JICA Team has not confirmed such "allowance range" in the documents yet, and so recommends enquiring with RAJUK on this matter.

There is currently a building code which mainly defines the superstructure building as well as the basement car parking. However, no design codes for underground substation facilities exist, particularly for the power system, electrical system and/or fire extinguishing system. Therefore, some kind of new design code and/or approval authority needs to be established.

There are two divided construction contracts in this project, one for the underground substation and the other for the superstructure building. Therefore, practically, the project owner (DESCO) submits the application to RAJUK and gets a Building Permit under the usual Building Code before the appointment of the underground substation contractor. Following this, after appointment of the underground substation contractor the contractor will do the detailed design for the underground substation and any necessary detailed design and changes according to the Design-Build Contract specified by the JICA Standard Contract document.

With regard to the Firefighting system, there are hardly any constructions of deep underground structures in Bangladesh and no experience at all in underground substation building. Therefore, as described in other Chapter, a sprinkler system, which is a water-based firefighting system, will be required for both superstructure building and underground building. In Japan, however, non-water based firefighting systems (Large-sized fire-extinguishers, Powder fire extinguishing systems, and Inert Gas fire extinguishing systems) are very common. In order to employ a non-water based firefighting system, application for a waiver for the water-based system should be submitted to the Fire Services; a relatively lower cost non-water-based system (Large-sized fire extinguisher, Powder fire extinguishing system, or Inert Gas fire extinguishing system) can then be installed. This is quite common in Japan. The reason for this alternative method is that considering the substation's fire protection capability, if some rooms need a firefighting system installed, installation of a lower cost system (Large-sized fire-extinguisher, Powder fire extinguishing system, or Inert Gas fire extinguishing system) based on the capacity of the substation could suffice. If using an Inert Gas fire extinguishing system, a Nitrogen Gas system should be required, because inert gas causes no harm to the human body and, in addition to this, the Nitrogen Gas cylinder room could be installed in an isolated location away from the fireproof compartment due it producing less friction resistance when activated. Therefore, the JICA Team considers that the Japanese practices, covering numerous experiences and practical regulations, should be introduced for this UGSS project. The JICA Team recommends that the pre-discussion should be done with the Fire Service authority upon completion of the schematic design for the superstructure.

With regard to the Ventilation design, as described in other Chapter, according to the Bangladesh design code the conventional duct method will be applied. In this case, the ceiling height of each basement floor will be higher with the duct height and, as a result, the total depth of the basement building will be significantly deeper and the cost will be higher. In Japan, however, the Building code does not specify the type of duct system. Therefore, the JICA Team recommends Japan's Open Ventilation Method, which uses passages and rooms as ventilation corridors, because there are numerous instances of this in Japan.

With regard to the underground tunnel, in principle, the extent of application for the Building Permit will be the inside of the site boundary perimeter. However, it has been reported by the local architect and local consultant that if an underground tunnel which is located outside of the UGSS site but adjoining the UGSS building structure is used, such underground tunnel will be considered part of the UGSS building and will need a Building Permit application. Therefore, in order to avoid such application requirement, the two portions (the underground tunnel and UGSS) should be divided into two in terms of the structure. The JICA Team recommends that the underground tunnel, where adjoining

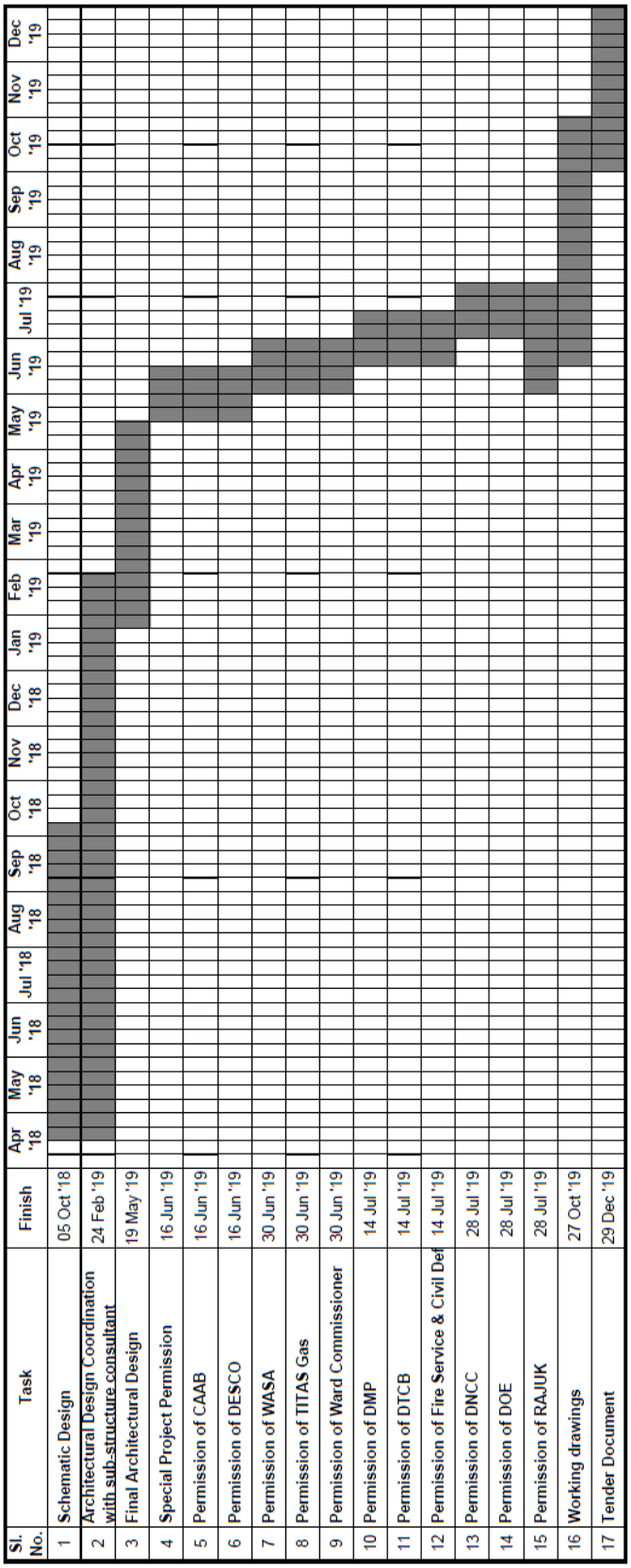
the UGSS, should be constructed via a duct type structure instead of being structurally connected by reinforced steel bars.

2.5 Work Program/Schedule and Work Program for Superstructure

The work program/schedule by DESCO's local architect for the Superstructure is shown in Figure 2-4. There is a total of four working phases.

- Phase-1: Schematic Design Phase
- Phase-2: Design Development Phase
- Phase-3: Building Permit Phase
- Phase-4: Construction Document Phase

The Schematic Design phase has already been completed as of the end of September 2018. The Design Development Phase is to be completed by the middle of May 2019. Then, after obtaining the Special Project Permit and all NOCs, the Building Permit is to be obtained by the end of July 2019. After that, the construction tender document is to be completed by the end of December 2019. Based on this program/schedule, the Building Permit application could be submitted in early June 2019. However, the actual timing for its application should be decided by DESCO while assessing the work progress for the underground substation portion, which is managed by the ES Consultant for the underground structure. It is considered that the construction contract type for the superstructure building will be similar to the FIDIC Red Book, in which the Employer prepares the detailed design and obtains the Building Permit, and the contractor executes the construction work only, without design work.



Sl. No.	Task	Finish
1	Schematic Design	05 Oct '18
2	Architectural Design Coordination with sub-structure consultant	24 Feb '19
3	Final Architectural Design	19 May '19
4	Special Project Permission	16 Jun '19
5	Permission of CAAB	16 Jun '19
6	Permission of DESCO	16 Jun '19
7	Permission of WASA	30 Jun '19
8	Permission of TITAS Gas	30 Jun '19
9	Permission of Ward Commissioner	30 Jun '19
10	Permission of DMP	14 Jul '19
11	Permission of DTCB	14 Jul '19
12	Permission of Fire Service & Civil Def	14 Jul '19
13	Permission of DNCC	28 Jul '19
14	Permission of DOE	28 Jul '19
15	Permission of RAJUK	28 Jul '19
16	Working drawings	27 Oct '19
17	Tender Document	29 Dec '19

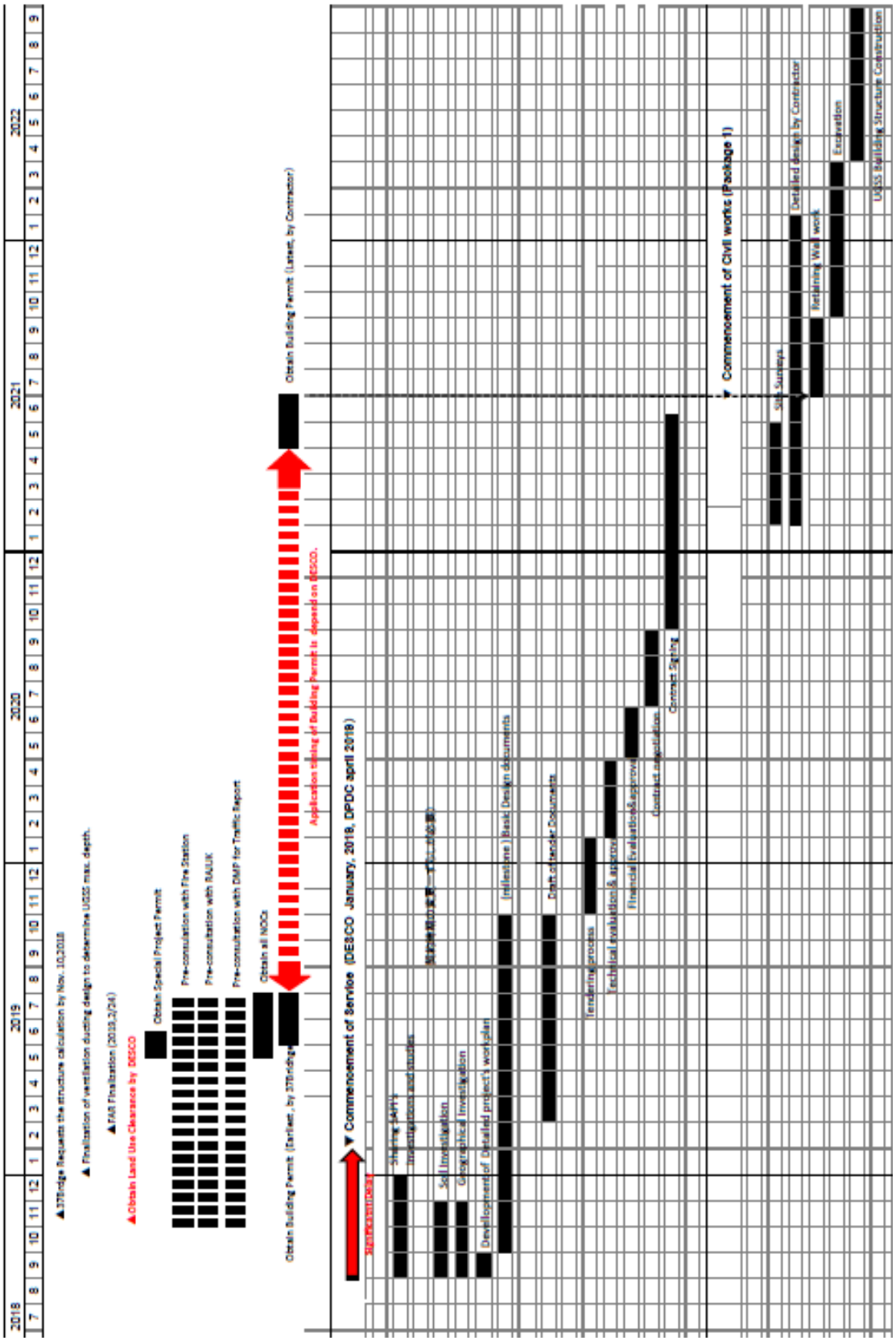
(Source: DESCO's local architect)

Figure 2-4 Work program/schedule by DESCO's local architect for the Superstructure

Work Program for Underground Substation

The Figure 2-5 shows the program/schedule for DESCO's Gulshan UGSS portion from the commencement of the consulting services until commencement of the construction work. As shown in Figure 2-5, there is a long gap, of approximately 18 months, between the timing of when the Building Permit is obtained by DESCO from RAJUK before appointment of the substructure contractor and the further permit/approval being obtained by the substructure contractor.

It is estimated that DESCO's Gulshan Project has already been delayed 6 months compared to the RFP's program/schedule. Therefore, if DESCO still needs to keep to the project completion time, this delay (6 months) should be recouped and the possibility of minimizing the schedule should be looked into.



(Source: The JICA Team)

Figure 2-5 Organization Chart for pre-consultation for RAJUK and other authority

Table 2-2 Summary of Permits/Approvals

Sl. No.	Type of Permission	Key Documents Required	Time to Issue	Remarks
1.	**Land Use Clearance from RAJUK**	Three certified copies of the following documents: • Application on Form No. 101 • Land deeds • Power of Attorney deed • C.S/R.S. Mutation Khatian/ City Survey Khatian; • Receipt of up-to-date ground rent payment; Location Map and site plan; • Mutation and separation proposal letter along with Duplicate Carbon Receipt in respect of the land. • Permission letter/allotment letter from the related Ministry in the case of abandoned property; • City Survey Khatian along with Survey Map • Survey Map, R.S. Map and MS/City Survey Map (1:5000 or 1:10000 sized) • Location Map and copies of 15 cm * 20 cm site plan (Ammonia printing on C.S. Khatian Map) signed by the applicant (Three copies) • Payment Receipt of Tk. 1,000 for Land Use Clearance fee.	30 days	Application can be filed now. No Drawing is required.
2.	**Special Project Permit from RAJUK**	• Application on Form No. 201 • 11 (Eleven) sets of the documents indicated below. • a) Copy of land use clearance • b) Ownership document, Holding No., C.S./R.S. Khatian, City Survey Khatian, Dag No., location Map, any other deed, Khatian or/and schedule required by the authority. • c) Total number and area of the floors of the proposed building; • d) Total area of each floor; • e) Total number of residential units; • f) FAR calculation; • g) Estimated demand for water for construction work and its source of supply; • h) Estimated demand for electricity for construction work and its source of supply; • i) Different stages of construction work, and the starting time and total period required for construction; • Documents relating to ownership of the land;	45 days	Drawing is required

		• Drawing/design for the Special Project Permit as indicated below. a) Boundaries of the site along with measurements of roads and adjacent land, if any, owned by the applicant; b) Image of the site marking its North side; c) Name of the road adjacent to the site or, if the site is connected to a private road, name of the road from which that private road started; d) Mouza No., Holding No., Plot No. and Road No. of the proposed project; e) Width and location of all roads and pavement, if any, adjacent to the site; f) Average height of the plot comparing to adjacent road; g) Existing establishments on the site and their distance from the boundary of the site; h) Height and location of buildings or establishments adjacent to site and their distance from the site; Ingress and egress for pedestrians and vehicles at the site; i) Drainage alongside all roads adjacent to site, channels for natural water flow and proposed drainage system for the site; j) Existing electricity lines, water supply lines, sewerage system, if any, and proposed connections at the site; k) The proposed waste management system at the site; l) All-natural elements (water bodies, open spaces, gardens, hills etc.) and historic buildings located within 250 meters of the site; m) 11 (eleven) sets of Conceptual Drawings signed by the applicant and other related professionals, including architect listed as per rule 41 of the Rules, 2008.		
3.	**Building Permit from RAJUK**	• Application on Form No. 301; • Land Use Clearance; • Special Project Permit; • Receipt of fees paid as per annexure-4 of the Rules, 2008 • Certified copy of all land documents that prove the ownership of the applicant • Soil Test report if directed by the authority under Special Project Permit;	45 days	Land Use Clearance and Drawing are required

		• Number of units in each floor, in the case of a residential building; • Area of the plot, FAR calculation, ground coverage, setback measurement and total number of floors • Indemnity bond on tk. 150 non-judicial stamp for the construction of deep foundations, piling and basement floor; • Copy of certificate describing previous work experience of the architect • All drawings/designs for the building • Nine (9) copies of the plan (for building up to ten floors) • Site plan and location map drawn at 1 : 4000 scale; • Layout plan/drawing drawn at 1 : 200 scale; • Key-plan, in the case of more than one building, describing location of all buildings; • Floor plan for each floor of the building including basement, designed at 1 : 100 scale; • Application form cost is tk. 300 and the building permit fee will be determined as per FAR calculation		
4.	**Occupancy Certificate**	• Completion Report; • As-built Architectural Drawing; • Structural Design/Drawing; • Design of Building Services.	30 days	No immediate step
5.	**Clearance from CAAB**	• Application on prescribed form; • Mouza, location map marking the position of the building; • Geographical coordinates of the place; • Elevation of the place (if known);	3 weeks	Application can be filed immediatel y
6.	**Clearance from DESCO**	• Application mentioning total volume of load required, starting and ending period of construction; • Location map, • Mutation khatian (RS/City Survey) • Drawing/Design from the architect: • Volume of land needed in each floor;	15 days	Drawing is required
7.	**Clearance from WASA**	• Application on prescribed form; • Documents on ownership of land; • Drawing of the building • Site plan;	60 days	Drawing is required
8.	**Clearance from TITAS**	• Application addressed to Deputy General Manager, Pipeline Design Department;	15 days	Land Use Clearance

		• Land Use Clearance from RAJUK; • Documents relating to ownership of land; • Design/Drawing of the building.		and Drawing are required
9.	**Clearance from DTCA**	• Application on prescribed Form; • Documents on ownership of the land; • Clearance from DNCC/DSCC; • Two separate undertakings on non-judicial stamp; • Traffic count report; • Drawing/Design of the building; • a) Type of Building, width of road (meters), FAR/MGC (%) • b) Total amount of land (square meters), area of floor (square meters), total number of parking spaces, total number of plot; • c) Design of ground floor and basement of the building. If there are any requirements under Building construction Rules, 2008 for parking places, pathways for the general public, or parking facilities for disabled people, these must be shown in the design; • d) Drawing of entrances and exits for the building and drawing marking the pavement; • e) Parking facilities for guests and proposed traffic management system during social ceremonies at the building. • f) Key location plan marking the location of the building; • g) All establishments and road intersections within 250 meters of the building; • h) Key-location plan; • i) Traffic Impact Assessment Report.	60 days	DNCC clearance and Drawing are required
10.	**Clearance from Fire Service**	• Application on prescribed form; • Design of the Building (location plan with legend chart, site plan, floor plan, layout plan and fire safety plan); • Documents on ownership of the land; • Google Map.	30 days	Drawing is required
11.	**Clearance from DNCC**	• Application on prescribed form; • Document on ownership of land, • Receipt of holding tax payment; • Land Use Clearance from RAJUK; • Design/Drawing of the building; • Undertaking on a non-judicial stamp of tk. 300;	7 Days	Drawing is required
12.	**Location Clearance**	• Application on prescribed form; • Feasibility Report,	45 days	Clearance from

	Certificate from DOE	• Report on Initial Environmental Examination, • Report on Environmental Management Plan, • No objection certificate from DNCC/DSCC; • Emergency plan describing adverse environmental impacts and plan for mitigation of the effects of pollution; • Outline of the relocation/rehabilitation plan (where applicable) • Location Map (boundary, notable establishments, drainage system and its layout plan); • Mouza Map, Dag no. Khatian • Ownership deed for the land, Mutation Khatian, • License from fire service; • Payment of the Environmental Clearance fee;		DNCC is required
13.	**Environmental Impact Assessment**	• Environmental Impact Assessment report.	30 days	Location Clearance Certificate is required
14.	**Environmental Clearance Certificate**	• Compliance Monitoring report on the conditions of clearance. • Location Clearance Certificate.	30 days	Location Clearance Certificate is required
15.	**Clearance from DMP**	• Application on white paper; • Land Use Clearance from RAJUK; • Document on ownership of land (Deeds, C.S/S.A./R.S. Khatian, Mutation Khatian); • Receipt of holding tax payment, • Receipt of ground rent payment; • Undertaking on non-judicial stamp of tk. 300	60 days	Land Use Clearance is required

(Source: The JICA Team)

Chapter 3. Progress and Changes of Gulshan UGSS Project (DESCO)

3.1 Brief Overview of Dhaka Network

Currently, the Bangladesh government has strong intentions to develop underground network constructions in Dhaka city considering the scarcity of land in the metropolitan area and its will to develop a highly reliable Dhaka network. Following the government's policy, DESCO and DPDC are eager to have UGSS in Dhaka city. In parallel, the 132 kV network in the Dhaka area will be gradually shifted from PGCB to DESCO/DPDC according to the Data Collection Survey, though PGCB is the main administrator of the 132 kV network in Bangladesh as of now. Hence, DESCO and DPDC are expected to play more important roles in providing a reliable and stable supply in Dhaka city via the development of the 132kV network and underground network, including UGSS.

The necessity of UGSS will also be taken into consideration by PGCB. However, PGCB has some issues regarding the sustainability of the entire network in Bangladesh, such as back-bone network development surrounding Dhaka city, long transmission line projects for power imports from other countries and some on-going thermal power plant projects in rural areas. Hence, PGCB is examining the necessity of UGSS considering its budget constraints.

Given the above situation in Bangladesh, DESCO/DPDC are going to proceed to the pilot project stage for UGSS projects in Dhaka city. Overviews of the projects are given below.

3.2 Updated Status from Previous Preparatory survey

3.2.1 Network planning & Electric design for Gulshan Substation

The JICA Team confirmed the fundamental requirement on electrical requirements from DESCO, then, also confirmed no change compared to the Data Collection Survey. Accordingly, the JICA Team studied the layout and other issues focusing on the impact to tentatively finalize the contents of Building Permit. The following shows the overview of DESCO's UGSS.

Table 3-1 Overview of DESCO's UGSS

Item	
Voltage Class	132/33/11 kV
Substation Capacity	510 MVA
Number of 132/33 kV Transformers	80/120 MVA x 3
Number of 33/11 kV Transformers	35/50 MVA x 3
Number of 132 kV lines	11 lines (8 Feeders, 2 Voltage Transformers, 1 Bus coupler)
Number of 33 kV lines	20 lines (14 Feeders, 5 Voltage Transformers, 1 Bus coupler)
Number of 11 kV lines	29 lines (21 Feeders, 6 Voltage Transformers, 2 Bus coupler)

(Source: The Data Collection Survey)

According to the Data Collection Survey, the Gulshan site has been selected as the top priority among DESCO's candidates for an UGSS project site from the network requirements, social-environmental and economic points of view. Currently, the Gulshan site is owned by PDB and used for a DESCO substation, DPDC office and PGCB substation. DESCO, PGCB and DPDC agreed an MOU in which

the Gulshan site would be used, due to it being the best site with the most efficient usage, according to PDB's lead. The current situation of the Gulshan site is shown below.

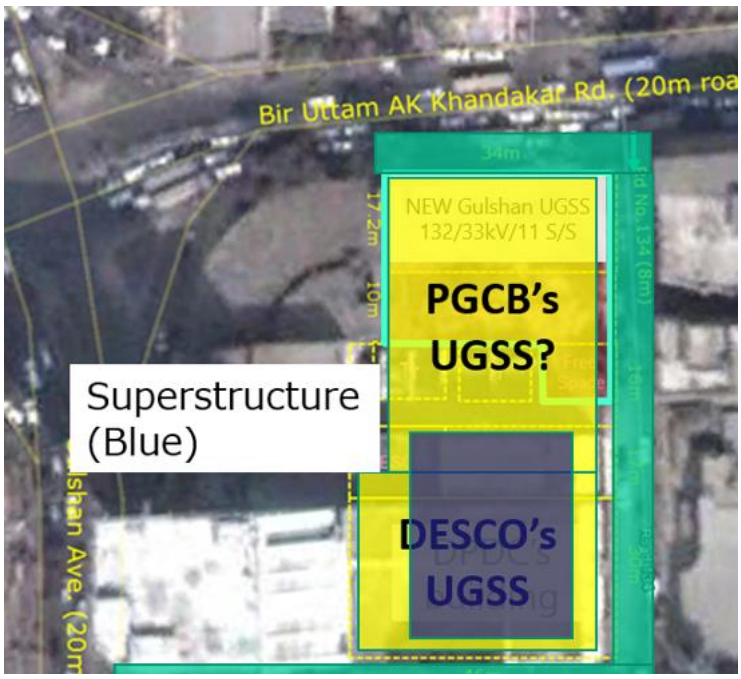
(Source: The Data Collection Survey)

Figure 3-1 Current Situation at Gulshan Site

The Data Collection Survey Team found difficulties in shifting the current load of the existing Gulshan substation to other substations. Hence, the first step in the process is to demolish DPDC's office in order to construct DESCO's UGSS on the bare land that the office previously occupied. The current load from existing substations will then be shifted to DESCO's new UGSS. Finally, DESCO's UGSS will be constructed after demolishing two existing substations used by DESCO and PGCB. After that, the two existing substations will be removed and PGCB's UGSS might be built there according to a precondition in the Data Collection Survey.

Under the above conditions, the JICA Team confirmed that DESCO applied to the Bangladesh government for a Development Project Proposal (hereinafter "DPP") and that this was approved in June 2018. In addition, since one of the most important issues requiring assistance from the JICA Team would be construction approval and procedure, the JICA Team confirmed the current status of the construction approvals. As a result, the team found that DESCO has to apply for the application as one package, including all projects on the Gulshan land, such as DESCO's UGSS, PGCB's UGSS and the superstructure. The specific content and procedures for the construction application are described in later chapters. The below shows an overview of the site after the project's completion.

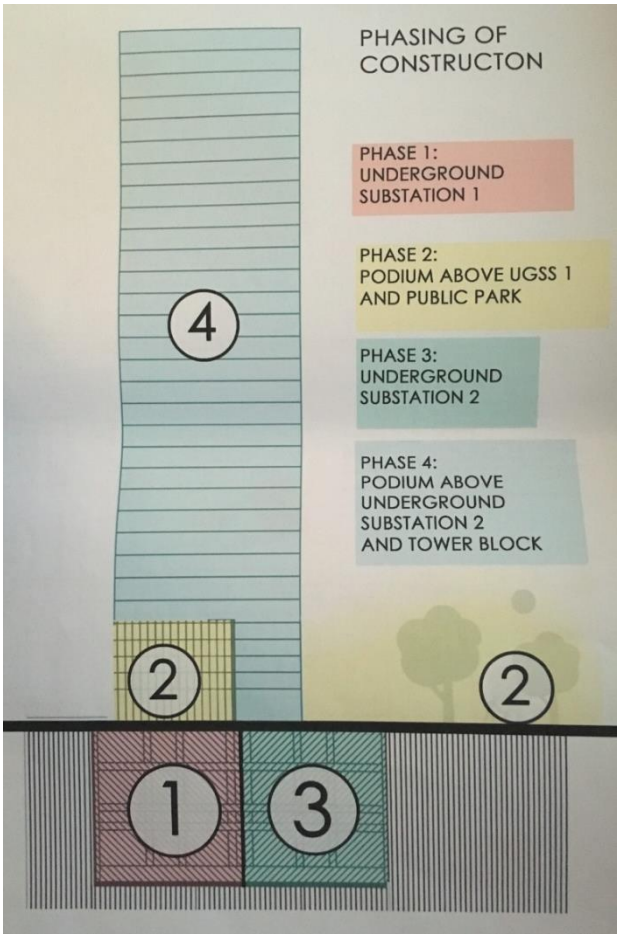
3.2.2 Updated Project Plan for Gulshan Substation



(Source: The Data Collection Survey)

Figure 3-2 Expected Final Usage of Gulshan Site

Since DESCO is eager to install the UGSS as soon as possible to enhance network reliability in the Dhaka area, they were looking for the fastest way to get approval in order to begin UGSS construction quickly. The biggest obstacle in achieving this would be PGCB's UGSS design. As of June 2018, no feasibility study for PGCB's UGSS has kicked off. Accordingly, DESCO cannot make applications without PGCB's design. Hence, DESCO and a local architect, who was hired by DESCO for the project, developed a scheme to submit the application without delay and start construction work even with no progress in the design of PGCB's UGSS. The JICA Team reviewed their idea. The procedure for the scheme is shown as follows.



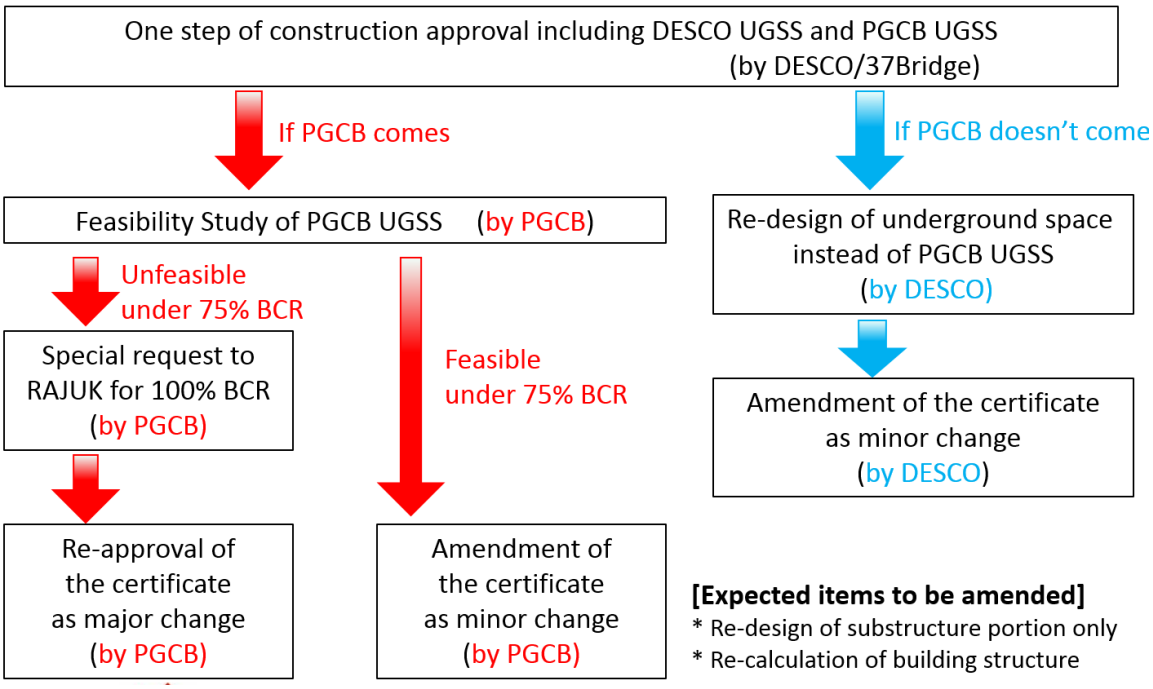
(Source: DESCO's local architect)

Figure 3-3 Application for Construction Procedure for the Project at the Gulshan Site

The above procedures are as follows:

- Phase I: Install DESCO's UGSS after removal of the existing DPDC office
- Phase II: Build lower superstructure on DESCO's UGSS for UGSS operation and create a public park after shifting load from the two existing outdoor substations to the newly constructed UGSS
- Phase III: Build PGCB's UGSS
- Phase IV: Complete superstructure construction

As mentioned above, there is no design for PGCB's UGSS as of yet. Hence, DESCO and their local architect has to develop a tentative PGCB UGSS design to get approval, and requested the JICA Team to design this. As a DESCO precondition, PGCB will carry out a feasibility study later if PGCB decides to construct their UGSS on this land. If PGCB decides not to proceed with the UGSS project on the Gulshan land, DESCO will change the use of PGCB's space to a car park. Hence, DESCO can proceed with the project thanks to this scheme regardless of PGCB's intentions for the Gulshan land. A summary of this scheme is shown as follows.



(Source: The JICA Team)

Figure 3-4 Expected Flow after getting Construction Approval for Gulshan Site

In summary, DESCO will apply for the construction approval to start construction work without delay. The content of the application will be prepared by DESCO, their local architect and the JICA Team. The JICA Team will develop DESCO's UGSS layout and tentative PGCB UGSS layout through discussions with DESCO, manufacturers and the Bangladesh authorities. Explanations of both layouts are described in later chapters.

3.2.3 Surrounding Structures for Gulshan Substation

Since the Gulshan area is one of the centers of Dhaka, the Gulshan plot is surrounded by a lot of buildings. Specifically, the western area of the plot faces existing buildings. The following shows a neighboring building.

(Source: The JICA Team)

Figure 3-5 Neighboring Building facing the West of the Gulshan Plot

This building structure, including its substructure, has zero-setback to the border of their land due to the construction work being implemented according to old regulations. Accordingly, there is a possibility of damaging or tilting their structure in the excavation work for Gulshan UGSS. Hence, the JICA Team confirmed the necessary clearance based on the feasible excavation method.

Considering the UGSS depth, an Earth Retaining or Stabilizing Structure (ERSS) is necessary to support the excavation. The JICA Team has assessed that the ERSS may be secant bored piles or D-wall and may be constructed via bottom-up excavation or top-down.

The use of high stiffness sheet piles with I-beam soldier piles may also still be feasible, but this method is not as robust as the abovementioned method and unless very accurate information can be obtained regarding the adjacent building foundations, and ground conditions, then such a method cannot be recommended at this stage. Hence there are two possible methods:

1) Diaphragm Wall

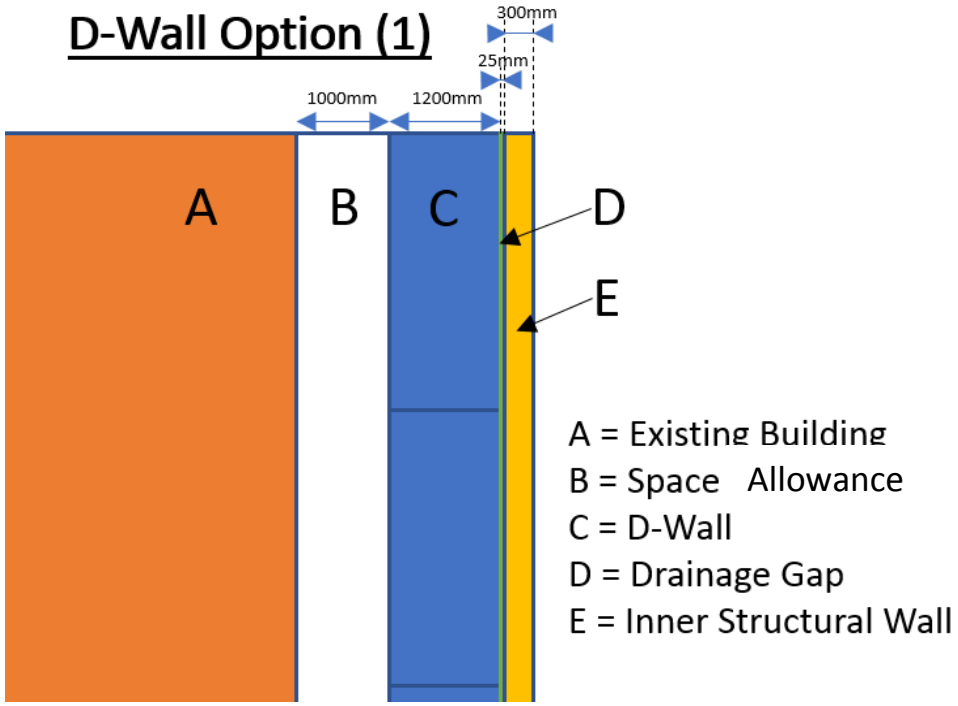
Based on past projects in Singapore it appears that 3m of space from the outer edge of the neighboring building to the inside wall of the substation is sufficient for the scheme.

One previous project in Singapore included a D-wall installed only 300mm from an existing structure, so theoretically the same could be undertaken here but we would not recommend it due to the ongoing uncertainty regarding the building conditions, and instead recommend D-wall construction at least 1m from the existing structure. Therefore, a suitable D-wall solution may involve:

- 1000mm (minimum) space between any adjacent structure (i.e. the 22 story adjacent building) and outer edge of D-wall;
- 1200mm thick D-wall;
- 25mm gap to allow drainage, and scupper drain;

- 300mm thick inner structural wall, but this may need to be thicker depending on structural requirements.

For D-wall: Total distance from building to inside wall = 2525mm.



(Source: The JICA Team)

Figure 3-6 Schematic Plan showing Preferred Minimum Space Requirements for D-wall

Note that the D-wall thickness of 1200mm is just an estimate. With more detailed analysis once the ground investigation is complete, it may be possible to optimize and select a thinner D-wall of 1000mm or even less.

There are also other options, like applying a waterproof membrane to the D-wall and then applying a skin wall, but the above is the most typical for M&E projects.

However, with D-wall, it should be noted that there is a risk of trench collapse during the D-wall's construction depending on the soil profile. The risk can only be properly assessed following a ground investigation to confirm the soil profile but it is important to have an alternative option if D-Walls are considered too risky.

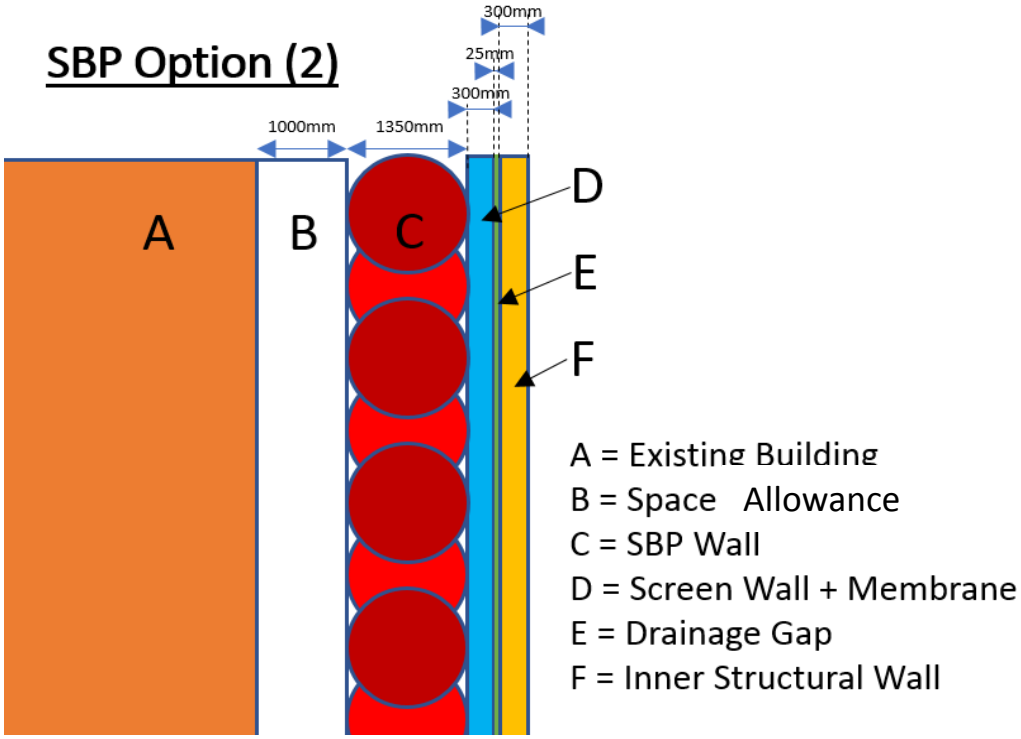
2) Secant Bored Piles

An alternative to D-Wall is to consider Secant Bored Piles (SBP), which are slightly more stable in construction. However, once installed they are not quite as stiff as D-walls. It is therefore necessary to create a slightly thicker wall to achieve the equivalent stiffness. Therefore a suitable SBP-wall solution may involve:

- 1000mm (minimum) space between any adjacent structure and outer edge of SBP-wall;
- 1350mm thick SBP-wall;
- 300mm screen wall with waterproof membrane;
- 25mm gap to allow drainage, and scupper drain (although this may not be necessary)

- 300mm thick inner structural wall, depending on structural requirements.

For SBP: Total distance from building to inside wall = 2975mm.



(Source: The JICA Team)

Figure 3-7 Schematic Plan showing Preferred Minimum Space Requirements for SBP

Therefore, the JICA Team confirmed that a 3m setback is appropriate for excavation. Then, if necessary, temporary struffing should be taken.

(Source: The JICA Team)

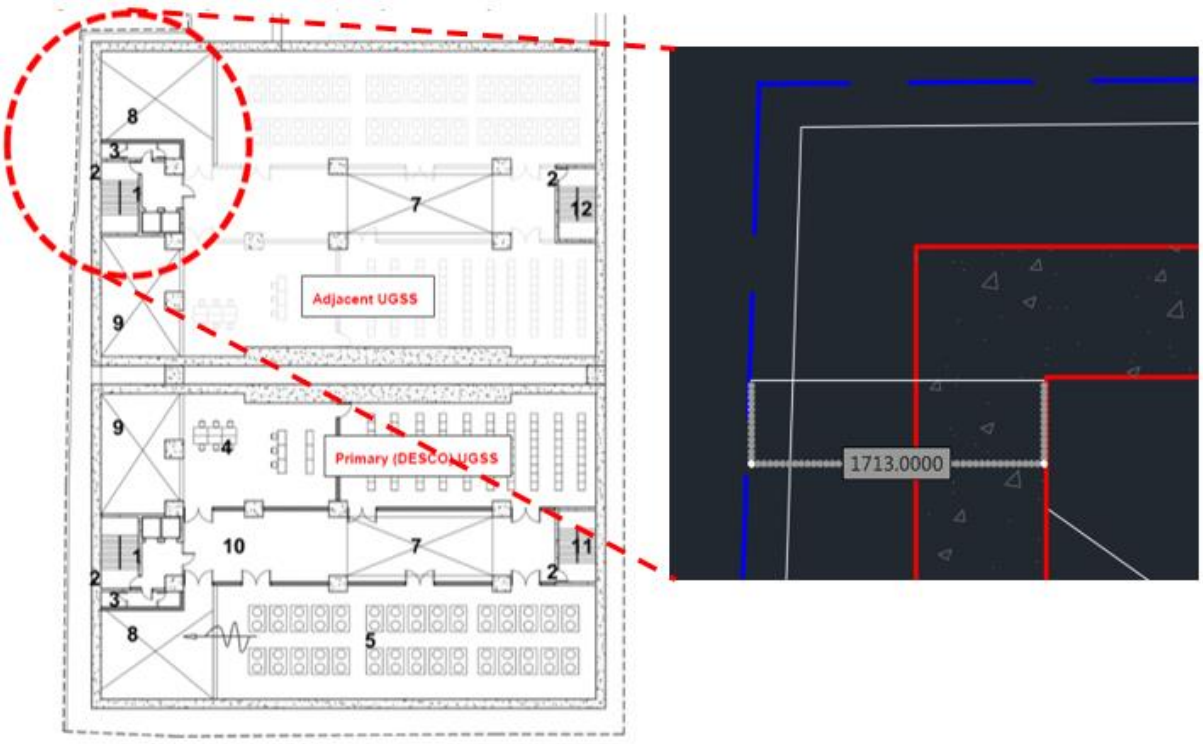
Figure 3-8 3m Clearance between the Neighboring Building and Gulshan UGSS

There is also a concern that the outer wall of the adjacent UGSS lies extremely close to the property boundary, along much of which adjacent buildings lie. Such constraints may be prohibitive and require a change in the layout, meaning that the two UGSS layouts may not be identical.

The figures below show how the property boundary tapers in along the western edge of the PGCB UGSS. At its northwest point, the distance between the inside wall of the substation and the property boundary is only 1.71m. It is not known if the adjacent building structure runs right up to the property line because no accurate topographic or building survey has been completed, but based on site observations it appears that the adjacent structure runs very close to the property boundary and parts of the structure, including air conditioner units, may even overhang the boundary.

Such an allowance is possibly generous but recommended given the uncertainty regarding the actual site conditions and adjacent building foundation. Therefore, constructing such a system under such constraints (as those apparent in the northwest corner) may be possible but is unusual and would likely require sophisticated protection measures and need detailed analysis to confirm its feasibility. If possible, as an alternative, it may be better to adjust the layout of the PGCB UGSS, or shift it more towards the eastern boundary, where there is a distance of approximately 2.4m between the inside wall of the DESCO UGSS and the property boundary, with no major adjacent structures.

Any change in layout or position of the PGCB UGSS may however have an impact on the position of the DESCO UGSS as both need to be sited in order to accommodate the superstructure. The local architect will therefore need to assess this matter further and develop an appropriate solution.



(Source: The JICA Team)

Figure 3-9 The Clearance at the North-west Point of Gulshan Plot

3.2.4 Project Implementation Unit for Gulshan Substation

The JICA Team confirmed that a Project Implementation Unit (hereinafter "PIU") for DESCO's project will be organized after getting the approval for their DPP. Hence, the Bangladesh Gorvernment nominated Engr. Md. Shariful Islam as the Project Director for the project.

3.2.5 Development Status of Power Source Substations and Underground Transmission Lines

In the Data Collection Survey, the power source substations were finalized as 230/132 kV Rampura substation for DESCO. Accordingly, the JICA Team confirmed the current status for both substations' operation in the SAPI because one and a half years have passed since the Data Collection Survey.

Accordingly, The JICA Team confirmed DESCO plans to keep Rampura Substation for the sake of power source. Also, the JICA Team confirmed Rampura Substation has available three bays, unused two bays and a space to add one bay on 132kV GIS. Hence, DESCO and the JICA Team have agreed to use 230/132 kV Rampura substation as the power source substation. The JICA Team considered route selection and the feasibility of the power source lines in Chapter 4.

Chapter 4. Examination on the specified Electric Design of UGSS Component for precise UGSS layouts (DESCO)

4.1 Transformer Specifications

The JICA Team has confirmed the specifications for the Gas Insulated Transformer with DESCO as follows. Hence, all designs by the JICA Team are based on the following. The Engineering Services Consultant will finalize the specifications and designs for the project accordingly.

Table 4-1 Specifications of Gas Insulated Transformer

No.	Item		Requested Specification	
1	Rated Capacity [MVA]		120	50
2	Max Weight [t]		302	100
3	Max Dimensions [mm]	W	11,000	10,000
4		D	12,000	6,000
5		H	6,200	6,050
6	Rated Voltage [kV]	Primary	132	33
7		Secondary	33	11
8	Voltage Range		+10%/−15%	+10%/−15%
9	Tap Voltage [%]		1.25	1.25
10	The Number of Taps		21	21
11	Winding		Dyn1	Dyn11
12	Phase Number [Phase]		3	3
13	Frequency [Hz]		50	50
14	Short-Circuit Impedance [%]		18	8
15	Type of Cooling		GFWF	GFWF
16	Max Ambient Temperature [℃]		45	45
17	Noise [dB]		78	78
18	Connection Method with the Outside	Primary	Cable	Cable
19		Secondary	Cable	Cable

(Source: The JICA Team)

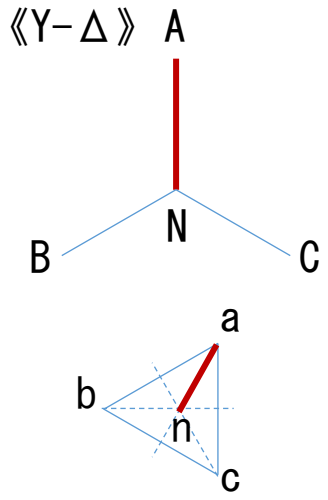
The JICA Team tentatively fixed the maximum dimensions of GIT through interviews with manufacturers. Hence, the JICA Team designed the GIT room on the current UGSS layout, which can accommodate the maximum size. Accordingly, the Engineering Services Consultant will have to specify the allowable and maximum GIT size to enable the Contractor to design their size to meet the current room size, also considering equipment transportation and installation.

4.1.1 Winding Type

For the Transformer Winding method, it is necessary to choose from two methods. The Y-Δ method and Δ-Y method each have different characteristics. For example, the main tank in the Δ-Y method is huge compared with the Y-Δ method. The JICA team once confirmed the possibility of adopting the Y-Δ method with DESCO/DPDC, but this issue must be discussed further by considering the number of manufacturers for GIT with the proposed specifications and the necessary technical studies, such as that for the introduction of GTrs. If an UGSS adopts this method, there are several manufacturers that can produce it.

However, greater confirmation is necessary from the viewpoint of network operation, such as protection coordination with other substations. In addition, an Earthing Tr (GTr) will be required for this method. This will also affect the layout of the UGSS.

Therefore, comprehensive judgment is necessary in order to determine the winding method.



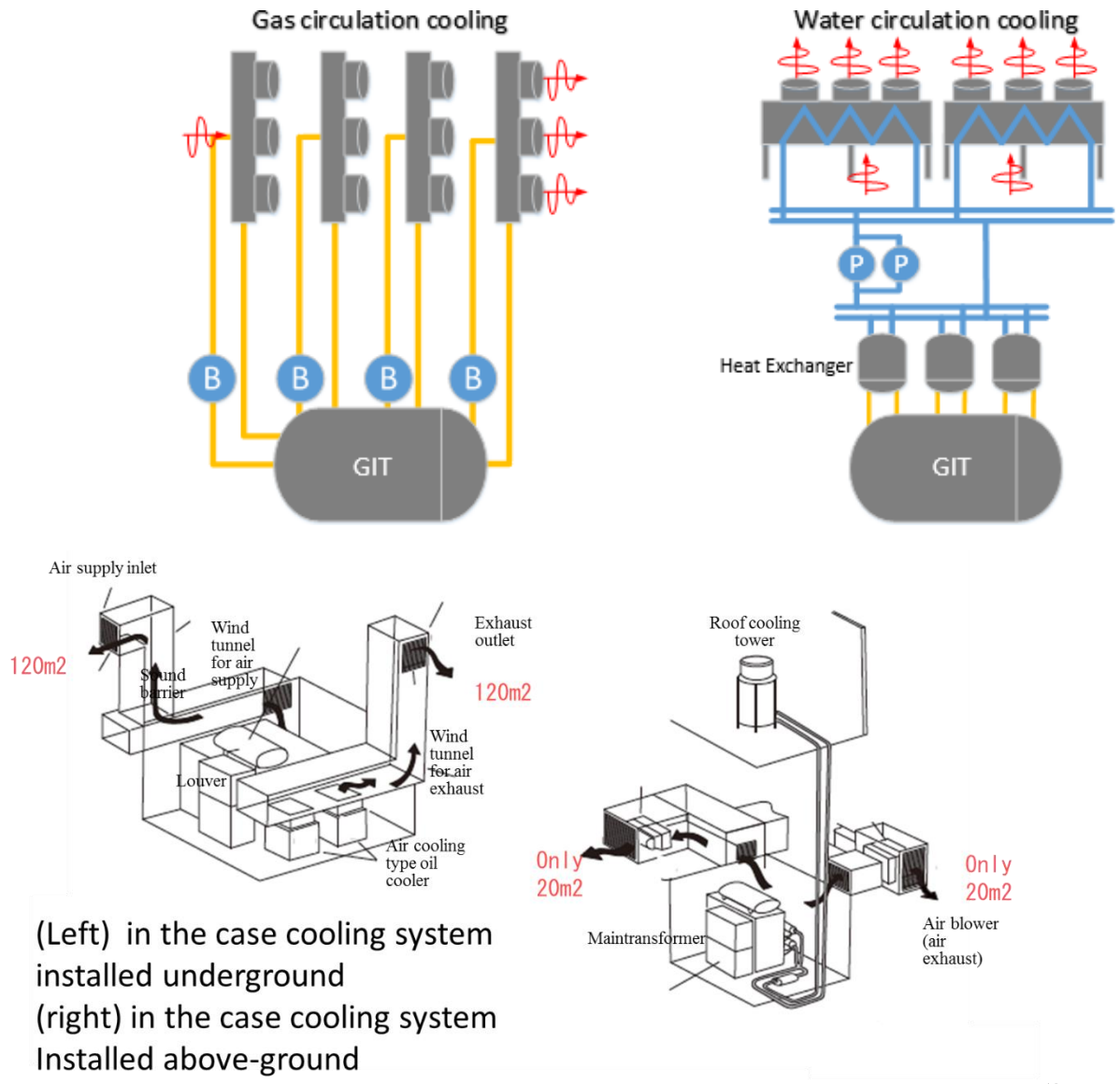
(Source: The JICA Team)

Figure 4-1 Transformer Winding Method

The transformer room in the current layout follows the delta-star winding method. The Engineering Services Consultant might re-design the substation to become more compact if the manufacturers propose realistic and available technical solutions changing the winding type.

4.2 Cooling System Design for Transformers

It is essential to install a cooling system to deal with the heat dissipation from equipment. Though outdoor substations generally have transformers with radiators, UGSS cannot have these due to the room size constraints. Hence, an alternative cooling method to cool the heat transferred from the transformer room to other rooms is installed in UGSS. Generally, there are two mediums for transferring the heat: "Water" and "GIT Gas itself". The following shows the two cooling systems.

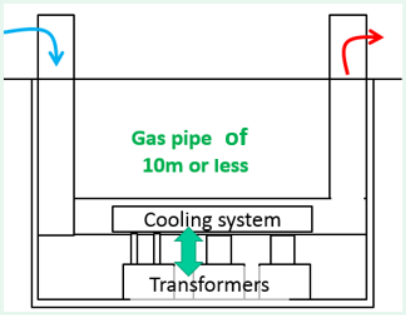
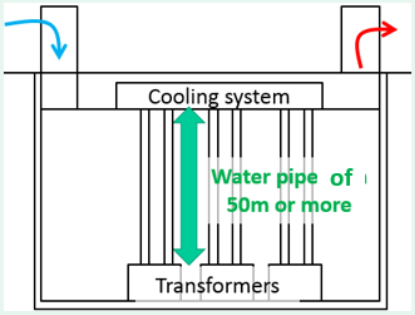


(Source: The JICA Team)

Figure 4-2 Two Cooling Systems for Transformer, and Comparison of Openings

Gas circulation cooling involves extending the gas pipe from the transformer tank directly to the cooling tower, while water circulation cooling needs initially to shift the heat from the gas pipe to the water pipe in the heat exchanger, then the heated water pipe is extended to the cooling tower, which is located on another floor. Each method needs different equipment, and the biggest difference is the allowable length of pipe. Given the characteristics of water and gas, the maximum length of a water pipe is longer than a gas pipe. A longer water pipe can lead to more flexible location of the cooling tower. The following shows the differences of each medium's characteristics.

Table 4-2 Comparison of Cooling Systems for Transformer

Item	Gas Circulation system	Water circulation system
Available Piping length	**Short (20～100 m)** Depending on each manufacturer's capability	**Long (20m or more)** ・Available from all manufacturers.
Pipe Size	200A or more	150A or less
Auxiliary equipment	Gas blower	Heat exchanger, Circulating water pump and valve, water tank
Expected location of Cooling system		

(Source: The JICA Team)

The transformer should be installed on the bottom floor to better support its heavy weight. As mentioned above, the cooling system must be put on the same floor or the one above due to the limited pipe length when gas circulation cooling is used in the UGSS. Employing water circulation cooling enables the cooling tower to be on a higher floor.

The following shows the tentative specifications of a single cooling unit for the assumed design of the entire cooling system in the SAPI. Currently, the JICA Team estimates that a maximum of 20 units would be necessary to deal with the total amount of the heat described in the next section. At the detailed design stage, the Contractor will have to calculate the proper number of single cooling units based on the actual heat emitted from their equipment. Hence, they will take the maximum weight with 20 units into consideration for their design from the aspect of structure strength. This means they can change their design within the maximum weight and available space.

Table 4-3 Tentative Specifications of Cooling Unit

№	Item		Specification
1	Water Temperature for Inlet/Outlet [℃]	Outlet	55
2		Inlet	45
3	Average Intaked Air Temperature [℃]		36
4	Cooling Capacity per Single Unit [kW]		225
5	Max Weight per Single Unit[kg]		3000
6	Max Dimensions per Single Unit[㎜]	W	1,500
7		D	2,500
8		H	6,100
9	Plumbing size	Main	200A
10		Makeup	80A
11	The number of Bending Points of Plumbing	Main	6
12		Makeup	4

(Source: The JICA Team)

And the following shows a view of the single cooling unit as a wind system. The number of cooling units should be calculated based on the necessary cooling capacity.

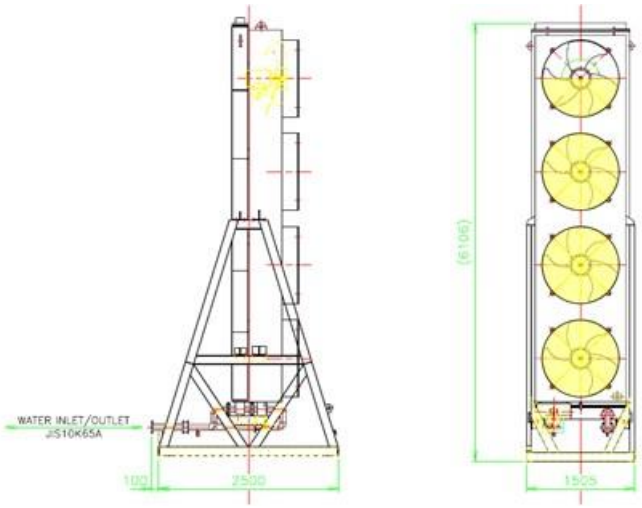


Figure 4-3 View of Single Cooling Unit

It is also to be noted that cooling units must be installed in the UGSS when gas circulation cooling is applied. The feasibility of the idea is verified in the next section.

4.2.1 Location Study of Cooling System

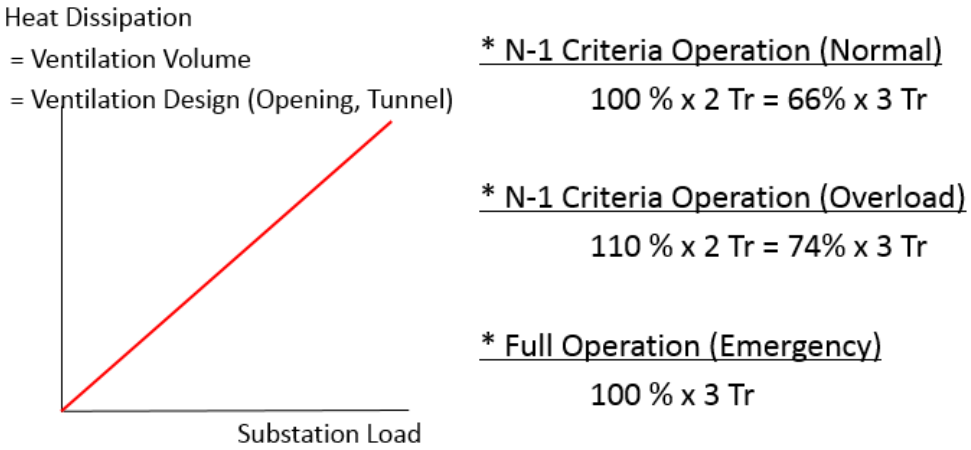
Initially, the cooling equipment was planned to be installed in the basement. However, the JICA team suggested that it should be installed on the ground or above floor, as doing so can reduce the amount of underground ventilation needed for the UGSS. Specifically, installation of the cooling system in the basement requires a huge ventilation tunnel in the UGSS. Eventually, this might lead to higher excavation costs. In addition, it might be difficult to make the best use of the ground floor, which is one of the greatest benefits of UGSS, since a huge air opening on the ground floor might occupy the ground floor space. Hence, the JICA Team tentatively designed the expected size of the ventilation tunnel and air opening on the ground floor in order to verify the feasibility of installing the cooling system in the UGSS. The following shows the procedure for the design.

[Case Study] Cooling system in the UGSS

[Study flow]
1. Calculation of Total Heat Dissipation emitted from equipment
2. Calculation of necessary ventilation volume based on the heat dissipation
3. Design of air opening size on ground floor considering the expected wind speed at the air opening and ventilation tunnel

The greatest heat would be emitted from the transformer. Approximately 90% of transformer heat would be cooled at the heat exchanger and dedicated cooling system using a gas or water circulation system. Accordingly, approximately 10% of transformer heat should be treated by the ventilation system to keep the room within an allowable temperature.

A transformer has two loss types: iron loss as constant loss, and copper loss as changeable loss in proportion to transformer load. This means the heat dissipation mostly depends on the load on the transformer. It would be possible to consider a lower load, which means lower heat, under the assumption of N-1 operation as DESCO's policy. However, the JICA Team estimated 100% load for the maximum heat because of the challenges that DESCO faces, such as high power demands in the Gulshan area and the difficulty of quick load transfer in the event of overload at the future UGSS. The following shows the relation between load and heat dissipation.



(Source: The JICA Team)

Figure 4-4 Relation between Load and Heat Dissipation

The JICA Team estimated a tentative value as the maximum amount of heat dissipation to meet the technical requirements for each piece of equipment. The tentative heat assumption is used to design the ventilation volume for cooling. Hence, the Contractor will have to re-calculate the proper ventilation design according to their equipment's heat.

Other than heat estimation, the JICA Team set 36 Degrees Celsius as the yearly average temperature for the air intake. Since this value is cited from the highest yearly average temperature in Bangladesh, 36 Degrees Celsius would be regarded as the most severe assumption for the cooling system design.

[Case Study] Cooling system in the UGSS
Based on the above study flow, the JICA Team listed the heat dissipation as follows.

Table 4-4 List of Heat Dissipation from Equipment

Floor	Items	Loss [kW]	Quantity	Unit	Total [kW]
B4	132/33kV GIT	700.0	3	Sets	216.3
	33/11kV GIT	800.0	3	Sets	246.3
B3	Cooling system	4037.5	1	Lot	4,056.3
	Panels	114.0	1	Sets	120.3
B2	Cable	0.0	1	Lot	6.3
B1	132kV GIS	58.4	3	Sets	181.5
	33kV CGIS	13.2	3	Sets	45.9
	11kV SW	11.0	3	Sets	39.3
	DC set	35.0	2	Sets	76.3
GF	DC set	35.0	1	Sets	41.3
-	Others	50.0	1	Lot	56.3
Total					5,023.1

(Source: The JICA Team)

The necessary ventilation volume is estimated as follows based the above heat dissipation.

[Neccesary Ventilation Volume]

$$= \frac{Total\ Heat\ Dissipation\ [kW]}{0.33 \times (Maximum\ Ambient\ Temperature - Intaked\ Air\ Temperature)}$$

$$= 1{,}691{,}263\ m^3/\mathrm{h}$$

The size of the ventilation tunnel and air opening should be designed to satisfy the necessary ventilation volume with the allowable wind speed. For the ventilation flow size study, the maximum and allowable wind speed should be taken into consideration. The standard wind speed recommended by the Architectural Institute of Japan is 3-4 m/s. Bangladesh has no similar standard, hence the JICA Team uses the Japanese recommendation for this study.

The JICA Team also simulated case studies with some wind speeds. The following shows cases for the necessary size of the ventilation tunnel and air opening when the cooling system is installed in the UGSS.

Table 4-5 Size Study for Ventilation Tunnel and Opening

Ventilation Tunnel

	100 % Load
Wind : 3 m/s	**156.6 m2**
Wind : 4 m/s	**117.4 m2**
Wind : 5 m/s	**94 m2**

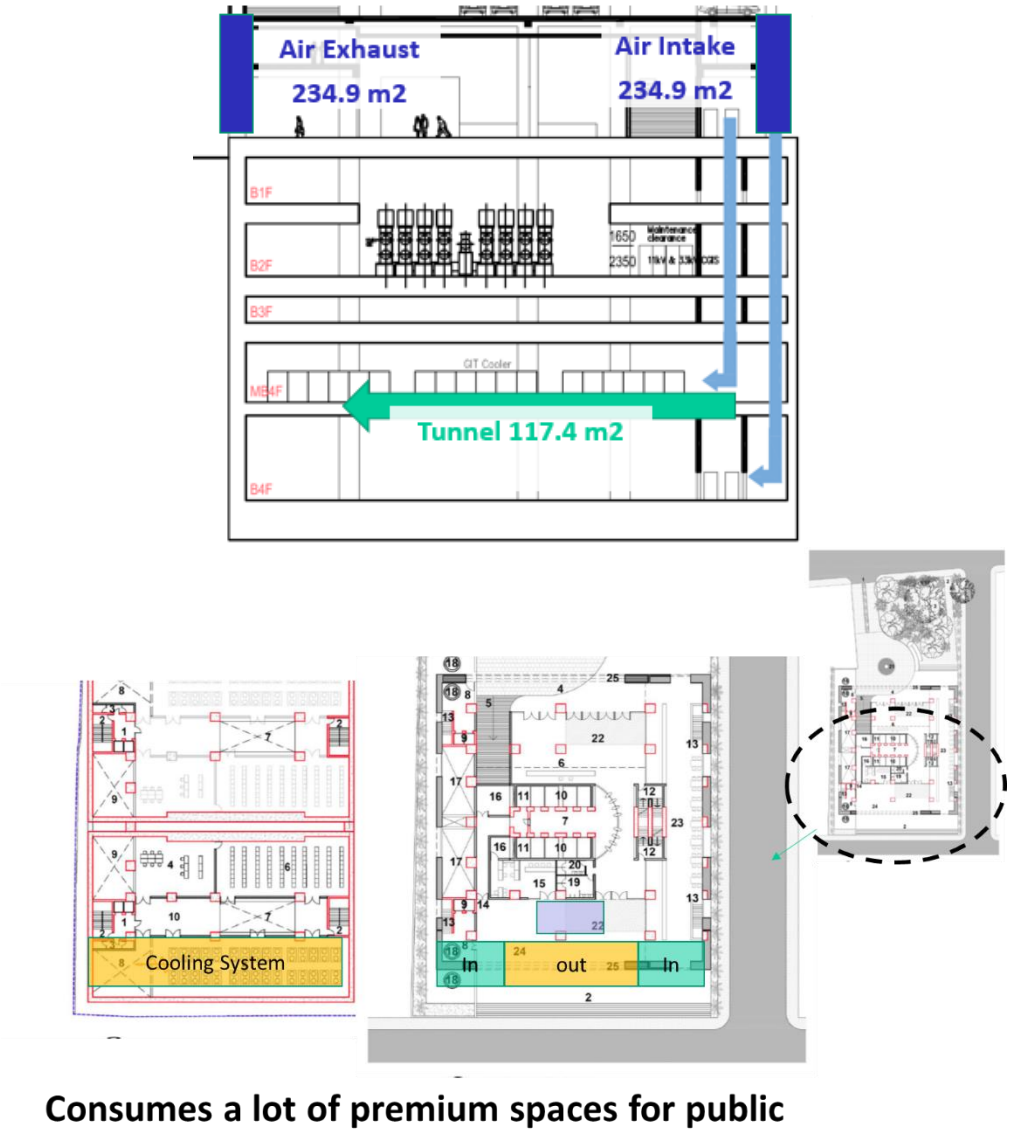
Ventilation Opening (Available rate of Louver: 50%)

	100 % Load
Wind : 3 m/s	**313.2 m2**
Wind : 4 m/s	**234.9 m2**
Wind : 5 m/s	**187.9 m2**

* Ambient Temp: 36℃
* Maximum Room Temp: 45℃

(Source: The JICA Team)

Based on the above sizes, the following shows a cross section with air opening size and ventilation tunnel size when wind speed is specified as 4 m/s.



(Note: the opening is shown based on 75% loading, 4m/s wind speed)

(Source: The JICA Team)

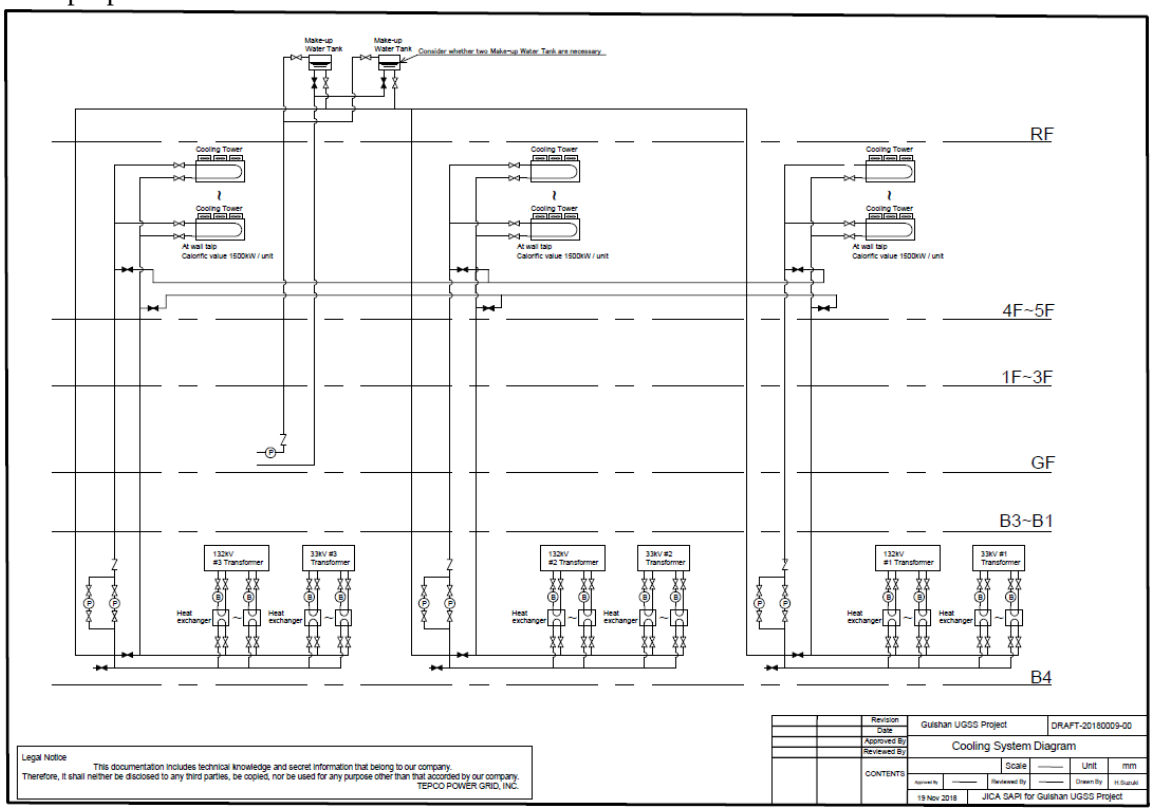
Figure 4-5 Drawing of Opening Size and Wind Tunnel Size

This would lead to a 10 m deeper UGSS, and the JICA Team considered that this idea would not be realistic due to the greater excavation costs and longer excavation period. Additionally, the huge air opening required on the ground floor would negatively affect the commercial value of the ground floor. Based on the above studies, DESCO and the JICA Team agreed that the cooling system be installed in the superstructure. Naturally, gas circulation cooling cannot be applied due to the limited gas pipe length, so a cooling system with heat exchanger and water pipe will be applied.

Hence, the JICA Team and DESCO agreed that the location of the cooling system should be on ground or above floor with water circulation cooling to avoid the large size of wind tunnel and air opening.

4.2.2 Cooling System Scheme

The location of the cooling system in Gulshan UGSS has been agreed as per the previous section. For the next step, the JICA Team designed the scheme for the cooling system in order to design the location and size of the pipe shaft from the UGSS to the podium structure. The following shows the cooling scheme proposed.



(Source: The JICA Team)

Figure 4-6 Preliminary Diagram of Water-cooling System

In the proposed cooling scheme, each GIT set, 132/33kV GIT and 33/11 kV GIT, has each cooling system as a "unit cooling system". There is another cooling scheme, the "common piping cooling system", which has bus-pipes between each GIT unit. However, the current architectural design doesn't take the common piping system into consideration due to space issues, and the JICA Team estimated a heavier weight using the common piping system for the structure design.

Accordingly, Gulshan UGSS will tentatively use the unit cooling system in the current layout. However, it isn't necessary to apply for a change of building permit even if the common piping system ends up being applied at the detailed design stage.

4.3 Case study in Gulshan's case

4.3.1 Cooling System in the Superstructure

This section describes where the cooling tower should be installed in the superstructure. The location is closely related to the superstructure design and structure strength. Initially, the JICA Team suggested three proposals for the cooling tower location. The following shows a summary of the proposals.

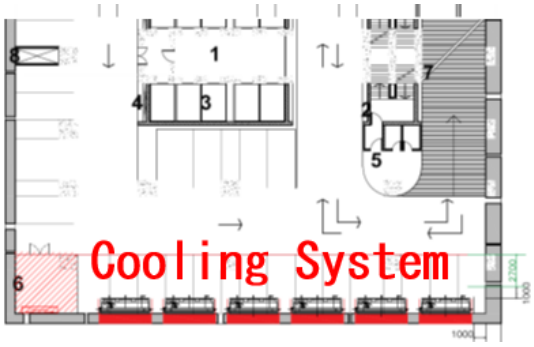
Table 4-6 Summary of Cooling Tower Locations

Item	Plan (A) On Wall	Plan (B) On 5th floor	Plan (c) On Roof of low-rise building
Installation Location	Use walls of the 1st to 4th FL of low-rise building	Use the 5th floor of low-rise building	Roof of low-rise building
Installation Feusibility	OK	When the ceiling of the 5th floor was raised and the equipment installation area can be secured	The installation area in not satisfied
Wind Direction	*Parking space intake from *Exhaust to the outer wall (Sideways blowing)	*Intake air from outer wall or floor of the 5th floor *Exhaust with ceiling duct (Blowing up)	*Direct air intake *Direct exhaust (Blowing up)

(Source: The JICA Team)

Plan A is to install cooling systems on 1F to 4F. Specifically, cooling units are vertically installed along the wall in the southern portion of the superstructure. If necessary, louvers to cover the surface of the cooling system would be installed to avoid public exposure. In this case, the availability factor of the louvers must be considered based on the necessary air flow. The following shows a cross-section and layout for installation of the cooling system.

Cross Section for Plan (A)



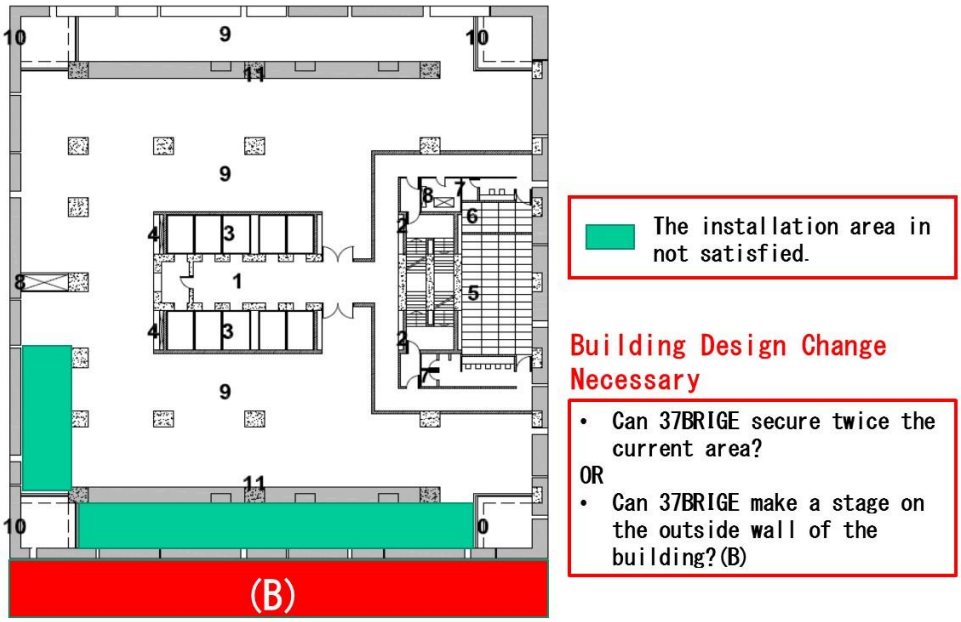
Layout for Plan (A)

(Source: The JICA Team)

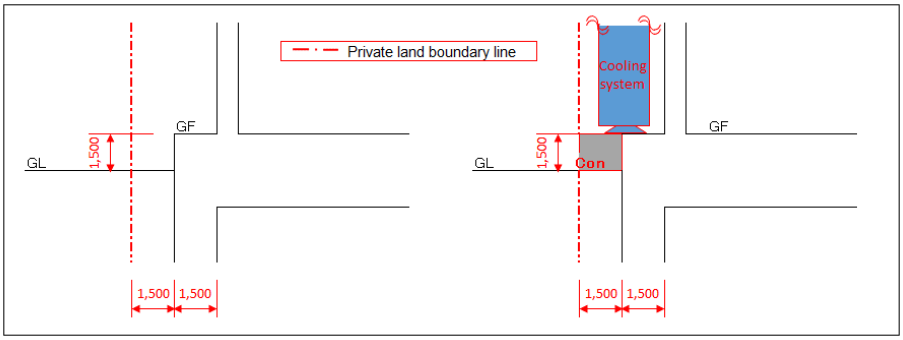
Figure 4-7 Location Study for Cooling System (Plan A)

Since air flow in Plan A is from inside the superstructure to outside the superstructure, approximately 39 x 3.6 x 2.7 m space for the installation of vertical cooling units would be necessary on floors 1-4.

Plan B is a proposal to install the cooling system outside of the superstructure. In concrete terms, it is necessary to have the floor extend out for the cooling units' installation. Sufficient strength for the floor to extend out should be guaranteed. The following shows a cross section and layout for Plan B.



