Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
CENTRAL OFFICE
Manila

BAGONG PILIPINAS

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12.29.2023

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DEPARTMENT ORDER)
)
NO. 160)
Series of 2023 12/29/23 **)**

SUBJECT: Updated Standard Plan and Design Guidelines for Rural Water Supply for Level II (Domestic and Potable Use)

In line with the mandate of the Department on planning, designing, constructing and maintaining water resources development system and other public works in accordance with national development objectives, the updated standard plan and design guidelines for rural water supply for level II (domestic and potable use) is now available for reference.

The updated standard plan incorporates the introduction of a water treatment system particularly for potable applications. This includes a multi-step filtration process which aims to reduce contaminants to safe drinking levels based on the Philippine National Standard for Drinking Water (PNSDW) guidelines. The said plan consists of three separate tanks for raw, domestic and potable use. In addition, material options are made available in the updated plan since certain site conditions may require the use of other materials for more advantageous application.

Moreover, included in this issuance is the guidelines on the design of Rural Water Supply which include sample calculations for reference of the Regional and District Planning and Design Engineers.

The issuance of the said standard plan and design guidelines aims to ensure the safety, cost effectiveness and development of high-quality detailed design for rural water supply for level II incorporating the industry's best practice in design adaptable to local requirements. It shall also serve as a guide for District Engineering Offices, Regional Offices, Project Management Office Clusters and Engineering Consultants in the preparation of plans and reports for rural water supply for level II.

The said updated standard plan consisting of fourteen (14) sheets, and guidelines for the design of Rural Water Supply for Level II (Domestic and Potable Use), can be downloaded from the DPWH Intranet (http:dpwhnet) under the Bureau of Design – Standard Design.

This Order supersedes Department Order No. 29, Series of 2023 and shall take effect immediately.

MANUEL M. BONOAN
Secretary

5.1 EBS/RFIL/LLL/DLB/AGC

Department of Public Works and Highways
Office of the Secretary
WIN3R01613

Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
CENTRAL OFFICE
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BAGONG PILIPINAS

GUIDELINES FOR THE DESIGN OF RURAL WATER SUPPLY FOR LEVEL II (DOMESTIC AND POTABLE USE)

BUREAU OF DESIGN

CY 2023

Website: https://www.dpwh.gov.ph
Tel. No(s).: 5304-3000 / (02) 165-02

CERTIFICATION INTERNATIONAL SOCOTEC ISO 9001

Table of Contents

GUIDELINES FOR THE DESIGN OF RURAL WATER SUPPLY FOR LEVEL II (DOMESTIC AND POTABLE USE)

A. DOCUMENTARY REQUIREMENTS

The water supply project should conform with the documentary requirements and procedures stipulated in the set of Guidelines for the Construction of Government Water Supply Projects issued by the Department of Environment and Natural Resources (DENR) as well as applicable codes, standards, laws, orders and ordinances relevant thereto.

B. PRELIMINARY DESIGN REQUIREMENTS

B.1 Service Level

There are three (3) water service level classification in the Philippines depending on the method by which the water is made available to the consumers:

- Level I (Point Source) – This level provides a protected well or a developed spring with an outlet, but without a distribution system. The users go to the source to fetch water.

  This is generally adaptable for rural areas where affordability is low and the houses in the intended service area are not crowded. A level I facility normally serves an average of 15 households within a radius of 250 meters.

Source: © 2021 SciDev.Net

- Level II (Communal Faucet System or Stand Posts) - is adopted for the standard design. This type of system is composed of a source, a reservoir, a piped distribution network, and communal faucets. One faucet serves an average of five (5) households within a 25 meter radius. It is generally suited for rural and urban

areas where houses are clustered in sufficient density to justify a simple piped system.

Source: USAID Safe Water

- Level III (Waterworks System or Individual House Connections) – this system includes a source, a reservoir, a piped distribution network, and individual household taps.

Source: Asian Development Bank

It is generally suited for densely populated urban areas where the population can afford individual connections.

B.2 Design Period

For small water utilities, a design period of 5-10 years is recommended.

B.3 Design Population

The design population is the target number of people that the project will serve.

There are two (2) ways of projecting the design population:

i. Estimate the population that can be served by the sources. In this case, the supply becomes the limiting factor in the service level, unless a good abundant and proximate source is available in the locality.

ii. Project the community of barangay population, and determine the potential service area and the served population

$$P_F = P_P(1 + GR)^n$$

Where:

PF = Projected Future Population
PP = Present Population
GR = Annual Growth Rate
n = Number of Years between the Two (2) Census

B.4 Water Consumption

For a Level II Public Faucet, water consumption ranges from 50 – 60 liters per capita per day (lpcd).

B.5 Non-Revenue Water (NRW)

Non-revenue water is the amount of water that is produced but not billed as a result of leaks, pilferages, free water, utility usages, etc. The water demand projection should assume that the NRW of the new system will be fifteen percent (15%) of the estimated consumptions.

B.6 Water Demand

The water demand is a summation of all the consumptions given in the preceding sections and will determine the capacity needed from the source/s.

Demand Variations and Demand Factors

Demand Parameter	Demand Factor
Minimum Day Demand	0.3 of Average Day Demand
Average Day Demand	1.0
Maximum Day Demand	1.3 of Average Day Demand
Peak Hour Demand	2.5 of Average Day Demand (>1000 connections) 3.0 of Average Day Demand (<1000 connections)

i. Minimum Day Demand – The pipe network system is analyzed under a minimum demand condition to check on possible occurrence of excessive static pressures that the system might not be able to withstand. No point in the transmission and distribution system should be subjected to pressure more than 70m.

ii. Average Day Demand – Annual estimates and projections on production, revenues, non-revenue water, power costs, and other O&M costs are based on the average day demand.

iii. Maximum Day Demand – The total capacity of all existing and future water sources should be capable of supplying at least the projected maximum day demand at any year during the design period. The design of treatment plants, pump capacity and pipeline considers the maximum day demand supply rate as an option in the optimization analysis.

iv. Peak Hour Demand – The pipeline network should be designed to operate with no point in the system having pressure below 3 meters during peak hour conditions. If there is no reservoir, the power ratings of pumping stations should be sufficient for the operation of the facilities during peak hour demands.

C. CLASSIFICATION OF WELLS BASED ON AQUIFER TAPPED

C.1 Shallow Wells

Generally, a well is considered shallow if it is less than 20 meters deep. Shallow wells tap the upper water-bearing layer underground. This permeable layer, however, usually has limited safe yield due to its great dependence on seasonal rainfalls.

C.2. Deep Wells

Deep wells, which are over 20 meters deep, tap the deeper unconfined aquifer. This aquifer is not confined by an overlying impermeable layer and is characterized by the presence of a water table.

C.3 Artesian Wells

Artesian wells are much like deep wells except that the water extracted is from a confined aquifer. The confining impermeable layers are above and below the aquifer.

D. TYPES OF WELLS BASED ON DESIGN AND CONSTRUCTION METHODS

D.1 Dug Wells

Dug wells are holes or pits dug manually into the ground to tap the water table. The dug well may be up to 15 meters deep, with diameter usually ranging from 1 meter to 1.5 meters.

D.2 Driven Wells

Driven wells are like dug wells, in the sense that they tap the shallow portion of the unconfined aquifers. They are easy and relatively inexpensive to construct in locations with unconsolidated formations that are relatively free of cobbles or boulders. The wells are constructed by driving to the ground an assembly of G.I. pipe and a pointed metal tube called a "well point". The pointed end of the well point, which is the penetrating end, has screens or holes to allow the passage of water. The upper end of the G.I. pipe is hit at the top with a heavy weight, usually suspended from a block attached to a tripod. As the driving progresses, the well point sinks further into the ground and lengths of G.I. pipes are added at the top. Wooden blocks or steel caps should be placed at the top to protect it from being damaged by the impact of the driving weight.

D.3 Bored Wells

Bored wells are constructed with hand or power augers, usually into soft cohesive or non-caving formations that contain enough clay to support boreholes. The depth of the bored wells could be up to 15 meters.

D.4 Drilled Wells

Wells drilled by professional drillers with appropriate experience and equipment can extract groundwater to a much deeper level than the other types of wells.

Well construction usually comprises four or five distinct operations: drilling, installing the casing and screen, placing the filter pack, grouting to provide sanitary protection, and developing the well to insure sand-free operation at maximum yield.

There are two (2) common types of drilling methods, namely: cable tool and rotary drilling method.

Well drilling must be contracted to an experienced and competent well drilling company duly accredited by NWRB. The driller's role goes beyond the physical drilling of an appropriate size borehole; it includes, importantly, the performance of standard practices and tests.

E. TEST OF WELL SUITABILITY

E.1 Pumping ("Safe Yield") Test

The well's safe yield test can be roughly determined by operating a test pump with capacity at least equal to the system peak demand and operating it for 24-48 hours. After 24 hours of pumping, the drawdown should be measured at several time intervals to determine if it has stabilized.

The pumping rate at a stabilized pumping water level is the so called maximum pumping level and the safe yield is about 60%-80% of the figure. In water where incrustation is anticipated, the safety factor should be set low. In areas where water quality is good, with a sand and gravel aquifer and low seasonal water table fluctuation, a higher safety factor can be considered.

E.2 Water Quality Test

This is done to determine if the physical and chemical characteristics of the groundwater meet the required parameters for the intended use. For drinking water purposes, the characteristics of groundwater shall conform to the standards set by the Philippine National Standards for Drinking Water (PNSDW).

E.3 Estimated Well Yield

The production of the well should be at least equivalent to the projected maximum day demand of the water system by the design year. The hydro-geological study mentioned would indicate the estimated yield of a well.

F. WELL CONFIGURATION

F.1 Well Depth

The depth of the well depends on the water-bearing formation and the budgeted cost. The well must be designed to penetrate the aquifer as deep as possible within the budgeted cost.

During the test hole drilling, the drilling contractor will complete a formation log. Soil and rock samples are taken at various depths and the type of geologic material is recorded. This allows the driller to identify aquifers with the best potential for water supply. Some drillers also run an electric or gamma-ray log in the test hole to further define the geology.

Generally, a well is completed to the bottom of the aquifer. This allows more of the aquifer to be utilized and ensures the highest possible production from the well.

F.2 Casing Diameter

The well casing could be either a straight casing or telescopic casing. The diameter of a straight casing is the same from top to bottom of the well. Telescopic casing is a combination of a larger diameter casing/screen portion and a smaller diameter lower casing/screen portion.

The casing serves as a housing for the pumping equipment and as a conduit for the flow of groundwater from the screen opening to the suction of the pump. The housing portion of the casing should be located such that the pump will always be submerged in water. It should be set a few meters below the lowest drawdown level, considering seasonal fluctuations. The casing should be large enough to accommodate the pumping unit for the desired supply rate.

The minimum casing size must be equal to 50mm larger than the pump bowl but should not be less than 100mm.

F.3 Well Screen

The well screen is the intake portion of the well. The yield of a well depends greatly on the design and location of the screen. Wells can be screened continuously along the bore or at specific depth intervals.

Stainless steel screens are most widely used because they are strong and relatively able to withstand corrosive water.

A screen slot size that allows 60 percent of the aquifer material to pass through during the well development phase of drilling should be chosen. The remaining 40 percent, comprising the coarsest materials, will form a natural filter pack around the perforations or screens.

F.4 Wellhead Protection

The construction of the final well seal is intended to provide protection from leakage and to keep runoff from entering the wellhead. It is also important to install backflow prevention devices.

G. WATER TREATMENT

It is best to select sources with good water quality to avoid water treatment in order to reduce facility and operation cost. However, groundwater usually contains minerals, and other undesirable particles and contaminants, which should be eliminated or reduced to acceptable levels, for use in domestic or potable application

The type of water treatment selected shall be based on the requirement of water use. Depending on the treatment method, the concentration of the undesirable particulates or contaminants may be reduced or even eliminated. These contaminants include suspended particles, dissolved elements and minerals, bacteria, and algae that degrade the raw water quality.

Based on the Philippine National Standards for Drinking Water (PNSDW), potable water must be clear, colorless and free from objectionable taste and odor. Both physical and chemical tests shall be carried out to check treated water potability based on acceptable standards.

Water Treatment is comprised of several stages, which reduce and remove the amount of undesired contaminants from the extracted groundwater. Amongst these treatment methods are as follows, but are not limited to, to wit:

1. Pre-chlorination – removes algae, pathogenic organisms and other bacteria particularly, in surface water.

2. Sedimentation – water is allowed to sit in large settling tanks. During this stage, the floc particle settle at the bottom due to gravity forming a layer of sludge. The clarified water at the top is then ready for the next stage. This removes organic matter, bacteria, and other suspended solids.

3. Slow Sand and Carbon Filtration – The clarified water is passed through various filters to remove the remaining suspended particles, bacteria, and some dissolved contaminants. Sand Filters and Activated Carbon Filters are used for this process to remove suspended solids, colloidal particles, microorganisms, dissolved organic compounds, iron and manganese, chlorine and chloramines, some dissolved gases, certain inorganic compounds, and treat color, taste and odor. Anti-scalant and De-chlorination dosing may also be included during the pre-treatment phase.

4. Post Treatment – this entail use of advanced filters which can remove very small particles, bacteria and some viruses. Common post chlorination process uses Reverse Osmosis to achieve desired water quality. Pathogenic organisms, bacteria and the remaining total dissolved solids, organic compounds, heavy metals, nitrate, turbidity, color and odor compounds, and radioactive substances are also filtered.

5. Disinfection – Even after filtration, there might still be microorganisms present in the water. To ensure safety, disinfection is necessary. Common disinfection involves post chlorination, UV disinfection, Ozonation, and pH adjustment and stabilization.

H. PUMP AND STORAGE SYSTEM

H.1 Pump Sizing

Pump types can vary depending on the required configuration of the system. The pump types being used for water supply are either centrifugal pumps or positive displacement pumps. The pump capacity shall be selected based on the number of intended operation-hours for maximum day demand and reservoir size.

Pump selection is based on the depth of the pumping water level:

a. If pumping water level (PWL) is less than 6 meters, use a centrifugal pump (maximum suction lift = 6 meters);
b. If the pumping water level is from 6-20 meters , use jet or submersible pumps; and
c. If the pumping water level is greater than 20 meters, use a submersible or a vertical line shaft turbine pump.

The pump stop is set at the elevation of the designated well yield where static water level is set.

Pump power is determined by calculating the total dynamic head of the pump considering friction losses in the pipes and fittings from the source to the maximum water level at the overhead tank.

Pumps are best selected using a pump curve where the duty point is plotted against. The pump characteristics must be examined for both shut-off and run-out point of the selected curve.

The standard plan shows a 3.0hp, 64m, 1Ø, 60Hz multi-stage pump with the given configuration. The well yield is set at 60.0m but may vary depending on site condition. The actual pump capacity shall be based on the actual data collected at site and on the configuration of the piping and storage system. Sizing and design of the forced main shall be undertaken by a qualified Mechanical Engineer.

H.2 Pipeline

The pipe material must be selected to withstand the highest possible pressure that can occur in the pipeline. Steel Pipes or Plastic Pipes i.e., Polyvinyl Chloride (PVC) or Polyethylene (PE) can be used depending on the requirement of the system.

For the transmission line design, a maximum computed HGL based on a minimum supply rate equivalent to 0.3 times the average day demand should be examined. At any point in the transmission line, this maximum HGL should not be over the allowable maximum pressure of the line (70 m head).

To limit the maximum pressure, break pressure tanks or chambers could be installed along the main.

The distribution pipelines must be designed to handle the peak hour demand of the system:

1. Minimum pressure head at the remotest end of the system = 3.0 m
2. Maximum velocity of flow in pipes
    a. Transmission Line = 3.0 m/s
    b. Distribution Line = 1.5 m/s
3. Minimum velocity of flow in pipes = 0.4 m/s
4. Demand Factor: varies from 0.3 (minimum demand) to 3.0 (peak demand)
5. Allowable head loss: minimum = 0.50m/1000m, maximum = 10m/1000m
6. Allowable pressure head: minimum = 3m, maximum = 70m

H.3 Reservoirs

There are two (2) main types of reservoir being used for water supply, elevated reservoirs and ground level reservoirs.

The standard plan provides an elevated reservoir to minimize the use of pump power and conserve energy produced through solar energy.

As a rule of thumb, the storage tank volume should be at least equal to one-fourth (25%) of average day demand of the community.

The structural design of reservoirs must meet the standards set by the National Structural Code of the Philippines. The reservoirs must be strong enough to withstand all loads, such as hydrostatic pressure, earth pressure, wind loads, seismic loads and other dead or live loads.

H.3.1 Inlet Line

The size of the inlet line must be determined by the supply and demand requirements. The inlet line on all reservoirs must have a shut-off valve located adjacent to the reservoir.

