KERR WOOD LEIDAL
consulting engineers

Appendix A

Flood Hazard and Risk Assessment

KERR WOOD LEIDAL
consulting engineers

Vancouver Island
201 - 3045 Douglas Street
Victoria, BC V8T 4N2
T 250 595 4223
F 250 595 4224

Technical Memorandum

FINAL

DATE: June 29, 2016

TO: Helen Lockhart, P.Eng., City of Colwood

FROM: Eric Morris, P.Eng.

RE: **OCEAN BOULEVARD PUMP STATION PROTECTION PLAN**
Flood Hazard and Risk Assessment
Our File 2417.006-300

1. Introduction

1.1 Background

The Ocean Boulevard Sewage Pump Station is owned and operated by the City of Colwood (the City) and is located at the southern end of the Coburg Peninsula which separates Esquimalt Lagoon from the Strait of Juan de Fuca (Figure 1-1, attached). The station is located directly adjacent to the beach (Figures 1-2 and 1-3) and the pump station site has reportedly been splashed with seawater during extreme storm events. Kerr Wood Leidal Associates Ltd. (KWL) has been retained by the City to assess the risk of flooding at the station and develop a protection plan.

This memorandum provides a summary of our flood hazard and risk assessment of the Ocean Boulevard Pump Station. The flood hazard and risk assessment provides the estimated probability of flooding from the sea due to tides, storms, sea level rise and tsunami. Potential flooding from overland sources (e.g. rainfall and creeks) is not considered in the analysis.

Figure 1-2: Ocean Boulevard Pump Station, wet well in foreground

Figure 1-3: Pump Station as seen from the sea

1.2 Glossary and Abbreviations

Astronomical Tide	=	tide caused by forces of the sun and the moon
CD	=	Chart Datum, roughly equal to lowest tide
CGVD	=	Canadian Geodetic Vertical Datum, roughly equal to mean sea level
Diffraction	=	change in wave direction when waves encounter an obstacle
FCL	=	Flood Construction Level for a building. Underside of wooden floor system or top of concrete slab must be above the FCL.
Hindcast	=	use of historical data to calculate the value of another unmeasured historical parameter
H_s	=	Significant Wave Height, average height of the highest 1/3 of the waves in a sea state
H_{max}	=	Maximum Wave Height
HAT	=	Highest Astronomical Tide, the highest astronomical tide over the 18.6 year tidal cycle
HHWLT	=	Higher High Water, Large Tide, the average of the highest annual tides over the 18.6 year tidal cycle
L_o	=	Deep Water Wave Length
LLWLT	=	Lower Low Water, Large Tide, the average of the lowest annual tides over the 18.6 year tidal cycle
MHWMT	=	Mean High Water, Mean Tide
MLWMT	=	Mean Low Water, Mean Tide
MWL	=	Mean Water Level
Refraction	=	change in wave direction in water of varying depth due to change in wavelength
Return Period	=	an estimate of the interval of time between events of a certain intensity or size
Shear (Land/Water)	=	wind speeds close to sea/ground level are slowed due to drag; the amount of slowing is different for land and water, therefore a correction factor must be applied to wind speeds measured on land when calculating wind speeds over water
Shoaling	=	Change of wave height in shallow water due to water depth
Storm Surge	=	increase in water level caused by low atmospheric pressure and winds
T_p	=	Peak Wave Period, the period of the peak of the wave spectrum
Wave Setup	=	increase in mean water level in the breaking wave zone
Wind Shear	=	Transfer of energy between the wind and water

1.3 References

The following references have been used in our risk assessment:

1. AECOM, "Modeling of Potential Tsunami Inundation Limits and Run-Up", for the Capital Regional District, June 2013.
2. Ausenco Sandwell, "Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Draft Policy Discussion Paper", January 2011.
3. BC Ministry of Forests, Lands and Natural Resource Operations, Flood Hazard Area Land Use Management Guidelines, Draft Amendment to Sections 3.5 and 3.6- The Sea, May 2013.
4. CIRIA, "The Rock Manual- Use of Rock in Hydraulic Engineering", 2nd Edition, 2007.
5. Coastal Engineering Research Center (CERC), U.S. Army Corps of Engineers, "Shore Protection Manual", 1984;
6. Eurotop, "Wave Overtopping of Sea Defences and Related Structures: Assessment Manual", January 2007.
7. Mase, Hajime and Iwagaki, Yuichi, "Run-Up of Random Waves on Gentle Slopes", Coastal Engineering, 1984, Chapter 40, pp 593-609.
8. Papronty, Dominic, et al. "Application of Empirical Wave Run-Up Formulas to the Polish Baltic Sea Coast", PLOS One, August 2014, Volume 9, Issue 8.
9. U.S. Federal Emergency Management Agency, "Wave Run-up and Overtopping, FEMA Coastal Flood Hazard Analysis Mapping Guidelines Focused Study Report", 2005.
10. U.S. Geological Survey, "Turbidite Event History – Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone", 2012.

2. Pump Station Description

The Ocean Boulevard Pump Station was constructed in 2000; drawings of the station are provided in Appendix A and a cross section through the station site is provided in Figure 2-1, attached. The station pumps raw sewage from a catchment area including approximately 200 dwellings. The station includes a masonry block building which houses electrical equipment, a standby diesel generator set and public washrooms and a wet well which houses two submersible sewage pumps. There is a small kiosk housing a ventilation fan and odour control equipment located adjacent to the wet well.

The pump station is situated directly west of the beach. The station floor elevation is 2.80 m CGVD and the top of slab elevation of the wet well is 2.45 m CGVD. If flooding reaches the 2.80 m CGVD elevation, it is possible that the pump station electrical systems will be damaged and rendered inoperable and the pump station structure and architectural finishes will receive some damage. In addition, access to the station under this flooding scenario would be unsafe. At the 2.45 m CGVD flooding elevation, seawater can enter the wet well, potentially causing an overflow, the ventilation and odour control kiosk can be damaged and access to the station will be difficult due to standing water and debris.

A lock-block and riprap berm has been constructed on the seaward side of the station; the elevation of the top of the berm is estimated as 3.3 m CGVD. The berm is 25 m long and extends roughly the length of the station (wetwell and building). Key station data are provided in Table 2-1.

Table 2-1: Key Data for the Ocean Boulevard Pump Station

Parameter	Value
Catchment Area	Area sloping down to the shoreline east of Metchosin Road, south of the 205 Portsmouth Dr. Pump Station and north of the 293 Perimeter Pl. Pump Station, 36.7 ha, approximate population of 534 (2011) with 200 dwellings in catchment area
Peak Winter Station Inflow	11.7 L/s existing/28.1 L/s projected future[1]
Firm Pumping Capacity	87.8 L/s (1 of 2 pumps running)
Note: 1. Based on the City's Sewer Master Plan, completed by Kerr Wood Leidal Associates Ltd. in 2013.	

Given that the pump station was constructed in 2000, there are no expected deficiencies in its pumping capacity and facilities of this type typically last about 65 years, one can expect that the pump station will require replacement in approximately 2065. It should be noted that the service life is for the structural components and that electrical and mechanical systems will require replacement before this date.

3. Flood Hazard Assessment

3.1 Overview

The objective of the flood hazard assessment is to provide the estimated probability that the station will be flooded by seawater to the year 2100. Two different flooding probabilities have been calculated for various time horizons:

1. The probability of being flooded by "blue water"- i.e. the station elevation is less than or equal to the sea level; and
2. The probability of being flooded by waves- i.e. the station is above the sea level but is transiently flooded by waves or "white water" during storms and tsunamis.

The water level and elevation components included in each scenario are summarized in Table 3-1. The development of the various water level components are provided in the following sections.

Table 3-1: Water Level and Elevation Components

Scenario		Water Level and Elevation Components Included
"Blue Water" Flooding		Astronomical Tides Storm Surge Ground Uplift Sea Level Rise
Wave Flooding	Storm	Astronomical Tides Storm Surge Ground Uplift Sea Level Rise Wave Effect
	Tsunami	Astronomical Tides Storm Surge Ground Uplift Minus Expected Subsidence in Earthquake Sea Level Rise Earthquake Generated Tsunami

It should be noted that a freeboard is customarily included in the water level when estimating a Flood Construction Level (FCL). The intent of the freeboard is to provide an additional measure of safety against flooding to account for uncertainties in the estimated high sea level and wave run-up components. A freeboard has not been included in this flood hazard assessment because the objective of the assessment is to provide a best estimate of the flooding probability. However, an appropriate freeboard should be added to the water levels when flood protection design concepts are developed.

3.2 Astronomical Tides

Astronomical tides are caused by the gravitational interaction of the sea, moon and sun. Due to the timing of the elliptical orbits of the moon around the earth and the earth around the sun, the tidal cycle repeats approximately every 18.6 years.

The closest ports to the Ocean Boulevard Pump Station with available tidal data are Pedder Bay, Esquimalt and Victoria. The Pedder Bay station is located to the south of the site and the Esquimalt and Victoria stations are located to the north.

According to the Canadian Hydrographic Service Canadian Tide and Current Tables, Volume 5, 2015, the magnitude of the predicted tides for Pedder Bay, Esquimalt and Victoria are identical with minor variances in their timing. Water levels from the Victoria tide station have therefore been used for the analysis because this station has both predicted tides, and a long observed tide data record.

Astronomical tide data for Victoria is summarized in Table 3-2. Water levels have been converted from CD to CGVD (HTv2 2010) by means of elevation data provided for Benchmark Number 87C9766 in Victoria Harbour; the conversion according to this benchmark is 1.895 m (CD – CGVD).

Table 3-2: Astronomical Tides (Victoria)

Tidal Level	Water Level (m, CD)	Water Level (m, CGVD)
Higher High Water, Large Tide (HHWLT)	3.4	1.5
Higher High Water, Mean Tide (HHWMT)	2.5	0.6
Mean Water Level (MWL)	1.9	0.0
Lower Low Water, Mean Tide (LLWMT)	0.7	-1.2
Lower Low Water, Large Tide (LLWLT)	0.0	-1.9

3.3 Tide + Storm Surge

Storm surges are increases and decreases in the sea level caused by storm generated atmospheric pressure fluctuations and wind. When a large storm surge occurs at the same time as a high tide, extraordinary flooding can occur. Given that storm surges and astronomical tides are caused by entirely different phenomena, one can expect that they are entirely uncorrelated; however, it has been shown in some areas (e.g. Southend, UK) that storm surges are smaller for higher tidal levels due to local hydrodynamics.

In order to estimate the probability of storm surges for this project, we have performed a Peaks-over-Threshold (PoT) analysis of observed water levels from the Victoria tide station from 1910 to 2014 (56 complete years of data in this period). PoT analysis involves analyzing the recorded data for independent storm events above a threshold elevation (taken as the minimum of the annual extremes). The PoT data is then fitted using the Generalized Pareto Distribution to determine flood levels and their respective annual return period.

The PoT analysis method provides a water level that includes astronomical tides, storm surge and other longer term water level changes due to seasonal weather patterns (winter/summer) and multi-annual phenomena (e.g. El Nino, Pacific Decadal Oscillation). In addition, potential correlation between tides and storm surge are accounted for in this technique. Water levels for various return periods are provided in Table 3-3.

Table 3-3: Water Levels (Tide + Storm Surge) for Various Return Periods

Return Period	Water Level (m, CGVD)
5	1.63
10	1.68
25	1.74
50	1.78
85	1.80
100	1.81
200	1.84

3.4 Sea Level Rise

The BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) published the Flood Hazard Area Land Use Management Guidelines (FHALUMG) in 2004. MFLNRO issued a draft amendment to the section of the FHALUMG related to “The Sea” in 2013 [3]. This draft amendment includes a recommended curve for sea level rise policy in BC; estimated sea level rise values for various time horizons are summarized in Table 3-4.

Table 3-4: Expected Sea Level Rise

Year	Sea Level Rise (m)
2025 (10 years)	0.25
2040 (25 years)	0.40
2065 (50 years)	0.65
2100 (85 years)	1.0

3.5 Wind Generated Waves

Wind

Wind data from the Environment Canada station at Gonzales (Gonzales CS and Gonzales HTS) was processed to determine the wind climate at the site and design wind speeds. The Gonzales station is located approximately 10 km east of the site on Gonzales Hill at an elevation 69 m.