Layout for Plan (B)



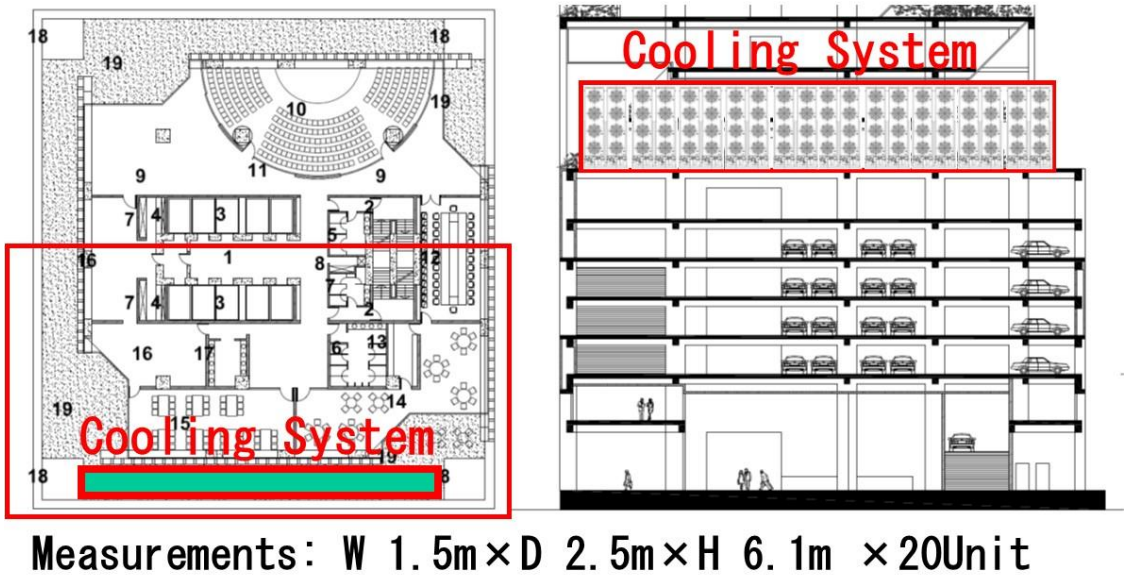
Preliminary Drawing for Plan (B)

(Source: The JICA Team)

Figure 4-8 Location Study for Cooling System (Plan B)

Since the dimensions in the above drawing are preliminary, the structure designer will have to reconfirm the dimensions of the extended floor to secure sufficient strength given the cooling system weight.

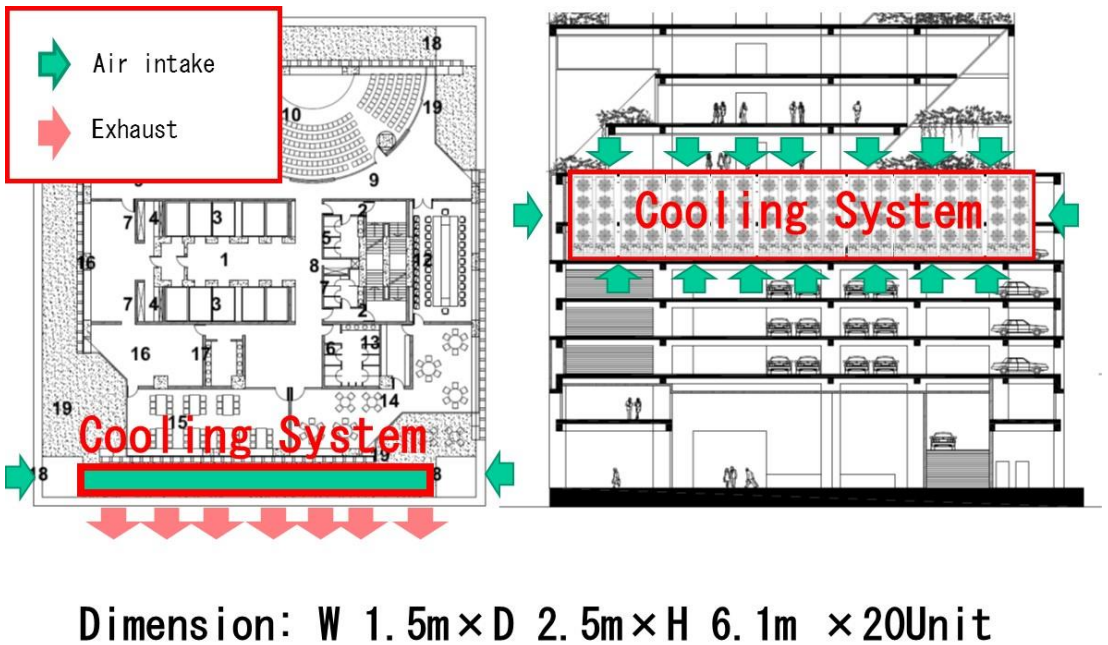
Plan C is a proposal to install the cooling system on the top of the podium, which will be constructed in Phase II of DESCO's construction procedure. Initially, the JICA Team proposed that the cooling system be installed in the terrace space of the podium, with 5 stories. The following shows drawings for Plan C.



(Source: The JICA Team)

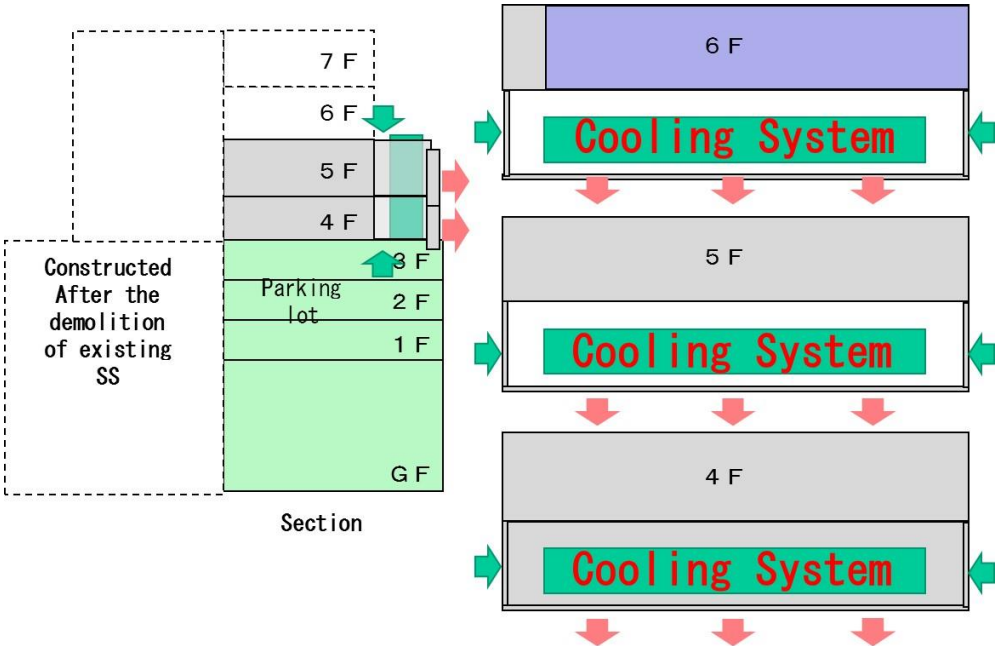
Figure 4-9 Location Study for Cooling System (Plan C)

However, DESCO cannot make use of the terrace space for commercial usage, as opposed to installation of the cooling system. Hence, the JICA Team re-proposed Plan C', in which the cooling system is installed on 3F and 4F by shrinking part of the podium on 3F and 4F. The following shows Plan C'.



(Source: The JICA Team)

Figure 4-10 Location Study for Cooling System (Plan C') (1)

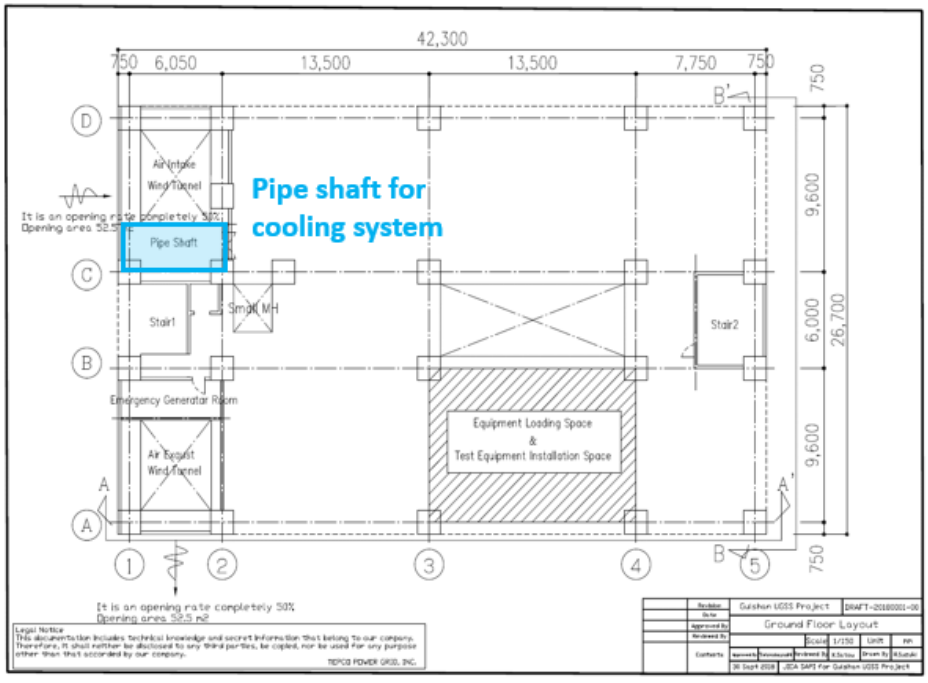


(Source: The JICA Team)

Figure 4-11 Location Study for Cooling System (Plan C') (2)

DESCO and the JICA Team agreed Plan C' for the location of the cooling system in Gulshan UGSS following discussions on Plans A, B, C and C'.

In terms of the unit cooling system, it is necessary to set six sets of piping passing from the UGSS to the upper podium for the cooling. Hence the JICA Team designed the shaft as follows, and has informed the superstructure designer of this in order to reflect it in the superstructure design.



(Source: The JICA Team)

Figure 4-12 Shaft Size and Location on Ground Floor

Chapter 5. Underground Substation Layout (DESCO)

5.1 General technical requirements for UGSS

The following are basic UGSS design considerations to be harmonized as nominated in the previous UGSS Feasibility Study for DESCO:

(1) Equipment layout with consideration of safety and ease of maintenance and the operability of future extension construction work.

(2) Proper ventilation method for the removal of underground substation facilities' heat dissipation.

(3) The equipment transportation passages will be arranged to face a road.

(4) Sufficient power cable routing space must be provided to facilitate the installation of equipment for cable tunnels, outgoing cable tunnels and cable ducts.

(5) Sufficient space both on above-ground and underground floors for equipment installation, removal, repair, transportation, testing and site-assembly.

(6) Large equipment will be located near the equipment machine hatch with a corridor of sufficient width.

(7) The control room will be located near the exit and possibly above ground for occupational safety.

5.2 UGSS layout for Gulshan Project

The layout for Gulshan UGSS is now being revised with the architect for its superstructure to provide the necessary ventilation system, with upgraded information on the GIT transformer's requirements, and UGSS building's structure for supporting its superstructure. The study on the cooling system for GIT is discussed.

(Structure)

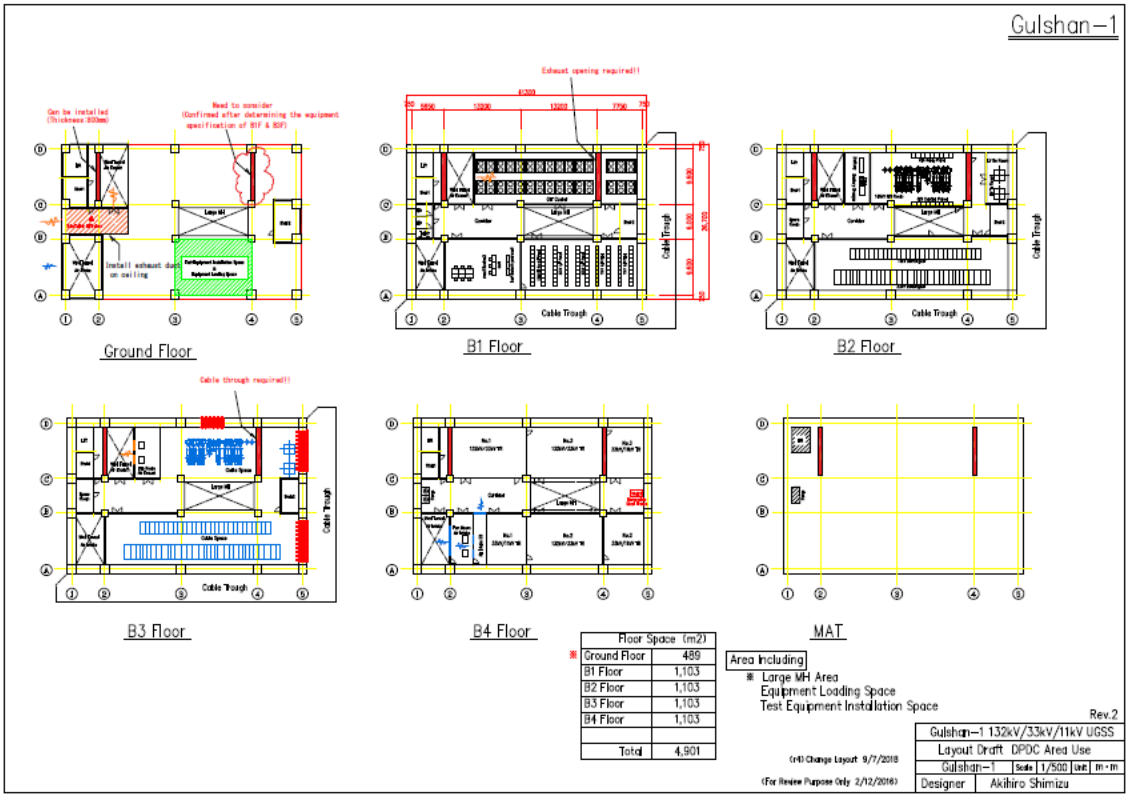
The JICA team received requests from the local architect to adopt a load bearing wall design for construction of the superstructure. Accordingly, the JICA team tried to revise the UGSS design.

It is difficult to change the position of the load bearing walls the local architect shows because the UGSS has a mirror structure with the building on the PGCB side. With a change of equipment arrangement, addition of a load bearing wall in one location (ventilation side) is no problem, but the other (machine hatch side) requires a ventilation opening for the GIT cooling device and an opening through the GIS cable. In addition, as the exhaust port moves to the inside of the building, there is a concern that the waste heat will affect the adjacent building.

The JICA team proposed a conditional straight-column layout instead of adjusting the opening range of the load bearing wall because it took a long time to complete the equipment selection and it was difficult to quickly decide the layout.

The conditions were to increase the size of the straight columns by 1,500mm×1,500mm, and for the effective dimensions of the machine hatch to be (length) 12,000mm × (width) 4,500mm in order to secure a transportation corridor of (width) 4,500mm inside the substation.

As a result of further structural calculations by the local architect, it became possible to accommodate this by adding and strengthening the straight columns instead of the load bearing walls.



(Source: The JICA Team)

Figure 5-1 Layout Plan for Gulshan UGSS Project

(Layout)

Based on this confirmation, the layout of the straight columns, openings, and small machine hatch, and the layout of each room were decided. Then. the JICA Team studied the equipment size based on DESCO's practice and the interview with GIT manufacturers. Therefore, the following sizes are set as the maximum size, which can be accommodated in the layout.

- 132/33 kV GIT Room: (length) 13320 × (width) 9540 × (height) 6500 [mm]
- 33/11 kV GIT Room: (length) 6910 × (width) 9540 × (height) 6500 [mm]
- 132 kV GIS Room: (length) 17220 × (width) 9920 × (height) 6250 [mm]
- Large machine hatch: (length) 12000 × (width) 4500 [mm]
- Small machine hatch: (length) 2995 × (width) 2500 [mm]

From interviews with three GIT manufacturers, at the current design stage it appears that some of the equipment sizes will be difficult to accommodate in the current GIT Rooms, but it has been confirmed that the problem can be solved with arrangement the assemble items on GIT and using electric shutter instead of the walls of the building.

The JICA team believes that further downsizing can be achieved by reviewing the sizes, including equipment options, in the future detailed design.

Equipment installation quantities assumed at present, and the reflected in the detailed design, are shown below.

- 132/33 kV GIT:3
- 33/11 kV GIT:3
- 132 kV protection control device: 18 + spare
- 132 kV GIS control panel: 10 + spare
- 33 kV CGIS: 20 boxes
- 11 kV Switchgear: 31 boxes
- LV Transformer: 2 units

As an advantage of changing the layout of the cooling device for the GIT to outdoors, the opening area for ventilation on the ground floor is reduced by 60% compared with the FS design. In addition, because there is no heat release inside the substation, the work environment is improved.

Furthermore, as a cost reduction measure, excavation depth was reduced by 2.6m by opening the ceiling of the GIS room and lifting the floor.

However, it is necessary to adopt a method for separating places affected by fire using a fire damper when a fire occurs by using the corridors and each room as ventilation ducts, as recommended by the JICA team. If the duct system is adopted for ventilation, it needs to be deepened by +4.0m.

(Border)

The separation between the outer wall of the legal underground building and the boundary line that the JICA team confirmed with the local architect is as follows.

- Road side: +1.5m
- Private land side: 0m

However, since +1.5m from the border line is necessary for a bracing wall and waterproof layer construction range, neither shall be spaced apart by +1.5m from the boundary. (Note that the building's B1F is supposed to be GL +1.5m.)

- Road side: +1.5m
- Private side: +1.5m

(Underground Building Dimensions)

The above separation was reflected in the building, and the building size was partially expanded.

- East-west direction: 41,300mm → 42,300mm
- North-South direction: 26,700mm (no change)

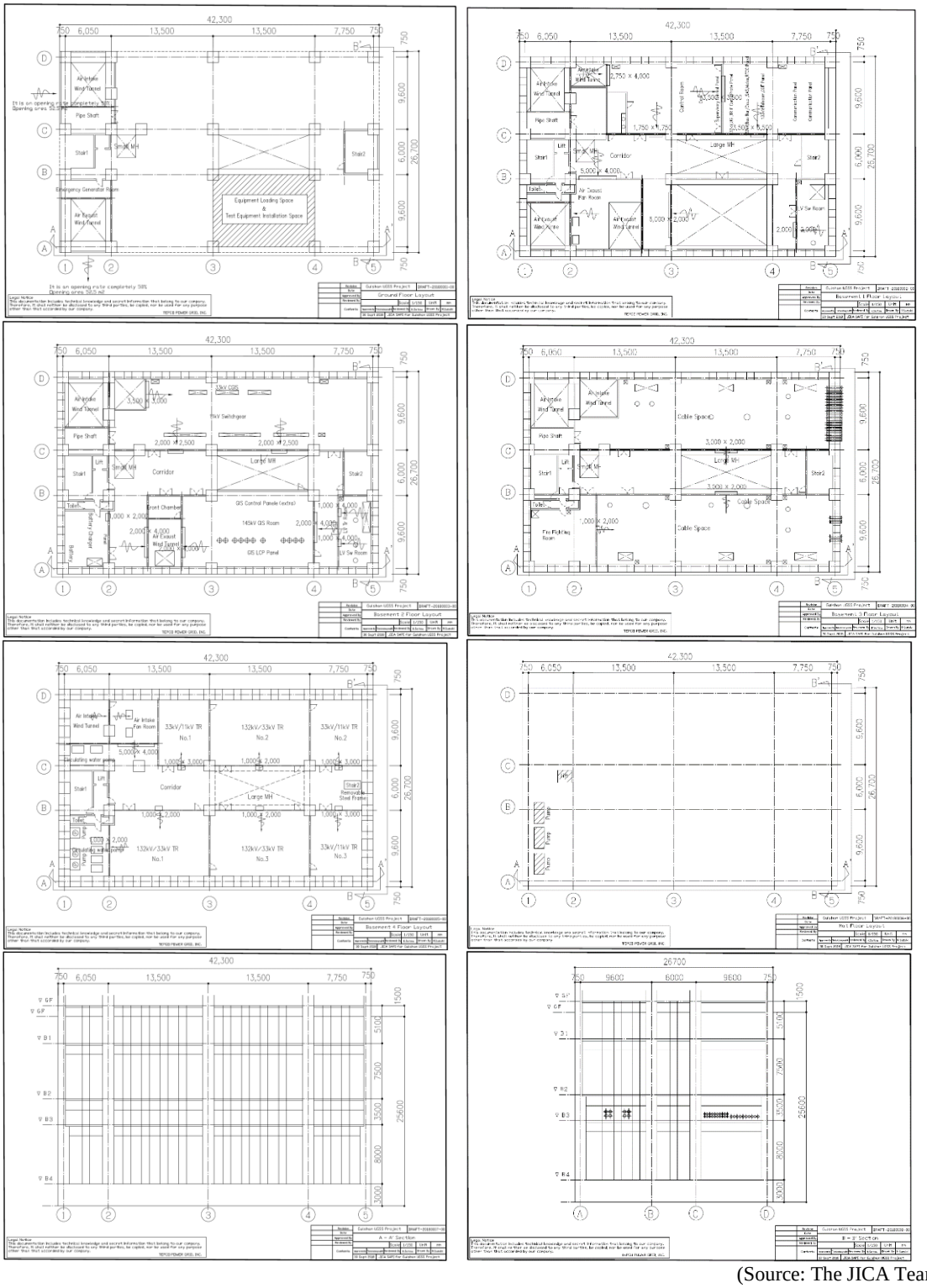
(Future plans)

On October 3, 2018, the JICA team made adjustments to the designs of the UGSS and superstructure with the superstructure's architectural design company, and gained agreement on the underground substation's columns' span, position and size.

The JICA team also submitted this information to DESCO as the final layout. (Figure 5-2 Final Layout Plan for Gulshan UGSS Project)

The floor opening, the wall opening and the position of the waterproof pipe will need to be reviewed when the substation equipment is decided in the future. We have already informed DESCO and the building design company about this.

Currently, the JICA team is discussing the detailed design with the local architect based on the previous layout plan. We are also in discussions with transportation experts to confirm that the GIT, when transported by trailer, can be loaded from the machine hatch without any problems and installed in the designated position.

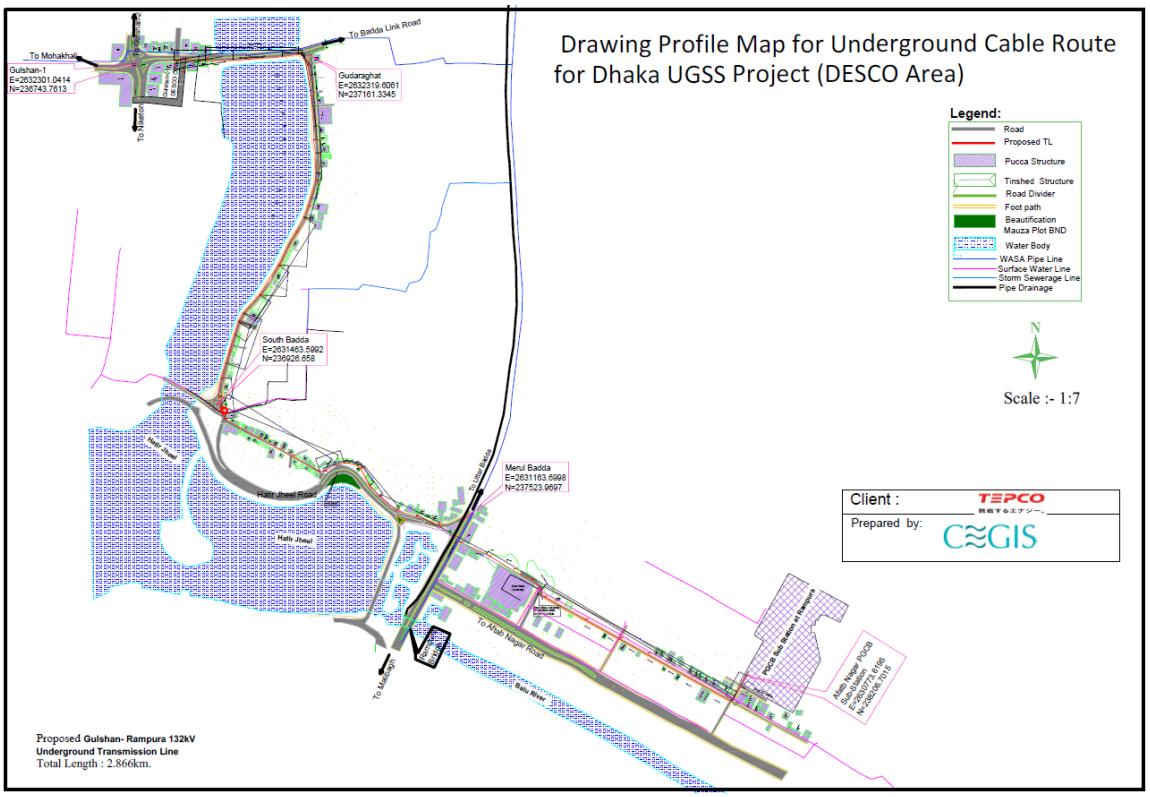


(Source: The JICA Team)

Figure 5-2 Final Layout Plan for Gulshan UGSS Project

Chapter 6. Underground Transmission and Distribution Line Design (DESCO)

The UGSSs and their power source substations are to be connected with underground transmission lines based on the Data Collection Survey. The project also includes underground tunnels, which are located in the area surrounding the UGSS, in order to accommodate a great deal of transmission and distribution lines within the limited area. Hence, the JICA team carried out a route survey to identify any obstacles and considered the applicable construction methods according to the design in the Data Collection Survey. Based on this survey, the route was decided as shown in the drawing below.



(Source: The JICA Team)

Figure 6-1 PowerTransmission Route for Plan Drawing in Gulshan Area

6.1 Results of Investigation on Power Source Line Route

For DESCO, the UGSS will be constructed at Gulshan 1, including an underground cable route from Rampura to Gulshan 1.

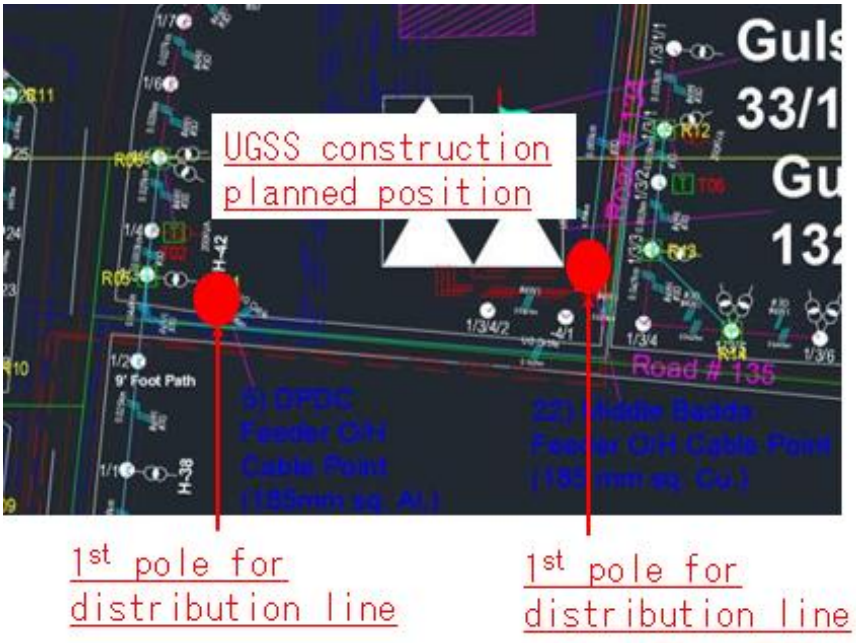
The table below shows the number of underground transmission and distribution lines at DESCO.

Table 6-1 The Number of Transmission and Distribution Lines at DESCO

Voltage	DESCO area
132 kV	5
33 kV	8
11 kV	18

(Source: The Data Collection Survey)

The distribution lines will be buried around the UGSS at the planned construction site, and accommodated in the tunnel. Distribution lines will be accommodated in the tunnel until the 1st pole, and after that it will be overhead wire transmission. Based on the survey data previously conducted by DESCO, the 1st pole around the UGSS has been determined as follows.



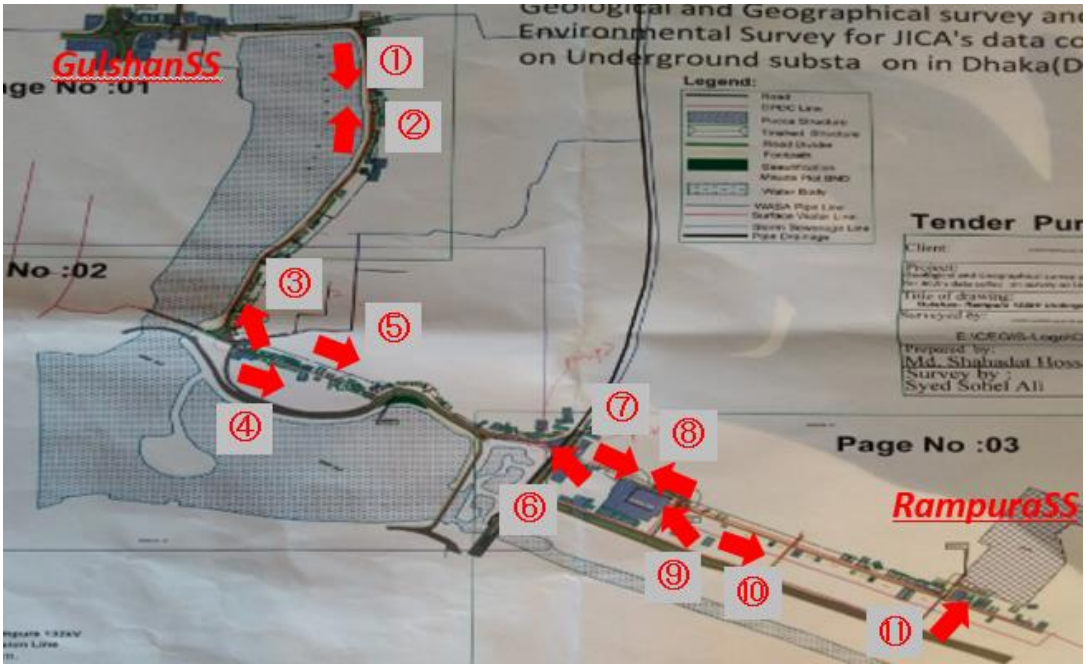
(Source: The JICA Team)

Figure 6-2 Distribution Network surrounding Gulshan UGSS

The transmission lines will be buried over long distances from the UGSS at the planned construction site to the power source substations. However, the Data Collection Survey does not include information on buried objects, which might cause difficulties in the installation of underground lines. Therefore, the JICA Team has confirmed the validity of the transmission line routes in advance.

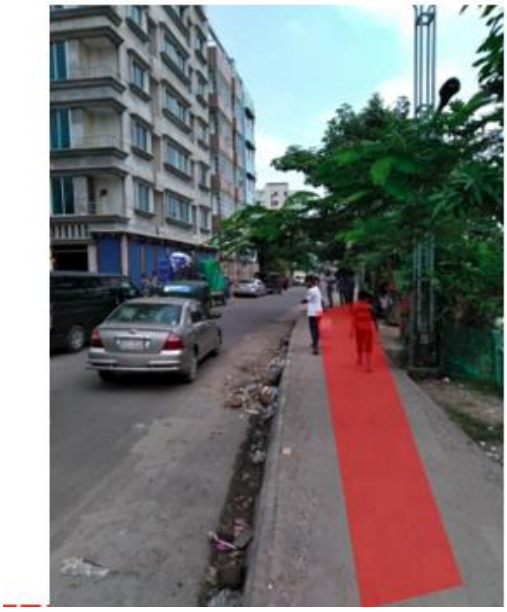
Several congested traffic crossings and places with existing buried objects exist, so it is necessary to consider the routes for these. In order to do so, the SAPI team conducted a route survey based on the survey drawing created by CEGIS.

【Route Survey for Rampura to Gulshan 1 (11 points)】



(Source: The JICA Team)

Figure 6-3 Route Overview from Gulshan UGSS to Rampura



(Source: The JICA Team)

Figure 6-4 Point 1 (to Rampura SS)

(Source: The JICA Team)

Figure 6-5 Point 2 (to Gulshan SS)

(Source: The JICA Team)

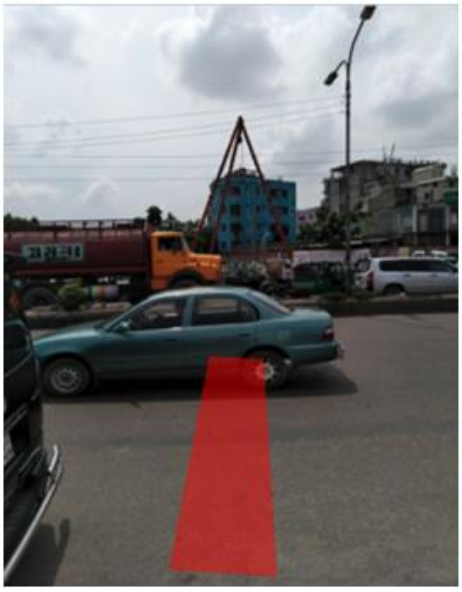
Figure 6-6 Point 3 (to Gulshan SS)

(Source: The JICA Team)

Figure 6-7 Point 4 (to Rampura SS)

(Source: The JICA Team)

Figure 6-8 Point 5 (to Rampura SS)

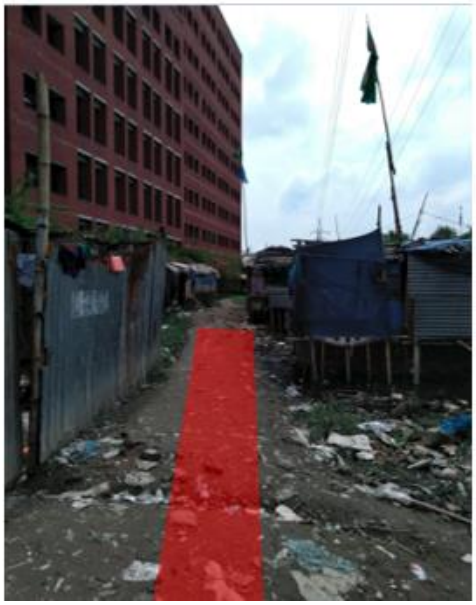


(Source: The JICA Team)

Figure 6-9 Point 6 (to Gulshan SS)

(Source: The JICA Team)

Figure 6-10 Point 7 (to Rampura SS)



(Source: The JICA Team)

Figure 6-11 Point 8 (to Gulshan SS)

(Source: The JICA Team)

Figure 6-12 Point 9 (to Gulshan SS)

(Source: The JICA Team)

Figure 6-13 Point 10 (to Rampura SS)

(Source: The JICA Team)

Figure 6-14 Point 11 (to Rampura SS)

For points 1 to 3, it was confirmed that there are fewer vehicles, so places to bury underground transmission and distribution cables could be secured. Therefore, there is no route change.
For points 4 to 6, route change is not necessary. However, as there are several overhead lines, attention is required when excavating.

For points 6 to 7, there is a traffic crossing and the traffic volume was large. Therefore, it is assumed that excavation work will be difficult. In order to solve this issue, the SAPI team adopted the Small Diameter Jacking Method described in Figure 6-15 to make the route possible.

For points 7 to 9, people live here who did not do so at the time of the FS. It is necessary to temporarily move them during construction.
For points 9 to 11, route change is not necessary.

6.2 Analysis of Construction Methods

Based on the route surveys done in June and July, the JICA Team studied the applicable construction methods. The study found several congested traffic crossings and places with existing buried objects on the underground transmission route. The JICA Team implemented the necessary analysis of construction methods, which are described below.

The JICA team proposed two construction methods.

The first one is the Open Cut method.
This is the most common construction method and it is inexpensive. This has two variations.

(1) One day backfilling

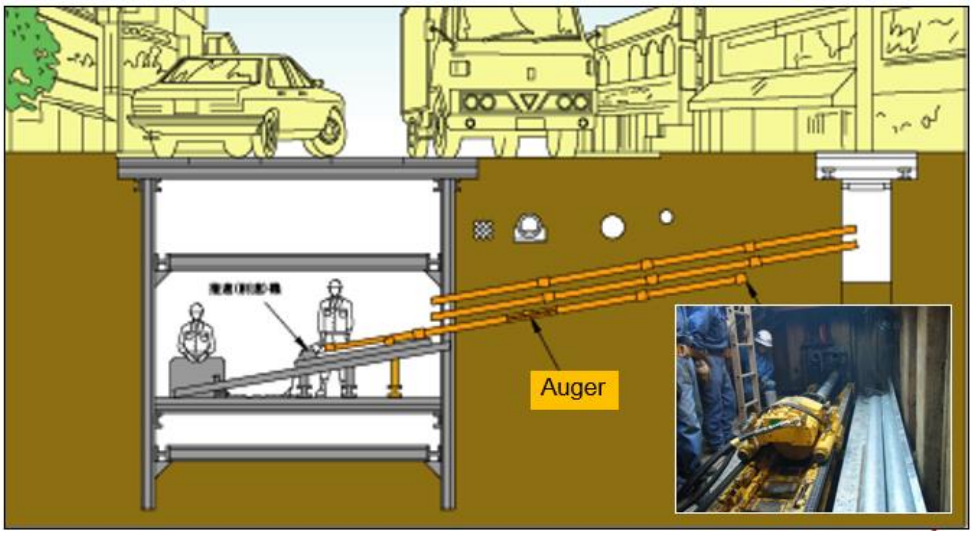
- The construction cycle is: dig a tunnel → Lay cables → Backfill.
- Back filling will be completed by the end of the day.

(2) Lining Method

- After the work, the road decking panel will be used for excavating the road.

The second one is the Small Diameter Jacking Method.

This is also a common construction method in Japan, like the Open Cut method. This is the next inexpensive method to the Open Cut method, and does not require excavation work. The premise of the construction method is to join together 1m pipes and dig augers.



(Source: The JICA Team)

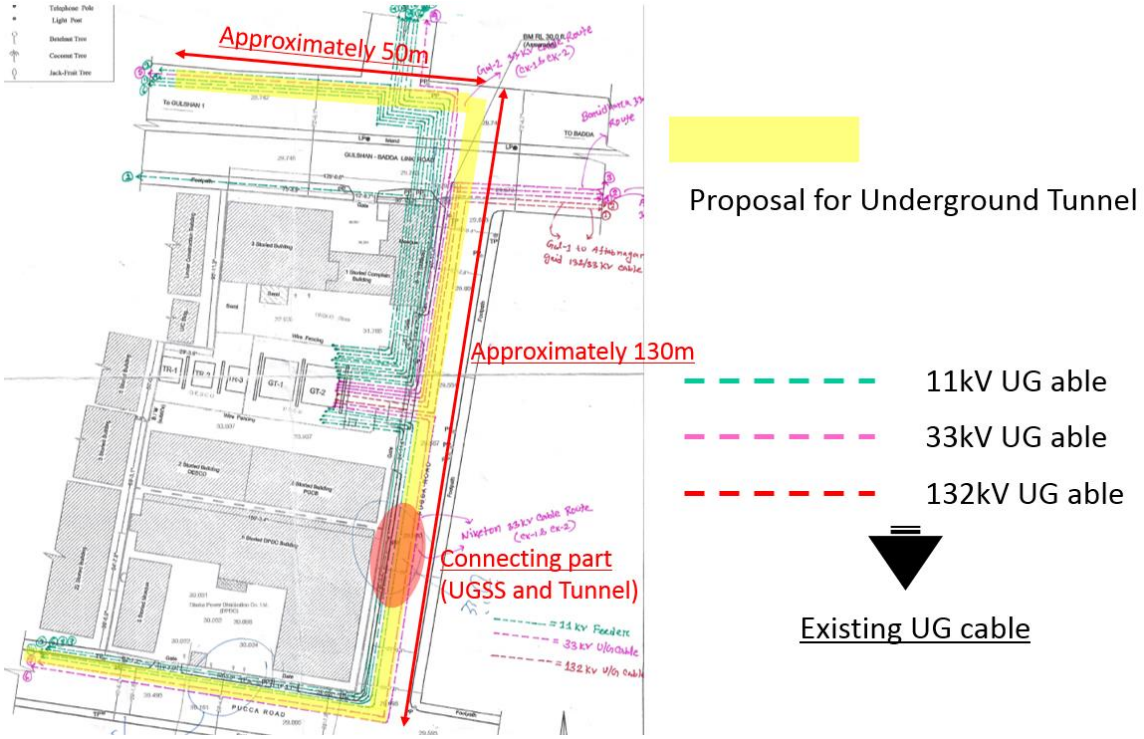
Figure 6-15 The Small Diameter Jacking Method

Based on the studies done so far, the JICA Team expects that most of the TL tunnels on the route proposed can be constructed via the open cut method, because the width of the road necessary for excavation has been secured. However, several congested traffic crossings and places with existing buried objects on the underground transmission routes will require the Small Diameter Jacking Method.

The reason for this is that if such parts are constructed via the open cut method, it will adversely affect traffic and buried objects, and require longer construction periods and greater costs.

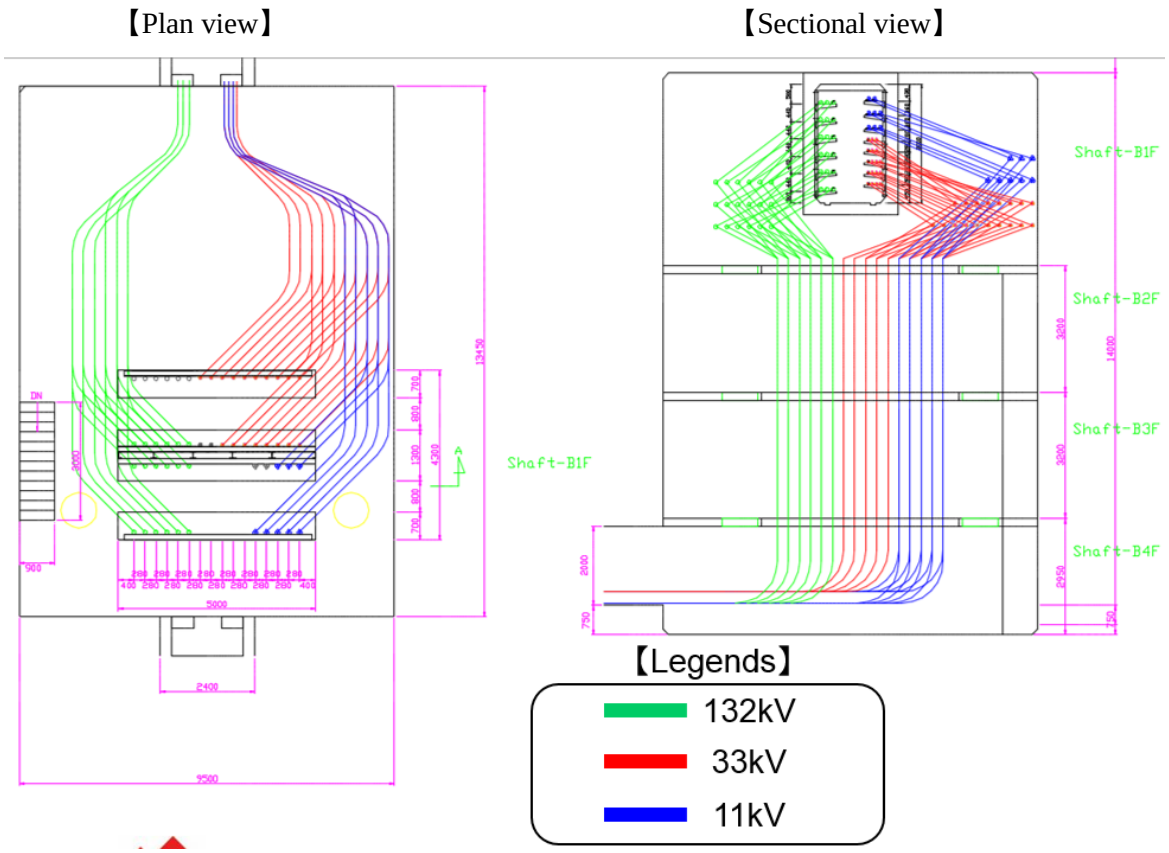
6.3 The results of the design around UGSS

The JICA Team confirmed the location of the underground tunnel, which is connected to the UGSS, with the substation design team. Consequently, the location of the underground tunnel for Gulshan UGSS is specified as below.



(Source: The JICA Team)

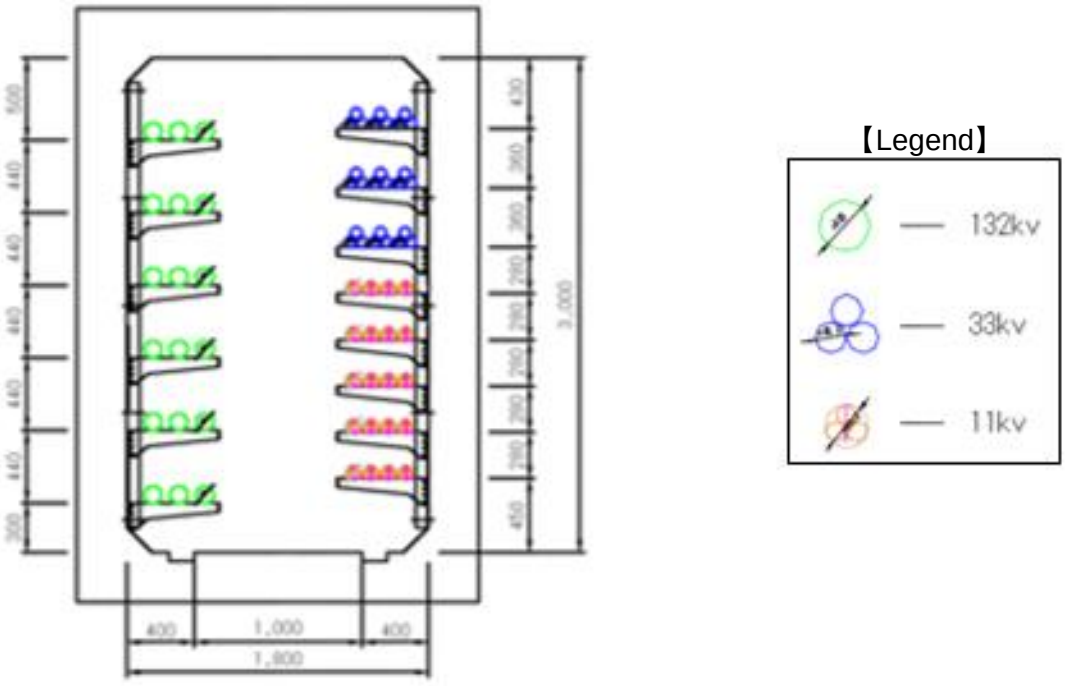
Figure 6-16 Location of Underground Tunnel for Gulshan UGSS



(Source: The JICA Team)

Figure 6-17 Connection between UGSS and Underground Tunnel for Gulshan UGSS

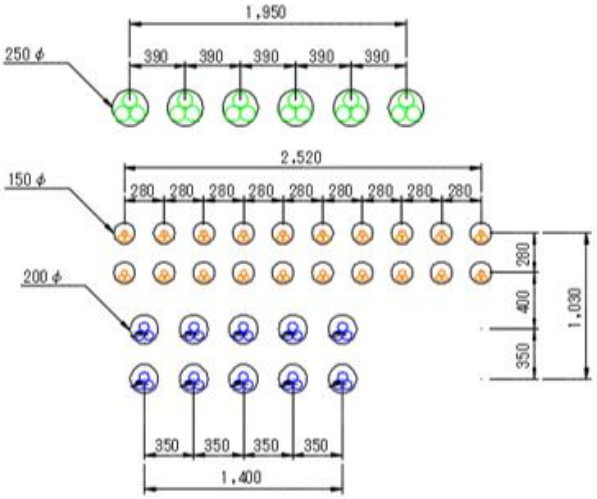
As a result of confirming the cable drawing method and working space with DESCO, the SAPI team decided on the Transmission and Distribution tunnel design as below.



(Source: The JICA Team)

Figure 6-18 Cross section view for Transmission and Distribution tunnel

The design for the connecting part between the UGSS and Transmission and Distribution tunnel is a DUCT type, because it is necessary to separate the structure of the UGSS and Transmission and Distribution tunnel. This is described below.



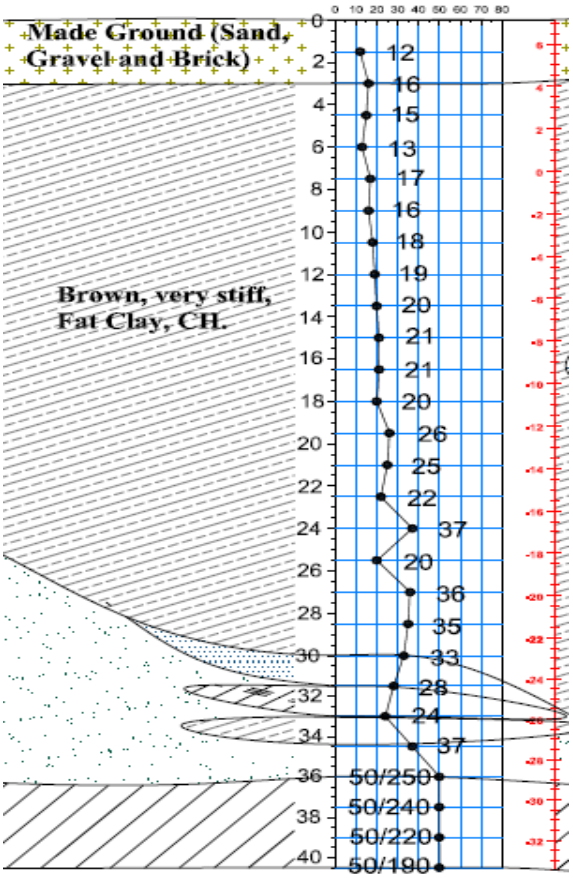
(Source: The JICA Team)

Figure 6-19 Connection view for Transmission and Distribution DUCTs

As mentioned above, the duct part is only the part connecting the UGSS and Transmission and Distribution tunnel. After passing through the duct, it is accommodated in the Transmission and Distribution tunnel as described in Figure 6-18 "Cross section view for Transmission and Distribution tunnel". The reason for the connection with the UGSS and Transmission and Distribution tunnel duct is to make the UGSS and the tunnel separate structures.

6.4 Soil conditions around the UGSS

The SAPI team obtained the geological survey data previously collected for the Mass Rapid Transit project undertaken by Nippon Koei, and evaluated the geological data for the area surrounding the UGSS construction as follows.



(Source: PROSOIL FOUNDATION CONSULTANT)

Figure 6-20 Subsoil Stratification around UGSS

Analysis of the data shows that the clay layer is less than GL -3.0 m. One of the important decisions to be taken for construction of the Underground Tunnel is the steel sheet piling method.

From this data, the SAPI team can propose a method for installing the seat pile press in consideration of water proofing. The SMW method is another proposal. This is because there is a possibility of implementing civil engineering work for the UGSS construction and construction work for the Underground Tunnel at the same time.

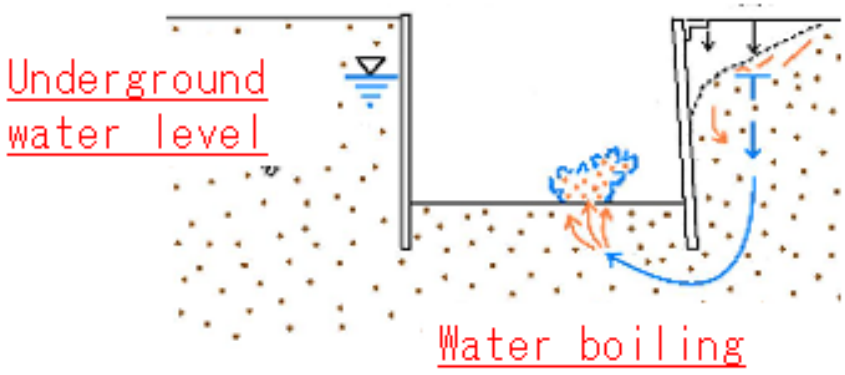
Next, with regard to the occurrence of water boiling, it could be confirmed from the data that it will not occur at the tunnel construction site, because water boiling is a phenomenon that can occur when the sand layer ground is a bottom plate. There is, however, a possibility of the heaving phenomenon occurring. If this is confirmed via the detailed design, the Engineering Services Consultant will provide a ground reinforcing method to prevent water boiling and heaving caused by excavating the ground. Further detailed boring surveys will be conducted by the Engineering Services Consultant.

6.4.1 Explanation of water boiling

The state of the ground conditions is as follows.

- Drilling base is sandy soil
- High groundwater level

When using the retaining wall of a water barrier (steel sheet pile, SMW, etc.), upward penetrant flow occurs due to the water level difference. If this osmotic pressure exceeds the effective weight of soil, it boils like water. Soil at the bottom of the excavation loses shear resistance and suddenly the stability of the soil retention is impaired. As a result, the excavation of the bottom surface is destroyed by the water influx.



(Source: The JICA Team)

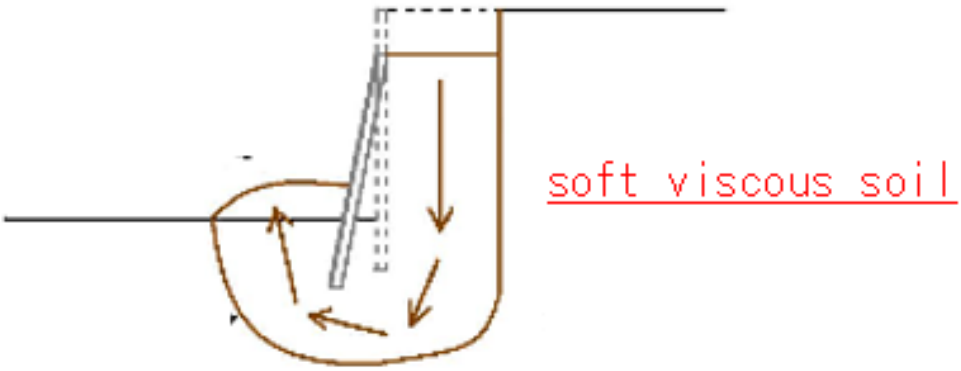
Figure 6-21 Explanation of water boiling

6.4.2 Explanation of heaving

The state of the ground conditions is as follows.

- N value is mainly 3 or less
- Drilling base is soft viscous soil

Depending on the weight of the soil at the back, etc., one of the following occurs: 1. Bumping of the drilling dase 2. The dirt of the retaining wall 3. Settlement of the surrounding ground. Ultimately, the retaining wall will collapse. As a result, the phenomenon of the bottom of the excavation being destroyed due to soil influx occurs.



(Source: The JICA Team)

Figure 6-22 Explanation of heaving

6.4.3 Explanation of SMW (Soil Mixing Wall)

An SMW is a wall body that mixes soil and cement slurry to create a wall in the ground. The SMW method involves drilling the original ground with an auger machine, which discharges cement slurry from its tip to make one wall body. In addition, we will create each element by wrapping it.

(Source: The JICA Team)

Figure 6-23 Explanation of SMW (Soil Mixing Wall)

6.4.4 Explanation of Steel Sheet Piling

The steel sheet pile method involves joining steel sheet piles to each other, and it exerts excellent water-proofing performance. There are various construction methods, such as the vibrating construction method, press fitting with auger, press fitting method, water jet construction method, etc. It is necessary to decide the construction method considering ground conditions, construction scale, site conditions, and surrounding environment of the site.

(Source: The JICA Team)

Figure 6-24 Explanation of Steel Sheet Piling

6.5 Laying method for underground transmission and distribution cable

Initially, the SAPI team was considering the direct burial method, which is a common, low-cost construction method in Bangladesh. However, as a result of discussion with DESCO, the SAPI team proposed DUCT type (only 132KV) due to the following benefits.

① After completion of a construction day, the road can be released. This is effective for alleviating traffic congestion. If 500 m is set as the cable entry section, using the direct burial method entails closing the road for about 2 months. Therefore, the DUCT type is more effective.

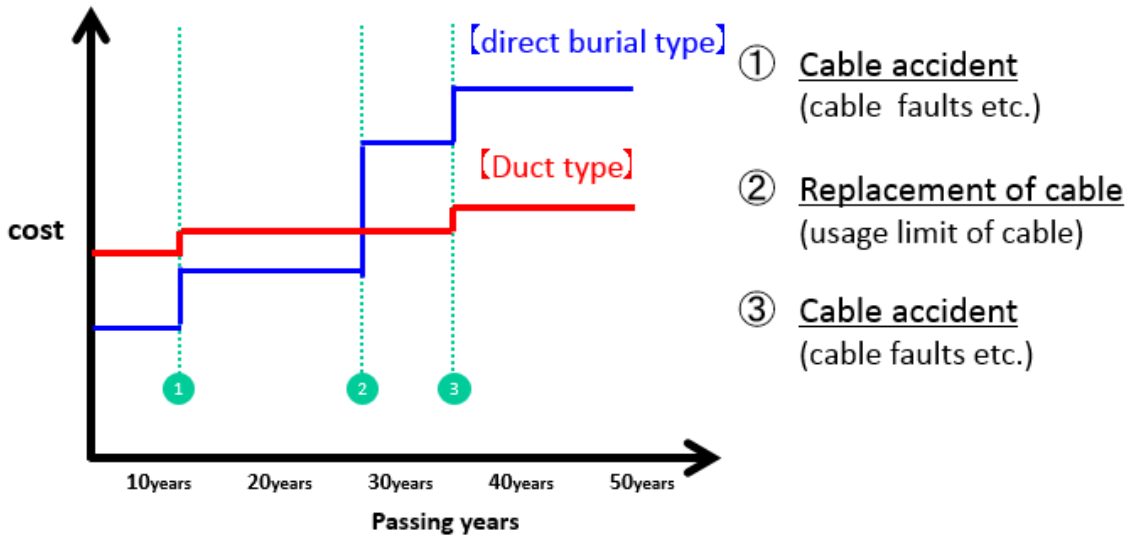
② If a cable accident occurs, remediation is completed within several days. However, in the case of the direct burial method, this takes about one month or more because it is necessary to excavate all the sections and take out the cables. Therefore, the DUCT type is more effective.

Table 6-2 Comparison of the two cable laying methods

Terms	DUCT type	Direct burial
Road closure period	Real construction time only (7-8 hours)	Approximately 2 months per span
Accident handling period	Approximately 1 week	Approximately 1 month
Evaluation	1st	2nd

(Source: The JICA Team)

③ When comparing construction costs, at the beginning of construction the DUCT type is costly, but this situation will be reversed in approximately 30 years because the direct burial method requires excavation of all spans during cable exchange, whilst the DUCT type does not require such excavation. Therefore, the DUCT type is more effective.



(Source: The JICA Team)

Figure 6-25 The relation between cable construction cost and passing years

However, there are concerns about the initial costs for the Duct type being higher than those for the direct burial type. Therefore, it is necessary to examine the detailed construction costs and obtain agreement with DESCO. At present, there is no consensus from DESCO, so it has been decided to implement the construction using the direct burial method.

6.6 Ground Penetrating Radar (GPR) survey

Since the 11th general election in Bangladesh was decided to be held on 30th December 2018, all excavation work on public roads by the city corporation to the end of 2018 and beginning of 2019 was prohibited. Therefore, the initially planned Soil Investigation became impossible.

As an alternative, the SAPI team planned a GPR survey.

A GPR survey involves irradiating microwaves from above ground and checking the location and scale of buried objects from the data generated by the rebounds.

The SAPI team evaluated the results obtained from the GPR survey and the geographical survey data carried out by CEGIS, producing the following results.

As a result of the GPR survey, the SAPI team was able to confirm several existing power cables, together with water, sewage and unknown pipes, especially around the UGSS.

Therefore, it is necessary to carry out additional investigations at an early stage of the ES, and to ascertain the detailed positional relationship between the existing buried objects and the tunnel. Depending on the results, the Engineering Services Consultant may need to request DESCO and the owner of the buried material to relocate the material.

(Source: The JICA Team)

Figure 6-26 Example picture of GPR survey

6.6.1 Points for selection of GPR survey locations

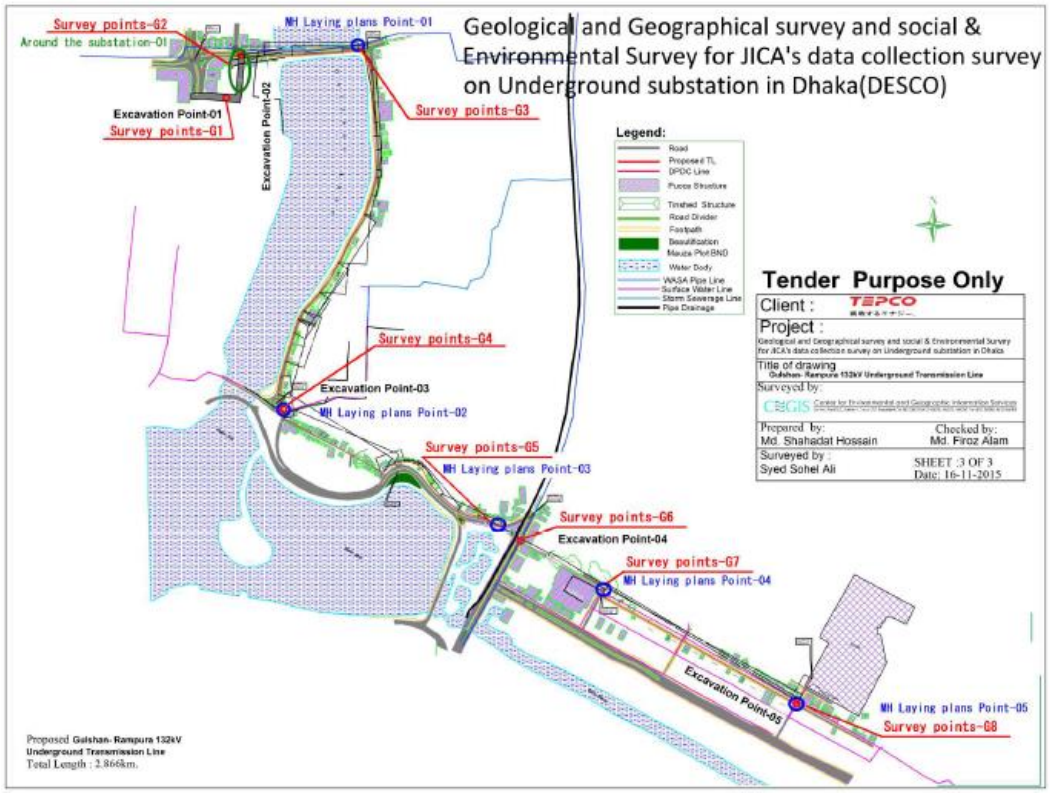
- Around UGSS
  Because large-scale excavation work is necessary for tunnel laying, depending on the situation of the buried objects around the UGSS it may be necessary to change the tunnel size and route, and this may become a factor that greatly changes the construction period and cost.
- Excavation locations that were originally planned
  To check the intersections of the existing buried objects and the planned power transmission route. These locations are as per the GPR survey locations.
- Plans for construction of cable joint boxes (MH)
  In order to determine the underground transmission route, it is necessary to determine the MH locations.

6.6.2 Work items and Quantities for GPR survey locations

Table 6-3 Work items and Quantities for GPR survey locations

District	Survey area		Number of measurements		
	Longitudinal (m)	Cross sectional (m)	Longitudinal	Cross sectional	Total
Gulshan 1	20.0	6.0	5	4	9
Gulshan 2	20.0	6.0	5	4	9
Gulshan 3	10.0	2.0	3	3	6
Gulshan 4	10.0	2.0	3	3	6
Gulshan 5	10.0	2.0	3	3	6
Gulshan 6	10.0	2.0	3	3	6
Gulshan 7	10.0	2.0	3	3	6
Gulshan 8	10.0	2.0	3	3	6

(Source: The JICA Team)

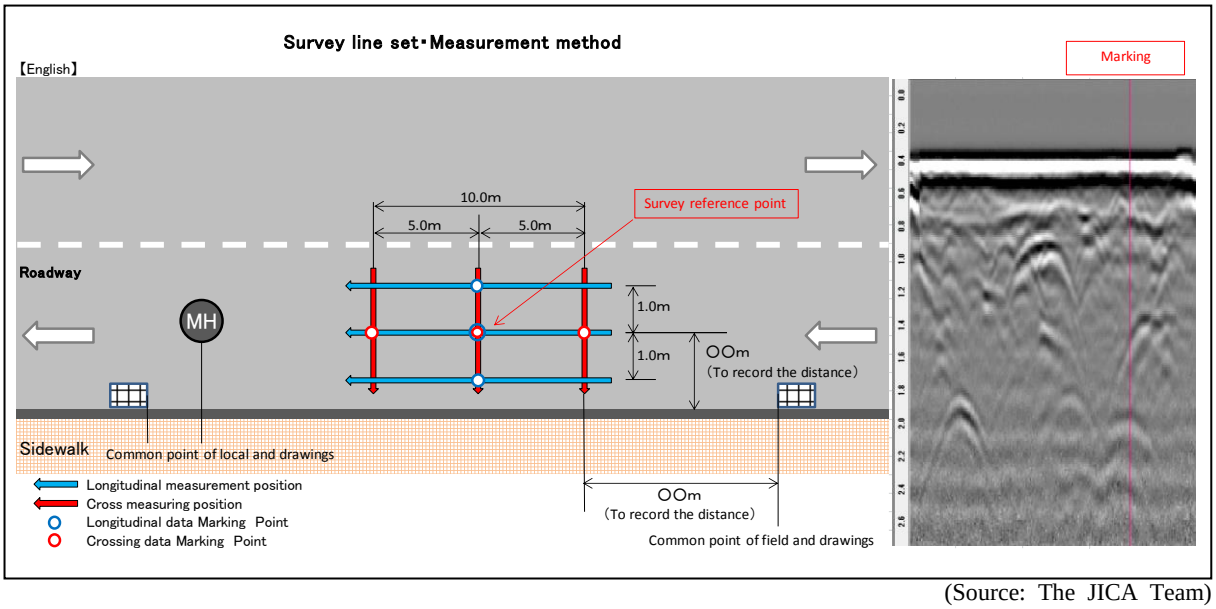


(Source: The JICA Team)

Figure 6-27 GPR Survey locations in Gulshan area

6.6.3 Planning measurement method according to local situation

Considering the characteristics of the underground radar owned by the BUET, the SAPI team devised a measurement method to ascertain the precise status of buried objects, as follows.

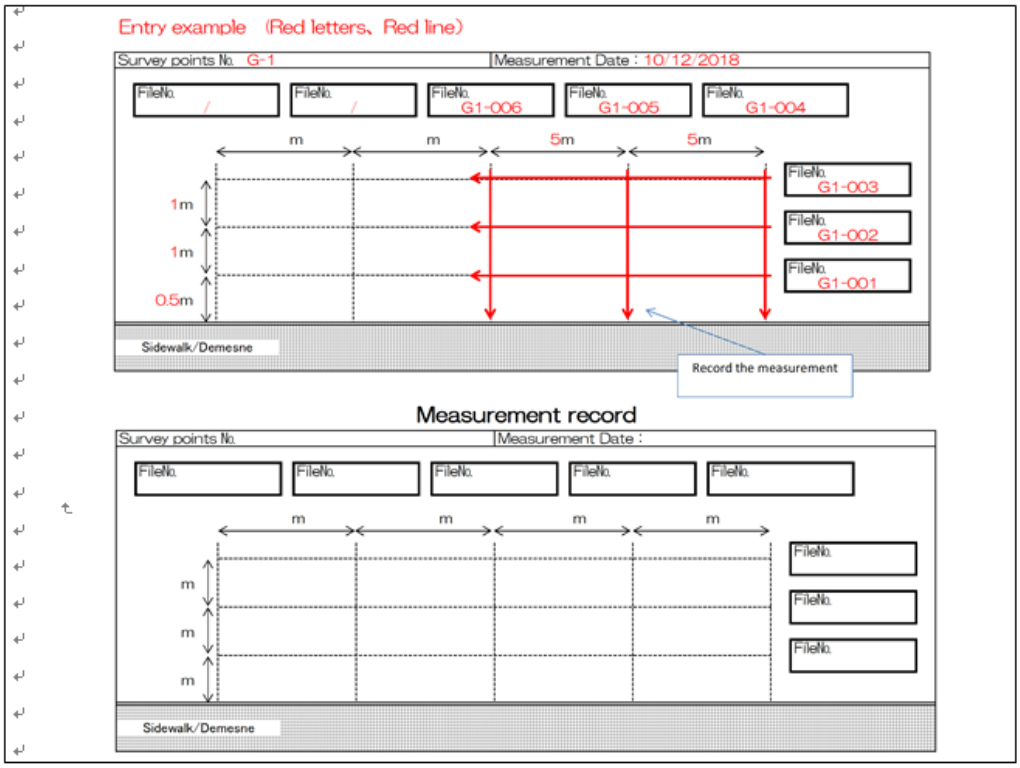


(Source: The JICA Team)

Figure 6-28 GPR Survey measuring method diagram

6.6.4 Planning measurement record method

In order to ensure field repeatability of the survey results, a measurement recording method was devised. Survey reference points were set and survey pins were installed. Below is an example of a measurement record document.



(Source: The JICA Team)

Figure 6-29 Example of Planning measurement record

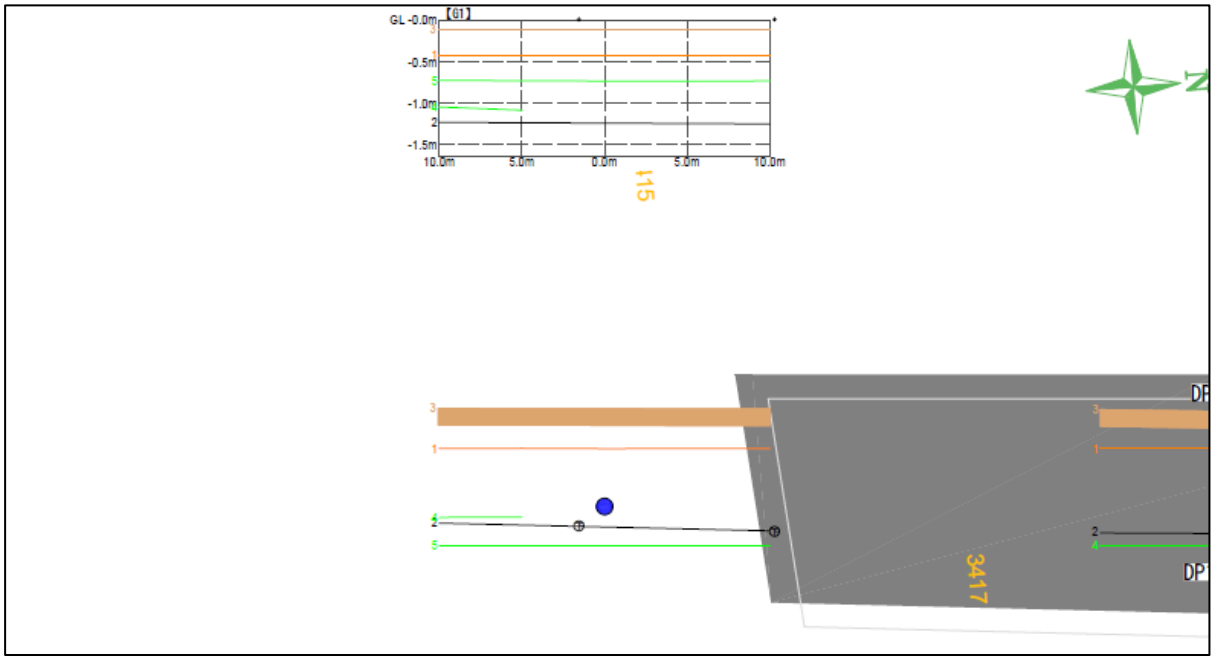
6.6.5 Data analysis results

Dedicated analysis software was used on the data provided from BUET to correct soil covering via migration processing, and the positions of the buried objects were specified. As a result of the data analysis, we confirmed an additional 25 buried items not listed in the existing buried ledger. A list of the survey results is shown below.

Table 6-4 The Results of the Buried Object Survey and Analysis

District	Investigation results					
	Water	Sewage	Electrical	Drain	Gas	Unspecified
Gulshan 1		○	○	○		○
Gulshan 2		○	○	○		○
Gulshan 3			○			
Gulshan 4	○	○				○
Gulshan 5						○
Gulshan 6	○					
Gulshan 7						
Gulshan 8						
Legend						

(Source: The JICA Team)

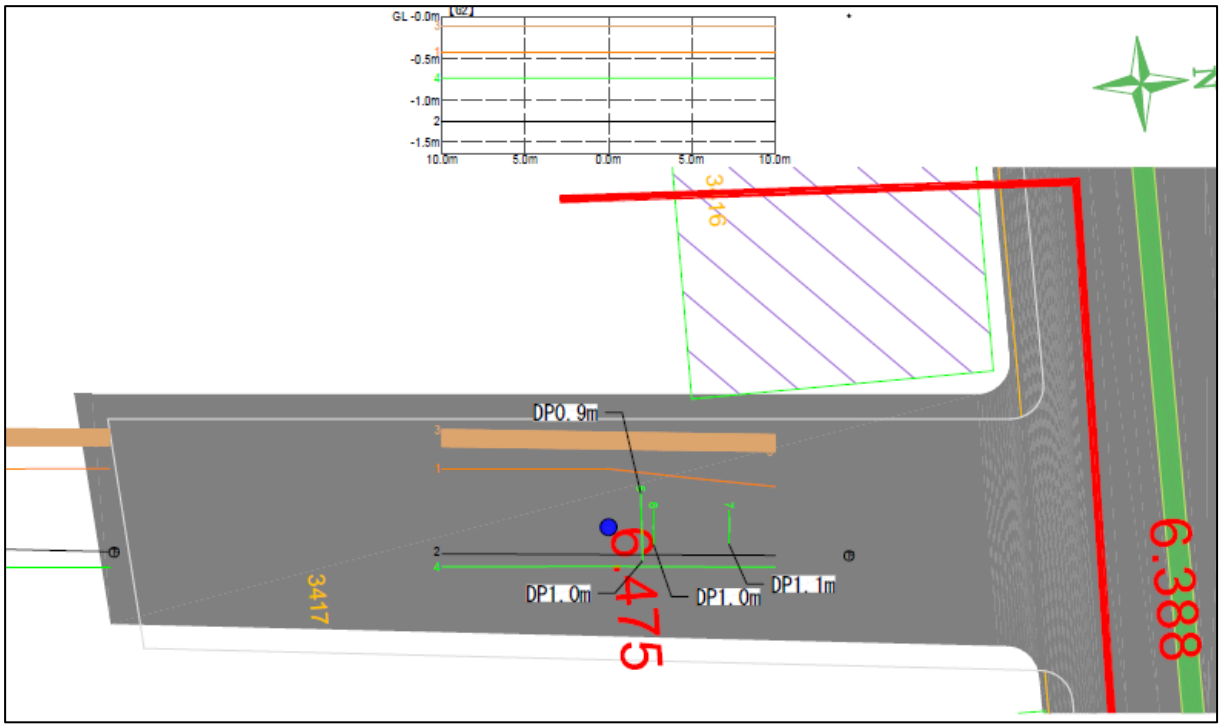


(Source: The JICA Team)

Figure 6-30 Data for Gulshan 1

It was confirmed that Sewage, Electrical, Drain and Unspecified objects were buried at the Gulshan 1 point. The depth of burials is as follows.

・Sewage: GL -1.2m ・Electrical: GL-0.4m ・Drain: GL-0.2m ・Unspecified: GL-0.7～1.1m

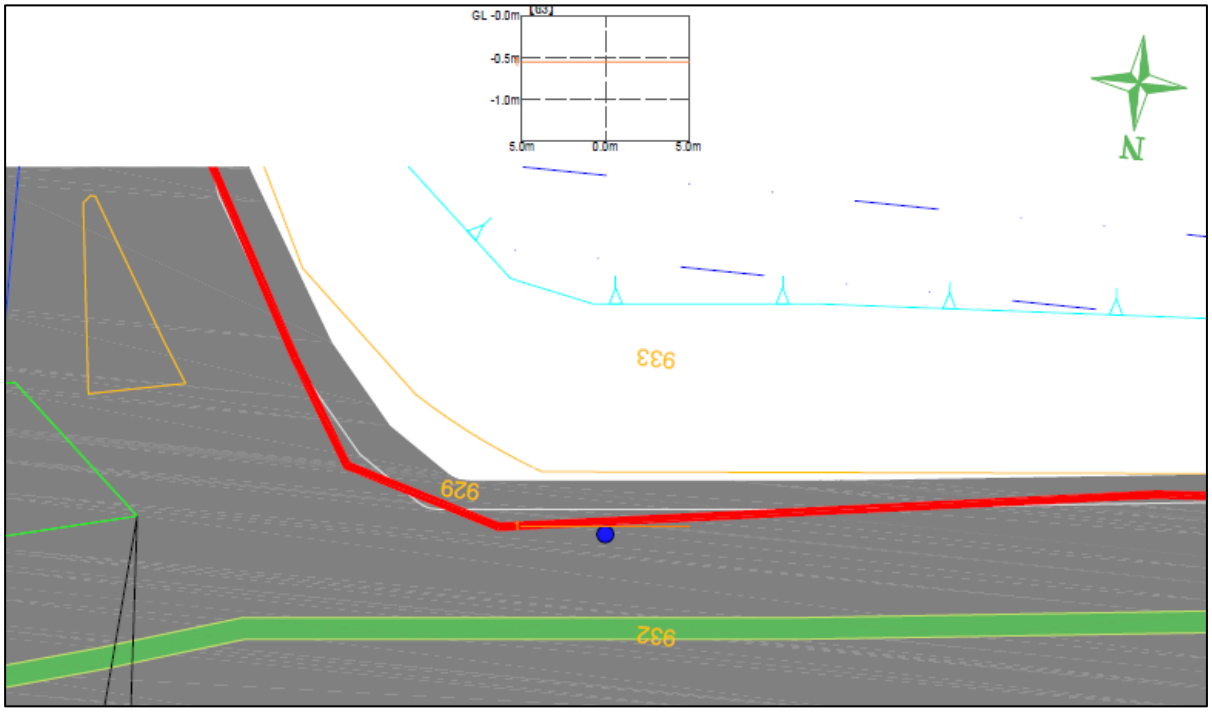


(Source: The JICA Team)

Figure 6-31 Data for Gulshan 2

It was confirmed that Sewage, Electrical, Drain and Unspecified objects were buried at the Gulshan 2 point. The depth of burials is as follows.