H.3.2 Outlet or Discharge Line

Like the inlet line, the size of the outlet line is determined by the supply and demand requirements. The upstream-end of the outlet pipe is usually installed at least 5 cm, above the floor of the reservoir to create a dead volume of water.

H.3.3. Drain Line

This is provided for draining and cleaning the reservoir. Draining could be done through the inlet-outlet line by shutting off the valve controlling the flow in the main line and opening the drain valve.

H.3.4 Ventilation Facilities

These are provided in reservoirs to allow the air to escape fast enough to prevent pressure from building up inside the reservoir during filling, and to prevent a vacuum from forming when water is being drawn out. The ventilation facilities should be designed to keep rain and surface water from entering, and they should be screened to keep out insects. Overflow and drainage pipes should be designed with a valve chamber to prevent rodents from entering the reservoir.

H.3.5 Overflow Line

Reservoirs should be provided with an overflow line large enough to allow the maximum anticipated overflow (pump or spring capacity) and should be properly screened and covered like an air vent.

H.3.6 Manhole and Covers

These are installed in reservoirs to serve as entrance during repair, cleaning and maintenance. To prevent the entry of surface water which may contain pollutants, manholes should be installed slightly raised above the roof level and must be equipped with an overlaying cover. The cover is also necessary to prevent the sun's rays from promoting algae growth.

H.3.7 Water Level Indicators

Depth gauges using a flow and wires are usually used.

H.3.8 Control Valves

The flow into the reservoir may be stopped manually or automatically.

I. SOLAR POWER SYSTEM

I.1 Solar Panels

The solar cell is the basic unit of a photovoltaic (PV) system. Solar panels shall be of mono-crystalline or poly-crystalline type with efficiency range of 14-19% and 12-15%, respectively. Voltage rating of each panel varies from 12V, 24V or 48V.

The standard plan adopts/specifies a 550 watts or its approved equivalent for a 1mx2m mono-crystalline solar panel.

The type of solar power produced by a photovoltaic solar cell is a direct current (DC) power. Most commercially available photovoltaic solar cells have solar power ratings which indicate the maximum deliverable solar power that the cell can provide in watts and is equal to the product of the cell voltage multiplied by the maximum cell current.

The number of solar panel needed for a given installation can be determined by dividing the estimated hourly energy requirement by the peak sunlight hours for the specific area and dividing it by the panel's wattage taking into consideration the efficiency of the electrical system.

The designer shall also take note of the string size or how many group of panels can be wired to account for the specific input voltage range of the selected inverter. The minimum string size shall correspond to the minimum range of the inverter specification. The string shall not exceed the specified maximum DC input voltage to protect the inverter from overloading. For the given standard plan, an 8 strings of 3 is adopted.

I.2 Inverters

Inverters are also known as power conditioning units used to convert direct current (DC) electricity from batteries and solar panels into alternating current (AC) electricity. The specifications of the inverter shall be based on the input battery voltage, maximum load, the maximum surge required, variations in voltage and any optional features needed.

A hybrid solar inverter is the combination of a solar inverter and a battery inverter into a single piece of equipment that can intelligently manage power from your solar panels, solar batteries, and the utility grid at the same time.

The size of the inverter shall account for the power conversion efficiency to about 88-92% from DC to AC.

I.3 Batteries

Batteries are used both as storage and back-up energy for the solar powered system. These are classified into two (2): Lead Acid and Lithium Ion Batteries. These varies in the depth of discharge of 50% and 80%, respectively. The number of batteries in the system shall be determined based on the utilization limit of the battery and the number of autonomy days designed for the system taking into consideration its efficiency.

Lithium iron phosphate ($LiFePO_4$) battery is a new type of lithium-ion battery that uses lithium iron phosphate as the cathode material to store lithium ions. $LiFePO_4$ batteries typically use graphite as the anode material. The chemical component of $LiFePo_4$ batteries gives them a high current rating, good thermal stability, and a long service life.

Prepared by:

MARU BRYAN T. ZAPLAN
Engineer II, Buildings Division

VINCENT A. BERAN
Engineer III, Buildings Division

MARK JOSEPH L. RIVERA
Engineer III, Water Projects Division

GIAN PAULO G. RABACAL
Engineer III, Water Projects Division

Checked by:

ERIBERTO B. SIOSON
Chief, Buildings Division

RICHELIEU FELIPE I. LIM
OIC, Water Projects Division

Recommended:

DANILO L. BALISI
Director IV
Bureau of Design

Approved:

ADOR G. CANLAS, CESO IV
Undersecretary for Technical Services
and Information Management Service

APPENDIX
SAMPLE CALCULATIONS

DESIGN CONSIDERATIONS FOR RURAL WATER SUPPLY FOR LEVELS II (DOMESTIC AND POTABLE USE)

(Sample Calculations)

The following calculations were done in accordance with the requirements of the Rural Water Supply Design Manual (Volume I), Philippine Mechanical Engineering Code, Philippine Electrical Code, National Structural Code of the Philippines and other relevant codes and standards.

The parameters considered in the sample calculations were based on assumptions and shall be adjusted based on actual site condition and data gathered thru the conduct of geo-resistivity test, water quality test, and pump "safe yield" test, among others, during the planning stage.

Mechanical Works:

Design Data:

Sample Size Population: 500 individuals or 100 households
Design Period: 5-10 years
Service Level: Level II (Communal faucet System or Stand Posts)
Communal Faucet Service = 4-6 households (5 households average)
Per Capita Water Consumption: 50-60 liters per capita/ day (55 lpcd average)
Water Demand:

- Average Day Demand (ADD) = 27,500 L/day
- Minimum Day Demand = 0.3(ADD) = 8,250 L/day
- Maximum Day Demand = 1.3(ADD) = 35,750 L/day
- Peak Hour Demand = 3.0(ADD) less than 1000 connections
  3,437.5 L/hr (upper limit)
- Non-Revenue Water = 0.15(ADD) = 4,125 L/day

Drilled Well >20m (average aquifer depth) = 40-60 m, use 60m
Raw Water Tank Elevation above ground = 2.20 meters
Domestic Water Tank Elevation above ground = 7.60 ~ 8.0 meters
Potable Water Tank Elevation above ground = 2.20 meters

Other Assumptions/Considerations

Pumping "Safe Yield" Test Elevation = 60.0 m below NGL
Minimum Pumping Level (after drawdown) = Pumping "Safe Yield" Test Elevation
Pump Type: Submersible Pump (>20 m depth)

Reservoir Sizing

An elevated water tank is considered for this standard plan. The size of the reservoir shall account for about 25% of the Maximum Day Demand (MDD).

Typical commercial tank size is 10,000 liters, 2.5mØ x 2.0mH

The filtered/treated water is separated in the filtration process. Dense water output, which can be utilized for domestic applications account for 60-75% and left treated water is about 25-40% of raw water.

Two (2) units of 3000-Liter tank can be utilized to collect dense water output for domestic use and Two (2) units of 2000-Liter tank for potable use.

Pump Sizing

Pump capacity shall deliver the required water demand for the day considering the results of the pumping test for the subject well as to limits in pumping duration and rate. Typically, aquifer properties are estimated from a constant rate pumping test by fitting mathematical models to drawdown data through a procedure known as curve matching. Diagnostic tools such as derivative analysis are useful for identifying flow regimes and aquifer boundaries from a pumping test prior to performing curve matching.

There are several pumps considered in the design of water treatment system, such as follows:

1. Submersible Well Pump – use for extracting groundwater from the well and filling the raw water reservoir.

2. Raw Water Pump – use to draw water from the raw water reservoir for the first stage of the water treatment process.

3. High Pressure Pump – use to deliver water for the succeeding stages of the water treatment process and deliver filtered water to pure water tanks.

4. Supply Pump – use to deliver the dense water output from the water treatment system to the elevated domestic water tanks.

5. Distribution Pump – use for distributing domestic water supply to communal faucet connections. If necessary, booster pumps are also installed along the distribution system to maintain and attain the required fluid pressure.

This guideline only shows the calculations made for the submersible well pump, as the raw water pump and the high-pressure pump are integrated to the water treatment system's capacity selected per the manufacturer's recommendation. Typical size for these pumps are indicated in the plan for the sample 2000L/hr treatment rating. On the other hand, the supply pump is a standard 1-Hp capacity pump used for filling the elevated domestic water tank. The distribution pump is not included in this guideline since piping is dependent on the proximity and configuration of the distribution line.

This standard plan considers a submersible pump operation of about 5 hours daily with a pump capacity of 2.0 liters/second or 32 gal/min. This will limit disturbance in the raw water tank to a minimum and agitation of suspended solids.

Reservoir Capacity: 10,000 Liters
Pump Capacity: ADD/(15% NRW)/(Operation Hours)
27,500 L/day (1/0.85)(1/5 hours)(1/3600sec)
1.91 L/sec ~ 2.0 L/sec
Tank Filling Time: 1.39 ~1.40 hours
Water Treatment Cap: Based on the minimum and maximum day demands of 8,250 L/day and 35,750 L/day, respectively, use a 2000 L/hr water treatment capacity, capable of running up to 18 hours daily with power sourced directly from solar panels during the day, supplemented by utility and battery back-up during nighttime. 60-75% of raw water or 1200-1500 L/hr is converted to dense water output and 25-40% 500-800 L/hr is converted to pure water.
Total Dynamic Head: 63.911 m or 64 m
Actual Head – 62.2 m
60.0 m (NGL-Min. Pumping Level)
0.20 m (Raw Water Tank Frame Elevation)
2.00 m (Tank Height)
Friction Loss – 1.711 m
Pipes and Fittings
Velocity Head
10% Allowance
Pump Power: 2.082 kW or 3.070 HP
Commercial Pump Size: 3.0 HP
Pump Specifications:
Design Head: 64.0 m
Pump Speed: 3450.0 rpm
Discharge Port Size: 2.0 in. or 50mm
Stages: 14
Pump Material: SS 304 (Stainless Steel)
Electrical Data: 230V, 1Ø, 60Hz
Recommended Well Size Diameter: 4.0 in. or 100mmØ

The pump specifications may vary depending on the designation of the minimum pumping level after drawdown based on the pumping "safe yield" test. This also corresponds to the configuration of the system, the pipes and fittings used, and the efficiencies considered by the designer in sizing.

The initial size of the system shall be coordinated with the manufacturer under the close supervision of a Registered Mechanical Engineer.

Electrical Works

Initial Solar System Sizing

The solar panels selected for this standard plan is of 550 Watt, 48V, Monocrystalline Type.

Solar Panel Wattage: 550 Watts
Electrical Load: 2.2kW Submersible Pump, 0.75kW Raw Water Pump, 5.5kW Water Treatment Pump, 1 HP Air-conditioning Loads, Luminaires and Convenience Outlets
Daily Operations: 5 Hours for motor loads
kW-hr Requirement for the Day: 60805 WHr/Day
Total Wattage: 12647 kW
80% Inverter Efficiency
85% Battery Efficiency
97% Wire Losses
Maximum Peak Sunlight Hours per Day (Philippines): 4 Hours
Required Number of Solar Panels: 36 Panels

The Electrical Engineer shall also account for the string connections of the solar panels taking into consideration the maximum photovoltaic input voltage and the current of the Hybrid Inverter Specification.

For the given standard plan, the Hybrid Solar System consist of a 20kW Hybrid inverter, single phase, 6-200AH LiFePo4 Batteries, Automatic Transfer Switch, and their respective DC and AC Circuit Breakers.

9 - 550W Solar Monocrystalline Panels per string for a total of 36 panels or its approved equivalent is designed to meet the design requirement.

Any equivalent Solar Panel Wattage rating can be used in consideration with the Maximum PV input Power of the Hybrid Inverter:
36 X 550W Monocrystalline Solar Panel = 19800W
40 X 500W Monocrystalline Solar Pane = 20000W
44 X 450W Monocrystalline Solar Pane = 19800W

The initial size of the system shall be coordinated with the manufacturer under the close supervision of a Registered Electrical Engineer.

Civil Works

Structural Considerations

The design criteria and considerations used are based on the National Structural Code of the Philippines (NSCP) 2015.

Structural Loading (considered in the Updated Standard Plan)

Occupancy Category	=	Standard Occupancy Structures
Seismic Zone Factor	=	Zone IV
Basic Wind Velocity	=	250 kph

Material Strength

Concrete Strength at 28 days	=	21 MPa
Reinforcement Yield Strength		
Diameter 12 and below	=	230 MPa (Grade 33)
Diameter 16 and above	=	276 MPa (Grade 40)

The allowable soil bearing capacity to be used must be based on the actual site geotechnical investigation.

The actual sizes of structural members must be supported by a structural analysis based on actual site condition.

Elevated Platform for Water Tank

Polyethylene water tanks or commercial size steel tanks, instead of stainless steel water tanks, can also be adopted for smaller storage designs. The tanks can be raised using steel frame platform.

The tank will sit on 50-mm thick steel plate to be supported by I-beam steel frame. The steel columns are connected to concrete pedestals through anchor bolts and base plate. All steel-to-steel connection must be fully weld. Pedestals are then supported by isolated footings. Angle bar steel bracings must be provided for added support during lateral pressure.

Structural steel members shall be painted with anti-rust and anti-corrosion to avoid rapid deterioration.

On-ground Solar Panel Module Support

Solar Panels connected on module rail will be supported by truss system composed of U-Channels. The truss is then connected to concrete pedestals through u-bolts and baseplate with isolated footings. However, if on-ground solar panels need to be raised, circular steel tube may be use for column connected to the pedestals.

On-roof Solar Panel Module Support

Solar Panels connected on module rail will be attached to the roofing/c-purlin by hanger bolts. The angle of tilt for solar panels will reflect the angle of the roofing system.

Power House

The provided powerhouse in the updated standard plan may vary based on the actual lot area for the project.

The water treatment unit should be enclosed in a separate room where noise can be kept at a minimum level and where personnel will not have to stay for more than the recommended duration.

REPUBLIC OF THE PHILIPPINES

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

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MANILA

UPDATED STANDARD PLAN FOR RURAL WATER SUPPLY FOR LEVEL II (DOMESTIC AND POTABLE USE)

SUBMITTED BY:

RICHELIEU FELIPE I. LIM
OIC, WATER PROJECTS DIVISION
BUREAU OF DESIGN
DATE: 11-07-23

ERIBERTO B. SIOSON
CHIEF, BUILDINGS DIVISION
BUREAU OF DESIGN
DATE: 10-03-2023

RECOMMENDING APPROVAL:

DANILO L. BALISI
DIRECTOR IV
BUREAU OF DESIGN
DATE: 12/20/23

MEDMIER G. MALIG
ASSISTANT SECRETARY FOR
TECHNICAL SERVICES AND
INFORMATION MANAGEMENT SERVICE
DATE: 12/22/23

APPROVED BY:

ADOR G. CANLAS, CESO IV
UNDERSECRETARY FOR
TECHNICAL SERVICES AND
INFORMATION MANAGEMENT SERVICE
DATE: 12/27/23

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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE: INDEX OF DRAWINGS

SHEET CONTENTS: INDEX OF DRAWINGS

PREPARED:
GIAN PAULO S. RABACAL, ENGINEER III
MARK JOSEPH L. RIVERA, ENGINEER III

DRAFTED:
JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT

REVIEWED:
CRISSA RICA E. BARIL, ENGINEER IV

SUBMITTED:
RICHELIEU FELIPE I. LIM
OFFICER-IN-CHARGE
WATER PROJECTS DIVISION
BUREAU OF DESIGN
DATE:

RECOMMENDING APPROVAL:
DANILO L. BALISI
DIRECTOR IV
BUREAU OF DESIGN
DATE:

(SEE COVER SHEET)
MEDMIER G. MALIG
ASSISTANT SECRETARY FOR
TECHNICAL SERVICES AND
INFORMATION MANAGEMENT SERVICE

APPROVED: (SEE COVER SHEET)
ADOR G. CANLAS, CESO IV
UNDERSECRETARY FOR
TECHNICAL SERVICES AND
INFORMATION MANAGEMENT SERVICE

SET NO. STD GE

SHEET NO. 1

GENERAL NOTES :

I. GENERAL

1. THESE NOTES SHALL APPLY UNLESS SPECIFICALLY OTHERWISE INDICATED IN THE PLANS. IN CASE OF CONFLICT BETWEEN PLANS AND SPECIFICATION, SPECIFICATION SHALL GOVERN.
2. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED IN THE PLANS.
3. ALL ELEVATION ARE IN METERS UNLESS OTHERWISE NOTED IN THE PLANS.
4. ALL DIMENSIONS AND ELEVATION SHOWN IN THE PLANS SHALL BE VERIFIED BEFORE COMMENCEMENT OF THE WORKS.
5. ALL DIMENSIONS, ELEVATIONS AND LOCATION OF OPENING RELATED TO THE EQUIPMENT ARE TENTATIVE AND SUBJECT TO CHANGE AFTER THE EQUIPMENT DIMENSIONS HAVE BEEN ESTABLISHED.