Data from 2000 to 2010 was processed to produce the wind rose in Figure 3-1. It can be seen from the figure that the predominant direction for high winds is west-south-west (WSW) and south-east (SE) and the 99th percentile hourly wind speeds for both these directions are similar (about 50 km/hr).

Strong south-east winds are common in the fall/winter while strong westerly winds tend to occur in the summer.

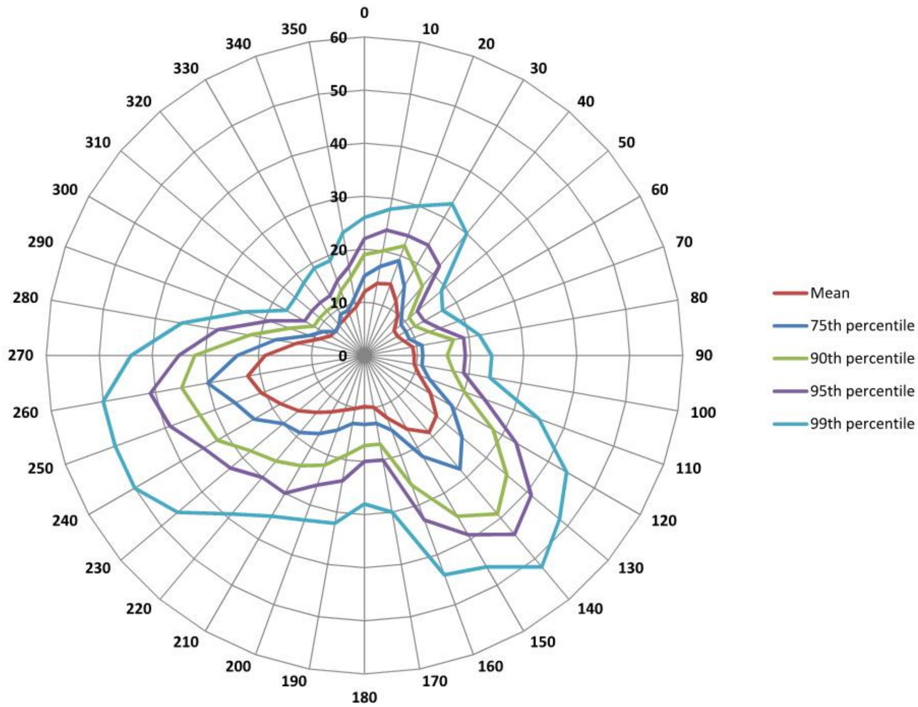


Figure 3-1: Wind Rose for Gonzales (Hourly Wind Speeds in km/hr)

Wind speeds for various return periods were determined through extreme value analysis of all-direction annual maximum hourly wind speeds from 1953 to 2014. The design wind speeds are provided in Table 3-5 along with 90% confidence intervals. The data was found to be best-fit by the Weibull Distribution. For reference, the 1/50 year wind pressure for Victoria in the BC Building Code corresponds to a wind speed of 112 km/hr.

Table 3-5: All-Direction Wind Speeds for Various Return Periods

Return Period (years)	Hourly Wind Speed (km/hr)		
	90% Confidence Lower Bound	Mean	90% Confidence Upper Bound
Annual	76	80	84
5	84	89	94
10	90	95	102
25	96	103	111
50	100	108	116
85	103	112	121
100	104	113	122

Deep Water Waves

The pump station site is exposed to large fetches to the south (approximately 30 km) and east (approximately 50 km). As noted above, the highest wind speeds at Gonzales tend to come from the southeast and west, however, the Gonzales station is on the top of a hill and is exposed to winds from all directions while the pump station site is at the bottom of the hill and is sheltered from direct westerly winds. Instead, the westerly winds measured at Gonzales tend to “bend” around the Metchosin peninsula and turn into a southerly wind at the site. Given that the westerly and south-easterly winds are of similar magnitudes, but the fetch is larger in the south-east direction, it is expected that the south easterly fetch provides the governing wave conditions at the site. Deep water waves were hindcast using the methods outlined in the Coastal Engineering Manual [5]. Deep water wave conditions for various return periods are summarized in Table 3-6.

Table 3-6: Deep Water Wave Conditions

Return Period (years)	Significant Wave Height, H_s (m)	Peak Wave Period, T_p (s)	Deep Water Wave Length, L_o (m)
Annual	2.29	5.65	50
5	2.97	6.16	59
10	3.22	6.33	63
25	3.57	6.55	67
50	3.78	6.68	70
85	3.96	6.78	72
100	4.01	6.81	72

Wave Effect on Pump Station

As the deep water waves propagate to the site, they transform due to refraction and shoaling, break and run-up the beach. The wave run-up can convey seawater and driftwood far inshore and cause flooding damage well above the level of the sea.

Wave run-up elevations have been calculated based on the laboratory and field work performed by Mase [7] and Papronty et al. [8]. For the purpose of the flood hazard assessment, we have neglected the effects of refraction, since the beach is oriented almost perpendicular to the south-east fetch and we have neglected the presence of the berm in front of the station because it is of limited extent and it is expected that floodwaters can travel around the ends of the berm and damage the station. It is also assumed that the beach profile will not significantly change due to climate change.

Current guidance from the US Federal Emergency Management Agency [8] suggests that the use of the run-up elevation reached by between 10% and 33% of the waves ($R_{10\%}$ and $R_{33\%}$) defines the elevation at which significant flooding damage to buildings occurs. For the purpose of this study, we have conservatively used the $R_{10\%}$ value.

One important consideration in determining the flooding risk is the water level at which the wave run-up occurs. If the wave run-up occurs at low tide, the water may not reach the pump station even if the waves are large. However, if the wave run-up occurs at a high astronomical tide with storm surge, flooding and associated damage may occur even for smaller wave heights. A key component in the analysis is therefore the extent to which high water levels, winds and waves are dependant variables. If they are dependant variables, large tides would be accompanied by large storm surges and waves, but if they are independent, the fact that the tide is high, doesn't provide any indication of the magnitude of the other variables.

In order to account for the possible dependence, or correlation of astronomical tides, storm surges and waves, a frequency analysis of the estimated total water level including wave run-up was conducted. The methodology used is outlined as follows:

- Create a continuous hourly record of water levels and winds (37 years of data available);
- Calculate the deep water wave height for each wind speed conservatively assuming the winds are coming from the southeast fetch. Note that the strongest winds at the site come from the south-east and south as discussed above;
- Calculate the estimated wave run-up elevation at the beach (total water level) based on the deepwater wave conditions, the beach slope and the water level (tide + storm surge);
- Perform a Peaks-over-Threshold (PoT) analysis on the total water level and determine the expected return period of a range of run-up elevations.

The results of the PoT analysis are presented in Figure 3-2. The "best-estimate" total water level from extreme value analysis is presented along with lower and upper bound values. The lower bound value is the result obtained when assuming that storm surges and waves and completely uncorrelated (i.e. there is an equal probability of any wind speed happening at any storm surge + tide level). The upper bound value is the result obtained when assuming that storm surges and waves and completely correlated (i.e. the 100-year wind speed and wave run-up always happens along with the 100-year storm surge + tide). The "best-estimate" total water level is between the lower and upper bounds, indicating that wave run-up and storm surge + tide have a partial correlation at this site.

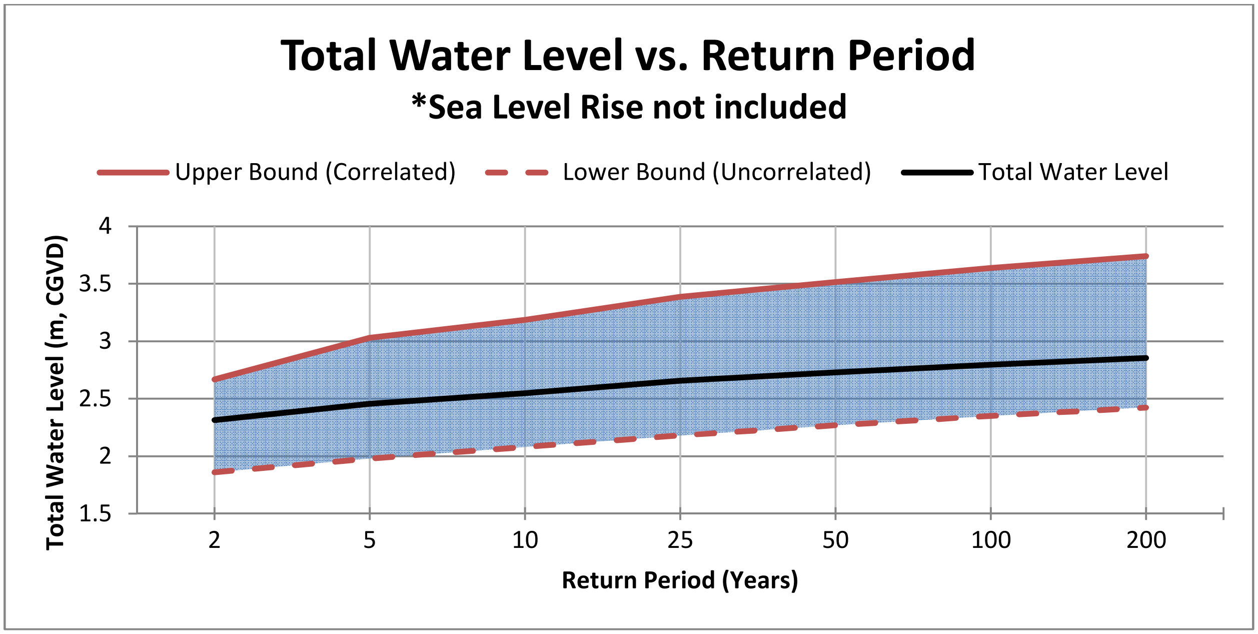


Figure 3-2: Total water levels (tide + storm surge + wave run-up) for various return periods

It should be noted that the wave run-up includes a component called “wave set-up” which is an increase in the static water level at the shoreline due to wave breaking, In general, wave set-up can contribute to “blue-water” flooding during storm events. However, at this particular site, the contribution of wave set-up is only considered for “wave” flooding due to the presence of Esquimalt Lagoon. The water levels in Esquimalt Lagoon are expected to respond to storm surge but not wave set-up and therefore the lagoon attenuates the wave set-up component of blue water flooding since its’ water level is lower than that at the adjacent shoreline.

3.6 Tsunami

Tsunamis are waves caused by landslides and earthquakes. At the Ocean Boulevard Pump Station site, tsunamis could be caused by landslides within the Strait of Juan de Fuca (both above and below the sea surface), local (crustal) earthquakes and Cascadia Subduction Zone earthquakes. Of these tsunami generating phenomena, only the Cascadia Subduction Zone (CSZ) earthquake and tsunami has been researched to the extent that flooding elevations have been calculated and probabilities of occurrence are available. Two references have been used to determine CSZ related tsunami flooding hazards:

<u>AECOM, “Modeling of Potential Tsunami Inundation Limits and Run-Up”, for the Capital Regional District, June 2013 [1].</u>

This study involved the development of a hydrodynamic tsunami model for the entire Capital Regional District including the Ocean Boulevard Pump Station site. This model predicts the maximum water level and water velocity due to the tsunami. The earthquake and tsunami event modelled has a return period of 500 years and a magnitude of Mw 9.0. Water levels at the Ocean Boulevard Pump Station site for the 1-in-500-year CSZ tsunami are provided in Table 3-7 below.

Table 3-7: Tsunami Inundation Levels at Ocean Boulevard Pump Station Site

Parameter	Value
Maximum Water Level in Conjunction with Subsidence	2.7 m from MWL[1]
50% Factor for Public Safety[2]	1.35 m
Estimated Total Flood Level	4.1 m CGVD

Notes:
1. MWL and CGVD are approximately equal at Ocean Boulevard Pump Station site. Tsunami assumed coincident with HHWMT. Water level includes expected land subsidence (about 0.15 m) in the CSZ earthquake.
2. Factor for Public Safety is to account for uncertainty related to the magnitude of the earthquake and the initial tsunami wave amplitude, tide variations (i.e. tsunamis that occur at tides higher than HHWMT and potential inaccuracies in topographic/bathymetric data.