・Sewage: GL -1.2m ・Electrical: GL-0.4m ・Drain: GL-0.2m ・Unspecified: GL-0.7m

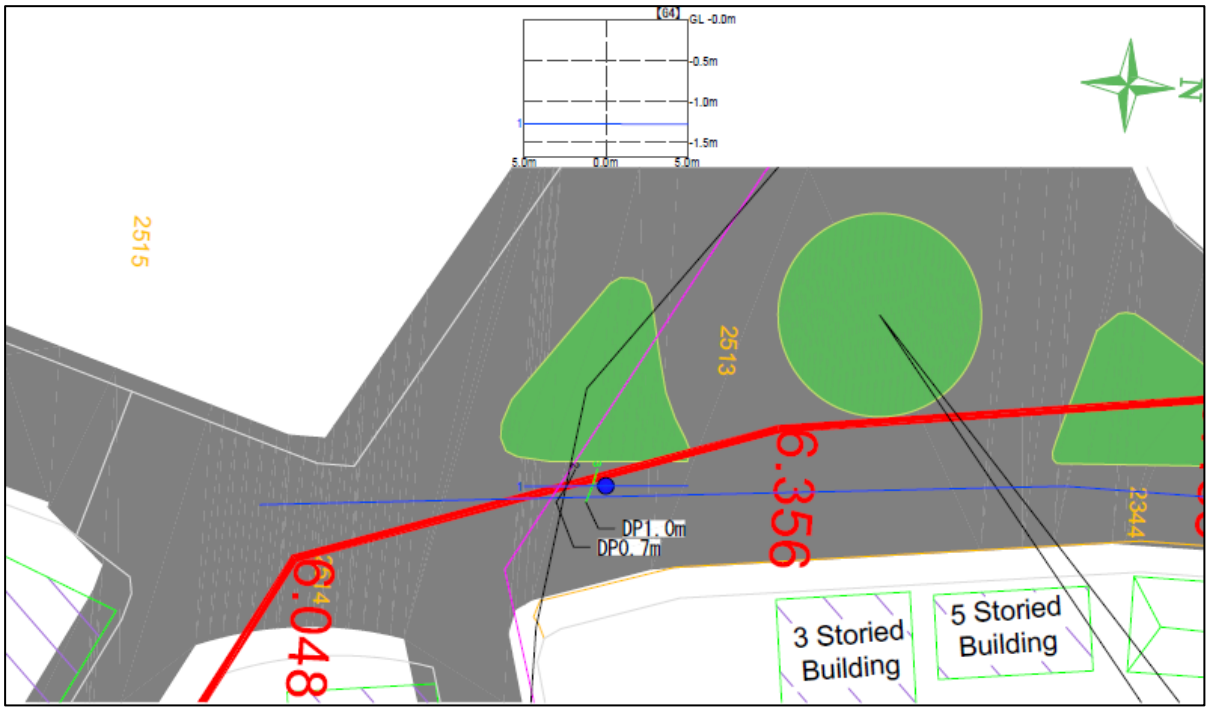


(Source: The JICA Team)

Figure 6-32 Data for Gulshan 3

It was confirmed that Electrical objects were buried at the Gulshan 3 point. The depth of burials is as follows.

・Electrical: GL-0.5m

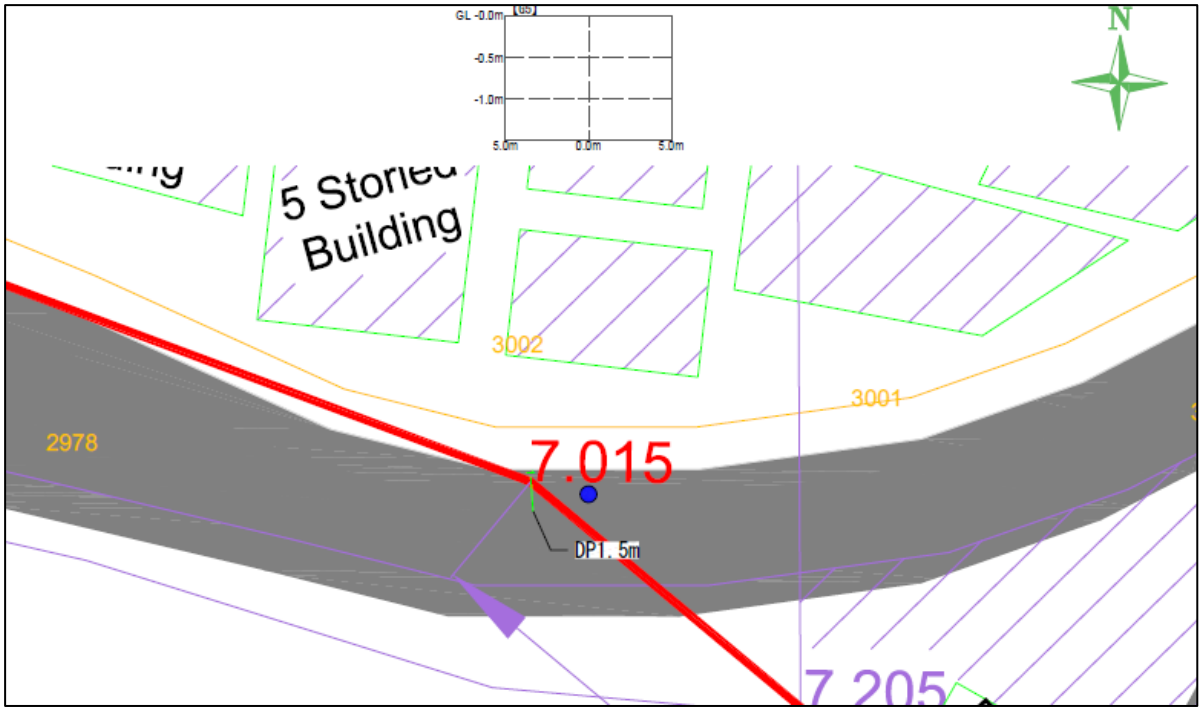


(Source: The JICA Team)

Figure 6-33 Data for Gulshan 4

It was confirmed that Water and Drain objects were buried at the Gulshan 4 point. The depth of burials is as follows.

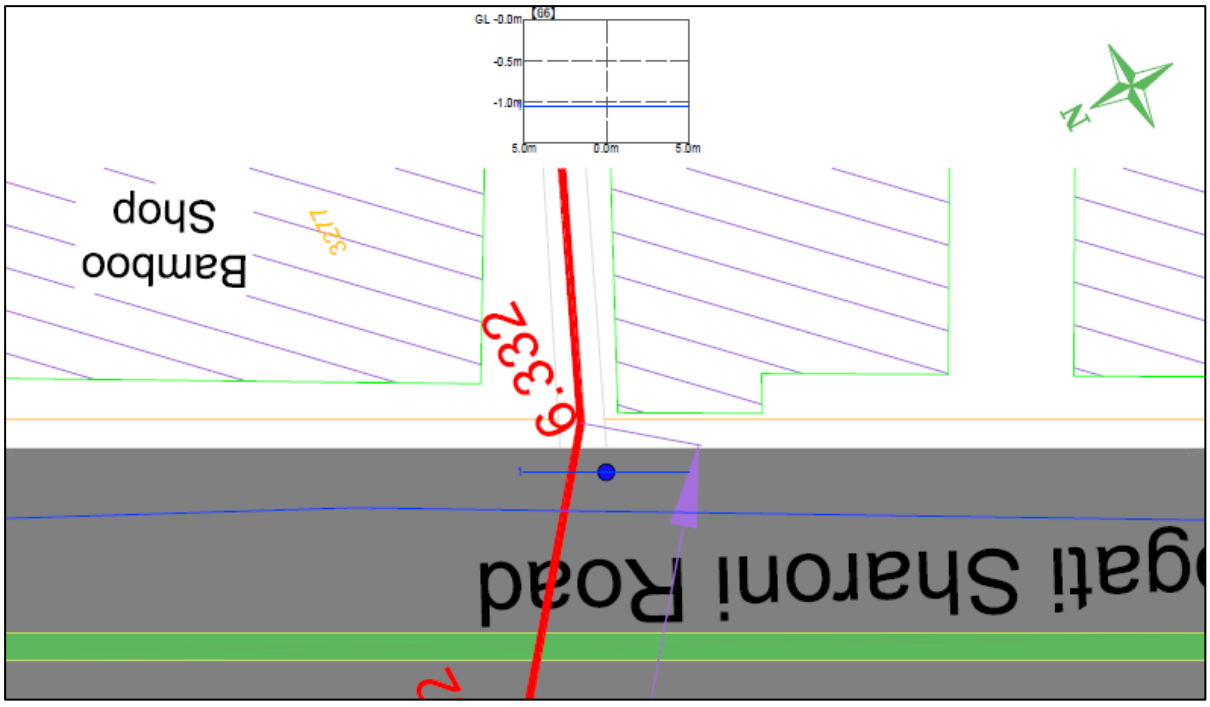
・Water: GL-1.3m ・Drain: GL-0.7m



(Source: The JICA Team)

Figure 6-34 Data for Gulshan 5

It was confirmed that no buried objects exist at the Gulshan 5 point.

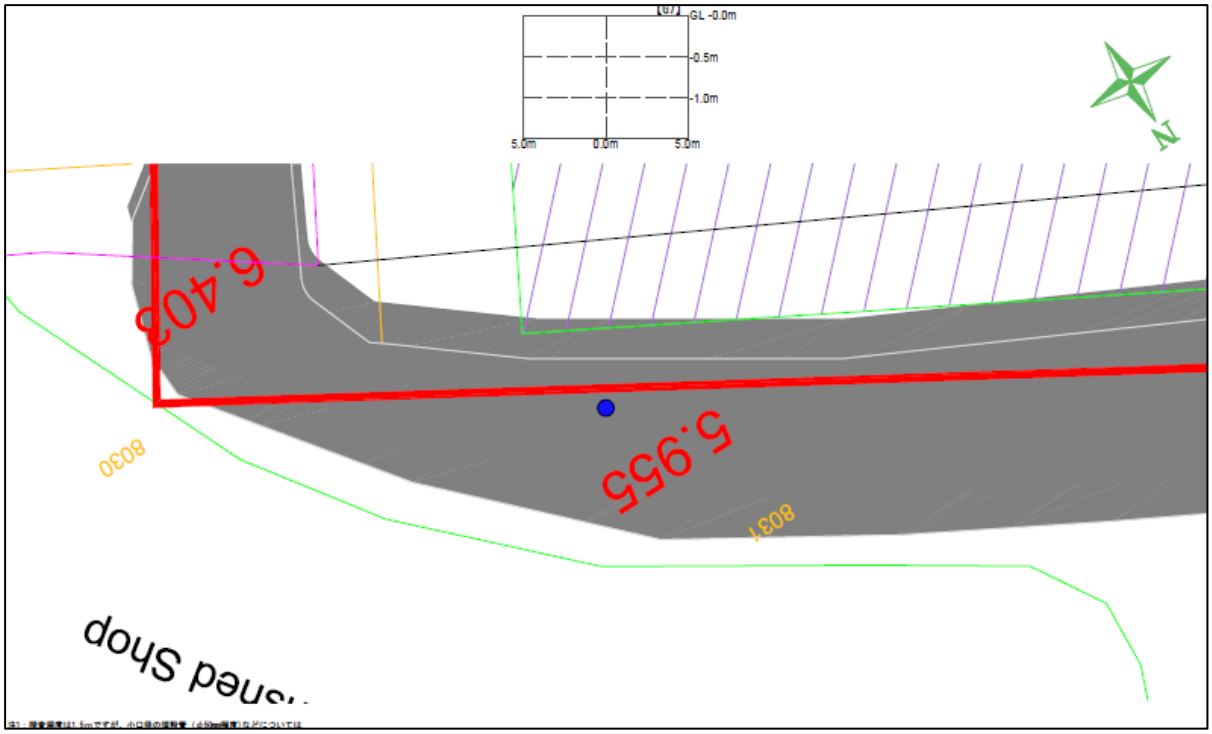


(Source: The JICA Team)

Figure 6-35 Data for Gulshan 6

It was confirmed that Water and Unspecified objects were buried at the Gulshan 6 point. The depth of burials is as follows.

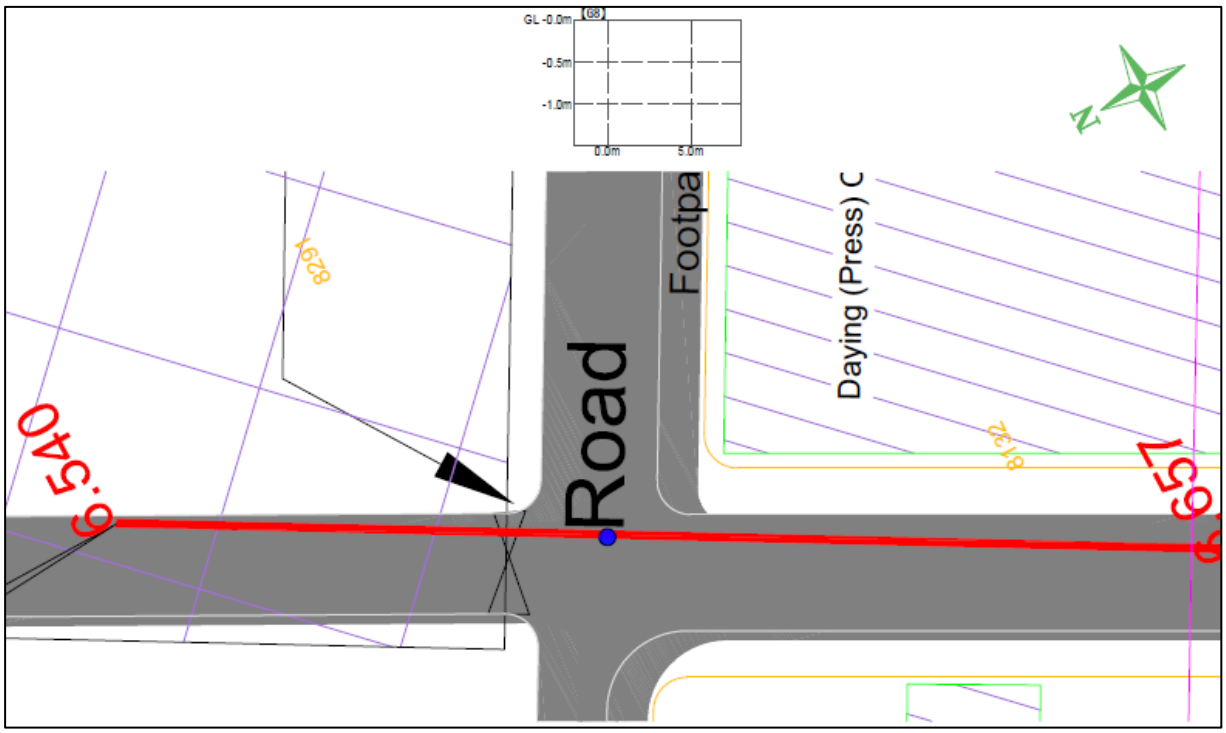
・Water: GL-1.0m



(Source: The JICA Team)

Figure 6-36 Data for Gulshan 7

It was confirmed that no buried objects exist at the Gulshan 7 point.



(Source: The JICA Team)

Figure 6-37 Data for Gulshan 8

It was confirmed that no buried objects exist at the Gulshan 8 point.

The SAPI team was able to confirm several existing power cables, together with water, sewage and unknown pipes, around the UGSS site.

A matter for concern when constructing the underground tunnel at this place is that an excavation width of approximately 3 m is required. However, the area is congested with various buried objects and it will be difficult to construct a tunnel after excavation via precasting.

The necessary measures are:

- Relocate buried objects and secure excavation width
- Protect buried objects with hanging protection, and construct tunnel at site without using precasting

Regardless of which measures are taken, there is a concern that the construction costs and construction period will increase. Pictures of hanging protection implementation are shown below.

(Source: The JICA Team)

Figure 6-38 Pictures of hanging protection

6.7 Surveys and tasks to be conducted after SAPI project

Based on the results of this SAPI project, it is necessary for the Engineering Services Consultant and DESCO to implement the following future tasks.

【Engineering Services Consultant】

- Adjustment of 1st pole around the UGSS with DESCO
- Excavation to confirm buried objects (especially around the UGSS)
- Request DESCO to relocate buried objects based on the excavation results
- Confirm on city corporation certificate
- Structural calculations for optimum shaft part based on boring results
- Detailed design for tunnels, ducts and direct burial (including drawing preparation and structural calculations)
- Construction cost study

【DESCO】

- Determination of position for 1st pole around the UGSS
- Determination regarding relocation of existing power cables
- Determination of tunnel conditions (e.g. maximum temperature, maximum wind velocity, minimum lighting intensity)
- Confirmation of fire department permission for the cable tunnel equipmen

Chapter 7. Architectural Design of Underground Substations and Superstructures (DESCO)

7.1 General considerations for the co-ordination

As described, available land area is still subject to change, and building set back issues are also an obstacle to be solved. These will affect the building design significantly. Therefore, the JICA Team has discussed with DESCO about building the design based on the UGSS's current layout design. The JICA Team will continue to discuss this with DESCO while studying the details of the underground building.

7.1.1 Design Constraints on Ground Floor due to Underground Substation Operation

Design constraints on the superstructure building's ground floor which come from underground substation operation will be as follows. DESCO's architect has been advised of these already.

(1) The architect understands the matter of the size of the opening for the intake/exhaust design, but requested to the JICA Team that the services should be located together at one side of the building. The JICA Team will study this issue and reply to the architect by the end of August.

(2) The JICA Team has advised the architect to secure the load bearing strength for the ceiling above the machine hatch, sliding-in route and passage route. The architect has requested to the JICA Team that the ceiling height above the machine hatch should be as low as possible. After discussions, it was decided that the current design height should be lowered from 12m in height to 11m. The JICA Team has agreed that this ceiling height should be 11m subject to the installation of the machine hatch opening cover on the car parking floor. (Blocking some car parking space for a few days whilst opening the machine hatch cover on the floor would not be a significant issue.)

(3) Separation of the entrance/exit between superstructure and underground building

7.1.2 Design Coordination with Superstructure and Underground Structure

In order to satisfy the superstructure layout design, the straight columns should be matched with the underground building's straight columns. In addition, the piping and plumbing which passes from superstructure to underground structure needs to be designed properly. These designs should be done while continuing the coordination work between superstructure and underground structure, ensuring that sufficient space is secured within the building.

7.1.3 Firefighting

The firefighting system must meet the requirements specified in the BNBC standards - specifically, whether firefighting apparatus is necessary for each room or not, what kind of sensors should be prepared, what kind of firefighting must be employed and so on. However, there may be no description in BNBC fitting the UGSS's design because the project is a pilot project for constructing underground substations. If no, or insufficient descriptions exist in BNBC, a new proposal to complete the missing specifications for firefighting should be prepared to secure human and equipment safety. Hence, the JICA Team confirmed the current laws and regulations regarding UGSS operation with the local consultant based on the current designs, layouts and equipment specifications for the UGSS. The following shows a summary of these in Japan, Singapore and Bangladesh.

Table 7-1 Summary of Firefighting Standards in Bangladesh

S/N	Respective authority	Provision in Japan	Provision in Sg	Req'd provision in BD
1	Fire Dept	Smoke detectors could be integrated with Fire Alarm system?	Yes	Yes
2	Fire Dept	There are the following Fire regulations in Japan. Are they the same in Bangladesh? - Passages and rooms are to be used as exhaust ducts. - Walls and floors used as ducts should have Fire protection dampers. - In the case of fire, if the temperature increases and the fuse of the fire protection damper melts and fuses, the damper will be activated to close automatically in order to stop flames and smoke. - And/or in the case of activation of inert gas, the damper will close automatically in order to stop flames and smoke.	● Exhausts/fresh air ducts shall be used for passages and rooms. Passages/corridors are more commonly ventilated by supplying fresh air instead of exhaust. ● Ducts that pass through fire compartment walls and floors shall be fitted with fire dampers. ● Fire dampers shall be constructed in accordance with the requirements in Singapore Standard SS 333. ● Pressure relief dampers shall be provided at the walls of clean gas protected rooms to relieve room pressure during clean gas discharge.	BNBC 2006 Part 4 Fire Protection. Appendix D. - D 9.2 Fire Dampers
3	Fire Dept	Fire extinguishing system in the electrical facilities room requires inert gas fire extinguishing system?	Electrical rooms shall be protected by a sprinkler for a sprinkler-protected building. However, if the room houses high value equipment such as servers and telecommunication equipment, the sprinklers can be replaced by a clean gas total flooding system.	Inert gas fire extinguishing system is required.
4	Fire Dept	The room in which the inert gas fire extinguishing system is installed will require smoke detector + heat sensor?	Smoke detectors shall be installed and clean gas total flooding system shall operate automatically with the activation of at least two	BNBC 2006 Part 4 Fire Protection. Appendix C. - C 2.1 Heat Detectors.

			smoke detectors in the gas protected room to minimize false discharge.	- C 2.2. Smoke Detectors.
5	Fire Dept	Activating conditions of inert gas fire extinguishing system will require a timing in which smoke detector and heat sensor go off?	After the second detector is activated, a signal will be transmitted from the clean gas panel to open the respective solenoid valves in order to release the clean gas after a 30-second delay.	BNBC 2006 Part 4 Fire Protection. Appendix C. - C 2.1 Heat Detectors. - C 2.2. Smoke Detectors.
6	Fire Dept	Transformers, switch gear, electrical cables, control panels, protective relays, batteries and house transformers are considered electrical facilities?	Yes. However, for room housing batteries, hydrogen gas detectors shall be provided and room ventilation shall be designed to limit the maximum concentration of Hydrogen gas to 1% of the total volume of the room.	Yes
7	Fire Dept	- Intakes/exhausts, relays, cooling systems, passages, toilets and shafts will not be considered electrical facilities? - Fire extinguishing system will not be required for these?	All rooms shall be protected with sprinklers for a sprinkler-protected building except for areas specified in the Fire Code, such as canopies, external corridors, external linkways, etc.	Yes. These are considered electrical facilities. All items having an electrical connection need to have a Fire Extinguishing system. Unsure about toilet shafts.
8	Fire Dept	- Inert gas cylinders need to be duplicated for redundancy in order to avoid difficulties in cylinder procurement?	The number of reserved cylinders shall be equal to the largest number of connected cylinders in any of the gas cylinder rooms.	Yes, stand-by inert gas cylinders are required.
9	Fire Dept	- Hole closings on the wall and floor for control cables and electrical cables will require fireproof compartment and to be filled with non-shrinkage mortar?	Yes, seal with fire-stopping sealant.	Yes, required.
10	Fire Dept	Emergency elevators, indoor fire hydrants, underground radio system, direct contact system, connected water supply	Yes, required.	Yes, required.

		system and connected sprinkler system will be required?		
11	Fire Dept	Pipe shafts and machine hatches will be required to be divided on each floor? (This is for the vertical dividing concept.)	Yes, required.	Yes, required
12		- Emergency power supply system will require emergency generator for power system and battery for non-power system?	Emergency generator shall be provided as secondary source of supply.	Yes, required.
13	Building Division	- Emergency elevator will be required?	For a building with a habitable height that exceeds 24m or with a depth of basement exceeding 9m below ground level, at least 2 fire lifts shall be provided.	BNBC 2012 Chapter 4, Lifts, Escalators and Moving Walks. At least 1 fire lift for building height of more than 15m.
14	Building Division	Pipe shafts and machine hatches will be required to be divided on each floor? (This is for the vertical dividing concept.)	Yes, required for building compartmentation.	Yes, required for building compartmentation .

(Source: The JICA Team)

The JICA Team confirmed the specific firefighting design based on the above fundamental requirements on firefighting.

Table 24: Fire requirements for ground floor

№	Floor	Room Name	Room Volume [m^3]	Firefighting requirement in Japan	Firefighting requirement in Singapore's case	Firefighting requirement In Bangladesh case (BNBC 2006)
1	GF	Pipe Shaft	W : 6530 ㎜ D : 2000 ㎜ H : 9000 ㎜ Total : 118 m3	No	yes/ smoke detector for electrical shaft and sprinkler for wet shaft	yes/ smoke detector for electrical shaft and sprinkler for wet shaft
2	GF	Emegency Generatar	W : 6530 ㎜ D : 2000 ㎜ H : 9000 ㎜ Total : 118 m3	Yes	yes	No clear indication. To follow as per Singapore/ Japan
3	GF	Lift Machine	W : 3500 ㎜ D : 1500 ㎜ H : 6000 ㎜ Total : 32 m3	No	yes/ detector	yes/ detector
4	GF	Lift	W : 3500 ㎜ D : 4000 ㎜ H : 3000 ㎜ Total : 42 m3	No	No	No
5	GF	Stair 1	W : 3000 ㎜ D : 5000 ㎜ H : 25600 ㎜ Total : 384 m3	No	yes/detector and cut off sprinkler at the door.	yes/detector and cut off sprinkler at the door.
6	GF	Stair 2	W : 3000 ㎜ D : 5000 ㎜ H : 22600 ㎜ Total : 339 m3	No	yes/detector and cut off sprinkler at the door.	yes/detector and cut off sprinkler at the door.
7	GF	Air Intake Wind tunnel	W : 4550 ㎜ D : 5800 ㎜ H : 31600 ㎜ Total : 834 m3	No	NO	yes/ smoke detector
8	GF	Air Exaust Wind tunnel	W : 4520 ㎜ D : 5640 ㎜ H : 31600 ㎜ Total : 806 m3	No	yes/ smoke detector	yes/ smoke detector

(Source: The JICA Team)

Table 7-2 Fire requirements for basement level 1

№	Floor	Room Name	Room Volume [m^3]	Firefighting requirement in Japan	Firefighting requirement in Singapore's case	Firefighting requirement In Bangladesh case (BNBC 2006)
9	B1	Control	W : 15260 ㎜ D : 9260 ㎜ H : 5100 ㎜ Total : 721 m3	Yes	yes/ smoke detector	yes/ smoke detector
10	B1	Control Panel	W : 13660 ㎜ D : 9260 ㎜ H : 5100 ㎜ Total : 645 m3	Yes	yes/smoke detector	yes/smoke detector
11	B1	Superstructure Transformer	W : 3720 ㎜ D : 9260 ㎜ H : 5100 ㎜ Total : 176 m3	Yes	yes/ deluge water system/ Flame detector	yes/ deluge water system/ Flame detector
12	B1	Air Exhaust Fan	W : 8760 ㎜ D : 9260 ㎜ H : 5100 ㎜ Total : 414 m3	No	yes/Sprinkler point	yes/Sprinkler point
13	B1	Corridor	W : 31000+37300+3000 ㎜ D : 5820+9260+9260 ㎜ H : 5100 ㎜ Total : 1238 m3	No	yes/ sprinkler point	yes/ sprinkler point
14	B1	Toilet	W : 2500 ㎜ D : 1000 ㎜ H : 5100 ㎜ Total : 13 m3	No	yes/Sprinkler point	yes/Sprinkler point
15	B1	Hot Water Supply	W : 2500 ㎜ D : 1000 ㎜ H : 5100 ㎜ Total : 13 m3	No	No	No

(Source: The JICA Team)

Table 7-3 Fire requirements for basement level 2

№	Floor	Room Name	Room Volume [m^3]	Firefighting requirement in Japan	Firefighting requirement in Singapore's case	Firefighting requirement In Bangladesh case (BNBC 2006)
16	B2	33/11kV Switchgear	W : 33910 ㎜ D : 9260 ㎜ H : 7500 ㎜ Total : 2355 m3	No	yes/flame detector	yes/flame detector
17	B2	House Transformer	W : 3720 ㎜ D : 9260 ㎜ H : 7500 ㎜ Total : 258 m3	Yes	yes/ deluge water system/ Flame detector	yes/ deluge water system/ Flame detector
18	B2	132kV GIS	W : 17220 ㎜ D : 9260 ㎜ H : 12600 ㎜ Total : 2009 m3	No	yes/ deluge water system/ Flame detector	yes/ deluge water system/ Flame detector
19	B2	Battery Charger	W : 5710 ㎜ D : 7350 ㎜ H : 7500 ㎜ Total : 315 m3	No	yes/smoke/heat detector	yes/smoke/heat detector
20	B2	Air Intake Tunnel 2	W : 4000 ㎜ D : 4000 ㎜ H : 7500 ㎜ Total : 120 m3	No	No	yes/detector
21	B2	Front Chamber	W : 4000 ㎜ D : 3000 ㎜ H : 7500 ㎜ Total : 90 m3	No	Flame detector	Flame detector
22	B2	Air Exhaust Tunnel 2	W : 4100 ㎜ D : 9260 ㎜ H : 7500 ㎜ Total : 285 m3	No	yes/smoke detector	yes/smoke detector
23	B2	Corridor	W : 30860+4920+3000 ㎜ D : 5820+9260+9260 ㎜ H : 7500 ㎜ Total : 1897 m3	No	yes/Sprinkler point	yes/Sprinkler point
24	B2	Toilet	W : 2500 ㎜ D : 1000 ㎜ H : 7500 ㎜ Total : 19 m3	No	yes/ sprinkler point	yes/ sprinkler point

(Source: The JICA Team)

Table 7-4 Fire requirements for basement level 3

№	Floor	Room Name	Room Volume [m^3]	Firefighting requirement in Japan	Firefighting requirement in Singapore's case	Firefighting requirement In Bangladesh case (BNBC 2006)
25	B3	33/11kV Cable Treatment	W : 33910 ㎜ D : 9260 ㎜ H : 3500 ㎜ Total : 1099 m3	No	yes/Sprinkler point	yes/Sprinkler point
26	B3	132kV Cable Treatment	W : 31500 ㎜ D : 9260 ㎜ H : 3500 ㎜ Total : 1021 m3	No	yes/Sprinkler point	yes/Sprinkler point
27	B3	Fire Fighting	W : 8650 ㎜ D : 7350 ㎜ H : 3500 ㎜ Total : 223 m3	No	yes/Sprinkler point	yes/Sprinkler point
28	B3	Corridor	W : 30860 ㎜ D : 5820 ㎜ H : 3500 ㎜ Total : 629 m3	No	yes/Sprinkler point	yes/Sprinkler point
29	B3	Toilet	W : 2500 ㎜ D : 1000 ㎜ H : 3500 ㎜ Total : 9 m3	No	yes/Sprinkler point	yes/Sprinkler point

(Source: The JICA Team)

Table 7-5 Fire requirements for basement level 4

№	Floor	Room Name	Room Volume [m^3]	Firefighting requirement in Japan	Firefighting requirement in Singapore's case	Firefighting requirement In Bangladesh case (BNBC 2006)
30	B4	Air Intake Fan	W : 11780 ㎜ D : 5800 ㎜ H : 8000 ㎜ Total : 547 m3	No	No	yes/detector
31	B4	132kV Transformer #1	W : 13320 ㎜ D : 8820 ㎜ H : 8000 ㎜ Total : 940 m3	Yes	yes/ automated deluge system/flame detector	BNBC 2006 (Appendix D):- when housed in basement , transformer rooms shall be equipped with automatic high velocity water spray system. -Yes/ automated deluge system/flame detector
32	B4	132kV Transformer #2	W : 13320 ㎜ D : 8820 ㎜ H : 8000 ㎜ Total : 940 m3	Yes	yes/ automated deluge system/flame detector	
33	B4	132kV Transformer #3	W : 13320 ㎜ D : 8820 ㎜ H : 8000 ㎜ Total : 940 m3	Yes	yes/ automated deluge system/flame detector	
34	B4	33kV Transformer #1	W : 6600 ㎜ D : 8820 ㎜ H : 8000 ㎜ Total : 466 m3	Yes	yes/ automated deluge system/flame detector	
35	B4	33kV Transformer #2	W : 6900 ㎜ D : 8820 ㎜ H : 8000 ㎜ Total : 487 m3	Yes	yes/ automated deluge system/flame detector	
36	B4	33kV Transformer #3	W : 6910 ㎜ D : 8820 ㎜ H : 8000 ㎜ Total : 488 m3	Yes	yes/ automated deluge system/flame detector	
37	B4	Pump	W : 5210 ㎜ D : 6850 ㎜ H : 8000 ㎜ Total : 286 m3	No	yes/Sprinkler point	yes/Sprinkler point
38	B4	Circulating Water Pump	W : 4500 ㎜ D : 2700 ㎜ H : 8000 ㎜ Total : 97 m3	No	N/A	
39	B4	Corridor	W : 34000+11780 D : 5940+2930 ㎜ H : 8000 ㎜ Total : 1892 m3	No	yes/Sprinkler point	yes/Sprinkler point
40	B4	Toilet	W : 2500 ㎜ D : 1000 ㎜ H : 8000 ㎜ Total : 20 m3	No	yes/Sprinkler point	yes/Sprinkler point

(Source: The JICA Team)

The above table shows our understanding regarding the required fire protection provisions for an underground sub-station building. In the above summary, the JICA Team noted the below points.

- Basically, sprinklers are the main method of firefighting. This might necessitate considerable space for large water tanks in the UGSS. Additionally, water-proof specifications would be required for equipment.
- Water-type firefighting for oil-immersed transformers.

- Flame sensor is required for electric facility room.
- Two emergency lifts.

If the UGSS follow the above designs, a huge amount of water would be necessary. This might lead to deeper UGSS due to the additional space needed for water tanks, pumps and emergency generators. Furthermore, having two emergency lifts would require changing the current layout. Hence, the JICA Team is considering discussing the above problems with RAJUK and other relevant authorities in order to get waivers based on Japanese practices.

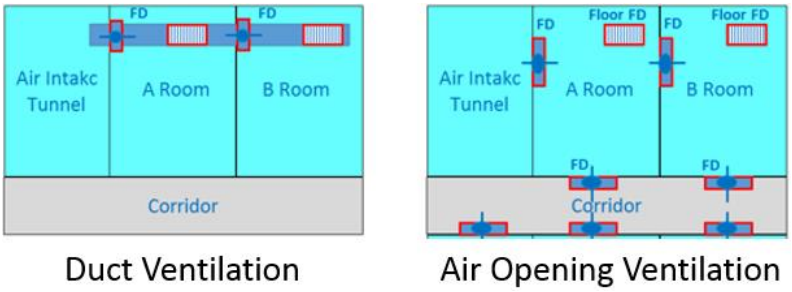
- Waiver to change firefighting methods from water to inert gas for some rooms
- Waiver to remove flame sensors for GIT and station transformer room
- Waiver for the number of emergency elevators from two to one

7.1.4 Ventilation Methods and Depth Study based on Bangladesh Practice

The ventilation design needs to meet the minimum number of air changes in each room for human safety based on BNBC. In parallel, it is also important to maintain the allowable ambient temperature specified in the technical requirements in the equipment room using ventilation cooling to dissipate heat. It is general practice to consider only the latter issue, ventilation cooling to dissipate heat, because the necessary volume of air flow for the latter is much greater than for the former. Hence, the JICA Team calculated the ventilation volume based on the amount of heat dissipation from equipment with the assumption of meeting the minimum number of air changes for each room.

The necessary ventilation volume is calculated in the previous section. Next, the air distribution to every room, with proper air volume, should be considered. Generally, there are two types of air distribution in a UGSS, as per the following.

- Duct usage for ventilation: Air distribution through ducts to every room. Easy distribution with proper air volumes to every room. The disadvantage is that the UGSS might have to be deeper due to the duct spaces.
- Room and corridor usage for ventilation: No need to install ducts since all rooms and corridors are regarded as passages for air flow. However, it is difficult to distribute the proper volume to the target rooms because of the difficulty in controlling the air flow.



(Source: The JICA Team)

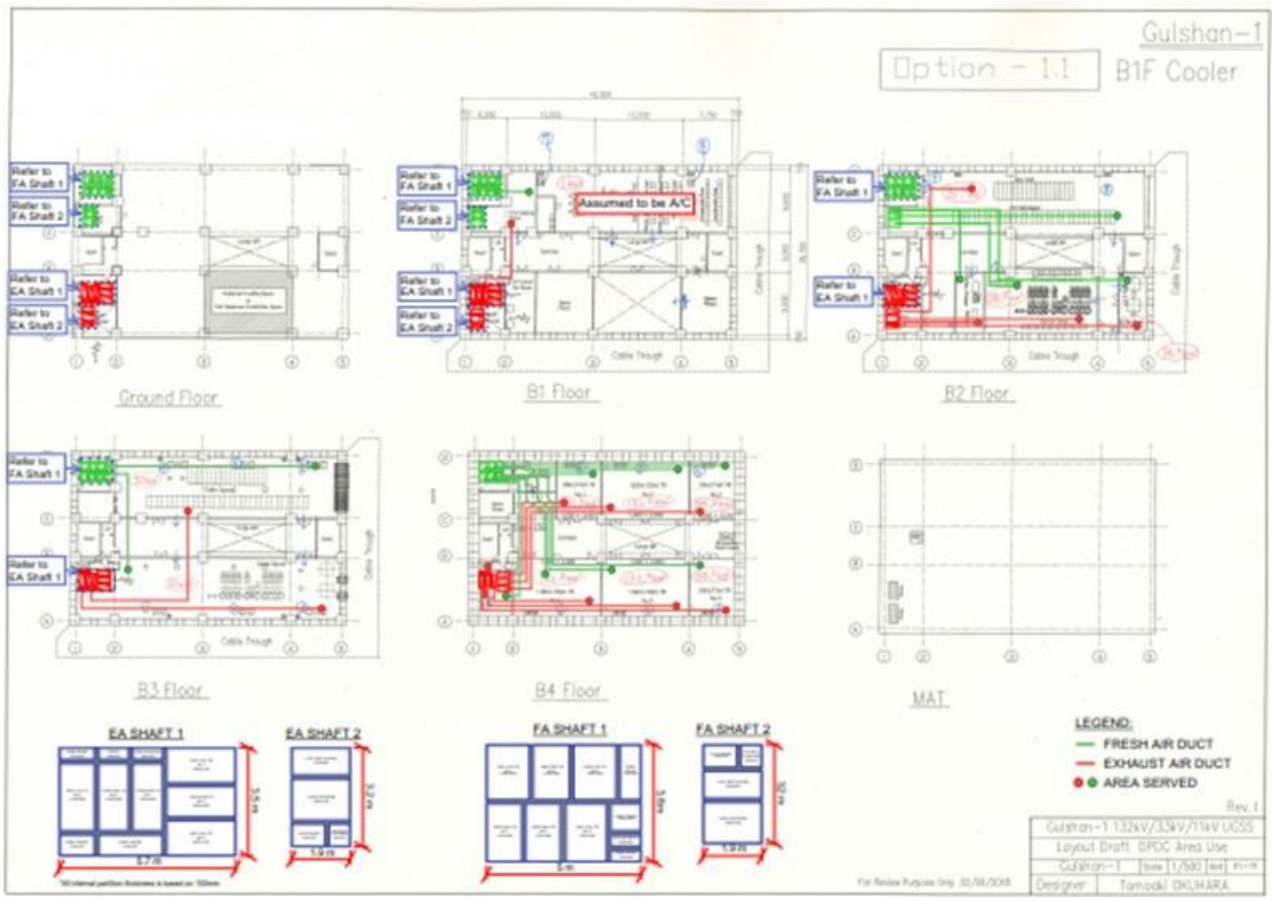
Figure 7-1 Ventilation Types

In Japan, the relevant regulations don't specify the ventilation methods, so the utility can choose the method on a case-by-case basis. However, the JICA Team confirmed that utilities might not be able to regard rooms and corridors as ventilation routes in Bangladesh. Specifically, BNBC 2012 states "Exits and exit access corridors shall not be used as supply or return air ducts or plenums". Hence, it would be necessary to discuss this issue with RAJUK in order to get waivers if ducting ventilation cannot be installed in the UGSS.

Therefore, the JICA Team confirmed the preliminary UGSS depth with duct ventilation. Some points to note are:

1. Duct sizes shown in MV calculation are designed to be run within ventilation shafts therefore the air velocity used is on the higher side.

2. Control Room located at B1 floor is assumed to be A/C.
3. Current basement staircase height exceeds 24m (currently at 25m) hence it shall be pressurized to comply with local code (Singapore) requirement. The required vent shaft size for staircase pressurization is 1100x1100 and could be downsized to 700x700 if basement staircase height reduces to below 24m.
4. Vent shafts for lift lobby, corridor and staircases are preferred to be located within their served area to eliminate the need of fire rated ducts.
5. To consider relocating Air Exhaust Fan Rom to ground floor as the current fan room could not connect all ducts from lower floors and discharge to upper floor.
6. To consider enlarging Air Intake Fan room to accommodate 6 intake fans (1250mm dia. each).



(Source: The JICA Team)

Figure 7-2 Initial layout indicating the floor plan and heat dissipation

The following shows the results of the depth studies based on ducting.

MECHANICAL VENTILATION CALCULATION (FRESH AIR)

FAN DESIGNATION	LOCATION	AREA SERVED	AREA (m^2)	HT (m)	AIR CHANGE PER HOUR	AIR QTY (m^3/s)	REMARKS
FAF-01	G FLOOR	GF STAIR 1	19.8	5.5	4	0.121	
		B1F STAIR 1	19.7	6.0	4	0.131	
		B2F STAIR 1	19.7	7.6	4	0.166	
		B3F STAIR 1	19.7	3.5	4	0.077	
		B4F STAIR 1	17.5	7.9	4	0.154	
					TOTAL	0.649	DUCT SIZE: 500x450
FAF-02	G FLOOR	GF STAIR 2	22.9	5.5	4	0.140	
		B1F STAIR 2	19.7	6.0	4	0.131	
		B2F STAIR 2	19.7	7.6	4	0.166	
		B3F STAIR 2	19.7	3.5	4	0.077	
		B4F STAIR 2	43.9	7.9	4	0.385	
					TOTAL	0.899	DUCT SIZE: 600x600
FAF-03	G FLOOR	B1F LIFT LOBBY	6.8	4.5	4	0.034	
		B2F LIFT LOBBY	6.8	6.1	4	0.046	
		B3F LIFT LOBBY	6.8	2.0	4	0.015	
		B4F LIFT LOBBY	6.8	6.4	4	0.048	
					TOTAL	0.144	DUCT SIZE: 300x300
FAF-04	G FLOOR	B1 CORRIDOR	79.2	4.5	9	0.891	
		B1 CORRIDOR 2	24.6	4.5	9	0.277	
		B2 CORRIDOR	123.9	6.1	9	1.889	
		B2 CORRIDOR 2	51.8	6.1	9	0.790	
		B3 CORRIDOR	79.2	2.0	9	0.376	
		B3 CORRIDOR 2	24.6	2.0	9	0.117	
		B4 CORRIDOR	106.7	6.4	9	1.707	
		B1 TO B4 LARGE MH	69.8	23.5	9	4.101	
					TOTAL	10.148	DUCT SIZE: 950x800
FAF-05	B1 FLOOR	FIRE FIGHTING ROOM	60.9	4.5	10	0.761	
					TOTAL	0.761	DUCT SIZE: 600x200
FAF-06	B2 FLOOR	11KV SWITCHGEAR	85.2 kW / 1.2 / 5			14.200	BASED ON HEAT DISSIPATION
					TOTAL	14.200	DUCT SIZE: 1700x700
FAF-07	B2 FLOOR	145KV GIS ROOM	181.5 kW / 1.2 / 5			30.250	BASED ON HEAT DISSIPATION
					TOTAL	30.250	DUCT SIZE: 1700x1150
FAF-08	B2 FLOOR	LV SW ROOM	26.3 kW / 1.2 / 5			4.383	BASED ON HEAT DISSIPATION
					TOTAL	4.383	DUCT SIZE: 900x550
FAF-09	B2 FLOOR	BATTERY CHARGER	40.0	6.1	20	1.356	
					TOTAL	1.356	DUCT SIZE: 450x450
FAF-10	B3 FLOOR	CABLE SPACE	50.0 kW / 1.2 / 5			8.333	BASED ON HEAT DISSIPATION
					TOTAL	8.333	DUCT SIZE: 1450x500
FAF-11	B3 FLOOR	CABLE SPACE 2	10.0 kW / 1.2 / 5			1.667	BASED ON HEAT DISSIPATION
					TOTAL	1.667	DUCT SIZE: 600x400
FAF-12	B4 FLOOR	132KV/33KV TR 1	132.3 kW / 1.2 / 5			22.050	BASED ON HEAT DISSIPATION
					TOTAL	22.050	DUCT SIZE: 1700x950
FAF-13	B4 FLOOR	132KV/33KV TR 2	132.3 kW / 1.2 / 5			22.050	BASED ON HEAT DISSIPATION
					TOTAL	22.050	DUCT SIZE: 1600x1000
FAF-14	B4 FLOOR	132KV/33KV TR 3	132.3 kW / 1.2 / 5			22.050	BASED ON HEAT DISSIPATION
					TOTAL	22.050	DUCT SIZE: 1700x950
FAF-15	B4 FLOOR	33KV/11KV TR 1	150.3 kW / 1.2 / 5			25.050	BASED ON HEAT DISSIPATION
					TOTAL	25.050	DUCT SIZE: 1600x1200
FAF-16	B4 FLOOR	33KV/11KV TR 2	150.3 kW / 1.2 / 5			25.050	BASED ON HEAT DISSIPATION
					TOTAL	25.050	DUCT SIZE: 1600x1200
FAF-17	B4 FLOOR	33KV/11KV TR 3	150.3 kW / 1.2 / 5			25.050	BASED ON HEAT DISSIPATION
					TOTAL	25.050	DUCT SIZE: 1700x1150
FAF-18	B4 FLOOR	PUMP ROOM	35.7	6.4	10	0.635	
					TOTAL	0.635	DUCT SIZE: 650x200

MECHANICAL VENTILATION CALCULATION (EXHAUST)

FAN DESIGNATION	LOCATION	AREA SERVED	AREA (m²)	HT (m)	AIR CHANGE PER HOUR	AIR QTY (m³/s)	REMARKS
EAF-01	B1 FLOOR	FIRE FIGHTING ROOM	60.9	4.5	10	0.761	
					TOTAL	0.761	DUCT SIZE: 600x200
EAF-02	B1 FLOOR	B1 TOILET	6.3	4.5	10	0.079	
		B2 TOILET	6.3	6.1	10	0.107	
		B3 TOILET	6.3	2.0	10	0.035	
		B4 TOILET	6.3	6.4	10	0.112	
					TOTAL	0.333	DUCT SIZE: 400x200
EAF-03	B2 FLOOR	11KV SWITCHGEAR		85.2 kW / 1.2 / 5		14.200	BASED ON HEAT DISSIPATION
					TOTAL	14.200	DUCT SIZE: 1700x700
EAF-04	B2 FLOOR	145KV GIS ROOM		181.5 kW / 1.2 / 5		30.250	BASED ON HEAT DISSIPATION
					TOTAL	30.250	DUCT SIZE: 1700x1150
EAF-05	B2 FLOOR	LV SW ROOM		26.3 kW / 1.2 / 5		4.383	BASED ON HEAT DISSIPATION
					TOTAL	4.383	DUCT SIZE: 900x550
EAF-06	B2 FLOOR	BATTERY CHARGER	40.0	6.1	20	1.356	
					TOTAL	1.356	DUCT SIZE: 450x450
EAF-07	B3 FLOOR	CABLE SPACE		50.0 kW / 1.2 / 5		8.333	BASED ON HEAT DISSIPATION
					TOTAL	8.333	DUCT SIZE: 1850x400
EAF-08	B3 FLOOR	CABLE SPACE 2		10.0 kW / 1.2 / 5		1.667	BASED ON HEAT DISSIPATION
					TOTAL	1.667	DUCT SIZE: 600x400
EAF-09	B4 FLOOR	132KV/33KV TR 1		132.3 kW / 1.2 / 5		22.050	BASED ON HEAT DISSIPATION
					TOTAL	22.050	DUCT SIZE: 2000x800
EAF-10	B4 FLOOR	132KV/33KV TR 2		132.3 kW / 1.2 / 5		22.050	BASED ON HEAT DISSIPATION
					TOTAL	22.050	DUCT SIZE: 2000x800
EAF-11	B4 FLOOR	132KV/33KV TR 3		132.3 kW / 1.2 / 5		22.050	BASED ON HEAT DISSIPATION
					TOTAL	22.050	DUCT SIZE: 2000x800
EAF-12	B4 FLOOR	33KV/11KV TR 1		150.3 kW / 1.2 / 5		25.050	BASED ON HEAT DISSIPATION
					TOTAL	25.050	DUCT SIZE: 2050x950
EAF-13	B4 FLOOR	33KV/11KV TR 2		150.3 kW / 1.2 / 5		25.050	BASED ON HEAT DISSIPATION
					TOTAL	25.050	DUCT SIZE: 2050x950
EAF-14	B4 FLOOR	33KV/11KV TR 3		150.3 kW / 1.2 / 5		25.050	BASED ON HEAT DISSIPATION
					TOTAL	25.050	DUCT SIZE: 2050x950
EAF-15	B4 FLOOR	PUMP ROOM	35.7	6.4	10	0.635	
					TOTAL	0.635	DUCT SIZE: 650x200

(Source: The JICA Team)

Figure 7-3 Study on UGSS Depth with Duct Ventilation

Considering the minimized depth, it is preferable to make the best use of each equipment room with the ducting and equipment installation, including O&M space. However, the above figures show the difficulty of achieving that due to the congested B2 and B4 floor in the current layout. The estimated duct sizes are shown as follows.

B2 Floor

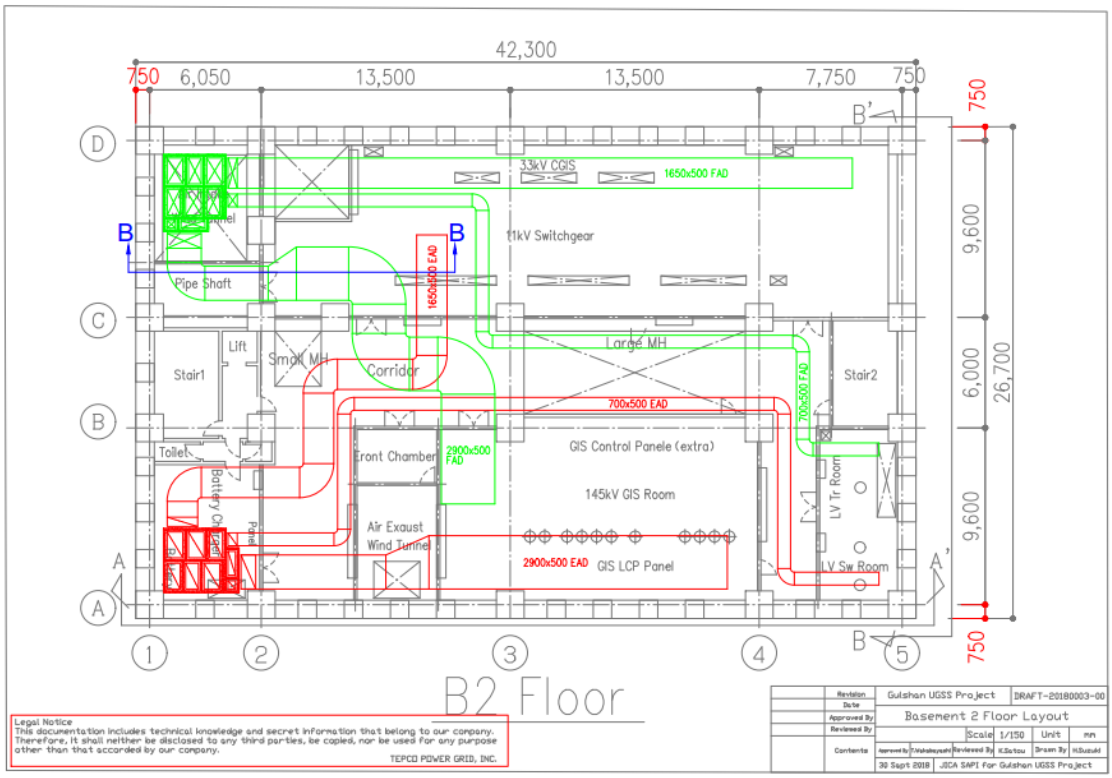
11kV Switchgear – 2350x500 FAD (aspect ratio of more than 1:4)
145kV GIS Room – 3850x500 FAD (aspect ratio of more than 1:4)
LV Switch room – 1000x500 FAD

B4 Floor

132KV/33KV TR 1 – 1600x1000 FAD
132KV/33KV TR 2 – 1600x1000 FAD
132KV/33KV TR 3 – 1600x1000 FAD
33KV/11KV TR 1 – 1900x1000 FAD
33KV/11KV TR 2 – 1900x1000 FAD
33KV/11KV TR 3 – 1900x1000 FAD

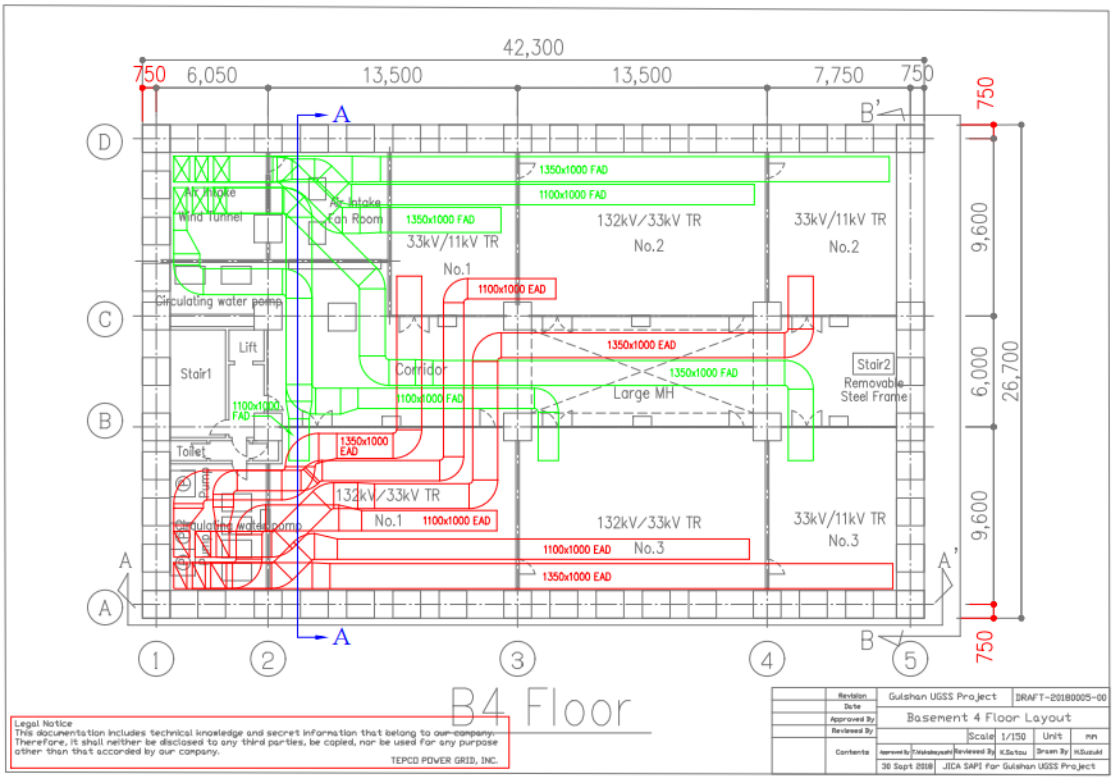
According to the above, Exhaust duct sizes are similar to FAD for these rooms. With the current vent shaft quantity and location, crossing of ducts is unavoidable, hence it is quite impossible to meet the space requirements given. The following is one of the constraints for illustration purposes. The space

for ducts to the vent shaft is restricted by columns. Further review of levels B2 and B4 was carried out to fit the ducts within the allowable depth. Ducts were in full scale to demonstrate the exact space constraints in both horizontal and vertical directions. The layout and sectional details are shown below:



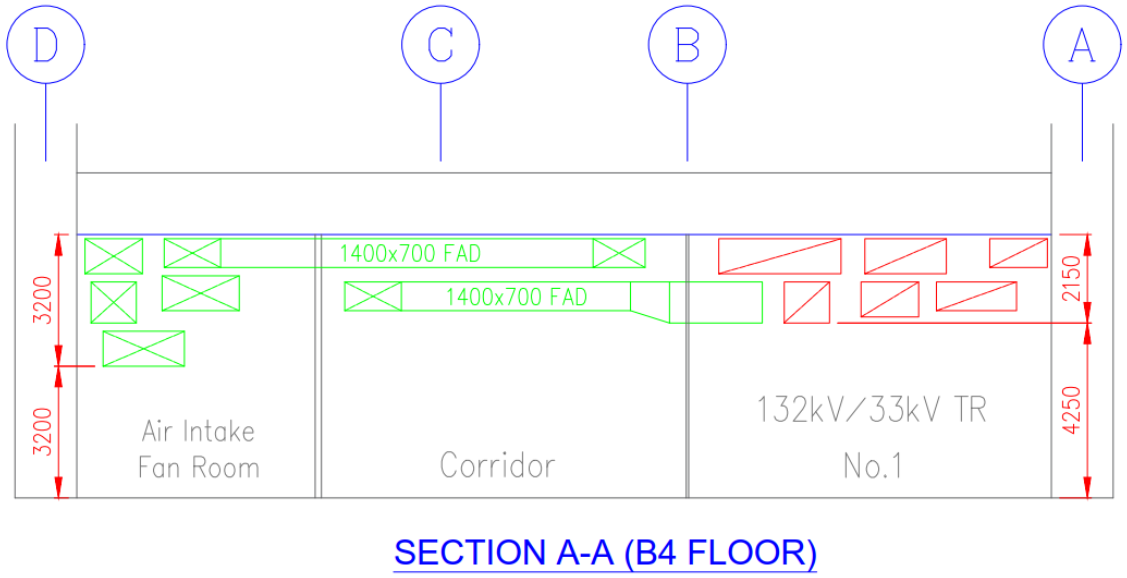
(Source: The JICA Team)

Figure 7-4 Duct layout on Level B2



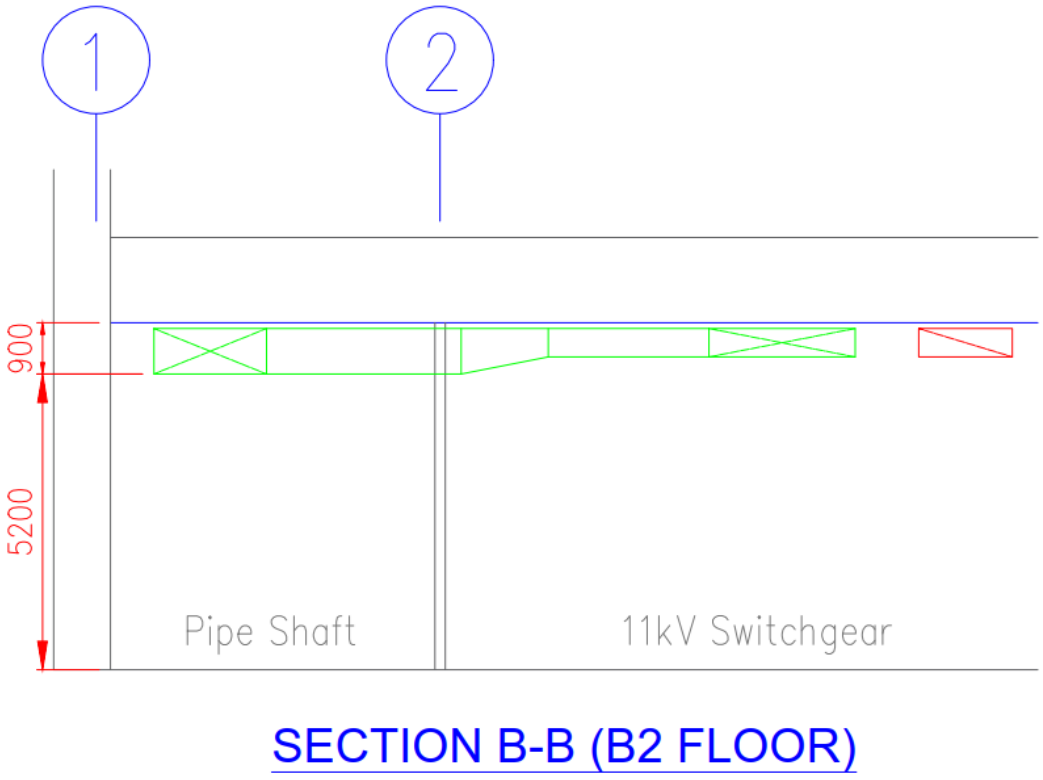
(Source: The JICA Team)

Figure 7-5 Duct layout on Level B4



(Source: The JICA Team)

Figure 7-6 Sectional details on B4 level



(Source: The JICA Team)

Figure 7-7 Sectional details on B2 level

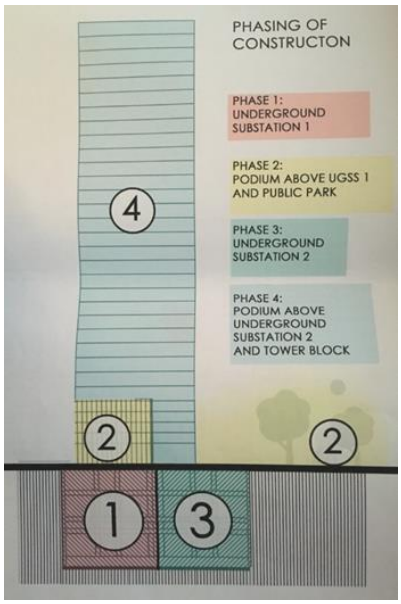
Based on the above, when ducting is applied for the ventilation method in DESCO's UGSS, the depth with ducting would be approximately 10 m deeper than the case without ducting. This would make the project unviable due to unrealistic excavation costs. Hence, the utilities will have to discuss the matter with RAJUK to get a waiver for ducting ventilation as per practices in Japan. Or the follow can be considered as candidate solutions:

1. Divert some of the ducts from level B4 to run at B3-high level and then vertically penetrate to level B4. The implications are that additional vertical space in the form of a vertical shaft/duct will be required. The ducts might also need to provide fire rating to maintain the integrity of the different fire compartmentation.
2. Some of the rooms on the B4 level could be provided with direct expansion split type air conditioning to remove the dissipated heat. This will reduce the need for high-volume ducts.
3. Discuss with the local authority on the acceptance of TEPCO-proposed open air concept through corridors.
4. Allow 2m space for ducts on level B4, especially in Transformer rooms where all ducts are crossing.

7.2 Design co-ordination with Superstructure

As for DESCO, they have constraints with regard to PGCB's land portion. DESCO's architect designed the column layout for the superstructure building based on the underground building's column design, which was done by the JICA Team during the Data Collection Survey and, fortunately, design coordination produced no significant problems. However, following this, the JICA Team was informed that PGCB's SS development on their land portion will be significantly delayed and cannot match the timing in DESCO's UGSS development schedule. Therefore, the JICA Team is currently continuing to study possible cases. However, it is possible to re-do the design coordination.

The JICA Team has been advised that the superstructure building will be an RC structure, with a building height of 137m above the ground level and with 34 stories above ground, and that the superstructure building has been calculated to be less than the unit load, 15kN/m2. The straight column layout for the superstructure is the same as the straight column layout for the underground building; however, the architect has requested to the JICA Team one additional straight column. It is not easy to add a straight column because it will block the equipment entry/exit, and it is also not easy to install the maintenance space. However, after discussions with the architect, the JICA Team has agreed to add one straighter column as per the architect's request. The team will continue to study the layout for PGCB's land portion.



① DESCO UGSS
② DESCO UGSS pop up structure and Green area (DESCO)
③ PGCB UGSS (future)
④ DESCO Superstructure

Design negotiations for ①, ② and ④ were carried out.

・137m building height above the ground level
・34 stories above the ground and superstructure building

(Source: 37Bridge)

Figure 7-8 Phasing of Construction

7.2.1 Superstructure Specifications for Gulshan Substation

DESCO appointed 37 Bridge as the superstructure design architect in March 2018. 37 Bridge has prepared the schematic design for the superstructure building based on the UGSS building's layout design which was provided by the Data Collection Survey Team. The JICA Team has confirmed that the design coordination includes no significant discrepancies, but also found some issues to be solved. In particular, the Intake/Exhaust duct, machine hatch and entrance/exit for the UGSS building are locations where coordination is needed. The following items need to be developed further.

(1) As the opening size of the intake/exhaust duct is small compared to the UGSS building's cubic volume, wind speed would be very fast. In order to avoid this problem, the JICA Team advised the architect to enlarge the opening size (approximately 20 m^2 will be needed, subject to further study with the equipment's heating values).

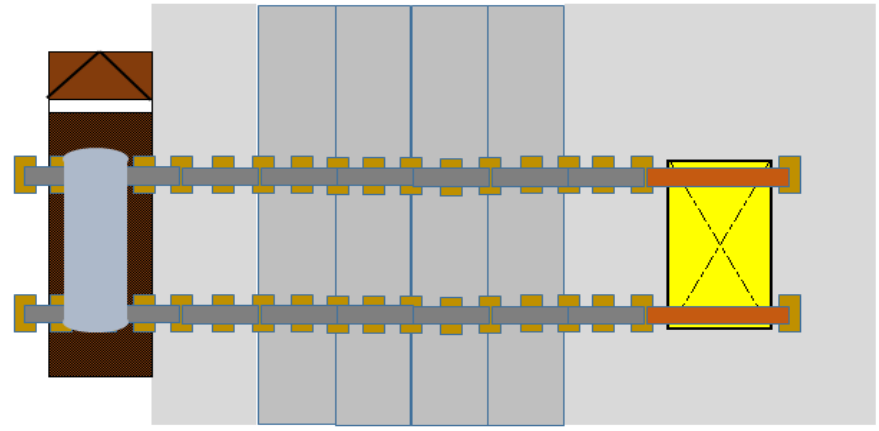
(2) The JICA Team has advised the architect that depends on the detailed design for cooling system; apart from the intake/exhaust duct for the entire building, a separate intake duct will be needed. The JICA Team has confirmed with the architect that such additional design could be done. The JICA Team will advise the architect on the location of the opening for the building, which will be calculated via equipment heating values later on.

(3) The JICA Team has confirmed that the machine hatch opening size is no problem at this stage. The team will advise the architect on the opening size which is needed after the equipment sizes have been designed by the manufacturers and the detailed transportation plan has been done by the logistics company.

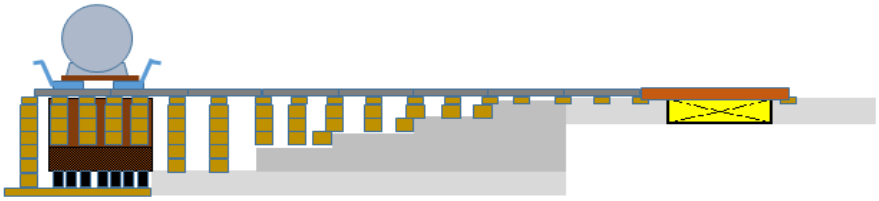
(4) The JICA Team has confirmed that the effective ceiling height above the machine hatch is at least 12m. The team will advise the architect on the ceiling height necessary for above the machine hatch and the space needed in surrounding areas after the equipment sizes have been designed by the manufacturers and the detailed transportation plan has been done by the logistics company.

(5) The JICA Team has advised the architect on the gantry crane for lifting up the heavy transformer into the machine hatch area and confirmed that the superstructure building design can house such a gantry crane as part of the superstructure building.

(6) The JICA Team assumes that in order to move the transformer in from the road to the machine hatch, jacking-up should be arranged on the trailer truck first, then temporary planking installed to adjust the height to the machine hatch level. Then, the transformer will be slid to the machine hatch location.



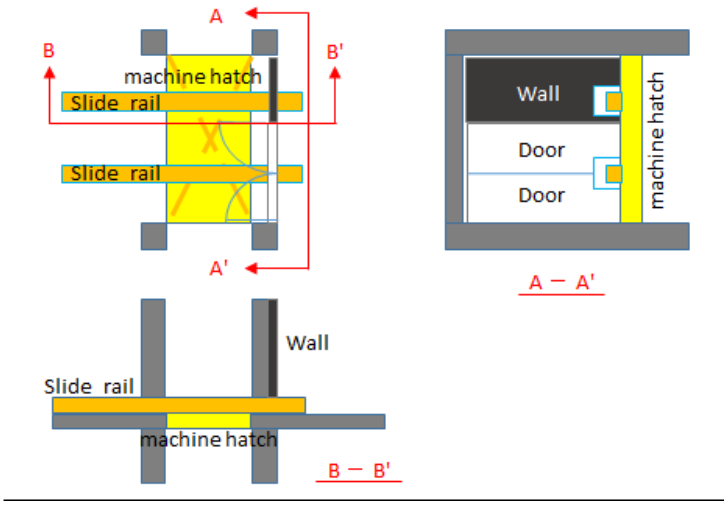
Overview



Sectional view

(Source: The JICA Team)

Figure 7-9 GIT Loading Map



(Source: The JICA Team)

Figure 7-10 Interface between Slide Rails and the Superstructure

(7) The architect requested the JICA Team to add one additional straight column for structural support for the superstructure. After the discussion with the architect and careful study, the JICA Team agreed to add one straighter column as requested, subject to there being no negative effect on the O&M (operation & maintenance) of the UGSS.

(8) The JICA Team will continue to discuss the eccentric column on the ground floor of the superstructure building. As for DPDC, the design competition will close on September 6 and the tender will be awarded a few months later, after the assessment procedure.

7.2.2 Calculation of Ventilation Volume

As described in 3.4, DESCO and the JICA Team agreed to install the cooling units on the superstructure. This would help to reduce the size of the ventilation tunnel in the UGSS, though the shaft for water piping should be passed through the UGSS to the superstructure. Since the shaft location and size should be reflected in the superstructure design, the JICA team studied the shaft size and location via ventilation calculations as well as the procedure described in 3.4.

[Case Study] Cooling system in the Superstructure

[Study flow]

1. Calculation of Total Heat Dissipation emitted from equipment
2. Calculation of necessary ventilation volume based on the heat dissipation
3. Design of air opening size on ground floor considering the expected wind speed at the air opening and ventilation tunnel

[Case Study] Cooling system in the Superstructure

Based on the above study flow, the JICA Team listed the heat dissipation as follows.

Table 7-6 List of Heat Dissipation Amounts from Equipment

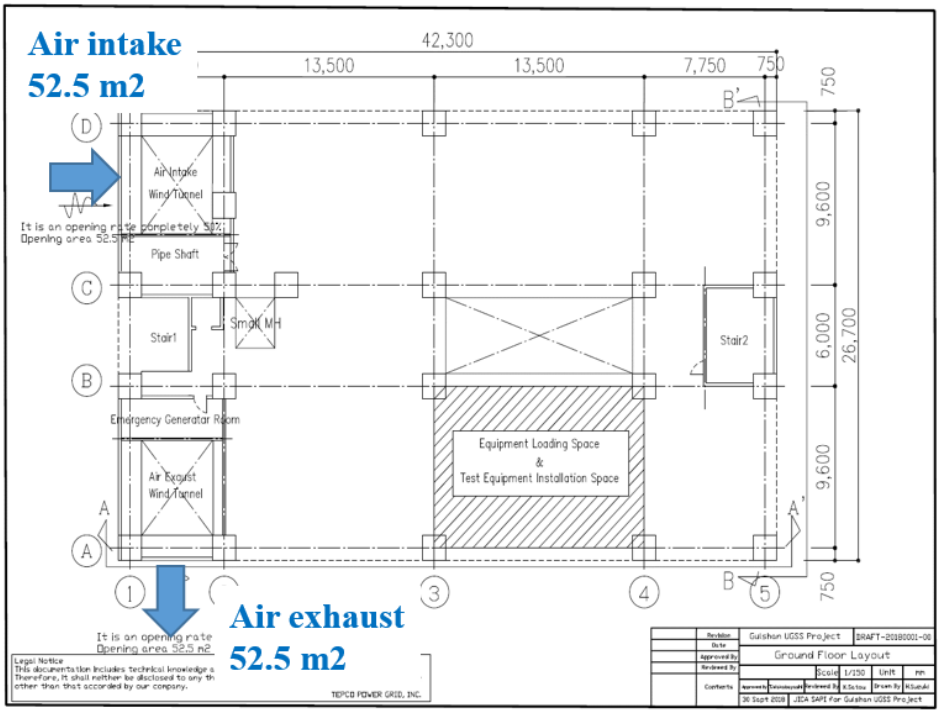
Floor	Items	Loss [kW]	Quantity	Unit	Total [kW]
B4	132/33kV GIT	700.0	3	Set	216.3
	33/11kV GIT	800.0	3	Set	246.3
B3	Cables	100.0	1	Lot	106.3
B2	132kV GIS	58.4	3	Set	181.5
	33kV C-GIS	13.2	3	Set	45.9
	11kV SW	11.0	3	Set	39.3
B1	Panels	114.0	1	Lot	120.3
	DC Set	35.0	3	Set	111.3
GF	-				
-	Others	50.0	1	Lot	56.3
Total					**1123.1**

(Source: The JICA Team)

The necessary ventilation volume is estimated as follows based on the above heat dissipation.

$$\text{Neccesary Volume} = \frac{Total\ Heat\ Dissipation\ [kW]}{0.33 \times (Maximum\ Ambient\ Temperature - Intaked\ Air\ Temperature)} = 378{,}131\ m^3/\text{h}$$

For the assumption of wind speed for the air intake and exhaust, the JICA Team estimated 4 m/s for air intake and 4 m/s for air exhaust as per typical studies in Japan. The following shows the size and location of the air opening on the ground floor.



(Source: The JICA Team)

Figure 7-11 Position of Air Opening on the Ground Floor

The walls on the ground floor and first floor can be regarded as space for the air opening to secure the necessary dimensions for this. It would be approximately 9m in height. The JICA Team requested the designer of the superstructure to reflect the air opening design in their design. Additionally, the actual size of the air opening would depend on the available opening rate of the louver, which covers the air opening, so the JICA Team informed the superstructure designer of this issue.

7.2.3 Transportation Study on Ground Floor

The JICA Team confirms the transformer specifications for the project. For the GIT, which is the biggest and heaviest of the substation equipment, many items should be considered relating to loading, transportation from the manufacturer's factory to the installation site inside the UGSS, and installation, and these should be reflected in the superstructure and substructure designs. Hence, the JICA Team confirmed the following in the SAPI.

*Minimizing the shipping size for GIT

A minimized shipping size would lead to easy transportation and optimized superstructure and substructure designs. It is also important to take into consideration the allowable range (size/weight) of the transportation route when transporting or carrying in equipment. Hence, it is necessary to de-assemble any auxiliary devices and minimize the shipping size as much as possible. The JICA team is currently considering about W: 10,500, D: 3,700, H: 3,900, 140 t as the maximum shipping size in interviews with manufacturers.

*Secure route surrounding the UGSS

The transportation route covers both land and sea transportation, and loading and unloading at ports. The Contractor will ultimately be responsible for this transportation. However, the JICA Team has considered the transportation method in order to reflect a feasible method in the design. Specifically, assuming a trailer and the above shipping size, it should be verified whether it is possible to turn at narrow roads (intersections) where there are such turns near the UGSS. Detailed investigations, such as on the necessity of reinforcement for overland, waterway, road and bridge routes, etc. are required following the decision by the transformer manufacturer. In addition, it is necessary to investigate the road traffic laws in Bangladesh, consult with the relevant ministries and agencies, and determine a transportation method that satisfies the traffic conditions (size, time etc.).