II. DESIGN CRITERIA AND SPECIFICATIONS

1. DPWH DESIGN GUIDELINES, CRITERIA, AND STANDARDS (DGCS) - VOLUME 3 2015 EDITION
2. DPWH STANDARD SPECIFICATIONS FOR HIGHWAYS, BRIDGES, AND AIRPORTS - VOLUME II, LATEST EDITION
3. DPWH STANDARD SPECIFICATIONS FOR PUBLIC WORKS STRUCTURES (BUILDINGS, PORTS AND HARBORS, FLOOD CONTROL AND DRAINAGE STRUCTURES AND WATER SUPPLY SYSTEMS) - VOLUME III, 2019 EDITION
4. RURAL WATER SUPPLY VOLUME I DESIGN MANUAL.
5. PHILIPPINE SOCIETY OF MECHANICAL ENGINEERING CODE.
6. PHILIPPINE ELECTRICAL CODE.
7. NATIONAL STRUCTURAL CODE OF THE PHILIPPINES, VOLUME I (BUILDING, TOWERS AND OTHER VERTICAL STRUCTURES) 7TH EDITION 2015, (NSCP).

III. CIVIL AND STRUCTURAL DESIGN

1. REINFORCED CONCRETE

SCHEDULE OF STRUCTURAL CONCRETE

LOCATION	STRUCTURAL ELEMENTS	28–DAY COMPRESSIVE STRENGTH	DENSITY	MAX SLUMP
FOUNDATION	FOOTINGS, WALL FOOTINGS	3000 PSi= 21 MPa	24 KPa	4"(100mm)
GROUND TO ROOF	SLAB, BEAMS COLUMNS, RAMPS R.C. WALLS RETAINING WALLS	3000 PSi= 21 MPa	24 KPa	4"(100mm)
	SLAB ON GRADE	2500 PSi=17.24 MPa	24 KPa	4"(100mm)

1.1 LOCATION OF ALL CONSTRUCTION OR COLD JOINTS MUST BE APPROVED BY THE ENGINEER.
1.2 REINFORCING BARS, ANCHOR BOLTS, AND OTHER INSERTS SHALL BE SECURED IN PLACE BEFORE POURING CONCRETE, BAR PLACEMENT AND SUPPORTS SHALL BE IN ACCORDANCE WITH THE RECOMMENDED ACI PRACTICE.

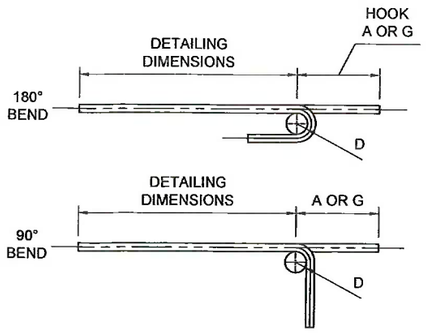
2. REINFORCING STEEL

SCHEDULE OF REINFORCING BARS

DIAMETER OF BARS	GRADE (fY)	ASTM
ø12 AND SMALLER	GRADE 33 (33,000psi)	A615/A615M DEFORMED
ø16 AND LARGER	GRADE 40 (40,000psi)	A615/A615M (DEFORMED)

MINIMUM REINFORCING LAP SPLICE AND BEND

BAR SIZE	LAP (cm)	BEND Ø (mm)	A OR G	
			180°	90°
D10	30	57	13	13
D12	45	76	15	18
D16	53	95	18	23
D20	61	114	20	25
D25	76	152	25	36
D28	91	229	31	41
D32	99	260	33	46
D36	114	285	36	51



3. STRUCTURAL STEEL

3.1 ALL STRUCTURAL MILL SECTIONS AND BUILT UP PLATE SECTIONS SHALL BE DESIGNED IN ACCORDANCE WITH AISC'S LATEST SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS.
3.2 DESIGN LOADS SHALL MEET THE REQUIRED STRUCTURAL DESIGN CRITERIA.
3.3 STEEL PLATES, SHAPES, BARS AND METAL FABRICATIONS: ASTM A-36.
3.4 STRUCTURAL BOLTS AND NUTS:
ASTM A-325, GALVANIZED. 7/8 Ø AND BELOW.

IV. MECHANICAL NOTES

1. ALL MECHANICAL WORKS SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE PHILIPPINE MECHANICAL ENGINEERING CODE.
2. THE TOTAL SCOPE OF WORKS SHALL INCLUDE ALL WORKS DESCRIBED IN PLANS AND LISTED IN TECHNICAL SPECIFICATIONS FOR MECHANICAL WORKS.
3. THE WORK SHALL BE EXECUTED IN CLOSE COORDINATION WITH OTHER TRADES.
4. THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS, TECHNICAL DATA / SPECIFICATION (BROCHURES/CATALOGUE) SUBJECT FOR FURTHER TECHNICAL EVALUATION OF THE CONCERNED AUTHORITY PRIOR TO PROCUREMENT / INSTALLATION OF THE EQUIPMENT / UNIT.
5. PROVIDE SEISMIC RESTRAINTS FOR ALL RIGIDLY & RESILIENTLY SUPPORTED EQUIPMENT FOR APPLICABLE CODE & AS SPECIFIED DESIGN & PROVIDE RESTRAINTS FOR PUMPS, FANS, TANKS, ALL PIPING WORKS, GENERATORS ENGINE EXHAUST PIPES, ETC. RESTRAINTS SHALL BE DESIGNED TO PREVENT PERMANENT DISPLACEMENT IN ANY DIRECTION CAUSE BY LATERAL MOTION.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TESTING AND COMMISSIONING OF ALL EQUIPMENT INSTALLED.
7. PROVIDE PIPE SLEEVES FOR ALL PIPING PASSING THROUGH BUILDING STRUCTURES.
8. PROVIDE GUIDES, HANGER AND SUPPLEMENTAL SUPPORT STEEL FOR ALL PIPING.
9. ALL STEEL PIPE SUPPORTS SHALL BE PHOSPHATED PRIOR TO APPLICATION OF TWO COATS OF RED LEAD AND A COAT OF ENAMEL PAINT FOR FINISHING.
10. THE QUANTITY OF EACH EQUIPMENT INDICATED IN THE SCHEDULE IS FOR GUIDANCE ONLY. FOR QUANTITY TAKE OFF COUNT THE NUMBER OF UNITS IN THE PLANS.
11. ALL MECHANICAL WORKS SHALL BE DONE UNDER THE DIRECT AND IMMEDIATE SUPERVISION OF A DULY REGISTERED MECHANICAL ENGINEER.

V. ELECTRICAL NOTES

1. ALL ELECTRICAL WORKS SHALL BE DONE IN ACCORDANCE AND IN STRICT COMPLIANCE WITH THE PROVISIONS OF THE LATEST EDITION OF THE PHILIPPINE ELECTRICAL CODE (PEC) EXISTING APPLICABLE LAWS, ORDINANCES, REQUIREMENTS, RULES AND REGULATIONS OF THE LOCAL GOVERNMENT AND LOCAL POWER COMPANY.
2. WHEREVER REQUIRED AND NECESSARY, JUNCTION BOXES OR PULL BOXES SHALL BE INSTALLED AT INCONSPICUOUS LOCATIONS ALTHOUGH SUCH BOXES ARE NOT SHOWN ON THE PLANS NOR MENTIONED IN THE SPECIFICATIONS.
3. ALL NON-CURRENT CARRYING METAL PARTS/ ENCLOSURES OF ELECTRICAL EQUIPMENT AND OVERCURRENT PROTECTIVE DEVICES SHALL BE PROPERLY GROUNDED INACCORDANCE WITH ARTICLE 2.50 OF THE PHILIPPINE ELECTRICAL CODE PART 1, 2000 EDITION
4. THE ELECTRICAL SYSTEM SHALL HAVE A GROUND RESISTANCE NOT EXCEEDING 5 OHMS..
5. STANDARD TYPE OF ACCESSORIES, SPLICING DEVICES, TERMINATIONS AND OTHER APPURTENANCES FOR THE ENTIRE ELECTRICAL INSTALLATION SHALL BE USED.
6. ALL MATERIALS TO BE USED AND INSTALLED SHALL BE BRAND NEW AND OF THE APPROVED TYPE FOR THE LOCATION AND PURPOSE.
7. SOLAR CONTRACTOR SHALL PROVIDE FINAL QUANTITY AND RATING OF SOLAR PANEL (PHOTOVOLTAIC PANEL), SOLAR CHARGE CONTROLLERS, BATTERIES, AND INVERTERS BASED ON ACTUAL ROOF AND SITE ORIENTATION AND SPACES
8 SOLAR CONTRACTOR SHALL PROVIDE FINAL DRAWINGS, SHOP SPECIFICATIONS AND OTHER RELATED DOCUMENTS FOR SOLAR POWER SYSTEM
9 DESIGN OF DISTRIBUTION SYSTEM IS NOT INCLUDED IN THIS STANDARD PLAN AS IT VARIES DEPENDING ON THE SITE LOCATION.
10 ALL ELECTRICAL WORKS SHALL BE DONE UNDER THE DIRECT AND IMMEDIATE SUPERVISION OF A DULY REGISTERED ELECTRICAL ENGINEER.

VI. SOLAR PANEL

1. BASIC WIND VELOCITY IN THE DESIGN, V = 250 kph
2. SOLAR PANEL ORIENTATION SHALL GENERALLY BE FACING SOUTH FOR MAXIMUM OUTPUT OF POWER BUT OPTIMUM RADIATION EXPOSURE SHALL BE CONSIDERED AT ALL TIMES BASED ON PROJECT LOCATION.
3. SOLAR PANEL MODULES SHALL BE OF MONO CRYSTALLINE OR POLY-CRYSTALLINE TYPE.
4. ALL ROOF PENETRATIONS SHALL BE SEALED WITH A HIGH PERFORMANCE ROOF SEALANT.
5. THE SOLAR PHOTOVOLTAIC INSTALLATION SHALL NOT OBSTRUCT ANY PLUMBING, MECHANICAL, OR BUILDING ROOF VENTILATION.
6. APPROPRIATE CAUTION AND WARNING ELECTRICAL SIGNS AND SIGNAGES SHALL BE POSTED AT CONSPICUOUS LOCATION AT THE SITE.

VII. AQUIFER / PUMP WELL

1. THE LOCATION AND DEPTH OF WELL SHALL BE BASED ON GEO-RESISTIVITY SURVEY.
2. THE DESIGNER SHALL CONDUCT A PUMPING ("SAFE YIELD") TEST AT LEAST EQUAL TO THE SYSTEM PEAK DEMAND AND OPERATE IT FOR 24-48 HOURS.
3. WELL DRILLING WILL COMMENCE UPON SECURING OF DRILLING PERMIT FROM THE NWRB AND MUST BE CONTRACTED TO AN EXPERIENCED AND COMPETENT WELL DRILLING COMPANY DULY ACCREDITED BY THE NWRB.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR WELL HEAD PROTECTION TO PROVIDE SEAL FROM LEAKAGE AND RUNOFF ENTERING THE WELL HEAD.

VIII. ABBREVIATIONS

BOTT. BARS	BOTTOM BARS	m	METER
C	COLUMN	mm	MILLIMETER
C.H.B.	CONCRETE HOLLOW BLOCK	ND	NOMINAL DIAMETER
C	CONCRETE	N	NORTH
cm	CENTIMETER	NGL	NATURAL GRADE LEVEL
DWG	DRAWING	N.T.S.	NOT TO SCALE
D	DOOR	PV	PHOTOVOLTAIC
DS	DOWNSPOUT	R.C.	REINFORCED CONCRETE
EA	EACH	STD	STANDARD
E.F	EACH FACE	STL	STEEL
E.W	EACH WAY	t, THK	THICKNESS
EL, ELEV	ELEVATION	TDH	TOTAL DYNAMIC HEAD
FLR	FLOOR	TYP	TYPICAL
F.T.G.	FOOTING TIE BEAM	T.B.	TOP BAR
G.I.	GALVANIZED IRON	VERT	VERTICAL
GRD, GRND	GROUND	W/	WITH
HOR.	HORIZONTAL	W/O	WITHOUT
L	LENGTH	W.P	WATER PROOFING

REPUBLIC OF THE PHILIPPINES
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BUREAU OF DESIGN
MANILA

SHEET TITLE: GENERAL NOTES

SHEET CONTENTS: CIVIL AND STRUCTURAL, MECHANICAL, ELECTRICAL, SOLAR PANEL, AQUIFER/PUMP WELL

PREPARED: GIAN PAOLO V. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA RICA E. BARIL, ENGINEER IV

SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECT DIVISION, BUREAU OF DESIGN, DATE:

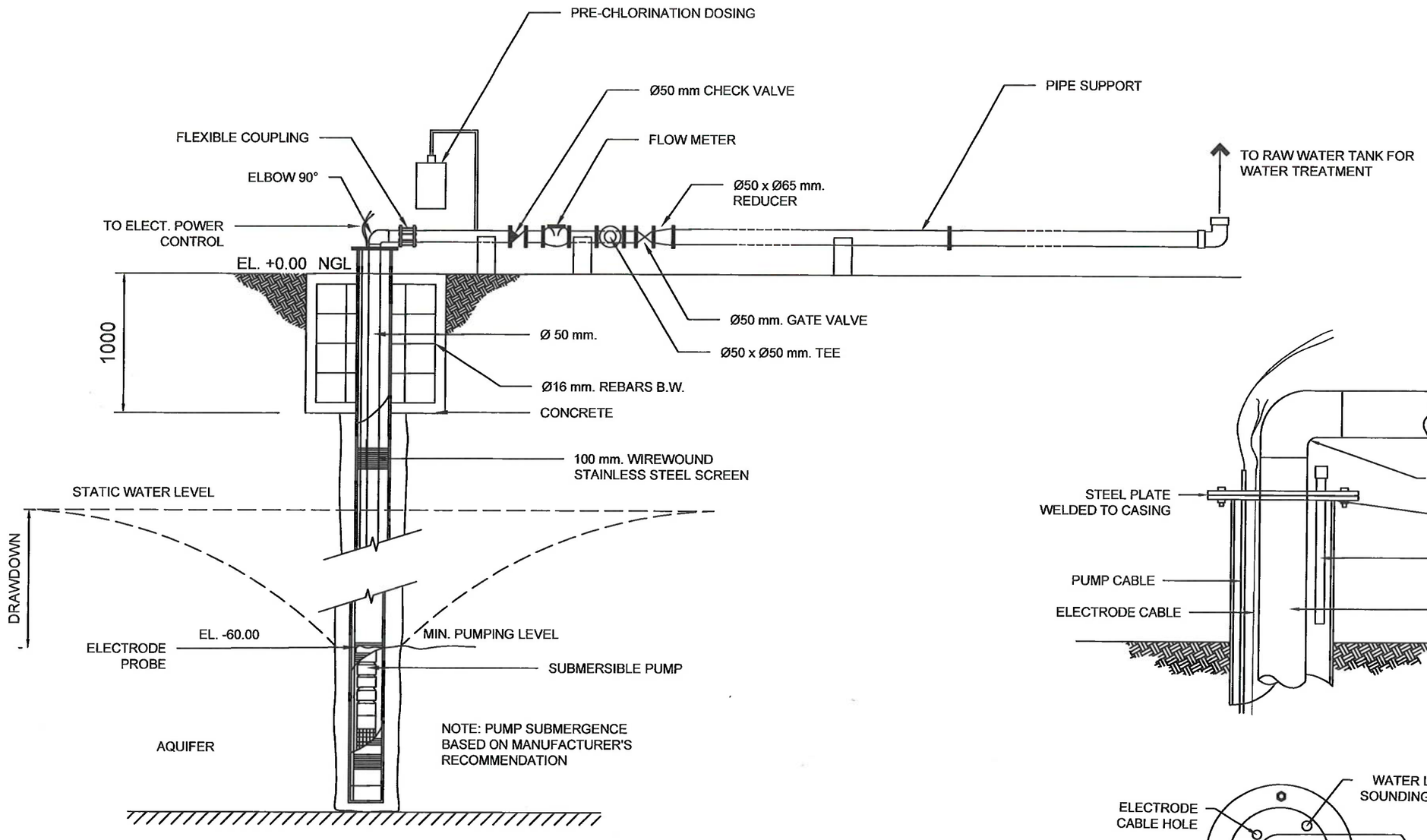
RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR, BUREAU OF DESIGN, DATE:

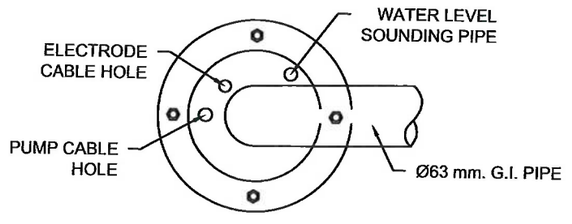
(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