The estimated total flood level (2015) is 4.1 m CGVD including the recommended safety factor. Given that the floor elevation of the pump station is 2.8 m CGVD, it is recommended that the City plans for complete destruction of the pump station in a CSZ tsunami scenario.

U.S. Geological Survey, Turbidite Event History – Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone, 2012 [10].

This study involved the collection of borehole (core) samples from the ocean floor along the length of the CSZ in order to identify sediment flows and deposits (turbidites) caused by subduction earthquakes. This investigation technique allowed for the identification of 19 north-central margin subduction earthquakes occurring over the past 10,000 years and their estimated dates of occurrence. Based on this data, a recurrence model for CSZ earthquakes (and tsunamis) was developed and encounter probabilities were estimated; these probabilities are provided in Table 3-8. It should be noted that subduction zone earthquakes have been shown to be dependant events, and therefore there is a continuously increasing probability with time since the last earthquake (A.D. 1700).

The USGS estimates that there is a 27% chance that a full margin subduction earthquake will occur between 1700 and 2060 with a 90% lower confidence bound of 14% and a 90% upper confidence bound of 41%.

Table 3-8: Probability of North-Central Margin Cascadia Subduction Zone Earthquake and Tsunami

Time Interval	Mean Probability of Occurrence
2015-2025	2%
2015-2040	4%
2015-2065	9%
2015-2100	15%

The water levels and probabilities presented above are subject to the following limitations:

- Due to a lack of data, tsunamis caused by landslides within the Strait of Juan de Fuca (both above and below the sea surface) and local (crustal) earthquakes are not considered in the probabilities; and
- Increases in water levels due to potential landslides triggered by CSZ earthquakes are not included.

For these reasons, the tsunami generated flood levels and probabilities presented in this memorandum must be considered approximate and indicative only.

3.7 Ground Uplift

The land in the Greater Victoria area is gradually being lifted as due to crustal movement in the CSZ. The uplift rate at the pump station site is estimated to be 0.6 mm/year based on data published by Ausenco Sandwell [2] for Albert Head. This ground uplift adjustment is included in the water levels for tide + storm surge. It should be noted that 0.15 m of subsidence is expected during the CSZ earthquake, and this adjustment has been included in the tsunami water levels.

3.8 Assessment

The flood hazard assessment of the Ocean Boulevard Pump Station was undertaken by assessing the flood risk due to "Blue Water" flooding and wave flooding due to storms and tsunami; the results are presented in Table 3-9 and Table 3-10.

Two different elevations were used for the flood hazard assessment:

- **The elevation of the top of the wet well (2.45 m CGVD).** At this flooding elevation, seawater can enter the wet well, potentially causing an overflow, the ventilation and odour control kiosk can be damaged and access to the station will be difficult due to standing water and debris.
- **The elevation of the flood slab of the pump station building (2.80 m CGVD).** At this elevation, it is possible that the pump station electrical systems will be damaged and rendered inoperable and the pump station structure and architectural finishes will receive some damage. Access to the station under this flooding scenario would be unsafe.

As discussed in Section 3.6, the CSZ tsunami is expected to reach an elevation of approximately 4.1 m CGVD, and it is recommended that the City plans for complete destruction of the pump station in a CSZ tsunami scenario.

The assessment was divided into time spans: current, 2015-2025, 2025-2040, 2040-2065 (the end the pump station's design life), and 2065-2100. For each time span, the sea level rise occurring at the end of the time span was conservatively assumed to be in effect for the entire time span; for example, for the 2040 to 2065 time span, a sea level rise value of 0.65 m was added to the existing total water levels. Table 3-9 and 3-10 include the estimated return period of the flooding event, the probability that the event will occur during a given time span (i.e. the encounter probability) and the cumulative probability that the event will occur between 2015 and a given date. For example, there is an estimated 36.2% probability of blue water flooding to the 2.45 m CGVD elevation between 2040 and 2065 and 36.7% probability of flooding occurring between 2015 and 2065.

It should be noted that one of the fundamental assumptions of the flood hazard assessment is that storm surge, winds and waves will not change with climate change. Current climate change research suggests that wind speeds will not change significantly in British Columbia, therefore this is considered to be a valid assumption.

For existing conditions, review of the return periods in Table 3-9 indicates that "Blue Water" flooding of the station, even to the lower elevation of 2.45 m CGVD is currently a remote possibility with a return period of greater than 1000 years. However, "white water" wave flooding due to storms ($R_{10\%}$) can currently be expected to occur to the 2.45 m CGVD elevation approximately every 5 years and waves can be expected to reach the 2.80 m CGVD elevation every 33 years.

Not surprisingly, the risk of flooding is expected to increase with rising sea levels over the next 85 years. By the year 2065, "Blue Water" flooding of the pump station to the 2.45 m CGVD elevation is expected to have a return period of 56 years, resulting is a probability of 36.7% that flooding will occur before the service life of the pump station is reached. “Blue Water” flooding to the 2.80 m CGVD elevation is not probable before the service life of the pump station is reached.

Storm wave flooding to the 2.80 m CGVD elevation is expected to occur on average every 8 years by the year 2025 reducing to an annual return period by 2065. There is a 9% chance that the pump station will be impacted by a CSZ tsunami before the service life of the pump station is reached.

Table 3-9: Encounter Probabilities for Various Flooding Scenarios Using 2.45 m, CGVD Threshold

Scenario		Time Span	Event Return Period (Years)	Encounter Probability in Time Span	Cumulative Encounter Probability
“Blue Water” Flooding **Mean Sea Level Threshold (m, CGVD) ≥ 2.45**		Current	>1,000		
		2015 to 2025 (10 years)	>1,000	0.1%	0.1%
		2025 to 2040 (15 years)	>1,000	0.7%	0.8%
		2040 to 2065 (25 years)	56	36.2%	36.7%
		2065 to 2100 (35 years)	3	99.9%	99.9%
Wave Flooding	Storm **10% Wave Run-Up Threshold (m, CGVD) ≥ 2.45**	Current	5.1		
		2015 to 2025 (10 years)	2.1	99.1%	99.1%
		2025 to 2040 (15 years)	1.5	99.9%	99.9%
		2040 to 2065 (25 years)	1.1	99.9%	99.9%
		2065 to 2100 (35 years)	<1	99.9%	99.9%
	Tsunami **Wave Height Threshold (m, CGVD) ≥ 2.45**	Current	~500		
		2015 to 2025 (10 years)			2%
		2025 to 2040 (15 years)			4%
		2040 to 2065 (25 years)			9%
		2065 to 2100 (35 years)			15%

Table 3-10: Encounter Probabilities for Various Flooding Scenarios Using 2.8 m, CGVD Threshold

Scenario		Time Span	Event Return Period (Years)	Encounter Probability in Time Span	Cumulative Encounter Probability
"Blue Water" Flooding **Mean Sea Level Threshold (m, CGVD) ≥ 2.8**		Current	>1,000		
		2015 to 2025 (10 years)	>1,000	0.1%	0.1%
		2025 to 2040 (15 years)	>1,000	0.1%	0.25%
		2040 to 2065 (25 years)	>1,000	0.2%	0.5%
		2065 to 2100 (35 years)	72	38.6%	38.7%
Wave Flooding	Storm **10% Wave Run-Up Threshold (m, CGVD) ≥ 2.8**	Current	33		
		2015 to 2025 (10 years)	8.5	69.2%	69.2%
		2025 to 2040 (15 years)	4.5	96.5%	98.9%
		2040 to 2065 (25 years)	2	99.9%	99.9%
		2065 to 2100 (35 years)	1.1	99.9%	99.9%
	Tsunami **Wave Height Threshold (m, CGVD) ≥ 2.8**	Current	~500	N/A	N/A
		2015 to 2025 (10 years)			2%
		2025 to 2040 (15 years)			4%
		2040 to 2065 (25 years)			9%
		2065 to 2100 (35 years)			15%

4. Summary and Conclusions

4.1 Summary of Findings

A flood hazard assessment for the Ocean Boulevard Pump Station has been performed. The objective of the flood hazard assessment is to provide the estimated probability that the station will be flooded by seawater due to storms and tsunami to the year 2065 (the end of its expected service life) and 2100. Potential flooding from overland sources (e.g. rainfall and creeks) is not considered in the analysis.

Two different flooding probabilities have been calculated for various time horizons:

1. The probability of being flooded by “blue water”- i.e. the station elevation is less than or equal to the sea level; and
2. The probability of being flooded by waves- i.e. the station is above the sea level but is transiently flooded by waves or “white water”.

The results of the flood hazard assessment are summarized as follows:

- It is estimated that there is a 37% probability that “blue water” flooding to the 2.45 m CGVD elevation could occur before the service life of the pump station is reached. At this flooding elevation, seawater can enter the wet well, potentially causing an overflow, the ventilation and odour control kiosk can be damaged and access to the station will be difficult due to standing water and debris (logs etc.).
- “Blue Water” flooding to the 2.80 m CGVD elevation, in which damage to electrical systems could occur, is not probable before the service life of the pump station is reached.
- Storm wave flooding to the 2.45 m CGVD elevation is predicted to occur every 2 years by 2025 and will become more frequent thereafter. Storm wave flooding to the 2.80 m CGVD elevation is expected to occur on average every 8 years by the year 2025 reducing to a 2-year return period by 2065. This storm wave flooding could result in damage to the station if it is not mitigated through the construction of shore protection or the station is flood-proofed.
- It is estimated that there is a 9% chance that the pump station will be impacted by a CSZ tsunami before the service life of the pump station is reached. The estimated total flood level (2015) in the CSZ tsunami is 4.1 m CGVD including a recommended safety factor. Given that the floor elevation of the pump station is 2.8 m CGVD, it is recommended that the City plans for complete destruction of the pump station in a CSZ tsunami scenario.

4.2 Next Steps

The next phase of the pump station protection plan is to develop mitigation options to address the hazards identified in this assessment. At this time, it is envisioned that the mitigation options will focus on:

- Floodproofing of the pump station to manage the blue water flooding hazard to the wetwell and the storm wave flooding of the wetwell and electrical room;
- Construction of shore protection works (e.g. a more extensive berm) to mitigate the storm wave flooding hazard;
- The required components of an emergency management plan to mitigate the tsunami hazard;

- The potential timing and triggers to "retreat" from the site and reconstruct the pump station in a safer location taking in account sea level rise, the tsunami hazard, potential erosion of the Coburg Peninsula and the need for eventual infrastructure renewal.

KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:

Eric Morris , M.A.Sc., P.Eng.
Project Manager

Reviewed by:

Dave Murray, P.Eng., A.Sc.T., CPESC
Project Reviewer

EM/am
Attachments: Appendix A- Pump Station Drawings

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of the intended recipient. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

Revision History

Revision #	Date	Status	Revision Description	Author
A	August 28, 2015	Draft		EM
B	June 29, 2016	Final	Revised Based on Client Comments	EM

OQM | Organizational Quality Management Program

City of Colwood - Ocean Boulevard Pump Station Protection Plan: Flood Hazard and Risk Assessment

Legend

- Pump Station
- Road

<bol>Reference: Orthophoto from CRD

KERR WOOD LEIDAL
consulting engineers

40 0 40 (m)

1:1,500

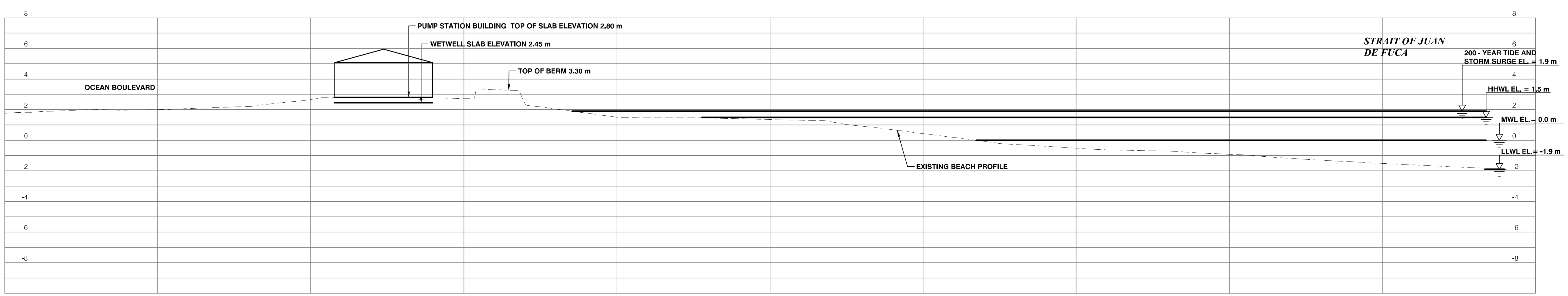
Project No.	Date
2417-006	July 2016

Location Plan

Figure 1-1

Path: Q:\2400-2499\2417-006\430-GIS\MXD-Rp\2417006_LocationMap.mxd Date Saved: 28/08/2015 1:51:20 PM
Author: MScruton

PLAN
Scale: 1:150



PROFILE
Scale: H 1:150, V 1:150

NOTE:
1) ALL ELEVATIONS ARE TO CANADIAN GEODETIC VERTICAL DATUM

KERR WOOD LEIDAL
consulting engineers

Rev	Date	Des	Dwn	Chk	Description of Revision
A	2015-08-25	EM	AF	DNM	ISSUED FOR INFORMATION

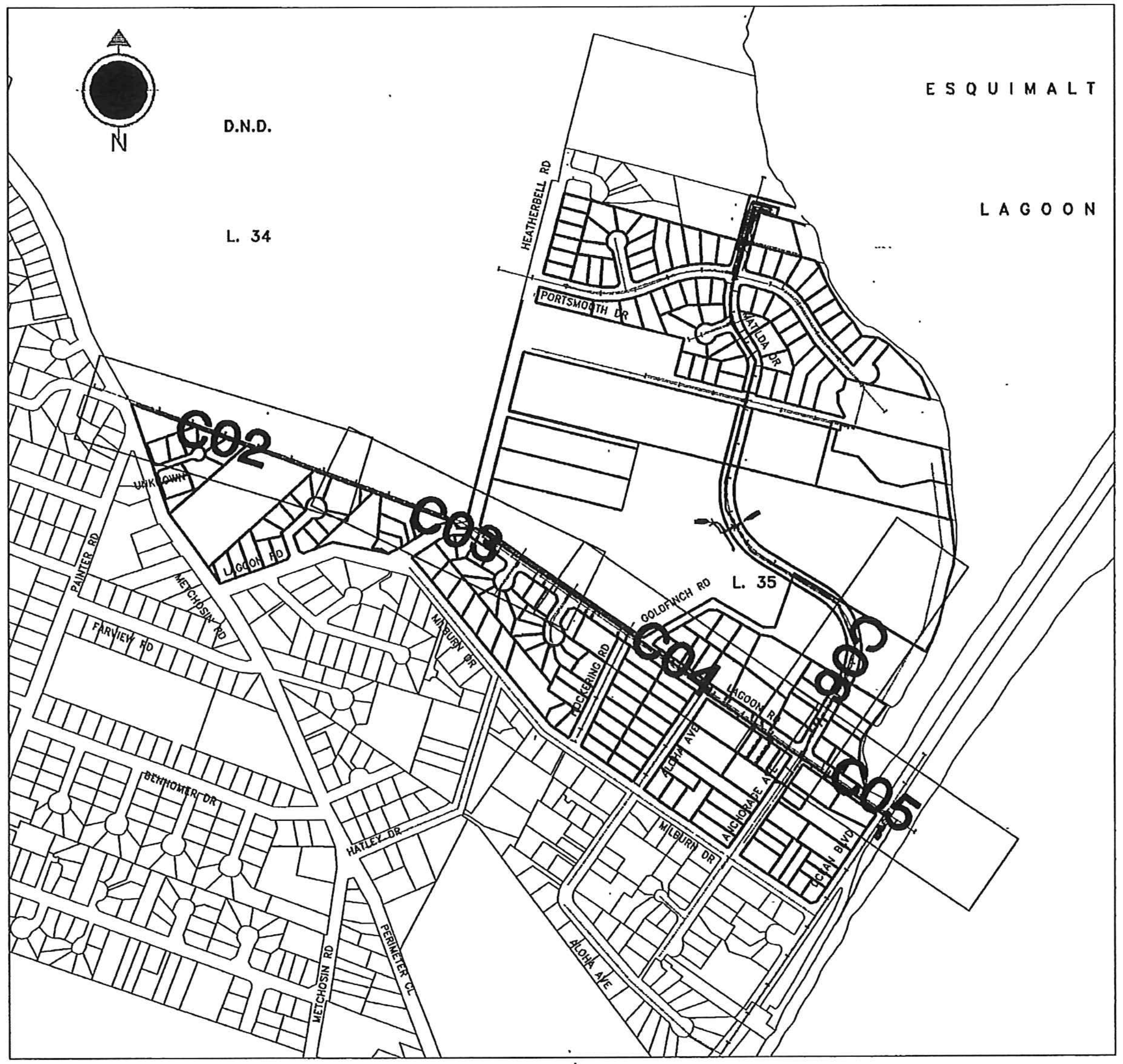
CITY OF COLWOOD

OCEAN BOULEVARD PUMP STATION PROTECTION PLAN FLOOD HAZARD ASSESSMENT

Project No. 2417.006
Group GENERAL
Drawing No. **FIGURE 2-1**

SAVED 2015-08-28 10:28 AM
Paper Size = ANSI D
At Full Size, this border measures 520 mm x 800 mm
O:\2400-2499\2417-006\501-Drawings\b_Figures\FIGURE 2-1.dwg

APPENDIX A
Pump Station Drawings



SITE PLAN

SCALE 1:5000

CITY OF COLWOOD

COLWOOD TRUNK SEWER PHASE V CONTRACT No. TS-2002-3

DRAWING INDEX

DRAWING No.	DESCRIPTION
C01	SITE PLAN, DRAWING INDEX AND GENERAL NOTES.
C02	DND – LAGOON ROAD STA.: 2+240 TO 1+920
C03	DND – LAGOON ROAD STA.: 1+920 TO 1+560
C04	DND – LAGOON ROAD STA.: 1+560 TO 1+200
C05	DND – LAGOON ROAD STA.: 1+200 TO 0+980
C06	ANCHORAGE AVENUE STA.: 3+120 TO 2+950
C07	MANHOLE BASE DETAILS
G01	OCEAN BLVD. PUMP STATION – SITE PLAN
A01	OCEAN BLVD. PUMP STATION – CONTROL BUILDING – PLAN & PROFILE
P01	OCEAN BLVD. PUMP STATION – PLAN
P02	OCEAN BLVD. PUMP STATION – SECTIONS
P03	OCEAN BLVD. PUMP STATION – MISCELLANEOUS DETAILS & SECTIONS
S01	OCEAN BLVD. PUMP STATION – PLAN
S02	OCEAN BLVD. PUMP STATION – SECTIONS AND DETAILS
S03	MISCELLANEOUS DETAILS
S04	OCEAN BLVD. PUMP STATION – PLANS, SECTIONS, AND DETAILS
M01	OCEAN BLVD. PUMP STATION – CONTROL BUILDING – HVAC/PLUMBING
E01	OCEAN BLVD. PUMP STATION – EQUIPMENT LAYOUT
E02	OCEAN BLVD. PUMP STATION – SINGLE LINE DIAGRAM

LEGEND

EXISTING

- TOP OF BANK
- BUSH LINE
- SANITARY SEWER
- STORM DRAIN
- UNDERGROUND TELEPHONE LINE
- DITCH BOTTOM
- PAVED DRIVEWAY
- WATER MAIN
- PAVEMENT EDGE
- FENCE LINE
- GAS MAIN
- UNDERGROUND HYDRO LINE
- PROFILE DITCH BOTTOM
- CLEAN OUT
- CATCH BASIN
- WATER METER
- WATER VALVE
- UTILITY POLE
- MANHOLE
- FIRE HYDRANT
- CULVERT INVERT
- MONUMENT

PROPOSED

- UNDERGROUND ELECTRICAL
- SANITARY FORCE MAIN
- SANITARY SEWER
- STORM DRAIN
- WATER MAIN
- SANITARY SERVICE
- CLEAN OUT
- LOWEST HABITABLE ELEVATION
- SERVICE INVERT AT PROPERTY LINE
- WATER VALVE
- MANHOLE
- INSPECTION CHAMBER: PROPOSED LOCATION
- INSPECTION CHAMBER: PREFERRED LOCATION

GENERAL NOTES

1. All work and materials are as described in the latest edition of the City of Colwood Subdivision and Development of Land Bylaw and standard drawings or as otherwise approved by the Engineer. Where allowed, Master Municipal Construction Document (MMCD) standards were used.

2. Notified Engineer and the City of Colwood 48 hours prior to commencement of work.

3. Connection to, or alteration of, existing City of Colwood owned utilities was undertaken by the City of Colwood forces only, unless otherwise authorized by the City of Colwood.

4. Connection to, or alteration of, existing BC Hydro, Telus, Shaw Cable, Centra Gas or other utilities was undertaken by the appropriate utility only, unless otherwise authorized by that utility company. Contractor co-ordinated pole relocation with BC Hydro, BC Tel and all other agencies having services on the same pole.

5. Contractor complied with all applicable Ministry of Water, Land and Air Protection and Department of Fisheries & Oceans Canada requirements at all times during construction.

6. Contractor confirmed location of existing utilities at all crossings and connections and reported any discrepancies to the engineer prior to construction.

7. Contractor obtained all necessary permits or clearances from the City of Colwood to do any work that may affect privately owned property.

8. Damage or removal of existing survey monuments outside of the required working area are subject to a $4,000 fine payable to the City of Colwood.

9. The Contractor provided and maintained adequate traffic control, including flag persons, signs and barricades and illuminate as required, all in accordance with the latest edition of the "Manual of Uniform Traffic Control Devices for Canada".

10. All areas affected by the work were restored to original or better condition and to the satisfaction of the City of Colwood.

CONSTRUCTION NOTES

1. All elevations are geodetic and all co-ordinates are UTM NAD83 ground level based on monument 89H4868 elevation 1.891m located at the intersection of Ocean Boulevard and Lagoon Road. To convert to UTM sea level co-ordinates, multiply by a combined scale factor of 0.9996174.

2. All surplus material was removed from the site and properly disposed of in accordance with all applicable guidelines and regulations.

3. All manholes are 1200ø unless otherwise noted. All services are 1.2m depth (MIN.) at property line or as otherwise shown. Trench dams were installed every 25m where pea gravel was used as bedding material at no additional cost to the owner.

4. All services are 100mmø (unless otherwise specified) c/w inspection chamber. See MMCD standard drawing S9 and City of Colwood standard drawing #SS1. Inspection chamber is offset minimum 1.5m from property line. All services have inspection chamber c/w concrete pull box and cast iron lid. Lid marked 'City of Colwood Sanitary'.

5. Inspection chamber rim elevations are approximate and are shown for estimating purposes only. Contractor set rim elevation to suit existing topography.

EROSION AND SEDIMENT CONTROL

1. Erosion and sediment control for this project is as outlined in the the latest edition of the Fisheries and Oceans Canada and Ministry of Water, Land and Air Protection Handbook entitled "LAND DEVELOPMENT GUIDELINES FOR THE PROTECTION OF AQUATIC HABITAT". The Contractor acquired these guidelines and familiarized himself with the requirements therein.

2. To protect the soil, water and vegetative resources of the area, only those areas necessary to construct the works contained in the Engineering drawings were disturbed.