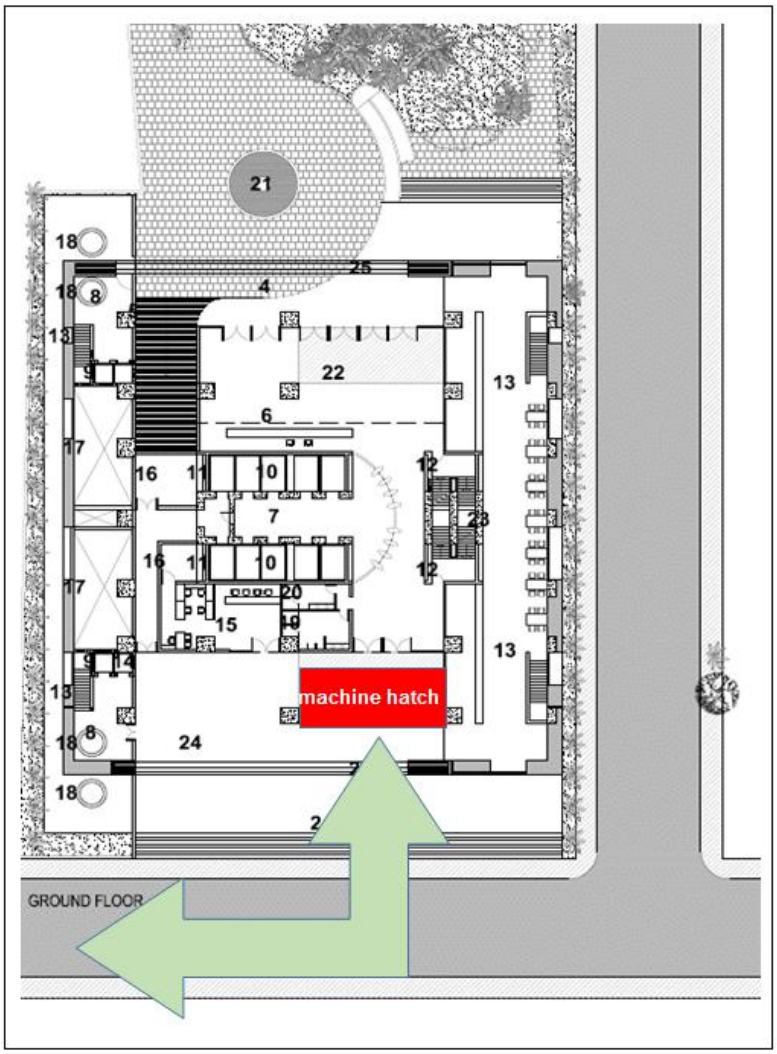
*Consideration of loading and installation method at the UGSS

The machine hatch is to be used for loading from the ground level to the installation site on B4F. The design of the machine hatch is still coordinated with the superstructure, such as its size, required height of its upper part, hook strength and installation position. The JICA Team is currently studying these issues with the logistics company.

With regard to the loading of construction equipment and UGSS facilities, and transportation from the loading place to the UGSS, the JICA team will conduct detailed investigations after the UGSS facility specifications are finalized.

It is necessary to consult with relevant government agencies considering the results of a detailed survey on transportation.

The JICA team explained to the local architect how to draw into the transformer from the road to the machine hatch in order to aid their understanding.

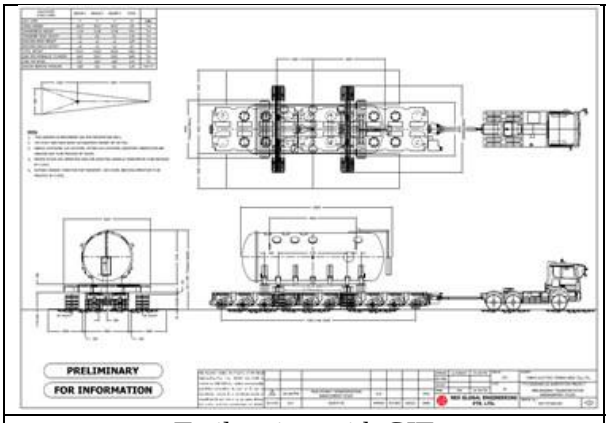


(Source: The JICA Team)

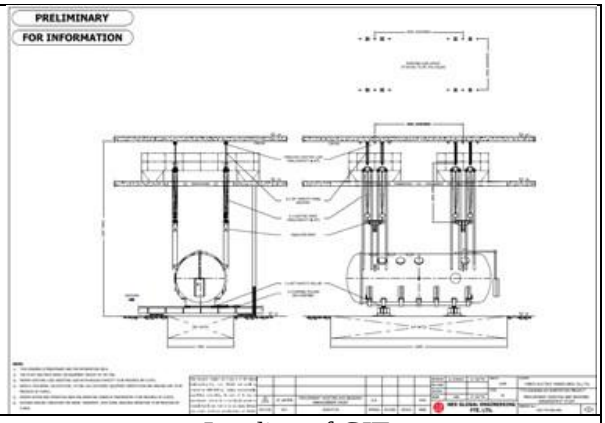
Figure 7-12 Loading Point into UGSS in Gulshan UGSS

The SAPI Team studied feasible transportation methods for the Gulshan case with Nippon Express Co., Ltd., a Japanese logistics company. As a result of the study, it was found that the transportation can be done with some detachable equipment, such as a wall and door, surrounding the machine hatch. The transportation work needs the ground floor and first floor to secure the space for hanging GIT. Hence, the ceiling on the ground floor should be openably designed when hanging GIT. Then, the alternative route on the first floor should be taken care of. Therefore, the local architect should fix the ground and first floor design with the other items the SAPI Team informed of.

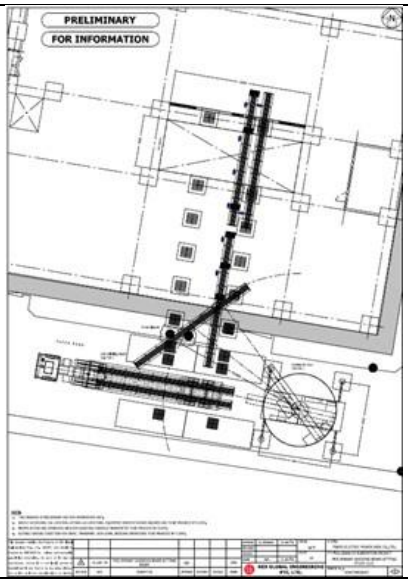
The transportation method needs the roadblock to use a crane and a trailer for the installation of skidding rail from the road to the machine hatch and other work. Hence, the Engineering Service Consultant should take the clearance using the road into consideration before the transportation.



Trailer view with GIT

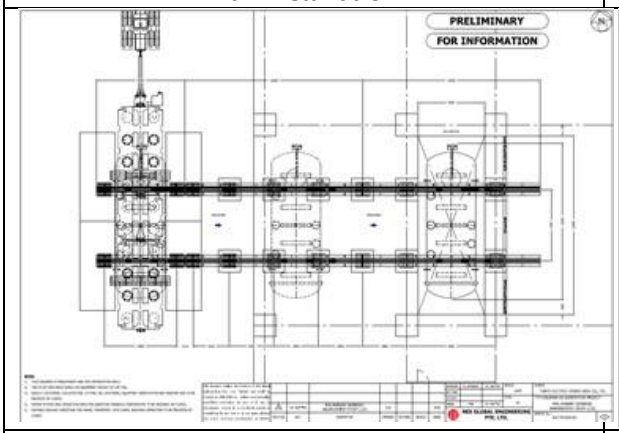


Loading of GIT

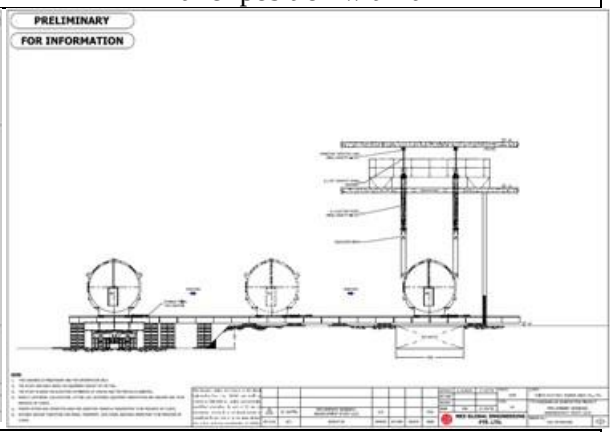


Rail installation

Trailer position with rail



Skidding GIT on rail (Horizontal view)



Skidding GIT on rail (Section view)

(Source: Nippon Express Co., Ltd.,)

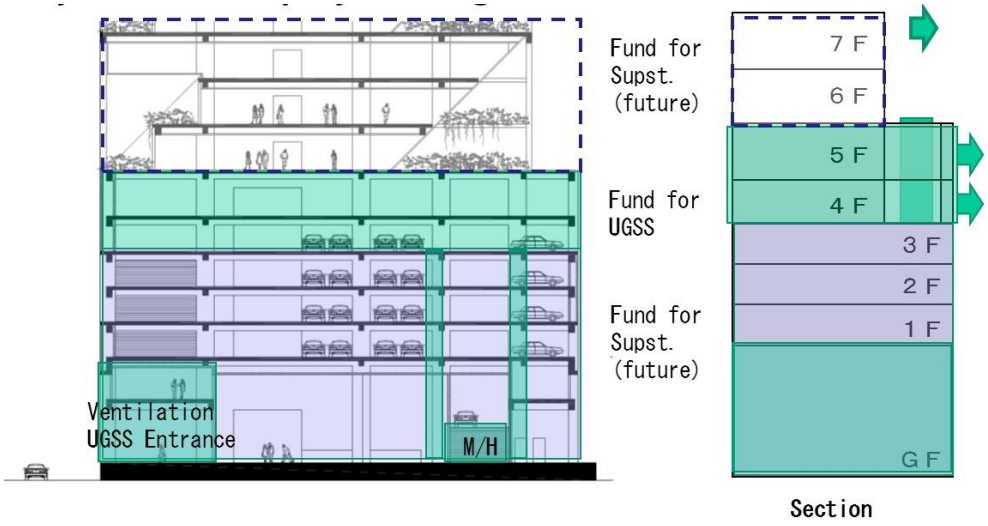
Figure 7-13 Loading Point into UGSS in Gulshan UGSS

7.3 Cost Allocation for Podium Construction

As discussed in Chapter 3, DESCO's technical director, 37 Bridge and the SAPI team have agreed that the cooling system for the Gulshan underground substation is to be integrated into part of the 4th and 5th floors of the podium part, which is allowed to have its footprint expanded to larger than the standard FAR to reduce the ventilation openings on the ground level. This would result in minimized design constraints on the podium part of the superstructure. This cooling system, integrated with the superstructure, is a critical functional component of the underground substation, while most components are still installed beneath the above-ground portion of Gulshan UGSS to enable use of the premium above-ground spaces for multiple purposes. The UGSS components integrated in the superstructure in the current design include not only this cooling system but also the minimized ventilation system, UGSS entrance and evacuation route, and large machine hatch as originally designed in the Feasibility Study.

The actual construction plan for the superstructure indicates that half of the podium's portion in the superstructure must be built posterior to the excavation of the places that the currently existing substation occupies. Thus, these underground substation components must be installed as part of the first-half spaces created on the podium.

The following illustration indicates the necessary underground components to be installed above ground, which are shown in green, and the available space in the podium.



(Source: The JICA Team)

Figure 7-14 Critical UGSS components to be integrated into the podium portion of the superstructure to indicate the construction cost coverage

This integration of the cooling system has been discussed from the feasibility study of the UGSS, and its report clearly indicates the necessity of the further design study during the actual design stages to streamline the UGSS project, because installation of the cooling system underground requires more excavation depth of the UGSS, which also increases the excavation cost, and also imposes significant design constraints onto the design of superstructure.

Therefore, the SAPI team proposes that the functional portion of the half of the podium building in which the cooling system components are to be installed must be regarded as part of the UGSS, and be included as part of "the UGSS Project" for both engineering and cost efficiency purposes. An underground substation must be designed to remove heat dissipated by the substation components, thus an underground substation cannot be operated without a cooling system, meaning this can be regarded

as a critical portion of the project. In other words, the project cannot be completed without a cooling system to fulfil the project's original purposes.

The current podium design developed by 37 Bridge specifies the first-half of the podium to be utilized as an equipment machine room and car parking lot. Assuming that a similar design will be applied for the final building design, these building features are not directly related to the UGSS's function even if the cooling system is integrated onto the podium. Thus, based on a judgment on whether these functions are "eligible items" for the Project, and originally stated as part of "the Project", these building features, not being a critical portion of the UGSS, are generally to be constructed via DESCO's own funding. Currently, DESCO aims to utilize the newly created spaces not used for UGSS components in the first-half of the podium portion for demolition of the existing facilities, including the existing substation, DESCO offices and customer center, and construction of the remainder of the superstructure in the next project phase. DESCO also proposes to bear the cost for the room compartmentalization, M&E service installation and interior decoration of the offices via its own funding, while expecting the building structures to be built as part of the UGSS project costs.

The construction of the first-half podium portion can be arranged in two ways. One arrangement is to include the construction in the UGSS project by asking the package 1 contractor to construct the building structure and UGSS components in the first-half podium portion. The other way is to appoint the construction company for the entire superstructure, and request them to construct the necessary podium portion to meet the UGSS construction schedule. In an extreme case, the cooling system could be temporarily installed on the ground floor, and the system then transferred after completion of the superstructure building's construction. However, considering security of the UGSS's operation, the first-half of the podium portion must be constructed as part of package 1 of the UGSS to minimize the risks concerning the UGSS's security and operational reliability. For example, if the superstructure is constructed by another entity (the construction company for the superstructure), completion of the Design-Build contract for the UGSS portion becomes dependent on the quality, workmanship, and project duration of the superstructure construction, and these are almost out of the control of the UGSS contractor. Furthermore, the decision on whether the UGSS is "fit-for purpose" also becomes dependent on another stakeholder's work.

In terms of an increase in project costs due to introduction of a closed-water circulation system, and installation of it in the superstructure, the SAPI team studied the matter as follows:

The SAPI team also evaluated a preliminary cost comparison using two cases: Case I) installing the entire cooling system underground and Case II) installing the cooling system on the top of the podium. The following table shows that the total cost increment for Case II is less than that for Case I because of the significant reduction in the UGSS depth necessary. According to the report to JICA concerning the current progress on the study on the cooling system and relevant cost sharing between JICA and DESCO's own funds, JICA proposed that the cost evaluation must be revised based on the actual construction conditions, so DESCO and JICA may discuss what the best design for the UGSS cooling system is by considering a revised superstructure design.

Table 7-7 Cost of the Installation of the Cooling System

Item	Cost (MUSD)	Note
Case I: Increase of the excavation depth by 16 meters & increase in UGSS building cost when cooling system installed underground	5.0	Based on FS's cost evaluation (addition of 1 floor), and this is not included in FS project costs
Case II: Introduction of water circulation system & heat exchanger (A)	2.0	1.6M USD is expected for the "cooling facility" in FS
Construction of half of the podium (B)	1.8	Based on 37Bridge's budgetary information * 0.7
Compartmentalization & interior work to be done by DESCO	(0.8)	Under revision, depends on the usage plan.
Total Cost (A)+(B)	3.8	< 5.0 (increased depth)

(Source: The JICA Team)

Therefore, the SAPI team proposes that the first-half podium portion be constructed by the UGSS contractor, and partially covered by the UGSS project fund because:

1) Having the water-cooling system in the podium portion reduces the overall UGSS project cost by reducing the total depth of the UGSS, and achieves design co-ordination between the UGSS and its superstructure.
2) Even with no cooling system, the superstructure must accommodate the UGSS entrance, ventilation facilities, and a large machine hatch and gantry system in a non-negligible portion of the superstructure.
3) Temporary installation of the cooling system can result in increased risks concerning the UGSS's project efficiency by allowing increased project delay risks introduced by a third party.

Based on this, the SAPI team also proposes that the cost for the first-half portion of the podium can be separated into 1) construction of building structure and installation of the cooling system, and 2) room clustering and interior finishing, and that the first portion (1) be covered by the UGSS project to maintain the fit-for purpose objective.

In January, the SAPI team will seek agreement from both JICA and DESCO stakeholders to settle this issue.

In the discussion between JICA and the SAPI team on December 5, 2018 it was concluded that JICA cannot cover all of the building structure, including places where the UGSS's components are not installed. A detailed cost breakdown for the entire project cost evaluation was requested for further study and discussion on the feasibility of placing the cooling system on top of the podium portion, and the method of cost sharing. Such detailed work must be done by the Engineering Services Consultant based on the SAPI's study.

Chapter 8. Environmental and Social Considerations (DESCO)

During the Data Collection and Analysis Survey 2016/17, laws and regulations on environmental and social issues were reviewed, environmental and social baseline data for the project area were collected based on which adverse impacts caused by the project implementation were anticipated, and environmental management and monitoring plans were developed accordingly.

Following the results of the Data Collection Survey, DESCO submitted an environmental impact assessment (EIA) report with an environmental management plan (EMP) and environmental monitoring plan (EMoP)[1], for which the Department of Environment (DOE) gave an environmental clearance certificate (ECC)[2] in September 2017[3]. As the Project uses a Japanese ODA loan, the EIA was developed in compliance with *the JICA Guidelines for Environmental and Social Considerations (April 2010)* and the international standards too.

It is common for there to be deviations from the predicted impacts and unforeseen adverse impacts, for which revisions and/or additions in the countermeasures shall be made. The JICA Team, in this SAPI, further investigated whether there have been any changes/alterations required in the layout, design or technical specifications, interviewed local associates, conducted site reconnaissance and discussed matters with DESCO to narrow down unforeseen areas and further specify mitigation measures.

The Team intended to work on the following issues, but a severe delay in design coordination between the UGSS and superstructure made it unable to examine e and f.

a. Update and analysis of relevant laws and regulations on environment and land issues
b. Update environmental and social baseline data
c. Update anticipated environmental and social impacts caused by the project implementation based on the revised and latest layout for UGSS and route for UGC
d. Update environmental management and monitoring plan accordingly
e. Predict impacts caused by superstructure construction (pre-survey basis)
f. Predict cumulative impacts of UGSS/UGC and superstructure
g. Draw up recommendations

The above a and b are as described in *the Final Report on Environmental and Social Survey, Route and GPR Survey* produced by the Center for Environmental and Geographic Information Services (CEGIS). 8.1 below and ANNEXES show the results of c and d. 8.2 is added to respond to some of the DOE's conditions given in the ECC. 8.3 describes recommendations as g.

8.1 Environmental and Social Impacts caused by the Project Implementation

The findings and analyses on relevant data and information in the Data Collection and Analysis Survey 2016/17 indicated that adverse impacts caused by the project implementation would remain low. They are expected to be offset or minimized if the mitigation measures are adequately implemented.

During this SAPI, the JICA Team reviewed the anticipated environmental and social impacts since the project design and layout has been revised as a result of technical examination, and mitigation measures were also updated accordingly as described below.

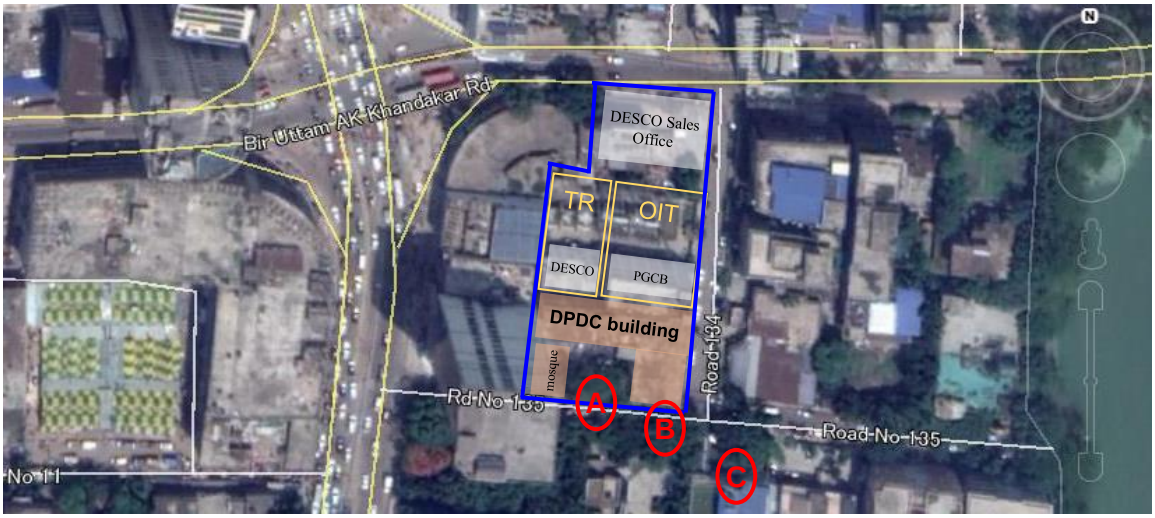
8.1.1 Pre-Construction Period

[1] The EMP presents mitigation measures and the EMoP is designed to collect specific parameters with which the effectiveness of mitigation measures are to be monitored periodically.

[2] Environmental Clearance for Installation of 132/33kV and 33/11 kV UG compact type SS in Gulshan Project under DESCO (No. 22.02.0000.091.72.151.16/458 dated 24/09/2017.

[3] The Project was under the red category, which may cause significant adverse environmental impacts, as listed in the *Environmental Conservation Rules (1997)* when the Data Collection Survey was conducted in 2016/17. However, the amendment of ECR in 2017 relaxed the requirements and now this project type is considered to be in the Orange B category, with moderately significant environmental impacts for which mitigation measures are easily identified. This no longer requires an EIA but does require an initial environmental examination (IEE) and EMP.

Prior to the construction of DESCO's UGSS, DPDC's building and mosque in the site (as in Figure 8-1 and Figure 8-2) shall be demolished as they are on the surface of the project site.



(Source) Google Earth (accessed in Jan 2019)

(Note) The Google Earth photo was taken in April 2018.

Figure 8-1 Present Layout of Substation Site

(Source) Google Earth (accessed in Feb 2019)

(Note 1) Left: mosque, bottom: DPDC building

(Note 2) The photo is as of Apr 2014.

(Source) The JICA Team

(Note 1) A bread stand in front of DPDC building

(Note 2) Photo was taken in Jan 2019.

Figure 8-2 Entrances on Road 135

In addition to demolishing the two structures, the contractor employed by DESCO will remove all the debris and prepare the land too prior to the construction of the UGSS. DESCO will reconfigure the distribution line before the EPC contractor starts the construction of the underground cable tunnel too. There is no pre-construction work anticipated on the route for the UGC.

Anticipated impacts during demolition and removal work, land preparation and distribution line reconfiguration are as described below. DESCO is encouraged to apply mitigation measures.

(1) Air Quality

The adverse impact is as anticipated at the timing of Data Collection Survey 2016/17. Dust will be generated due to the demolition of the DPDC building and mosque, and gas will be exhausted from machinery and vehicles which are used for carrying debris and other wastes from the site. To reduce particulate matters and exhaust gas, as well as prevent their diffusion in the surrounding area, the following mitigation measures are expected for minimization of air pollution.

- Optimize construction schedule
- Examine transportation route for construction vehicles
- Use low-emission equipment
- Spray water on access roads and construction site
- Build an enclosure around the DPDC building and mosque
- Use cover sheets on trucks for transportation of debris
- Conduct periodic maintenance and management of all construction machinery and vehicles

Air quality standards in Bangladesh are stipulated in the SCHEDULE-2 of *the Environmental Conservation Rules 1997*, which is amended by *the Notification SRO 220-Law/2005* of 19 July 2005.

(2) **Water Quality**

Rainwater can mix with debris and other wastes. Waste water from toilet and kitchen facilities of the existing structures, and those from the labor shed shall be taken care of. To prevent water pollution at the demolition site and its surrounding area, the below measures are considered:

- Cover demolition site to minimize rainwater mixed with demolition wastes
- Settle tanks for excessive construction sludge & waste water
- Install proper drainage to WASA drainage for treatment
- Connect to WASA's sewage line to send waste water to its sewage treatment plant from the site

They do not practice on-site water treatment in Dhaka. They collect waste water and directly discharge it into the WASA line. It is therefore important to confirm whether the above preventive measures for water pollution will be effective and that no waste water leaks from the site.

Standards for inland surface water and drinking water are stipulated in the SCHEDULE-3, with those for sewage discharge in the SCHEDULE-9 of *the Environmental Conservation Rules 1997*.

(3) **Waste**

In Bangladesh, facilities such as window frames, doors, rebars and steel frames are carefully removed from the demolished structures for reuse or resale, and only those which cannot be reused are hammered. Debris is often recycled as a construction material by smashing it into pieces.

The majority of waste generated from the demolition site will be industrial, which shall be handled by the contractor. Organic and human waste generated from the demolition site and labor shed will be collected by DNCC[4]. Hazardous wastes such as asbestos may be found and consultation with DNCC is recommended for their treatment.

Measures to be taken are the following:

- Separate wastes
- Reuse and recycle industrial wastes
- Reduce volume and weight of wastes by smashing and dehydrating them
- Dispose of non-recyclable waste according to DNCC rules
- Ask DNCC to sweep human waste from the site regularly
- Treat hazardous waste under the related regulations
- Ban on-site waste incineration/illegal dumping

Standards for waste from industrial units or project waste in Bangladesh are stipulated in the SCHEDULE-10 of *the Environmental Conservation Rules 1997*.

[4] As stipulated in the Local Government (City Corporation) Amended Act 2009, DNCC is responsible for collecting solid waste from domestic homes, businesses, hospitals, streets, public toilets and drains. They give permission to primary collection services to provide door-to-door waste collection from households/van services. (Dhaka North City Corporation, http://old.dncc.gov.bd/waste-management-department/, accessed in Feb 2019.)

(4) Soil Quality

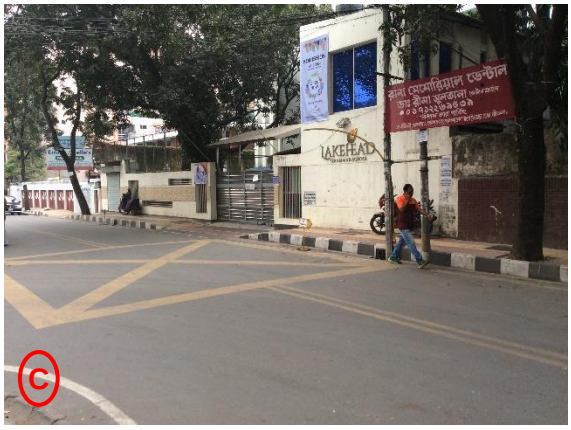
If runoff water from the demolition site or human and organic waste water leaks into the soil, the soil will become contaminated. Spillage oil and chemical substances generated during demolition work from construction machinery and vehicles may also affect the soil quality.

The following measures shall be taken to avoid or mitigate soil pollution:

- Cover the demolition site to prevent leakage of waste water
- Settle tanks for excessive construction sludge & waste water
- Install proper drainage to DWASA drainage for treatment
- Collect organic waste separately
- Connect to WASA's sewage line to send waste water from the site
- Install septic tanks for domestic facilities at labor shed
- Ask DNCC to sweep human waste from the site regularly
- Trap spillage oil and chemical substances at the demolition site for treatment

(5) Noise and Vibrations

Noise and vibrations due to construction machinery and equipment, and transportation vehicles and trucks will be caused. There are schools on Road No. 135, so demolition work shall be optimized to reduce the levels of noise and vibrations so as not to cause a nuisance during school hours. Heavy trucks will only be allowed to enter into Dhaka during the night time, and the transportation of large volumes of waste, conducted during the night time, shall be optimized and carefully planned since there are an event hall and residential apartments on Road No. 135 too.



(Source) The JICA Team
(Note 1) Right: school, left bottom: event hall.
(Note 2) Photo was taken in Jan 2019.

Figure 8-3 School and event hall (Road 135)

To reduce the levels of noise and vibrations and avoid disturbing local activities, mitigation measures are recommended as below:

- Optimize construction schedule
- Examine effective construction schedule in terms of period and time
- Use low-noise/low vibration machinery and equipment
- Abide by the traffic rules and speed limits
- Examine transportation route for construction vehicles
- Limit working hours and choose appropriate times

Standards for sound are stipulated in *the Bangladesh Sound Pollution (Control) Rules 2006*[5].

(6) Offensive Odors

Organic wastes and human wastes often generate odors if they are not properly sealed or treated, or kept for a long time at the same place without regular collection. Those wastes generated from the demolition site and labor shed shall be collected by DNCC. Mitigation measures are the same as those for waste treatment as described in the above (3).

Standards for odors in Bangladesh are stipulated in the SCHEDULE-8 of *the Environmental Conservation Rules 1997*.

[5] The Noise Pollution (Control) Rules 2006 say that the acceptable sound limit in silent areas is 50 dB for the daytime (6AM to 9PM) and 40dB for night (9PM to 6AM). In residential areas these limits are 55dB and 45dB; in mixed areas, 60dB and 50dB; in commercial areas, 70dB and 60dB; and in industrial areas, 75dB and 70dB.

(7) **Existing Social Infrastructure and Services**

Shifting of social infrastructure and services around the substation site and its adjacent road shall be conducted. DESCO shall request rearrangement, relocation and removal of existing utilities' facilities to avoid service interruptions, such as Titas Gas for gas facilities, DWASA for the water supply, drainage and sewage, BTCL for telecom cables and the dish authority for satellite communication. DESCO shall pay for the costs of shifting such facilities.

(8) **Land Use**

Temporary restriction of access in the surrounding area and traffic blocking during the demolition work will be required for safety reasons. Such restrictions will be imposed while heavy trucks enter the site, which will only take place during night time. So as not to disturb local activities, prior public notice of demolition work and its schedule shall be given to schools, residential apartments and institutions in the surrounding area.

(9) **Working Environment (including Occupational Safety)**

Demolition and removal of existing facilities may cause labor accidents. DESCO will reconfigure the distribution lines prior to construction of the underground cable tunnels, and labor accidents such as electric shocks while switching distribution lines are anticipated.

Organized demolition work and schedule will prevent the collapse of structures. Safety education and protective equipment shall be provided to workers. A labor accident prevention manual shall also be prepared. Protective facilities and equipment to prevent electric shocks shall be applied.

8.1.2 Construction Period

Soil excavation will take place at the substation site, followed by construction of the UGSS and installation of transformers and associated facilities. The site area for the UGSS is now smaller than the original plan in the Data Collection Survey 2016/17, since a 3-meter wide clearance to the neighboring building is now being considered for excavation and soil retaining purposes, which has made it difficult to install the cooling system underground. A standing type of 20 cooling units is now planned for on the fifth story of superstructure.

(Source) Google Earth (accessed in Jan 2019)

(Note) Google Earth photo was taken in April 2018.

Figure 8-4 Layout of DESCO's UGSS

Underground cable will be extended from the Gulshan UGSS to the existing Rampura SS, for as long as 2.866km.

Anticipated impacts during the construction period and mitigation measures which EPC contractors shall practice are as described below.

(1) Air Quality

Dust will be generated from construction work at the substation site as well as the ROW of the UGC. Transportation of soil will also cause dust diffusion. Exhaust gas will be emitted from machinery used at construction sites and by transportation vehicles. Air quality standards in Bangladesh are stipulated in the SCHEDULE-2 of *the Environmental Conservation Rules 1997*, which is amended by *the Notification SRO 220-Law/2005* of 19 July 2005. *IFC standards for ambient air quality*[6] shall also be referred to, to ensure the mitigation measures meet the international requirements.

The following mitigation measures shall be considered to reduce particulate matters and exhaust gas, as well as prevent their diffusion in the surrounding area.

- Optimize schedule for soil excavation and civil work
- Examine route of vehicles for construction and transportation
- Use low-emission equipment
- Spray water on access roads and construction site
- Build an enclosure around the construction site
- Use cover sheets on trucks for soil transportation
- Conduct periodic maintenance and management of all construction machinery and vehicles

(2) Water Quality

Rainwater can mix with excavated soil and construction wastes. Waste water from toilets and the kitchen facilities of the labor shed shall be taken care of. The below mitigation measures are considered to reduce and prevent water pollution.

- Cover excavation site to minimize the amount of rainwater mixing with excavated soil
- Pump up rainwater (or underground water) from the excavation site
- Settle tanks for excessive construction sludge & waste water
- Install proper drainage to WASA drainage for treatment
- Connect to WASA's sewage line to send waste water to its sewage treatment plant from the site

The effectiveness of prevention measures shall be confirmed, and no waste water shall be allowed to leak from the site to prevent soil contamination. Standards for inland surface water and drinking water are stipulated in the SCHEDULE-3, and those for sewage discharge in the SCHEDULE-9 of *the Environmental Conservation Rules 1997*. *IFC General EHS Guidelines for wastewater and ambient water quality* shall be referred to when environmental monitoring is conducted.

Although part of the UGC's ROW, Bashtola Lake Road runs along Gulshan Lake, which is designated as an Ecologically Critical Area (ECA). The JICA Team has found that the construction and installation work for the UGC will do no harm to the Lake as a result of interviews with local contractors and visits to on-going construction sites. Excavation work is planned on the UGC route, but it will last only for a few weeks at each section and soil will be transferred within a day and recycled for land reclamation and land-filling. Dhaka's practice of directly sending waste water to DWASA's drainage and sewage line from construction sites will also be applied.

(3) Waste

Excavated soil and surplus soil, industrial waste from construction work, hazardous waste such as dry batteries, etc. and organic and human wastes from workers will be generated during the construction period. For wastes other than organic and human wastes, which are collected by DNCC, inappropriate waste disposal or wrong treatment shall be prevented. Soil is in demand for land reclamation and land-filling in Dhaka and its recycling is common. Consultation with DNCC is recommended for the treatment of hazardous wastes. Measures to be taken are the following:

- Separate wastes for appropriate collection

[6] IFC General Environmental, Health, and Safety Guidelines (Air Emissions and Ambient Air Quality): https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines (accessed in Feb 2019)

- Reuse and recycle industrial wastes and excavated soil
- Reduce volume and weight of wastes by smashing and dehydrating them
- Dispose of non-recyclable waste according to DNCC's rules
- Ask DNCC to sweep human waste from the site regularly
- Treat hazardous waste under the related regulations
- Ban on-site waste incineration/illegal dumping

Standards for waste from industrial units or project waste in Bangladesh are stipulated in the SCHEDULE-10 of *the Environmental Conservation Rules 1997*. *IFC General EHS Guidelines for waste management and hazardous materials management* shall also be referred to.

(4) Soil Quality

The excavation work is expected to reach a depth of up to approximately 30 meters, and a massive amount of soil will be collected. Not only naturally occurring substances, but anthropogenic releases of wastes and oil, as a result of historic and current site activities, may be found in the soil[7]. Soil is in demand for land reclamation in Dhaka and it is important to screen soil concentrations of pollutants and make sure there is no risk to human health or ecological receptors before it is transferred.

Aside from this, runoff water or human and organic waste water may flow into the excavated place or accumulate at the construction site, causing soil contamination. Spillage oil and chemical substances generated from construction machinery and vehicles may also affect the soil quality.

The following measures shall be taken to avoid or mitigate soil pollution, and *IFC General EHS Guidelines for contaminated land* shall be referred to.

- Check quality of excavated soil before disposal and consult with DNCC if it is contaminated
- Cover the excavation site to prevent leakage of waste water
- Settle tanks for excessive construction sludge & waste water
- Install proper drainage to DWASA drainage for treatment
- Collect organic waste separately
- Connect to WASA's sewage line to send waste water from the site
- Install septic tanks for domestic facilities at labor shed
- Ask DNCC to sweep human waste from the site regularly
- Trap spillage oil and chemical substances at the demolition site for treatment

Although waste water is to be sent to WASA's sewage treatment plant through its line, there can be leakages within the site. Periodic monitoring of soil quality is thus recommended throughout the construction period.

(5) Noise and Vibrations

Construction machinery and equipment, and transportation vehicles and trucks will cause noise and vibrations during the construction phase. There are schools on Road 135, and construction work shall be optimized to reduce the level of noise and vibrations so as not to cause a nuisance during school hours. Heavy trucks will only be allowed to enter into Dhaka during the night time, and the transportation of large volumes of excavated soil, conducted during the night time, shall be optimized and carefully planned since there are an event hall and residential apartments on Road 135 too.

To reduce the level of noise and vibrations and avoid disturbing local activities, the below mitigation measures are recommended. *IFC General EHS Guidelines for noise management* shall be referred to.

- Optimize construction schedule
- Examine effective construction schedule in terms of period and time
- Use low-noise/low vibration machinery and equipment
- Abide by the traffic rules and speed limits
- Examine transportation route for construction vehicles
- Limit working hours and choose appropriate times

[7] Insulation oil for transformers often contains poly chlorinated biphenyl, PCB, and it contaminates soil when it is released. It is not listed in *the ECR 1997* as pollutant, but it is indicated as a hazardous material in *the IFS General EHS Guidelines*.

Sound standards are stipulated in *the Bangladesh Sound Pollution (Control) Rules 2006*, and the noise level guidelines in *the IFC General EHS Guidelines for noise management* shall also be referred to.

(6) **Offensive Odors**

Organic wastes and human waste generated from the labor shed shall be collected by DNCC. Mitigation measures are the same as those for waste treatment as described in the above (3).

Standards for odors in Bangladesh are stipulated in the SCHEDULE-8 of *the Environmental Conservation Rules 1997*.

(7) **Stability of Surrounding Structures**

Excavation up to a depth of 30 meters may cause foundation failure and displacement of the neighboring structures and such impacts must be avoided. During this SAPI, 3-meter wide setbacks to the surrounding plots and roads have been planned for excavation and soil retaining purposes. Soil loss shall be prevented by stabilizing slopes in the excavated area with concrete if necessary and appropriate. Periodic monitoring of surrounding structures will be required.

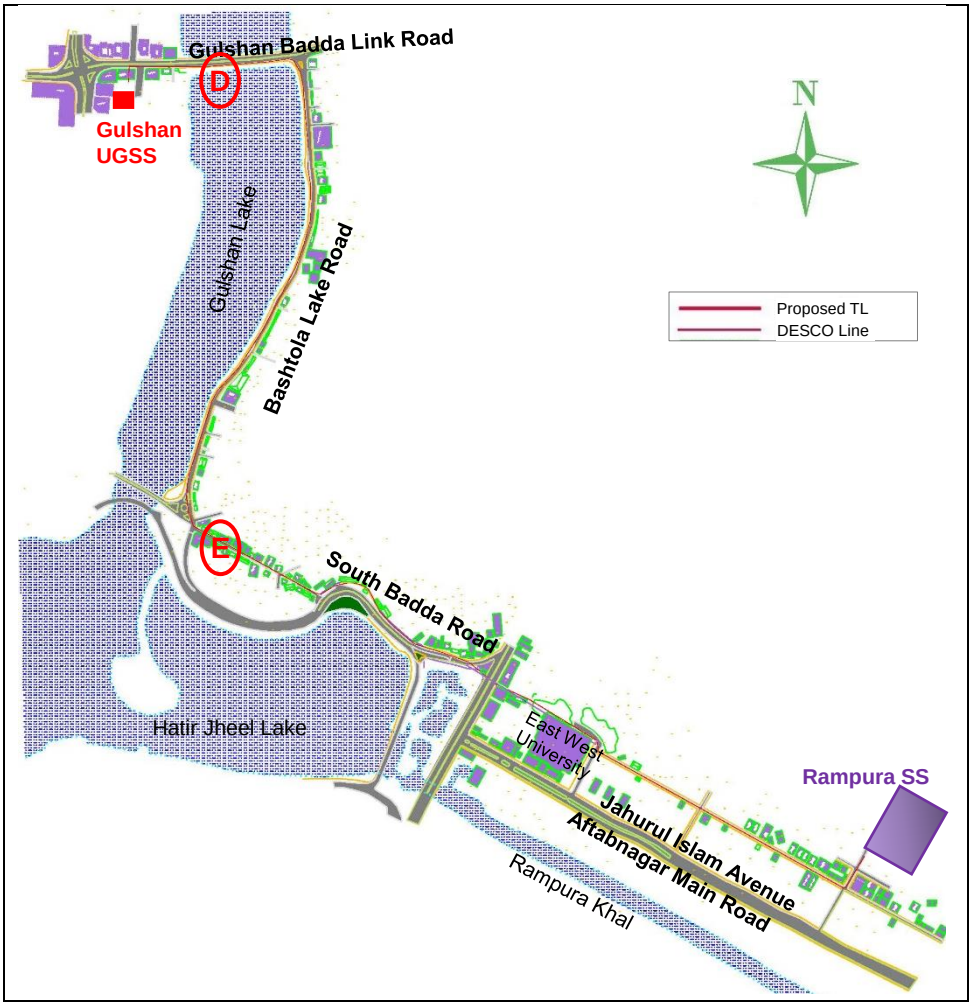
(8) **Land Use**

The area surrounding the UGSS site will face temporary access restrictions and traffic blocking for safety reasons while heavy trucks are in use during the night time. So as not to disturb local activities, prior public notice of the construction schedule shall be given to schools and residential apartments and institutions nearby.

The following mitigation measures are recommended to minimize adverse impacts on local activities:

- Land use clearance from Dhaka Metropolitan Police (DMP) and DNCC
- Prior public notice of construction schedule
- Optimization of construction schedule
- Prior notice with local corporations and relevant people
- While excavation work is in progress, proper site coverage shall be implemented with a temporary fence so as not to endanger passers-by or traffic
- Create alternative sidewalks

The ROW of the UGC is planned to pass Road 134, Bir Uttam AK Khandakar Road, and Gulshan Badda Link Road, where numerous vehicles and passers-by are found throughout the day. Various local activities take place and the route is crowded due to day-to-day land and lake transportation (by foot, rickshaw, auto-rickshaw, vehicle, bus, and water taxi). Bir Uttam Ak Khandakar Road, which bridges Gulshan Lake, for instance, is packed with vehicles as well as thousands of passers-by and people waiting for the water taxi between Gulshan and Kawranbazar on Gulshan Lake every day (Figure 8-6). Small shops and garages are found along Bashtola Lake Road. South Badda Road is also crowded with street vendors, shopkeepers and passers-by (Figure 8-7).



(Source) The JICA Team

(Note) Total length of UGC is planned to be 2.866 km.

Figure 8-5 Proposed 132kV UNC Route (Gulshan UGSS to Rampura SS)

(Source) The JICA Team

(Note 1) People in a long queue waiting for water taxi
(Note 2) Photo was taken in Jul 2018.

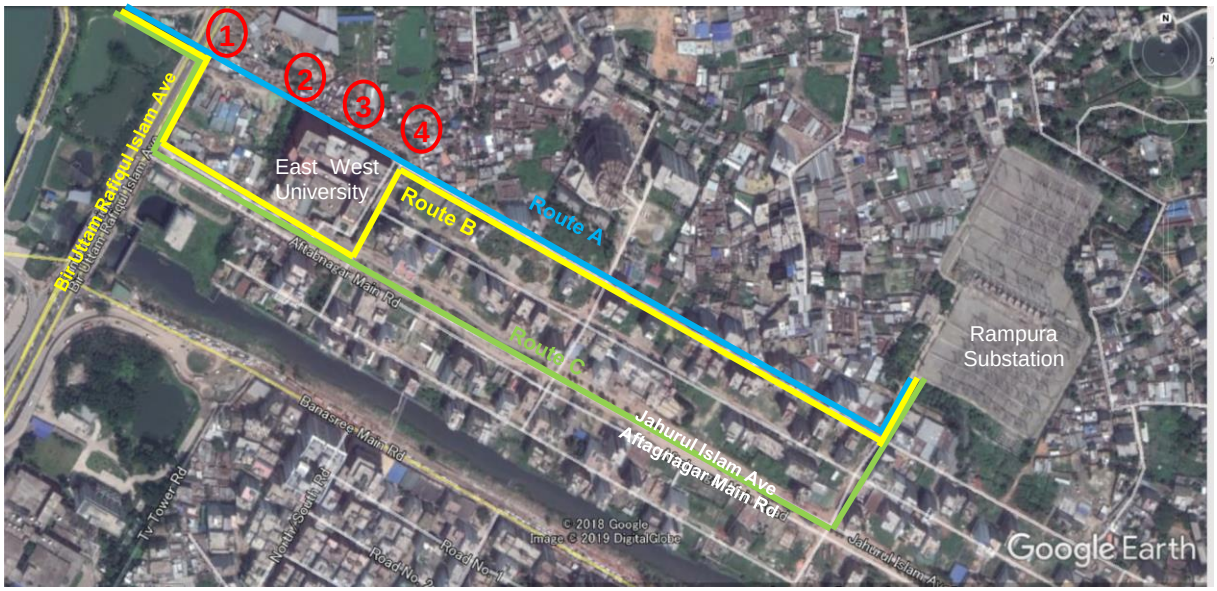
Figure 8-6 Gulshan Badda Link Road

(Source) The JICA Team

(Note 1) Most of the road has not been paved yet.
(Note 2) Photo was taken in Jul 2018.

Figure 8-7 South Badda Road

Between Bir Uttam Rafiqul Islam Avenue and Rampura Substation there are still three alternative routes that require further investigation during the ES, based on which DESCO will submit a land use clearance to DNCC for their approval.



(Source) Google Earth (accessed on 28 Jan 2019)

(Note) The photo is as of Apr 2018.

Figure 8-8 Alternative Routes for UGC ROW

Jahurul Islam Avenue and Aftabnagar Main Road run parallel, with a median strip in between. Both roads are wide, with two lanes that accommodate vehicles, passers-by and students from East West University.

Out of the alternative UGC routes, a narrow path accommodates a settlement between a transmission tower to the northeast of East West University and a fish market facing Bir Uttam Rafiqul Islam Avenue. The settlement has been growing and there were more than 100 structures there as of Jan 2019. All of them are temporary huts made of bamboo, wood, and iron sheets covered with cloths. Most people there seemed to be living as families.

The nature of UGC construction and installation requires only a few weeks of temporary requisition. However, the fact that the number of huts and people living in the settlement has been increasing day by day points to further growth until the commencement of construction work at this section. The JICA Team does not recommend choosing this path as part of UGC route, considering the following:

- The land belongs to DNCC and it is time-consuming to coordinate with them;
- Social impact is anticipated to be high and large-scale despite the fact that their resettlement will not be permanent; and
- It may be difficult and take time to get budget allocation for compensation, although the amount is not anticipated to be much, to meet the requirements of *the JICA Guidelines for Environmental and Social Considerations 2010* since it is beyond what is stipulated under *the Acquisition and Requisition of Immovable Property Ordinance 2017*[8].

[8] The JICA Guidelines require that occupants without tenure shall be eligible for compensation and assistance activities if they are confirmed to be there by the cut-off date.

Way out to the fish market.

They cover their structures with plastic sheets.

There is no water supply, sewerage or drainage network. Waste is dumped on the ground.

There are temporary structures, bikes and other facilities near the transmission tower.

(Source) The JICA Team

Figure 8-9 Photos of Local Settlement

(9) **Infectious Diseases**

A temporary influx of migrant laborers from outside Dhaka may increase the risk of infection. In addition to regular collection of organic and human waste by DNCC to maintain a favorable sanitation status at the construction site and labor shed, the following measures are necessary:

- Identify available clinics
- Implement periodic health check-ups for workers
- Provide health education and training for workers

(10) **Working Environment (including Occupational Safety)**

Excavation, construction and installation work may cause labor accidents such as falls to the ground and electric shocks. The following measures are recommended:

- Prepare a manual for labor accident prevention and safety education and training
- Provide workers with personal protection equipment (PPE)
- Inspect and ensure that all lifting devices, such as cranes, are appropriate for the expected loads
- Keep lifting devices well maintained and perform maintenance checks as appropriate during the construction period
- Use facilities and equipment that protect against electric shocks

(11) **Accidents**

Road traffic accidents may occur at any time if the construction work is not well organized or traffic management is not done properly and in harmony with the construction work. Abiding by traffic regulations, installation of traffic signs, education on safe driving, and training on safe operation of vehicles are expected.

8.1.3 Operation Period

After the completion of the UGSS's construction, DESCO will switch distribution lines back to the UGSS for its operation. Transformers and buildings that belong to DESCO and PGCB will also be

demolished for PGCB to develop another UGSS next to DESCO's. The superstructure will be built after that. Their plan, however, has not been fixed as of Jan 2019. All such work will take place after DESCO's UGSS starts operation.

(Source) Google Earth (accessed in Jan 2019)

(Note) Google Earth photo was taken in April 2018.

Figure 8-10 Future Layout of Substation Site

Anticipated impacts during the operation phase are as described below. DESCO is encouraged to apply mitigation measures.

(1) **Noise and Vibrations**

Twenty units of cooling facilities will be installed on the fifth level of the superstructure, which will generate noise and vibrations throughout the day and night. As there are schools on Road 135 and residential apartments nearby, covering the units and installing a sound-proof wall will mitigate the noise level and reduce adverse social impacts. Sound standards are stipulated in *the Bangladesh Sound Pollution (Control) Rules 2006*.

(2) **Working Environment (including Occupational Safety)**

Labor accidents during reconfiguration of distribution lines, and during O&M activities are anticipated. The following measures are recommended to DESCO:

- Keep a manual for labor accident prevention, including safety education and training
- Provide workers with PPE
- Proper maintenance of lifting equipment and tools, and conducting of safety checks prior to work
- Use facilities and equipment that protect against electric shocks

The updated environmental management plan, environmental monitoring plan and monitoring form are found as ANNEXES.

8.2 Conditions for the Environmental Clearance Certificate

The left column of the following table reproduces the DOE's conditions given to the ECC. They are for DESCO's actions during the construction and operation periods, but a few have been taken care of during the SAPI. The JICA Team's findings and analyses have been added next to the DOE's comments.

Table 8-1 Conditions given to ECC and Findings during SAPI

No	Conditions given in the ECC	JICA Team's findings & analyses
1	"The activities during construction and operation of the 132/33kV and 33/11kV UGSS shall not result in the loss of containment of any materials that would affect health or have a damaging impact on the environment or natural resources."	To be addressed by the ES Consultants during construction and operation stages.
2	"Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project activities."	To be addressed by the ES Consultants during construction stage.
3	"Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora or fauna is demolished or destroyed."	
4	"No solid waste can be burnt in the project area. An environmentally-friendly solid waste management plan should be in place during the entire project period in the field."	Taking the practices in Dhaka and facts about the site found below during the SAPI into consideration, the ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring: - It is the contractors who are to take out construction waste from their construction sites to the waste collection spots or dumping sites of Dhaka City Corporation (DCC). Such practices will be applied to this project too, so environmental education for contractors will play an important role. - They are to reuse or recycle as many facilities and materials as they can from the demolished buildings. - Waste collection is managed by DCC, including human waste. Project proponents are also to abide by the ECR 1997. However, the extent to which environmental pollution is avoided (or mitigated) owes a lot to each contractor's ESG policy and actions. - The UGSS site is small. The existing facilities within the UGSS site can catch fire if they burn solid waste there, since sufficient distance cannot be kept. Besides, construction work will be disturbed if solid waste accumulates for more than a day. - The ROW of the UGC extends to a crowded area with heavy traffic in the heart of Dhaka, which makes it unrealistic to burn solid waste on site.
5	"All the required mitigation measures suggested in the EIA report, along with the emergency response plan, are to be strictly implemented and kept operative/functioning on a continuous basis."	The JICA Team has found that pre-conditions for the Project have been changing since the Data Collection Survey 2016/17. As a result of technical coordination between the UGSS and superstructure, the UGSS design and layout is now being reconsidered, and further technical examination will be needed if PGCB makes its final decision to construct another UGSS next to DESCO's. The UGC has also been rerouted partly to avoid social impact. The JICA Team has revised some parts of the EMP based on such changes as above, as well as normal practices conducted at construction sites in Dhaka (see ANNEXES). The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
6	"Mitigation measures, along with EMP as described in the EIA report, should be strictly maintained."	
7	"In future, if any legitimate complaint is made regarding environmental pollution due to the Project's activities and if it is found to be valid by the DOE, the entrepreneur shall be required to take reasonable and appropriate mitigation measures/corrective measures as per DOE's	To be addressed by the ES Consultants during construction stage.

No	Conditions given in the ECC	JICA Team's findings & analyses
	requirements."	
8	"To reduce problems concerning traffic movement, construction work should preferably be performed during the night."	
9	"Resettlement plan should be properly implemented, and people should be adequately compensated."	No resettlement is so far anticipated as it has been carefully examined during SAPI.
10	"Construction material should be properly disposed of after the construction work has been completed."	Same as the above No. 4.
11	"All pollution control measures undertaken at this point as part of the infrastructural development should be maintained continuously."	The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
12	"To reduce dust, spraying of water over earthen materials should be carried out from time to time."	As written in the EMP and EMoP. The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
13	"As described in the EIA report, environmental monitoring should be strictly followed, and the monitoring report should be shared with DOE to ensure proper environmental management."	DESCO shall report to the DOE.
14	"In the case of any emergency, the following information shall immediately be reported to the Dhaka Metropolitan Office and Headquarters of DOE simultaneously: a) Nature of incident (fire, accident, etc.) b) Personnel affected (injured, missing, fatalities etc.)"	
15	"Rehabilitation for human resettlement or compensation for any sort of activity which will incur damage, or loss of public or private property or any natural resources shall be addressed as per GOB rules and regulations."	The degrees of such impact on the passers-by, residents, street vendors and shopkeepers along the UG cable route from Gulshan SS to Rampura SS vary but they are temporary. Temporary requisition of the UGC's ROW will take place during the construction phase, which will last a few weeks or a few months, section by section. Construction work will disturb local daily activities and cause traffic congestion on the ROW. The JICA Team has revised some parts of the EMP based on changes such as the above, as well as normal practices conducted at construction sites in Dhaka (see ANNEXES). The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
16	"No activity involving cutting/razing/dressing of hills or hilly land is endorsed under this clearance without due permission/clearance from the relevant GOB authority."	No hills or hilly land have been found in or along the project site and its surrounding area. If soil is required as a construction material, the excavated soil can be reused.
17	"If the project boundary passes through forest land, appropriate permission would be required from the forest department."	No forest land has been found in or along the project site and its surrounding area.
18	"The project authority shall extend active cooperation to DOE officials to facilitate their visits to the site as and when necessary."	DESCO shall report to the DOE.
19	"This clearance is valid only for the proposed installation of 132/33kV and 33/11kV UGSS as per the EIA report submitted to this department."	-
20	"This Environmental Clearance shall entitle the aforesaid entrepreneur to open LC for equipment."	DESCO will submit the ECC to open LC for equipment.
21	"Without prior approval from the DOE, no alteration/change can be made to matters already reported, such as location of the project boundaries, technology or operating process."	There has been no major alteration/change made during SAPI in terms of project location, technology or operating process, although there have been changes in design and layout. This matter shall be handled by the ES Consultant during construction too.

No	Conditions given in the ECC	JICA Team's findings & analyses
22	"As per *ECA 1995* and *ECR 1997*, prior approval from the DOE is needed in the case of further extension of project activities or further infrastructural build up."	Superstructure is planned for the surface of the UGSS within the site. DESCO will undertake an IEE for this as stipulated in the *ECA 1995* and *ECR 1997 (amended in 2017)*. The JICA Team will share all the findings and analyses relevant to environmental and social issues to coordinate with DESCO and the ES Consultant. DESCO will inform the DOE if there is any further extension of project activities or infrastructural build up.
23	"In installation of 132/33kV and 33/11kV UGSS, the project authority shall extend active cooperation to DOE officials to facilitate their visits to the site as and when necessary."	DESCO shall report to the DOE.
24	"This clearance is valid for one year from the date of issuance and the project authority shall apply for renewal to the Dhaka Metropolitan Office of DOE in Dhaka, with a copy to the DOE Head Office in Dhaka, at least 30 days ahead of expiry."	DESCO submitted the renewal application to DOE in Sep 2018.
25	"Violation of any of the above-mentioned conditions shall render this Environmental Clearance as void and legal action will be taken as per *ECA 1995* and *ECR 1997*."	-
26	"This ECC has been issued with the approval of the appropriate authority."	-

(Source: The JICA Team)

8.3 Recommendations

As DESCO plans to apply the building permit to the whole development plan (DESCO's UGSS, and PGCB's UGSS and superstructure), it will take some more time to become able to anticipate the adverse impacts caused by each item of construction work for PGCB's UGSS and superstructure, and the overall picture of cumulative impacts.

DESCO and ES consultants are recommended to work on such cumulative impacts, which must be reflected in the tender documents of EPC contractors.

Further technical coordination with the superstructure may require further changes/alterations in the layout, design or technical specifications, and the EMP shall be reviewed and updated accordingly.

Chapter 9. Revision of UGSS Project Schedule (DESCO)

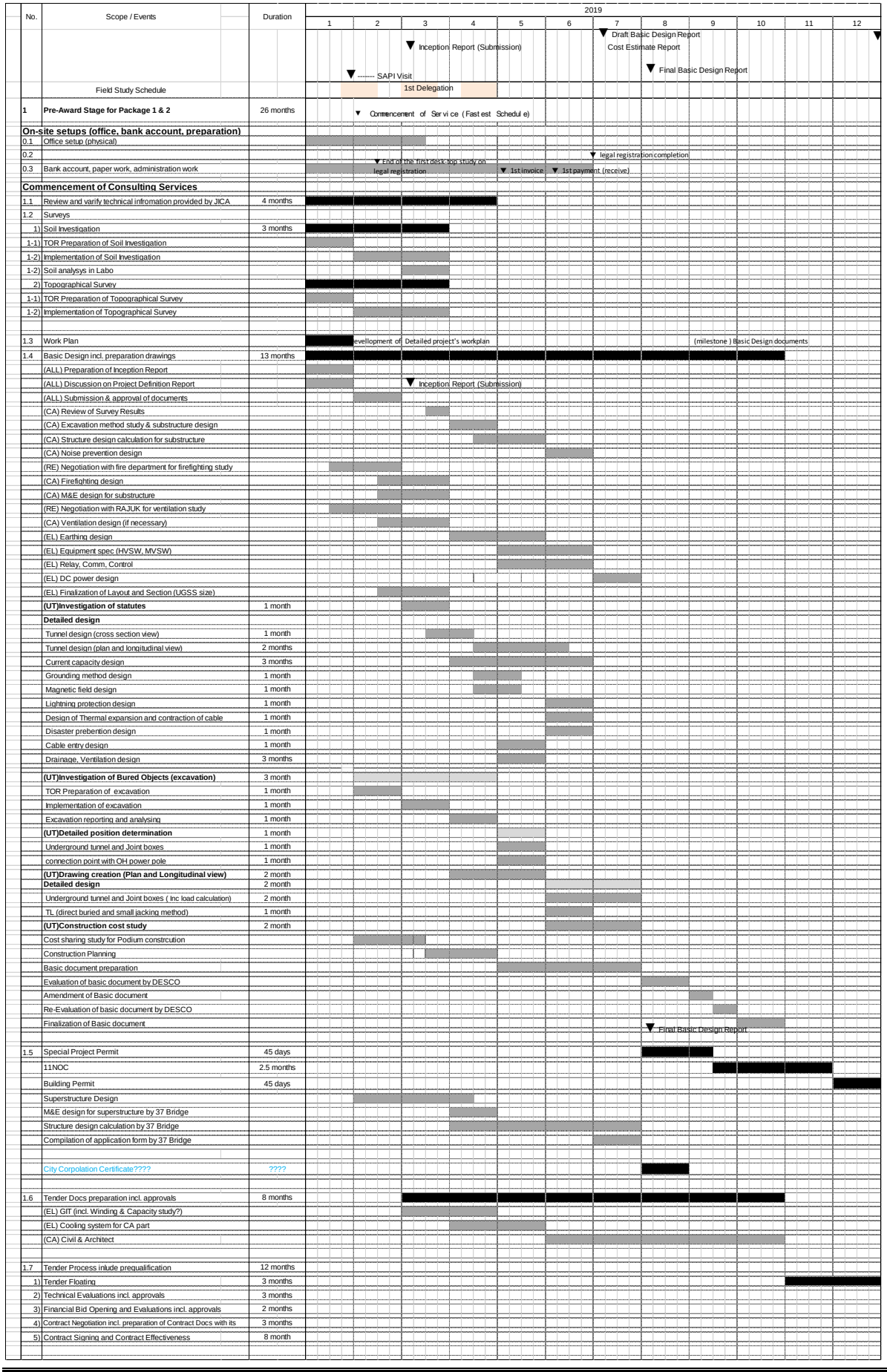
The JICA Team revised the schedule for the Engineering Services only for the early stages according to the current situation, such as the delay to hire the Engineering Services, re-start of trial excavation for buried objects and detour study on underground transmission lines. Excavation work in the rainy season should be taken into consideration in particular. The monsoon/rainy season in Bangladesh runs from June to October, when high levels of rainfall can lead to extensive flooding across Dhaka and much of the country. Ideally, the excavation should be programmed to minimize the amount of excavation work conducted during the rainy season. However, the following should also be taken into consideration:

- Flooding into the excavation area is considered a risk, and appropriate protection measures, including height level of walls and ground, and allowance for high capacity pumps, should be taken.
- The heavy rains will also cause issues for the general excavation and may interfere with the staging works (described below) if the ground is saturated to the point that it cannot be safely stockpiled in the small staging area. Where possible the excavation and the stockpiles should be covered to restrict excessive rain infiltration.

The impacts of the rainy season on the excavation work are to be further assessed at the detailed design stage.

In addition, high traffic volumes in the Gulshan area might affect the scheduling for transportation of excavated soil. Due to the high traffic volumes and site constraints at Gulshan, it will be necessary to construct a staging area where excavated soil can be stored during peak traffic hours and then removed at quieter times. However, given the tight constraints, such a staging area may need to be constructed over the excavation. This may be created by constructing a platform straddling the excavation, giving the added benefit of it functioning as a rain cover for that section.

The Engineering Service Consultant will have to review these points and modify their plans through discussions with DESCO.



No.	Scope / Events	Duration
1	**Pre-Award Stage for Package 1 & 2**	26 months
	On-site setups (office, bank account, preparation)	
0.1	Office setup (physical)	
0.2		
0.3	Bank account, paper work, administration work	
	Commencement of Consulting Services	
1.1	Review and varify technical infromation provided by JICA	4 months
1.2	Surveys	
1)	Soil Investigation	3 months
1-1)	TOR Preparation of Soil Investigation	
1-2)	Implementation of Soil Investigation	
1-2)	Soil analysys in Labo	
2)	Topographical Survey	
1-1)	TOR Preparation of Topographical Survey	
1-2)	Implementation of Topographical Survey	
1.3	Work Plan	
1.4	Basic Design incl. preparation drawings	13 months
	(ALL) Preparation of Inception Report	
	(ALL) Discussion on Project Definition Report	
	(ALL) Submission & approval of documents	
	(CA) Review of Survey Results	
	(CA) Excavation method study & substructure design	
	(CA) Structure design calculation for substructure	
	(CA) Noise prevention design	
	(RE) Negotiation with fire department for firefighting study	
	(CA) Firefighting design	
	(CA) M&E design for substructure	
	(RE) Negotiation with RAJUK for ventilation study	
	(CA) Ventilation design (if necessary)	
	(EL) Earthing design	
	(EL) Equipment spec (HVSW, MVSW)	
	(EL) Relay, Comm, Control	
	(EL) DC power design	
	(EL) Finalization of Layout and Section (UGSS size)	
	(UT)Investigation of statutes	1 month
	Detailed design	
	Tunnel design (cross section view)	1 month
	Tunnel design (plan and longitudinal view)	2 months
	Current capacity design	3 months
	Grounding method design	1 month
	Magnetic field design	1 month
	Lightning protection design	1 month
	Design of Thermal expansion and contraction of cable	1 month
	Disaster prebention design	1 month
	Cable entry design	1 month
	Drainage, Ventilation design	3 months
	(UT)Investigation of Bured Objects (excavation)	3 month
	TOR Preparation of excavation	1 month
	Implementation of excavation	1 month
	Excavation reporting and analysing	1 month
	(UT)Detailed position determination	1 month
	Underground tunnel and Joint boxes	1 month
	connection point with OH power pole	1 month
	(UT)Drawing creation (Plan and Longitudinal view)	2 month
	Detailed design	2 month
	Underground tunnel and Joint boxes (Inc load calculation)	2 month
	TL (direct buried and small jacking method)	1 month
	(UT)Construction cost study	2 month
	Cost sharing study for Podium constrcution	
	Construction Planning	
	Basic document preparation	
	Evaluation of basic document by DESCO	
	Amendment of Basic document	
	Re-Evaluation of basic document by DESCO	
	Finalization of Basic document	
1.5	Special Project Permit	45 days
	11NOC	2.5 months
	Building Permit	45 days
	Superstructure Design	
	M&E design for superstructure by 37 Bridge	
	Structure design calculation by 37 Bridge	
	Compilation of application form by 37 Bridge	
	City Corpolation Certificate????	????
1.6	Tender Docs preparation incl. approvals	8 months
	(EL) GIT (incl. Winding & Capacity study?)	
	(EL) Cooling system for CA part	
	(CA) Civil & Architect	
1.7	Tender Process inlude prequalification	12 months
1)	Tender Floating	3 months
2)	Technical Evaluations incl. approvals	3 months
3)	Financial Bid Opening and Evaluations incl. approvals	2 months
4)	Contract Negotiation incl. preparation of Contract Docs with its	3 months
5)	Contract Signing and Contract Effectiveness	8 month

Chapter 10. Explanation to Engineering Services (DESCO)

Based on the study in the SAPI, the JICA Team takes the following as items that the Engineering Service Consultant will especially take care of. The items are not limited to the following.

[Regulatory process for necessary approvals, Regulations and Design Codes applicable to UGSS]

- Project Schedule must be reviewed based on the current situation, such as the delay to hire the Engineering Service Consultant, start of trial excavation for buried objects and design coordination with superstructure, and necessary regulatory procedures to acquire the construction permission.
- In terms of deregulation of the superstructure height in the aerial law, supporting DPDC in the smooth implementation of the whole project is required to maximize the revenue from the superstructure business. If necessary, support requests to JICA etc. should also be considered. If DPDC achieves the waiver for a higher building, the Engineering Service Consultant will have to modify the structure due to the heavier load from the higher building.
- Underground substation design may be revised based on the statutory requirements, and relevant design codes and standards agreed with the authorities, so if necessary DESCO and DPDC must seek design waivers to establish UGSS design practices.
- M&E system for UGSS building design must be finalized in ES consultancy to satisfy relevant codes. In particular, mechanical ventilation system can be streamlined, and therefore the total project cost, by introducing the Japanese common corridor system for air supply.
- Dimensions of the emergency elevator, its elevator pit, and emergency power supply scheme must be coordinated with the superstructure.

[Construction conditions, constraints in plot usage]

- On-site geographical surveys and verification of neighboring buildings must be done to develop a proposed standard excavation method for bidding document FS, and availability of the construction machinery and necessary import procedures must be confirmed.
- Regardless of the applied method, D-wall or sheet-piling, quality requirements, methodology, on-site workspace planning, and monitoring plan must be studied to avoid any fatal consequences in the land excavation.

[Electric Design for UGSS]

- ES consultant will carry out further study on GIT and GIS installation to verify the feasibility of the layout, especially room size.
- Feasible coordination between the Civil Contractor and the Electrical Contractor: After the selection of manufacturers for each item of equipment, the Contractor who is eventually going to design the UGSS building must adjust the layout according to the actual equipment dimensions.

[Mechanical and Electrical Design for UGSS Building]

- Streamlining of M&E system applicable for UGSS must be sought to define new technical standards for firefighting and ventilation system specific to UGSSs in Bangladesh, as GIT is inflammable, and most of the UGSS compartments can be regarded as inhabitable except during maintenance work. For examples of technical requirements that may not applicable, BNBC requires sprinkler systems all the way to the corridor, and flame detectors for transformers, which may not operate properly because GIT does not create flames even in a malfunction.
- The ventilation ducting system must be designed with the following three variations for the pre-consultation and negotiation for the waiver with RAJUK's technical officers.
  1. The maximum depth of UGSS building must be determined along with the ducting system,

complying with BNBC standards.

2. Japanese common-air intake system using corridors must be introduced to streamline the project, and its cost.
3. In some extreme cases, a localized cooling system may be introduced for optimization of the project cost with optimized UGSS depth.

[Equipment Layout: Underground Substation]

- The Engineering Service Consultant will have to carefully consider the UGSS dimensions remodeling the existing substation, considering civil work methods between the cable shaft and the shrunken Kawranbazar substation structure. Necessary clearance should be fixed without any damage to the shrunken Kawranbazar SS.
- Design collaboration with the superstructure: the position of the common pillar, the arrangement of the cooling facility and the direction of the air exhaust are necessary.
- Considering the equipment and site conditions and other factors, the SAPI team strongly recommends the cooling equipment be located above the ground. Hence, the Engineering Service Consultant might re-design everything if the location of the cooling system is shifted from the ground floor to the underground portion.
- Building M&E design, and firefighting design should be finalized based on BNBC's standards and applicable technical waivers negotiated with authorities. The proposed water-cooling system must also be well harmonized into the superstructure design to avoid any adverse impacts on the surrounding environment. In particular, the application of GIS must be well explained to streamline necessary building facilities for the UGSS building.
- Necessary accessories and facilities below ground for the superstructure, such as sewage facility, elevator pits, hook for UGSS, and necessary ceiling clearance above the machine hatch, must be continuously discussed in order to be accommodated in the superstructure final design.

[Superstructure Design]

- The superstructure design must be reviewed and finalized by 37 Bridge for further study on the transposition and coordination of the earth retaining structure in the overall project site.
- O&M of the cooling system, cost sharing and construction procedure must be developed based on 37 Bridge's superstructure design and construction scheduling. Proper noise prevention measures must be applied to the elevated cooling fans on the superstructure's floor level. Heat dissipation from the cooling system may be simulated at the request of DESCO.

[Transmission line and its installation method]

- Detailed investigation on the buried objects must be done first, to identify who will be responsible for the relocation of the objects.
- DESCO must develop the load evacuation plan by considering the expected load increase, and available network to be switched over. If some buried objects are not removable during the construction of the tunnel, the protection method and construction method must be duly studied and agreed by the authorities concerned.
- Along the transmission route to Rampura substation, a power cable conduit system or piping system may be applied to the physically constrained portion for DESCO's implementation.
- If there are any the congested cables zone on the candidate transmission route, the Engineering Service Consultant might propose a ducting system.

[Project Scheduling, Cost estimation]

- Construction schedule for UGSS building and UG tunnel facilities around UGSS, and vertical shafts requires detailed project schedule coordination to share common workspaces.
- Considering aforementioned schedule co-ordination and delays in ES consultant appointments, their consequent design work, and the delay in superstructure design development, the entire project design must be re-negotiated with all stakeholders to create a more realistic and safer construction work procedures.
- Project Cost breakdown must be updated and reviewed based on the introduction of water-cooling system, GIT's detailed specifications (delta-Y), and increased cost for BNBC standard designs for the ventilation ducting system and firefighting facilities.

[Review and updates of Environmental Management Plan and Monitoring Plan]

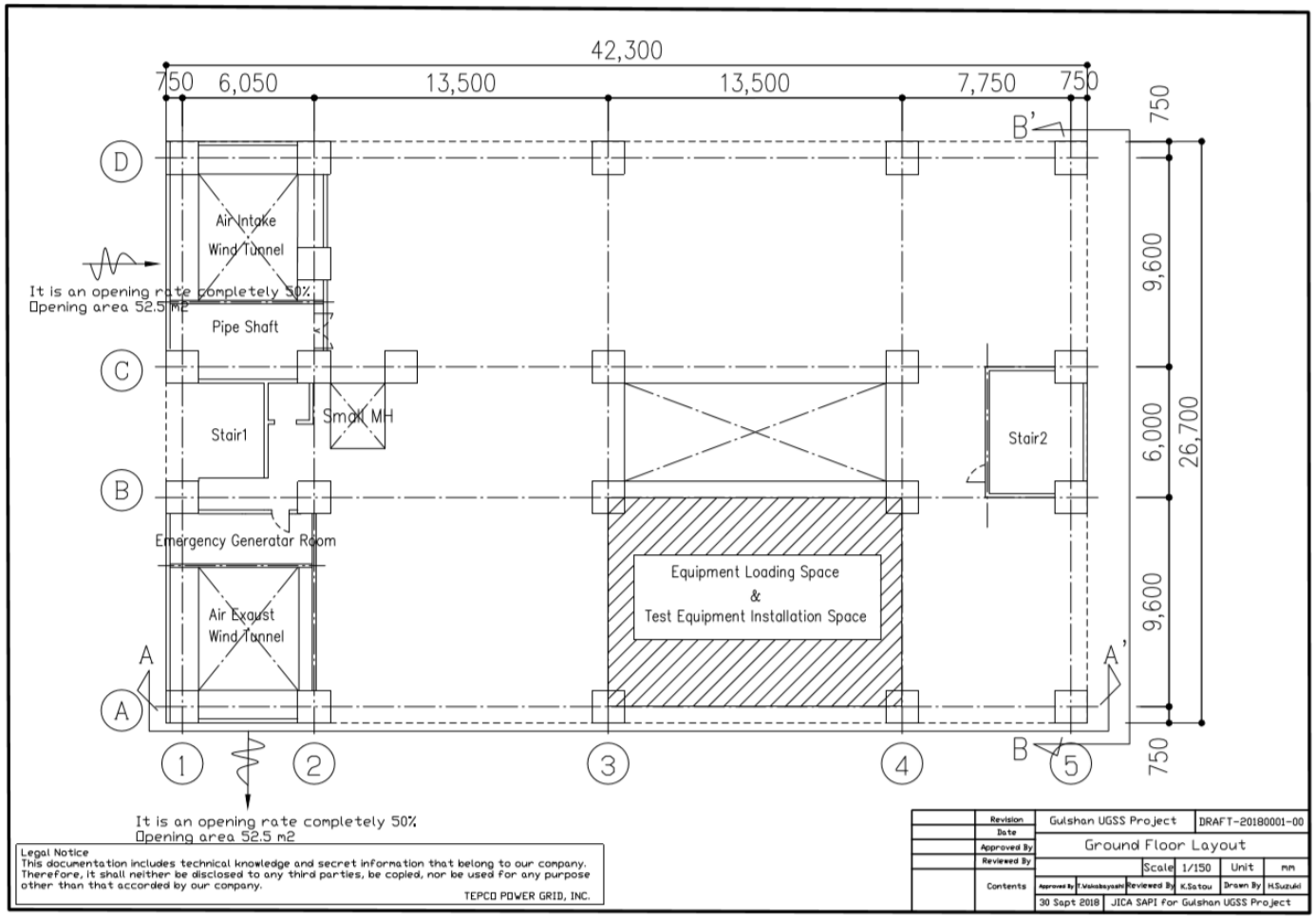
- It will take some more time to ascertain the adverse impacts caused by each item of construction work for PGCB's UGSS and superstructure, and the entire picture of cumulative impacts. DESCO and ES consultants are recommended to work on such cumulative impacts, which must be reflected in the tender documents of EPC contractors.
- Further technical coordination with superstructure may require further changes/alterations in the layout, design or technical specifications, and the EMP shall be reviewed and updated accordingly.

The Engineering Service Stage might require the following JICA support to keep the entire project on the right track.