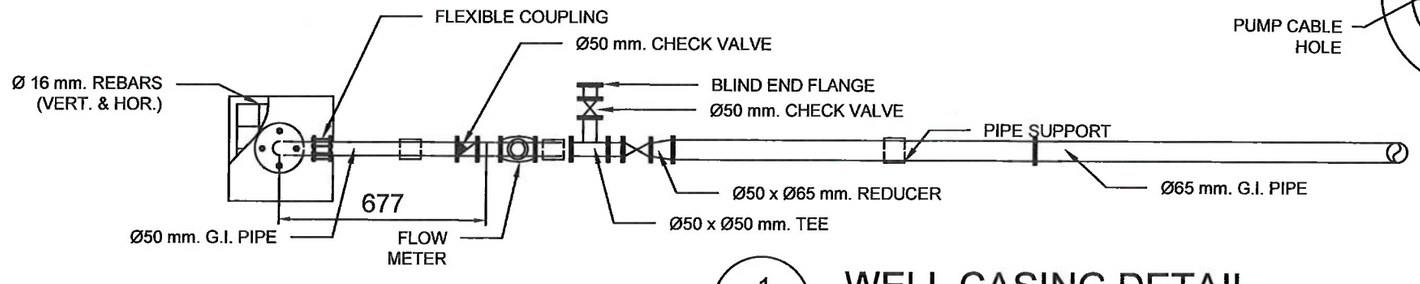
APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

SET NO. STD GE

SHEET NO. 2







1 WELL CASING DETAIL

SCALE: 1:35M

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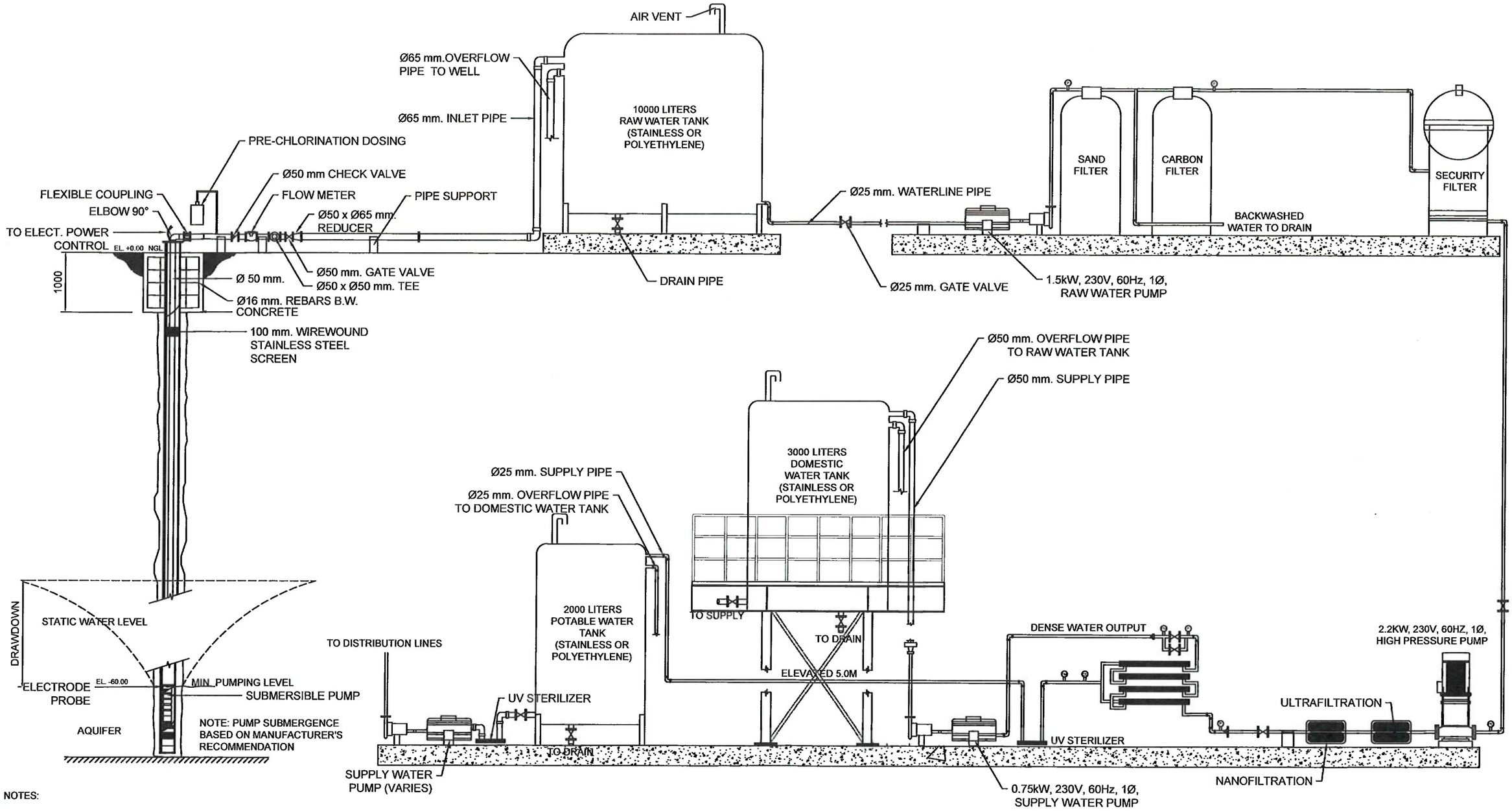
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE:	SHEET CONTENTS:
WELL CASING DETAIL	WELL CASING DETAIL

PREPARED: GIAN PAOLO G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA RICA E. BARIL, ENGINEER IV
SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN, DATE:
RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN, DATE
(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE
APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

SET NO.	SHEET NO.
STD MW	1



NOTES:

1. COMPONENTS OF A WATER TREATMENT FACILITY VARIES DEPENDING ON THE INITIAL WATER QUALITY TEST OF THE GROUND WATER SOURCE. THE PROCESS DIAGRAM SHOWS A TYPICAL CONFIGURATION IN TREATING GROUNDWATER. FINAL SYSTEM CONFIGURATION (TYPE OF FILTRATION SYSTEM) MAY VARY DEPENDING ON MANUFACTURER'S RECOMMENDATION.
2. STAGES FOR THE REVERSE OSMOSIS PROCESS SHALL BE BASED ON MANUFACTURER'S RECOMMENDATION PER TOTAL DISSOLVED SOLIDS (TDS) OF TESTED RAW WATER. THE U.S. EPA SETS THE MAXIMUM CONTAMINANT LEVEL FOR TDS AT 500 PPM AND THE WORLD HEALTH ORGANIZATION (WHO) SETS THE MAXIMUM CONTAMINANT LEVEL FOR TDS AT 1000 PPM.
   FOR GUIDANCE:
   -TDS VALUE GREATER THAN 1,000 BUT LESS THAN 5,000 PPM IS CONSIDERED BRACKISH WATER AND REQUIRES 4 STAGES.
   -TDS EQUAL OR ABOVE 5,000 BUT LESS THAN 15,000 PPM IS CONSIDERED HIGHLY BRACKISH AND REQUIRES 8 STAGES
   -TDS EQUAL OR ABOVE 15,000 BUT LESS THAN 30,000 PPM IS CONSIDERED SALINE AND REQUIRES 8 STAGES

1 WATER TREAMENT PROCESS DIAGRAM

SCALE: 1:40M

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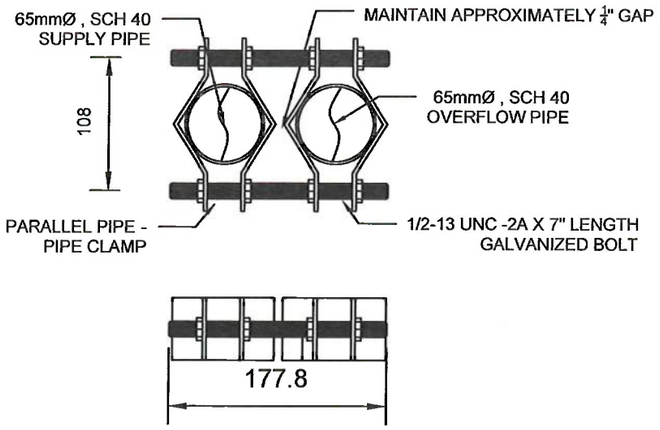
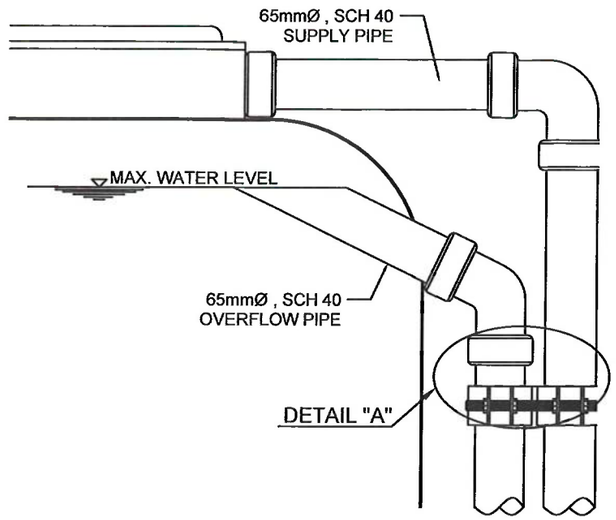
MANILA

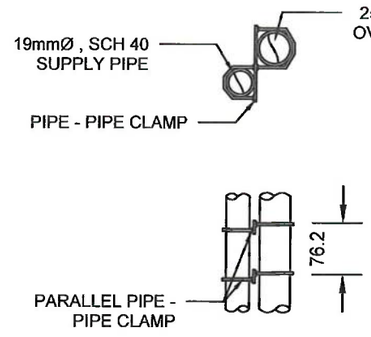
SHEET TITLE:	SHEET CONTENTS:	PREPARED:	SUBMITTED:	RECOMMENDING APPROVAL:	APPROVED:	SET NO.	SHEET NO.
WATER TREATMENT PROCESS DIAGRAM	WATER TREATMENT PROCESS DIAGRAM	GIAN PAULO G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III DRAFTED: JOSELITO P. DELA ROSA, JR, DRAFTING ASSISTANT REVIEWED: CRISSA RICA E. BARIL, ENGINEER IV	RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN DATE:	DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN DATE:	(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE	STD MW	2



1 PARALLEL SUPPLY- OVERFLOW PIPE - PIPE CLAMP CONNECTION DETAIL "A"

SCALE: 1:5M





2 PARALLEL SUPPLY- OVERFLOW PIPE - PIPE CLAMP DETAIL "C"

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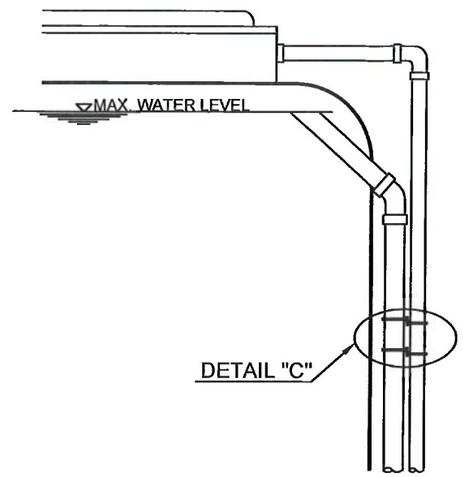
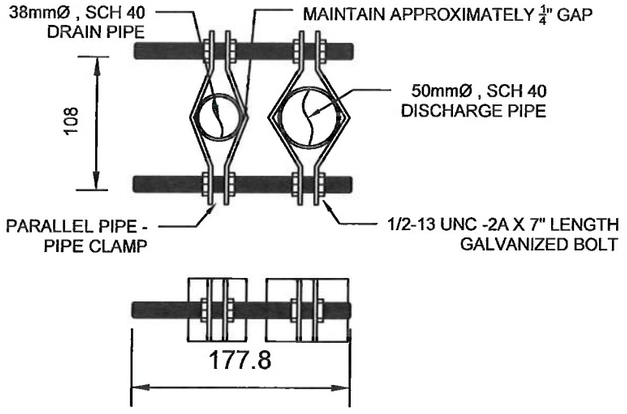
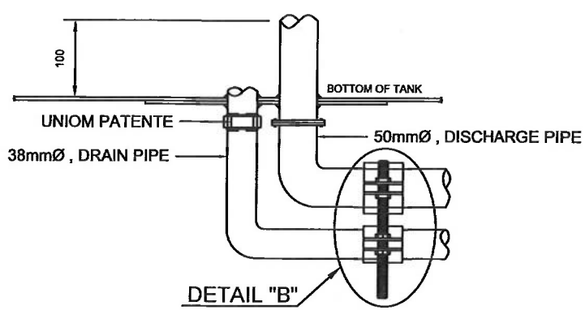




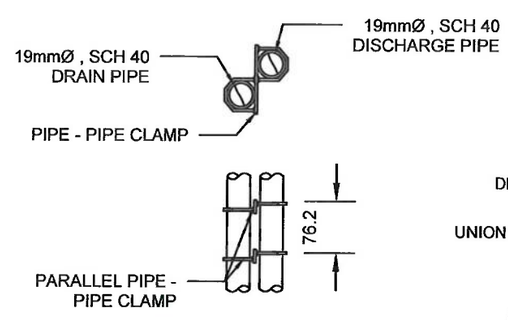
3 PARALLEL DISCHARGE-DRAIN PIPE - PIPE CLAMP DETAIL "B"

SCALE: 1:5M



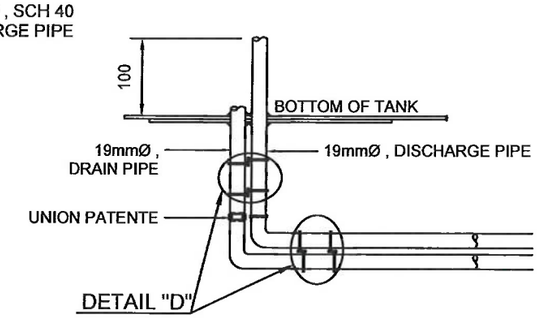
4 10,000 LITER ELEVATED WATER TANK PIPE CONNECTIONS

SCALE: 1:8M



5 PARALLEL DISCHARGE-DRAIN PIPE - PIPE CLAMP DETAIL "D"

SCALE: 1:5M



6 2000 LITER VERTICAL WATER TANK PIPE CONNECTIONS

SCALE: 1:8M

REPUBLIC OF THE PHILIPPINES
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MANILA

SHEET TITLE: 10000L & 2000L WATER TANK PIPE CONNECTIONS

SHEET CONTENTS: 10,000 LITER ELEVATED WATER TANK PIPE CONNECTIONS
2000 LITER VERTICAL WATER TANK PIPE CONNECTIONS

PREPARED: GIAN PAULO G. PABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA RICA E. BARIL, ENGINEER IV

SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN, DATE:

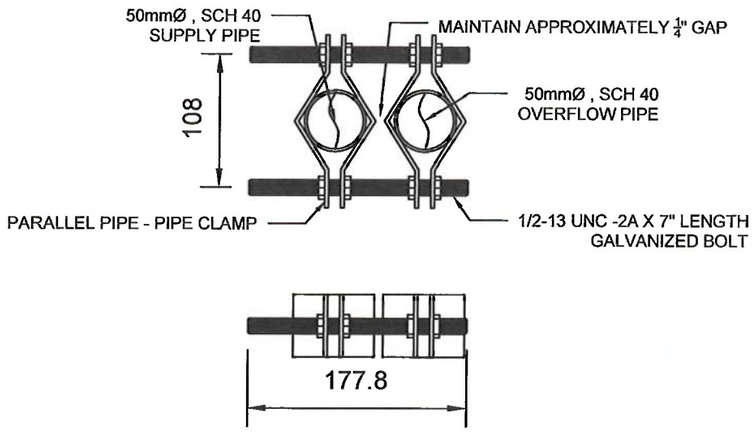
RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN, DATE:

(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

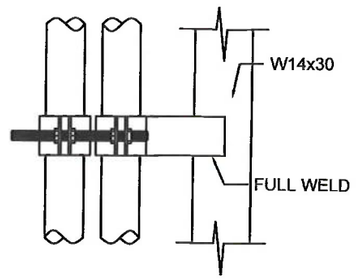
SET NO. STD MW

SHEET NO. 3



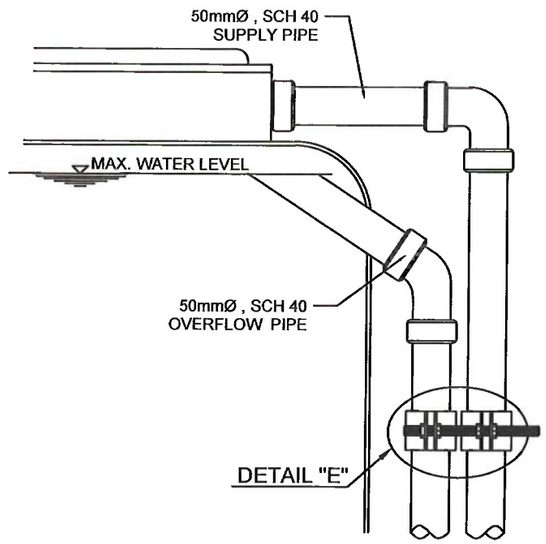
1 PARALLEL SUPPLY-OVERFLOW PIPE - PIPE CLAMP DETAIL "E"