3. SEDIMENT CONTROL:

The Contractor ensured that:
a. All works were undertaken and completed by the Contractor in such a manner as to prevent the release of sediment laden water into any body of water, watercourse or storm sewer.
b. During construction, the Contractor ensured sediment control facilities were maintained and working adequately to control all discharges from the site. All facilities were inspected by the Contractor on a daily basis to ensure proper operation until removal.
c. Maintenance included flushing of any storm sewer as required. Silt build-up was removed by the Contractor as necessary to ensure proper operation until removal of siltation control facilities.
d. Silt fence was "control silt fence plus" or equivalent as approved by the Engineer. Fence had a minimum clear water flow rate of 0.03 m^3/m^2 (0.10 cfs/sf). Fence was stapled at 1.0m O/C. Bottom of silt fence was anchored as required.
e. Any irregularities were reported to the Engineer immediately.
f. No silt laden water from excavations was pumped out or otherwise directly discharged into any watercourse or storm sewer system bypassing the silt control works.

4. The City assumed no responsibility for damages resulting from improper erosion and sediment control measures undertaken by the Contractor.

REVISIONS

No.	DESCRIPTION	DATE	APPROVED
7	RECORD DRAWING	03.05	

DRAWING STATUS

No.	DESCRIPTION	DATE	APPROVED
6	MICROFILMED		
5	PLAN OF RECORD		
4	APPROVAL FOR CONSTRUCTION		
3	FOR TENDER	02.06.21	TB
2	FOR APPROVAL	02.05.10	TB
1	PRELIMINARY	00.09.20	TB

SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com
www.stantec.com

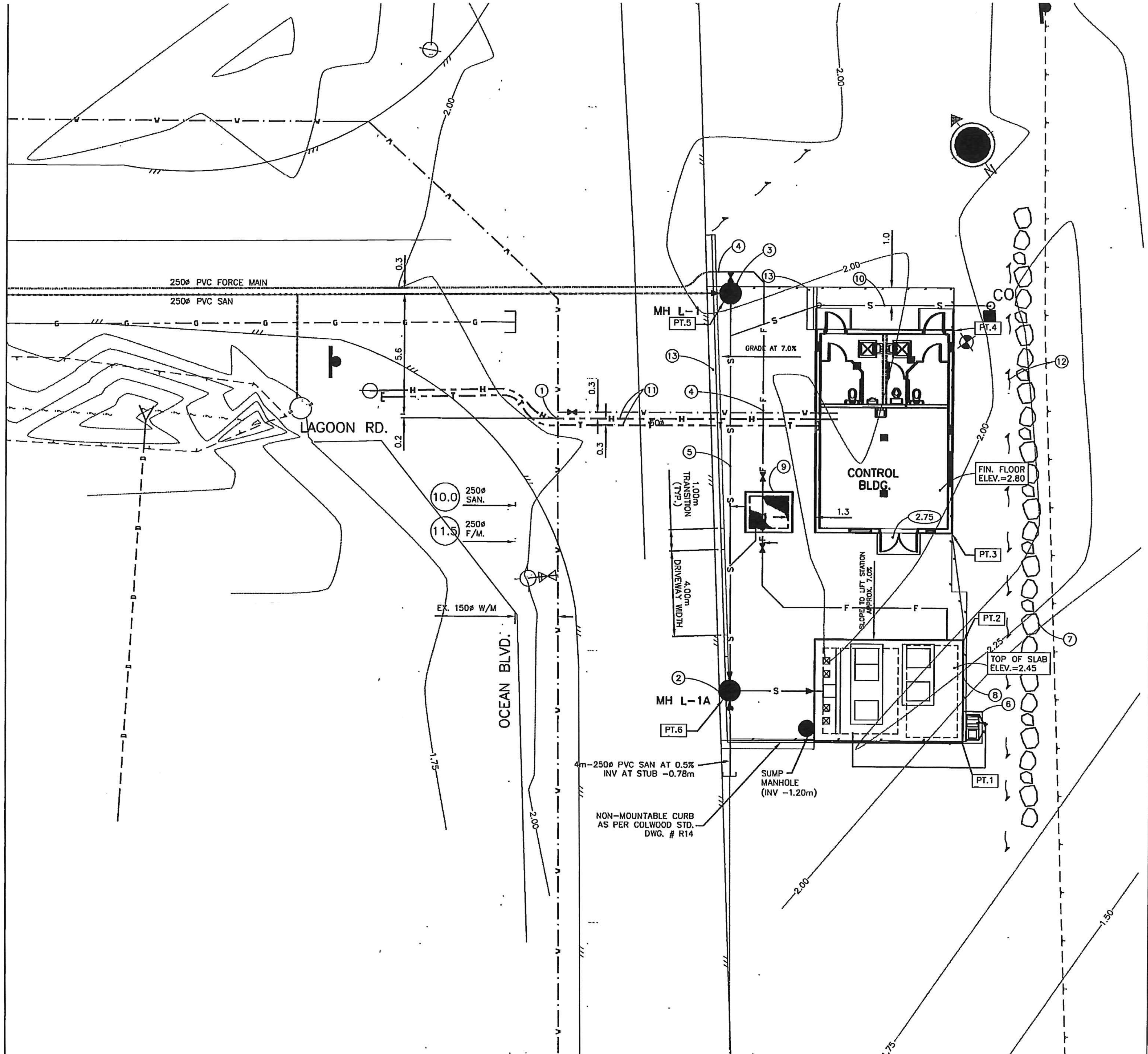
DESIGNED: JDM/TB	DRAWN: JDM
CHECKED: MAP	APPROVED: TB
SCALE: 1:5000 HOR.	

CLIENT: CITY OF COLWOOD

TITLE: COLWOOD TRUNK SEWER PHASE V SITE PLAN, DRAWING INDEX AND GENERAL NOTES.

DATE: JUNE 2001	SHEET:
JOB No. 120 30700	
REVISION: 7	DRAWING: C01

AS-BUILT FOLDER NO. V S1 09

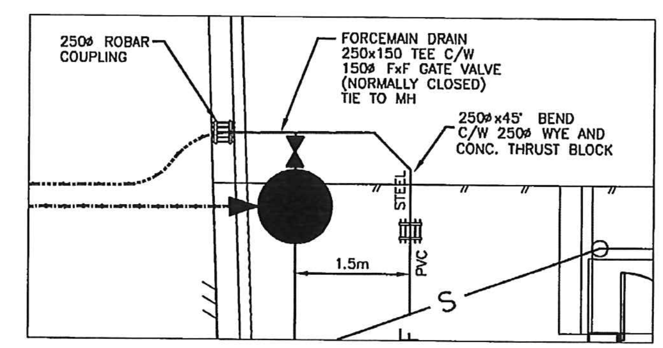


1. 50ø WATER CONNECTION
2. CONSTRUCT 1200ø MH c/w PRECAST BASE & TOP, RIM EL. +2.16m, NORTH INV. -1.098m, EAST INV. -1.128m SOUTH INV. -0.80m c/w INSIDE DROP STRUCTURE & 4.0m STUB w/CAP @ 0.5%.
3. CONSTRUCT 1200ø MH, c/w PRECAST BASE & TOP, RIM EL. +2.06m, WEST INV. -0.98, SOUTH INV. -1.01
4. CONSTRUCT +/- 15m-250ø PVC DR18 CLASS 150 FORCEMAIN c/w 2-45' HORIZONTAL BENDS CONCRETE THRUST BLOCKS & TEMPORARY CAP. TIE ROD CAP AND BENDS TOGETHER
5. CONSTRUCT 17.5m-250ø PVC SAN MAIN @ 0.50%.
6. FAN KIOSK.
7. STONE ARMOUR 0.3-0.9m³ BOULDERS ON HIGH STRENGTH GEOTEXTILE. TOP OF STONE ARMOUR ELEVATION TO BE 3.70m
8. PUMP STATION.
9. PIG LOADER MANHOLE (SEE DWG P03).
10. CONSTRUCT +/- 10m-100ø PVC SAN SERVICE CONNECTION c/w RISER, CLEANOUT & WYES TO BUILDING SERVICES (SEE DWG. M01)
11. 2x103ø CONCRETE ENCASED HYDRO DUCTS. CONNECT TO EXIST. HYDRO POLE WITH NEW PILASTER. & 1-103ø TELUS DUCT CAPPED AT BOTH ENDS
12. CONSTRUCT SWALE TO PROVIDE POSITIVE DRAINAGE AWAY FROM SITE.
13. NEW CURB FACE TO MATCH EX. PAVEMENT EDGE. AS PER COLWOOD STD. DWG R14

LEGEND

- PROPOSED ASPHALT PARKING AREA w/75mm HMAC, 150mm-20ø CRUSH GRAVEL BASE 450mm-75mm SELECT GRANULAR SUB-BASE & SUBGRADE PREPARATION. GRADE EXISTING AREA AS REQUIRED TO OBTAIN POSITIVE DRAINAGE.
- (2) KEYNOTE
- (2.20) FINISHED GRADE.
- 2.25 EXISTING CONTOUR

PT#	COORDINATE	DESCRIPTION
1	N=5364853.956 E=465224.296	PUMP STATION
2	N=5364857.890 E=465227.446	PUMP STATION
3	N=5364862.304 E=465229.859	BUILDING CORNER
4	N=5364870.091 E=465235.300	BUILDING CORNER
5	N=5364877.441 E=465227.727	MANHOLE
6	N=5364862.175 E=465217.124	MANHOLE



DETAIL 1 - FM DRAIN

N.T.S.

EXISTING UNDERGROUND UTILITIES AND SURFACE FEATURES
THE SIZE AND LOCATION OF ALL UNDERGROUND UTILITIES AND SURFACE FEATURES ILLUSTRATED ON THE DRAWINGS CAN BE CONSIDERED APPROXIMATE ONLY. THE CONTRACTOR WILL BE RESPONSIBLE FOR FIELD CONFIRMING THE EXACT SIZE AND LOCATION OF ALL SURFACE FEATURES AND UNDERGROUND UTILITIES WITH THE INDIVIDUAL UTILITY COMPANIES. ANY CONFLICTS SHALL BE REPORTED TO THE ENGINEER PRIOR TO CONSTRUCTION.

Xrefs: LEGAL-EX.DWG; 307BASE.DWG; PRECAST.DWG;
Drawing: V:\120\ACTIVE\12030700\DRAWINGS\TENDER\G01.DWG
June 18, 2002 3:30 p.m.

REVISIONS

No.	DATE	DESCRIPTION	BY	APPROVED
7	05.03	RECORD DRAWING		

DRAWING STATUS

No.	DESCRIPTION	DATE	APPROVED
6	MICROFILMED		
5	PLAN OF RECORD		
4	APPROVAL FOR CONSTRUCTION		
3	FOR TENDER	06.21.02	TB
2	FOR APPROVAL	02.05.13	TB
1	PRELIMINARY	00.08.25	RAF

SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com
www.stantec.com

DESIGNED: PP / MC	DRAWN: MC
CHECKED: TB	APPROVED: RAF
SCALE: 1:100	

CLIENT: CITY OF COLWOOD

TITLE: OCEAN BLVD. PUMP STATION

SITE PLAN

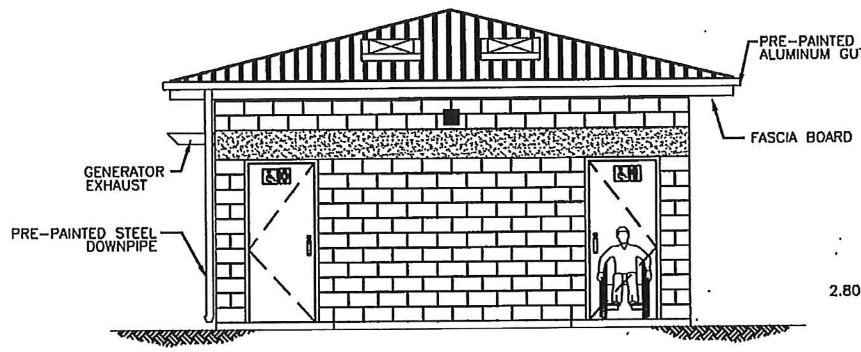
DATE: 00.08.25

SHEET:

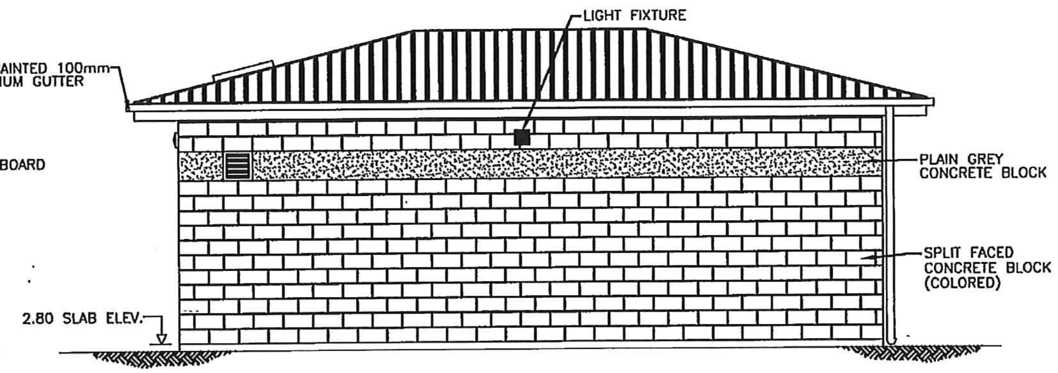
JOB No. 12030700

REVISION: 7

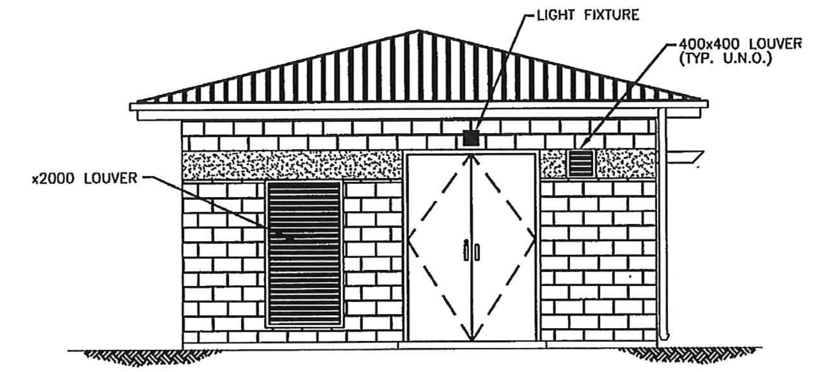
DRAWING: G01



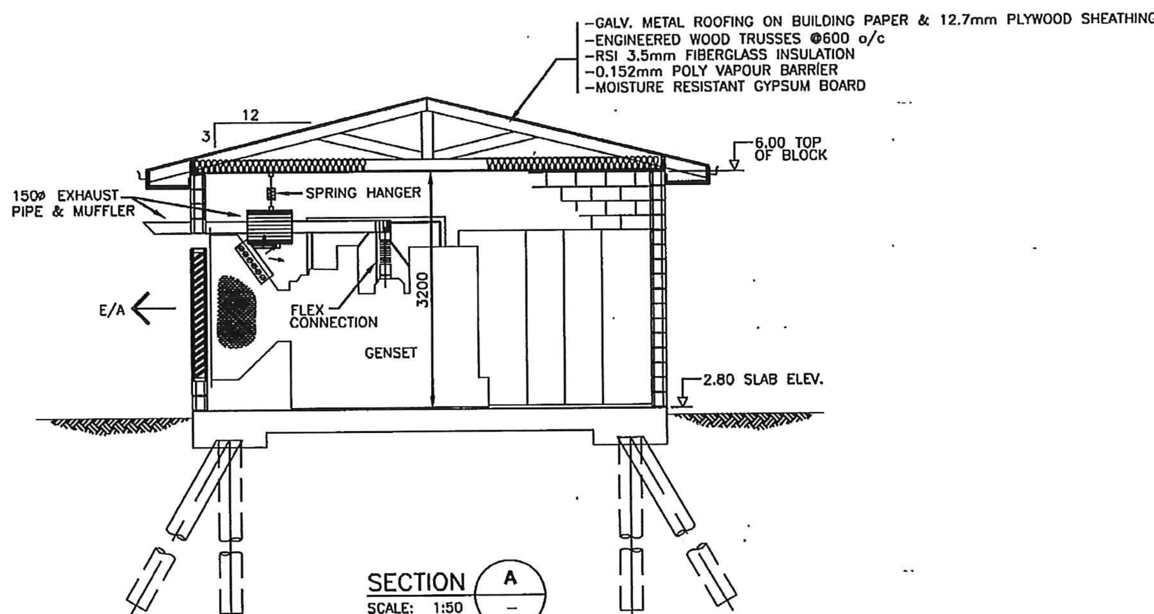
NORTH ELEVATION
SCALE: 1:50



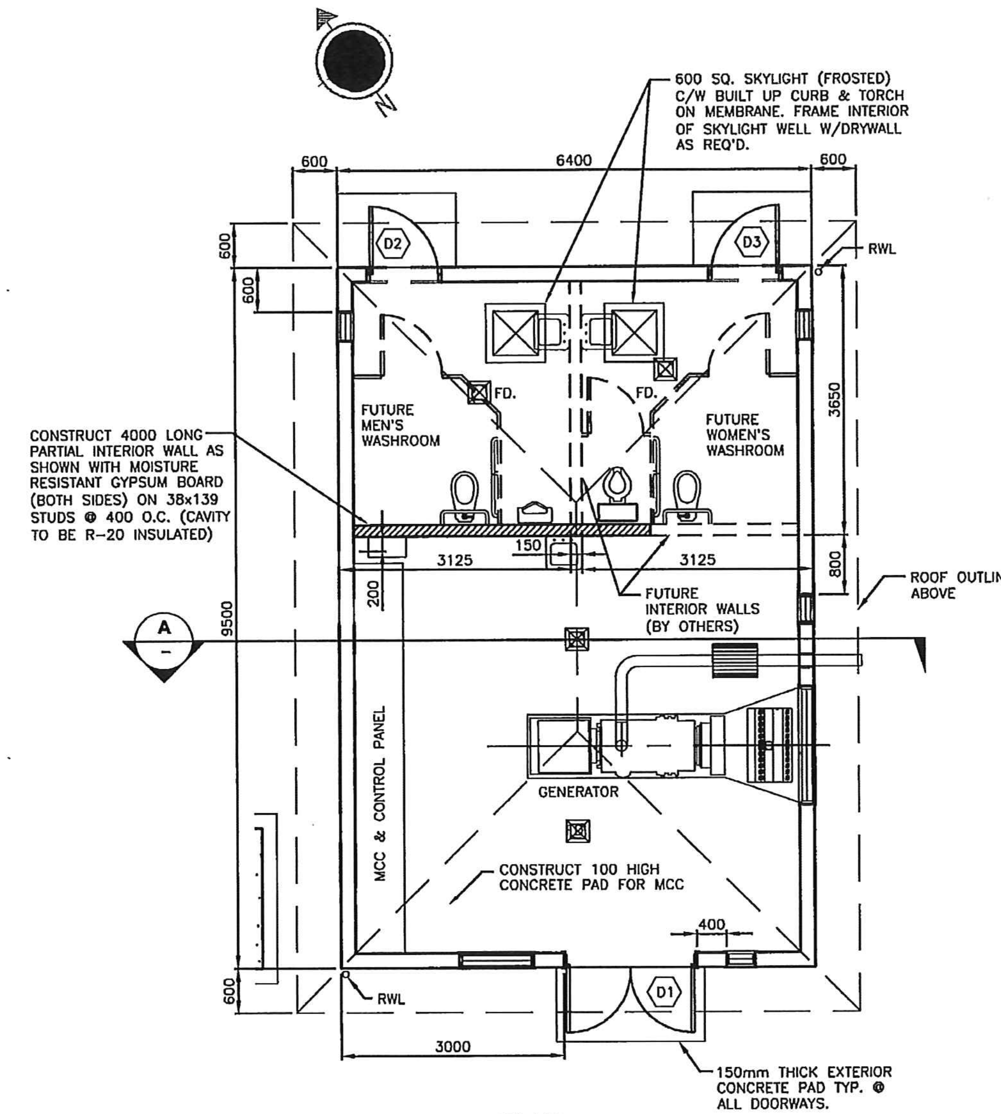
WEST ELEVATION
SCALE: 1:50



SOUTH ELEVATION
SCALE: 1:50



SECTION A
SCALE: 1:50



PLAN
SCALE: 1:50

DOOR SCHEDULE

DOOR No.	LOCATION	DOOR SIZE (W x H)	ROUGH OPENING (W x H)	REMARKS
D1	CONTROL ROOM	1700 x 2550	1800 x 2600	METAL DOUBLE DOOR
D2	MEN'S WASHROOM	900 x 2150	1000 x 2200	METAL DOOR
D3	WOMEN'S WASHROOM	900 x 2150	1000 x 2200	METAL DOOR

Xref: PRECAST.DWG; Drawing: V:\1203\ACTIVE\12030700\DRAWINGS\TENDER\A01.DWG June 18, 2002 9:23 a.m.

REVISIONS

No.	DATE	DESCRIPTION	BY	APPROVED
7	05.03	RECORD DRAWING		

DRAWING STATUS

No.	DESCRIPTION	DATE	APPROVED
6	MICROFILMED		
5	PLAN OF RECORD		
4	APPROVAL FOR CONSTRUCTION		
3	FOR TENDER	06.21.02	TB
2	FOR APPROVAL	02.05.13	TB
1	PRELIMINARY	00.08.25	RAF

SEAL:

Stantec
Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0537
email: victoria@stantec.com
www.stantec.com