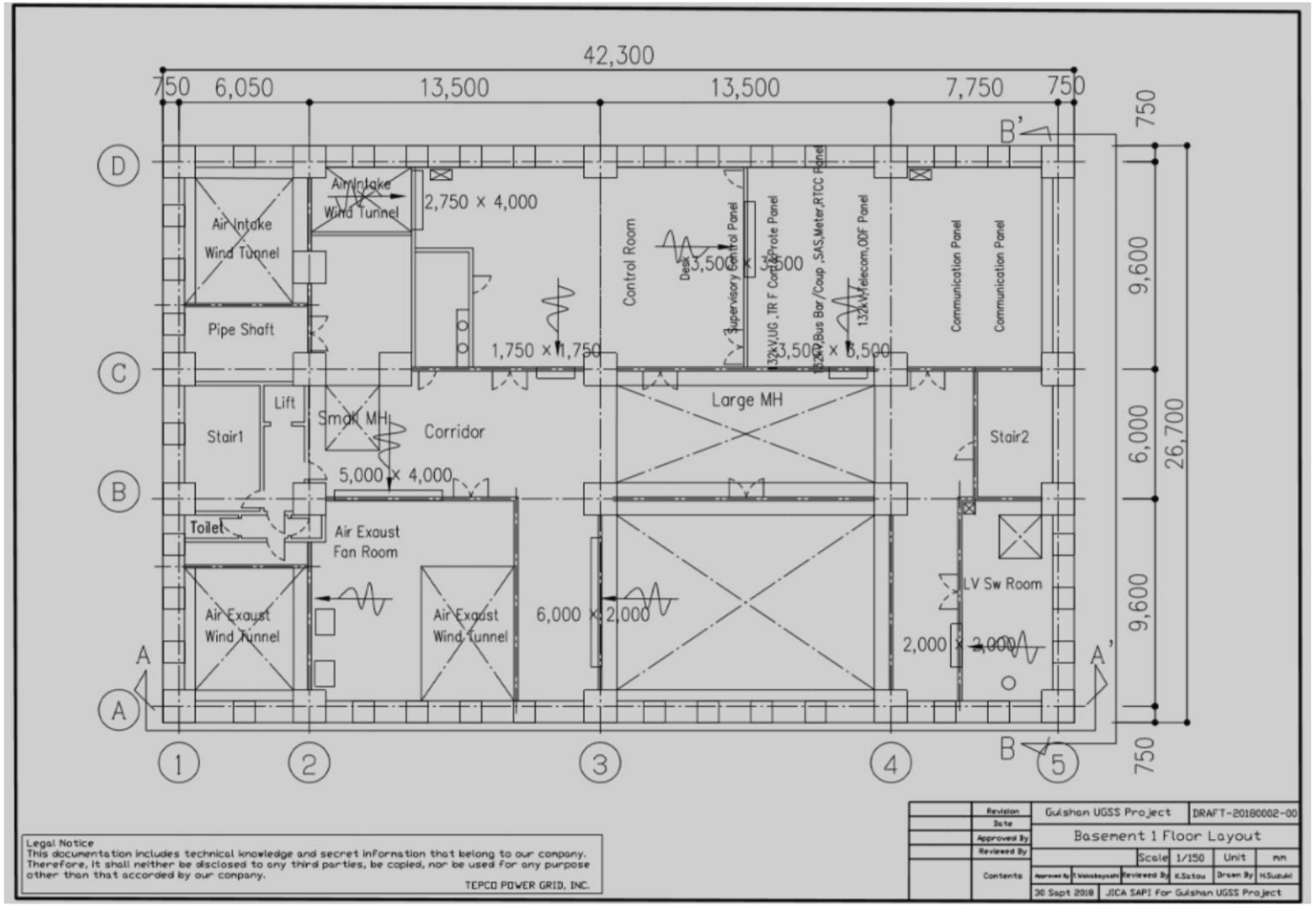
1. Advice on the project framework changes from JICA's viewpoint, esp. decision making, project cost monitoring, and scheduling
2. Support for regulatory clarification & negotiation for building design and construction by encouraging relevant authorities, and proposing appropriate method and timings for negotiation
3. Support for the ES Consultancy appointed, esp. bidding document development, and PQ conditions to be clarified
4. Technical assistance for PGCB's UGSS FS if requested

Appendix (DESCO)-1 Gulshan Substation Layout

(Ground Floor)



(B1 Floor)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Air Intake Wind Tunnel
Air Intake Wind Tunnel
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Pipe Shaft
1,750 x 1,750
Control Room
Supervisory Control Panel
Dem 3,500 x 3,500
132kV,UG ,TR F Cont&Prote Panel
132kV,Bus Bar /Coup ,SAS,Meter,RTCC Panel
132kV,Telecom,00F Panel
3,500 x 8,500
Communication Panel
Communication Panel
Large MH
Lift
Smal MH
Corridor
Stair1
Stair2
5,000 x 4,000
Toilet
Air Exaust Fan Room
Air Exaust Wind Tunnel
Air Exaust Wind Tunnel
6,000 x 2,000
LV Sw Room
2,000 x 2,000
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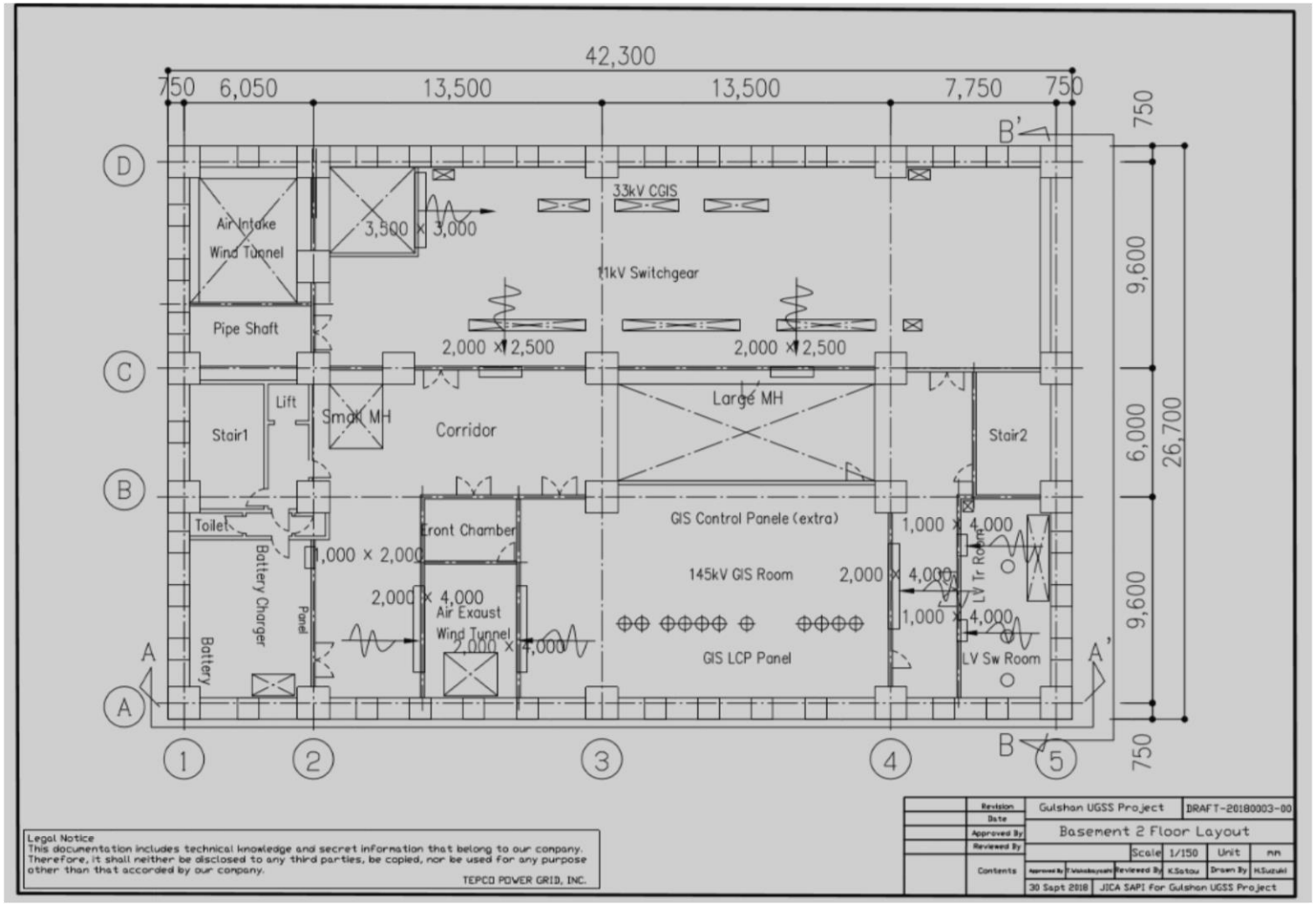
Revision
Date
Approved By
Reviewed By
Contents
Gulshan UGSS Project
DRAFT-20180002-00
Basement 1 Floor Layout
Scale 1/150
Unit mm
Approved by T.Yoshikoyoshi
Reviewed By K.Satou
Drawn By H.Suzuki
30 Sept 2018
JICA SAPI for Gulshan UGSS Project

(B2 Floor)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Air Intake
Wind Tunnel
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11kV Switchgear
Pipe Shaft
2,000 x 2,500
2,000 x 2,500
Lift
Smok MH
Corridor
Large MH
Stair1
Stair2
Toilet
Front Chamber
GIS Control Panele (extra)
1,000 x 4,000
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145kV GIS Room
2,000 x 4,000
LV Tr Room
2,000 x 4,000
Air Exaust
Wind Tunnel
2,000 x 4,000
1,000 x 4,000
Battery
Battery Charger
Panel
GIS LCP Panel
LV Sw Room
9,600
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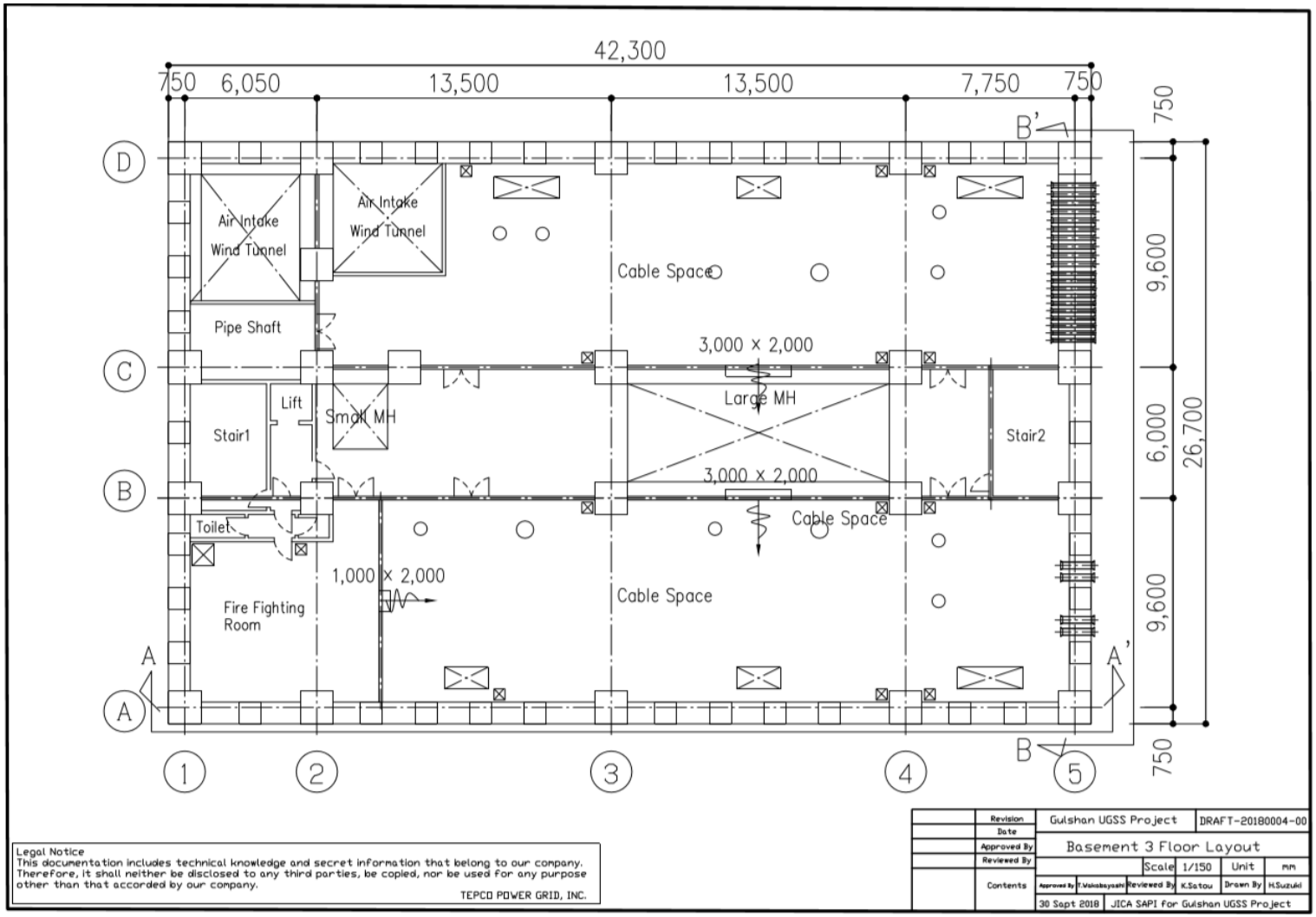
Basement 2 Floor Layout
Scale 1/150
Unit mm
K.Satou
H.Suzuki
30 Sept 2018
JICA SAPI for Gulshan UGSS Project

(B3 Floor)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Wind Tunnel
Air Intake
Wind Tunnel
Cable Space
Pipe Shaft
3,000 x 2,000
Large MH
Lift
Small MH
Stair1
Stair2
3,000 x 2,000
Cable Space
Toilet
1,000 x 2,000
Cable Space
Fire Fighting
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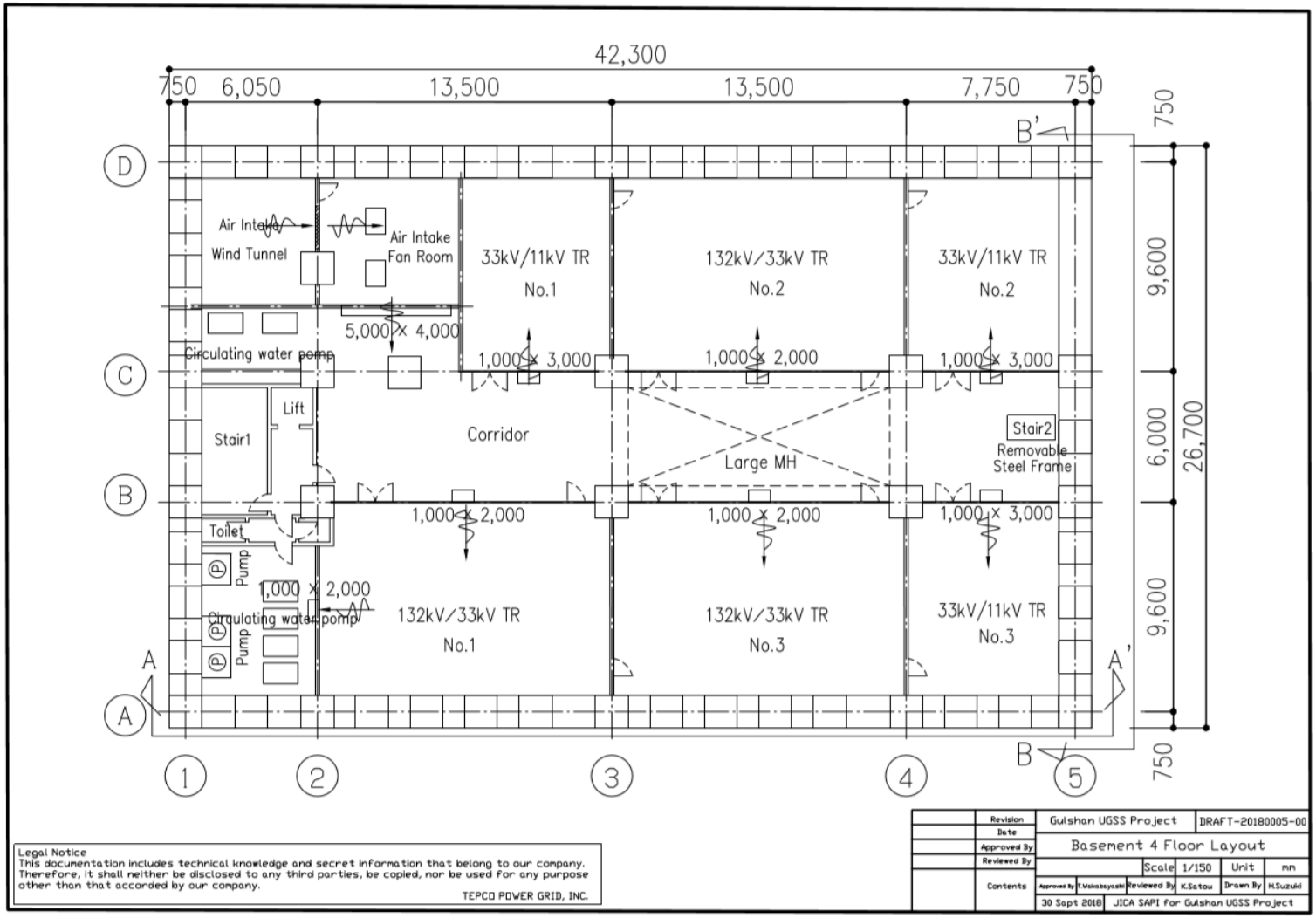
DRAFT-20180004-00
Basement 3 Floor Layout
Scale 1/150
Unit mm
Approved By T.Wakabayashi
Reviewed By K.Satou
Drawn By H.Suzuki
30 Sept 2018
JICA SAPI for Gulshan UGSS Project

(B4 Floor)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B'
Air Intake
Wind Tunnel
Air Intake
Fan Room
33kV/11kV TR
No.1
132kV/33kV TR
No.2
33kV/11kV TR
No.2
5,000 x 4,000
Circulating water pump
1,000 x 3,000
1,000 x 2,000
1,000 x 3,000
Lift
Stair1
Corridor
Large MH
Stair2
Removable
Steel Frame
1,000 x 2,000
1,000 x 2,000
1,000 x 3,000
Toilet
Pump
1,000 x 2,000
Circulating water pump
Pump
132kV/33kV TR
No.1
132kV/33kV TR
No.3
33kV/11kV TR
No.3
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DRAFT-20180005-00
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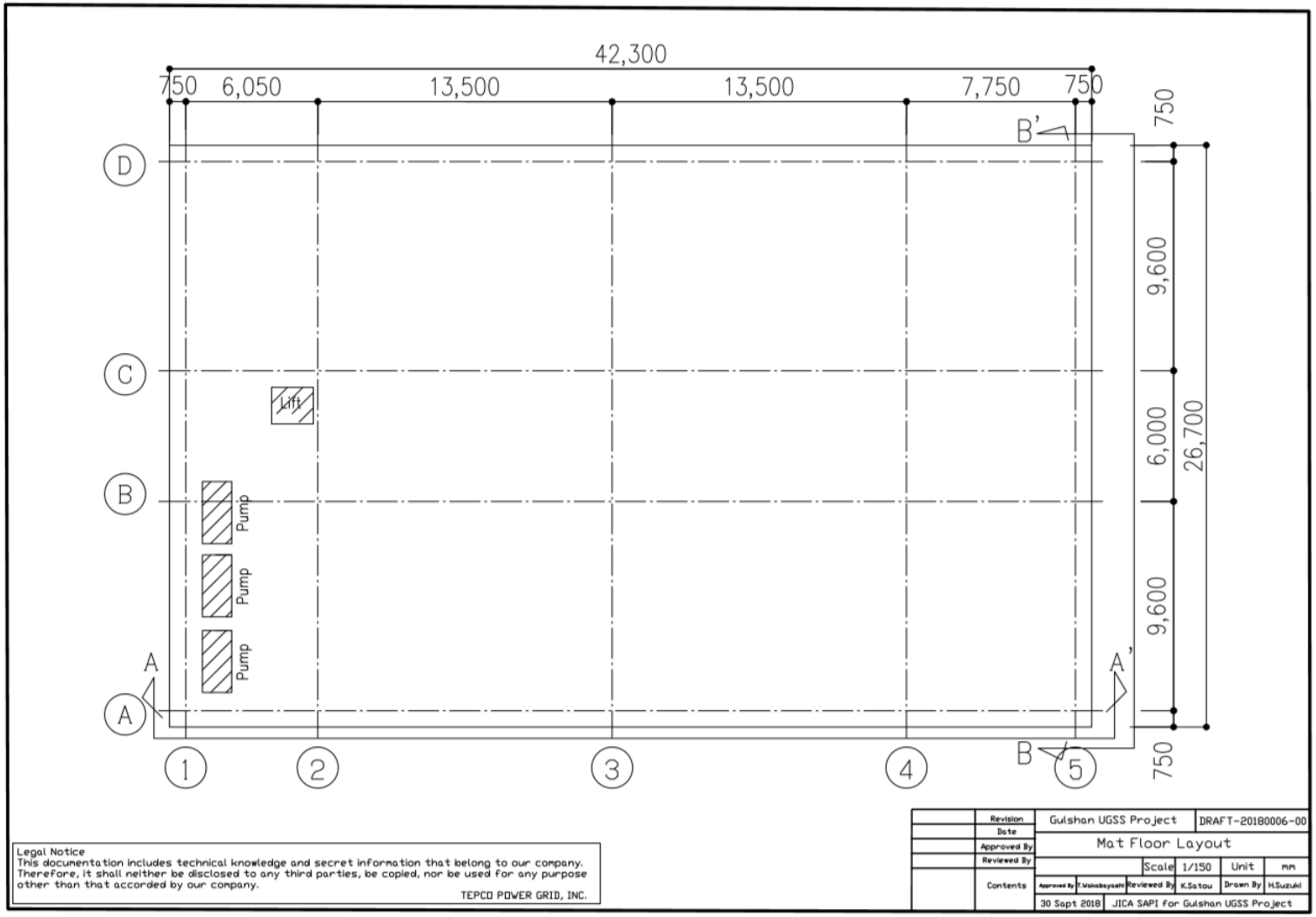
Scale 1/150
Unit mm
Approved By T.Wakabayashi
Reviewed By K.Satou
Drawn By H.Suzuki
30 Sept 2018
JICA SAPI for Gulshan UGSS Project

(MAT Floor)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Pump
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Gulshan UGSS Project
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Mat Floor Layout
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Unit mm
Approved By T.Wakabayashi
Reviewed By K.Satou
Drawn By H.Suzuki
30 Sept 2018
JICA SAPI for Gulshan UGSS Project

Appendix (DESCO)-2 Environmental Management Plan and Monitoring Plan

1. Environmental Management Plan (DESCO)

(1) Demolition of existing buildings, Removal, Land Preparation, Distribution Line Reconfiguration

Table 1: Environmental Management Plan (Demolition of Existing Buildings, Removal, Land Preparation, Distribution Line Reconfiguration)

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
1	Air Pollution	1) Dust at substation site from demolition work for the existing buildings	-Ambient Air Quality Standard	- Avoidance and reduction of dust dispersion and air pollution at the substation site and surrounding area	1) - Optimizing construction schedule - Spraying water on access roads and construction site - Enclosing around buildings to be demolished - Using cover sheet on trucks for debris transportation	<Location> Demolition and removal site <Period> Demolition and removal work phase	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
		2) Exhaust gas from machinery and vehicles used for carrying debris and other wastes			2) - Route examination for construction vehicles - Using low-emission equipment - Periodic maintenance and management of all construction machinery and vehicles			
2	Water Pollution	1) Runoff water from demolition site	- Wastewater standards	- Prevention of water pollution at the demolition site and surrounding area	1) Runoff water - Covering demolition site to minimize rainwater mixed with demolition wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution	<Location> Demolition and removal site, labor shed (temporary toilet site, and cooking & eating site) <Period> Demolition and removal work phase	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
		2) Domestic waste water from existing structures and labor shed			2) Domestic waste water - Connecting to DWASA's sewage line to send waste water from the site			
3	Waste	1) Domestic waste from workers	- Waste standards - Waste Management Rules of the DOE	- Prevention of inappropriate waste disposal	1) Domestic wastes - Separate waste and ask DNCC for collection and treatment - Reduction of volume and weight of wastes by dehydration	<Location> Demolition and removal site, labor shed (temporary toilet	<Implementation> Contractor hired by DESCO <Supervisor>	DESCO

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
					- Install septic tanks for domestic facilities at labor shed - Ask DNCC to sweep human waste from the site	site, and cooking & eating site) <Period> Demolition and removal work phase	DESCO	
		2) Industrial waste from demolition work and hazardous demolition waste such as asbestos			2) Industrial and hazardous wastes - Separate waste collection, and recycling & reuse of industrial wastes - Reduction of volume and weight of wastes by smashing them - Appropriate disposal of non-recyclable waste according to rules of Dhaka City Corporation - Treatment of hazardous waste under the related regulations - Ban of on-site waste incineration/illegal dumping			
4	Soil Pollution	1) Runoff water from demolition site	- Soil Quality standards	- Prevention of soil pollution at the demolition site and the surrounding area	1) Runoff water - Covering demolition site to minimize rainwater mixed with demolition wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution	<Location> Demolition and removal site, labor shed (temporary toilet site, and cooking & eating site) <Period> Demolition and removal work phase	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
		2) Domestic waste water of workers			2) - Collect organic waste separately - Connecting to WASA's sewage line to send waste water from the site - Install septic tanks for domestic facilities at labor shed - Ask DNCC to sweep human waste from the site			
		3) Spillage oil and chemical substances generated during demolition work from construction machinery and vehicles			3) Spillage oil and chemical substances should be trapped at the demolition site for treatment			

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
5	Noise and vibration	1) Noise and vibration from machinery and equipment 2) Noise and vibration from vehicles and trucks	- Noise level standards	- Reduction of noise level from demolition work	1) Machinery and equipment - Optimizing construction schedule - Effective construction schedule (period and time) - Using low-noise/low vibration machinery and equipment 2) Vehicles and trucks - Abide the traffic rule and limit speed - Route examination for construction vehicles - Limit working hours and choose appropriate times	<Location> Demolition and removal site <Period> Demolition and removal work phase	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
6	Offensive Odors	1) Domestic waste water of workers 2) Demolition of domestic facilities in the existing buildings	- Odor standards	- Prevention of offensive odors	1) Prepare septic tanks facilities for workers - Dispose of organic waste at the collection point - Ask DNCC to sweep human waste from the site regularly 2) Separate waste collection and treatment	<Location> Demolition and removal site, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
7	Existing Social Infrastructure and Services	Shift of social infrastructure and services around substation site and its adjacent road	-	- Consideration for services provided through the existing utility facilities (e.g. gas, water supply, telecom)	- Rearrangement, relocation, and removal of existing utilities' facilities to avoid service interruption. - Payment for shifting cost of existing facilities	<Location> Substation site and adjacent road <Period> Pre-construction phase (the removal will last until the project completion)	<Implementation> DESCO: power facility, Titas Gas (gas facility), WASA (water supply and sewage), BTCL (telecom cable), Dish authority (satellite communication) <Supervisor> DESCO	DESCO
8	Land Use (Land requisition around the substation site)	- Temporary access restriction and traffic increase	Temporary restriction of access in the surrounding area and traffic blocking during the demolition work	- Consideration for footpath, side road crossing etc. - Minimization of disturbances to the surrounding area	- Prior public notice of demolition work and its schedule	<Location> Gulshan UGSS site <Period> During demolition work (temporary)	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
9	Working Environment (including Occupational Safety)	1) Labor accidents during demolition and removal of existing facilities 2) Labor accidents while switching distribution lines	- Handling heavy loads - Electric shocks	- Prevention measures for labor accidents, accidents and health problems - Prevention of collapse of the existing buildings	- Prepare a manual for labor accident prevention, including safety education and training - Provide workers with appropriate protective equipment - Use facilities and equipment that protect against electric shocks	<Location> Demolition and removal site <Period> Demolition and removal work phase	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO

(Source: The JICA Team)

(2) Construction period

Table 2: Environmental Management Plan (Construction Period)

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
1	Air Pollution	1) Dust in substation site as well as ROW of transmission line sites 2) Exhaust gas from construction machinery and vehicles used for equipment and transportation	-Ambient Air Quality Standard	- Avoidance and reduction of dust dispersion and air pollution at the construction site and surrounding area	1) Particulate matter reduction: - Optimizing construction schedule - Spraying water on access roads and construction site - Enclosing around construction site - Using cover sheet on trucks for soil transportation 2) Prevention of exhaust gas - Route examination for construction vehicles - Using low-emission equipment - Periodic maintenance and management of all construction machinery and vehicles	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor
2	Water Pollution	1) Runoff water from construction site 2) Domestic waste water of workers	- Wastewater standards	- Prevention of water pollution at the construction site and surrounding construction area	1) Runoff water - Covering construction site to minimize rainwater mixed with excavated soils and wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution 2) Domestic waste water - Connecting DWASA's sewage line to send waste water from the site	<Location> Construction area, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its Engineering Consultant	Expenses included in contract cost by Contractor

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
3	Waste	1) Industrial waste from construction work	-Waste standards - Waste Management Rule of the DOE	- Prevention of inappropriate waste disposal	- Separate waste collection, and recycling & reuse of industrial wastes - Appropriate disposal of non-recyclable waste according to rules of Dhaka City Corporation - Ban of on-site waste incineration/illegal dumping - Install septic tanks for domestic facilities at labor shed - Ask DNCC to sweep human waste from the site	<Location> Construction area, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor
		2) Domestic waste from workers						
		3) Hazardous waste such as dry batteries, etc.			- Treatment of hazardous waste under the related regulations			
		4) Excavated soil and surplus soil	- Soil Management Rule	- Appropriate treatment and effective use of generated soil	Appropriate recycle & reuse of excavated soil			
4	Soil Pollution	1) Runoff water from demolition site	- Soil standards	- Prevention of soil pollution at the construction site and surrounding area	1) Runoff water - Covering construction site to minimize rainwater mixed with wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution	<Location> Construction area, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor
		2) Domestic waste water of workers			2) - Collect organic waste separately - Connecting to WASA's sewage line to send waste water from the site - Install septic tanks for domestic facilities at labor shed - Ask DNCC to sweep human waste from the site			
		3) Spillage oil and chemical substances generated from construction machinery and vehicles			3) Spillage oil and chemical substances should be trapped at the demolition site for treatment			

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
		4) Excavated soil and surplus soil	- Soil Management Rule	- Appropriate treatment and effective use of generated soil	- Risk assessment of excavated soil to human health or ecological receptors - Appropriate recycling & reuse of uncontaminated soil			
5	Noise and vibration	1) Noise and vibration by machinery and equipment	- Noise level standards	- Reduction of noise level from construction activities	1) Machinery and equipment - Optimizing construction schedule - Effective construction schedule (period and time) - Using low-noise/low vibration machinery and equipment	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor
		2) Noise and vibration by vehicles and trucks			2) Vehicles and trucks - Abide by the traffic rules and speed limits - Route examination for construction vehicles - Limit working hours and choose appropriate times			
6	Offensive Odors	1) Domestic waste from workers	- Odor standards	- Prevention of offensive odors	- Install septic tank at domestic facilities of labor shed - Dispose of organic waste at the collection point - Ask DNCC to sweep human waste from the site regularly	<Location> Labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
7	Stability of surrounding structures	Excavation work	-	Minimization of impact and safety of surrounding structures against foundation failure and displacement	- Preventing soil loss by stabilizing slopes in the construction site with concrete if necessary and appropriate - Install retaining walls	<Location> Construction area and its proximity <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor
8	Land Use	- Temporary access restriction to the surrounding area of substation site - Access restriction to the construction site on the transmission line's ROW	- JICA Guidelines for Environmental and Social Considerations (2010) - Temporary restriction of access to the surrounding area and traffic management	- Consideration for footpath, sidewalk, crossing etc. - Minimization of disturbances to the surrounding area - Consideration for land/property owners - Compensation for the existing	- Land use clearance from Dhaka Metropolitan Police (DMP) and Dhaka City Corporation - Prior public notice of construction schedule - Optimization of construction schedule - Prior notice with local corporations and relevant people - Conduct household survey and interviews, and examination of	<Location> Gulshan UGSS site, ROW of UGC route <Period> During requisition and installation work	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
				structures in the surrounding area (if any) - Consideration for livelihood activities and employment	compensation and other assistance packages, and implementation of public consultation (in case there are local people affected by the construction work) - While excavation work is in progress, proper site coverage shall be done with temporary fence in order not to do harm to passers-by or car traffics. - Create alternative sidewalks			
9	Infectious Diseases	- Temporary influx of migrant laborers from outside Dhaka during construction may increase risk of infection	Occupational Health and Safety	- Consideration of sanitation of local area	- Identify available clinics - Implement periodic health check-ups for workers - Provide health education and training for workers	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor
10	Working Environment (including Occupational Safety)	Labor accidents	- Handling heavy loads - Electric shocks	- Prevention measures for labor accidents, accidents, and health problems	- Prepare a manual for labor accident prevention, including safety education and training - Provide workers with appropriate protective equipment - Inspect and ensure that any lifting devices, such as cranes, are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate during the construction period - Use facilities and equipment that protect against electric shocks	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor
11	Accidents	LRoad traffic accidents	LRoad traffic accidents	Prevention of traffic accidents	- Abide by traffic regulations, installation of traffic signs and education on safe driving - Training on safe operation of vehicles	<Location> Substation construction area and ROW of UGC route <Period> During construction phase	<Implementation> Contractor <Supervisor> DESCO and its ES Consultant	Expenses included in contract cost by Contractor

(Source: The JICA Team)

(3) Operation Period

Table 3: Environmental Management Plan (Operation Period)

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
1	Noise and vibration	Noise and vibration from operation of cooling system	- Noise level standards	- Reduction of noise level	- Covering the cooling system and installation of sound-proof wall	<Location> Superstructure <Period> During operation phase	DESCO	DESCO
2	Working Environment (including Occupational Safety)	1) Labor accidents while switching distribution lines	- Handling heavy loads (e.g. Power cables) - Oxygen deficiency - Electric shocks (power cables, equipment operation)	- Prevention measures for labor accidents, accidents, and health problems	- Prepare a manual for labor accident prevention, including safety education and training - Provide workers with appropriate protective equipment - Proper maintenance for lifting equipment & tools, and conducting of safety checks prior to work. - Use facilities and equipment that protect against electric shocks	<Location> Worksites for distribution line reconfiguration <Period> Distribution line reconfiguration phase	DESCO	DESCO
		2) Labor accidents in Operation and maintenance activities				<Location> O&M venues <Period> During O&M work		

(Source: The JICA Team)

2. Environmental Monitoring Plan (DESCO)

(1) Demolition of existing buildings, Removal, Land Preparation, Distribution Line Reconfiguration

Table 4: Environmental Monitoring Plan (Demolition of Existing Buildings, Removal, Land Preparation, Distribution Line Reconfiguration)

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
1	Air Quality	1) Dust resulting from demolition work 2) Exhaust gas from construction machinery and vehicles	SO2, NO2, PM10, PM10, PM2.5, Ambient Air Quality Standard	- Collect baseline data - Evaluate the effect of mitigation measures for air pollution	<Method of data collection & analysis> Sample collection and laboratory analysis <Location> Demolition and removal site <Duration & frequency> a) Once prior to demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
2	Water Quality	1) Runoff water from construction site 2) Domestic waste water of workers	Temperature, pH, oil, coliform, Wastewater standards	Evaluate the effect of mitigation measures for water pollution	<Method of data collection & analysis> Sample collection and laboratory analysis <Location> Demolition and removal site <Duration & frequency> a) Once upon demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
3	Waste	1) Domestic waste from workers 2) Industrial waste from demolition work and hazardous demolition waste such as asbestos	Waste Management Rules	Evaluation of effect of mitigation measures for wastes	<Method of data collection & analysis> Record of kinds and quantity of waste, and treatment method <Location> Demolition and removal site <Duration & frequency> Continuous records	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
4	Soil Pollution	1) Runoff water from demolition site 2) Domestic waste water of workers 3) Spillage oil and chemical substances generated during demolition work from construction machinery and vehicles	Soil Quality standard	Evaluation of effect of mitigation measures for soil contamination	<Method of data collection & analysis> Sample collection of soil pollutants and laboratory analysis <Location> Demolition and removal site <Duration & frequency> a) Once prior to demolition work b) Once upon completion of demolition and removal work	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
5	Noise and Vibration	1) Noise and vibration by machinery and equipment 2) Noise and vibration by vehicles and trucks	Noise level, and Noise level standards	- Collect baseline data - Evaluate the effect of mitigation measures for noise	<Method of data collection & analysis> Measurement using noise level meter <Location> Demolition and removal site <Duration & frequency> a) Once upon demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
6	Offensive Odors	1) Domestic waste water of workers 2) Demolition of domestic facilities in the existing buildings	Waste Management rules	Evaluate the effect of mitigation measures for odors	<Method of data collection & analysis> Record odors, causes, venues and treatment methods <Location> Demolition and removal site <Duration & frequency> Continuous records	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
7	Existing Social Infrastructure and Services	Shift of social infrastructure and services around substation site and its adjacent road	Rearrangement, relocation, and removal of existing utilities (e.g. gas, water supply, and telecommunication)	For smooth implementation of rearrangement, relocation, and removal of existing utilities	<Method of data collection & analysis> Spot visiting and meetings with concerned stakeholders <Location> Venues of rearrangement, relocation and removal of existing utilities at substation site and adjacent road <Duration & frequency> Upon rearrangement, relocation and removal work	<Implementation> DESCO: power facility, Titas Gas (gas facility), WASA (water supply and sewage), BTCL (telecom cable), Dish authority (satellite communication) <Supervisor> DESCO	DESCO
8	Land Use	- Temporary access restriction and traffic increase	- Media for prior notice - No. of prior notices - No. of access restrictions	- Consideration for footpath, sidewalk, crossing etc. - Minimization of negative impact on the surrounding area	<Method of data collection & analysis> Spot visiting <Location> Substation site and surrounding area <Duration & frequency> During demolition work (temporary)	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO
9	Work Environment (Including Work Safety)	1) Labor accidents during demolition and removal of existing facilities	- No. of handling heavy loads - No. of labor accidents including electric shocks	- Evaluate the effect of work safety plan	<Method of data collection & analysis> Record of labor accidents <Location> Contractor's office <Duration & frequency> Record continuously and monitor once a year	<Implementation> Contractor hired by DESCO <Supervisor> DESCO	DESCO

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
		2) Labor accidents during distribution line reconfiguration				DESCO	DESCO

(Source: The JICA Team)

(2) Construction Phase

Table 5: Environmental Monitoring Plan (Construction Phase)

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
1	Air Quality	1) Dust resulting from construction work 2) Exhaust gas from construction machinery and vehicles	SO2, NO2, PM10, PM10, PM2.5, Ambient Air Quality Standard	- Evaluate the effect of mitigation measures for air pollution	<Method of data collection & analysis> Sample collection and laboratory analysis <Location> Substation site <Duration & frequency> a) Once prior to demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
2	Water Quality	1) Runoff water from construction site 2) Domestic waste water of workers	Temperature, pH, oil, As, coliform, Wastewater standards	Evaluate the effect of mitigation measures for water pollution	<Method of data collection & analysis> Sample collection of surface water (waste water) and groundwater, and laboratory analysis <Location> Substation site <Duration & frequency> Quarterly for surface water and biannually for groundwater	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
3	Waste	1) Industrial waste from construction work 2) Domestic waste from workers 3) Hazardous waste such as dry batteries, etc. 4) Excavated soil and surplus soil	Waste Management Rules	Evaluate the effect of mitigation measures for wastes	<Method of data collection & analysis> Record of kinds and quantity of waste, and treatment method <Location> Substation site <Duration & frequency> Continuous records	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
4	Soil Pollution	1) Runoff water from demolition site 2) Domestic waste water of workers 3) Spillage oil and chemical substances generated from construction machinery and vehicles	Soil standards	Evaluate the effect of the mitigation measures for soil contamination	<Method of data collection & analysis> Sample collection of soil pollutants and laboratory analysis <Location> Substation site <Duration & frequency> Once upon the commencement of construction work	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
5	Noise and Vibration	1) Noise and vibration by machinery and equipment 2) Noise and vibration by vehicles and trucks	Noise level, and Noise level standards	Evaluate the effect of mitigation measures for noise	<Method of data collection & analysis> Measurement using noise level meter <Location> Substation site <Duration & frequency> a) Once upon the commencement of construction work	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
					b) Quarterly c) Every time when specific works which cause unusual noise and vibration are conducted that may affect the public		
6	Offensive Odors	Domestic waste from workers	-Waste Management rules	Evaluate the effect of mitigation measures for odors	<Method of data collection & analysis> Record odors, causes, venues and treatment methods <Location> Substation site <Duration & frequency> Continuous records	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
7	Stability of Surrounding structures	Excavation work	- Design and layout - Building condition - Inclination condition - Subsidence condition	- Collect baseline information and data - Evaluate the influence on the surrounding structures	<Method of data collection & analysis> - Confirm the conditions of surrounding structures - Record changes in their conditions (if any) according to the progress of construction work <Location> Surrounding structures of substation site <Duration & frequency> a) Once before excavation work b) Once upon completion of excavation work c) Once upon completion of the whole of UGSS construction work	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
8	Land Use	- Temporary access restriction to the surrounding area of substation site - Access restriction to the construction site on the transmission line's ROW	- No. of access restrictions - No. of affected structures - No. of affected households, family members and their livelihood status	- Consideration for footpath, sidewalk, crossing etc. - Minimization of negative impact on the surrounding area - Consideration of negative impact on the affected households (if any)	<Method of data collection & analysis> Traffic management, progress monitoring for land requisition, record of consultation with affected households <Location> Substation site and ROW of UGC route <Duration & frequency> Prior to the requisition, continuous record	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
9	Infectious disease	- Deterioration of laborer health - Spreads of infectious diseases	Health conditions of laborers	-Monitor health condition	<Method of data collection & analysis> Health check-ups <Location> Contractor's office <Duration & frequency> Record continuously and monitor twice a year	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor
10	Work Environment (Including Work Safety)	- Labor accidents	- No. of handling heavy loads - No. of labor accidents including electric shocks	- Evaluate the effect of work safety plan	<Method of data collection & analysis> Record of labor accidents <Location> Contractor's office <Duration & frequency>	<Implementation> Contractor	Expenses included in contract cost by Contractor

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
					Record continuously and monitor once a year	<Supervisor> DESCO & ES Consultant	
11	Accidents	LRoad traffic accidents	LRoad traffic accidents	- Evaluation of effect of traffic schedule	<Method of data collection & analysis> Record of road traffic accidents <Location> Contractor's office <Duration & frequency> Record continuously and monitor once a year	<Implementation> Contractor <Supervisor> DESCO & ES Consultant	Expenses included in contract cost by Contractor.

(Source: The JICA Team)

(3) Operation Period (Distribution line reconfiguration and O&M for UGSS and UG cables)

Table 6: Environmental Monitoring Plan (Operation Phase)

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
1	Noise and vibration	Noise and vibration by operation of cooling system	- Noise level standards	Evaluate the effect of mitigation measures for noise	<Method of data collection & analysis> Measurement using noise level meter <Location> Substation site <Duration & frequency> Periodic O&M	DESCO	DESCO
2	Work Environment (Including Work Safety)	1) Labor accidents while switching distribution lines 2) Labor accidents in Operation and maintenance activities	- Handling heavy loads - Oxygen deficiency - Electric shocks	Evaluate the effect of work safety plan	<Method of data collection & analysis> Record of labor accidents <Location> DESCO's office <Duration & frequency> Record continuously and monitor once a year	DESCO	DESCO

(Source: The JICA Team)

3. Monitoring Form

The following items should be monitored periodically during each phase.

(1) Demolition work for existing buildings, distribution line switching and land leveling

1) **Air quality**

(Frequency) a) When commencing the demolition work b) Every month (in the first two months), c) Set the frequency after two months based on the monitoring results.

(Date & Time)

(Location)

(Work content and volume, etc.)

(Monitoring results & evaluation)

Monitoring Parameter	Unit	Value (short-term exposures)	Results	Standards for Air in Bangladesh*	IFC Standard for Air	Evaluation
SO2	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		365	125 (ITM1)	
CO	mg/m3	1hr (Max)		40		
	mg/m3	8hrs		10		
NO2	µg/m3	1hr (Max)			200 (guideline)	
	µg/m3	24hrs (average)		-	-	
PM10	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		150	150 (ITM1)	
PM2.5	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		65	75 (ITM1)	

Note: Schedule-2 Air Quality Standards, Environmental Conservation Rules 1997 (dated 28 Aug 1997) (amended by the Notification SRO 220-Law/2005 (dated 16 July 2005)).

(Meteorological Conditions)

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

2) **Water quality (Discharge wastewater)**

(Frequency) 1) When commencing the demolition work 2) Every month (in the first two months), 3) Set the frequency after two months based on the monitoring results.

(Date)

(Location)

Note: Monitoring shall be conducted at the discharge point of waste water treatment facilities.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Remarks (measurement method)
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	
Arsenic (As)	mg/L		0.2	0.05	-	
Total fecal coliform	MPN/ 100mL		-	-	400	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).
Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.
Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

3) **Waste**

(Frequency) Continuously

(Unit: ton/gm)

Month	Sample Date	Kinds of Waste (Quality)			Rate of recycling/Reuse (%)		Remarks
		Industrial	Domestic	Hazardous	Industrial	Domestic	
		(A)	(B)	(C)	(A)	(B)	

4) **Soil conditions**

(Frequency) a) When commencing the demolition work (Baseline data) b) When completing the demolition work (collect those parameters detected at the baseline only)
(Date)
(Location)
Note: Monitoring shall be conducted at the demolition site.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Countermeasures and Notes
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Countermeasures and Notes
			Inland surface water*	Public sewage system*		
Arsenic (As)	mg/L		0.2	0.05	-	
Total fecal coliform	MPN/ 100mL		-	-	400	
Chromium (hexavalent)	Mg/l		0.1	1.0	-	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).
Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.
Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

5) **Noise**

(Frequency) a) When commencing the demolition work b) Every month (in the first two months), c) Set the frequency after two months based on the monitoring results.
(Date)
(Location)

(Unit: dBA)

Result		Bangladesh Noise Standards*					IFC Noise Level Guidelines*		Evaluation	Remarks
		A	B	C	D	E	A & B	D & E		
	Day	50	55	60	70	75	55	70		
	Night	40	45	50	60	70	45	70		

(Note 1) Area categories are: A: Silent zone, B: Residential zone, C: Mixed zone (mainly residential area, and also commercial and industrial areas), D: Commercial zone, D: Industrial zone
(Note 2) "Day" and "Night" of Bangladesh Noise Standards indicate 6AM to 9PM, and 9PM to 6AM respectively, whereas those of IFC Guidelines are 7AM to 10PM, and 10PM to 7AM.
(Note 3) Noise level of IFC Guidelines is L_{Aeq} per hour.

(Meteorological Conditions**)**

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

6) **Odors**

(Frequency) Continuously during the work period
(Date)
(Location)

Specific malodorous substance	Odor index	Source	Measure	Remarks

7) **Existing Social Infrastructure and Services**

Conduct site monitoring upon relocating, reconfiguring and removing the existing service facilities
(Frequency) When relocating, reconfiguring and removing service infrastructure

	ROrganization responsible	Date of work	Location	Situation	Remarks
Electricity line	DESCO				
Gas pipeline	Titas Gas				
Water pipeline	WASA				
Sewage pipeline	WASA				
Telecommunication line	BTCL				
Satellite/dish antenna line	Dish Authority				
Others					

8) **Land use**

Means of prior notice and information sharing about the demolition work and its schedule, venues of such notice and meetings, contents of discussions shall be recorded.
(Frequency) Continuously recorded.

Date	Means	Venue	Contents and Actions	Remarks

9) **Work Environment**

- Periodic monitoring of safety measures (implementation of training, provision of protection equipment, etc.)

(Frequency) Continuously recorded, monitor once a year.

Date	Name of safety measures	Venue	Contents	Remarks

- Periodic monitoring of labor accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Place	Cause of accident	Action	Remarks

(2) During Construction Period

1) **Air quality**

(Frequency) a) When commencing the construction work b) Every month (in the first two months), c) Set the frequency after two months based on the monitoring results.
(Date)
(Location)
(Work content and volume, etc.)

(Monitoring results & evaluation)

Monitoring Parameter	Unit	Value (short-term exposures)	Results	Standards for Air in Bangladesh*	IFC Standard for Air	Evaluation
SO2	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		365	125 (ITM1)	
CO	mg/m3	1hr (Max)		40		
	mg/m3	8hrs		10		
NO2	µg/m3	1hr (Max)			200 (guideline)	
	µg/m3	24hrs (average)		-	-	
PM10	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		150	150 (ITM1)	
PM2.5	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		65	75 (ITM1)	

Note: Schedule-2 Air Quality Standards, Environmental Conservation Rules 1997 (dated 28 Aug 1997) (amended by the Notification SRO 220-Law/2005 (dated 16 July 2005).

(Meteorological Conditions)

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

2) **Water quality**

- Surface Water (Discharge wastewater)

(Frequency) Once every three months
(Date)
(Location)
Note: Monitoring shall be conducted at the discharge point of waste water treatment facilities.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Remarks (measurement method)
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	
Arsenic (As)	mg/L		0.2	0.05	0.1	
Total fecal coliform	MPN/ 100mL		-	-	400	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).
Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.
Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

▸ Groundwater
(Frequency) Once every six months
(Date)
(Location)

Monitoring Parameter	Unit	Results	Bangladesh Standards for drinking water	Remarks (measurement method)
Temperature	℃		20 - 30	
pH	-		6.5 – 8.5	
Oil & grease	mg/L		0.01	
Arsenic (As)	mg/L		0.05	
Total fecal coliform	MPN/ 100mL		0	
Groundwater level	meter			
Chromium (hexavalent)	Mg/l		0.05	

Note 1: Schedule-3 Standards for Water, (B) Standards for drinking water, Environmental Conservation Rules 1997 (dated 28 Aug 1997).

3) **Waste**

(Frequency) Continuously

(Unit: ton/gm)

Month	Sample Date	Kinds of Waste (Quality)				Rate of recycling/Reuse (%)			Remarks
		Industrial (A)	Domestic (B)	Hazardous (C)	Soil (D)	Industrial (A)	Domestic (B)	Soil (D)	

4) **Soil conditions**

(Frequency) When commencing the construction work (collect those parameters detected at the baseline only)
(Date)
(Location)
Note: Monitoring shall be conducted at substation site.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Countermeasures and Notes
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	
Arsenic (As)	mg/L		0.2	0.05	-	
Total fecal coliform	MPN/ 100mL		-	-	400	
Chromium (hexavalent)	Mg/l		0.1	1.0	-	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).
Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.
Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

5) **Noise**

(Frequency) a) When commencing the construction work b) Every three months, c) Separately conduct monitoring for the works which create large-scale noise and vibrations.
(Date)
(Location)

(Unit: dBA)

Result		Bangladesh Noise Standards*					IFC Noise Level Guidelines*		Evaluation	Remarks
		A	B	C	D	E	A & B	D & E		
	Day	50	55	60	70	75	55	70		
	Night	40	45	50	60	70	45	70		

(Note 1) Area categories are: A: Silent zone, B: Residential zone, C: Mixed zone (mainly residential area, and also commercial and industrial areas), D: Commercial zone, D: Industrial zone
(Note 2) "Day" and "Night" of Bangladesh Noise Standards indicate 6AM to 9PM, and 9PM to 6AM respectively, whereas those of IFC Guidelines are 7AM to 10PM, and 10PM to 7AM.
(Note 3) Noise level of IFC Guidelines is L_{Aeq} per hour.

(Meteorological Conditions**)**

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa

	AM								
	PM								

6) **Odors**

(Frequency) Continuously during construction period
(Date)
(Location)

Specific malodorous substance	Odor index	Source	Measure	Remarks

7) **Stability of surrounding structures**

(Frequency) a) right before excavation work starts b) right after excavation work is completed c) right after the UGSS construction is completed
(Date)

Location	Structure, no of stories, years of construction, plot area, total floor area	Physical condition	Displacement and angle	Subsidence and depth

8) **Land use**

- Prior notice and public consultation

Means of prior notice and information sharing about the construction schedule, venues of such notice and meetings, contents of discussions shall be recorded.
(Frequency) Continuously recorded.

Date	Means	Venue	Contents and Actions	Remarks

(In the case that temporary land requisition for ROW of UGC route and surrounding area causes resettlement/demolition of existing structures, the following issues shall be monitored.

- Results of local survey and interviews

Questionnaire format (household head name, father's name, household members, asset inventory, occupation and livelihood mean, monthly income, etc.), facts about the local survey and interview (such as date, venue and surveyors), aggregated data shall be attached.

- Compensation plan

Action plan for compensation and other assistance measures shall be attached.

- Progress of requisition

Progress of resettlement, demolition/removal of existing structures shall be monitored.

Date	Name of requisition site	Work progress and actions	Remarks

9) **Infectious diseases**

(Frequency) Twice a year

- Monitor health records through health check-ups

10) **Work Environment**

- Periodic monitoring of safety measures (implementation of training, provision of protection equipment, etc.)

(Frequency) Continuously recorded, monitor once a year.

Date	Name of safety measures	Venue	Contents	Remarks

- Periodic monitoring of labor accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Place	Cause of accident	Action	Remarks

11) **Accidents**

- Periodic monitoring of road traffic accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Venue	Causes	Action	Remarks

(3) Operation Period

1) **Noise and vibration (substation)**

(Frequency) Upon periodic O&M

(Date)

(Location)

(Unit: dBA)

Result		Bangladesh Noise Standards*					IFC Noise Level Guidelines*		Evaluation	Remarks
		A	B	C	D	E	A & B	D & E		
	Day	50	55	60	70	75	55	70		
	Night	40	45	50	60	70	45	70		

(Note 1) Area categories are: A: Silent zone, B: Residential zone, C: Mixed zone (mainly residential area, and also commercial and industrial areas), D: Commercial zone, D: Industrial zone
(Note 2) "Day" and "Night" of Bangladesh Noise Standards indicate 6AM to 9PM, and 9PM to 6AM respectively, whereas those of IFC Guidelines are 7AM to 10PM, and 10PM to 7AM.
(Note 3) Noise level of IFC Guidelines is L_{Aeq} per hour.

(Meteorological Conditions**)**

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

2) **Work Environment**

- Periodic monitoring of safety measures (implementation of training, provision of protection equipment, etc.)

(Frequency) Continuously recorded, monitor once a year.

Date	Name of safety measures	Venue	Contents	Remarks

- Periodic monitoring of labor accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Place	Cause of accident	Action	Remarks

Chapter 11. Progress and Changes of Kawran Bazar UGSS Project(DPDC)

11.1 Brief Overview of Dhaka Network

Currently, the Bangladesh government has strong intentions to develop underground network constructions in Dhaka city considering the scarcity of land in the metropolitan area and its will to develop a highly reliable Dhaka network. Following the government's policy, DESCO and DPDC are eager to have UGSS in Dhaka city. In parallel, the 132 kV network in the Dhaka area will be gradually shifted from PGCB to DESCO/DPDC according to the Data Collection Survey, though PGCB is the main administrator of the 132 kV network in Bangladesh as of now. Hence, DESCO and DPDC are expected to play more important roles in providing a reliable and stable supply in Dhaka city via the development of the 132kV network and underground network, including UGSS.

The necessity of UGSS will also be taken into consideration by PGCB. However, PGCB has some issues regarding the sustainability of the entire network in Bangladesh, such as back-bone network development surrounding Dhaka city, long transmission line projects for power imports from other countries and some on-going thermal power plant projects in rural areas. Hence, PGCB is examining the necessity of UGSS considering its budget constraints.

Given the above situation in Bangladesh, DESCO/DPDC are going to proceed to the pilot project stage for UGSS projects in Dhaka city. Overviews of the projects are given below.

11.2 Updated Project Plan for Kawranbazar Substation

11.2.1 Network planning & Electric design for Kawranbazar Substation

The JICA Team confirmed the fundamental requirement on electrical requirements from DPDC, then, also confirmed no change compared to the Data Collection Survey. Accordingly, the JICA Team studied the layout and other issues focusing on the impact on tentatively finalize the contents of Building Permit. The following shows the overview of DPDC's UGSS.

Table 11-1 Overview of DPDC's UGSS

Item	
Voltage Class	132/33/11 kV
Substation Capacity	510 MVA
Number of 132/33 kV Transformers	80/120 MVA x 3
Number of 33/11 kV Transformers	35/50 MVA x 3
Number of 132 kV lines	11 lines (8 Feeders, 2 Voltage Transformers, 1 Bus coupler)
Number of 33 kV lines	21 lines (15 Feeders, 5 Voltage Transformers, 1 Bus coupler)
Number of 11 kV lines	35 lines (27 Feeders, 6 Voltage Transformers, 2 Bus coupler)

(Source: The Data Collection Survey)

11.2.2 Updated Project Plan for Kawranbazar Substation

(1) Usage of BPDB's plot

According to the Data Collection Survey, the Kawranbazar site was selected as the top priority among DPDC's candidates for an UGSS project site from the network requirements, social-environmental and

economic points of view, as was the case for DESCO. Currently, the Kawranbazar site is used for an outdoor DPDC substation, DPDC housing and a BPDB building. DPDC and BPDB agreed an MOU, which uses the Kawranbazar site due to it being the best site with the most efficient usage, according to PDB's lead. The current usage of the Kawranbazar site is shown as follows.

(Source: The JICA Team)

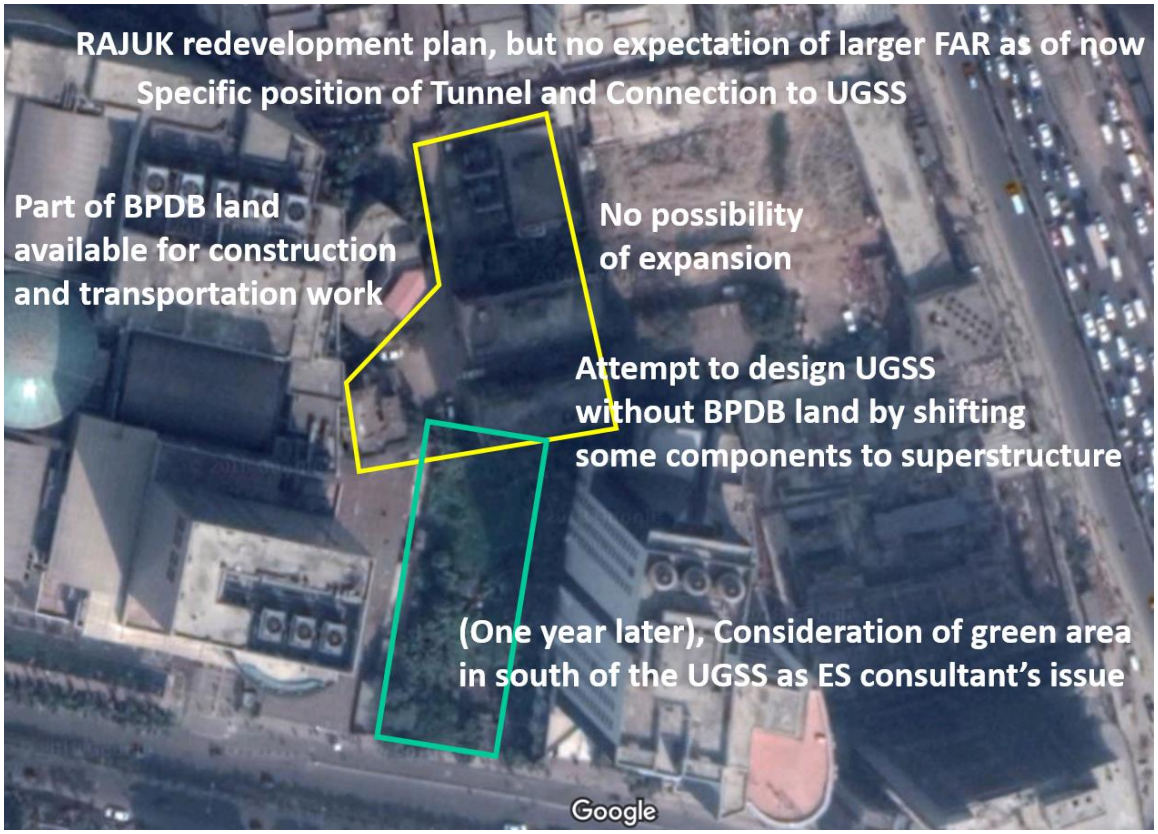
Figure 11-1 Current Usage of Kawranbazar Site

In the Data Collection Survey, the new Kawranbazar UGSS will be constructed in the southern portion of the land after demolishing DPDC's housing. Additionally, it was concluded that the BPDB building has to be removed to secure suitable space for construction work, such as soil transportation, equipment transportation and space for construction vehicles.

However, there are two noteworthy points in the MOU between DPDC and BPDB in the case that BPDB's land is used for the project. The first is that DPDC has to transfer 50% of the ownership rights for the superstructure to BPDB as a reward for use of the land. The second is that DPDC has to get agreement on the UGSS and superstructure designs from BPDB before construction. This means that DPDC has some obligations and constraints if it asks BPDB to provide their land for DPDC's UGSS. Hence, DPDC requested the JICA Team to attempt to design its UGSS without BPDB's land in order to avoid the above issues. The specific designs are described in Chapter 5.

The Floor Area Ratio (hereinafter "FAR") is the key factor in enabling a taller superstructure. FAR is mainly determined by the width of the access road based on the Data Collection Survey. Hence, in order to increase the FAR for the superstructure on the top of DPDC's UGSS, some setback of DPDC and BPDB land was taken into consideration in the Data Collection Survey. However, if BPDB's land does not form part of the project, only a portion of DPDC's land would be considered for setback. Therefore, the JICA Team will confirm whether a larger FAR would be applicable or not by giving only DPDC setback.

In addition to the above method, DPDC has already considered some other ideas in order to acquire a larger FAR, as per the following figure.



(Source: The JICA Team)

Figure 11-2 Current Situation of Area Surrounding Kawranbazar Site

(2) RAJUK's Redevelopment plan, including Garden Road, which is the access road for Kawranbazar substation

RAJUK is going to create the redevelopment master plan for this area, including Garden Road. However, RAJUK is not considering expanding the width of Garden Road because there are a lot of small shops along the road. Hence, this redevelopment plan doesn't contain any Garden Road expansion in order for RAJUK to avoid the resettlement of many shops. This means DPDC cannot gain a larger FAR via this idea.

(3) Site expansion of Kawranbazar substation to West area

There is a regulation that states a road is regarded as an access road for FAR calculation if the clearance between the land and the access road is less than 50 meters. Hence, DPDC attempted to acquire the site to the east of Kawranbazar substation in order to set a wider road for FAR calculation. However, this site already had an on-going project to construct a new building.

(Source: The JICA Team)

Figure 11-3 Case Study on Access Road for Kawranbazar Substation

(4) Acquirement of green land to the south of Kawranbazar substation

DPDC has attempted to acquire the green area to the south of Kawranbazar substation based on the same consideration as that for the area to the east, namely securing a larger FAR. Accordingly, DPDC has requested the Bangladesh government to proceed with the land's acquisition. However, the results of the land acquisition will take a year or more. Hence, the JICA Team and DPDC have agreed not to use the green area in the SAPI. If DPDC is able to acquire the land one year later, the Engineering Services Consultant for DPDC's UGSS will take it into consideration.

(5) Setback of DPDC land for a larger FAR

Maximum FAR is fixed based on the footprint of the objective land and the road width in front of the objective land, as follows.

Table 11-2 Road width, FAR and Maximum Ground Coverage (MGC)

[Building Type: F (F1-F5): Commercial Building]

Area of the Plot		Building Type (F1) (Office)			Building Type (F2-F5) (Shop, market, etc.)		
Sq. Meter	Katha	Road Width (meter)	FAR	MGC (%)	Road Width (meter)	FAR	MGC (%)
Up to 134	2 or less than 2	6	2.50	67.5	6	2.25	65.0
More than 134 to 201	More than 2 to 3	6	3.00	65.0	6	2.50	62.5
More than 201 to 268	More than 3 to 4	6	3.00	65.0	6	2.50	62.5
More than 268 to 335	More than 4 to 5	6	3.50	62.5	6	3.00	60.0

More than 335 to 402	More than 5 to 6	6	3.50	62.5	6	3.00	60.0
More than 402 to 469	More than 6 to 7	6	3.75	60.0	9	3.25	57.5
More than 469 to 536	More than 7 to 8	9	4.50	57.5	9	3.25	57.5
More than 536 to 603	More than 8 to 9	9	5.50	57.5	9	3.25	57.5
More than 603 to 670	More than 9 to 10	9	6.00	55.0	9	3.50	55.0
More than 670 to 804	More than 10 to 12	9	6.50	55.0	12	3.75	52.5
More than 804 to 938	More than 12 to 14	9	7.00	55.0	12	4.00	52.5
More than 938 to 1072	More than 14 to 16	9	7.50	55.0	12	4.25	50.0
More than 1072 to 1206	More than 16 to 18	9	8.00	52.5	12	4.50	50.0
More than 1206 to 1340	More than 18 to 20	9	8.50	50.0	12	4.75	50.0
More than 1340	More than 20	12	9.50	50.0*	12	5.50	50.0
Any	Any	18	NR**	50.0*	18	6.50	50.0
Any	Any	24	NR**	50.0*	24	NR**	50.0*
*12 meter height podium can be installed at the ground floor considering the setbacks **NR - No FAR is needed							

(Source: RAJUK Document)

In the Data Collection Survey, the Team and DPDC considered providing BPDB and DPDC with land as a setback for getting a larger FAR. Then, RAJUK would accept the trade with larger FAR and setback of their land. However, DPDC is considering not using BPDB land for their UGSS site. In this case, DPDC has to reconfirm whether RAJUK could allow DPDC to get larger FAR or not since DPDC can provide the setback for only DPDC land without BPDB land.

(Source: The JICA Team)

Figure 11-4 Study on FAR Expansion and Setback Range

As a result of these considerations, the only way to obtain a larger FAR is via setback of DPDC land. However, since DPDC hasn't yet explained their idea to RAJUK, the Engineering Service Consultant will confirm its feasibility through discussions with DPDC and RAJUK. If RAJUK allow DPDC to get higher FAR, the Engineering Service Consultant will reflect the revised superstructure design to UGSS design properly.

(6) Height constraints of the superstructure due to Civil Aviation requirements

Heights of buildings in Bangladesh have to follow Civil Aviation regulations in order to secure the take-off space for Air Force flights. Specifications for building heights are based on two issues: 1) the distance between an objective building and air force runway, 2) the location of an objective building considering the take-off direction.

Since the Kawranbazar site is located on an extension of an air force runway, the height of the superstructure has to follow the height regulation, which is 114 feet. However, the other buildings surrounding the Kawranbazar site would be higher than the regulated height, such as Bashundhara City Mall with 21 stories. Hence, DPDC will negotiate with the Civil Aviation authority and Air Force to get a waiver for a higher building.

(Source: The JICA Team)

Figure 11-5 Location of Kawranbazar Site and Air Force Runway

Though this issue of superstructure height is mainly a matter for DPDC, building height is related to the design of the pillar span and size in a UGSS. Hence the Engineering Service Consultant will continue to monitor their progress and reflect this in the UGSS design, if necessary.

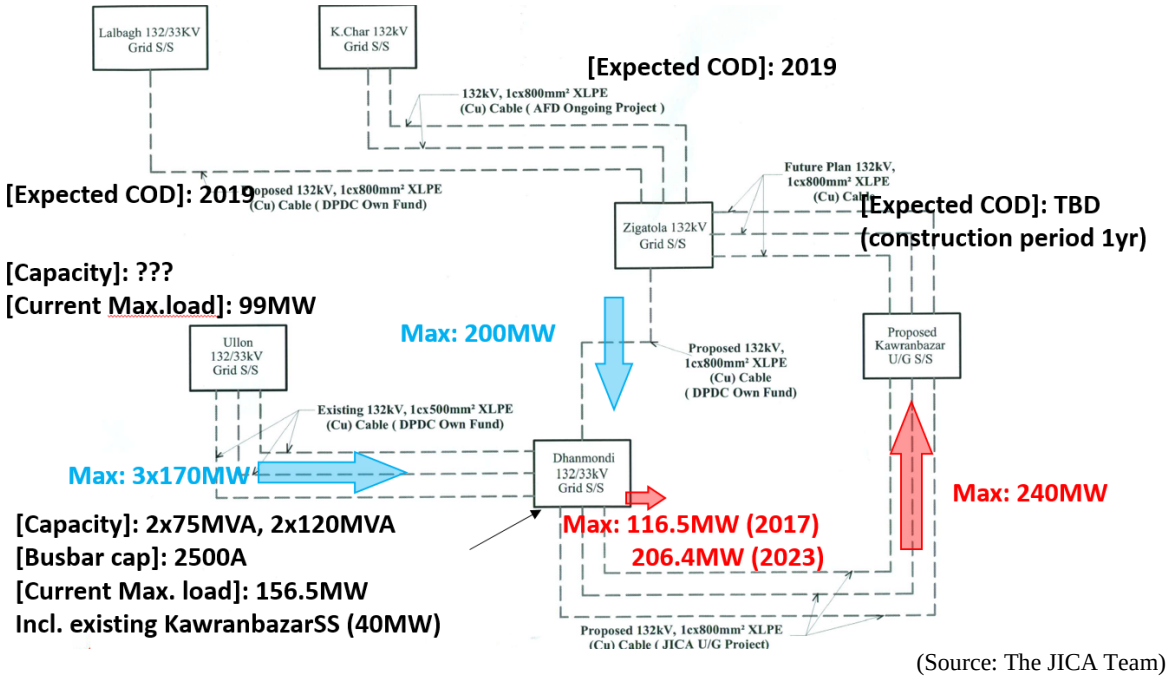
11.2.3 Development Status of Power Source Substations and Underground Transmission Lines

In the Data Collection Survey, the power source substations were finalized as 230/132 kV Dhanmondi substation for DPDC. Accordingly, the JICA Team confirmed the current status for both substations' operation in the SAPI because one and a half years have passed since the Data Collection Survey.

DPDC has problems in securing a power source from 230/132 kV Dhanmondi substation because of the prospective delay in its commissioning. 230/132 kV Dhanmondi substation was expected to be newly built by 2019 via Chinese funds. However, the JICA Team confirmed that the project might be delayed due to slow progress in negotiations regarding these funds. Accordingly, DPDC suggested 230/132kV Ullon substation as a new power source.

However, DPDC itself decided not to pursue the idea of receiving power from Ullon substation because of its having a longer underground transmission line distance from the power source to the new DPDC UGSS compared to the original power source, 230/132 kV Dhanmondi substation. If the power source line changes, some work might have to be re-done, such as the social-environmental study. Additionally, a longer underground transmission line means more expensive construction costs, so DPDC might have to re-apply for the DPP in the worst case.

Finally, DPDC suggested the existing 132/33kV Dhanmondi substation as an alternative source substation. Therefore, the JICA Team confirmed its feasibility as a new power source. An overview of the existing 132/33 kV Dhanmondi substation and surrounding substations is shown below.



(Source: The JICA Team)

Figure 11-6 Overview of Existing 132/33 kV Dhanmondi Substation and Surrounding Substations

The above figure shows load flow for each substation. The existing 132/33 kV Dhanmondi substation will be able to receive the maximum 710 MVA, which consists of the existing 170 MVA x 3 lines from Ullon substation and the 200 MVA x 1 line from Zigatora substation (a future project). This means that the available power secured for 132 kV Dhanmondi substation is 340 MVA (= 170 MVA x 2 lines) based on there being no Zigatora line and N-1 criteria, which drops one circuit from Ullon substation. The expected load at this 132 kV Dhanmondi substation will be 206.4 MVA in 2023, the commissioning date for DPDC's UGSS. Hence, 132/33 kV Dhanmondi substation can be expected to transmit 133.6 MVA (340 - 206.4 MVA) to DPDC's UGSS.

The new DPDC UGSS will require 240 MVA as its maximum load under N-1 criteria. However, the below Data Collection Survey information shows the fact that the expected demand will be increasing from year to year and reach the maximum in 2031. Even if the Zigatora line does not appear until 2023, DPDC will be able to operate their UGSS until 2027. Accordingly, the JICA Team and DPDC confirmed that DPDC has to build the Zigatora line by 2027 to enable full operation of the UGSS.

Table 11-3 Expected Demand at Kawranbazar UGSS in the Data Collection Survey

			Location	Kawran Bazar B
Project Life	Operation	Year	Max Demand MW	Supply Energy GWh
0		2016		
1		2017		
2		2018		
3		2019		
4		2020		
5		2021		
6		2022	77.2	385.5
7	1	2023	84.9	424.1
8	2	2024	93.4	466.5
9	3	2025	102.8	513.1
10	4	2026	113.0	564.4
11	5	2027	124.3	620.9
12	6	2028	136.8	683.0
13	7	2029	150.5	751.3
14	8	2030	165.5	826.4
15	9	2031	182.1	909.0
16	10	2032	182.1	909.0

(Source: The Data Collection Survey)

The existing 132/33 kV Dhanmondi substation is located next to 230/132 kV Dhanmondi substation. Hence, there would be no concerns regarding cost increases when constructing underground transmission lines compared to the original lines.

Therefore, DPDC and the JICA Team agreed that Dhanmondi substation is to be fixed as the power source substation for DPDC's UGSS. The studies on route surveys for the underground transmission lines are described in the later Chapter.

Chapter 12. Examination on the specified Electric Design of UGSS Component for precise UGSS layouts (DPDC)

12.1 Transformer Specifications

The JICA Team has confirmed the specifications for the Gas Insulated Transformer with DPDC as follows. Hence, all designs by the JICA Team are based on the following. The Engineering Services Consultant will finalize the specifications and designs for the project accordingly.

Table 12-1 Specifications of Gas Insulated Transformer

No.	Item		Requested Specification	
1	Rated Capacity [MVA]		120	50
2	Max Weight [t]		302	100
3	Max Dimensions [mm]	W	11,000	10,000
4		D	12,000	6,000
5		H	6,200	6,050
6	Rated Voltage [kV]	Primary	132	33
7		Secondary	33	11
8	Voltage Range		+10%/−15%	+10%/−15%
9	Tap Voltage [%]		1.25	1.25
10	The Number of Taps		21	21
11	Winding		Dyn1	Dyn11
12	Phase Number [Phase]		3	3
13	Frequency [Hz]		50	50
14	Short-Circuit Impedance [%]		18	8
15	Type of Cooling		GFWF	GFWF
16	Max Ambient Temperature [℃]		45	45
17	Noise [dB]		78	78
18	Connection Method with the Outside	Primary	Cable	Cable
19		Secondary	Cable	Cable

(Source: The JICA Team)

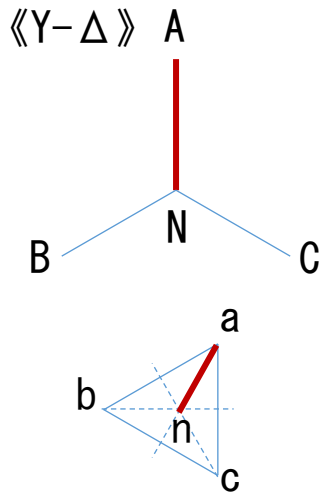
The JICA Team tentatively fixed the maximum dimensions of GIT through interviews with manufacturers. Hence, the JICA Team designed the GIT room on the current UGSS layout, which can accommodate the maximum size. Accordingly, the Engineering Services Consultant will have to specify the allowable and maximum GIT size to enable the Contractor to design their size to meet the current room size, also considering equipment transportation and installation.

12.1.1 Winding Type

For the Transformer Winding method, it is necessary to choose from two methods. The Y-Δ method and Δ-Y method each have different characteristics. For example, the main tank in the Δ-Y method is huge compared with the Y-Δ method. The JICA team once confirmed the possibility of adopting the Y-Δ method with DPDC, but this issue must be discussed further by considering the number of manufacturers for GIT with the proposed specifications and the necessary technical studies, such as that for the introduction of GTrs. If an UGSS adopts this method, there are several manufacturers that can produce it.

However, greater confirmation is necessary from the viewpoint of network operation, such as protection coordination with other substations. In addition, an Earthing Tr (GTr) will be required for this method. This will also affect the layout of the UGSS.

Therefore, comprehensive judgment is necessary in order to determine the winding method.



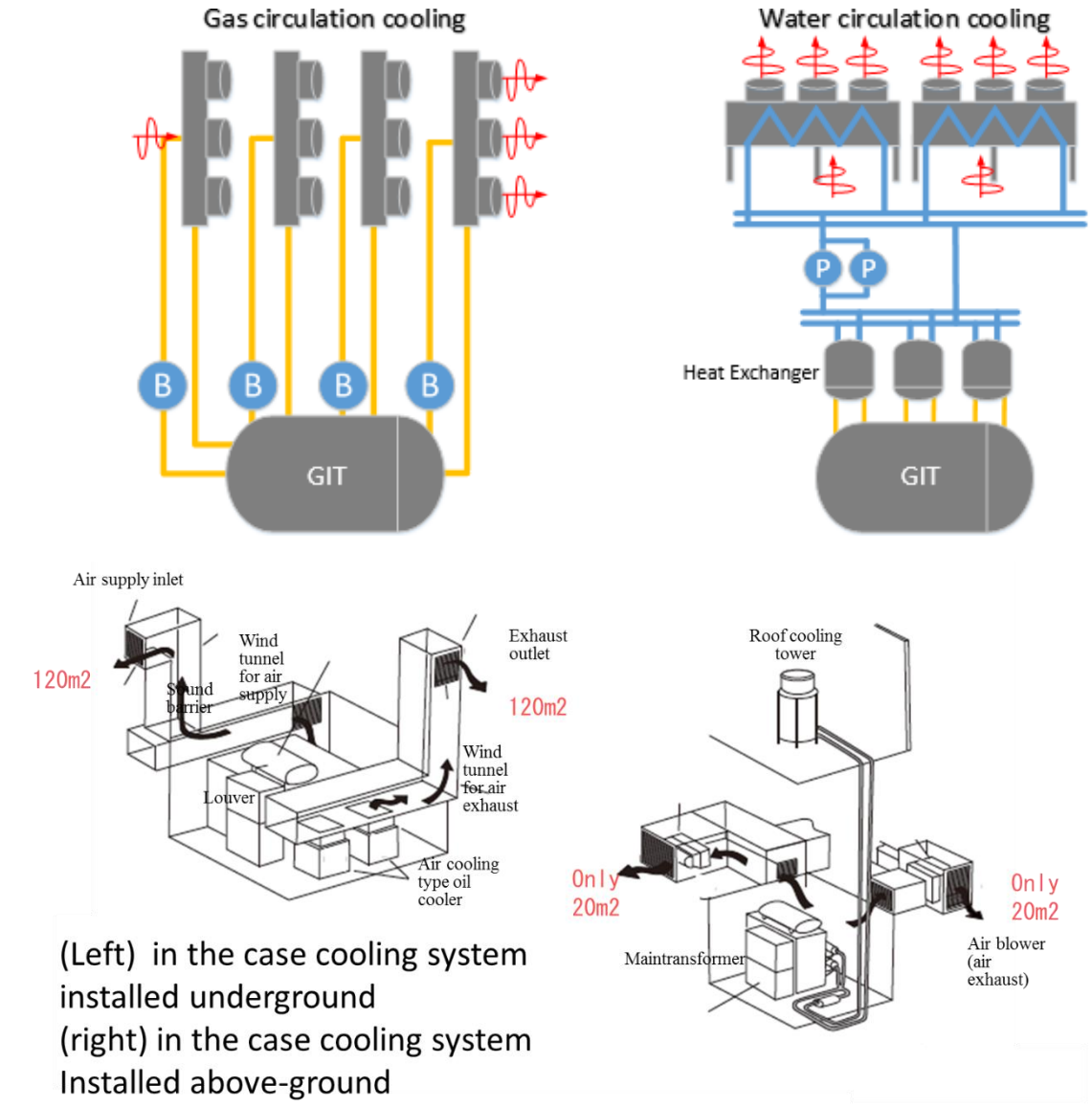
(Source: The JICA Team)

Figure 12-1 Transformer Winding Method

The transformer room in the current layout follows the delta-star winding method. The Engineering Services Consultant might re-design the substation to become more compact if the manufacturers propose realistic and available technical solutions changing the winding type.