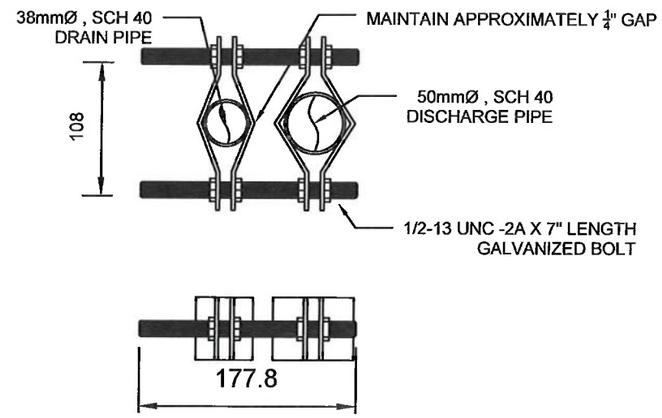
SCALE: 1:5M



2 SUPPLY-OVERFLOW PIPE TO WATERTANK COLUMN CONNECTION

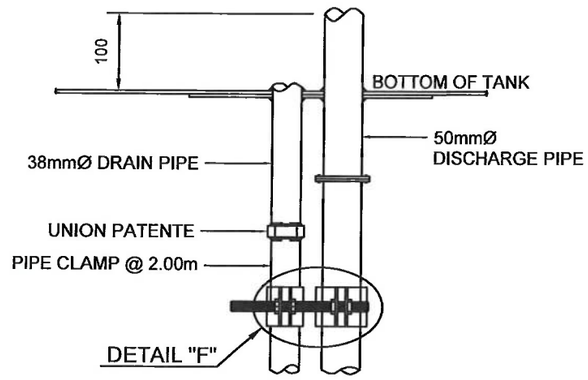
SCALE: 1:8M





3 PARALLEL DISCHARGE-DRAIN PIPE - PIPE CLAMP DETAIL "F"

SCALE: 1:5M



4 3000 LITER ELEVATED WATER TANK PIPE CONNECTIONS

SCALE: 1:5M

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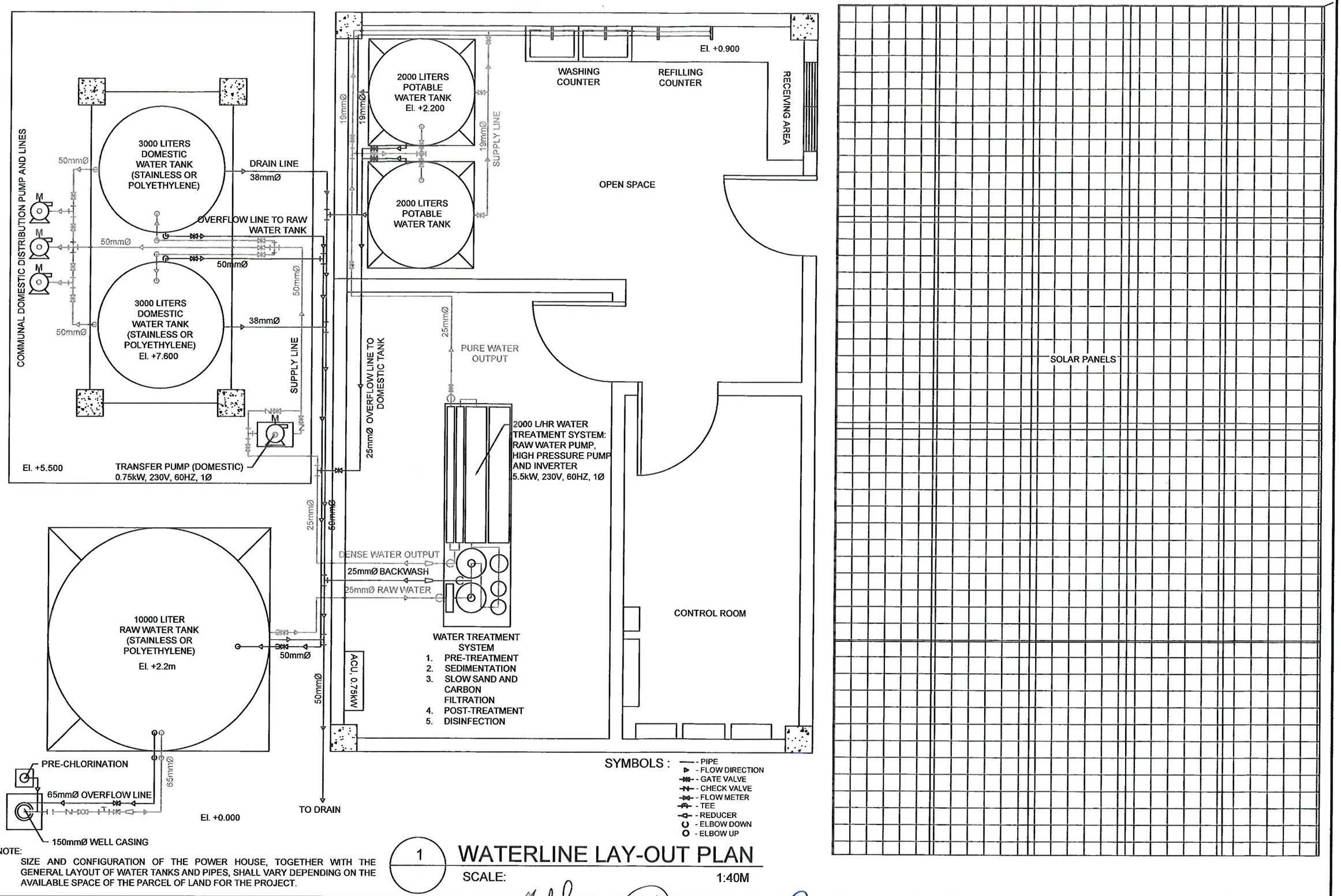
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE:	SHEET CONTENTS:
3000L WATER TANK PIPE CONNECTIONS	3000 LITER ELEVATED WATER TANK PIPE CONNECTIONS

PREPARED: GIAN PAULO GVRABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA RICA E. BARIL, ENGINEER IV
SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN, DATE:
RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN, DATE:
(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE
APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

SET NO.	SHEET NO.
STD MW	4



NOTE:
SIZE AND CONFIGURATION OF THE POWER HOUSE, TOGETHER WITH THE GENERAL LAYOUT OF WATER TANKS AND PIPES, SHALL VARY DEPENDING ON THE AVAILABLE SPACE OF THE PARCEL OF LAND FOR THE PROJECT.

1 **WATERLINE LAY-OUT PLAN**

SCALE: 1:40M

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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE:	SHEET CONTENTS:
WATERLINE LAY-OUT PLAN	WATERLINE LAY-OUT PLAN

PREPARED: GIAN PAULO G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO F. DELA ROSA, JR
REVIEWED: CRISSAFICA E. BARIL, ENGINEER IV
SUBMITTED: RICHELIEU FELIPE J. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN; DATE:
RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN; DATE:
(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE
APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

SET NO.	SHEET NO.
STD MW	5

Recommended Water System Component per Sample Population

Level	Population	No. of Households	Submersible Pump			Well Size Diameter (mm)	Water Treatment		Raw Water Tank		Domestic Water Tank		Potable Water Tank		Solar Panels		Batteries		Hybrid Inverter		Panelboard			
			No. of Units	Capacity (lps)	Power (HP)		No. of Unit/s	Capacity (L/hr)	No. of Unit/s	Capacity (L)	No. of Unit/s	Capacity (L)	No. of Unit/s	Capacity (L)	No. of Unit/s	Rating (Watts)	No. of Unit/s	Rating (Ah)	Rating (Watts)	Phase	Size of Main Breaker	Size of Main Conductor	Size of Grounding Conductor	Phase
II	500	100	1.00	2.00	3.00	100	1.00	2000	1.00	10000	2.00	3000	2.00	2000	36.00	550	6	200	20000	1	125	2-30mm² THHN	1-8.0mm² THHN	1
II	750	150	1.00	3.00	5.00	100	2.00	2000	1.00	15000	3.00	3000	3.00	2000	62.00	550	8	300	36000	3	125	3-30mm² THHN	1-8.0mm² THHN	3
II	1000	200	1.00	4.00	7.50	100	2.00	2000	2.00	10000	4.00	3000	4.00	2000	68.00	550	9	300	40000	3	150	3-38mm² THHN	1-14mm² THHN	3

NOTE: THE RECOMMENDED WATER SYSTEM COMPONENTS PER SAMPLE POPULATION IS ONLY FOR GUIDE. PUMP POWER AND CAPACITY SHALL BE STUDIED DURING PLANNING STAGE BASED ON PUMP "YIELD" TEST AND GEORESISTIVITY TEST TO DETERMINE WELL EXTRACTION LIMIT, STABLE PUMPING LEVEL CONSIDERING DRAWDOWN, AND DEPTH OF WATER TABLE, RESPECTIVELY. TOTAL DYNAMIC HEAD SHALL BE RECALCULATED FOR PUMP POWER SIZING BASED ON PIPING CONFIGURATION AND INSTALLATION. CONSULT A REGISTERED MECHANICAL ENGINEER FOR VALIDATION OF SYSTEM EQUIPMENT SIZING.

Schedule of Equipment (100 Households)

Submersible Pump

Quantity	Unit	Description	Capacity (lps)	Head (m)	Electrical Data	Remarks
1	Set	Submersible Axial Flow Pump (Continuous Duty)	2	64	2.2kW, 230V, 60Hz, 1Φ	Material: Stainless Steel All unit shall be brand new and complete with standard accessories ready for service

Water Treatment System

Quantity	Unit	Description	Capacity (L/hr)	Electrical Data	Remarks
1	L.S	Complete Water System Configuration composed of Raw Water and High Pressure Pumps, Carbon and Sand Filters, Security Filter, UV Sterilizer, Micro, Ultra and Nano Filtrations, and other components inclusive of the entire package.	2000	5.5kW, 230V, 60Hz, 1Φ	All unit shall be brand new and complete with standard accessories ready for service

Raw Water Tank

Quantity	Unit	Description	Capacity (L)	Material	Remarks
1	Set	Raw Water Tank (1.96mD x 4.45mH)	10000	Steel (SUS), Polyethelyne	All unit shall be brand new and complete with standard accessories ready for service

Domestic Tank

Quantity	Unit	Description	Capacity (L)	Material	Remarks
2	Set	Elevated Water Tank (1.48mD x 2.5mH)	3000	Steel (SUS), Polyethelyne	All unit shall be brand new and complete with standard accessories ready for service

Potable Water Tank

Quantity	Unit	Description	Capacity (L)	Material	Remarks
2	Set	Potable Water Tank (1.23mD x 2.25mH)	2000	Steel (SUS), Polyethelyne	All unit shall be brand new and complete with standard accessories ready for service

Solar Panels

Quantity	Unit	Description	Capacity (W)	Battery	Remarks
36	L.S	Monocrystalline Photovoltaic Solar Panels with Inverter, battery and other Devices	550	Lithium Iron Phosphate (LiFEP04)	All unit shall be brand new and complete with standard accessories ready for service

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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE: SCHEDULE OF EQUIPMENT

SHEET CONTENTS: SCHEDULE OF EQUIPMENT

PREPARED: GIAN PAULO G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA RIKA E. BARIL, ENGINEER IV

SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN, DATE:

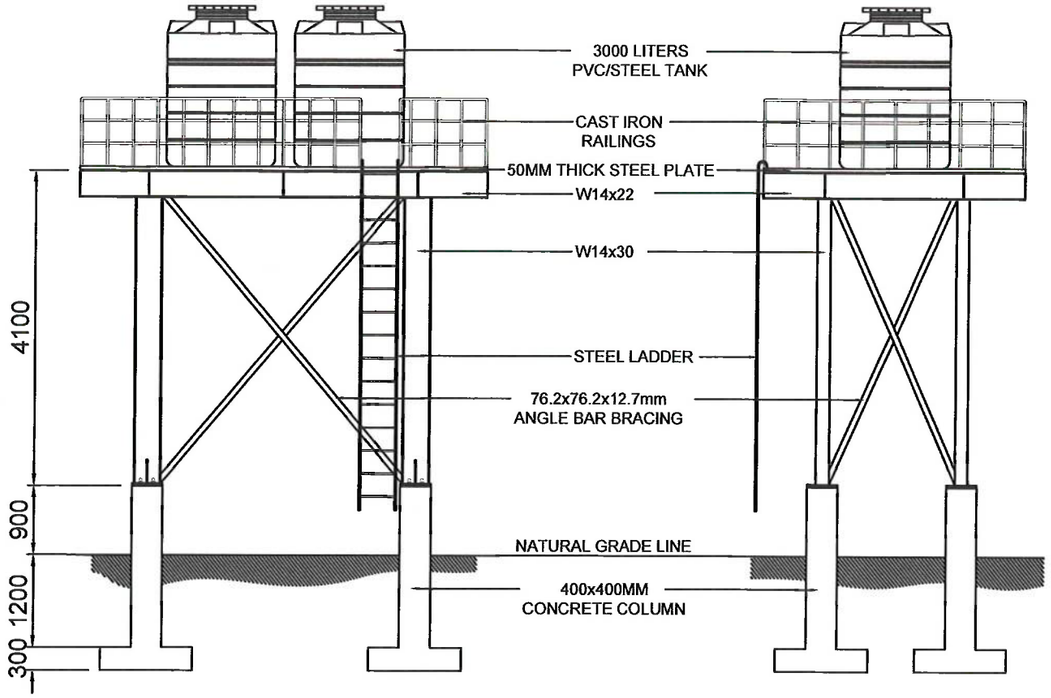
RECOMMENDING APPROVAL: DANILO L. BALISA, DIRECTOR IV, BUREAU OF DESIGN, DATE:

(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

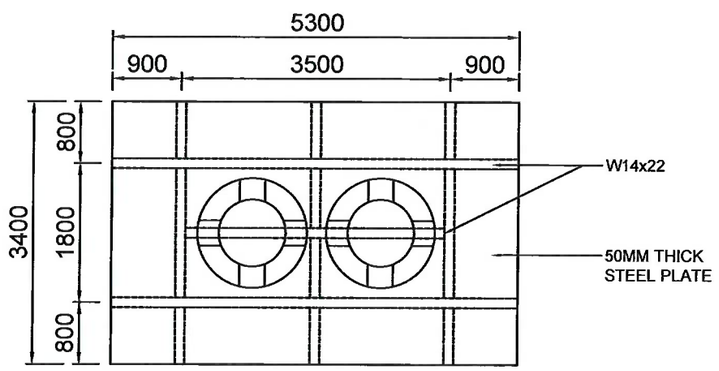
SET NO.: STD / MW

SHEET NO.: 6



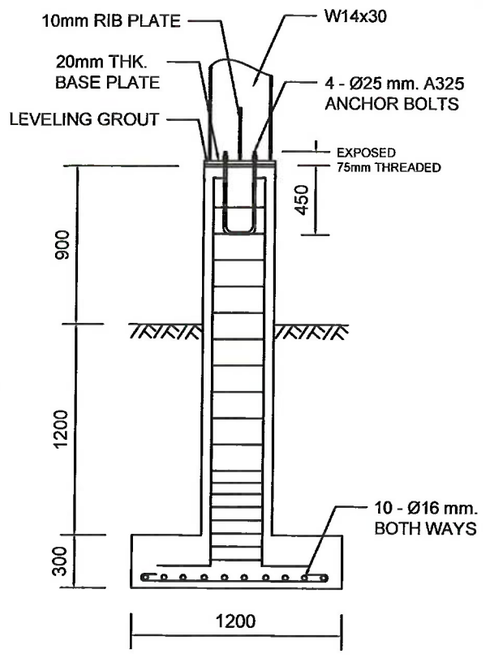
1 ELEVATION

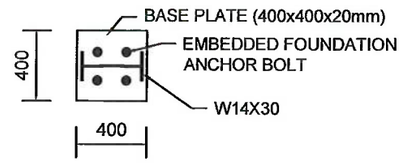
SCALE: 1:80M

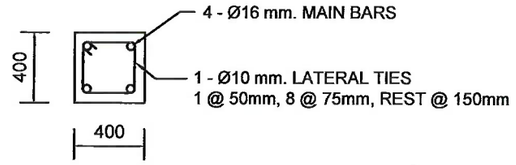


3 PLAN

SCALE: 1:80M

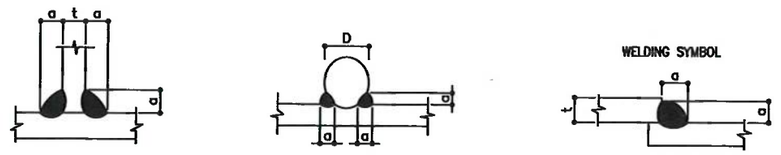






2 CONCRETE PEDESTAL DETAILS

SCALE: 1:35M



4 FILLET WELD DETAILS

SCALE: NTS

NOTE: THIS IS AN ALTERNATIVE TO THE PREVIOUSLY RELEASE STANDARD PLAN FOR ELEVATED STEEL WATER TANK. USING ELEVATED PLATFORM DESIGN WILL ENTAIL LOWER TDH, THUS, MAY REQUIRE ADDITIONAL PUMP FOR DISTRIBUTION.