12.2 Cooling System Design for Transformers

It is essential to install a cooling system to deal with the heat dissipation from equipment. Though outdoor substations generally have transformers with radiators, UGSS cannot have these due to the room size constraints. Hence, an alternative cooling method to cool the heat transferred from the transformer room to other rooms is installed in UGSS. Generally, there are two mediums for transferring the heat: "Water" and "GIT Gas itself". The following shows the two cooling systems.



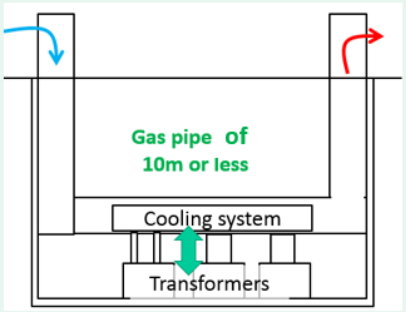
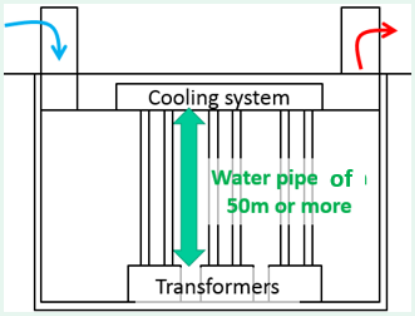
(Source: The JICA Team)

Figure 12-2 Two Cooling Systems for Transformer, and Comparison of Openings

Gas circulation cooling involves extending the gas pipe from the transformer tank directly to the cooling tower, while water circulation cooling needs initially to shift the heat from the gas pipe to the water pipe in the heat exchanger, then the heated water pipe is extended to the cooling tower, which is located on another floor. Each method needs different equipment, and the biggest difference is the allowable length of pipe. Given the characteristics of water and gas, the maximum length of a water

pipe is longer than a gas pipe. A longer water pipe can lead to more flexible location of the cooling tower. The following shows the differences of each medium's characteristics.

Table 12-2 Comparison of Cooling Systems for Transformer

Item	Gas Circulation system	Water circulation system
Available Piping length	**Short (20～100 m)** Depending on each manufacturer's capability	**Long (20m or more)** ・Available from all manufacturers.
Pipe Size	200A or more	150A or less
Auxiliary equipment	Gas blower	Heat exchanger, Circulating water pump and valve, water tank
Expected location of Cooling system		

(Source: The JICA Team)

The transformer should be installed on the bottom floor to better support its heavy weight. As mentioned above, the cooling system must be put on the same floor or the one above due to the limited pipe length when gas circulation cooling is used in the UGSS. Employing water circulation cooling enables the cooling tower to be on a higher floor.

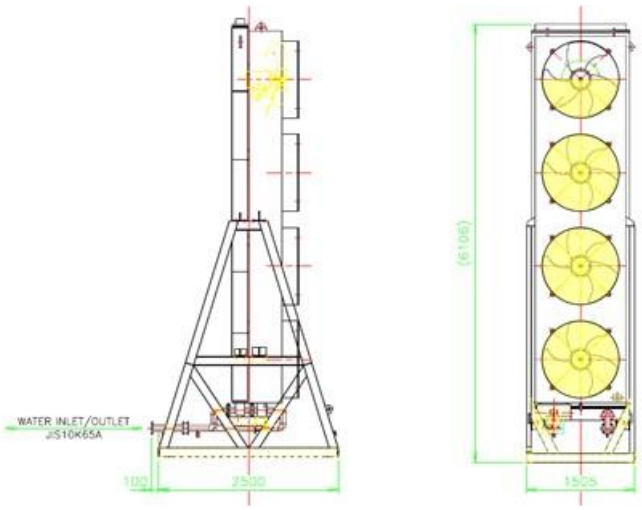
The following shows the tentative specifications of a single cooling unit for the assumed design of the entire cooling system in the SAPI. Currently, the JICA Team estimates that a maximum of 20 units would be necessary to deal with the total amount of the heat described in the next section. At the detailed design stage, the Contractor will have to calculate the proper number of single cooling units based on the actual heat emitted from their equipment. Hence, they will take the maximum weight with 20 units into consideration for their design from the aspect of structure strength. This means they can change their design within the maximum weight and available space.

Table 12-3 Tentative Specifications of Cooling Unit

№	Item		Specification
1	Water Temperature for Inlet/Outlet [℃]	Outlet	55
2		Inlet	45
3	Average Intaked Air Temperature [℃]		36
4	Cooling Capacity per Single Unit [kW]		225
5	Max Weight per Single Unit[kg]		3000
6	Max Dimensions per Single Unit[㎜]	W	1,500
7		D	2,500
8		H	6,100
9	Plumbing size	Main	200A
10		Makeup	80A
11	The number of Bending Points of Plumbing	Main	6
12		Makeup	4

(Source: The JICA Team)

And the following shows the view of single cooling unit as wind system. The number of cooling units should be calculated based on necessary cooling capacity.



(Source: The JICA Team)

Figure 12-3 View of Single Cooling Unit

It is also to be noted that cooling units must be installed in the UGSS when gas circulation cooling is applied. The feasibility of the idea is verified in the next section.

12.2.1 Location Study of Cooling System

Initially, the cooling equipment was planned to be installed in the basement. However, the JICA team suggested that it should be installed on the ground floor, as doing so can reduce the amount of underground ventilation needed for the UGSS. Specifically, installation of the cooling system in the basement requires a huge ventilation tunnel in the UGSS. Eventually, this might lead to higher excavation costs. In addition, it might be difficult to make the best use of the ground floor, which is one of the greatest benefits of UGSS, since a huge air opening on the ground floor might occupy the ground floor space. Hence, the JICA Team tentatively designed the expected size of

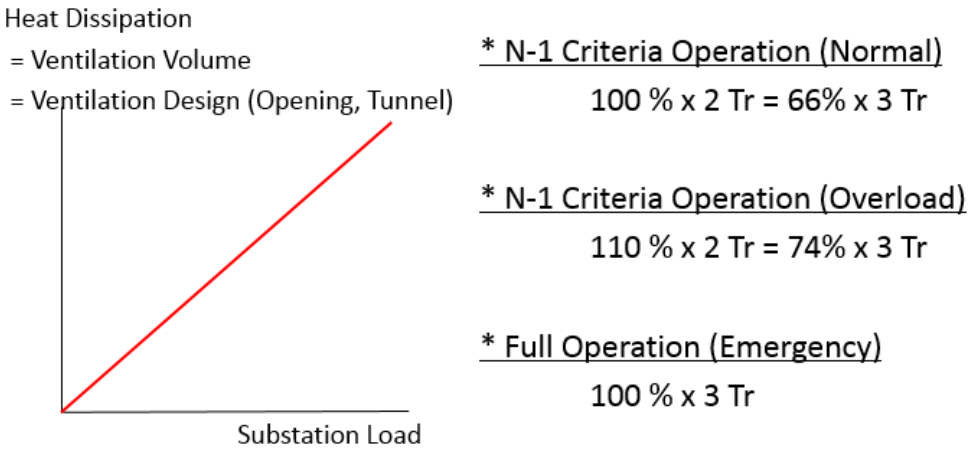
the ventilation tunnel and air opening on the ground floor in order to verify the feasibility of installing the cooling system in the UGSS. The following shows the procedure for the design.

[Case Study] Cooling system in the UGSS

[Study flow]
1. Calculation of Total Heat Dissipation emitted from equipment
2. Calculation of necessary ventilation volume based on the heat dissipation
3. Design of air opening size on ground floor considering the expected wind speed at the air opening and ventilation tunnel

The greatest heat would be emitted from the transformer. Approximately 90% of transformer heat would be cooled at the heat exchanger and dedicated cooling system using a gas or water circulation system. Accordingly, approximately 10% of transformer heat should be treated by the ventilation system to keep the room within an allowable temperature.

A transformer has two loss types: iron loss as constant loss, and copper loss as changeable loss in proportion to transformer load. This means the heat dissipation mostly depends on the load on the transformer. It would be possible to consider a lower load, which means lower heat, under the assumption of N-1 operation as DPDC's policy. However, the JICA Team estimated 100% load for the maximum heat because of the challenges that DPDC faces, such as high-power demands in the Kawranbazar area and the difficulty of quick load transfer in the event of overload at the future UGSS. The following shows the relation between load and heat dissipation.



(Source: The JICA Team)

Figure 12-4 Relation between Load and Heat Dissipation

The JICA Team estimated a tentative value as the maximum amount of heat dissipation to meet the technical requirements for each piece of equipment. The tentative heat assumption is used to design the ventilation volume for cooling. Hence, the Contractor will have to re-calculate the proper ventilation design according to their equipment's heat.

Other than heat estimation, the JICA Team set 36 Degrees Celsius as the yearly average temperature for the air intake. Since this value is cited from the highest yearly average temperature

in Bangladesh, 36 Degrees Celsius would be regarded as the most severe assumption for the cooling system design.

[Case Study] Cooling system in the UGSS

Based on the above study flow, the JICA Team listed the heat dissipation as follows.

Table 12-4 List of Heat Dissipation from Equipment

Floor	Items	Loss [kW]	Quantity	Unit	Total [kW]
B4	132/33kV GIT	700.0	3	Sets	216.3
	33/11kV GIT	800.0	3	Sets	246.3
B3	Cooling system	4037.5	1	Lot	4,056.3
	Panels	114.0	1	Sets	120.3
B2	Cable	0.0	1	Lot	6.3
B1	132kV GIS	58.4	3	Sets	181.5
	33kV CGIS	13.2	3	Sets	45.9
	11kV SW	11.0	3	Sets	39.3
	DC set	35.0	2	Sets	76.3
GF	DC set	35.0	1	Sets	41.3
-	Others	50.0	1	Lot	56.3
Total					5,023.1

(Source: The JICA Team)

The necessary ventilation volume is estimated as follows based the above heat dissipation.

[Neccesary Ventilation Volume]

$$= \frac{Total\ Heat\ Dissipation\ [kW]}{0.33 \times (Maximum\ Ambient\ Temperature - Intaked\ Air\ Temperature)}$$

$$= 1{,}691{,}263\ m^3/\mathrm{h}$$

The size of the ventilation tunnel and air opening should be designed to satisfy the necessary ventilation volume with the allowable wind speed. For the ventilation flow size study, the maximum and allowable wind speed should be taken into consideration. The standard wind speed recommended by the Architectural Institute of Japan is 3-4 m/s. Bangladesh has no similar standard, hence the JICA Team uses the Japanese recommendation for this study.

The JICA Team also simulated case studies with some wind speeds. The following shows cases for the necessary size of the ventilation tunnel and air opening when the cooling system is installed in the UGSS.

Table 12-5 Size Study for Ventilation Tunnel and Opening

Ventilation Tunnel

	100 % Load
Wind : 3 m/s	**156.6 m2**
Wind : 4 m/s	**117.4 m2**
Wind : 5 m/s	**94 m2**

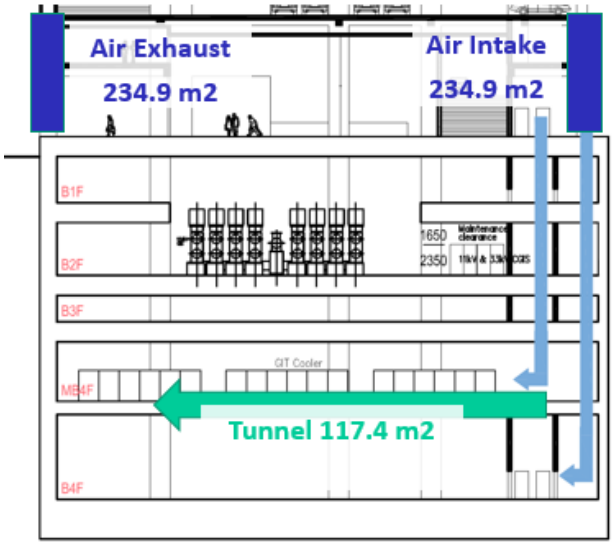
Ventilation Opening (Available rate of Louver: 50%)

	100 % Load
Wind : 3 m/s	**313.2 m2**
Wind : 4 m/s	**234.9 m2**
Wind : 5 m/s	**187.9 m2**

* Ambient Temp: 36℃
* Maximum Room Temp: 45℃

(Source: The JICA Team)

Based on the above sizes, the following shows a cross section with air opening size and ventilation tunnel size when wind speed is specified as 4 m/s.



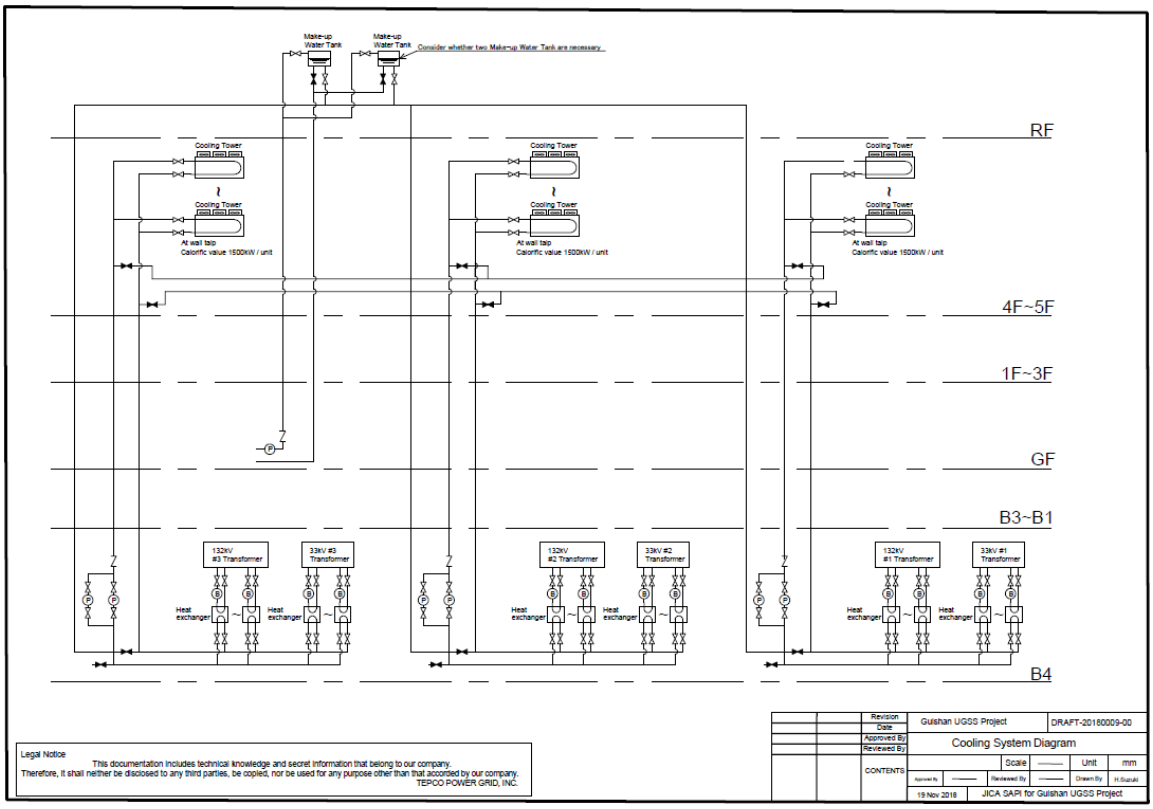
(Source: The JICA Team)

Figure 12-5 Drawing of Opening Size and Wind Tunnel Size

This would lead to a 10 m deeper UGSS, and the JICA Team considered that this idea would not be realistic due to the greater excavation costs and longer excavation period. Additionally, the huge air opening required on the ground floor would negatively affect the commercial value of the ground floor. Based on the above studies, DPDC and the JICA Team agreed that the cooling system be installed in ground floor of the superstructure. Naturally, gas circulation cooling cannot be applied due to the limited gas pipe length, so a cooling system with heat exchanger and water pipe will be applied.

12.2.2 Cooling System Scheme

The location of the cooling system in Kawranbazar UGSS has been agreed as per the previous section. For the next step, the JICA Team designed the scheme for the cooling system in order to design the location and size of the pipe shaft from the UGSS to the podium structure. The following shows the cooling scheme proposed.



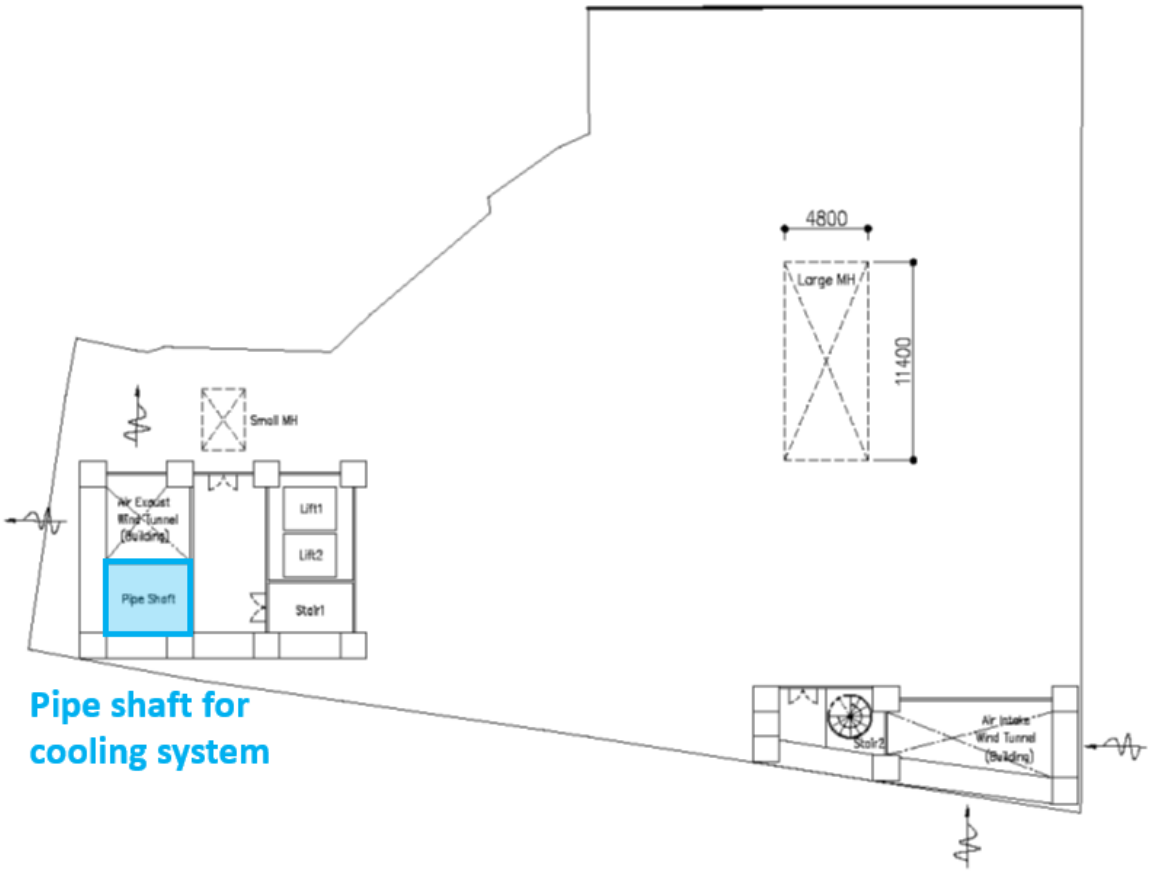
(Source: The JICA Team)

Figure 12-6 Preliminary Diagram of Water-cooling System

In the proposed cooling scheme, each GIT set, 132/33kV GIT and 33/11 kV GIT, has each cooling system as a "unit cooling system". There is another cooling scheme, the "common piping cooling system", which has bus-pipes between each GIT unit. However, the current architectural design doesn't take the common piping system into consideration due to space issues, and the JICA Team estimated a heavier weight using the common piping system for the structure design.

Accordingly, Gulshan UGSS will tentatively use the unit cooling system in the current layout. However, it isn't necessary to apply for a change of building permit even if the common piping system ends up being applied at the detailed design stage.

In terms of the unit cooling system, it is necessary to set six sets of piping passing from the UGSS to the ground floor for the cooling. Hence the JICA Team designed the shaft as follows, and has informed the superstructure designer of this in order to reflect it in the superstructure design.



(Source: The JICA Team)

Figure 12-7 Shaft Size and Location on Ground Floor

12.3 Case study of Cooling System in Kawranbazar Plot

The location of the cooling system is closely related to the superstructure design and structure strength due to its size and weight. In the previous section, DPDC and the JICA Team agreed to install the cooling units on ground floor within the superstructure. However, the specific location of the cooling system cannot be arranged in the SAPI because of no superstructure design. Hence, the JICA Team has informed the local architect of the necessary dimension of the cooling units and O&M space. In the early stage of Engineering Service, the Engineering Service Consultant will have to decide where to install the cooling units through the discussion with the local architect to make the best use of ground floor and secure the necessary space for UGSS operation.

Chapter 13. Underground Substation Layout (DPDC)

13.1 General technical requirements for UGSS

The following are basic UGSS design considerations to be harmonized as nominated in the previous UGSS Feasibility Study for DPDC:

(1) Equipment layout with consideration of safety and ease of maintenance and the operability of future extension construction work.

(2) Proper ventilation method for the removal of underground substation facilities' heat dissipation.

(3) The equipment transportation passages will be arranged to face a road.

(4) Sufficient power cable routing space must be provided to facilitate the installation of equipment for cable tunnels, outgoing cable tunnels and cable ducts.

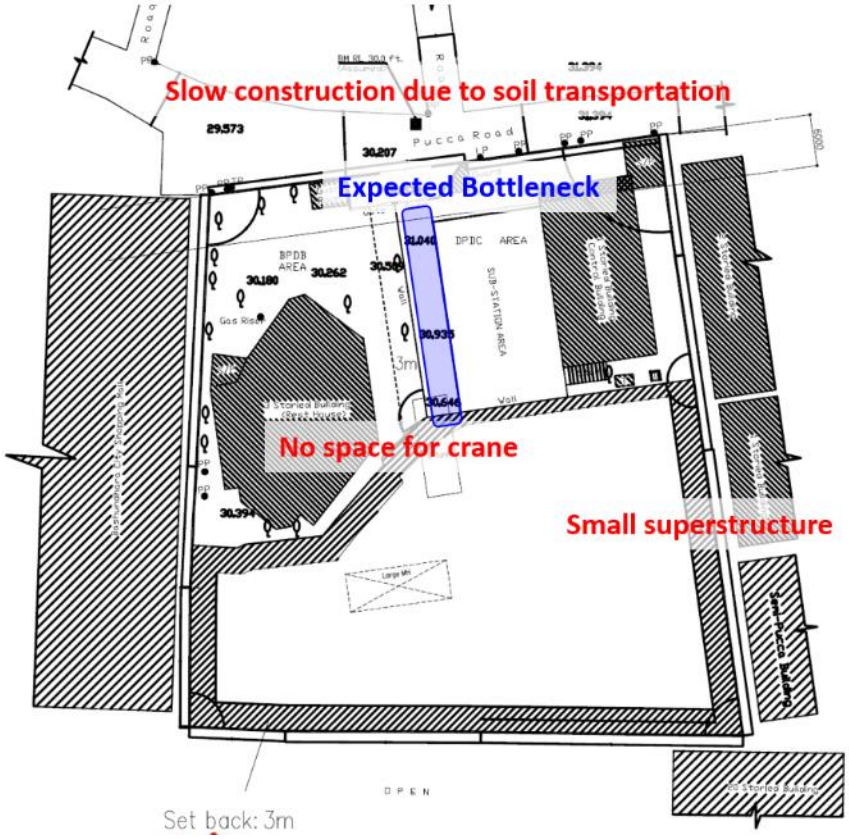
(5) Sufficient space both on above-ground and underground floors for equipment installation, removal, repair, transportation, testing and site-assembly.

(6) Large equipment will be located near the equipment machine hatch with a corridor of sufficient width.

(7) The control room will be located near the exit and possibly above ground for occupational safety.

13.2 UGSS layout for Kawranbazar Project

The layout for Kawranbazar UGSS is now being revised to minimize the need to use BPDB's land during construction and after the UGSS's completion, by considering possible load evacuation from the existing outdoor substation on-site. This UGSS layout does not include the candidate for the new plot behind the current proposed site, which is not confirmed to be acquirable based on the following UGSS layout.



(Source: The JICA Team)

Figure 13-1 Preliminary Design for DPDC's UGSS in the Southern Portion of the Land

As per the previous Chapter, which shows the land usage, the JICA Team attempted to design a feasible DPDC UGSS and developed three choices.

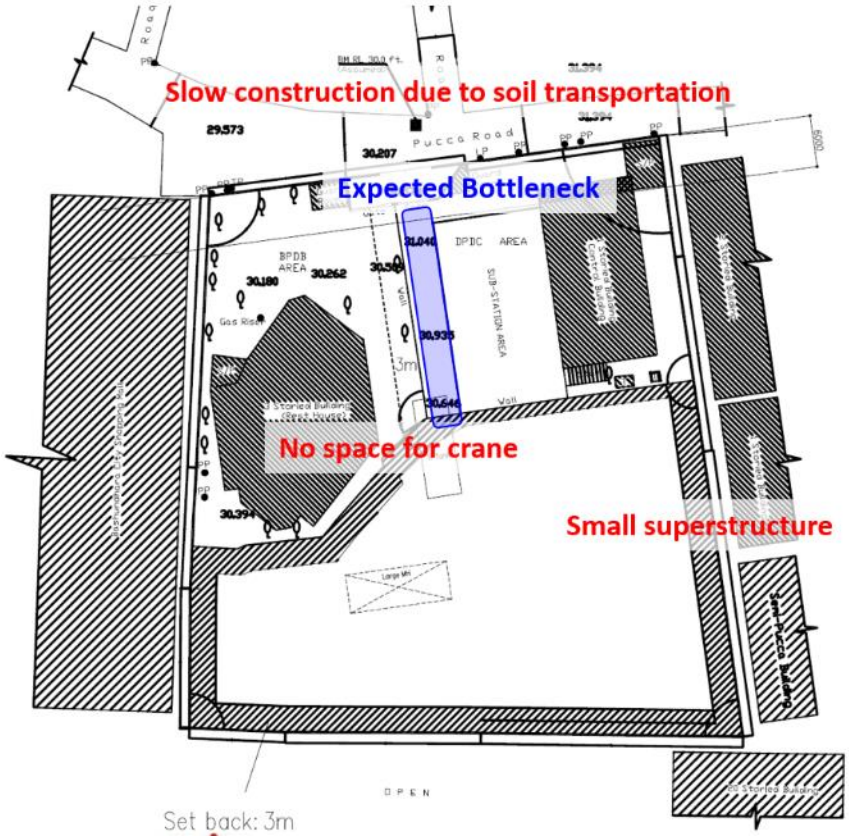
Case I) Use only southern portion of the land without load evacuation from the existing DPDC substation to other substations

Case II) Include eastern portion of the land owned by BPDB along with tentative load transfer from the existing DPDC substation to utilize south and west portions of the land

Case III) Use south and west portions of the plot with a partial load transfer from the existing DPDC substation to other substations

The JICA team designed the corresponding DPDC UGSS layouts as follows.

13.2.1 Case I) Use only southern portion of the land without load evacuation from the existing DPDC substation to other substations



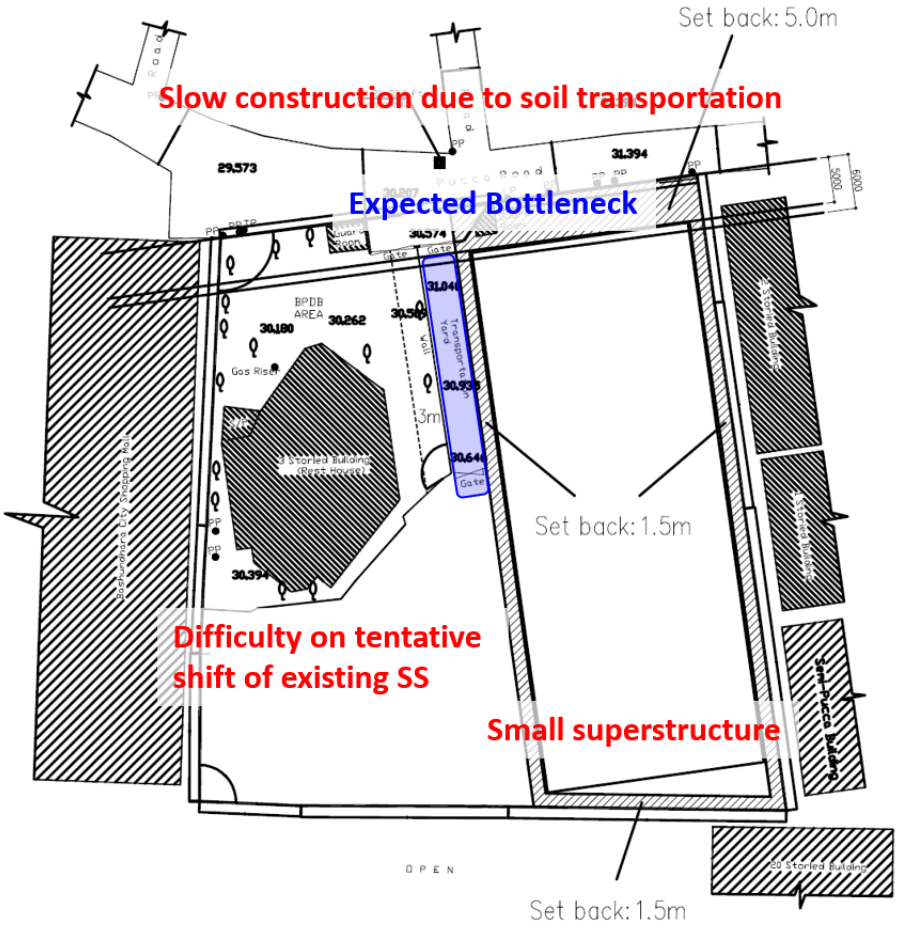
(Source: The JICA Team)

Figure 13-2 Preliminary Design for DPDC's UGSS in the Southern Portion of the Land

Although the former FS team studied this arrangement as an option with minimized footprint, the JICA Team does not recommend this design for reasons of difficult operation and maintenance due to space constraints. Additionally, the construction of the UGSS seems to be more difficult and the construction period would be longer because of there being insufficient space for transportation of excavated soil and equipment. The below shows the bottleneck for these issues. Also, the underground tunnel would be installed in the same road. Since not all of the work that uses the same road can be done simultaneously, the total construction period is expected to be considerably longer. Hence, this idea would not be applied considering earlier UGSS commissioning.

13.2.2 Case II) Use eastern portion of the land with tentative load transfer from the existing DPDC substation to south-west portion of the land

As per DPDC's idea of shifting the existing substation to the south-west portion of the land, the JICA team developed the below design in the east portion of the land.



(Source: The JICA Team)

Figure 13-3 Preliminary Design for DPDC's UGSS in the Eastern Portion of the Land

For this design, the same problems would be encountered as those with the UGSS using the south portion of the land, such as soil transportation, equipment transportation and installation of the underground tunnel. Hence, this design should also not be recommended.

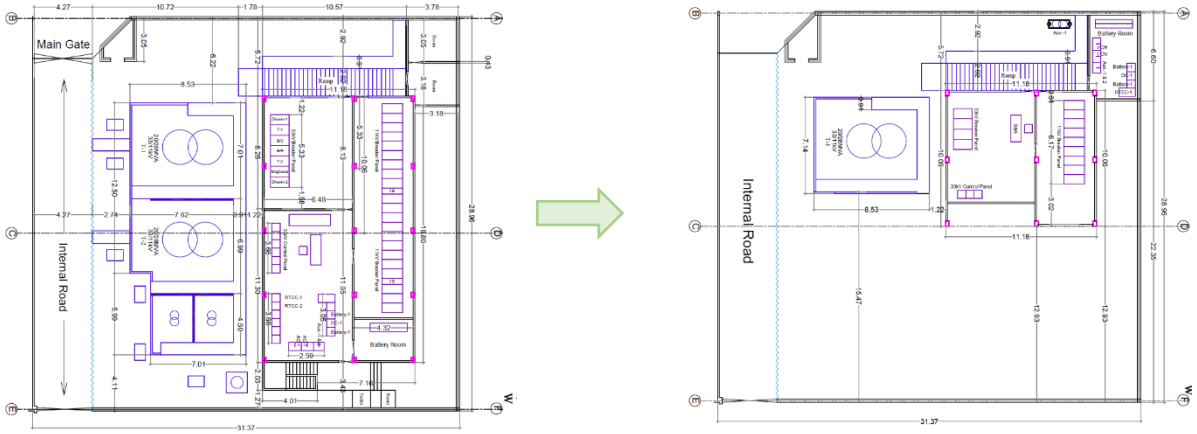
13.2.3 Case III) Use with a partial load transfer from the existing DPDC substation to other substations

As a result of consultation with the DPDC, it has been found that there is a possibility that the DPDC can cut the size of the existing substation in half. By reducing the size of the existing substation, it is possible to secure enough space to use for the UGSS. However, careful investigation is necessary for this because the existing drawing is inaccurate and the load situation is unclear. Therefore, a site survey, building survey and load survey are required. These were presented to DPDC as their tasks. The JICA team cooperated with DPDC on the site survey. As a result, a site that can be used as an underground substation has now become clear. In consideration of this, the JICA team proposes a possible layout at this stage.

Procedures to reduce the size of the existing substation.

(1) Switch the load and demolish T2 and AT2.
(2) Move AT1 to the empty space on the north side (or install a movable transformer).
(3) Make a half-control room (remove half of the existing devices).
(4) Install a fence and secure space for the new UGSS.

By executing this procedure, it is possible to secure a suitable site for the UGSS.

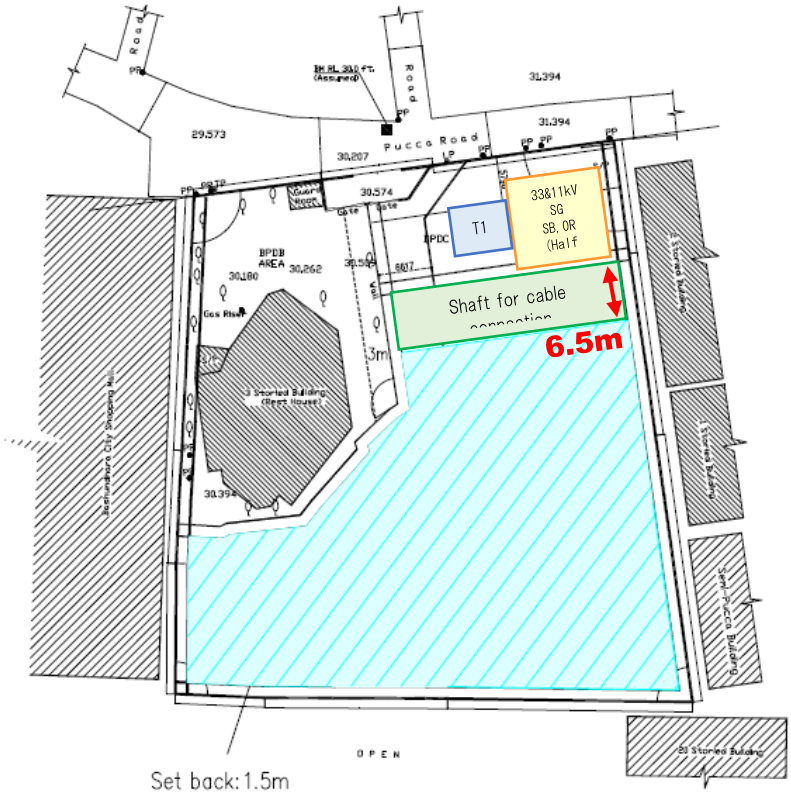


(Source: The JICA Team)

Figure 13-4 Reduction of the existing DPDC substation reflecting site survey

For transferring the load from the existing Kawranbazar substation to other substations, DPDC has already issued the implementation order for the work, which describes the feeders' name of T2 and the proposed substations as receivers for load transfer. Hence, the Engineering Service Consultant will have to follow the progress of DPDC's work, which is load evacuation and shrinking the existing Kawranbazar substation.

In order to identify the area that can be used as a UGSS, the JICA team conducted a survey at the DPDC site and reflected the correct figures in the drawing. In addition, a shaft for cable connection must be installed on the north side of the UGSS. As the correct location of the existing substation and construction method for the earth retaining wall became clear, it turned out that about 6.5 m of space is needed.

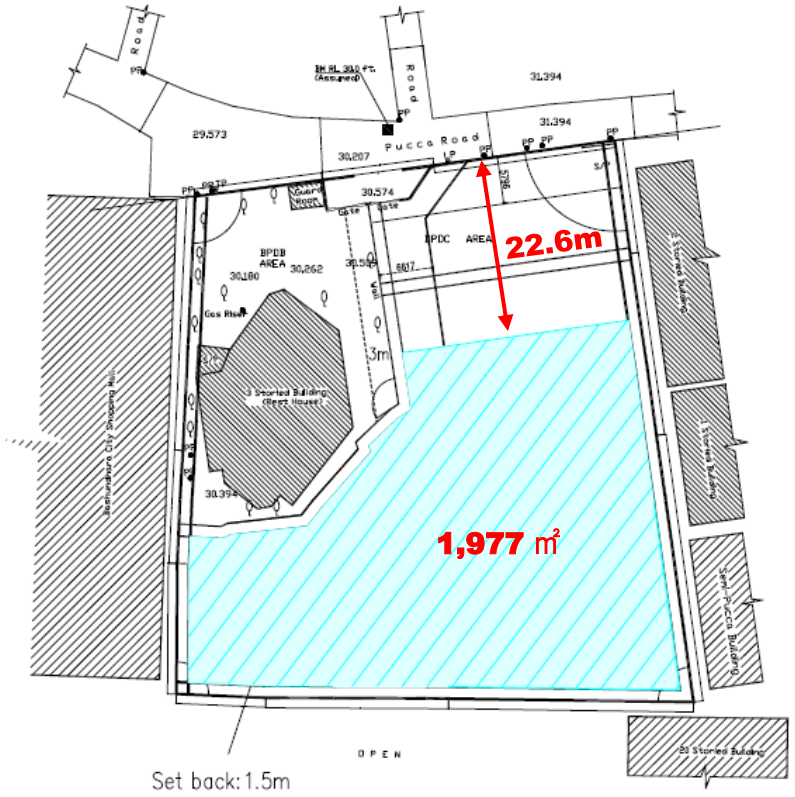


(Source: The JICA Team)

Figure 13-5 Positional relationship between available site for the UGSS, the halved S/S and Shaft

An UGSS site of 1,977 m^2 can be secured. This is approximately 67 % of the DPDC site.

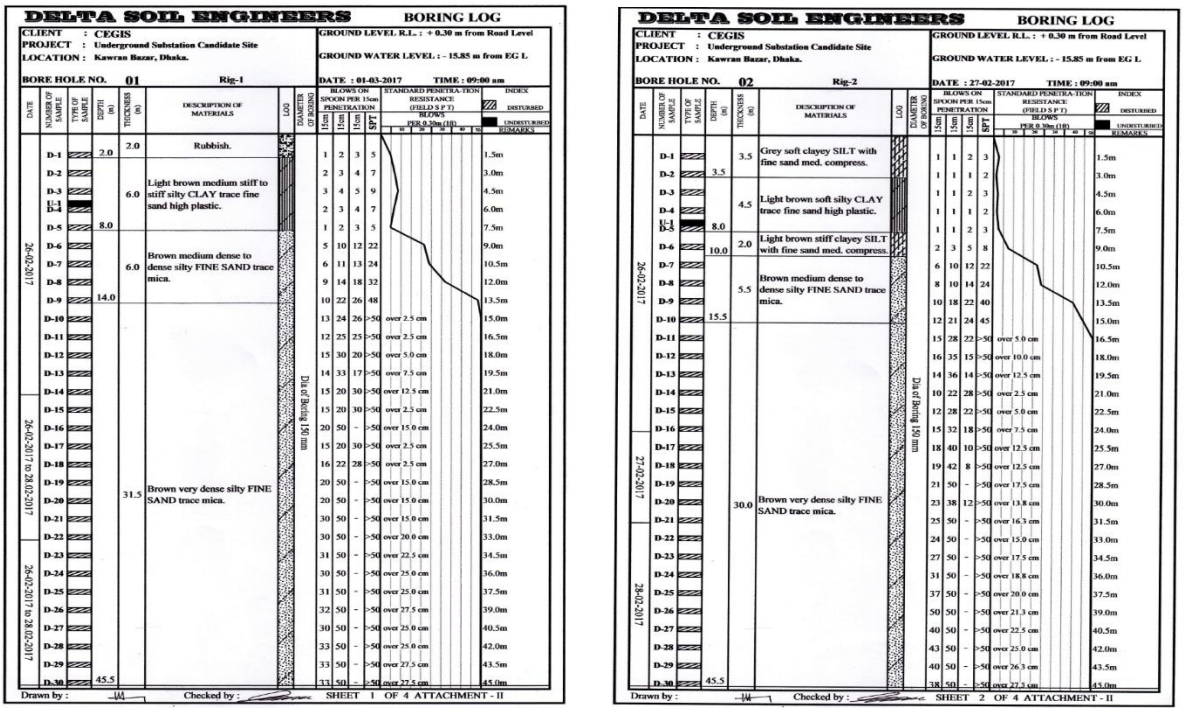
As a secondary effect, the new UGSS can have a wider access road than the existing one. In order to load large equipment into the new UGSS a wide road is necessary. In addition, after removing the existing substation (half S/S), the new UGSS can provide 22.6 m of green space on the north side.



(Source: The JICA Team)

Figure 13-6 Available site for the UGSS when the existing DPDC substation is halved

However, the soil situation for Kawranbazar was found to be more serious than in the past data. According to the latest data, the stable layer is at a depth of approximately 13.5m. This is considerably shallower than the initial expectation. Therefore, there is a threat of increasing excavation costs. Generally, it is said that it costs about 1.3 times more when excavating deeper than the stable layer. In the Kawranbazar case, the usable area is wide, and the impact of excavation costs will be very big. Considering the excavation cost aspect, the JICA team recommends a shallower underground substation.

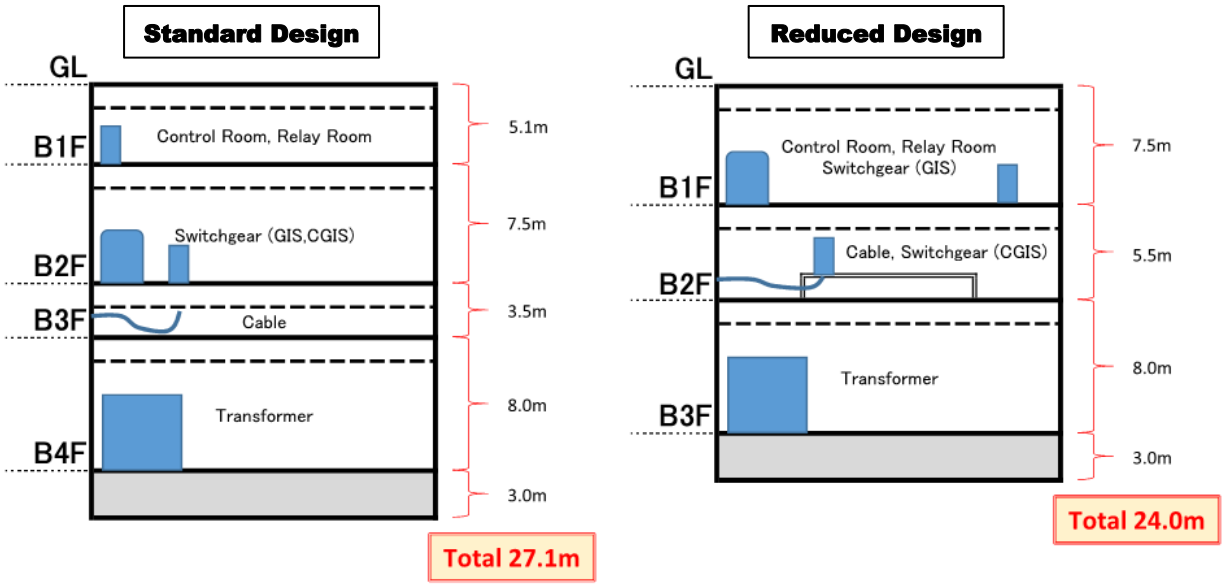


(Source: The JICA Team)

Figure 13-7 The latest soil survey data for the Kawranbazar site

In order to make the UGSS shallower, it is necessary to make it an efficient hierarchical structure. A UGSS is generally composed of 4 layers. By rearranging some SGs and placing other SGs in the cable processing room, it is possible to construct a shallow UGSS in which all equipment is installed underground. This method will be effective for a relatively large land area like the Kawranbazar site.

However, depending on the ventilation design etc. of the substation, the depth may change.

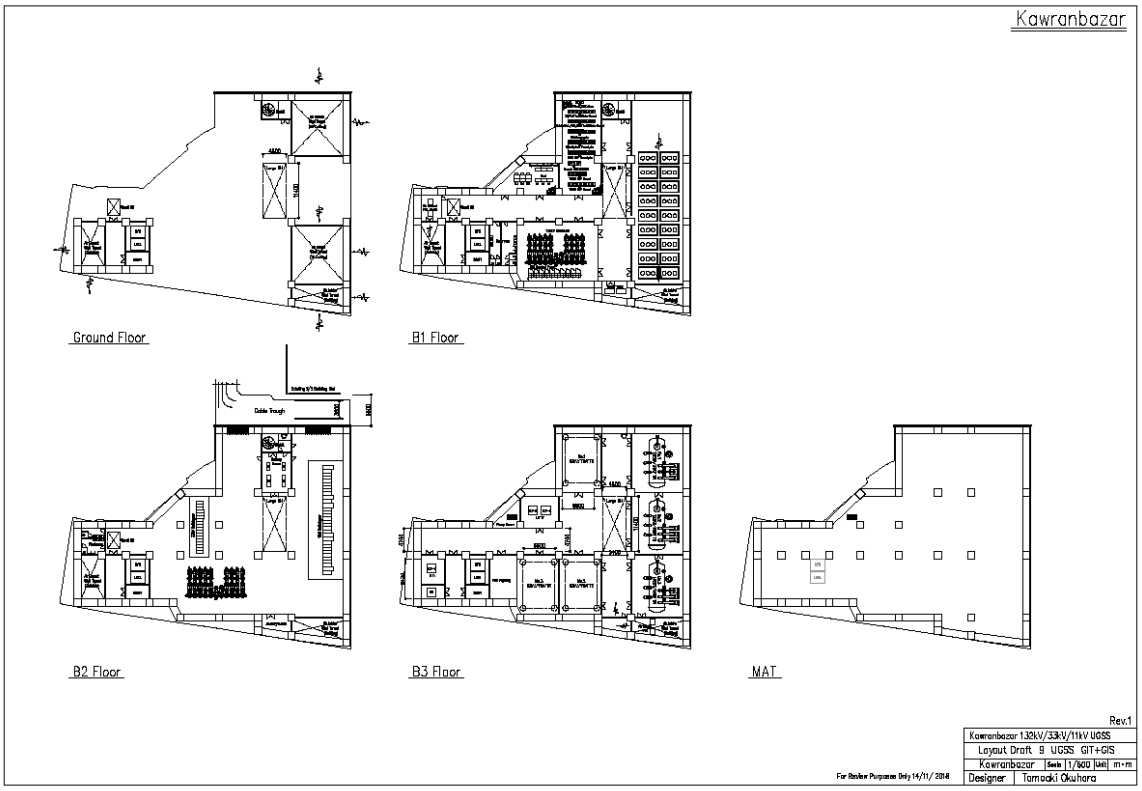


(Source: The JICA Team)

Figure 13-8 Floor reduction plan A

If DPDC decides to implement the proposed procedure and put all the equipment underground, the JICA team can propose the following layout (Plan A) with all equipment underground.

However, when all equipment is installed underground, careful consideration must be given to the ventilation wind tunnel for the transformer and basement. Since the structure of the upper building is undecided, it is impossible to investigate whether a wind tunnel is to be installed or not. This is an important issue in this layout for the connection portion between the basement and the upper building.

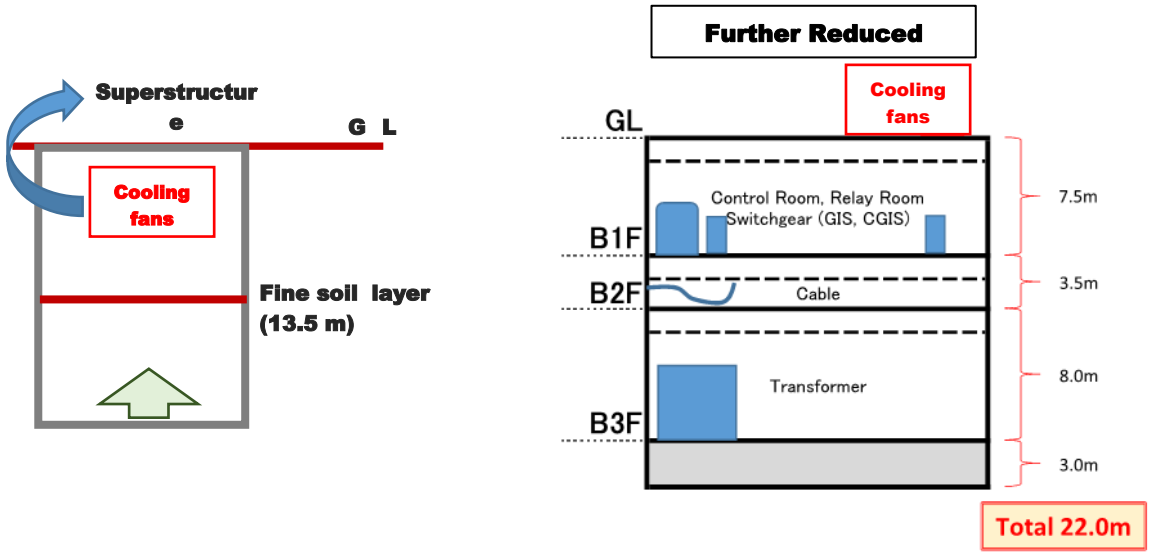


(Source: The JICA Team)

Figure 13-9 Proposed Kawranbazar UGSS plan A that uses available site

As mentioned earlier, it is very costly to excavate in order to construct a deep UGSS. Therefore, it would be more beneficial to place some of the equipment on the ground and aim for a shallow UGSS.

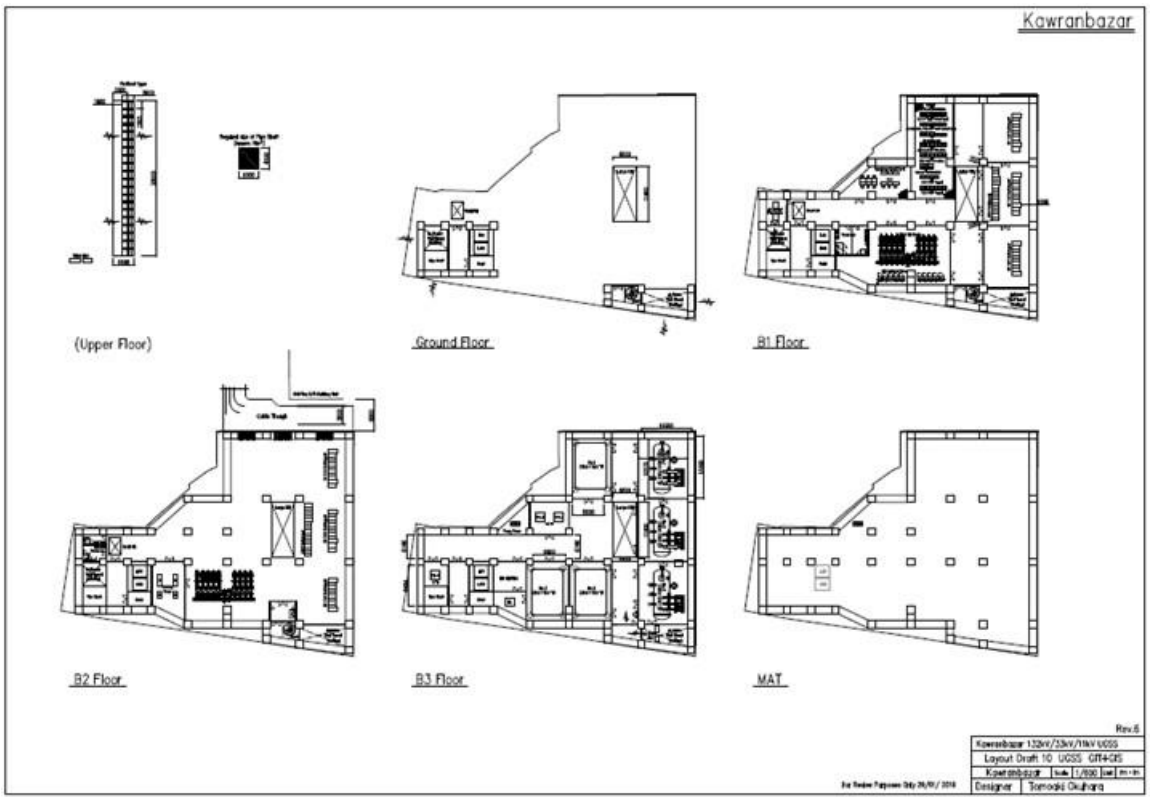
In Japan, there are many underground substations in which some facilities are installed above-ground (or in the upper building). In this case, it is common to install the transformer cooling facility above-ground. By doing so, it is possible to create a shallower UGSS. However, depending on the ventilation design etc. of the substation, the depth may change.



(Source: The JICA Team)

Figure 13-10 Floor reduction plan B

If DPDC decides to implement the proposed procedure and put the cooling fans above-ground, the JICA team can propose the following layout (Plan B) without installing the cooling fans underground. In this case, it is necessary to carefully coordinate with the upper building design concerning the installation site for the cooling fans. In this proposal, the cooling pipe shaft (approx. 18 square meters) is set to the southwest position.



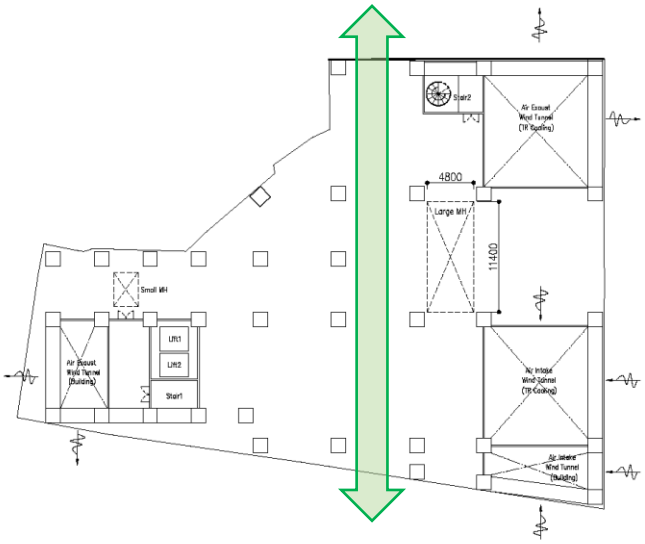
(Source: The JICA Team)

Figure 13-11 Proposed Kawranbazar UGSS plan B that uses available site

With regard to the following matters, which were concerns at the time of consultation, if DPDC can adopt Plan A or Plan B they will be solved.

- Narrow space for 33/11kV Tr → Secured sufficient space on B3F
- Equipment necessary for each floor → Possible to place on each floor
- Unsuitable cable connection space → Secured sufficient space on B2F

However, considering the equipment specifications to be adopted in the future, detailed continuous consultation is necessary. In particular, it is necessary to discuss the connecting portion between the UGSS and the upper building in detail with the upper building architect.



(Source: The JICA Team)

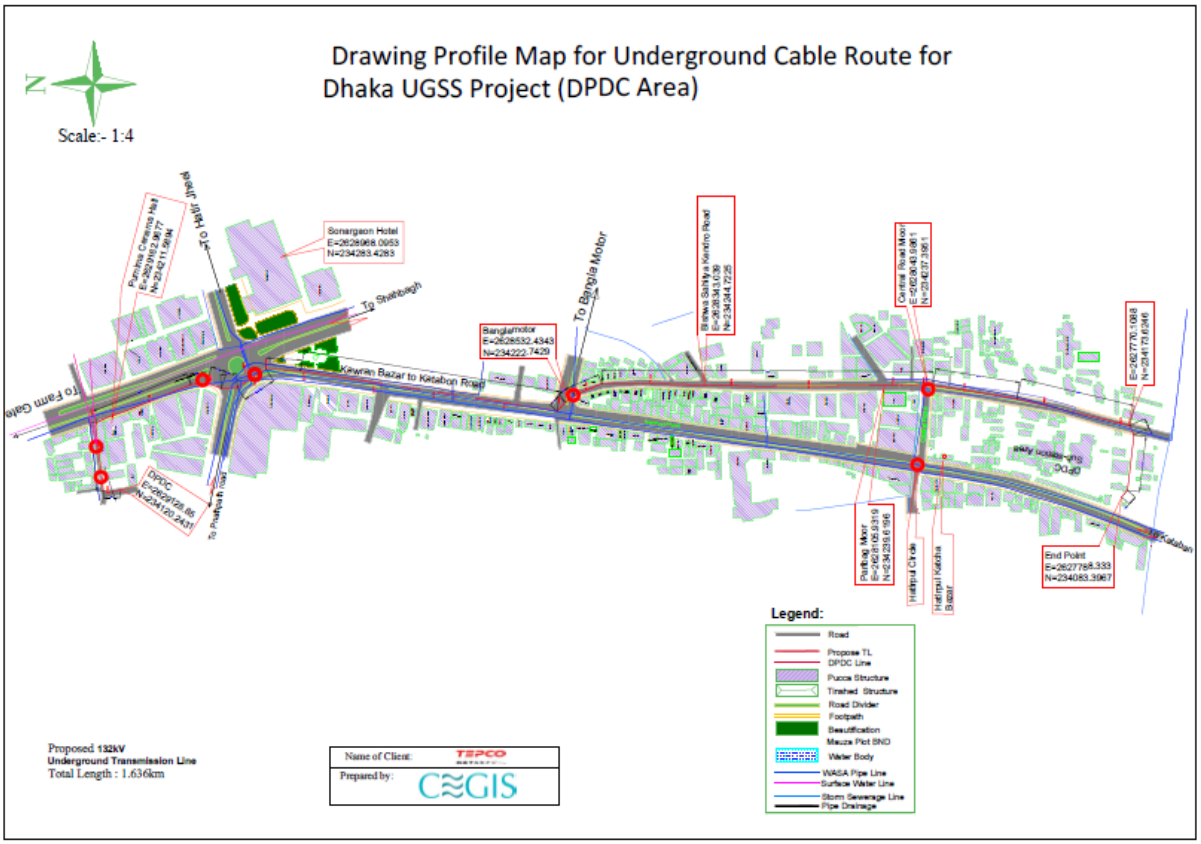
Figure 13-12 Ground floor design including possibility of easy access

The superstructure plan is undecided at present, while, the air supply and exhaust openings are installed at the edge of the site. These facilities are closely related to the superstructure. However, some changes are possible. Therefore, the amount of flexibility in the design regarding the superstructure is very high. In addition, if DPDC can acquire the green area on the south side, a very accessible roadway will become available.

In any case, the UGSS and the superstructure have a large effect on each other, so the JICA team recommends early policy decisions.

Chapter 14. Underground Transmission and Distribution Line Design (DPDC)

Based on the Data Collection Survey, the UGSSs and their power source substations are to be connected with underground transmission lines. The project also includes underground tunnels, which are located in the area surrounding the UGSS, in order to accommodate a great deal of transmission and distribution lines within the limited area. Hence, the JICA team carried out a route survey to identify any obstacles and considered the applicable construction methods according to the design in the Data Collection Survey. Based on this survey, the route was decided as shown in the drawing below.



(Source: The JICA Team)

Figure 14-1 Power transmission route for plan drawing in Kawranbazar area

14.1 Results of Investigation on Power Source Line Route

132 kV UGSS will be constructed at Kawranbazar, including a cable route from Dhanmondi to Kawranbazar.

The table below shows the number of underground transmission and distribution lines at DPDC.

Table 14-1 The number of transmission and distribution lines at DPDC

Voltage	DPDC area
132 kV	5
33 kV	9
11 kV	24

(Source: the Data Collection Survey)

The distribution lines will be buried around the UGSS at the planned construction site, and accommodated in the tunnel. Distribution lines will be accommodated in the tunnel until the 1st pole, and after that it will be overhead wire transmission. However, the transmission lines will be buried over long distances from the UGSS at the planned construction site to the power source substations. The Data Collection Survey doesn't show information on buried objects, which might cause difficulties for installation of underground lines. Therefore, the JICA Team has confirmed the validity of the transmission line routes in advance.

Several congested traffic crossings and places with existing buried objects exist, so it is necessary to consider the route for these. In order to do so, the SAPI team conducted a route survey based on the survey drawing created by CEGIS.

【Route Survey for Route survey for Dhanmondi to Kawranbazar (12 points)】

(Source: The JICA Team)

Figure 14-2 Dhanmondi to Kawranbazar

(Source: The JICA Team)

Figure 14-3 Point 1 (to Kawranbazar SS)

(Source: The JICA Team)

Figure 14-4 Point 2 (to Kawranbazar SS)

(Source: The JICA Team)

Figure 14-5 Point 3 (to Dhanmondi SS)

(Source: The JICA Team)

Figure 14-6 Point 4 (to Dhanmondi SS)

(Source: The JICA Team)

Figure 14-7 Point 5 (to Kawranbazar SS)

(Source: The JICA Team)

Figure 14-8 Point 6 (to Dhanmondi SS)

(Source: The JICA Team)

Figure 14-9 Point 7 (to Dhanmondi SS)

(Source: The JICA Team)

Figure 14-10 Point 8 (to Dhanmondi SS)

(Source: The JICA Team)

Figure 14-11 Point 9 (to Dhanmondi SS)

(Source: The JICA Team)

Figure 14-12 Point 10 (to Dhanmondi SS)

((Source: The JICA Team)

Figure 14-13 Point 11 (to Dhanmondi SS)

(Source: The JICA Team)

Figure 14-14 Point 12 (to Dhanmondi SS)

For points 1 to 3, places to bury underground transmission and distribution cables could be secured. Therefore, there is no route change. However, a lot of people come and go here during the daytime. Thus, there is a possibly of construction during the night.

For points 4 and 5, route change is not necessary.

For points 5 and 6, there is a traffic crossing and the volume of vehicles was large. Therefore, it is assumed that excavation work will be difficult. In order to solve this issue, the SAPI team adopted the Small Diameter Jacking Method described in Figure 14-26 to make the route possible.

For points 7 and 12, route change is not necessary.

14.2 Analysis of Construction Methods

Based on the route surveys done in June and July, the JICA Team studied the applicable construction methods. The study found several congested traffic crossings and places with existing buried objects on the underground transmission route. The JICA Team implemented the necessary analysis of construction methods, which are described below.

The JICA team proposed two construction methods.

The first one is the Open Cut method.
This is the most common construction method and it is inexpensive. This has two detailed methods.

(1) One day backfilling

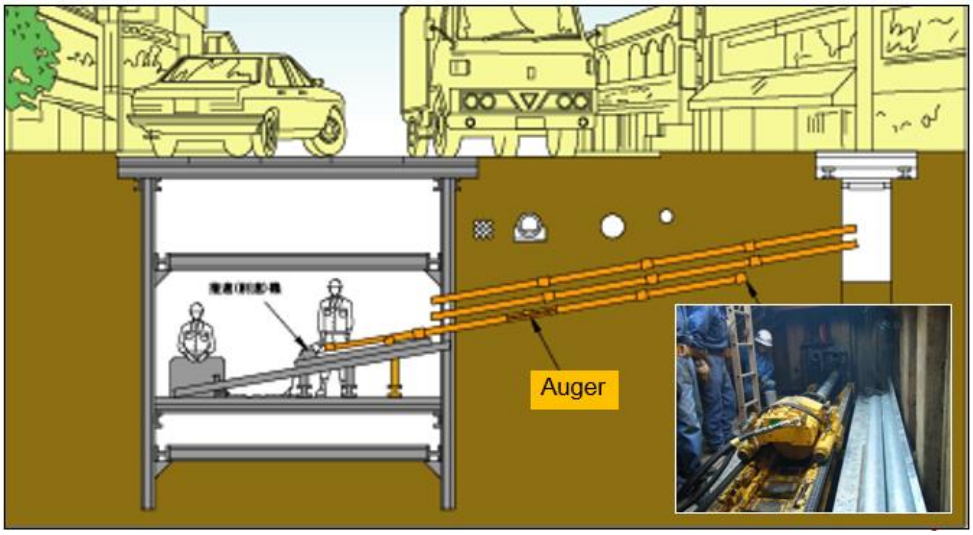
- The construction cycle is: dig a tunnel → Lay cables → Backfill.
- Back filling will be completed by the end of the day.

(2) Lining Method

- After the work, the road decking panel will be used for excavating the road.

The second one is the Small Diameter Jacking Method.

This is also a common construction method in Japan, like the Open Cut method. This is the next inexpensive method to the Open Cut method, and does not require excavation work. The premise of the construction method is to join together 1m pipes and dig augers.



(Source: The JICA Team)

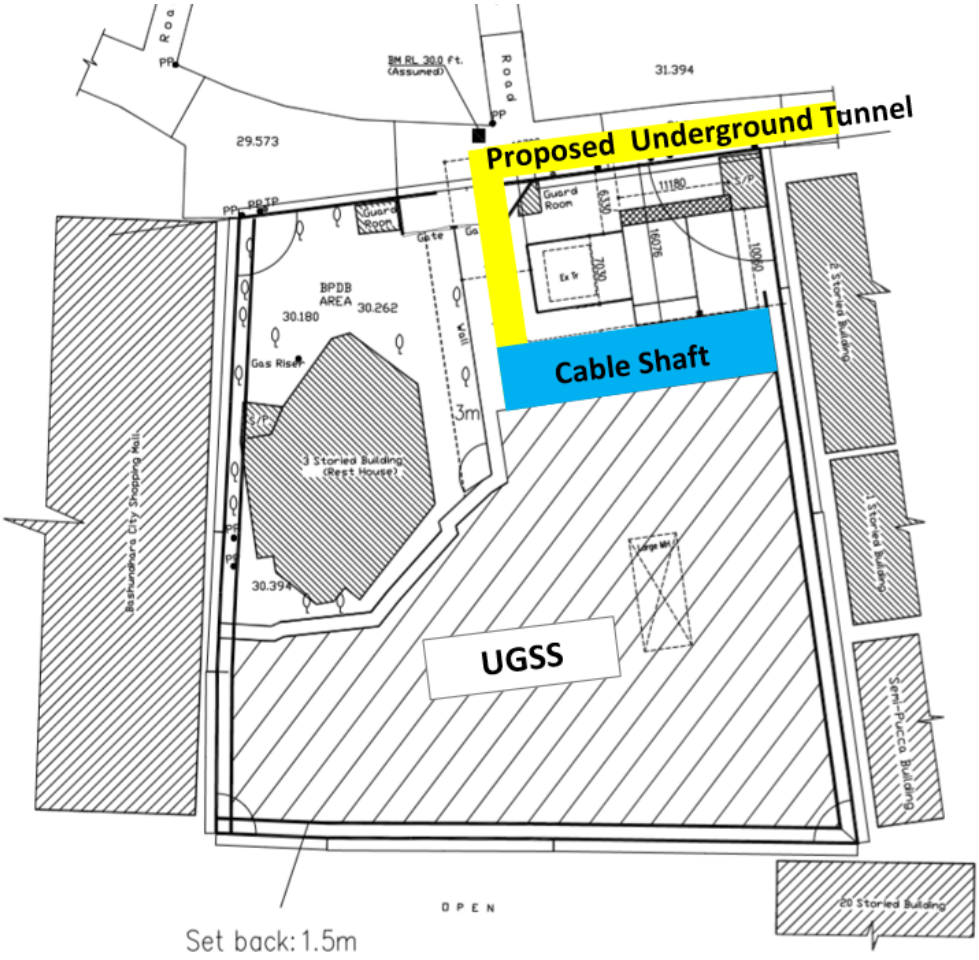
Figure 14-15 The Small Diameter Jacking Method

Based on the studies done so far, the JICA Team expects that most of the TL tunnels on the route proposed can be constructed via the open-cut method, because the width of the road necessary for excavation has been secured and there are few overhead wires that interfere with construction work. However, several congested traffic crossings and places with existing buried objects on the underground transmission routes will require the Small Diameter Jacking Method.

The reason for this is that if such parts are constructed via the open cut method, it will adversely affect traffic and buried objects, and require longer construction periods and greater costs.

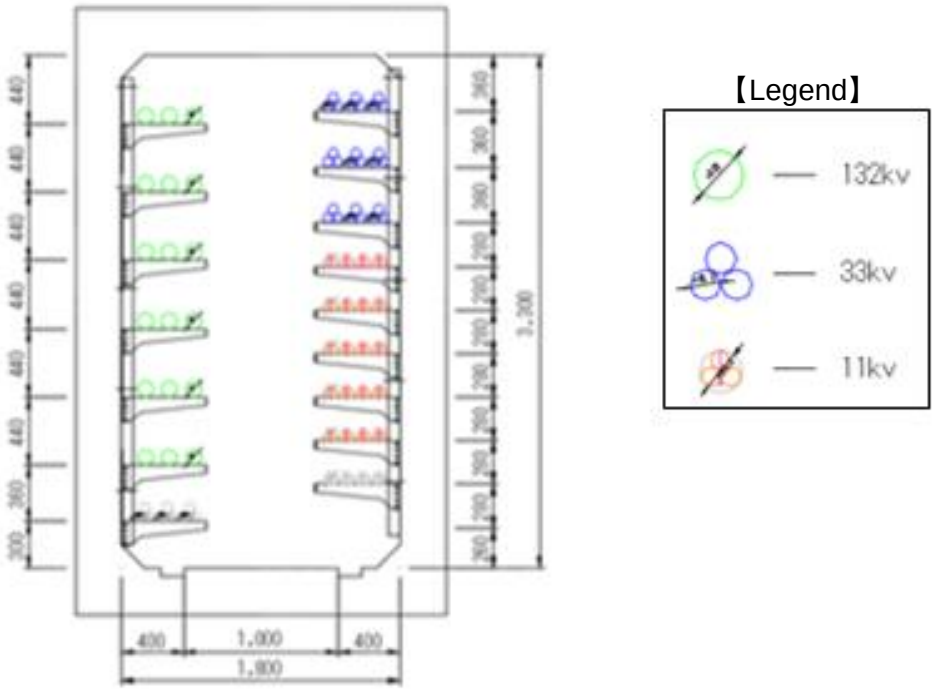
14.3 The results of the design around UGSS

The JICA Team confirmed the location of the underground tunnel, which is connected to the UGSS, with the substation design team. Consequently, the location of the underground tunnel for Gulshan UGSS is specified as below.



(Source: The JICA Team)

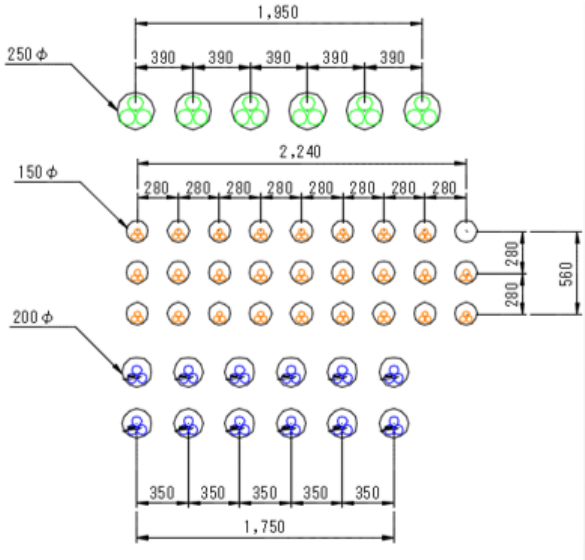
Figure 14-16 Location of Underground Tunnel for Kawranbazar UGSS



(Source: The JICA Team)

Figure 14-17 Cross section view for Transmission and Distribution tunnel

The design for the connecting part between the UGSS and Transmission and Distribution tunnel is a DUCT type, because it is necessary to separate the structure of the UGSS and Transmission and Distribution tunnel. This is described below.



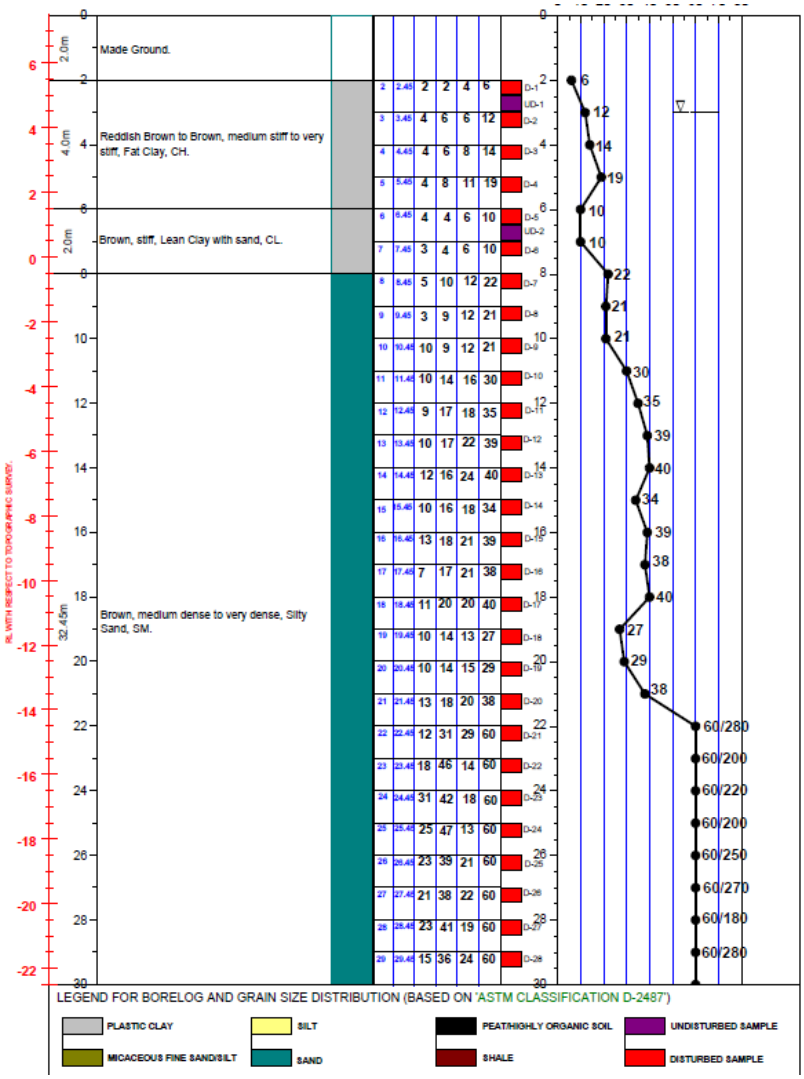
(Source: The JICA Team)

Figure 14-18 Connection view for Transmission and Distribution DUCTs

As mentioned above, the duct part is only the part connecting the UGSS and Transmission and Distribution tunnel. After passing through the duct, it is accommodated in the Transmission and Distribution tunnel as shown in "Cross section view for Transmission and Distribution tunnel". The reason for the connection with the UGSS and Transmission and Distribution tunnel duct is to make the UGSS and the tunnel separate structures.

14.4 Soil conditions around the UGSS

The SAPI team obtained the geological survey data previously conducted by the Mass Rapid Transit project undertaken by Nippon Koei, and evaluated the geological data for the UGSS construction surrounding areas as follows.



(Source: PROSOIL FOUNDATION CONSULTANT)

Figure 14-19 Subsoil stratification around UGSS

One of the important decisions at the time of construction of the Underground Tunnel is the steel sheet piling method.

From this data, The SAPI team can propose a method for installing the seat pile press in consideration of water proofing. Alternatively, the SMW method is another proposal. This is because there is a possibility of civil engineering work for the UGSS construction and construction work for the Underground Tunnel at the same time.

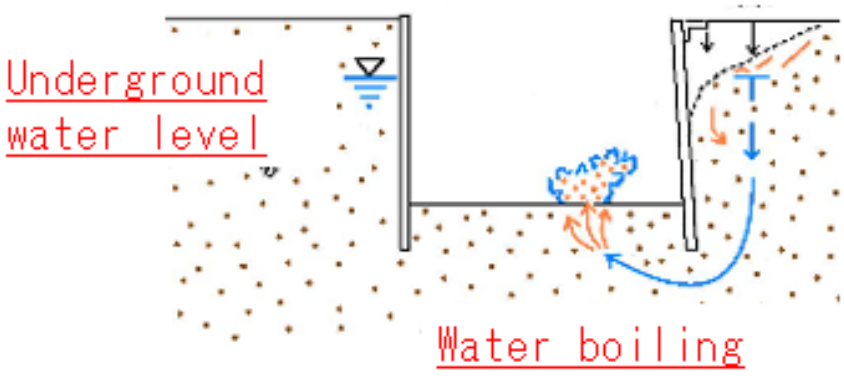
Next, regarding the occurrence of heaving, it could be confirmed from the data that it will not occur at the tunnel construction site, because heaving is a phenomenon that can occur when the clay layer ground is a bottom plate. There is, however, a possibility of the water boiling phenomenon occurring. If it is confirmed in the detailed design, the Engineering Services Consultant will provide a ground reinforcing method and prevent any water boiling and heaving caused by excavating the ground. A further detailed boring survey will be conducted by the Engineering Services Consultant.

14.4.1 Explanation of water boiling

The state of the ground conditions is as follows.

- Drilling base is sandy soil
- High groundwater level

When using the retaining wall of a water barrier (steel sheet pile, SMW, etc.), upward penetrant flow occurs due to the water level difference. If this osmotic pressure exceeds the effective weight of soil, it boils like water. Soil at the bottom of the excavation loses shear resistance and suddenly the stability of the soil retention is impaired. As a result, the excavation of the bottom surface is destroyed by the water influx.



(Source: The JICA Team)

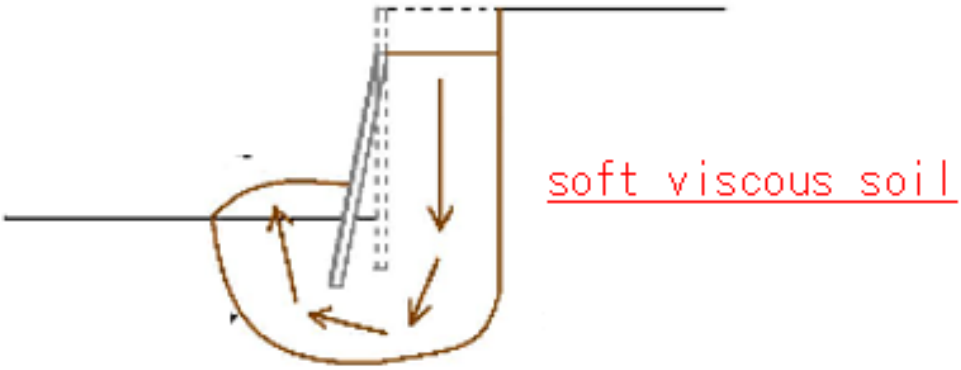
Figure 14-20 Explanation of water boiling

14.4.2 Explanation of heaving

The state of the ground condition is as follows.

・Mainly N value is 3 or less･
・Drilling base is soft viscous soil

Depending on the weight of the soil on the back, etc. 1. Bumping of the drilling dase 2. The dirt of the retaining wall 3. The settlement of the surrounding ground occurs, Ultimately the retaining wall will collapse. As a result, the phenomenon that the bottom of excavation is destroyed by the inclusion of soil is said.



(Source: The JICA Team)

Figure 14-21 Explanation of heaving

14.4.3 Explanation of SMW (Soil Mixing Wall)

An SMW is a wall body that mixes soil and cement slurry to create a wall in the ground. The SMW method involves drilling the original ground with an auger machine, which discharges cement slurry from its tip to make one wall body. In addition, we will create each element by wrapping it.

(Source: The JICA Team)

Figure 14-22 Explanation of SMW (Soil Mixing Wall)

14.4.4 Explanation of Steel Sheet Piling

The steel sheet pile method involves joining steel sheet piles to each other, and it exerts excellent water-proofing performance. There are various construction methods, such as the vibrating construction method, press fitting with auger, press fitting method, water jet construction method, etc. It is necessary to decide the construction method considering ground conditions, construction scale, site conditions, and surrounding environment of the site.

(Source: The JICA Team)

Figure 14-23 Explanation of Steel Sheet Piling

14.4.5 Other information accompanying Mass Rapid Transit construction

Part of the underground transmission route from Kawranbazar to Dhanmondi SS overlaps the Mass Rapid Transit construction site.

(Source: The JICA Team)

Figure 14-24 Overlap Point between Underground Line and MRT

The construction process of this part takes 42 months from September 2018, and Nippon Koei are planning to pile to the roadway and sidewalk part. As a result of this, the Engineering Services Consultant will need to coordinate with Nippon Koei on the construction process and construction site.

14.5 Laying method for underground transmission and distribution cables

Initially, the SAPI team was considering the direct burial method, which is a common, low-cost construction method in Bangladesh. However, as a result of discussions with DPDC, the SAPI team proposed DUCT type (only 132KV) due to the following benefits.

① After completion of a construction day, the road can be released. This is effective for alleviating traffic congestion. If 500 m is set as the cable entry section, using the direct burial method entails closing the road for about 2 months. Therefore, the DUCT type is more effective.

② If a cable accident occurs, remediation is completed within several days. However, in the case of the direct burial method, this takes about one month or more because it is necessary to excavate all the sections and take out the cables. Therefore, the DUCT type is more effective.

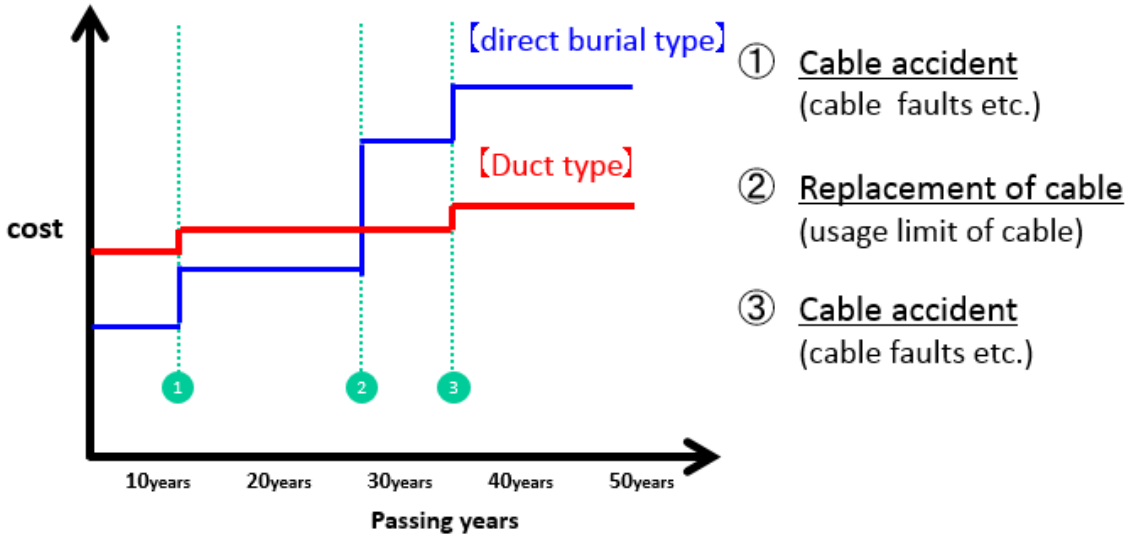
Table 14-2 Comparison of the two cable laying methods

Terms	DUCT type	Direct burial
Road closure period	Real construction time only (7-8 hours)	Approximately 2 months per span
Accident handling period	Approximately 1 week	Approximately 1 month
Evaluation	1st	2nd

(Source: The JICA Team)

③ When comparing construction costs, at the beginning of construction the DUCT type is costly, but this situation will be reversed in approximately 30 years because the direct

burial method requires excavation of all spans during cable exchange, whilst the DUCT type does not require such excavation. Therefore, the DUCT type is more effective.



(Source: The JICA Team)

Figure 14-25 The relation between cable construction cost and passing years

However, there are concerns about the initial costs for the Duct type being higher than those for the direct burial type. Therefore, it is necessary to examine the detailed construction costs and obtain agreement with DPDC, it is decided to construct with direct burial type.

14.6 Ground Penetrating Radar (GPR) survey

Since the 11th general election in Bangladesh was decided to be held on 30th December 2018, all excavation work on public roads by the city corporation to the end of 2018 and beginning of 2019 was prohibited. Therefore, the initially planned Soil Investigation became impossible.

As an alternative, a GPR survey was planned, as per the below, and this will be carried out in December.

The GPR survey involves irradiating microwaves from above ground and checking the location and scale of buried objects from the data generated by the rebounds.

The SAPI team evaluated the results obtained from the GPR survey and the geographical survey data carried out by CEGIS, producing the following results.

As a result of GPR survey, the SAPI team was able to confirm several existing power cables, together with water, sewage and unknown pipes especially around the UGSS.

Therefore, it is necessary to carry out additional investigations at an early stage of the Engineering Services, and to ascertain the detailed positional relationship between the existing buried objects and the tunnel. Depending on the results, the Engineering Services Consultant may need to request DPDC and owner of the buried material to relocate it, or it may be necessary to negotiate with the relevant party to use the green area.

(Source: The JICA Team)

Figure 14-26 Picture of GPR survey

14.6.1 Points for selection of GPR survey locations

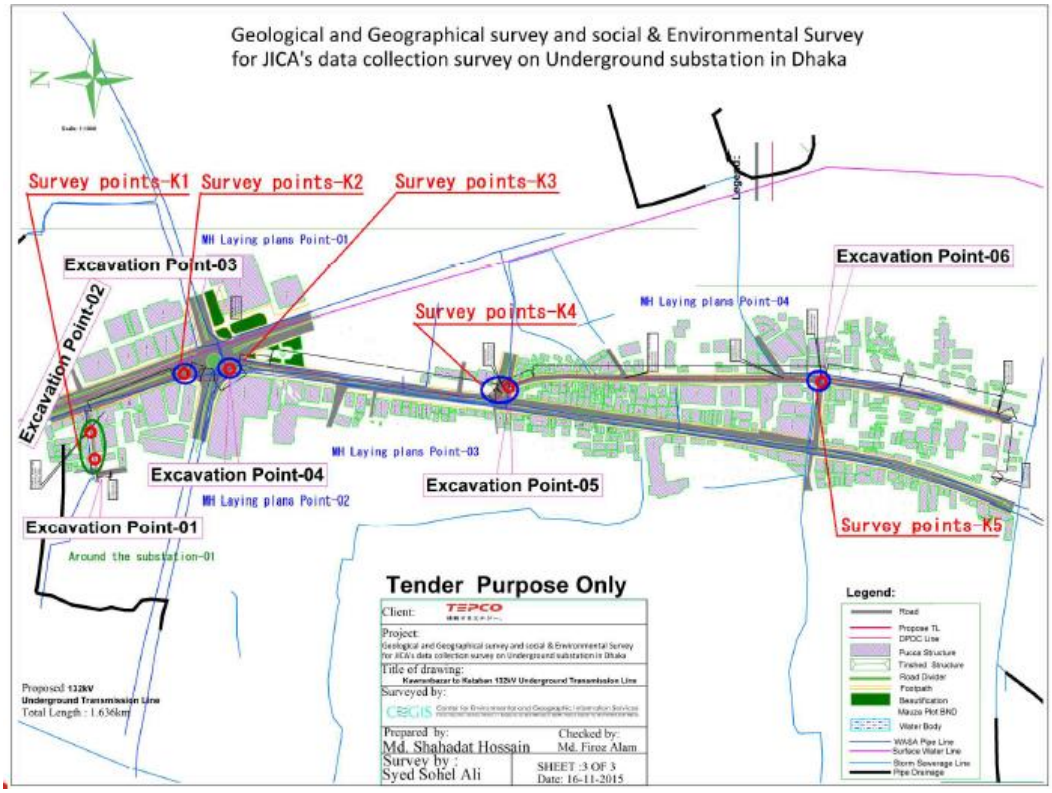
- Around UGSS
  Because large-scale excavation work is necessary for tunnel laying, depending on the situation of the buried objects around the UGSS it may be necessary to change the tunnel size and route, and this may become a factor that greatly changes the construction period and cost.
- Excavation locations that were originally planned
  To check the intersections of the existing buried objects and the planned power transmission route. These locations are as per the GPR survey locations.
- Plans for construction of cable joint boxes (MH)
  In order to determine the underground transmission route, it is necessary to determine the MH locations.

14.6.2 Work items and Quantities for GPR survey locations

Table 14-3 Work items and Quantities for GPR survey locations

District	Survey area		Number of measurements		
	Longitudinal (m)	Cross sectional (m)	Longitudinal	Cross sectional	Total
Kawran 1	20.0	2.0	5	3	8
Kawran 2	10.0	2.0	3	3	6
Kawran 3	10.0	2.0	3	3	6
Kawran 4	10.0	2.0	3	3	6
Kawran 5	10.0	2.0	3	3	6

(Source: The JICA Team)

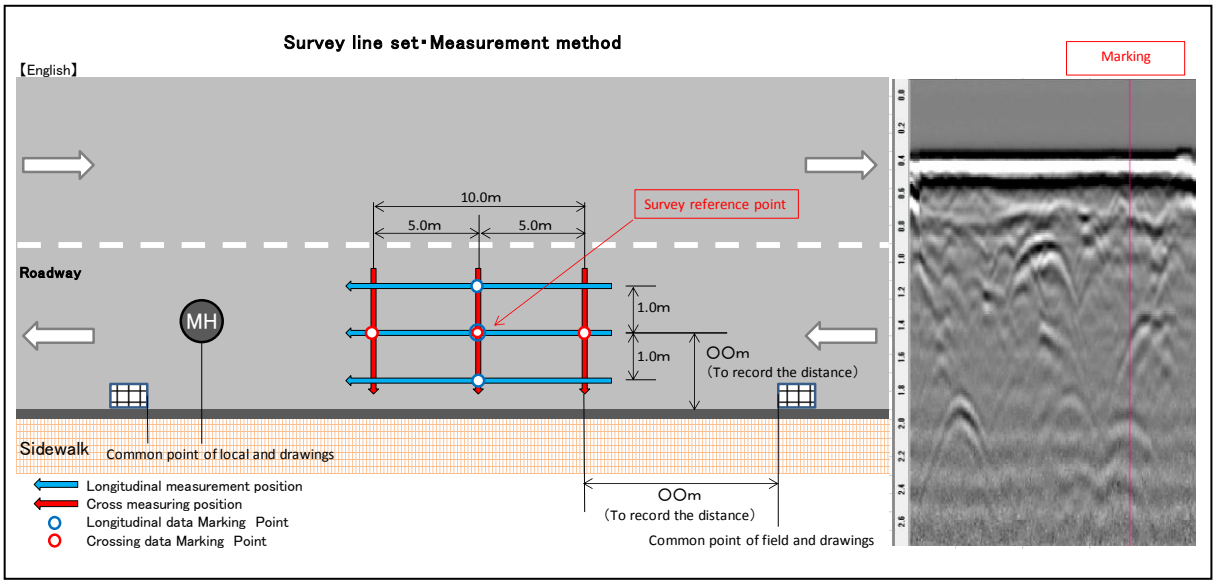


(Source: The JICA Team)

Figure 14-27 GPR survey locations in Kawranbazar area

14.6.3 Planning measurement method according to local situation

Considering the characteristics of the underground radar owned by the BUET, the SAPI team devised a measurement method so that we can ascertain the precise status of buried objects, as follows.

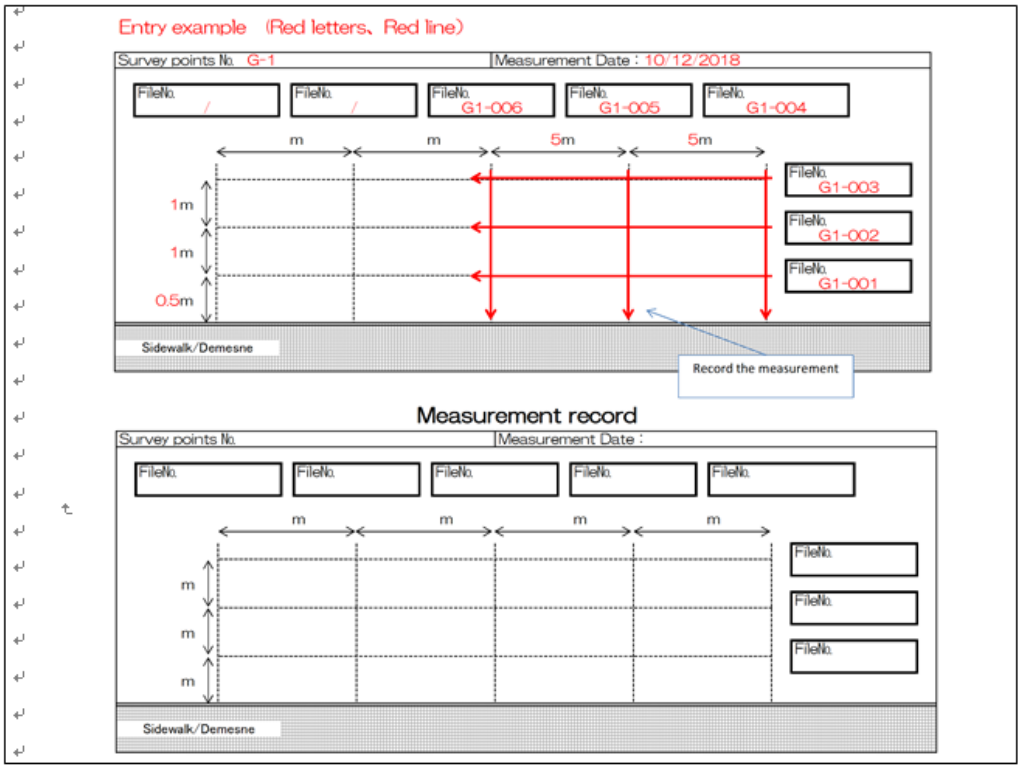


(Source: The JICA Team)

Figure 14-28 GPR Survey measuring method diagram

14.6.4 Planning measurement recording method

In order to ensure field repeatability of the survey results, a measurement recording method was devised. Survey reference points were set and survey pins were installed. Below is an example of a measurement record document.



(Source: The JICA Team)

Figure 14-29 Example of Planning measurement record

(Source: The JICA Team)

Figure 14-30 Pictures of GPR survey

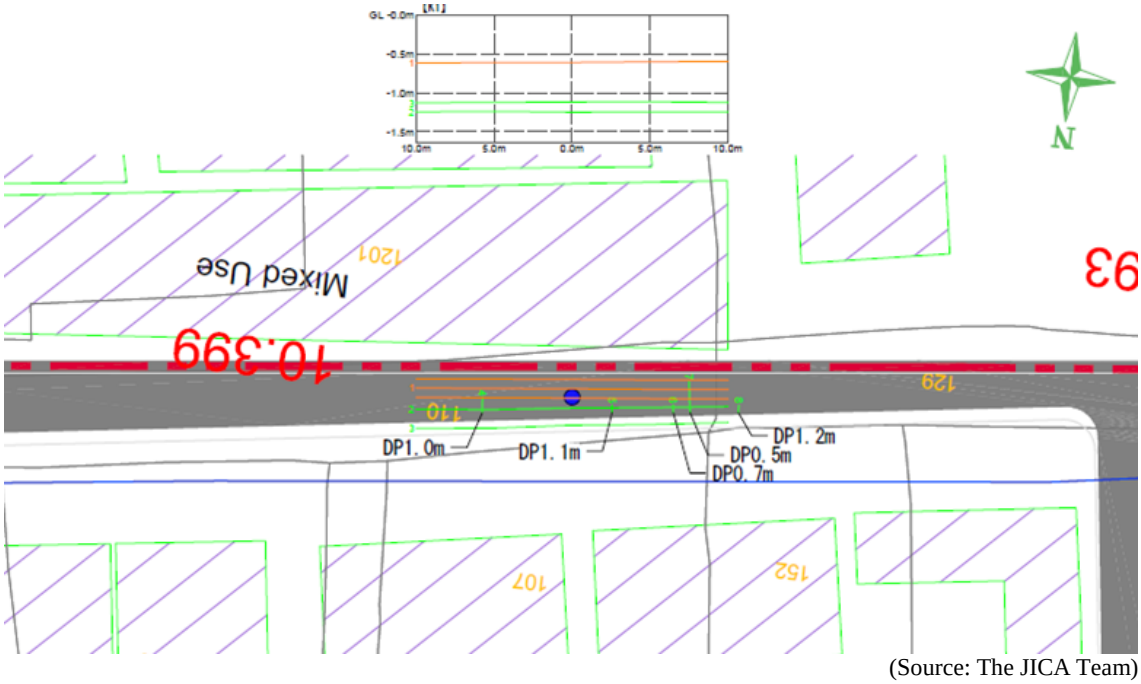
14.6.5 Data analysis results

For data provided from BUET, dedicated analysis software was used to correct soil covering by migration processing, and the positions of the buried objects were specified. As a result of the data analysis, we confirmed 25 buried items not listed in the existing buried ledger in addition to the buried items described in the existing buried ledger. The list of the survey results is shown below.

Table 14-4 The Results of the Buried Object Survey and Analysis

District	Investigation results					
	Water	Sewage	Electrical	Drain	Gas	Unknown
Kawran 1			○			○
Kawran 2			○			
Kawran 3						○
Kawran 4	○					○
Kawran 5	○		○			○
Legend						

(Source: The JICA Team)

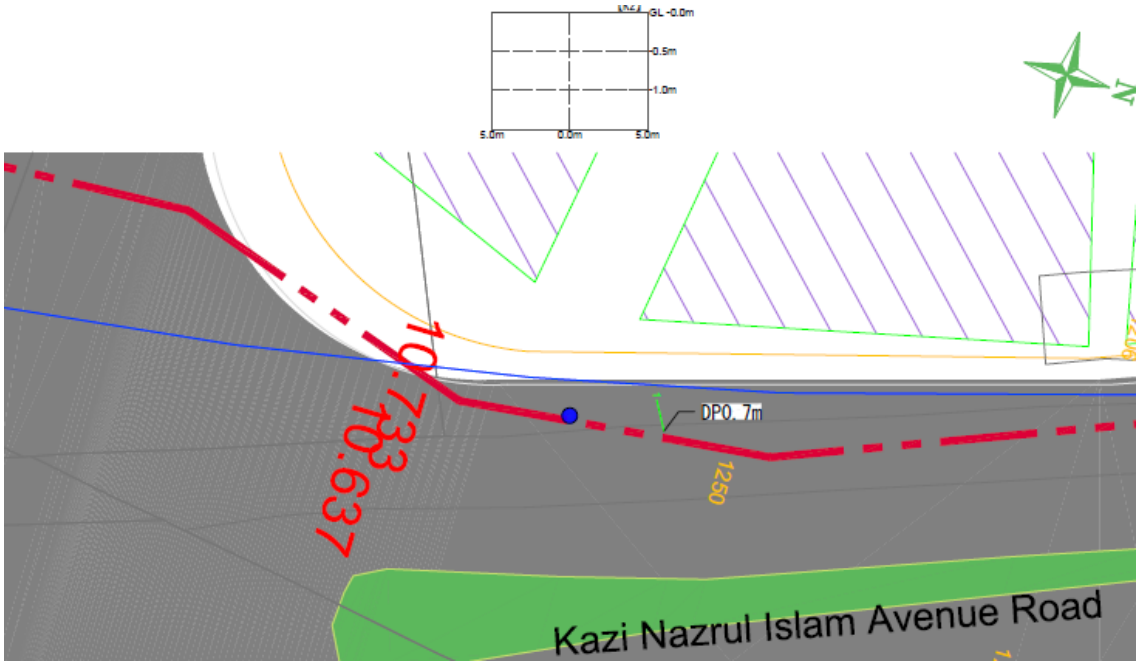


(Source: The JICA Team)

Figure 14-31 Data from Kawranbazar 1

It was confirmed that Water, Electrical and Unspecified objects were buried at the Kawranbazar 1 point. The depth of burials is as follows.

・Electrical: GL-0.6m ・Unspecified: GL-0.5～1.2m

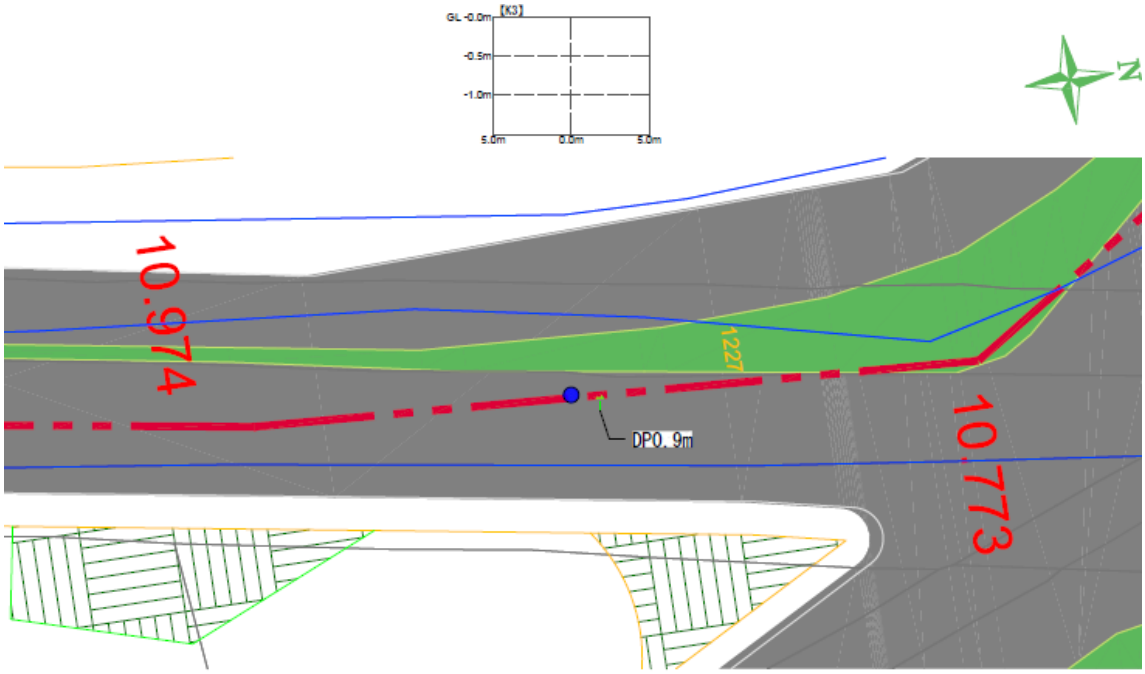


(Source: The JICA Team)

Figure 14-32 Data from Kawranbazar 2

It was confirmed that Water and Unspecified objects were buried at the Kawranbazar 2 point. The depth of burials is as follows.

・Unspecified: GL-0.7m

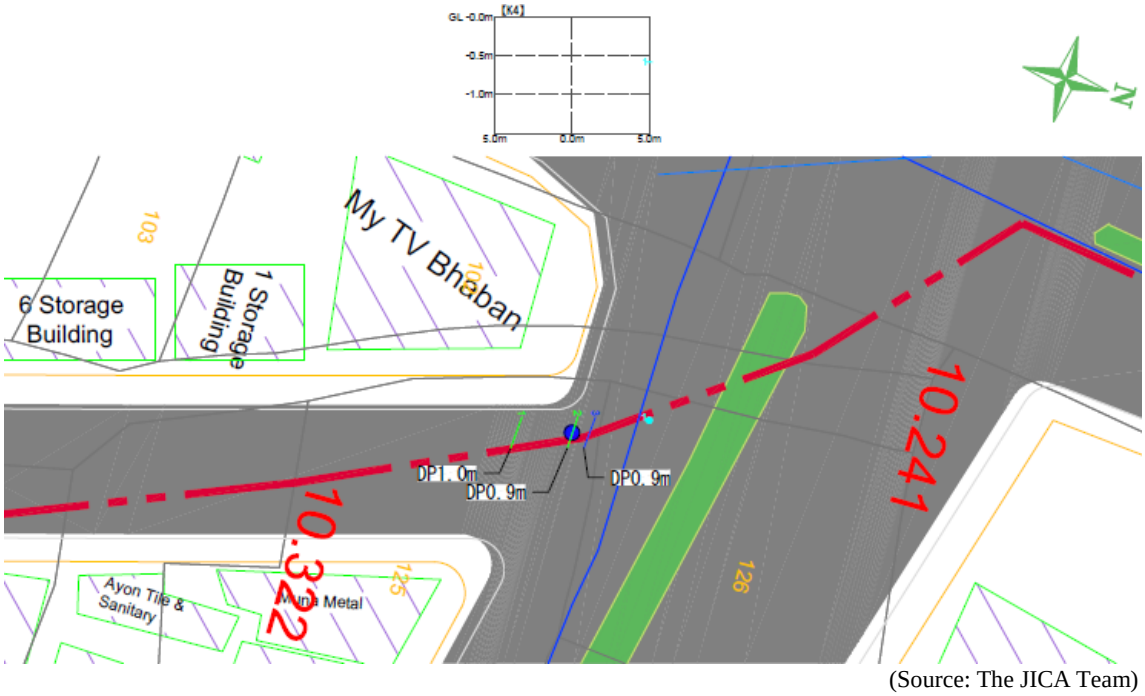


(Source: The JICA Team)

Figure 14-33 Data from Kawranbazar 3

It was confirmed that Water and Unspecified objects were buried at the Kawranbazar 3 point. The depth of burials is as follows.

・Unspecified: GL-0.9m

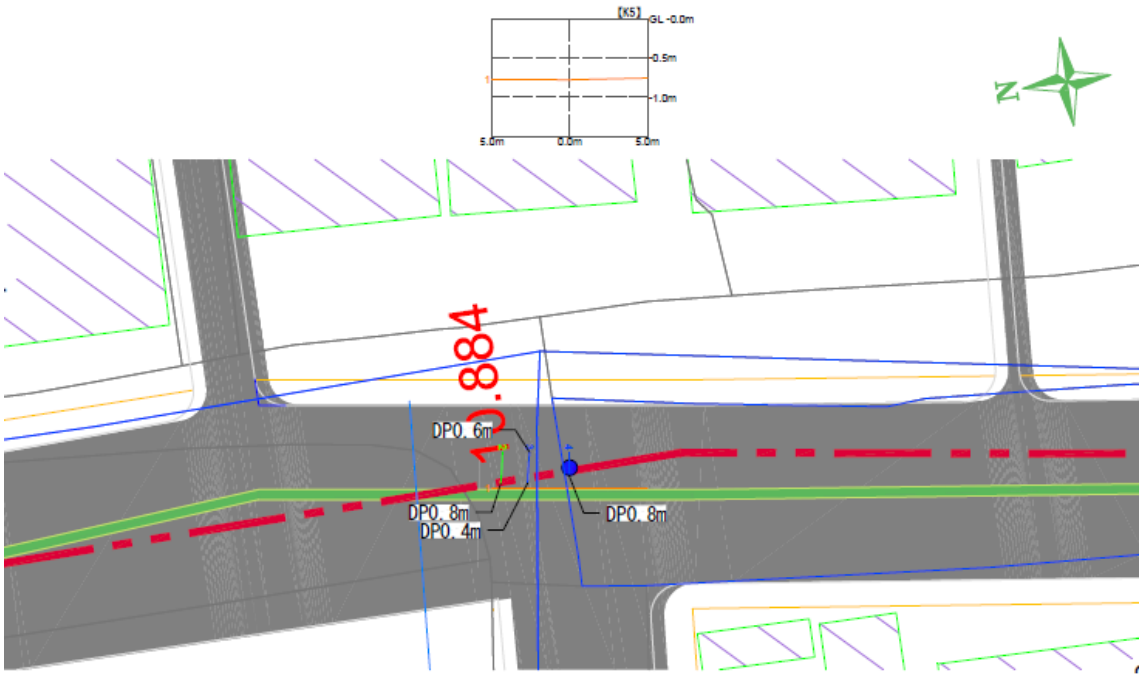


(Source: The JICA Team)

Figure 14-34 Data from Kawranbazar 4

It was confirmed that Water and Unspecified objects were buried at the Kawranbazar 4 point. The depth of burials is as follows.

・Water: GL-0.9m・Unspecified: GL-0.6～1.0m



(Source: The JICA Team)

Figure 14-35 Data from Kawranbazar 5

It was confirmed that Water, Electrical and Unspecified objects were buried at the Kawranbazar 5 point. The depth of burials is as follows.

・Water: GL-0.4～0.8m ・Electrical: GL-0.8m・Unspecified:GL-0.8m

The SAPI team was able to confirm several existing power cables, and water, sewage and unknown pipes around UGSS.

The items of concern when constructing an Underground tunnel at this place are as follows. When the tunnel is constructed, an excavation width of approximately 3 m is required. However, the area is congested with various buried objects and it will be difficult to construct a tunnel after excavation via precasting.

The necessary measures are:

(1) Relocate buried objects and secure excavation width
(2) Protect buried objects with hanging protection, construct tunnel at site without using precasting
(3) Change the planned Underground Tunnel construction location

Regardless of whether the (1) or (2) measures are taken, there is concern that the construction costs and construction period will increase. Regarding (3), if tunnel construction work can be done in the green area of the south side, it is highly possible that the construction costs and construction period can be reduced. Regardless of (2), there is concern that the construction costs and construction period will increase. Pictures of hanging protection implementation are shown below.

(Source: The JICA Team)

Figure 14-36 Pictures of hanging protection

14.7 Surveys and tasks to be conducted after SAPI project

Based on the results of this SAPI project, it is necessary for the Engineering Services Consultant and DPDC to implement the future following tasks.

【Engineering Services Consultant】
- Adjustment of 1st pole around the UGSS with DPDC
- Excavation to confirm buried objects (especially around the UGSS)
- Request relocation of buried objects to DPDC based on the excavation results
- Confirm city corporation certificate
- Coordinate with Nippon Koei on construction process and construction site
- Structural calculation of optimum shaft part based on boring results
- Detailed design for tunnels, ducts and Direct burial (including drawing preparation and Structural calculations)
- Construction cost study

【DPDC】
- Determination of position for 1st pole around the UGSS
- Determination of relocation for existing power cable
- Determination of tunnel conditions (e.g. maximum temperature, maximum wind velocity, minimum lighting intensity)
- Confirmation of the fire department permission for the cable tunnel equipment
- Negotiate with the relevant party for use of the green area

Chapter 15. Architectural Design of Underground Substations and Superstructures (DPDC)

15.1 General considerations for the co-ordination

As described in the previous Chapter available land area is still subject to change, and building set back issues are also an obstacle to be solved. These will affect the building design significantly. Therefore, the JICA Team has discussed with DPDC about building the design based on the UGSS's current layout design. The JICA Team will continue to discuss this with DPDC while studying the details of the underground building.

15.1.1 Design Constraints on Ground Floor due to Underground Substation Operation

(1) The architect understands the matter of the size of the opening for the intake/exhaust design, but requested to the JICA Team that the services should be located together at one side of the building. The JICA Team will study this issue and reply to the architect by the end of August.

(2) The JICA Team has advised the architect to secure the load bearing strength for the ceiling above the machine hatch, sliding-in route and passage route. The architect has requested to the JICA Team that the ceiling height above the machine hatch should be as low as possible. After discussions, it was decided that the current design height should be lowered from 12m in height to 11m. The JICA Team has agreed that this ceiling height should be 11m subject to the installation of the machine hatch opening cover on the car parking floor. (Blocking some car parking space for a few days whilst opening the machine hatch cover on the floor would not be a significant issue.)

(3) Separation of the entrance/exit between superstructure and underground building

15.1.2 Design Coordination with Superstructure and Underground Structure

In order to satisfy the superstructure layout design, the straight columns should be matched with the underground building's straight columns. In addition, the piping and plumbing which passes from superstructure to underground structure needs to be designed properly. These designs should be done while continuing the coordination work between superstructure and underground structure, ensuring that sufficient space is secured within the building.

15.1.3 Firefighting

The firefighting system must meet the requirements specified in the BNBC standards - specifically, whether firefighting apparatus is necessary for each room or not, what kind of sensors should be prepared, what kind of firefighting must be employed and so on. However, there may be no description in BNBC fitting the UGSS's design because the project is a pilot project for constructing underground substations. If no, or insufficient descriptions exist in BNBC, a new proposal to complete the missing specifications for firefighting should be prepared to secure human and equipment safety. Hence, the JICA Team confirmed the current laws and regulations regarding UGSS operation with the local consultant based on the current designs, layouts and equipment specifications for the UGSS. The following shows a summary of these in Japan, Singapore and Bangladesh.

Table 15-1 Summary of Firefighting Standards in Bangladesh

S/N	Respective authority	Provision in Japan	Provision in Sg	Req'd provision in BD
1	Fire Dept	Smoke detectors could be integrated with Fire Alarm system?	Yes	Yes
2	Fire Dept	There are the following Fire regulations in Japan. Are they the same in Bangladesh? - Passages and rooms are to be used as exhaust ducts. - Walls and floors used as ducts should have Fire protection dampers. - In the case of fire, if the temperature increases and the fuse of the fire protection damper melts and fuses, the damper will be activated to close automatically in order to stop flames and smoke. - And/or in the case of activation of inert gas, the damper will close automatically in order to stop flames and smoke.	● Exhausts/fresh air ducts shall be used for passages and rooms. Passages/corridors are more commonly ventilated by supplying fresh air instead of exhaust. ● Ducts that pass through fire compartment walls and floors shall be fitted with fire dampers. ● Fire dampers shall be constructed in accordance with the requirements in Singapore Standard SS 333. ● Pressure relief dampers shall be provided at the walls of clean gas protected rooms to relieve room pressure during clean gas discharge.	BNBC 2006 Part 4 Fire Protection. Appendix D. - D 9.2 Fire Dampers
3	Fire Dept	Fire extinguishing system in the electrical facilities room requires inert gas fire extinguishing system?	Electrical rooms shall be protected by a sprinkler for a sprinkler-protected building. However, if the room houses high value equipment such as servers and telecommunication equipment, the sprinklers can be replaced by a clean gas total flooding system.	Inert gas fire extinguishing system is required.
4	Fire Dept	The room in which the inert gas fire extinguishing system is installed will	Smoke detectors shall be installed and clean gas total flooding system	BNBC 2006 Part 4 Fire Protection. Appendix C.

		require smoke detector + heat sensor?	shall operate automatically with the activation of at least two smoke detectors in the gas protected room to minimize false discharge.	- C 2.1 Heat Detectors. - C 2.2. Smoke Detectors.
5	Fire Dept	Activating conditions of inert gas fire extinguishing system will require a timing in which smoke detector and heat sensor go off?	After the second detector is activated, a signal will be transmitted from the clean gas panel to open the respective solenoid valves in order to release the clean gas after a 30-second delay.	BNBC 2006 Part 4 Fire Protection. Appendix C. - C 2.1 Heat Detectors. - C 2.2. Smoke Detectors.
6	Fire Dept	Transformers, switch gear, electrical cables, control panels, protective relays, batteries and house transformers are considered electrical facilities?	Yes. However, for room housing batteries, hydrogen gas detectors shall be provided and room ventilation shall be designed to limit the maximum concentration of Hydrogen gas to 1% of the total volume of the room.	Yes
7	Fire Dept	- Intakes/exhausts, relays, cooling systems, passages, toilets and shafts will not be considered electrical facilities? - Fire extinguishing system will not be required for these?	All rooms shall be protected with sprinklers for a sprinkler-protected building except for areas specified in the Fire Code, such as canopies, external corridors, external linkways, etc.	Yes. These are considered electrical facilities. All items having an electrical connection need to have a Fire Extinguishing system. Unsure about toilet shafts.
8	Fire Dept	- Inert gas cylinders need to be duplicated for redundancy in order to avoid difficulties in cylinder procurement?	The number of reserved cylinders shall be equal to the largest number of connected cylinders in any of the gas cylinder rooms.	Yes, stand-by inert gas cylinders are required.
9	Fire Dept	- Hole closings on the wall and floor for control cables and electrical cables will require fireproof compartment and to be filled with non-shrinkage mortar?	Yes, seal with fire-stopping sealant.	Yes, required.

10	Fire Dept	Emergency elevators, indoor fire hydrants, underground radio system, direct contact system, connected water supply system and connected sprinkler system will be required?	Yes, required.	Yes, required.
11	Fire Dept	Pipe shafts and machine hatches will be required to be divided on each floor? (This is for the vertical dividing concept.)	Yes, required.	Yes, required
12		- Emergency power supply system will require emergency generator for power system and battery for non-power system?	Emergency generator shall be provided as secondary source of supply.	Yes, required.
13	Building Division	- Emergency elevator will be required?	For a building with a habitable height that exceeds 24m or with a depth of basement exceeding 9m below ground level, at least 2 fire lifts shall be provided.	BNBC 2012 Chapter 4, Lifts, Escalators and Moving Walks. At least 1 fire lift for building height of more than 15m.
14	Building Division	Pipe shafts and machine hatches will be required to be divided on each floor? (This is for the vertical dividing concept.)	Yes, required for building compartmentation.	Yes, required for building compartmentation .

(Source: The JICA Team)

The JICA Team confirmed the specific firefighting design based on the above fundamental requirements on firefighting.

Table 15-2 Firefighting requirements

№	Room Name	Japan		Singapore		Bangladesh (BNBC 2006)	
		Type of Fire Detector	Type of Fire Fighting	Type of Fire Detector	Type of Fire Fighting	Type of Fire Detector	Type of Fire Fighting
1	Pipe Shaft	Smoke detector	fire-extinguisher	Smoke detector for electrical shaft	Sprinkler for wet shaft	Smoke detector for electrical shaft	Sprinkler for wet shaft
2	Emegency Generator	Smoke/Heat detector	Inert gas fire fighting	yes	yes	No clear indication. To follow as per Singapore/ Japan	No clear indication. To follow as per Singapore/ Japan
3	Lift Machine	Smoke detector	fire-extinguisher	yes/ detector		yes/ detector	
4	Lift	No	fire-extinguisher	No	No	No	No
5	Stair 1	Smoke detector	fire-extinguisher	yes/detector	Cut off sprinkler at the door.	yes/detector	Cut off sprinkler at the door.
6	Air Intake Wind tunnel	Smoke detector	fire-extinguisher	NO	NO	Smoke detector	
7	Air Exaust Wind tunnel	Smoke detector	fire-extinguisher	Smoke detector		Smoke detector	
8	Control	Smoke detector	fire-extinguisher	Smoke detector		Smoke detector	
9	Control Panel	Smoke detector	fire-extinguisher	Smoke detector		Smoke detector	
10	Superstructure Transformer	Smoke/Heat detector	Inert gas fire fighting	Flame detector	Deluge water system	Flame detector	Deluge water system
11	Air Exaust Fan	Smoke detector	fire-extinguisher		Sprinkler point		Sprinkler point
12	Corridor	Smoke detector	fire-extinguisher		Sprinkler point		Sprinkler point
13	Toilet	Temperature de	fire-extinguisher		Sprinkler point		Sprinkler point

№	Room Name	Japan		Singapore		Bangladesh (BNBC 2006)	
		Type of Fire Detector	Type of Fire Fighting	Type of Fire Detector	Type of Fire Fighting	Type of Fire Detector	Type of Fire Fighting
14	Hot Water Supply	Constant temperature detector	fire-extinguisher	No	No	No	No
15	33/11kV Switchgear	Smoke detector	fire-extinguisher	Flame detector		Flame detector	
16	Station Transformer	Smoke/Heat detector	Inert gas fire fighting	Flame detector	Deluge water system	Flame detector	Deluge water system
17	132kV GIS	Smoke detector	fire-extinguisher	Flame detector	Deluge water system	Flame detector	Deluge water system
18	Battery Charger	Smoke detector	fire-extinguisher	Smoke/Heat detector		Smoke/Heat detector	
19	Front Chamber	Smoke detector	fire-extinguisher	Flame detector	Flame detector	Flame detector	
20	33/11kV Cable	Smoke/Heat detector	Inert gas fire fighting		Sprinkler point		Sprinkler point
21	132kV Cable	Smoke/Heat detector	Inert gas fire fighting		Sprinkler point		Sprinkler point
22	Fire Fighting	Smoke detector	fire-extinguisher		Sprinkler point		Sprinkler point
23	Air Intake Fan	Smoke detector	fire-extinguisher	No	No	yes/detector	
24	132kV Transformer	Smoke/Heat detector	Inert gas fire fighting	Flame detector	Automated deluge system	Flame detector	BNBC 2006 (Appendix D):- when housed in basement , transformer rooms shall be equipped with automatic high velocity water spray sysetm.
25	33kV Transformer	Smoke/Heat detector	Inert gas fire fighting		Automated deluge system		
26	Sewage Pump	Smoke detector	fire-extinguisher		Sprinkler point		Sprinkler point
27	Circulating Water Pump	Smoke detector	fire-extinguisher				

(Source: The JICA Team)

The above table shows our understanding regarding the required fire protection provisions for an underground sub-station building. In the above summary, the JICA Team noted the below points.

- Basically, sprinklers are the main method of firefighting. This might necessitate considerable space for large water tanks in the UGSS. Additionally, water-proof specifications would be required for equipment.
- Water-type firefighting for oil-immersed transformers.
- Flame sensor is required for electric facility room.
- Two emergency lifts.

If the UGSS follow the above designs, a huge amount of water would be necessary. This might lead to deeper UGSS due to the additional space needed for water tanks, pumps and emergency generators. Furthermore, having two emergency lifts would require changing the current layout. Hence, the JICA Team is considering discussing the above problems with RAJUK and other relevant authorities in order to get waivers based on Japanese practices.

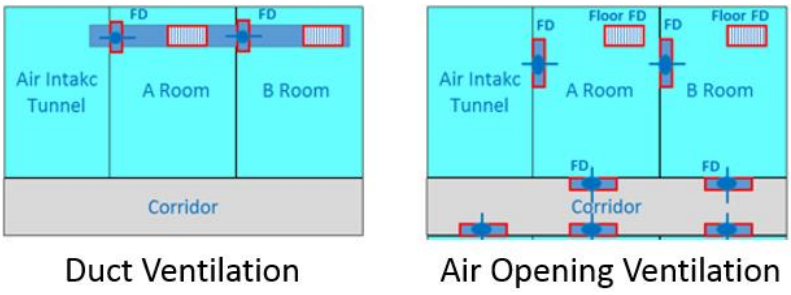
- Waiver to change firefighting methods from water to inert gas for some rooms
- Waiver to remove flame sensors for GIT and station transformer room
- Waiver for the number of emergency elevators from two to one

15.1.4 Ventilation

The ventilation design needs to meet the minimum number of air changes in each room for human safety based on BNBC. In parallel, it is also important to maintain the allowable ambient temperature specified in the technical requirements in the equipment room using ventilation cooling to dissipate heat. It is general practice to consider only the latter issue, ventilation cooling to dissipate heat, because the necessary volume of air flow for the latter is much greater than for the former. Hence, the JICA Team calculated the ventilation volume based on the amount of heat dissipation from equipment with the assumption of meeting the minimum number of air changes for each room.

The necessary ventilation volume is calculated in the previous section. Next, the air distribution to every room, with proper air volume, should be considered. Generally, there are two types of air distribution in a UGSS, as per the following.

- Duct usage for ventilation: Air distribution through ducts to every room. Easy distribution with proper air volumes to every room. The disadvantage is that the UGSS might have to be deeper due to the duct spaces.
- Room and corridor usage for ventilation: No need to install ducts since all rooms and corridors are regarded as passages for air flow. However, it is difficult to distribute the proper volume to the target rooms because of the difficulty in controlling the air flow.



(Source: The JICA Team)

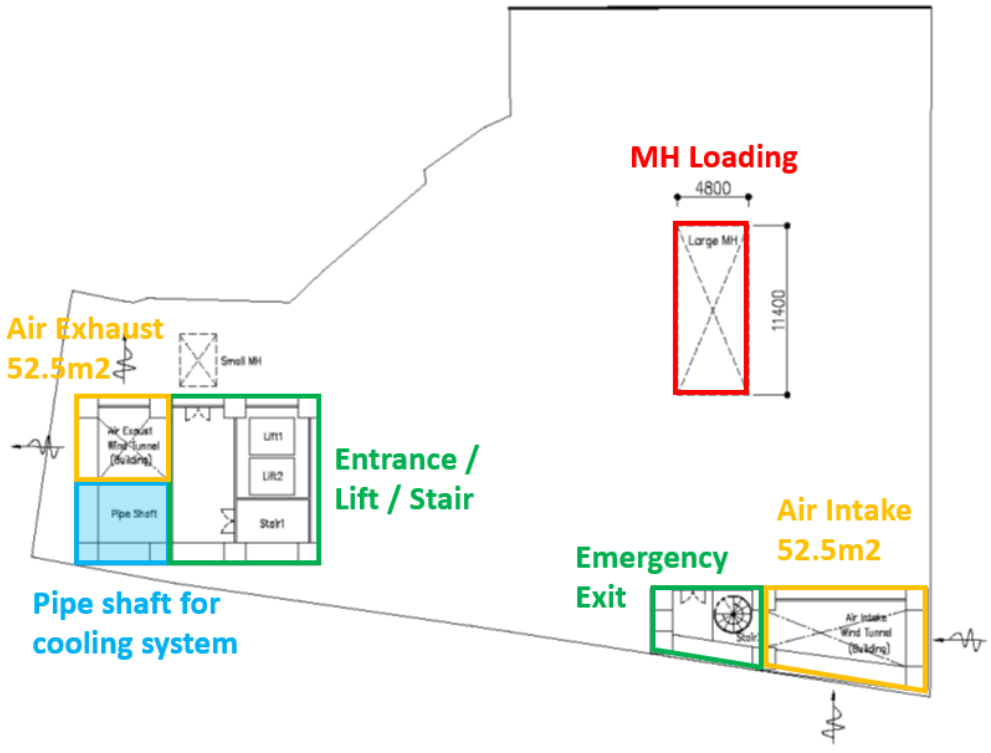
Figure 15-1 Ventilation Types

In Japan, the relevant regulations don't specify the ventilation methods, so the utility can choose the method on a case-by-case basis. However, the JICA Team confirmed that utilities might not be able to regard rooms and corridors as ventilation routes in Bangladesh. Specifically, BNBC 2012 states "Exits and exit access corridors shall not be used as supply or return air ducts or plenums". Hence, it would be necessary to discuss this issue with RAJUK in order to get waivers if ducting ventilation cannot be installed in the UGSS.

Therefore, the Engineering Service Consultant will have to consider the preliminary ducting design for ventilation to verify whether ducting space can affect the UGSS depth or not. If air opening ventilation would be technically and financially reasonable for excavation and other work, the Engineering Service Consultant will discuss a waiver with the authorities.

15.2 Superstructure Specifications for Kawranbazar Substation

DPDC announced the design competition in local newspapers in May 2018 and the competition will close in early September 2018. Eventually, the local architect had been hired on December 2018. Hence, The JICA Team informed the local architect of the ground floor design for UGSS operation in order for them to develop their design. The Engineering Service Consultant will have to review their design, and finalize the coordination on the ground floor. The following shows the ground floor design for UGSS operation.



(Source: The JICA Team)

Figure 15-2 Ground Floor Design for UGSS

15.2.1 Transportation Study on Ground Floor

The JICA Team confirms the transformer specifications for the project in this section. For the GIT, which is the biggest and heaviest of the substation equipment, many items should be considered relating to loading, transportation from the manufacturer's factory to the installation

site inside the UGSS, and installation, and these should be reflected in the superstructure and substructure designs. Hence, the JICA Team confirmed the following in the SAPI.

*Minimizing the shipping size for GIT

A minimized shipping size would lead to easy transportation and optimized superstructure and substructure designs. It is also important to take into consideration the allowable range (size/weight) of the transportation route when transporting or carrying in equipment. Hence, it is necessary to de-assemble any auxiliary devices and minimize the shipping size as much as possible. The JICA team is currently considering about W: 10,500, D: 3,700, H: 3,900, 140 t as the maximum shipping size in interviews with manufacturers.

*Secure route from manufacturer's factory to the UGSS

The transportation route covers both land and sea transportation, and loading and unloading at ports. The Contractor will ultimately be responsible for this transportation. However, the JICA Team has considered the transportation method in order to reflect a feasible method in the design. Specifically, assuming a trailer and the above shipping size, it should be verified whether it is possible to turn at narrow roads (intersections) where there are such turns near the UGSS. Detailed investigations, such as on the necessity of reinforcement for overland, waterway, road and bridge routes, etc. are required following the decision by the transformer manufacturer. In addition, it is necessary to investigate the road traffic laws in Bangladesh, consult with the relevant ministries and agencies, and determine a transportation method that satisfies the traffic conditions (size, time etc.).

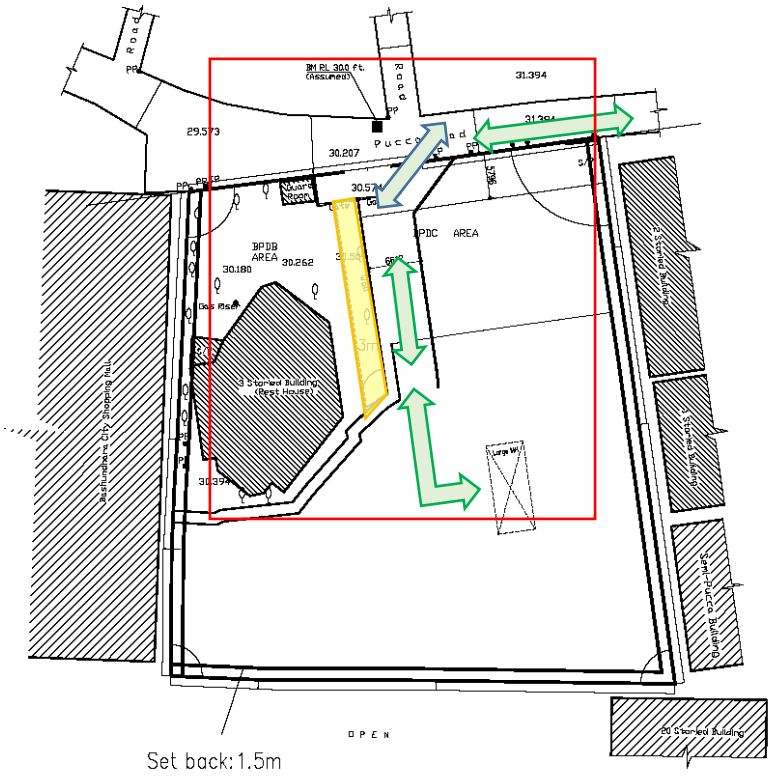
*Consideration of loading and installation method at the UGSS

The machine hatch is to be used for loading from the ground level to the installation site on B4F. The design of the machine hatch is still coordinated with the superstructure, such as its size, required height of its upper part, hook strength and installation position. The JICA Team is currently studying these issues with the logistics company.

【Kawranbazar】

As shown below, in the current layout plan the large MH is placed in the center of the UGSS area. Therefore, transportation of the UGSS equipment uses a widened introduction road. However, this width may not be sufficient. The required width depends on the specifications of the largest equipment (Transformer tank) and the size of the trailer carrying it. Considering the turning radius, it is necessary to widen the introduction road on the BPDB side. Introduction road width should be at least 6m. This is a temporary road during the construction period but negotiations with BPDB will be necessary in any case.

The intersection between the UGSS's north side road and east side road is a concern, as both are narrow roads with the east side being a busy road. It is currently being considered whether a trailer equipped with GIT of the expected maximum size can make the turn. After deciding the Tr manufacturer, a detailed examination is needed on the approach for the large machine hatch.

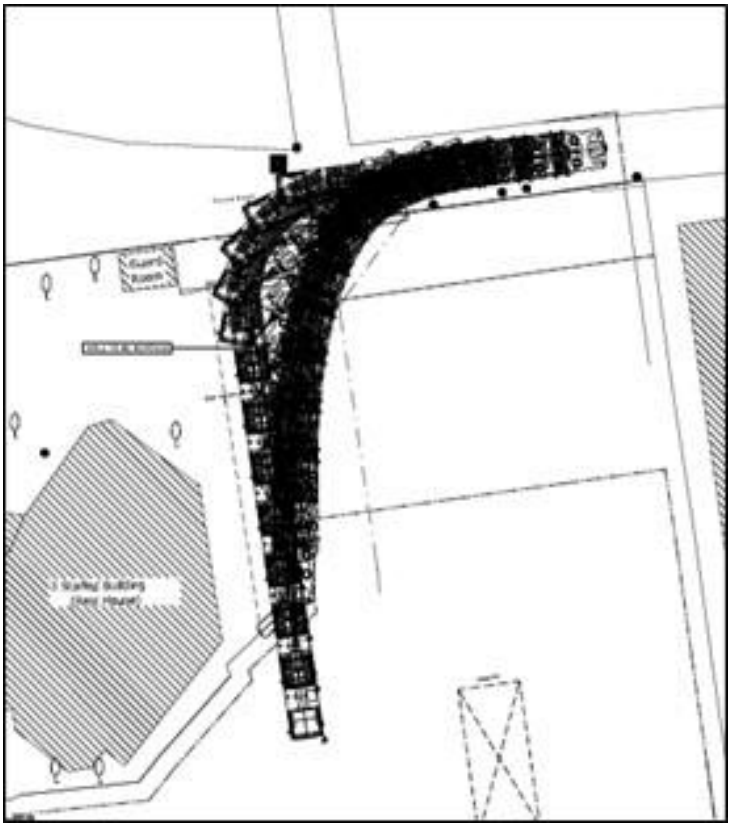


(Source: The JICA Team)

Figure 15-3 Route of loading/unloading large equipment

The JICA team studied with Nippon Express Co., Ltd., the approach using the largest equipment and trailer currently assumed. The locus shows that it cannot fit on the road that DPDC can secure by itself. As a result, it is quite evident that the project must temporarily borrow BPDB land during the construction of the UGSS.

Of course, this locus is applicable only during construction of the UGSS. The existing substation will be demolished after starting UGSS operation. After that, the upper building will be built on the UGSS. Therefore, the ground floor of the upper building must have a structure that secures the approach taking into consideration the loading/unloading of the UGSS equipment. Hence, the Engineering Service Consultant will have to study the specific transportation method based on the preliminary superstructure design. Then, they will inform the local architect of the request to modify the ground floor design if necessary.



(Source: Nippon Express Co., Ltd.,)

Figure 15-4 Close-up of entrance of Kawranbazar Site

Chapter 16. Environmental and Social Considerations (DPDC)

The Data Collection and Analysis Survey 2016/17 presents laws and regulations on environmental and social issues, environmental and social baseline data for the project area, and project outline based on which adverse impacts caused by the project implementation were anticipated, and environmental management and monitoring plans were developed accordingly.

DPDC submitted an environmental impact assessment (EIA) report with environmental management plan (EMP) and environmental monitoring plan (EMoP)[9], following the results of the Data Collection Survey, for which the Department of Environment (DOE) gave an environmental clearance certificate (ECC)[10] in September 2017[11]. The EIA was developed in compliance with *the JICA Guidelines for Environmental and Social Considerations (April 2010)* and the international standards too, as the Project uses a Japanese ODA loan.

The JICA Team, in this SAPI, further investigated if there have been any changes/alterations required in the layout, design or technical specifications from those in the Data Collection Survey. There are deviations from the predicted impacts and unforeseen adverse impacts, for which revisions and/or additions in the countermeasures have been made. The Team interviewed local associates, conducted site reconnaissance and discussed matters with DPDC to narrow down unforeseen areas, and further specified mitigation measures.

The Team intended to work on the following issues, but the severe delay in selecting architects for the superstructure made it unable to examine e and f.

a. Update and analysis of relevant laws and regulations on environment and land issues
b. Update environmental and social baseline data
c. Update anticipated environmental and social impacts caused by the project implementation based on the revised and latest layout for UGSS and route for UGC
d. Update environmental management and monitoring plan accordingly
e. Predict impacts caused by superstructure construction (pre-survey basis)
f. Predict cumulative impacts of UGSS/UGC and superstructure
g. Draw up recommendations

The Final Report on Environmental and Social Survey, Route and GPR Survey produced by the Center for Environmental and Geographic Information Services (CEGIS) describes the above a and b. 16.1 below and ANNEXES show the results of c and d. 16.2 is added to respond to some of the DOE's conditions given in the ECC. 16.3 describes recommendations as g.

16.1 Environmental and Social Impacts caused by the Project Implementation

The findings and analyses in the Data Collection and Analysis Survey 2016/17 indicated that adverse impacts caused by the project implementation would remain low, which is still effective up to the present although the project design and layout has been revised as a result of the technical examination in this SAPI. The JICA Team reviewed the anticipated environmental and social impacts, and updated mitigation measures accordingly as described below. The negative impacts are expected to be offset or minimized if the mitigation measures are adequately implemented.

[9] The EMP presents mitigation measures and the EMoP is designed to collect specific parameters with which the effectiveness of mitigation measures are to be monitored periodically.

[10] Environmental Clearance for Installation of 132/33kV and 33/11 kV UG compact type SS in Kawranbazar Project under DPDC (No. 22.02.0000.091.72.151.16/457 dated 24/09/2017.

[11] The Project was under the red category, which may cause significant adverse environmental impacts, as listed in the *Environmental Conservation Rules (1997)* when the Data Collection Survey was conducted in 2016/17. However, the amendment of ECR in 2017 relaxed the requirements and now this project type is considered to be in the Orange B category, with moderately significant environmental impacts for which mitigation measures are easily identified. This no longer requires an EIA but does require an initial environmental examination (IEE) and EMP.

16.1.1 Pre-Construction Period

Prior to the construction of DPDC's UGSS, staff quarters buildings and part of the existing substation and switchgear house (Figure 16-1) shall be demolished.

(Source) Google Earth (accessed in Feb 2019)

(Note) The photo was taken in April 2018.

Figure 16-1 Present Layout of Substation Site

DPDC will employ a contractor to demolish them, remove debris and prepare the land prior to the construction of the UGSS. DPDC will reconfigure the distribution line before the EPC contractor starts the construction of the underground cable tunnel too.

Apart from the demolition work, temporary requisition of Garden Road, setback of street shops and relocation of street vendors shall be required to make sufficient space for transportation vehicles and trucks. The requisition will last until the end of the UGSS construction work at least (approximately five years in total), which will impact local activities (Figure 16-2).

From substation gate toward Kazi Nazrul Islam Ave From substation gate toward Bashundhara City

(Source) The JICA Team

(Note) Photo was taken in June 2016.

Figure 16-2 Local Activities on Garden Road

Anticipated impacts during demolition and removal work, land preparation and distribution line reconfiguration are as described below. DPDC is encouraged to apply mitigation measures. There is no pre-construction work anticipated on the route for the UGC.

(1) Air Quality

The adverse impact is as anticipated at the timing of Data Collection Survey 2016/17. Dust will be generated due to the demolition of staff quarters and part of the existing substation facilities. Exhaust gas will be exhausted from machinery and vehicles which are used for carrying debris and other wastes from the site.

To reduce particulate matters and exhaust gas, as well as prevent their diffusion in the surrounding area, the following mitigation measures are expected for minimization of air pollution.

- Optimize construction schedule
- Examine transportation route for construction vehicles
- Use low-emission equipment
- Spray water on access roads and construction site
- Build an enclosure around the DPDC building and mosque
- Use cover sheet on trucks for transportation of debris
- Conduct periodic maintenance and management of all construction machinery and vehicles

Air quality standards in Bangladesh are stipulated in the SCHEDULE-2 of *the Environmental Conservation Rules 1997,* which is amended by *the Notification SRO 220-Law/2005* of 19 July 2005.

(2) Water Quality

Rainwater can mix with debris and other wastes. Waste water from toilet and kitchen facilities of the staff quarters, and those from labor shed shall be taken care of. To prevent water pollution within the boundary and its surrounding area, the below measures are considered:

- Cover demolition site to minimize rainwater mixed with demolition wastes
- Settle tanks for excessive construction sludge & waste water
- Install proper drainage to WASA drainage for treatment
- Connect to WASA's sewage line to send waste water to its sewage treatment plant from the site

They do not practice on-site water treatment in Dhaka. They collect waste water and directly discharge it into WASA line. It is therefore important to confirm whether the above prevention measures for water pollution are effective and that no waste water leaks from the site.

Standards for inland surface water and drinking water are stipulated in the SCHEDULE-3, and those for sewage discharge in the SCHEDULE-9 of *the Environmental Conservation Rules 1997*.

(3) Waste

The majority of waste generated from the demolition site in this project will be industrial, which shall be carried out by the contractor. Facilities such as window frames, doors, rebars and steel frames are carefully removed from the demolished structures for reuse or resale, and only those which cannot be reused are hammered. Debris is smashed into pieces and recycled as construction material.

Organic and human waste generated from the demolition site and labor shed will be collected by DSCC[12]. Hazardous wastes such as asbestos may be found and consultation with DSCC is

[12] Stipulated in the Local Government (City Corporation) Amended Act 2009, DSCC is responsible for collecting solid waste from domestic homes, businesses, hospitals, streets, public toilets and drains. They provide dustbins

recommended for their treatment. Mitigation measures for waste management are the following. Standards for waste from industrial units or project waste in Bangladesh are stipulated in the SCHEDULE-10 of *the Environmental Conservation Rules 1997*.

- Separate wastes
- Reuse and recycle industrial wastes
- Reduce volume and weight of wastes by smashing and dehydrating them
- Dispose of non-recyclable waste according to DSCC rules
- Ask DSCC to sweep human waste from the site regularly
- Treat hazardous waste under the related regulations
- Ban on-site waste incineration/illegal dumping

(4) Soil Quality

Soil will get contaminated if runoff water from demolition site or human and organic waste water leak into it. Spillage oil and chemical substances generated during demolition work from construction machinery and vehicles will also affect its quality.

The following measures shall be taken to avoid or mitigate soil pollution:

- Cover the demolition site to prevent leakage of waste water
- Settle tanks for excessive construction sludge & waste water
- Install proper drainage to DWASA drainage for treatment
- Collect organic waste separately
- Connect to WASA's sewage line to send waste water from the site
- Install septic tanks for domestic facilities at labor shed
- Ask DSCC to sweep human waste from the site regularly
- Trap spillage oil and chemical substances at the demolition site for treatment

(5) Noise and Vibration

Noise and vibration due to construction machinery and equipment, and transportation vehicles and trucks will be caused. The surrounding area is a mixed zone of commercial and residential area, and the noise level is already high. Demolition work and transportation of a large volume of wastes, conducted during night time[13], shall be optimized and carefully planned so as not to worsen their levels. Standards for sound are stipulated in *the Bangladesh Sound Pollution (Control) Rules 2006*[14].

To reduce the noise level and vibration, mitigation measures are recommended as below:

- Optimize construction schedule
- Examine effective construction schedule in terms of period and time
- Use low-noise/low vibration machinery and equipment
- Abide by the traffic rules and speed limits
- Examine transportation route for construction vehicles
- Limit working hours and choose appropriate times

(6) Offensive Odors

Organic wastes and human wastes often generate odors if they are not properly sealed or treated, or kept for a long time at the same place without regular collection. Those wastes generated from the demolition site and labor shed shall be collected by DSCC. Mitigation measures are the same as those for waste management as described in the above(3). Standards for odor in Bangladesh are stipulated in the SCHEDULE-8 of *the Environmental Conservation Rules 1997*.

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and other receptacles for accumulating waste. Its cleaners clean roads, drains and sewerage lines. (Dhaka South City Corporation, http://www.dhakasouthcity.gov.bd/department/22/index.html, accessed in Feb 2019.)

[13] Heavy trucks are only allowed to enter into Dhaka during night time.

[14] The Noise Pollution (Control) Rules 2006 say that the acceptable sound limit in silent areas is 50 dB for the daytime (6AM to 9PM) and 40dB for night (9PM to 6AM). In residential areas these limits are 55dB and 45dB; in mixed areas, 60dB and 50dB; in commercial areas, 70dB and 60dB; and in industrial areas, 75dB and 70dB.

(7) Existing Social Infrastructure and Services

A shifting of social infrastructure and services around the substation site and its adjacent road shall be conducted. DPDC shall request rearrangement, relocation and removal of existing utilities' facilities to avoid service interruptions, such as Titas Gas for gas facility, DWASA for water supply, drainage and sewage, BTCL for telecom cable and the dish authority for satellite communication. DPDC shall pay for the costs of shifting such facilities.

(8) Land Use

Land requisition, access restriction and traffic blocking on Garden Road will be necessary throughout the demolition period. Street shops shall be set back and street vendors shall be relocated to allow transportation vehicles and trucks to go and come on the road.

The requisition will last until the end of the UGSS construction work at least (approximately five years in total), which will impact local activities. Local consultations, interviews with the affected people and an asset inventory survey shall be conducted once the list of the affected people is finalized. As the project is financed via a Japanese ODA loan, compensation and other assistance measures shall be examined according to *the JICA Guidelines for Environmental and Social Considerations 2010*. Prior public notice is to be given to all shops, property owners and residents along the road.

(9) Working Environment (including Occupational Safety)

Demolition and removal of existing facilities may cause labor accidents. DPDC will reconfigure the distribution line prior to the construction of the underground cable tunnel, and labor accidents such as electric shocks while switching distribution lines are also anticipated.

Organized demolition work and schedule will prevent collapse of the structures. Safety education and personal protective equipment (PPE) shall be provided to workers. A labor accident prevention manual shall also be prepared. Protection facilities and equipment to prevent electric shocks shall be applied.

16.1.2 Construction Period

Following soil excavation at the substation site, the UGSS will be constructed with transformers and associated facilities. The pre-conditions for the UGSS design and layout have changed since the Data Collection Survey 2016/17, and the BPDB Guesthouse is no longer being considered. Besides, a 3-meter wide clearance to the neighboring building is now being considered for excavation and soil retaining purposes. The site area for the UGSS thus became smaller than the original, which made it difficult to install the cooling system underground. A standing type of 20 cooling units is now planned on the ground floor of the superstructure. See Figure 16-3 for the revised layout of Kawranbazar UGSS as of Feb 2019.

(Source) Google Earth (accessed in Feb 2019)

(Note) The photo was taken in April 2018.

Figure 16-3 Layout of DPDC's UGSS

From the UGSS, underground cable will be extended to the existing Dhanmondi SS for as long as 1.636km. The ROW will pass Garden Road, Kazi Nazrul Islam Avenue, Sonargaon Road and Paribagh Sonargaon Road.

Anticipated impacts during the construction period and the mitigation measures which EPC contractors shall practice are as described below.

(1) Air Quality

Construction work will generate dust at the substation site as well as the ROW of the UGC, and soil transportation will cause dust diffusion. Exhaust gas will be emitted from machinery used at construction sites and transportation vehicles. Air quality standards in Bangladesh are stipulated in the SCHEDULE-2 of *the Environmental Conservation Rules 1997*, which is amended by *the Notification SRO 220-Law/2005* of 19 July 2005. *IFC standards for ambient air quality*[15] shall also be referred to in order to ensure the mitigation measures meet the international requirements.

The following mitigation measures shall be considered to reduce particulate matters and exhaust gas, as well as prevent their diffusion in the surrounding area.

- Optimize schedule of soil excavation and civil works
- Examine route of vehicles for construction and transportation
- Use low-emission equipment
- Spray water on access roads and construction site
- Build an enclosure around the construction site
- Use cover sheet on trucks for soil transportation
- Conduct periodic maintenance and management of all construction machinery and vehicles

(2) Water Quality

Rainwater can mix with excavated soil and construction wastes. Waste water from toilets and kitchen facilities of the labor shed shall be taken care of, too. The below mitigation measures are considered to reduce and prevent water pollution.

[15] IFC General Environmental, Health, and Safety Guidelines (Air Emissions and Ambient Air Quality): https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines (accessed in Feb 2019)

- Cover excavation site to minimize rainwater mixed with excavated soil
- Pump up rainwater (or underground water) from the excavation site
- Settle tanks for excessive construction sludge & waste water
- Install proper drainage to WASA drainage for treatment
- Connect to WASA's sewage line to send waste water to its sewage treatment plant from the site

The effectiveness of prevention measures shall be confirmed, and no waste water shall be allowed to leak from the site to prevent soil contamination. Standards for inland surface water and drinking water are stipulated in the SCHEDULE-3, and those for sewage discharge in the SCHEDULE-9 of *the Environmental Conservation Rules 1997*. *IFC General EHS Guidelines for wastewater and ambient water quality* shall be referred to when environmental monitoring is conducted.

(3) Waste

Excavated soil and surplus soil, industrial waste from construction work, hazardous waste such as dry batteries, etc. and organic and human wastes from workers will be generated during the construction period. Aside from organic and human wastes, which are collected by DSCC, inappropriate waste disposal or wrong treatment shall be prevented. Soil is in demand for land reclamation and land-filling in Dhaka and its recycling is common. Consultation with DSCC is recommended for the treatment of hazardous wastes. Measures to be taken are the following:

- Separate wastes for appropriate collection
- Reuse and recycle industrial wastes and excavated soil
- Reduce volume and weight of wastes by smashing and dehydrating them
- Dispose of non-recyclable waste according to DSCC rules
- Ask DSCC to sweep human waste from the site regularly
- Treat hazardous waste under the related regulations
- Ban on-site waste incineration/illegal dumping

Standards for waste from industrial units or project waste in Bangladesh are stipulated in the SCHEDULE-10 of *the Environmental Conservation Rules 1997*. *IFC General EHS Guidelines for waste management and hazardous materials management* shall also be referred to.

(4) Soil Quality

Excavation work is expected up to an approximately 25-meter depth, and a massive amount of soil will be collected. Not only naturally occurring substances, but anthropogenic releases of wastes and oil, as a result of historic and current site activities, may be found in the soil[16]. Soil is in demand for land reclamation in Dhaka and it is important to screen soil concentrations of pollutants and make sure there is no risk to human health or ecological receptors before soil is transferred.

Apart from that, runoff water or human and organic waste water may flow into the excavated area or accumulate at the construction site, causing soil contamination. Spillage oil and chemical substances generated from construction machinery and vehicles may also affect the soil quality.

The following measures shall be taken to avoid or mitigate soil pollution. *IFC General EHS Guidelines for contaminated land* shall be referred to.

- Check quality of excavated soil before disposal and consult with DSCC if it is contaminated
- Cover the excavation site to prevent leakage of waste water
- Settle tanks for excessive construction sludge & waste water

[16] Insulation oil for transformers often contains poly chlorinated biphenyl, PCB, and it contaminates soil when it is released. It is not listed in *the ECR 1997* as a pollutant, but it is indicated as a hazardous material in *the IFS General EHS Guidelines*.

- Install proper drainage to DWASA drainage for treatment
- Collect organic waste separately
- Connect to WASA's sewage line to send waste water from the site
- Install septic tanks for domestic facilities at labor shed
- Ask DSCC to sweep human waste from the site regularly
- Trap spillage oil and chemical substances at the demolition site for treatment

Although waste water is to be sent to WASA sewage treatment plant through its line, there can be leakages within the site. Periodic monitoring of soil quality is thus recommended throughout the construction period.

(5) Noise and Vibration

Construction machinery and equipment, and transportation vehicles and trucks will cause noise and vibration during the construction phase. Heavy trucks are only allowed to enter into Dhaka during the night time, and the transportation of a large volume of excavated soil, conducted during the night time, shall be optimized and carefully planned.

So as not to worsen the noise and vibration levels, mitigation measures are recommended as below. *IFC General EHS Guidelines for noise management* shall be referred to.

- Optimize construction schedule
- Examine effective construction schedule in terms of period and time
- Use low-noise/low vibration machinery and equipment
- Abide by the traffic rules and speed limits
- Examine transportation route for construction vehicles
- Limit working hours and choose appropriate times

Sound standards are stipulated in *the Bangladesh Sound Pollution (Control) Rules 2006*, and the noise level guidelines in *the IFC General EHS Guidelines for noise management* shall also be referred to.

(6) Offensive Odors

Organic wastes and human wastes generated from the labor shed shall be collected by DSCC. Mitigation measures are the same as those for waste treatment as described in the above(3).

Standards for odor in Bangladesh are stipulated in the SCHEDULE-8 of *the Environmental Conservation Rules 1997*.

(7) Stability of Surrounding Structures

Excavation up to a 25-meter depth may cause foundation failure and displacement of the neighboring structures and such impacts must be avoided. During this SAPI, 3-meter wide setbacks to the surrounding plots and roads are planned for excavation and soil retaining purposes. Soil loss shall be prevented by stabilizing slopes in the excavated area with concrete if necessary and appropriate. Periodic monitoring of surrounding structures will be required.