3000 LITER TANK CAN BE MADE OF PVC OR STEEL.

ALL STEEL TO STEEL CONNECTION SHALL BE FULLY WELD.

STRUCTURAL STEEL MEMBERS SHALL BE PAINTED WITH ANTI-RUST AND ANTI-CORROSION TO AVOID RAPID DETERIORATION.

PROVIDE STEEL CASING/SUPPORT FOR THE TANK TO AVOID MOVEMENT.

SIZE OF FOOTING AND OTHER STRUCTURAL MEMBERS SHALL BE SUPPORTED BY STRUCTURAL ANALYSIS BASED ON THE GEOTECHNICAL INVESTIGATION.

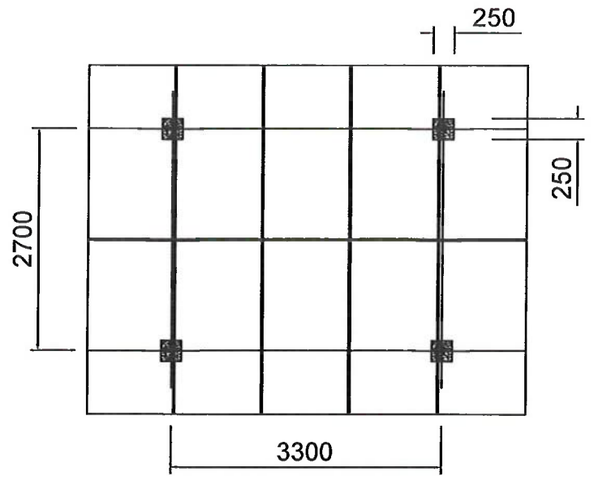
ALLOWABLE SOIL BEARING CAPACITY ADOPTED IN THE DESIGN: 90kPa

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE:	SHEET CONTENTS:
ELEVATED PLATFORM FOR WATER TANK	ELEVATED PLATFORM PLAN & ELEVATION CONCRETE PEDESTAL DETAILS FILLET WELD DETAILS

PREPARED: GIAN PAULO G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: GRISSA RIZA E. BARIL, ENGINEER IV
SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN; DATE:
RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN; DATE:
(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE
APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

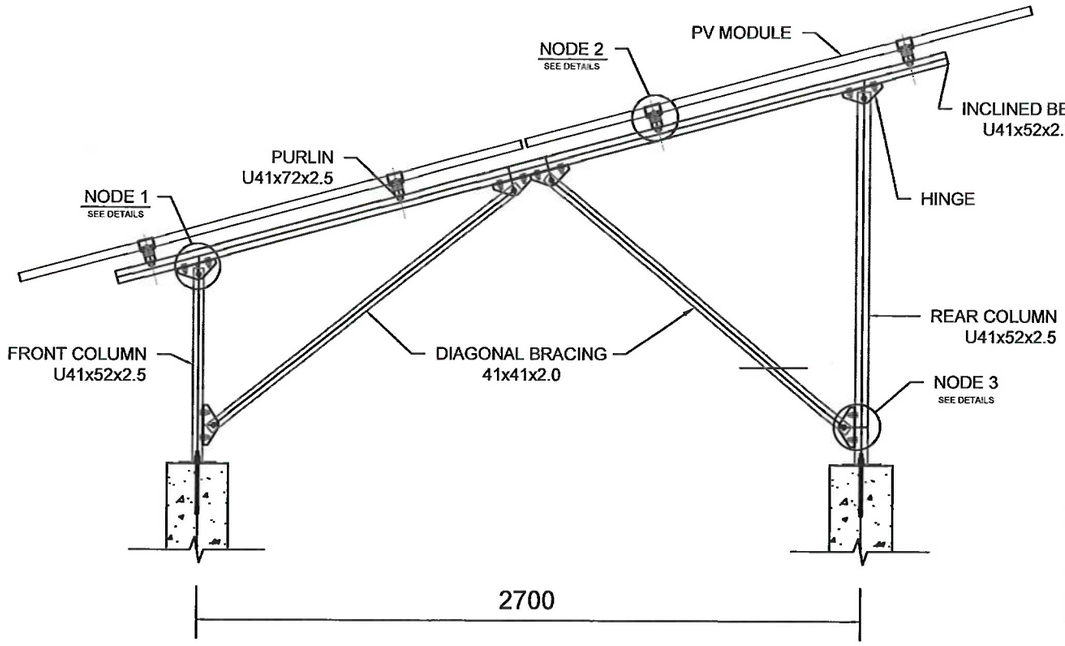
SET NO.	SHEET NO.
STD CW	1



STANDARD ARRAY PV MODULE SUPPORT LAYOUT

1

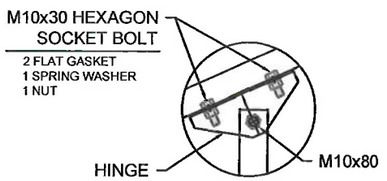
SCALE: 1:75M



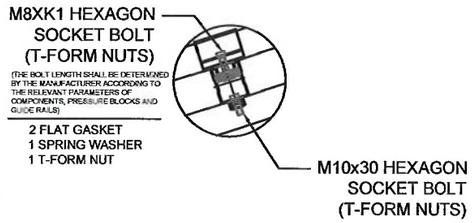
STANDARD ARRAY PV SIDE VIEW DOUBLE ROW VERTICAL

2

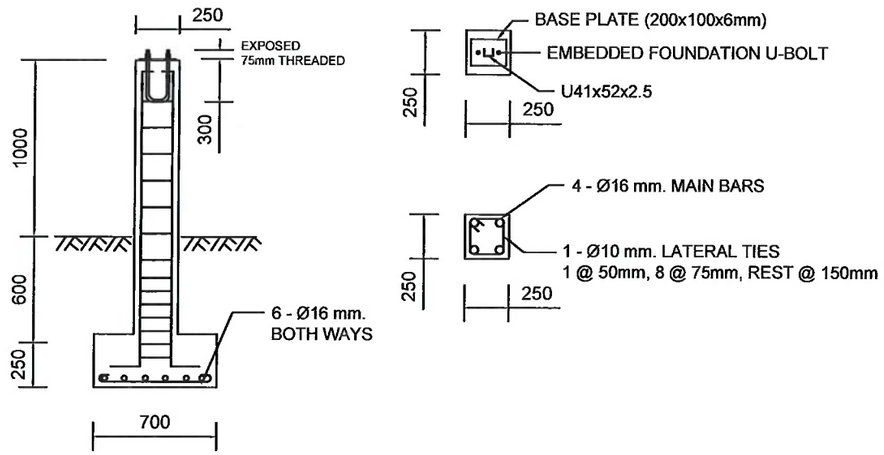
SCALE: 1:25M



NODE 1



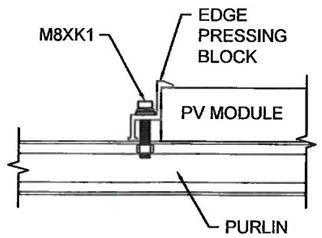
NODE 2



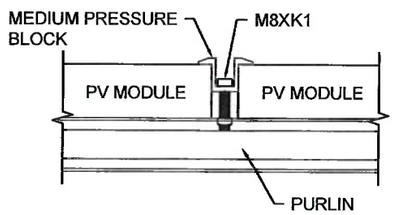
SOLAR PANEL CONCRETE PEDESTAL DETAILS

3

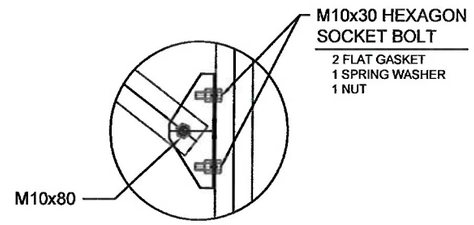
SCALE: 1:40M



EDGE PRESSING BLOCK NODE



MEDIUM PRESSURE BLOCK NODE



NODE 3

NOTE: IF ON-GROUND SOLAR PANELS NEED TO BE RAISED, STEEL TUBULAR MAY BE USED AS COLUMNS TO BE CONNECTED ON CONCRETE PEDESTALS ADOPTING THE ON-ROOF SYSTEM PRESENTED IN THE SUCCEEDING PAGE.
SIZES OF FOOTING AND OTHER STRUCTURAL MEMBERS SHALL BE SUPPORTED BY STRUCTURAL ANALYSIS BASED ON THE GEOTECHNICAL INVESTIGATION REPORT.

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE:	SHEET CONTENTS:
ON-GROUND SOLAR PANELS	ARRAY PV MODULE SUPPORT LAYOUT CONCRETE PEDESTAL CONNECTION DETAILS

PREPARED: GIAN PAULO G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA RICA E. BARIL, ENGINEER IV

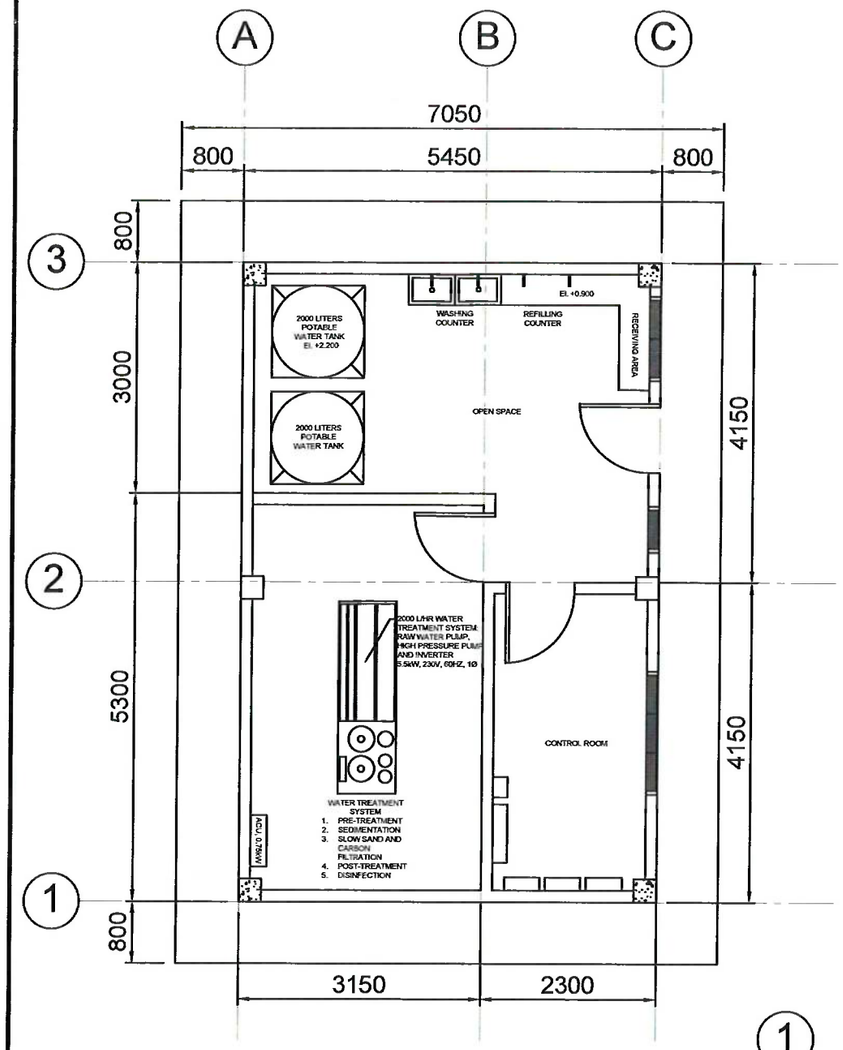
SUBMITTED: RICHELIEU FELIPE L. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN, DATE:

RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN, DATE:

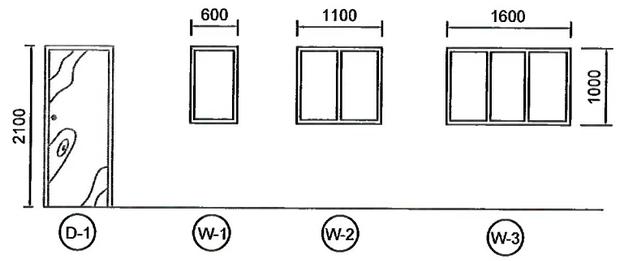
(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

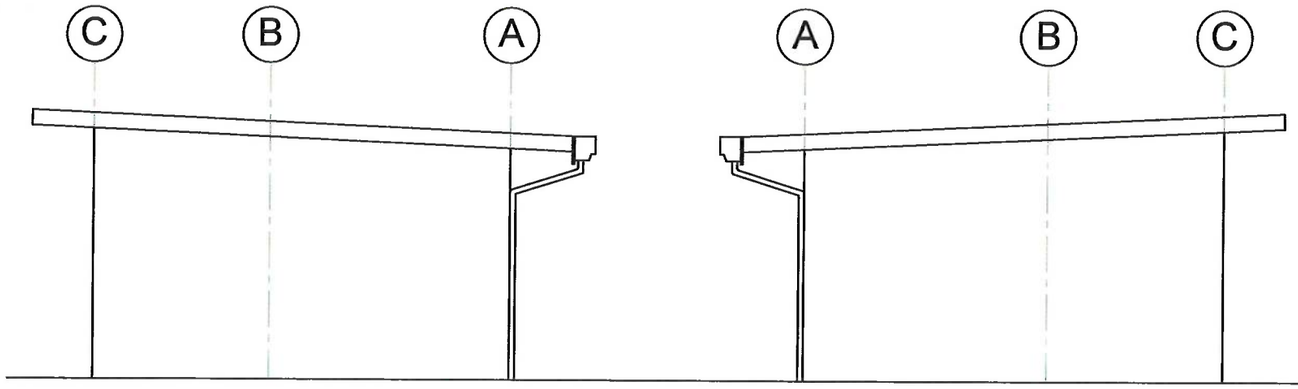
SET NO.	SHEET NO.
STD CW	2



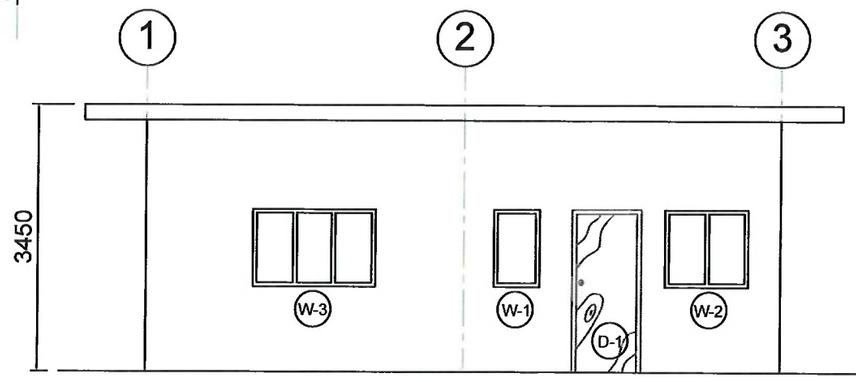
1 FLOOR PLAN
SCALE: 1:80M



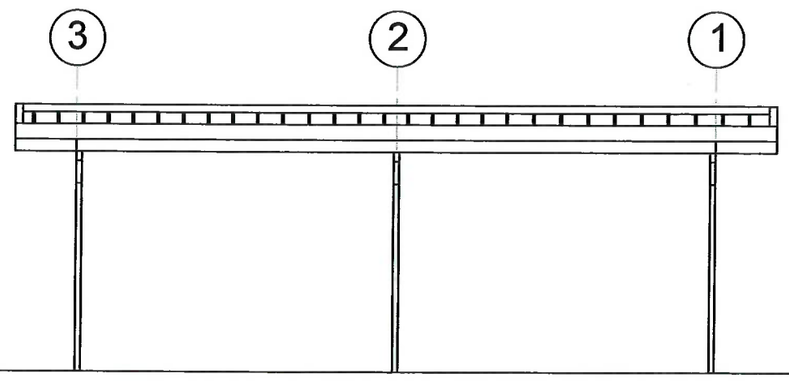
2 DOOR & WINDOWS SCHEDULE
SCALE: 1:80M



3 RIGHT SIDE ELEVATION
SCALE: 1:80M



4 LEFT SIDE ELEVATION
SCALE: 1:80M



5 FRONT ELEVATION
SCALE: 1:80M

6 REAR ELEVATION
SCALE: 1:80M

NOTE: THE PROVIDED POWER HOUSE DIMENSIONS MAY VARY BASED ON THE ACTUAL LOT AREA.