(8) Land Use

Access restriction and traffic blocking imposed during demolition work for the substation site will be continued to the construction phase too. At this stage, the ROW for the UGC construction site will also face temporary restriction of access and traffic blocking for safety reasons (see the UGC route: Figure 16-6). Local businesses are active throughout the UGC route. Kazi Nazrul Islam Avenue is one of the busiest streets in Dhaka. SAARC Fountain roundabout, where five roads meet, including Kazi Nazrul Islam Avenue, is crowded with numerous vehicles, buses, rickshaws and passers-by throughout the day, many of which enter into Sonargaon Road (Figure 16-4). Retail shops as well as residential apartments are found along Paribagh-Sonargaon Road

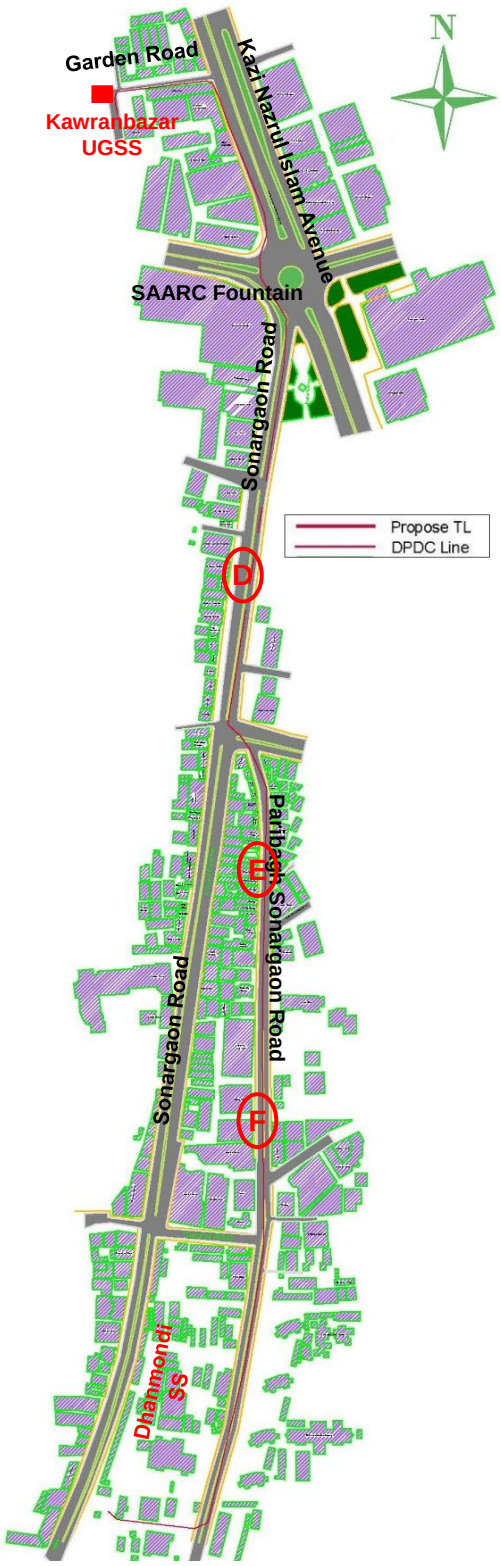
(Figure 16-5 and Figure 16-7). Prior public notice of the construction schedule shall be given to shops, residential apartments, and street workers.

The following mitigation measures are recommended to minimize adverse impacts on local activities:

- Land use clearance from Dhaka Metropolitan Police (DMP) and DSCC
- Prior public notice of construction schedule
- Optimization of construction schedule
- Prior notice with local corporations and relevant people
- While excavation work is in progress, proper site coverage shall be done with a temporary fence so as not to endanger passers-by or traffic
- Create alternative sidewalks

The nature of UGC construction and installation requires only a few weeks of temporary requisition. However, in the case that there are local people affected by the construction work along the ROW of the UGC, no matter if they have tenure or not, and if it is temporary or permanent, they shall be consulted and appropriate actions such as a household survey and interviews, asset inventory, and examination of compensation and other assistance packages shall be taken according to *the JICA Guidelines*[17].

[17] The JICA Guidelines require that occupants without tenure shall be eligible for compensation and assistance activities if they are found to be there by the cut-off date. This is beyond what is stipulated under *the Acquisition and Requisition of Immovable Property Ordinance 2017*.



(Source) The JICA Team
(Note) Total length of UGC is planned to be 1.636 km.

Figure 16-6 Proposed 132kV UGC Route (Kawranbazar UGSS to Dhanmondi SS)

(Source) The JICA Team
(Note) Photo was taken in Jul 2018.

Figure 16-4 Heavy Traffic on Sonargaon Road

(Source) The JICA Team
(Note) Photo was taken in Jan 2019.

Figure 16-5 Small Enterprises' Shops on Paribagh Sonargaon Road

(Source) The JICA Team
(Note) Photo was taken in Jul 2018.

Figure 16-7 Commercial Area on Paribagh Sonargaon Road

(9) **Infectious Diseases**

A temporary influx of migrant laborers from outside Dhaka may increase the risk of infection. In addition to regular collection of organic and human wastes by DSCC to maintain a favorable sanitation status at the construction site and labor shed, the following measures are necessary:

- Identify available clinics
- Implement periodic health check-ups for workers
- Provide health education and training for workers

(10) **Working Environment (including Occupational Safety)**

Excavation, construction and installation work may cause labor accidents such as falls to the ground and electric shocks. The following measures are recommended:

- Prepare a manual for labor accident prevention, including safety education and training
- Provide workers with PPE
- Inspect and ensure that all lifting devices, such as cranes, are appropriate for expected loads
- Keep lifting devices well maintained and perform maintenance checks as appropriate during the construction period
- Use facilities and equipment that protect against electric shocks

(11) **Accidents**

As the project is located in a busy commercial area, road traffic accidents may occur at any time if the construction work is not well organized or traffic management is not done properly. Abiding by traffic regulations, installation of traffic signs, education on safe driving, and training on the safe operation of vehicles are expected.

16.1.3 Operation Period

After the completion of the UGSS construction, DPDC will switch distribution lines to the new UGSS for its operation. The switchgear house and transformer which remained in the site will then be demolished and removed. The superstructure will be built after clearing the land. Their plan, however, had not been fixed as of Feb 2019. All such work will take place after DPDC's UGSS starts operation.

(Source) Google Earth (accessed in Feb 2019)

(Note) The photo was taken in April 2018.

Figure 16-8 Future Layout of Substation Site

Anticipated impacts during the operation phase of the new UGSS are as described below. DPDC is encouraged to apply mitigation measures.

(1) **Noise and Vibration**

Twenty units of cooling facilities will be installed on the ground floor of the superstructure, which generate noise and vibration throughout the day and night. Covering the units and installation of a sound-proof wall will mitigate the noise level. Sound standards are stipulated in *the Bangladesh Sound Pollution (Control) Rules 2006*.

(2) **Working Environment (including Occupational Safety)**

Labor accidents while reconfiguration of distribution lines takes place, and during O&M activities are anticipated. The following measures are recommended to DPDC:

- Keep a manual for labor accident prevention, including safety education and training
- Provide workers with PPE
- Proper maintenance of lifting equipment and tools, and conduct safety checks prior to work
- Use facilities and equipment that protect against electric shocks

The updated environmental management plan, environmental monitoring plan and monitoring form are found as ANNEXES.

16.2 Conditions for the Environmental Clearance Certificate

The left column of the following table reproduces the DOE's conditions given in the ECC. They are for DPDC's actions during the construction and operation periods, but a few have been taken care of during the SAPI. The JICA Team's findings and analyses have been added next to the DOE's comments.

Table 16-1 Conditions given in ECC and Findings during SAPI

No	Conditions given in the ECC	JICA Team's findings & analyses
1	"The activities during construction and operation of the 132/33kV and 33/11kV UGSS shall not result in the loss of containment of any materials that would affect health or have a damaging impact on the environment or natural resources."	To be addressed by the ES Consultants during construction and operation stages.
2	"Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project activities."	To be addressed by the ES Consultants during construction stage.
3	"Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora or fauna is demolished or destroyed."	
4	"No solid waste can be burnt in the project area. An environmentally-friendly solid waste management plan should be in place during the entire project period in the field."	Taking the practices in Dhaka and facts about the site found as below during SAPI into consideration, the ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring: - It is the contractors who will take out construction wastes from their construction sites to the waste collection spots or dumping sites of the Dhaka City Corporation (DCC). Such practices will be applied to this project too so environmental education for contractors will play an important role.

No	Conditions given in the ECC	JICA Team's findings & analyses
		- They are to reuse or recycle as many facilities and materials as they can from the demolished buildings. - Waste collection is managed by the DCC, including human waste. Project proponents also abide by the ECR 1997. However, the extent to which environmental pollution is avoided (or mitigated) owes a lot to each contractor's ESG policy and actions. - The UGSS site is small. The existing facilities within the UGSS site can catch fire if they burn solid waste there, since sufficient space cannot be kept. Besides, construction work will be disturbed if solid waste accumulates for more than a day. - The ROW of the UGC extends to a crowded area with heavy traffic in the heart of Dhaka, which makes it unrealistic to burn solid waste on site.
5	"All the required mitigation measures suggested in the EIA report, along with the emergency response plan, are to be strictly implemented and kept operative/functioning on a continuous basis."	The JICA Team has found that pre-conditions for the Project have been changing since the Data Collection Survey 2016/17. As a result of technical coordination between the UGSS and superstructure, the UGSS design and layout is now being reconsidered, and further technical examination will be needed if PGCB makes its final decision to construct another UGSS next to DPDC's. The UGC has also been rerouted partly to avoid social impact. The JICA Team has revised some parts of the EMP based on such changes as above, as well as normal practices conducted at construction sites in Dhaka (see ANNEXES). The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
6	"Mitigation measures, along with EMP as described in the EIA report, should be strictly maintained."	
7	"In future, if any legitimate complaint is made regarding environmental pollution due to the Project's activities and if it is found to be valid by the DOE, the entrepreneur shall be required to take reasonable and appropriate mitigation measures/corrective measures as per DOE's requirements."	To be addressed by the ES Consultants during construction stage.
8	"To reduce problems concerning traffic movement, construction work should preferably be performed during the night."	
9	"Resettlement plan should be properly implemented, and people should be adequately compensated."	No resettlement is so far anticipated as it has been carefully examined during SAPI.
10	"Construction material should be properly disposed of after the construction work has been completed."	Same as the above item No. 4.
11	"All pollution control measures undertaken at this point as part of the infrastructural development should be maintained continuously."	The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
12	"To reduce dust, spraying of water over earthen materials should be carried out from time to time."	As written in the EMP and EMoP. The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
13	"As described in the EIA report, environmental monitoring should be strictly followed, and the monitoring report should be shared with DOE to ensure proper environmental management."	DPDC shall report to the DOE.
14	"In the case of any emergency, the following information shall immediately be reported to the Dhaka Metropolitan Office and Headquarters of DOE	

No	Conditions given in the ECC	JICA Team's findings & analyses
	simultaneously: c) Nature of incident (fire, accident, etc.) d) Personnel affected (injured, missing, fatalities etc.)"	
15	"Rehabilitation for human resettlement or compensation for any sort of activity which will incur damage, or loss of public or private property or any natural resources shall be addressed as per GOB rules and regulations."	The degrees of such impact on the passers-by, residents, street vendors and shopkeepers along the UG cable route from Gulshan SS to Rampura SS vary but they are temporary. Temporary requisition of the UGC's ROW will take place during the construction phase, which will last a few weeks or a few months, section by section. Construction work will disturb local daily activities and cause traffic congestion on the ROW. The JICA Team has revised some parts of the EMP based on such changes as above, as well as normal practices conducted at construction sites in Dhaka (see ANNEXES). The ES Consultants shall give appropriate instructions to the EPC contractors and conduct environmental monitoring.
16	"No activity involving cutting/razing/dressing of hills or hilly land is endorsed under this clearance without due permission/clearance from the relevant GOB authority."	No hills or hilly land have been found in or along the project site and its surrounding area. If soil is required as a construction material, the excavated soil can be reused.
17	"If the project boundary passes through forest land, appropriate permission would be required from the forest department."	No forest land has been found in or along the project site and its surrounding area.
18	"The project authority shall extend active cooperation to DOE officials to facilitate their visits to the site as and when necessary."	DPDC shall report to the DOE.
19	"This clearance is valid only for the proposed installation of 132/33kV and 33/11kV UGSS as per the EIA report submitted to this department."	-
20	"This Environmental Clearance shall entitle the aforesaid entrepreneur to open LC for equipment."	DPDC will submit the ECC to open LC for equipment.
21	"Without prior approval from the DOE, no alteration/change can be made to matters already reported, such as location of the project boundaries, technology or operating process."	There has been no major alteration/change made during SAPI in terms of project location, technology or operating process, although there have been changes in design and layout. This matter shall be handled by the ES Consultant during construction too.
22	"As per *ECA 1995* and *ECR 1997*, prior approval from the DOE is needed in the case of further extension of project activities or further infrastructural build up."	Superstructure is planned for the surface of the UGSS within the site. DPDC will apply for an EMP clearance for the whole plan as stipulated in the *ECA 1995* and *ECR 1997 (amended in 2017)*. The SAPI Team will share all the findings and analyses relevant to environmental and social issues to coordinate with DPDC and the ES Consultant. DPDC will inform the DOE if there is any further extension of project activities or infrastructural build up.
23	"In installation of 132/33kV and 33/11kV UGSS, the project authority shall extend active cooperation to DOE officials to facilitate their visits to the site as and when necessary."	DPDC shall report to the DOE.
24	"This clearance is valid for one year from the date of issuance and the project authority shall apply for renewal to the Dhaka Metropolitan Office of DOE in Dhaka, with a copy to the DOE Head Office in Dhaka, at least 30 days ahead of expiry."	DPDC submitted the renewal application to DOE in Sep 2018.

No	Conditions given in the ECC	JICA Team's findings & analyses
25	"Violation of any of the above-mentioned conditions shall render this Environmental Clearance as void and legal action will be taken as per *ECA 1995* and *ECR 1997*."	-
26	"This ECC has been issued with the approval of the appropriate authority."	-

(Source: The JICA Team)

16.3 Recommendations

Further technical coordination with the superstructure may require further changes/alterations in the layout, design or technical specifications of the UGSS, and the EMP shall be reviewed and updated accordingly as well as reflected into the tender documents of EPC contractors.

As DPDC intends to obtain a building permit for the whole development plan, including the superstructure, an application for the EMP clearance for the entire plan shall be submitted to the DOE. As the superstructure design and its construction plan has not been done yet, it will take some more time to become able to anticipate the adverse impacts caused by the superstructure's construction and an overall picture of cumulative impacts between the UGSS and superstructure. DPDC and the ES consultants are recommended to work on these.

Chapter 17. Revision of UGSS Project Schedule (DPDC)

It would be difficult for the JICA Team to revise the schedule after the SAPI due to the unforecasted timing of hiring the Engineering Service Consultant. Hence, the Engineering Service Consultant will have to revise the construction schedule based on the current situation, such as the delay in Engineering Services, start of trial excavation for buried objects and design coordination with the superstructure.

Excavation work in the rainy season should be taken into consideration in particular. The monsoon/rainy season in Bangladesh runs from June to October, when high levels of rainfall can lead to extensive flooding across Dhaka and much of the country. Ideally, the excavation should be programmed to minimize the amount of excavation work conducted during the rainy season. However, the following should also be taken into consideration:

- Flooding into the excavation area is considered a risk, and appropriate protection measures, including height level of walls and ground, and allowance for high capacity pumps, should be taken.
- The heavy rains will also cause issues for the general excavation and may interfere with the staging works (described below) if the ground is saturated to the point that it cannot be safely stockpiled in the small staging area. Where possible the excavation and the stockpiles should be covered to restrict excessive rain infiltration.

The impacts of the rainy season on the excavation work are to be further assessed at the detailed design stage.

In addition, high traffic volumes and congested road in the Kawranbazar area might affect the scheduling for transportation of excavated soil. Due to the high traffic volumes and site constraints at Kawranbazar, it will be necessary to construct a staging area where excavated soil can be stored during peak traffic hours and then removed at quieter times. However, given the tight constraints, such a staging area may need to be constructed over the excavation. This may be created by constructing a platform straddling the excavation, giving the added benefit of it functioning as a rain cover for that section.

The following shows DESCO’s schedule to understand the period necessary to achieve each task, and will serve as a reference for the Engineering Service Consultancy.

No.	Scope / Events	Duration
	Field Study Schedule	
1	**Pre-Award Stage for Package 1 & 2**	26 months
	On-site setups (office, bank account, preparation)	
0.1	Office setup (physical)	
0.2		
0.3	Bank account, paper work, administration work	
	Commencement of Consulting Services	
1.1	Review and varify technical infromation provided by JICA	4 months
1.2	Surveys	
1)	Soil Investigation	3 months
1-1)	TOR Preparation of Soil Investigation	
1-2)	Implementation of Soil Investigation	
1-2)	Soil analysys in Labo	
2)	Topographical Survey	
1-1)	TOR Preparation of Topographical Survey	
1-2)	Implementation of Topographical Survey	
1.3	Work Plan	
1.4	Basic Design incl. preparation drawings	13 months
	(ALL) Preparation of Inception Report	
	(ALL) Discussion on Project Definition Report	
	(ALL) Submission & approval of documents	
	(CA) Review of Survey Results	
	(CA) Excavation method study & substructure design	
	(CA) Structure design calculation for substructure	
	(CA) Noise prevention design	
	(RE) Negotiation with fire department for firefighting study	
	(CA) Firefighting design	
	(CA) M&E design for substructure	
	(RE) Negotiation with RAJUK for ventilation study	
	(CA) Ventilation design (if necessary)	
	(EL) Earthing design	
	(EL) Equipment spec (HVSW, MVSW)	
	(EL) Relay, Comm, Control	
	(EL) DC power design	
	(EL) Finalization of Layout and Section (UGSS size)	
	(UT)Investigation of statutes	1 month
	Detailed design	
	Tunnel design (cross section view)	1 month
	Tunnel design (plan and longitudinal view)	2 months
	Current capacity design	3 months
	Grounding method design	1 month
	Magnetic field design	1 month
	Lightning protection design	1 month
	Design of Thermal expansion and contraction of cable	1 month
	Disaster prebention design	1 month
	Cable entry design	1 month
	Drainage, Ventilation design	3 months
	(UT)Investigation of Bured Objects (excavation)	3 month
	TOR Preparation of excavation	1 month
	Implementation of excavation	1 month
	Excavation reporting and analysing	1 month
	(UT)Detailed position determination	1 month
	Underground tunnel and Joint boxes	1 month
	connection point with OH power pole	1 month
	(UT)Drawing creation (Plan and Longitudinal view)	2 month
	Detailed design	2 month
	Underground tunnel and Joint boxes (Inc load calculation)	2 month
	TL (direct buried and small jacking method)	1 month
	(UT)Construction cost study	2 month
	Cost sharing study for Podium constrcution	
	Construction Planning	
	Basic document preparation	
	Evaluation of basic document by DESCO	
	Amendment of Basic document	
	Re-Evaluation of basic document by DESCO	
	Finalization of Basic document	
1.5	Special Project Permit	45 days
	11NOC	2.5 months
	Building Permit	45 days
	Superstructure Design	
	M&E design for superstructure by 37 Bridge	
	Structure design calculation by 37 Bridge	
	Compilation of application form by 37 Bridge	
	City Corpolation Certificate????	????
1.6	Tender Docs preparation incl. approvals	8 months
	(EL) GIT (incl. Winding & Capacity study?)	
	(EL) Cooling system for CA part	
	(CA) Civil & Architect	
1.7	Tender Process inlude prequalification	12 months
1)	Tender Floating	3 months
2)	Technical Evaluations incl. approvals	3 months
3)	Financial Bid Opening and Evaluations incl. approvals	2 months
4)	Contract Negotiation incl. preparation of Contract Docs with its	3 months
5)	Contract Signing and Contract Effectiveness	8 month

Chapter 18. Explanation to Engineering Services (DPDC)

Based on the study in the SAPI, the JICA Team notes the following items as those that the Engineering Service Consultant should take special care with. The items are not limited to the below.

[Regulatory process for necessary approvals, Regulations and Design Codes applicable to UGSS]

- Project Schedule must be reviewed based on the current situation, such as the delay in Engineering Services, start of trial excavation for buried objects, design coordination with superstructure, and necessary regulatory procedures to acquire the construction permission.
- In terms of deregulation of the superstructure height in the aerial law, support for DPDC is required to ensure smooth implementation of the whole project and maximize the revenue from the superstructure business. If necessary, support requests to JICA etc. should also be considered. If DPDC can achieve a waiver for a higher building, the Engineering Service Consultant will have to modify the structure due to the heavier load from the higher building.
- Dimensions of the emergency elevator, its elevator pit, and emergency power supply scheme must be coordinated with the superstructure.

[Construction conditions, constraints in plot usage]

- Necessary arrangements for temporary use of part of BPDB's site for the equipment transportation.
- In the future, if it becomes possible to acquire the southern green spaces, there is a possibility of changing the precondition for every component, such as layout design, underground transmission lines, tunnel, and superstructure design with ground floor and so on. In that case, the Engineering Service Consultant will have to discuss this issue with DPDC.

[Electric Design for UGSS]

- ES consultant will carry out a further study on GIT and GIS installation to verify the feasibility of the layout, especially room size.
- Feasible coordination between the Civil Contractor and the Electrical Contractor: After the selection of manufacturers for each equipment, the Contractor which is eventually going to design the UGSS building must adjust the layout according to the actual equipment dimensions.

[Equipment Layout Underground Substation]

- The Engineering Service Consultant will have to carefully consider the UGSS dimensions and remodel the existing substation, considering civil work methods for between the cable shaft and the shrunken Kawranbazar substation structure. Necessary clearance should be fixed without any damage to the shrunken Kawranbazar SS.
- Design collaboration with the superstructure; the position of the common pillar, the arrangement of the cooling facility and the direction of the air exhaust are necessary.
- Considering the equipment and site conditions and other factors, the SAPI team strongly recommends the cooling equipment be located above ground. Hence, the Engineering Service Consultant might re-design everything if the location of the cooling system is shifted from the ground floor to underground portion.

- Building M&E design, and firefighting design should be finalized based on BNBC's standards and applicable technical waivers negotiated with authorities. The proposed water-cooling system must also be well harmonized into the superstructure design to avoid any adverse impacts on the surrounding environment. In particular, the application of GIS must be well explained to streamline the necessary building facilities for the UGSS building.
- Necessary accessories and facilities below ground for the superstructure, such as sewage pan, elevator pits, hook for UGSS, and necessary ceiling clearance above the machine hatch, must be continuously discussed to be accommodated in the superstructure's final design.

[Superstructure Design]

- It is necessary to study the load conditions of the superstructure and for these to be reflected in the UGSS structure design by the Engineering Service Consultant.
- Regarding the cooling system, continuing consultation with the superstructure architect is necessary for the size of the air intake/exhaust and the maintenance method. In addition, it is necessary to consider countermeasures for noise from the cooling system.

[Transmission line and its installation method]

- When designing the cable tunnel, it is necessary to study which buried objects should be relocated by DPDC and consider the protection method for those which cannot be relocated. As for cable protection, it is necessary to consider hanging protection, temporary duct protection etc.
- If any the congested cables zone on the candidate transmission route, the Engineering Service Consultant might propose a ducting system.

[Project Scheduling, Cost estimation]

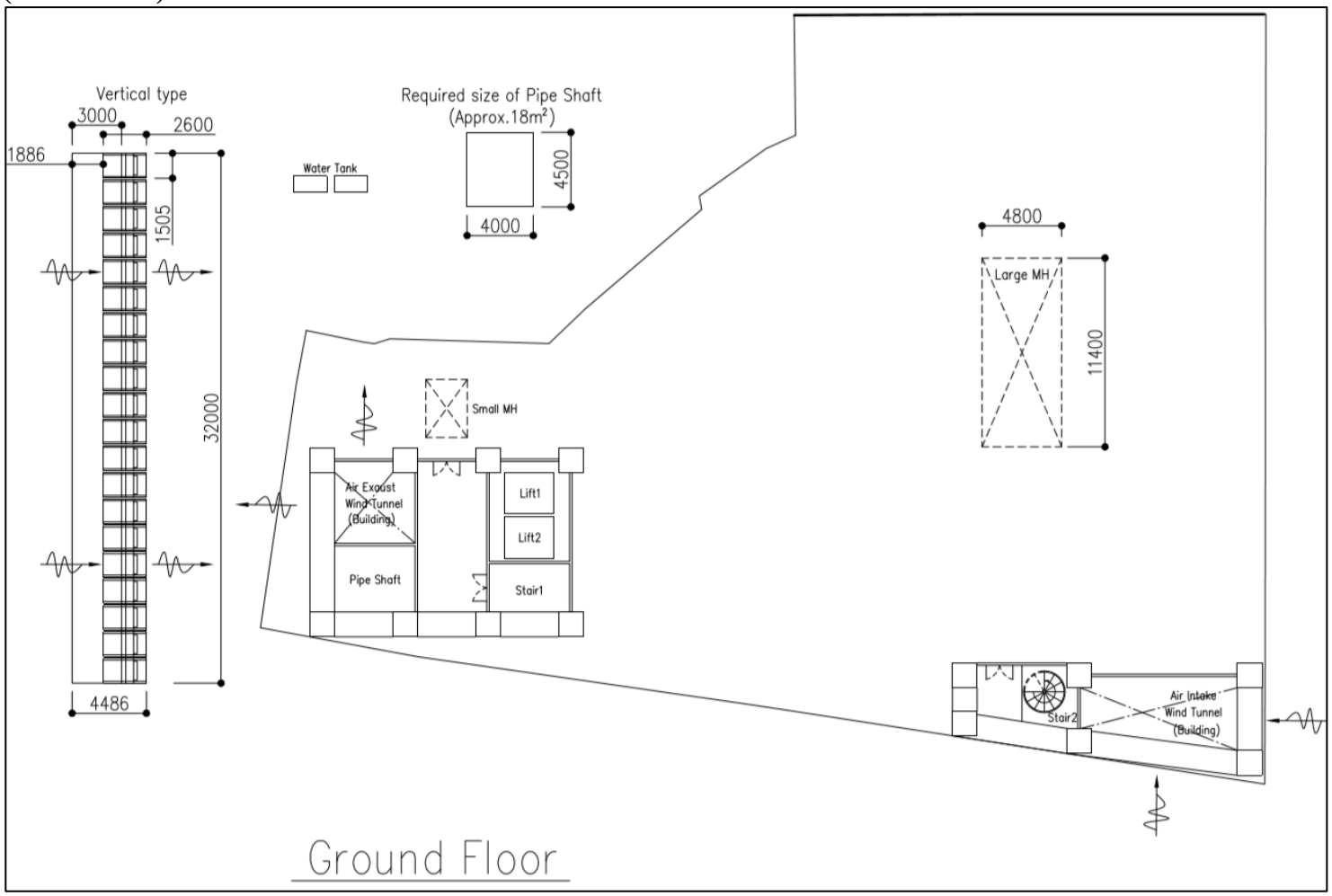
- Since the UGSS access road and the cable tunnel are planned to be at the same place, it is quite important to carefully adjust the construction procedure to avoid any constraints, especially duplicated work at the same time.
- The whole schedule must be established while negotiating with the relevant parties concerning the remodeling of the existing substation, setting the cable tunnel, construction of UGSS and so on.
- Project Cost breakdown must be updated and reviewed based on the introduction of a water-cooling system, GIT's detailed specifications (delta-Y), and increased costs for BNBC standard designs for the ventilation ducting system and firefighting facilities.

[Review and updates of Environmental Management Plan and Monitoring Plan]

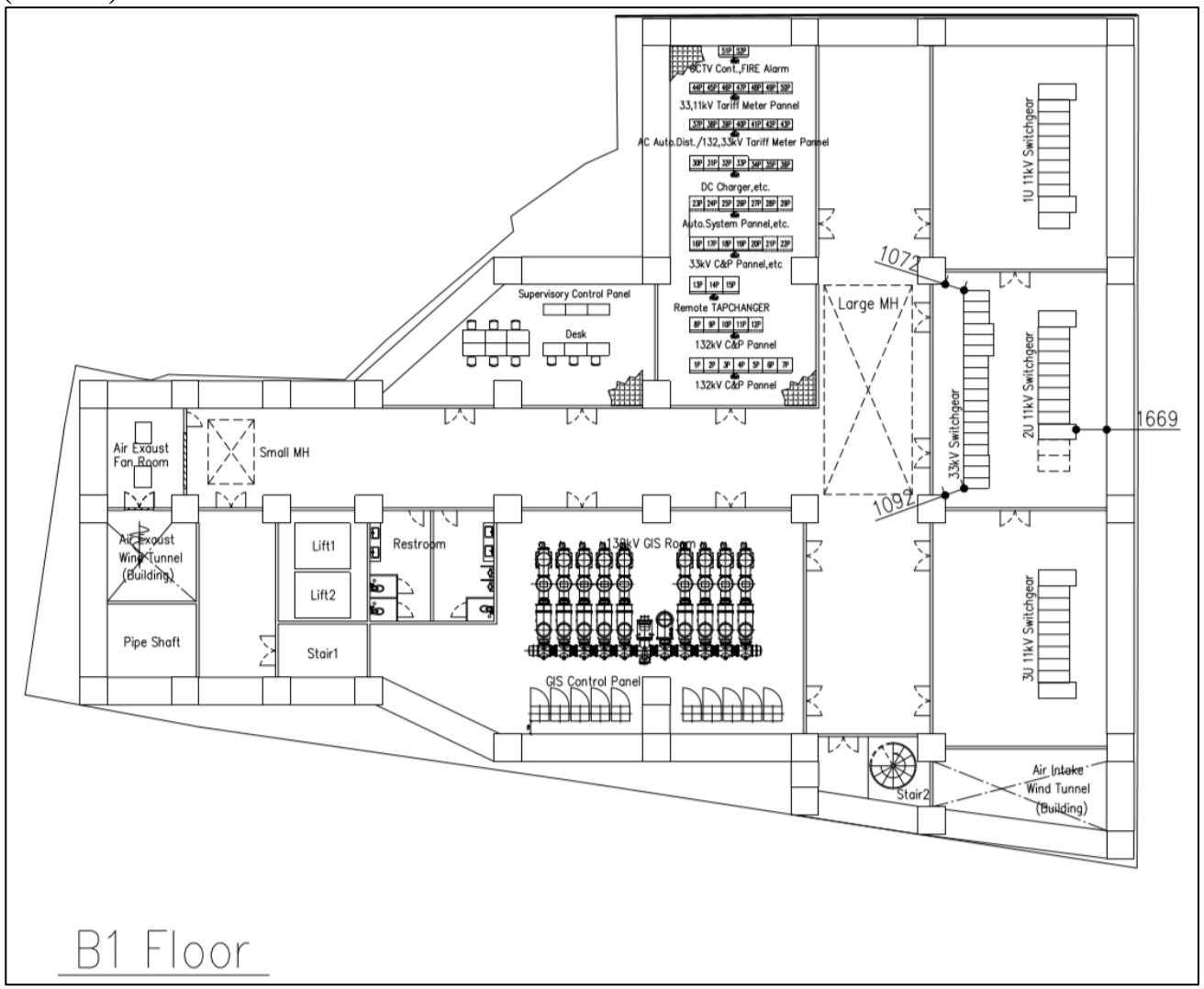
- Mitigation measures for social impacts shall be further examined when DPDC finalizes the site area and layout of the project.
- As the superstructure design and its construction plan has not been done yet, It will take some more time to become able to anticipate the adverse impacts caused by construction of the superstructure, and an overall picture of the cumulative impacts. DPDC and ES consultants are recommended to work on such cumulative impacts, which must be reflected in the tender documents of EPC contractors.
- Further technical coordination with the superstructure may require further changes/alterations in the layout, design or technical specifications, and the EMP shall be reviewed and updated accordingly.

Appendix (DPDC)-1 Kawranbazar Substation Layout

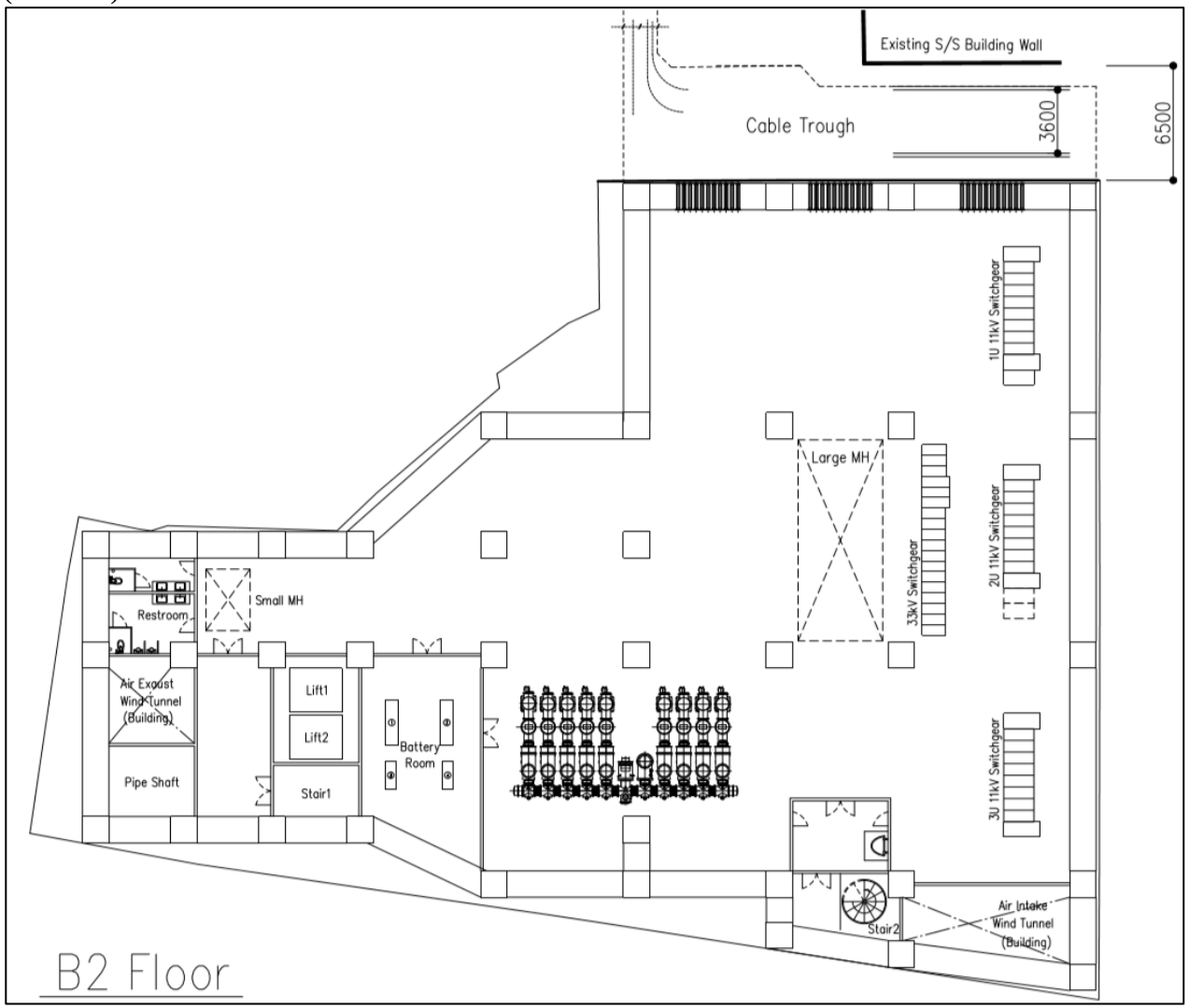
(Ground Floor)



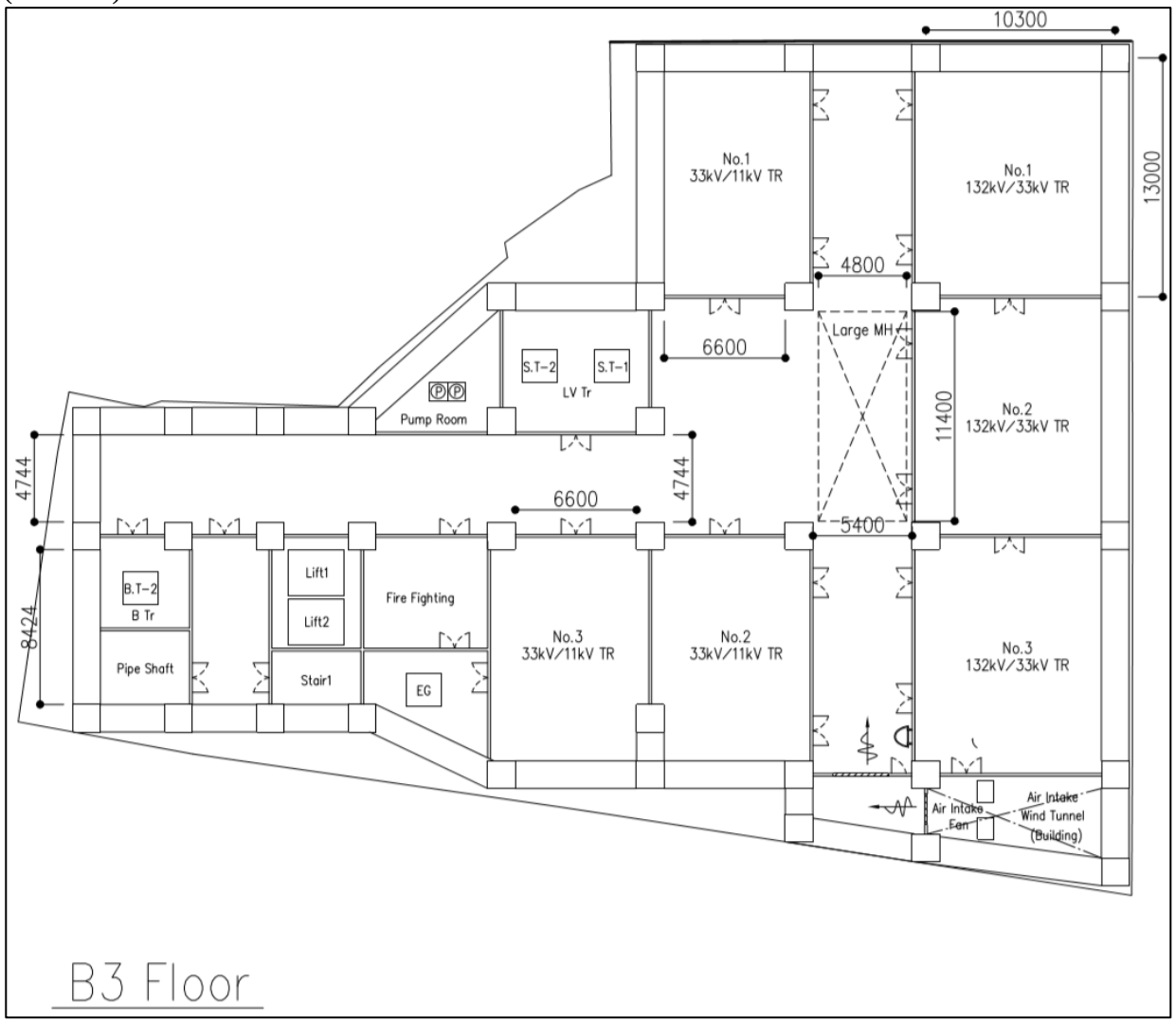
(B1 Floor)


CCTV Cont.,FIRE Alarm
33,11kV Tariff Meter Pannel
AC Auto.Dist./132,33kV Tariff Meter Pannel
DC Charger,etc.
Auto.System Pannel,etc.
33kV C&P Pannel,etc
Remote TAPCHANGER
132kV C&P Pannel
132kV C&P Pannel
Supervisory Control Panel
Desk
1U 11kV Switchgear
2U 11kV Switchgear
3U 11kV Switchgear
33kV Switchgear
Large MH
1072
1092
1669
Air Exaust Fan Room
Small MH
Air Exaust Wind Tunnel (Building)
Lift1
Lift2
Restroom
132kV GIS Room
Pipe Shaft
Stair1
GIS Control Panel
Stair2
Air Intake Wind Tunnel (Building)
B1 Floor

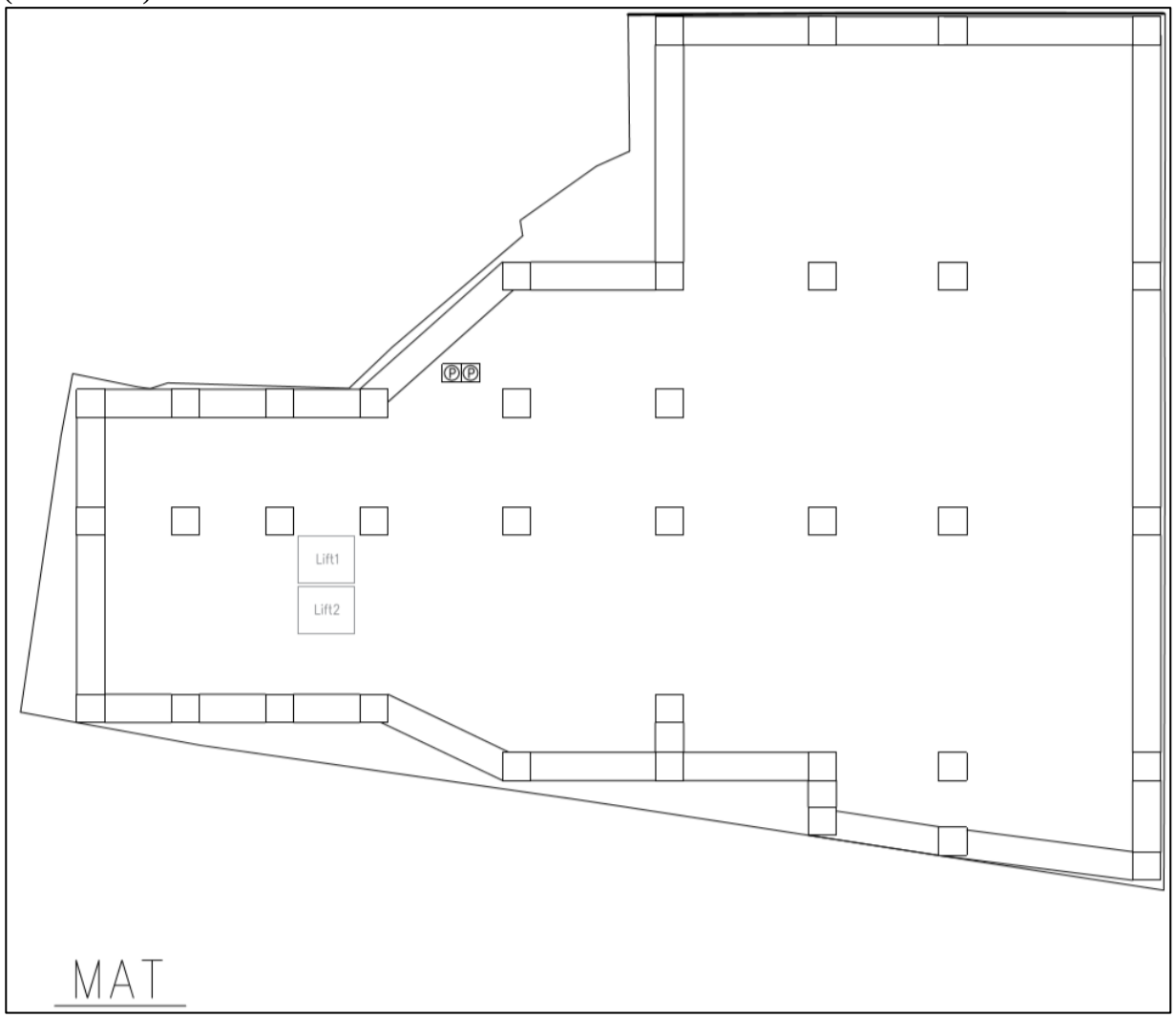
(B2 Floor)


Existing S/S Building Wall
Cable Trough
3600
6500
1U 11kV Switchgear
2U 11kV Switchgear
3U 11kV Switchgear
33kV Switchgear
Large MH
Small MH
Restroom
Air Exaust Wind Tunnel (Building)
Lift1
Lift2
Stair1
Pipe Shaft
Battery Room
Stair2
Air Intake Wind Tunnel (Building)
B2 Floor

(B3 Floor)


10300
13000
No.1
33kV/11kV TR
No.1
132kV/33kV TR
4800
Large MH
6600
S.T-2
S.T-1
LV Tr
Pump Room
11400
No.2
132kV/33kV TR
4744
4744
6600
5400
B.T-2
B Tr
Lift1
Lift2
Fire Fighting
8424
Pipe Shaft
Stair1
EG
No.3
33kV/11kV TR
No.2
33kV/11kV TR
No.3
132kV/33kV TR
Air Intake
Fan
Air Intake
Wind Tunnel
(Building)
B3 Floor

(MAT Floor)



Appendix (DPDC)-2 Environmental Management Plan and Monitoring Plan

1. Environmental Management Plan (DPDC)

(1) Demolition of existing buildings, Removal, Land Preparation, Distribution Line Reconfiguration

Table 1: Environmental Management Plan (Demolition of Existing Buildings, Removal, Land Preparation, Distribution Line Reconfiguration)

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
1	Air Pollution	1) Dust at substation site from demolition work for the existing buildings	-Ambient Air Quality Standard	- Avoidance and reduction of dust dispersion and air pollution at the substation site and surrounding area	1) Particulate matter reduction: - Optimizing construction schedule - Spraying water on access roads and construction site - Enclosing around buildings to be demolished - Using cover sheet on trucks for debris transportation	<Location> Demolition and removal site <Period> Demolition and removal work phase	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
		2) Exhaust gas from machinery and vehicles used for carrying debris and other wastes			2) Prevention of exhaust gas - Route examination for construction vehicles - Using low-emission equipment - Periodic maintenance and management of all construction machinery and vehicles			
2	Water Pollution	1) Runoff water from demolition site	- Wastewater standards	- Prevention of water pollution at the demolition site and surrounding area	1) Runoff water - Covering demolition site to minimize rainwater mixed with demolition wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution	<Location> Demolition and removal site, labor shed (temporary toilet site, and cooking & eating site) <Period> Demolition and removal work phase	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
		2) Domestic waste water from existing structures and labor shed			2) Domestic waste water - Connecting to DWASA's sewage line to send waste water from the site			
3	Waste	1) Domestic waste from workers	- Waste standards - Waste Management Rules of the DOE	- Prevention of inappropriate waste disposal	1) Domestic wastes - Separate waste and ask DSCC for collection and treatment - Reduction of volume and weight of wastes by dehydration	<Location> Demolition and removal site, labor shed (temporary toilet	<Implementation> Contractor hired by DPDC <Supervisor>	DPDC

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
					- Install septic tanks for domestic facilities at labor shed - Ask DSCC to sweep human waste from the site	site, and cooking & eating site) <Period> Demolition and removal work phase	DPDC	
		2) Industrial waste from demolition work and hazardous demolition waste such as asbestos			2) Industrial and hazardous wastes - Separate waste collection, and recycling & reuse of industrial wastes - Reduction of volume and weight of wastes by smashing them - Appropriate disposal of non-recyclable waste according to rules of Dhaka City Corporation - Treatment of hazardous waste under the related regulations - Ban of on-site waste incineration/illegal dumping			
4	Soil Pollution	1) Runoff water from demolition site	- Soil Quality standards	- Prevention of soil pollution at the demolition site and the surrounding area	1) Runoff water - Covering demolition site to minimize rainwater mixed with demolition wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution	<Location> Demolition and removal site, labor shed (temporary toilet site, and cooking & eating site) <Period> Demolition and removal work phase	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
		2) Domestic waste water of workers			2) - Collect organic waste separately - Connecting WASA's sewage line to send waste water from the site - Install septic tanks for domestic facilities at labor shed - Ask DSCC to sweep human waste from the site			
		3) Spillage oil and chemical substances generated during demolition work from construction machinery and vehicles			3) Spillage oil and chemical substances should be trapped at the demolition site for treatment			

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
5	Noise and vibration	1) Noise and vibration by machinery and equipment 2) Noise and vibration by vehicles and trucks	- Noise level standards	- Reduction of noise level from demolition work	1) Machinery and equipment - Optimizing construction schedule - Effective construction schedule (period and time) - Using low-noise/low vibration machinery and equipment 2) Vehicles and trucks - Abide by the traffic rules and speed limits - Route examination for construction vehicles - Limit working hours and choose appropriate times	<Location> Demolition and removal site <Period> Demolition and removal work phase	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
6	Offensive Odors	1) Domestic waste water of workers 2) Demolition of domestic facilities in the existing buildings	- Waste Management rules	- Prevention of offensive odors	1) Prepare septic tanks facilities for workers - Dispose of organic waste at the collection point - Ask DSCC to sweep human waste from the site regularly 2) Separate waste collection and treatment	<Location> Demolition and removal site, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
7	Existing Social Infrastructure and Services	Shift of social infrastructure and services around substation site and its adjacent road	-	- Consideration for services provided through the existing utility facilities (e.g. gas, water supply, telecom)	- Rearrangement, relocation, and removal of existing utilities' facilities to avoid service interruption. - Payment for cost of shifting existing facilities	<Location> Substation site and adjacent road <Period> Pre-construction phase (the removal will last until the project completion)	<Implementation> DPDC: power facility, Titas Gas (gas facility), WASA (water supply and sewage), BTCL (telecom cable), Dish authority (satellite communication) <Supervisor> DPDC	DPDC
8	Land Use (Land requisition around the substation site)	- Access restriction and traffic increase for long period	- JICA Guidelines for Environmental and Social Considerations (2010) - Access restriction to the surrounding	- Consideration for footpath, sidewalk, crossing etc. - Minimization of disturbances to the surrounding area	- Prior public notice of demolition work and its schedule - Conduct local survey and interviews with affected households - Examination of compensation and other assistance measures - Conduct public consultation	<Location> Garden Road in front of Kawranbazar UGSS site <Period>	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
			area and traffic increase	- Consideration for land/property owners - Compensation for the existing structures in the surrounding area - Consideration for livelihood activities and employment		During demolition work (until the project completion)		
9	Working Environment (including Occupational Safety)	1) Labor accidents during demolition and removal of existing facilities 2) Labor accidents while switching distribution lines	- Handling heavy loads - Electric shocks	- Prevention measures for labor accidents, accidents and health problems - Prevention of collapse of the existing buildings	- Prepare a manual for labor accident prevention, including safety education and training - Provide workers with appropriate protective equipment - Use facilities and equipment that protect against electric shocks	<Location> Demolition and removal site <Period> Demolition and removal work phase	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC

(Source: The JICA Team)

(2) Construction period

Table 2: Environmental Management Plan (Construction Period)

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
1	Air Pollution	1) Dust in substation site as well as ROW of transmission line sites	-Ambient Air Quality Standard	- Avoidance and reduction of dust dispersion and air pollution at the construction site and surrounding area	1) Particulate matter reduction: - Optimizing construction schedule - Spraying water on access roads and construction site - Enclosing around construction site - Using cover sheet on trucks for soil transportation	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor
		2) Exhaust gas from construction machinery and vehicles used for equipment and transportation			2) Prevention of exhaust gas - Route examination for construction vehicles - Using low-emission equipment - Periodic maintenance and management of all construction machinery and vehicles			
2	Water Pollution	1) Runoff water from construction site	- Wastewater standards	- Prevention of water pollution at the construction site and surrounding construction area	1) Runoff water - Covering construction site to minimize rainwater mixed with excavated soils and wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution	<Location> Construction area, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its Engineering Consultant	Expenses included in contract cost by Contractor
		2) Domestic waste water of workers			2) Domestic waste water - Connecting to DWASA's sewage line to send waste water from the site			
3	Waste	1) Industrial waste from construction work	-Waste Management Rules of the DOE	- Prevention of inappropriate waste disposal	- Separate waste collection, and recycling & reuse of industrial wastes - Appropriate disposal of non-recyclable waste according to rules of Dhaka City Corporation - Ban of on-site waste incineration/illegal dumping - Install septic tanks for domestic facilities at labor shed - Ask DSCC to sweep human waste from the site	<Location> Construction area, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor
		2) Domestic waste from workers						
		3) Hazardous waste such as dry batteries, etc.			- Treatment of hazardous waste under the related regulations			

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
		4) Excavated soil and surplus soil	- Soil Management Rule	- Appropriate treatment and effective use of generated soil	Appropriate recycling & reuse of excavated soil			
4	Soil Pollution	1) Runoff water from demolition site	- Soil standards	- Prevention of soil pollution at the construction site and surrounding area	1) Runoff water - Covering construction site to minimize rainwater mixed with wastes. - Settling tank for excessive construction sludge & waste water - Install proper drainage to DWASA drainage for treatment to prevent soil pollution	<Location> Construction area, labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor
		2) Domestic waste water of workers			2) - Collect organic waste separately - Connecting to WASA's sewage line to send waste water from the site - Install septic tanks for domestic facilities at labor shed - Ask DSCC to sweep human waste from the site			
		3) Spillage oil and chemical substances generated from construction machinery and vehicles			3) Spillage oil and chemical substances should be trapped at the demolition site for treatment			
		4) Excavated soil and surplus soil	- Soil Management Rule	- Appropriate treatment and effective use of generated soil	- Risk assessment of excavated soil to human health or ecological receptors - Appropriate recycling & reuse of uncontaminated soil			
5	Noise and vibration	1) Noise and vibration by machinery and equipment	- Noise level standards	- Reduction of noise level from construction activities	1) Machinery and equipment - Optimizing construction schedule - Effective construction schedule (period and time) - Using low-noise/low vibration machinery and equipment	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor
		2) Noise and vibration by vehicles and trucks			2) Vehicles and trucks - Abide by the traffic rules and speed limits - Route examination for construction vehicles			

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
					- Limit working hours and choose appropriate times			
6	Offensive Odors	1) Domestic waste from workers	- Waste Management rules	- Prevention of offensive odors	- Install septic tank at domestic facilities of labor shed - Dispose of organic waste at the collection point - Ask DSCC to sweep human waste from the site regularly	<Location> Labor shed (temporary toilet site, and cooking & eating site) <Period> During construction phase	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
7	Stability of surrounding structures	Excavation work	-	Minimization of impact and safety of surrounding structures against foundation failure and displacement	- Preventing soil loss by stabilizing slopes in the construction site with concrete if necessary and appropriate - Install retaining walls	<Location> Construction area and its proximity <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor
8	Land Use (ROW of UGC route)	- Temporary access restriction to the construction site on the transmission line's ROW (Note) Access restriction and associated actions are supposed to be done at the demolition stage.	- JICA Guidelines for Environmental and Social Considerations (2010) - Temporary restriction of access to the surrounding area and traffic management	- Consideration for footpath, sidewalk, crossing etc. - Minimization of disturbances to the surrounding area - Consideration for land/property owners - Compensation for the existing structures in the surrounding area - Consideration for livelihood activities and employment	- Land use clearance from Dhaka Metropolitan Police (DMP) and Dhaka City Corporation - Prior public notice of construction schedule - Optimization of construction schedule - Prior notice with local corporations and relevant people - Conduct household survey and interviews, examination of compensation and other assistance packages, and implementation of public consultation (if there are local people affected by the construction work along ROW of UGC) - While excavation work is in progress, proper site coverage shall be done with temporary fence in order not to do harm to passers-by or traffic. - Create alternative sidewalks	<Location> Kawranbazar UGSS site, ROW of UGC route <Period> During requisition and installation work	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
9	Infectious Diseases	- Temporary influx of migrant laborers from outside Dhaka during construction may increase risk of infection	Occupational Health and Safety	- Consideration of sanitation of local area	- Identify available clinics - Implement periodic health check-ups for workers - Provide health education and training for workers	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor
10	Working Environment (including Occupational Safety)	Labor accidents	- Handling heavy loads - Electric shocks	- Prevention measures for labor accidents, accidents, and health problems	- Prepare a manual for labor accident prevention, including safety education and training - Provide workers with appropriate protective equipment - Inspect and ensure that any lifting devices, such as cranes, are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate during the construction period - Use facilities and equipment that protect against electric shocks	<Location> Construction area <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor
11	Accidents	Road traffic accidents	Road traffic accidents	Prevention of traffic accidents	- Abide by traffic regulations, installation of traffic signs and education on safe driving - Training on safe operation of vehicles	<Location> Substation construction area and ROW of UGC route <Period> During construction phase	<Implementation> Contractor <Supervisor> DPDC and its ES Consultant	Expenses included in contract cost by Contractor

(Source: The JICA Team)

(3) Operation Period

Table 3: Environmental Management Plan (Operation Period)

No	Impact to be Managed	Sources of Potential Impact	Impact Standard	Management Purpose	Management Effort	Management Location & Period	Organization Responsible	Cost
1	Noise and vibration	Noise and vibration by operation of cooling system	- Noise level standards	- Reduction of noise level	- Covering the cooling system and installation of sound-proof wall	<Location> Superstructure <Period> During operation phase	DPDC	DPDC
2	Working Environment (including Occupational Safety)	1) Labor accidents while switching distribution lines	- Handling heavy loads (e.g. Power cables) - Oxygen deficiency - Electric shocks (power cables, equipment operation)	- Prevention measures for labor accidents, accidents, and health problems	- Prepare a manual for labor accident prevention, including safety education and training - Provide workers with appropriate protective equipment - Proper maintenance for lifting equipment & tools, and conducting of safety checks prior to work. - Use facilities and equipment that protect against electric shocks	<Location> Worksites for distribution line reconfiguration <Period> Distribution line reconfiguration phase	DPDC	DPDC
		2) Labor accidents in Operation and maintenance activities				<Location> O&M venues <Period> During O&M work		

(Source: The JICA Team)

2. Environmental Monitoring Plan (DPDC)

(1) Demolition of existing buildings, Removal, Land Preparation, Distribution Line Reconfiguration

Table 4: Environmental Monitoring Plan (Demolition of Existing Buildings, Removal, Land Preparation, Distribution Line Reconfiguration)

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
1	Air Quality	1) Dust resulting from demolition work 2) Exhaust gas from construction machinery and vehicles	SO2, NO2, PM10, PM10, PM2.5, Ambient Air Quality Standard	- Collect baseline data - Evaluate the effect of mitigation measures for air pollution	<Method of data collection & analysis> Sample collection and laboratory analysis <Location> Demolition and removal site <Duration & frequency> a) Once prior to demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
2	Water Quality	1) Runoff water from construction site 2) Domestic waste water of workers	Temperature, pH, oil, coliform, Wastewater standards	Evaluate the effect of mitigation measures for water pollution	<Method of data collection & analysis> Sample collection and laboratory analysis <Location> Demolition and removal site <Duration & frequency> a) Once upon demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
3	Waste	1) Domestic waste from workers 2) Industrial waste from demolition work and hazardous demolition waste such as asbestos	Waste Management Rules	Evaluation of effect of mitigation measures for wastes	<Method of data collection & analysis> Record of kinds and quantity of waste, and treatment method <Location> Demolition and removal site <Duration & frequency> Continuous records	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
4	Soil Pollution	1) Runoff water from demolition site 2) Domestic waste water of workers 3) Spillage oil and chemical substances generated during demolition work from construction machinery and vehicles	Soil Quality standard	Evaluation of effect of mitigation measures for soil contamination	<Method of data collection & analysis> Sample collection of soil pollutants and laboratory analysis <Location> Demolition and removal site <Duration & frequency> a) Once prior to demolition work b) Once upon completion of demolition and removal work	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
5	Noise and Vibration	1) Noise and vibration by machinery and equipment 2) Noise and vibration by vehicles and trucks	Noise level, and Noise level standards	- Collect baseline data - Evaluate the effect of mitigation measures for noise	<Method of data collection & analysis> Measurement using noise level meter <Location> Demolition and removal site <Duration & frequency> a) Once upon demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
6	Offensive Odors	1) Domestic waste water of workers 2) Demolition of domestic facilities in the existing buildings	Waste Management rules	Evaluate the effect of mitigation measures for odors	<Method of data collection & analysis> Record odors, causes, venues and treatment methods <Location> Demolition and removal site <Duration & frequency> Continuous records	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
7	Existing Social Infrastructure and Services	Shift of social infrastructure and services around substation site and its adjacent road	Rearrangement, relocation, and removal of existing utilities (e.g. gas, water supply, and telecommunication)	For smooth implementation of rearrangement, relocation, and removal of existing utilities	<Method of data collection & analysis> Spot visiting and meetings with concerned stakeholders <Location> Venues of rearrangement, relocation and removal of existing utilities at substation site and adjacent road <Duration & frequency> Upon rearrangement, relocation and removal work	<Implementation> DPDC: power facility, Titas Gas (gas facility), WASA (water supply and sewage), BTCL (telecom cable), Dish authority (satellite communication) <Supervisor> DPDC	DPDC
8	Land Use (surrounding area of substation site)	- Access restriction for long term and traffic increase	- Media for prior notice - No. of prior notices - No. of affected structures - No. of affected households, family members and their livelihood status	- Consideration for footpath, sidewalk, crossing etc. - Minimization of negative impact on the surrounding area - Consideration for those whose livelihood activities are affected	<Method of data collection & analysis> Progress monitoring for land requisition, record of consultation with affected households <Location> Surrounding area of substation site, requisitioned road <Duration & frequency> During demolition work	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC
9	Work Environment (Including Work Safety)	1) Labor accidents during demolition and removal of existing facilities	- No. of handling heavy loads - No. of labor accidents including electric shocks	- Evaluate the effect of work safety plan	<Method of data collection & analysis> Record of labor accidents <Location> Contractor's office <Duration & frequency> Record continuously and monitor once a year	<Implementation> Contractor hired by DPDC <Supervisor> DPDC	DPDC

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
		2) Labor accidents during distribution line reconfiguration				DPDC	DPDC

(Source: The JICA Team)

(2) Construction Phase

Table 5: Environmental Monitoring Plan (Construction Phase)

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
1	Air Quality	1) Dust resulting from construction work 2) Exhaust gas from construction machinery and vehicles	SO2, NO2, PM10, PM10, PM2.5, Ambient Air Quality Standard	- Evaluate the effect of mitigation measures for air pollution	<Method of data collection & analysis> Sample collection and laboratory analysis <Location> Substation site <Duration & frequency> a) Once prior to demolition work b) Every month for the first two months c) Adjusted frequency based on the results of the above a) & b) for proper monitoring	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
2	Water Quality	1) Runoff water from construction site 2) Domestic waste water of workers	Temperature, pH, oil, As, coliform, Wastewater standards	Evaluate the effect of mitigation measures for water pollution	<Method of data collection & analysis> Sample collection of surface water (waste water) and groundwater, and laboratory analysis <Location> Substation site <Duration & frequency> Quarterly for surface water and biannually for groundwater	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
3	Waste	1) Industrial waste from construction work 2) Domestic waste from workers 3) Hazardous waste such as dry batteries, etc. 4) Excavated soil and surplus soil	Waste Management Rules	Evaluate the effect of mitigation measures for wastes	<Method of data collection & analysis> Record of kinds and quantity of waste, and treatment method <Location> Substation site <Duration & frequency> Continuous records	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
4	Soil Pollution	1) Runoff water from demolition site 2) Domestic waste water of workers 3) Spillage oil and chemical substances generated from construction machinery and vehicles	Soil standards	Evaluate the effect of the mitigation measures for soil contamination	<Method of data collection & analysis> Sample collection of soil pollutants and laboratory analysis <Location> Substation site <Duration & frequency> Once upon the commencement of construction work	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
5	Noise and Vibration	1) Noise and vibration by machinery and equipment 2) Noise and vibration by vehicles and trucks	Noise level, and Noise level standards	Evaluate the effect of mitigation measures for noise	<Method of data collection & analysis> Measurement using noise level meter <Location> Substation site <Duration & frequency> a) Once upon the commencement of construction work	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
					b) Quarterly c) Every time when specific works which cause unusual noise and vibration are conducted that may affect the public		
6	Offensive Odors	Domestic waste from workers	-Waste Management rules	Evaluate the effect of mitigation measures for odors	<Method of data collection & analysis> Record odors, causes, venues and treatment methods <Location> Substation site <Duration & frequency> Continuous records	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
7	Stability of Surrounding structures	Excavation work	- Design and layout - Building condition - Inclination condition - Subsidence condition	- Collect baseline information and data - Evaluate the influence on the surrounding structures	<Method of data collection & analysis> - Confirm the conditions of surrounding structures - Record changes in their conditions (if any) according to the progress of construction work <Location> Surrounding structures of substation site <Duration & frequency> a) Once before excavation work b) Once upon completion of excavation work c) Once upon completion of the whole of UGSS construction work	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
8	Land Use	- Temporary access restriction to the construction site on the transmission line's ROW	- No. of access restrictions	- Consideration for footpath, sidewalk, crossing etc. - Minimization of negative impact on the surrounding area - Consideration of negative impact on the corporations/people (if any) - Compensation and provision of alternative structures (if required) - Consideration for livelihood activities	<Method of data collection & analysis> Traffic management, progress monitoring for land requisition, record of consultation with affected households <Location> ROW of UGC route <Duration & frequency> Prior to the requisition, continuous record	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
9	Infectious disease	- Deterioration of laborer health - Spreads of infectious diseases	Health conditions of laborers	-Monitor health condition	<Method of data collection & analysis> Health check-ups <Location> Contractor's office <Duration & frequency>	<Implementation> Contractor	Expenses included in contract cost by Contractor

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
					Record continuously and monitor twice a year	<Supervisor> DPDC & ES Consultant	
10	Work Environment (Including Work Safety)	- Labor accidents	- No. of handling heavy loads - No. of labor accidents including electric shocks	- Evaluate the effect of work safety plan	<Method of data collection & analysis> Record of labor accidents <Location> Contractor's office <Duration & frequency> Record continuously and monitor once a year	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor
11	Accidents	Road traffic accidents	Road traffic accidents	- Evaluation of effect of traffic schedule	<Method of data collection & analysis> Record of road traffic accidents <Location> Contractor's office <Duration & frequency> Record continuously and monitor once a year	<Implementation> Contractor <Supervisor> DPDC & ES Consultant	Expenses included in contract cost by Contractor.

(Source: The JICA Team)

(3) Operation Period (Distribution line reconfiguration and O&M for UGSS and UG cables)

Table 6: Environmental Monitoring Plan (Operation Phase)

No	Impact to be Monitored	Impact Source	Monitored Parameter	Monitoring Purpose	Monitoring Method	Organization Responsible	Cost
1	Noise and vibration	Noise and vibration by operation of cooling system	- Noise level standards	Evaluate the effect of mitigation measures for noise	<Method of data collection & analysis> Measurement using noise level meter <Location> Substation site <Duration & frequency> Periodic O&M	DPDC	DPDC
2	Work Environment (Including Work Safety)	1) Labor accidents while switching distribution lines 2) Labor accidents in Operation and maintenance activities	- Handling heavy loads - Oxygen deficiency - Electric shocks	Evaluate the effect of work safety plan	<Method of data collection & analysis> Record of labor accidents <Location> DPDC's office <Duration & frequency> Record continuously and monitor once a year	DPDC	DPDC

(Source: The JICA Team)

3. Monitoring Form

The following items should be monitored periodically during each phase.

(1) Demolition work for existing buildings, distribution line switching and land leveling

1) **Air quality**

(Frequency) a) When commencing the demolition work b) Every month (in the first two months), c) Set the frequency after two months based on the monitoring results.

(Date & Time)

(Location)

(Work content and volume, etc.)

(Monitoring results & evaluation)

Monitoring Parameter	Unit	Value (short-term exposures)	Results	Standards for Air in Bangladesh*	IFC Standard for Air	Evaluation
SO2	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		365	125 (ITM1)	
CO	mg/m3	1hr (Max)		40		
	mg/m3	8hrs		10		
NO2	µg/m3	1hr (Max)			200 (guideline)	
	µg/m3	24hrs (average)		-	-	
PM10	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		150	150 (ITM1)	
PM2.5	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		65	75 (ITM1)	

Note: Schedule-2 Air Quality Standards, Environmental Conservation Rules 1997 (dated 28 Aug 1997) (amended by the Notification SRO 220-Law/2005 (dated 16 July 2005)).

(Meteorological Conditions)

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

2) **Water quality (Discharge wastewater)**

(Frequency) 1) When commencing the demolition work 2) Every month (in the first two months), 3) Set the frequency after two months based on the monitoring results.

(Date)

(Location)

Note: Monitoring shall be conducted at the discharge point of waste water treatment facilities.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Remarks (measurement method)
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	
Arsenic (As)	mg/L		0.2	0.05	-	
Total fecal coliform	MPN/ 100mL		-	-	400	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).
Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.
Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

3) **Waste**

(Frequency) Continuously

(Unit: ton/gm)

Month	Sample Date	Kinds of Waste (Quality)			Rate of recycling/Reuse (%)		Remarks
		Industrial	Domestic	Hazardous	Industrial	Domestic	
		(A)	(B)	(C)	(A)	(B)	

4) **Soil conditions**

(Frequency) a) When commencing the demolition work (Baseline data) b) When completing the demolition work (collect those parameters detected at the baseline only)
(Date)
(Location)
Note: Monitoring shall be conducted at the demolition site.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Countermeasures and Notes
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	
Arsenic (As)	mg/L		0.2	0.05	-	

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Countermeasures and Notes
			Inland surface water*	Public sewage system*		
Total fecal coliform	MPN/ 100mL		-	-	400	
Chromium (hexavalent)	Mg/l		0.1	1.0	-	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).
Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.
Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

5) **Noise**

(Frequency) a) When commencing the demolition work b) Every month (in the first two months), c) Set the frequency after two months based on the monitoring results.
(Date)
(Location)

(Unit: dBA)

Result		Bangladesh Noise Standards*					IFC Noise Level Guidelines*		Evaluation	Remarks
		A	B	C	D	E	A & B	D & E		
	Day	50	55	60	70	75	55	70		
	Night	40	45	50	60	70	45	70		

(Note 1) Area categories are: A: Silent zone, B: Residential zone, C: Mixed zone (mainly residential area, and also commercial and industrial areas), D: Commercial zone, D: Industrial zone
(Note 2) "Day" and "Night" of Bangladesh Noise Standards indicate 6AM to 9PM, and 9PM to 6AM respectively, whereas those of IFC Guidelines are 7AM to 10PM, and 10PM to 7AM.
(Note 3) Noise level of IFC Guidelines is L_{Aeq} per hour.

(Meteorological Conditions**)**

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

6) **Odors**

(Frequency) Continuously during the work period
(Date)
(Location)

Specific malodorous substance	Odor index	Source	Measure	Remarks

7) **Existing Social Infrastructure and Services**

Conduct site monitoring upon relocating, reconfiguring and removing the existing service facilities
(Frequency) When relocating, reconfiguring and removing service infrastructure

	Organization responsible	Date of work	Location	Situation	Remarks
Electricity line	DPDC				
Gas pipeline	Titas Gas				
Water pipeline	WASA				
Sewage pipeline	WASA				
Telecommunication line	BTCL				
Satellite/dish antenna line	Dish Authority				
Others					

8) **Land use**

(For the temporary resettlement/demolition of existing structures close to the substation site and associated road)

- Results of local survey and interviews

Questionnaire format (household head name, father's name, household members, asset inventory, occupation and livelihood means, monthly income, etc.), facts about the local survey and interview (such as date, venue and surveyors), aggregated data shall be attached.

- Compensation plan

Action plan for compensation and other assistance measures shall be attached.

- Progress of requisition

Progress of resettlement, demolition/removal of existing structures shall be monitored.

Date	Name of requisition site	Work progress and actions	Remarks

- Prior notice and public consultation

Means of prior notice and information sharing about the construction schedule, venues of such notice and meetings, contents of discussions shall be recorded.
(Frequency) Continuously recorded.

Date	Means	Venue	Contents and Actions	Remarks

9) **Work Environment**

- Periodic monitoring of safety measures (implementation of training, provision of protection

equipment, etc.)
(Frequency) Continuously recorded, monitor once a year.

Date	Name of safety measures	Venue	Contents	Remarks

- Periodic monitoring of labor accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Place	Cause of accident	Action	Remarks

(2) During Construction Period

1) **Air quality**

(Frequency) a) When commencing the construction work b) Every month (in the first two months), c) Set the frequency after two months based on the monitoring results.
(Date)
(Location)
(Work content and volume, etc.)

(Monitoring results & evaluation)

Monitoring Parameter	Unit	Value (short-term exposures)	Results	Standards for Air in Bangladesh*	IFC Standard for Air	Evaluation
SO2	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		365	125 (ITM1)	
CO	mg/m3	1hr (Max)		40		
	mg/m3	8hrs		10		
NO2	µg/m3	1hr (Max)			200 (guideline)	
	µg/m3	24hrs (average)		-	-	
PM10	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		150	150 (ITM1)	
PM2.5	µg/m3	1hr (Max)		-	-	
	µg/m3	24hrs (average)		65	75 (ITM1)	

Note: Schedule-2 Air Quality Standards, Environmental Conservation Rules 1997 (dated 28 Aug 1997) (amended by the Notification SRO 220-Law/2005 (dated 16 July 2005).

(Meteorological Conditions)

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

2) **Water quality**

- Surface Water (Discharge wastewater)

(Frequency) Once every three months
(Date)
(Location)
Note: Monitoring shall be conducted at the discharge point of waste water treatment facilities.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Remarks (measurement method)
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	
Arsenic (As)	mg/L		0.2	0.05	0.1	
Total fecal coliform	MPN/ 100mL		-	-	400	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).
Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.
Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.
Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

- Groundwater

(Frequency) Once every six months
(Date)
(Location)

Monitoring Parameter	Unit	Results	Bangladesh Standards for drinking water	Remarks (measurement method)
Temperature	℃		20 - 30	
pH	-		6.5 – 8.5	
Oil & grease	mg/L		0.01	
Arsenic (As)	mg/L		0.05	
Total fecal coliform	MPN/ 100mL		0	
Groundwater level	meter			
Chromium (hexavalent)	Mg/l		0.05	

Note 1: Schedule-3 Standards for Water, (B) Standards for drinking water, Environmental Conservation Rules 1997 (dated 28 Aug 1997).

3) **Waste**

(Frequency) Continuously

(Unit: ton/gm)

Month	Sample Date	Kinds of Waste (Quality)				Rate of recycling/Reuse (%)			Remarks
		Industrial (A)	Domestic (B)	Hazardous (C)	Soil (D)	Industrial (A)	Domestic (B)	Soil (D)	

4) **Soil conditions**

(Frequency) When commencing the construction work (collect those parameters detected at the baseline only)

(Date)

(Location)

Note: Monitoring shall be conducted at substation site.

Monitoring Parameter	Unit	Results	Standards for Waste from Industrial Units or Project Waste*		IFC Guiding Values for Treated Sanitary Sewage Discharges	Countermeasures and Notes
			Inland surface water*	Public sewage system*		
Temperature	℃		-	-	-	
pH	-		6-9	6-9	6-9	
Oil & grease	mg/L		10	20	10	
Arsenic (As)	mg/L		0.2	0.05	-	
Total fecal coliform	MPN/ 100mL		-	-	400	
Chromium (hexavalent)	Mg/l		0.1	1.0	-	

Note 1: Schedule-10 Standards for Waste from Industrial Units or Project Waste, Environmental Conservation Rules 1997 (dated 28 Aug 1997).

Note 2: Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries. Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes below.

Note 3: Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.

Note 4: Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

5) **Noise**

(Frequency) a) When commencing the construction work b) Every three months, c) Separately conduct monitoring for the works which create large-scale noise and vibrations.

(Date)

(Location)

(Unit: dBA)

Result		Bangladesh Noise Standards*					IFC Noise Level Guidelines*		Evaluation	Remarks
		A	B	C	D	E	A & B	D & E		
	Day	50	55	60	70	75	55	70		
	Night	40	45	50	60	70	45	70		

(Note 1) Area categories are: A: Silent zone, B: Residential zone, C: Mixed zone (mainly residential area, and also commercial and industrial areas), D: Commercial zone, D: Industrial zone
(Note 2) "Day" and "Night" of Bangladesh Noise Standards indicate 6AM to 9PM, and 9PM to 6AM respectively, whereas those of IFC Guidelines are 7AM to 10PM, and 10PM to 7AM.
(Note 3) Noise level of IFC Guidelines is L_{Aeq} per hour.

(Meteorological Conditions**)**

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa
	AM								
	PM								

6) **Odors**

(Frequency) Continuously during construction period
(Date)
(Location)

Specific malodorous substance	Odor index	Source	Measure	Remarks

7) **Stability of surrounding structures**

(Frequency) a) right before excavation work starts b) right after excavation work is completed c) right after the UGSS construction is completed
(Date)

Location	Structure, no of stories, years of construction, plot area, total floor area	Physical condition	Displacement and angle	Subsidence and depth

8) **Land use**

Means of prior notice and information sharing about the construction schedule, venues of such notice and meetings, contents of discussions shall be recorded.
(Frequency) Continuously recorded.

Date	Means	Venue	Contents and Actions	Remarks

9) **Infectious diseases**

(Frequency) Twice a year
- Monitor health records through health check-ups

10) **Work Environment**

- Periodic monitoring of safety measures (implementation of training, provision of protection equipment, etc.)

(Frequency) Continuously recorded, monitor once a year.

Date	Name of safety measures	Venue	Contents	Remarks

- Periodic monitoring of labor accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Place	Cause of accident	Action	Remarks

11) **Accidents**

- Periodic monitoring of road traffic accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Venue	Causes	Action	Remarks

(3) Operation Period

1) **Noise and vibration (substation)**

(Frequency) Upon periodic O&M

(Date)

(Location)

(Unit: dBA)

Result		Bangladesh Noise Standards*					IFC Noise Level Guidelines*		Evaluation	Remarks
		A	B	C	D	E	A & B	D & E		
	Day	50	55	60	70	75	55	70		
	Night	40	45	50	60	70	45	70		

(Note 1) Area categories are: A: Silent zone, B: Residential zone, C: Mixed zone (mainly residential area, and also commercial and industrial areas), D: Commercial zone, D: Industrial zone

(Note 2) "Day" and "Night" of Bangladesh Noise Standards indicate 6AM to 9PM, and 9PM to 6AM respectively, whereas those of IFC Guidelines are 7AM to 10PM, and 10PM to 7AM.

(Note 3) Noise level of IFC Guidelines is L_{Aeq} per hour.

(4) (Meteorological Conditions**)**

Date	Time	Wind direction	Wind speed	Temperature	Humidity	Solar radiation	Net radiation	Rainfall	Air Pressure
		16 directions	m/sec	℃	%	MJ/m2	MJ/m2	mm	kPa

	AM								
	PM								

2) **Work Environment**

- Periodic monitoring of safety measures (implementation of training, provision of protection equipment, etc.)

(Frequency) Continuously recorded, monitor once a year.

Date	Name of safety measures	Venue	Contents	Remarks

- Periodic monitoring of labor accident record

(Frequency) Continuously recorded, monitor once a year.

Date	Name of accident	Place	Cause of accident	Action	Remarks