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MANILA

SHEET TITLE: POWER HOUSE PLAN

SHEET CONTENTS: FLOOR PLAN
FRONT/REAR/LEFT/RIGHT ELEVATION
DOOR & WINDOWS SCHEDULE

PREPARED: GIAN PAUL G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA PRIA E. BARIL, ENGINEER IV

SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN, DATE:

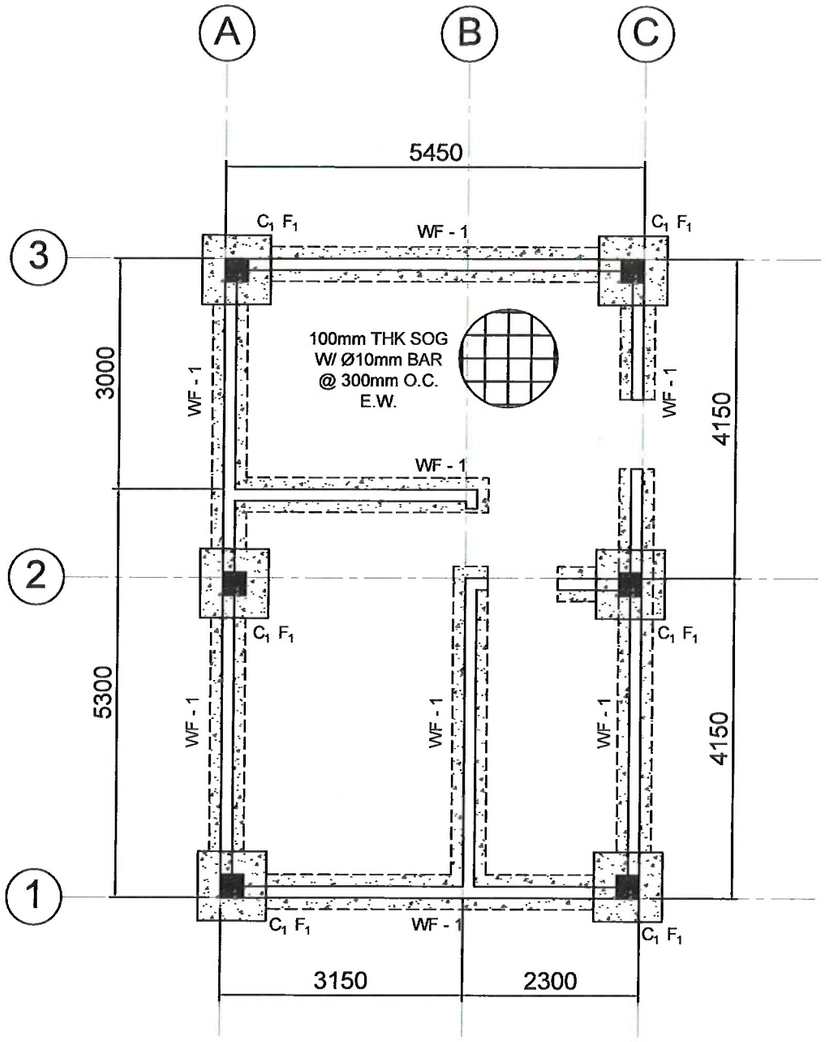
RECOMMENDING APPROVAL: DANILO L. BALUSI, DIRECTOR IV, BUREAU OF DESIGN, DATE:

(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

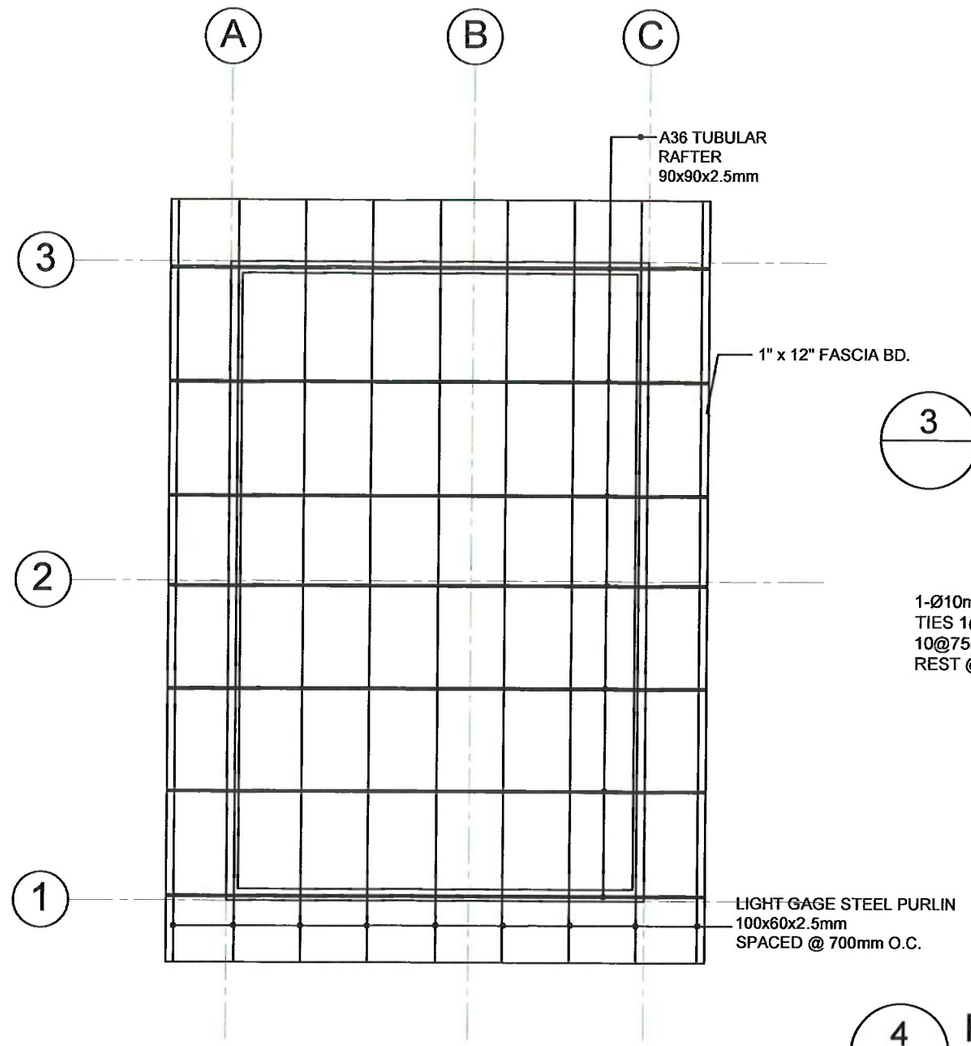
SET NO.: STD CW

SHEET NO.: 3



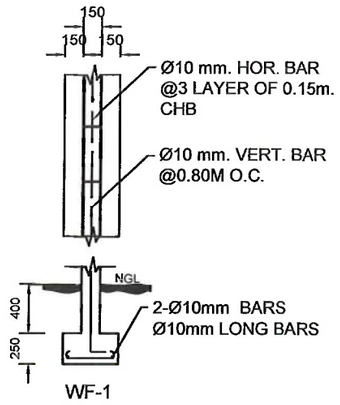
1 FOUNDATION PLAN

SCALE: 1:80M



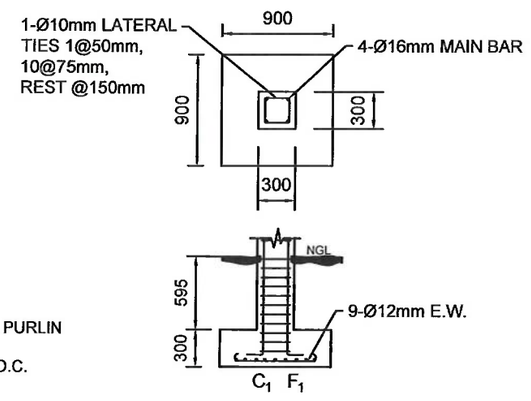
2 ROOF FRAMING PLAN

SCALE: 1:80M



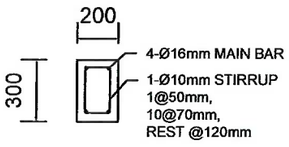
3 WALL & FOOTING DETAIL

SCALE: 1:50M



4 FOOTING-COLUMN DETAIL

SCALE: 1:50M



5 BEAM DETAIL

SCALE: 1:30M

NOTE: SIZES OF FOOTING AND OTHER STRUCTURAL MEMBERS SHOULD BE SUPPORTED BY STRUCTURAL ANALYSIS BASED ON GEOTECHNICAL INVESTIGATION REPORT.

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE: POWER HOUSE STRUCTURAL PLAN

SHEET CONTENTS:
FOUNDATION PLAN
ROOF FRAMING PLAN
WALL & FOOTING DETAIL
FOOTING & COLUMN DETAIL
BEAM DETAIL

PREPARED:
GIAN PAVLO P. RABACAL, ENGINEER III
MARK JOSEPH L. RIVERA, ENGINEER III

DRAFTED:
JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT

REVIEWED:
CRISSA RICA E. BARIL, ENGINEER IV

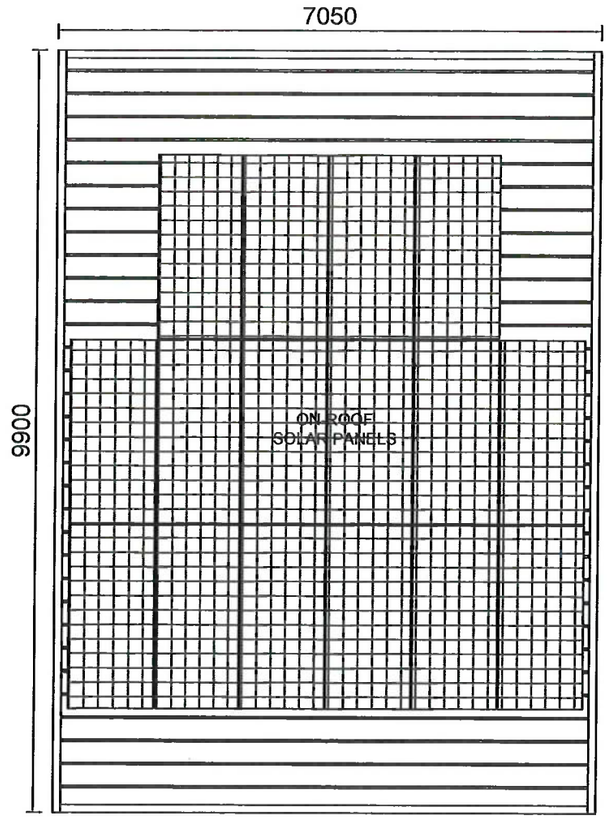
SUBMITTED:
RICHELIEU FELIPPE I. LIM
OFFICER-IN-CHARGE
WATER PROJECTS DIVISION
BUREAU OF DESIGN
DATE:

RECOMMENDING APPROVAL:
DANILO L. BALIS
DIRECTOR IV
BUREAU OF DESIGN
DATE:

(SEE COVER SHEET)
MEDMIER G. MALIG
ASSISTANT SECRETARY FOR
TECHNICAL SERVICES AND
INFORMATION MANAGEMENT SERVICE

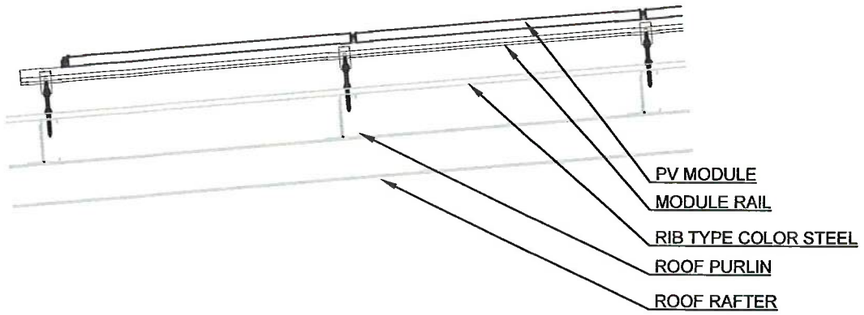
APPROVED:
(SEE COVER SHEET)
ADOR G. CANLAS, CESO IV
UNDERSECRETARY FOR
TECHNICAL SERVICES AND
INFORMATION MANAGEMENT SERVICE

SET NO.: STD CW
SHEET NO.: 4



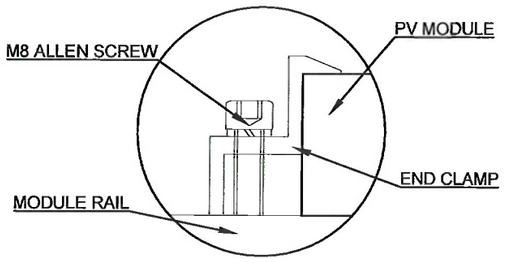
1 ON-ROOF PV SOLAR PANEL

SCALE: 1:80M



2 ON-ROOF PV SOLAR PANEL CONNECTION

SCALE: 1:80M



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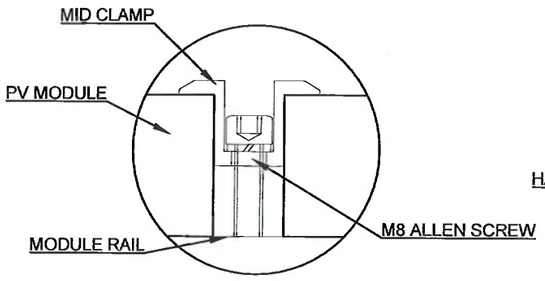

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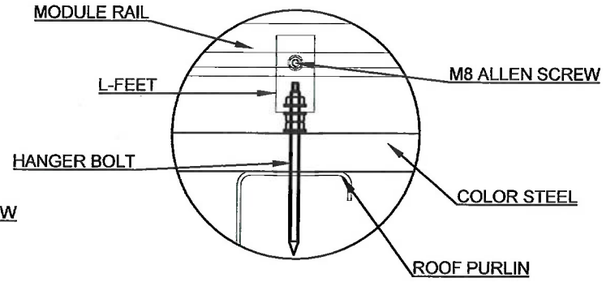

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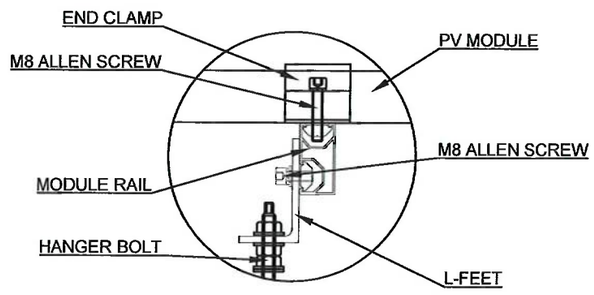

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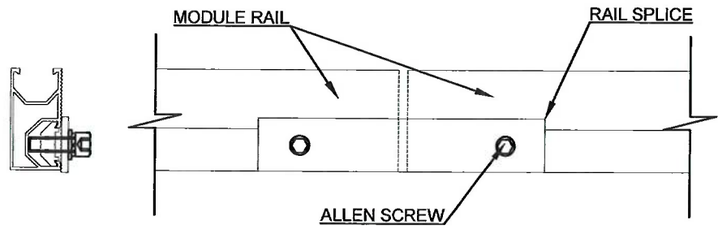

Detail "Rail Splice"

3 MOUNTING BRACKET DETAILS

SCALE: 1:80M

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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
MANILA

SHEET TITLE: ON-ROOF SOLAR PANELS

SHEET CONTENTS: ON ROOF PV SOLAR PANEL PLAN
CONNECTION DETAIL
MOUNTING BRACKET DETAILS

PREPARED: GIAN PAULO G. RABACAL, ENGINEER III; MARK JOSEPH L. RIVERA, ENGINEER III
DRAFTED: JOSELITO P. DELA ROSA, JR, ENGINEERING ASSISTANT
REVIEWED: CRISSA RICA E. BARIL, ENGINEER IV

SUBMITTED: RICHELIEU FELIPE I. LIM, OFFICER-IN-CHARGE, WATER PROJECTS DIVISION, BUREAU OF DESIGN, DATE:

RECOMMENDING APPROVAL: DANILO L. BALIS, DIRECTOR IV, BUREAU OF DESIGN, DATE:

(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

SET NO.: STD / CW

SHEET NO.: 5

ELECTRICAL SYMBOLS

- ONE (1) - 20 WATTS, 230VOLTS, 60Hz., LED PANEL LIGHT, 1200mm X 300mm, 4000lm, OR APPROVED EQUAL
- S — SINGLE-POLE WALL SWITCHES ON ONE SWITCH PLATE, (10AMPS, 250VOLTS)
- S'xx — 2 SINGLE-POLE WALL SWITCHES ON ONE SWITCH PLATE, (10AMPS, 250VOLTS)
- S'xxx — 3 SINGLE-POLE WALL SWITCHES ON ONE SWITCH PLATE, (10AMPS, 250VOLTS)
- DUPLEX CONVENIENCE OUTLET (TWO WAY), GROUNDING TYPE (20AMPS, 250VOLTS) WP DENOTES WEATHERPROOF OUTLET, REF DENOTES REFRIGERATOR OUTLET
- SPO — SPECIAL PURPOSE OUTLET, GROUNDING TYPE (30AMPS, 250VOLTS) ACU DENOTES AIRCONDITIONING OUTLET
- "DP" — DISTRIBUTION PANEL
- M — BI-DIRECTIONAL METER BASE OR REC METER
- AUTOMATIC AC/DC CIRCUIT BREAKER WITH SURGE PROTECTIVE DEVICE
- 550W SOLAR PHOTOVOLTAIC ARRAY OR APPROVED EQUAL
- HYBRID INVERTER
- LITHIUM IRON PHOSPHATE (LiFePO4) OR APPROVED EQUAL
- AUTOMATIC TRANSFER SWITCH
- CURRENT TRANSFORMER
- SERVICE ENTRANCE
- UNDERGROUND OR UNDERFLOOR CONDUIT RUN
- CONCEALED OR EMBEDDED CONDUIT RUN
- CIRCUIT HOMERUN
- GROUNDING SYSTEM

LOAD ANALYSIS

LOADS	WATTS	Hr/Day	QUANTITY	WHr/Day
LIGHT OUTLETS	20	8	5	800
CONVENIENCE OUTLETS	432	3	3	3888
1 HP AIRCONDITIONING UNIT	1472	5	1	7360
2.2 kW SUBMERSIBLE PUMP	2200	5	1	11000
0.75 kW RAW WATER PUMP	750	5	1	3750
5.5 kW WATER TREATMENT PUMP	6875	5	1	34375
TOTAL DAILY ENERGY CONSUMPTION PER DAY				61173

PV Power = $(\frac{61173}{4})(1.3)$ = 19881 W

No. of Panels = $\frac{19881}{550}$ = 36.14 ~ 36 Solar Monocrystalline Panels

String Output DC Voltage (VOC) = 49.9V x 9 = 449.1V

No. of String = $\frac{36}{9}$ = 4 = 4 Strings

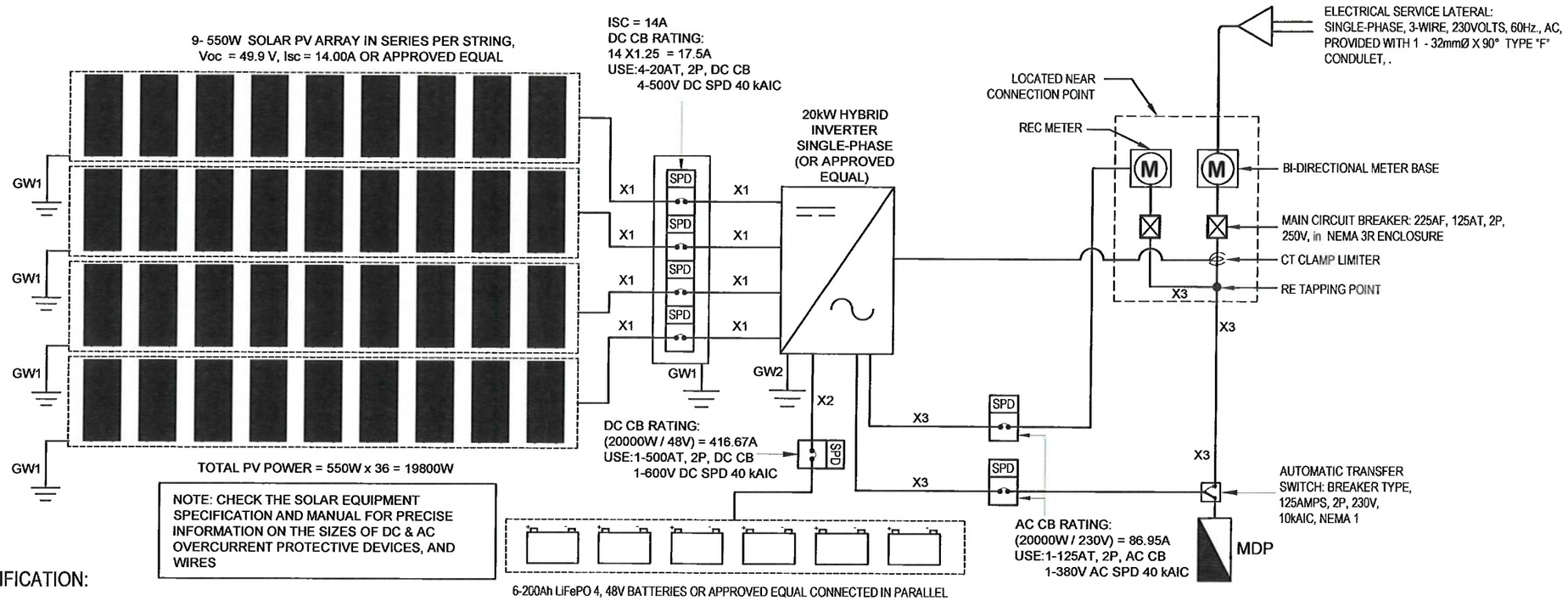
Use: 9 - 550W Solar Monocrystalline Panels per String

Total PV Power = 19800W

Use: 20kW Hybrid Inverter, Single Phase

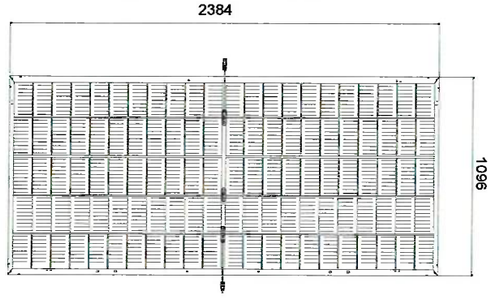
Battery Capacity = $\frac{61173}{0.95 \times 48}$ = 1341.44 Ah

Use: 6-200Ah LiFePO 4, 48V BATTERIES



NOTE: CHECK THE SOLAR EQUIPMENT SPECIFICATION AND MANUAL FOR PRECISE INFORMATION ON THE SIZES OF DC & AC OVERCURRENT PROTECTIVE DEVICES, AND WIRES

SOLAR PANEL SPECIFICATION:



- MAXIMUM POWER (PMAX) = 550W
- OPEN CIRCUIT VOLTAGE (VOC) = 49.9V
- SHORT CIRCUIT CURRENT = 14.00 A
- VOLTAGE AT MAXIMUM POWER (VMP) = 41.95V
- CURRENT AT MAXIMUM POWER (IMP) = 13.14 A

SCHEDULES OF WIRES AND CONDUIT

X1	1- 6.0mm² PV CABLE IN 15mm Ø IMC.
X2	2 - 100 mm² DC CABLE IN CABLE TRAY.
X3	2 - 30mm² THHN + 1- 8.0mm² THHN (G) IN 32mm Ø IMC.
GW1	1 - 4.0mm² PV CABLE IN 20mm Ø IMC.
GW2	1 - 8.0mm² THHN IN 20mm Ø PVC.

SOLAR POWER SYSTEM

SINGLE LINE DIAGRAM

1 / EW

SCALE NTS

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MANILA

SHEET TITLE: SINGLE LINE DIAGRAM

SHEET CONTENTS:
ELECTRICAL SYMBOL
LOAD ANALYSIS
SOLAR POWER SYSTEM (SINGLE LINE DIAGRAM)
SCHEDULES OF WIRES AND CONDUIT
SOLAR PANEL SPECIFICATION

PREPARED: MARU BRYAN T. ZAPLAN, ENGINEER II
DRAFTED: ALEXIS J. GRACUADO, ENGINEER II
REVIEWED: VINCENT A. BERAN, ENGINEER III

SUBMITTED: ERIBERTO B. SIOSON, CHIEF BUILDINGS DIVISION, BUREAU OF DESIGN, DATE:

RECOMMENDING APPROVAL: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN, DATE:

(SEE COVER SHEET) MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

SET NO. STD / EW

SHEET NO. 1

SCHEDULE OF LOADS AND COMPUTATIONS

CKT. NO.	LOAD DESCRIPTION	VA PER CKT.	VOLTS	BRANCH CKT. BREAKER AF	P	AT	SIZE OF HOMERUN (WIRES IN CONDUIT)
1	LIGHT OUTLETS	500	230	100	2	15	2 - 3.5mm² THHN IN 15mm Ø C
2	CONVENIENCE OUTLETS	720	↓	↓	↓	20	2 - 3.5mm² THHN + 1 - 3.5mm² THHN (G) IN 20mm Ø C
3	1HP AIRCONDITIONING UNIT	1840	↓	↓	↓	20	2 - 3.5mm² THHN + 1 - 3.5mm² THHN (G) IN 20mm Ø C
4	2.2 kW SUBMERSIBLE PUMP	2750	↓	↓	↓	40	2 - 5.5mm² THHN + 1 - 3.5mm² THHN (G) IN 20mm Ø C
5	0.75 kW RAW WATER PUMP	938	↓	↓	↓	20	2 - 3.5mm² THHN + 1 - 3.5mm² THHN (G) IN 20mm Ø C
6	5.5 kW HIGH PRESSURE PUMP	6875	↓	↓	↓	60	2 - 8.0mm² THHN + 1 - 5.5mm² THHN (G) IN 25mm Ø C
7	SPARE	1500	↓	↓	↓	20	———
8	SPARE	1500	↓	↓	↓	20	———
TOTAL		16623	MACB : 225AF, 2P, 230V, 125AT, 18KAIC				

TOTAL CONNECTED LOADS: 19623 VA

I_L @ 90% D.F. $= \left(\frac{16623}{230}\right)(0.90) + 0.25(29.89) = 72.52$ AMPERES

USE : 2 - 30mm² THHN + 1 - 8.0mm² THHN (G) IN 32mm Ø IMC
(72.52 A / 115 A)

ELECTRICAL DESIGN ANALYSIS

SHORT CIRCUIT ANALYSIS AND VOLTAGE DROP COMPUTATION

A. SHORT CIRCUIT ANALYSIS

LINE TO LINE FAULT @ 230V - FAULT X1
50 KVA 1ø, Pole Mounted Transformer

NOTE: *ASSUMPTION OF kVA RATING OF TRANSFORMER IN SITE = 50kVA

$$IFL = \frac{50 \times 1000}{230}$$

IFL = 217.39 A

%Z for 50kVA, 1Ø 230V = 2.4

$$\text{Multiplier} = \frac{100}{2.4} = 41.67$$

Isc = 217.39 x 41.67 = 9057.97 A

1 ø Line to Line (L - L) Faults
Copper Wire used : 30 mm2

Lft = 98.43 ISC = 9057.97
C = 5907 ELL = 230
n = 1

$$f = \frac{2xLxISC}{CxnxELL}$$

f = 1.312

Available Utility Infinite Assumption

$$M = \frac{1}{1 + 1.312}$$

M = 0.4325

Is.c.(sym) = 0.4325 x 9057.97

Is.c.(sym) = 3917.57 A Symmetrical

1-50 kVA Transformer 1ø, 1ø, 230V, 2.4% Z

Is.c.(sym) motor contrib. = 217.39 x 4

125AT, 225AF, 230V, 1Ø

Is.c.(sym) motor contrib. = 869.57 A

Fault X1

Is.c. L-L sym total = 4787.14 A x 1.25

Is.c. L-L sym total = 5983.93 A

M

Say = 10 kAIC minimum

B. VOLTAGE DROP

$$VD = \frac{2 \times R \times I \times L}{CM}$$

R = 12.9 for copper for a conductor that is 1 circular mil in diameter and 1 ft long @ 75ºC
I = Ampere (load at 100%) = 72.27
L = Feet (Length of Circuitfrom power supply) = 98.43
CM = Circular - Mils (conductor wire size) = 41740

$$VD = \frac{2 \times 12.9 \times 72.27 \times 98.43}{41740}$$

VD = 4.40 V

$$VD = \frac{4.40}{230} \times 100 = 1.91\%$$

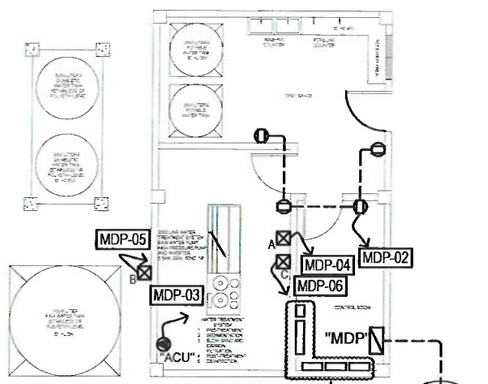
Use: 2 - 30 mm² THHN and 1 - 8.0 mm² THHN(G) cable for MDP

LEGEND:

⊠A ENCLOSED CIRCUIT BREAKER 50AF, 2P, 240VOLTS, 20AT IN NEMA 1 ENCLOSURE

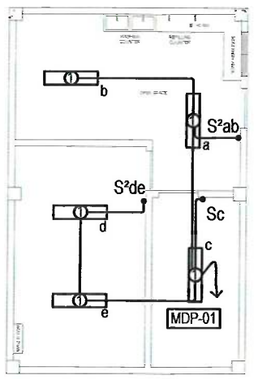
⊠B ENCLOSED CIRCUIT BREAKER 50AF, 2P, 240VOLTS, 40AT IN NEMA 1 ENCLOSURE

⊠C ENCLOSED CIRCUIT BREAKER 100AF, 2P, 240VOLTS, 60AT IN NEMA 3R ENCLOSURE

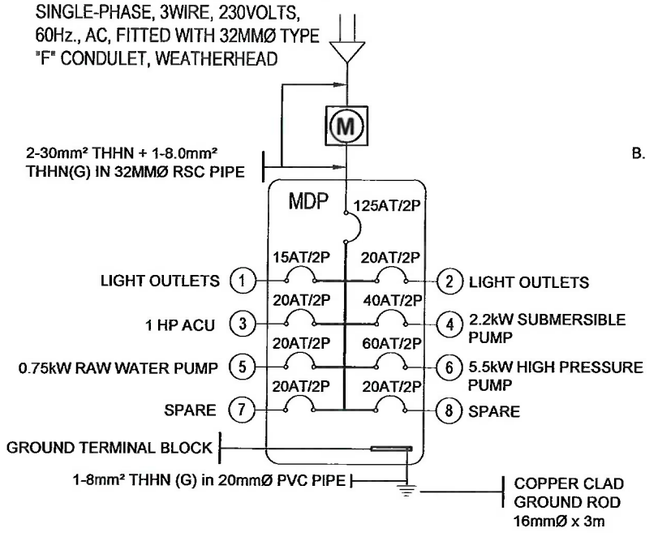


SOLAR PV SYSTEM (HYBRID INVERTER, BATTERIES, DC & AC BREAKERS, AND AUTOMATIC TRANSFER SWITCH)

PROPOSED OVERHEAD ELECTRICAL SERVICE ENTRANCE (REFER TO SINGLE LINE DIAGRAM) NOTE: VERIFY EXACT LOCATION



PROPOSED SERVICE ENTRANCE
SINGLE-PHASE, 3WIRE, 230VOLTS, 60Hz., AC, FITTED WITH 32MMØ TYPE "F" CONDULET, WEATHERHEAD



2 POWER LAYOUT
SCALE 1:140M

3 LIGHTING LAYOUT
SCALE 1:140M

4 PANELBOARD DIAGRAM
SCALE NTS

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MANILA

SHEET TITLE: ELECTRICAL LAYOUT

SHEET CONTENTS:
SCHEDULE OF LOADS AND COMPUTATIONS
POWER LAYOUT
LIGHTING LAYOUT
PANELBOARD DIAGRAM
ELECTRICAL DESIGN ANALYSIS

PREPARED: MARU-BRYAN T. ZAPLAN, ENGINEER II
DRAFTED: ALEXIS Z. ESCUADO, DRAFTSMAN
REVIEWED: VINCENT A. BERAN, ENGINEER III

SUBMITTED: ERIBERTO B. SIOSON, CHIEF, BUILDINGS DIVISION, BUREAU OF DESIGN, DATE:

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APPROVED: (SEE COVER SHEET) ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE

SET NO. STD EW

SHEET NO. 2