DESIGNED: MC/KJS
DRAWN: AA
CHECKED: RAF
APPROVED: TB
SCALE: AS NOTED

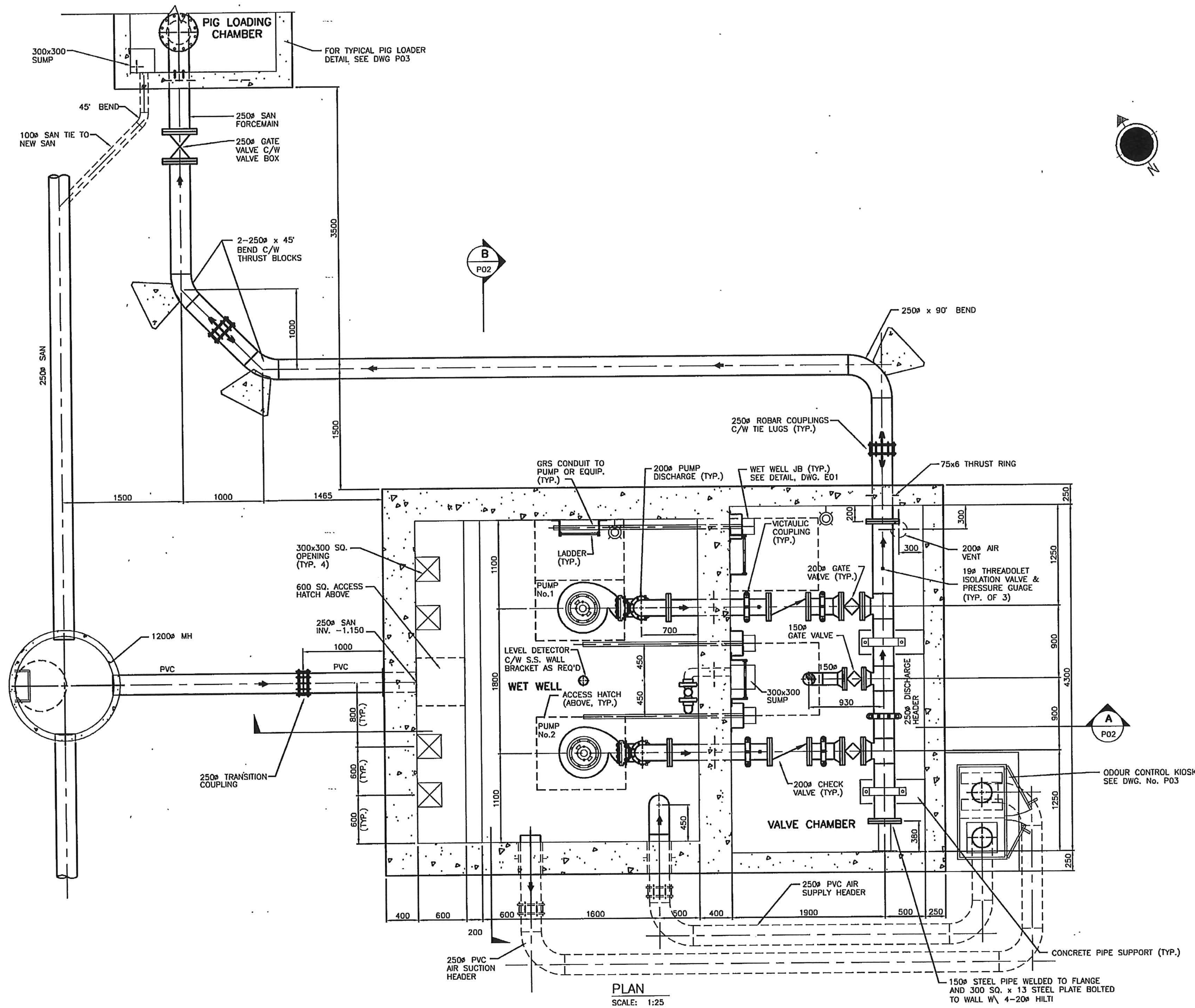
CLIENT: CITY OF COLWOOD

TITLE: OCEAN BLVD. PUMP STATION

CONTROL BUILDING PLAN & SECTIONS

DATE: 00.08.25
SHEET:
JOB No. 12030700
REVISION: 7
DRAWING: A01

AS-BUILT FOLDER NO. V-S1-09



PLAN
SCALE: 1:25

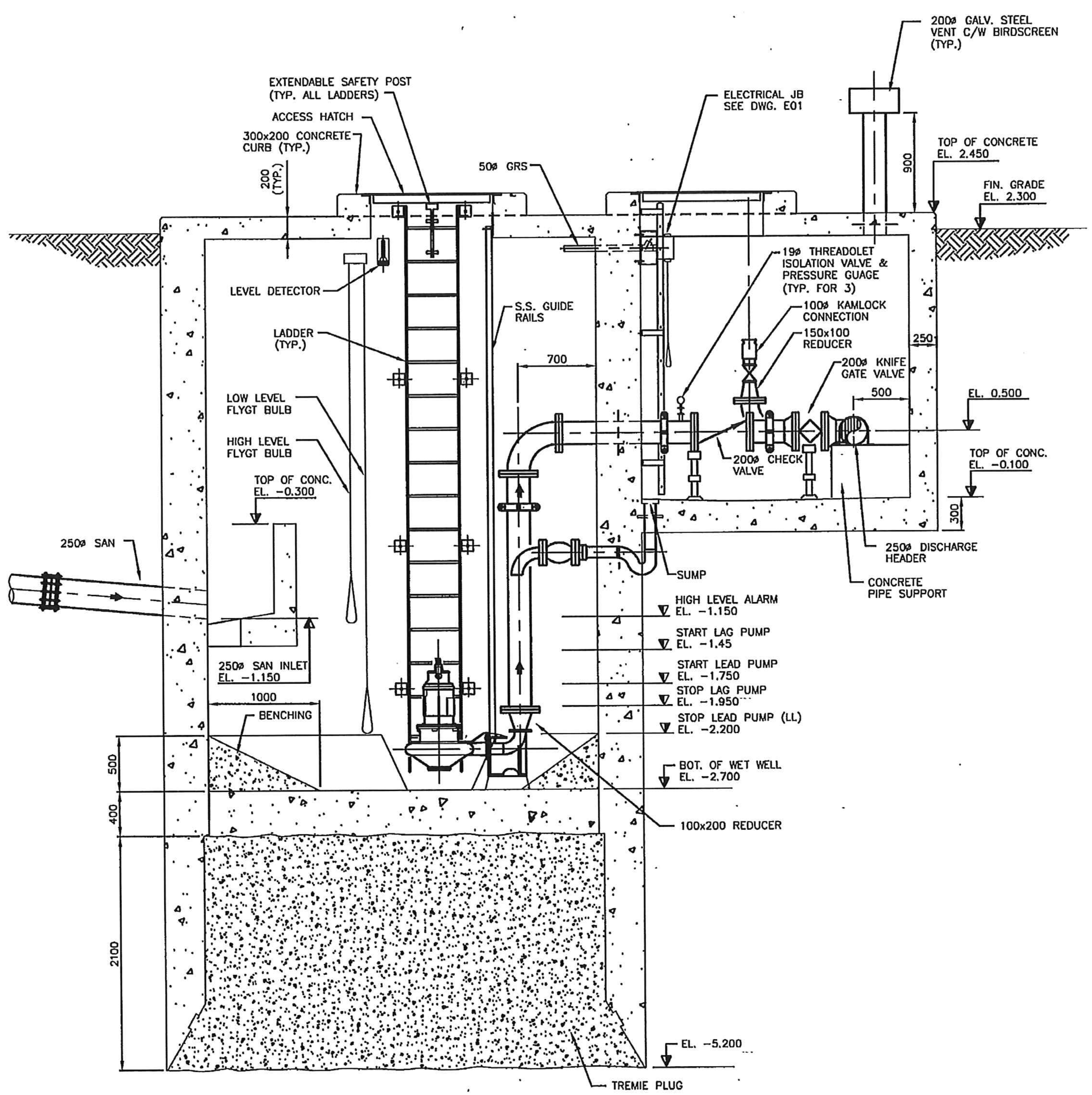
					6	MICROFILMED		
					5	PLAN OF RECORD		
					4	APPROVAL FOR CONSTRUCTION		
					3	FOR TENDER	06.21.02	TB
					2	FOR APPROVAL	02.05.13	TB
7	05.03	RECORD DRAWING			1	PRELIMINARY	00.08.25	RAF

SEAL:

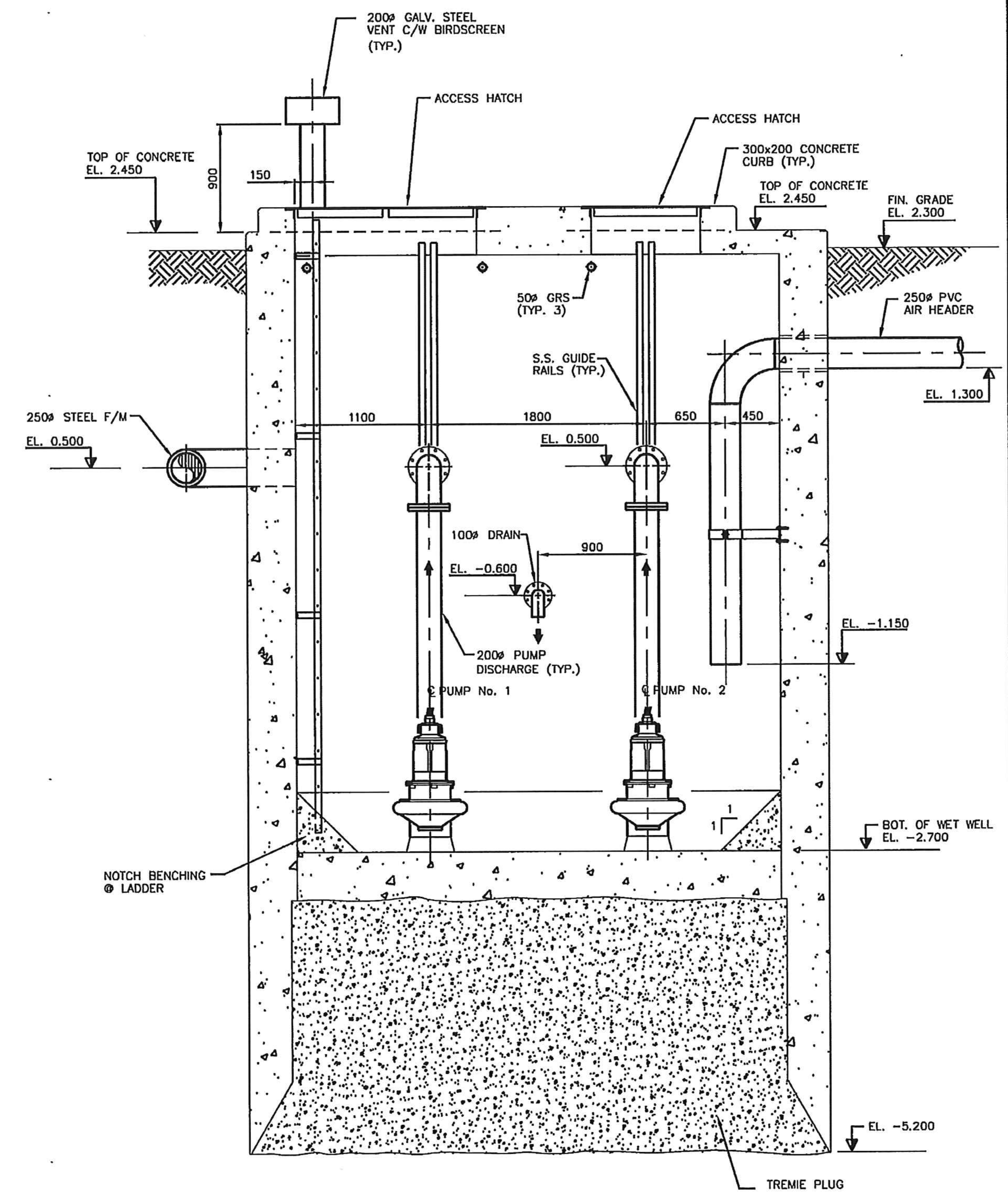
Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com

DESIGNED: PP \ MC	DRAWN: ESD	CLIENT: CITY OF COLWOOD	DATE: 00.08.25
CHECKED: RAF	APPROVED: TB	TITLE: OCEAN BLVD. PUMP STATION	JOB No. 12030700
SCALE: AS NOTED		WET WELL & VALVE CHAMBERS	REVISION: — / DRAWING: P01

PRECAST.DWG: V:\120\ACTIVE\12030700\DRAWINGS\TENDER\P01.DWG 2002 3:37 p.m.



SECTION A
SCALE: 1:25 P01



SECTION B
SCALE: 1:25 P01

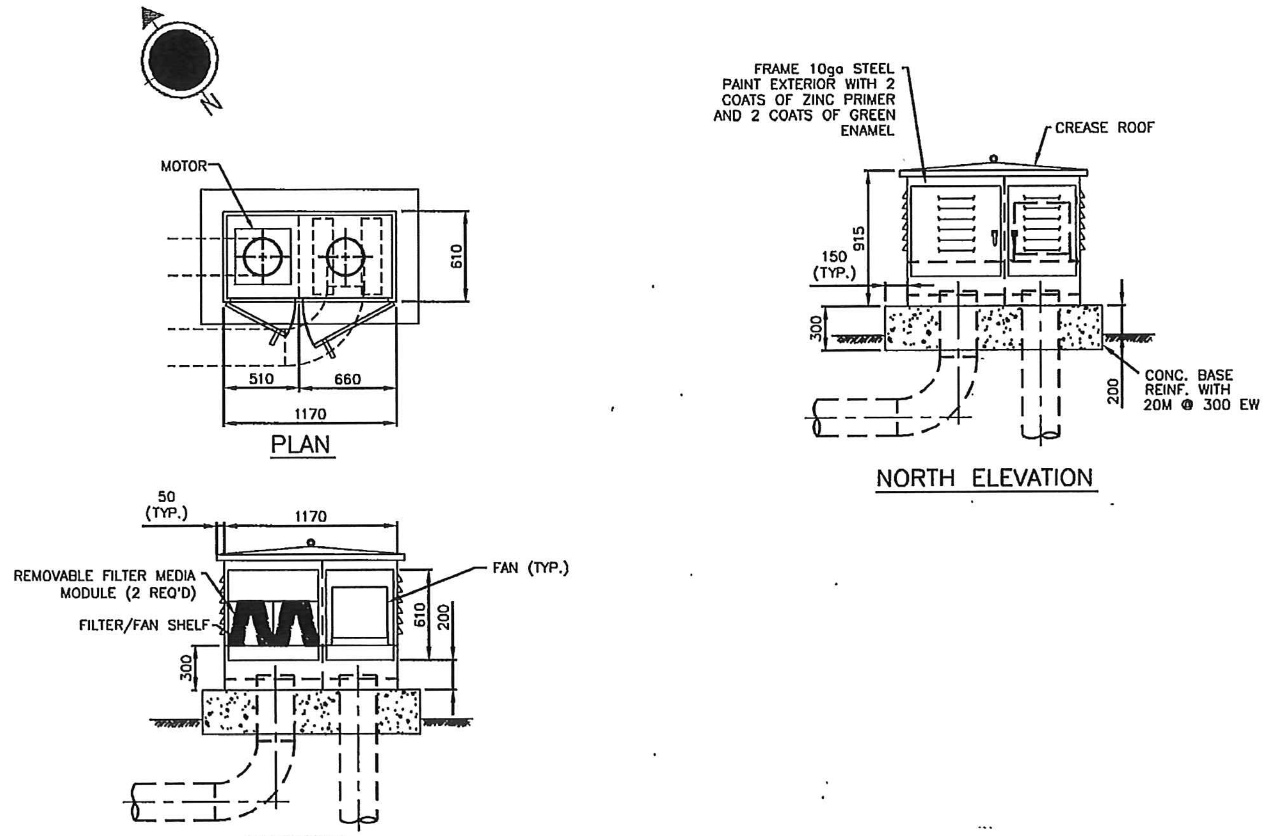
					6	MICROFILMED		
					5	PLAN OF RECORD		
					4	APPROVAL FOR CONSTRUCTION		
					3	FOR TENDER	06.21.02	TB
					2	FOR APPROVAL	02.05.13	TB
7	05.03	RECORD DRAWING			1	PRELIMINARY	00.08.25	RAF

SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com

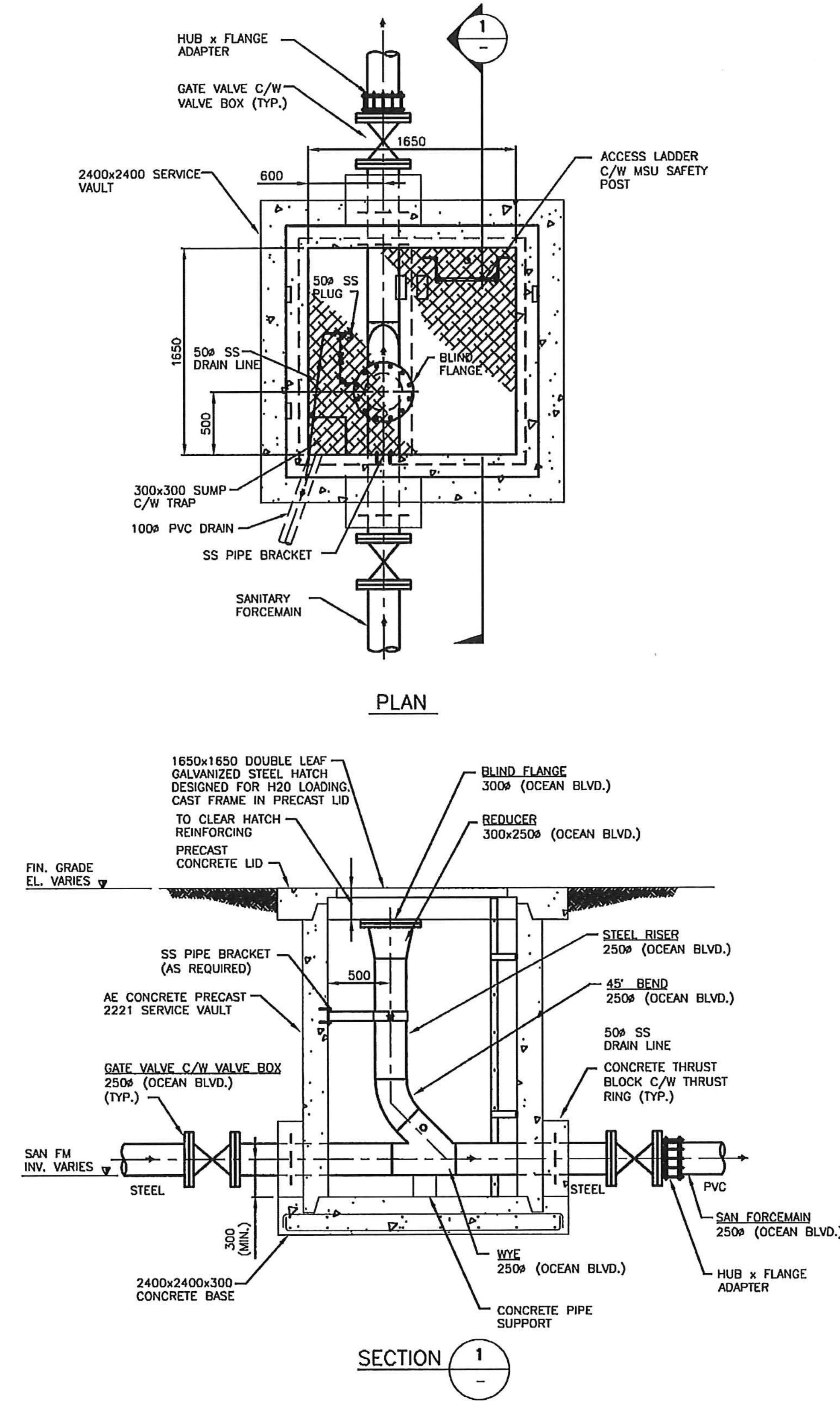
DESIGNED: PP \ MC	DRAWN: ESD	CLIENT: CITY OF COLWOOD	DATE: 00.08.25
CHECKED: RAF	APPROVED: TB	TITLE: OCEAN BLVD. PUMP STATION	JOB No. 12030700
SCALE: AS NOTED		WET WELL & VALVE CHAMBERS	REVISION: / DRAWING:

PRECAST.DWG; V:\120\ACTIVE\12030700\DRAWINGS\TENDER\P02.DWG 8, 2002 9:27 a.m.



ODOUR CONTROL/FAN KIOSK DETAILS

SCALE 1:10



TYPICAL PIG LOADING CHAMBER DETAILS

SCALE: 1:25

					6	MICROFILMED		
					5	PLAN OF RECORD		
					4	APPROVAL FOR CONSTRUCTION		
					3	FOR TENDER	06.21.02	TB
					2	FOR APPROVAL	02.05.13	TB
7	05.03	RECORD DRAWING			1	PRELIMINARY	00.08.25	RAF
No.	DATE	DESCRIPTION	BY	APPROVED	No.	DESCRIPTION	DATE	APPROVED

SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com

DESIGNED: MC/KJS	DRAWN: AA	CLIENT: CITY OF COLWOOD	DATE: 00.08.25
CHECKED: RAF	APPROVED: TB	TITLE: MISCELLANEOUS DETAILS & SECTIONS	JOB No. 12030700
SCALE: AS NOTED			REVISION: / DRAWING:

GENERAL NOTES

1. DO NOT SCALE DRAWINGS. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH RELEVANT BUILDING, PROCESS, ELECTRICAL, AND MECHANICAL DRAWINGS. IT IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR AND/OR SUBTRADES TO BRING TO THE ATTENTION OF THE ENGINEER ANY DISCREPANCIES HE MAY FIND IN DIMENSIONS AND/OR DETAILS FOR VERIFICATION PRIOR TO CONSTRUCTION. REFER TO MECHANICAL, PROCESS, AND ELECTRICAL DRAWINGS FOR LOCATION & SIZE OF ALL HOLES AND PENETRATIONS FOR PIPING, ETC. NOT SPECIFICALLY SHOWN ON THE DRAWINGS.

2. WORK TO BE CARRIED OUT IN ACCORDANCE WITH THE FOLLOWING CODES:
   BRITISH COLUMBIA BUILDING CODE 1998

3. SPECIFIED DESIGN LOADS

   WIND q_{10} = 0.48 kPa, q_{30} = 0.58 kPa — SEISMIC Za = 6.0, Zv = 5.0, v = 0.30

   ROOF LL = 4.8 kPa

   VALVE CHAMBER FLOOR: SUPERIMPOSED DL = 1.0 kPa MINIMUM, LL = 5.0 kPa

   WET WELL FLOOR: SUPERIMPOSED DL = 1.0 kPa MINIMUM, LL = 15.0 kPa

4. CONCRETE

   ALL CONCRETE TO HAVE A COMPRESSIVE STRENGTH OF 35 MPa AT 28 DAYS. MAXIMUM AGGREGATE SIZE 20mm, MINIMUM CEMENTIOUS CONTENT 335 Kg/m INCLUDING 20% FLY ASH. EXPOSURE CLASS C-1. TREMIE PLUG CONCRETE TO BE MINIMUM 25 MPa COMPRESSIVE STRENGTH. THE MIX DESIGN SHALL BE SUITABLE FOR A TREMIE POUR.

5. REINFORCING

   ALL REINFORCING TO BE GRADE 400. COVER = 75mm FOR CONCRETE CAST AGAINST EARTH, 50mm ELSEWHERE. SPLICE OR ANCHORAGE LENGTHS, UNLESS NOTED

BAR SIZE	TOP	OTHER
10M	590mm	455mm
15M	890mm	685mm
20M	1185mm	920mm
25M	1850mm	1425mm
30M	2220mm	1710mm

   TOP BARS HAVE GREATER THAN 300mm CONCRETE BELOW THE BAR.

6. STRUCTURAL STEEL & MISCELLANEOUS IRON

   ALL STEEL TO BE GRADE 300 W.
   ALL HSS SECTIONS TO BE GRADE 350 W, CLASS C.
   ALL MISCELLANEOUS IRON TO BE HOT DIPPED GALVANIZED AFTER FABRICATION.
   TOUCH UP FIELD WELDING WITH 2 COATS GALVACON (OR EQUIVALENT).
   ALL ANCHOR BOLTS/NUTS TO BE STAINLESS STEEL.

7. CAISSON CONSTRUCTION

   - THE WET WELL IS BASED ON A CAISSON TYPE CONSTRUCTION. THE VALVE CHAMBER IS DESIGNED TO BE SUPPORTED FROM THE WET WELL CAISSON WITH CONVENTIONAL CONSTRUCTION AFTER SINKING, PLACING AND CURING OF THE TREMIE PLUG.
   - GROUND SHIFTING ADJACENT TO THE CAISSON MAY OCCUR DURING SINKING OF THE CAISSON. THE CONTRACTOR'S METHOD OF CONSTRUCTION MUST ACCOUNT FOR ANY TEMPORARY MEASURES REQUIRED SUCH THAT SURROUNDING STRUCTURES AND UTILITIES DO NOT SHIFT AND ARE NOT DAMAGED DURING CONSTRUCTION.
   - DURING SINKING OF THE CAISSON AND PLACING OF THE TREMIE PLUG, THE WATER LEVEL INSIDE THE CAISSON SHALL BE MAINTAINED AT ELEVATION -1.500m OR HIGHER.
   - PRIOR TO PLACING THE TREMIE PLUG, THE CONTRACTOR SHALL PROVIDE A CERTIFIED SURVEY OF THE BOTTOM OF THE EXCAVATION TO INSURE THE EXCAVATED LEVEL IS AT ELEVATION -5.200m OR LOWER.
   - UNTIL THE TREMIE PLUG IS PLACED AND CURED TO A MINIMUM STRENGTH OF 20 MPa, THE WATER LEVEL INSIDE THE CAISSON MUST REMAIN AT ELEVATION -1.500m OR HIGHER.
   - WALL THICKNESS SHOWN IS MINIMUM THICKNESS REQUIRED. THICKER WALLS MAY BE USED TO SUIT THE CONTRACTOR'S METHOD OF CONSTRUCTION IF REQUIRED.
   - CONTRACTOR MAY PROVIDE 25ø AIR/ WATER PIPES IN WALLS AS SHOWN ON S02 TO ASSIST IN SINKING OF CAISSON. PIPES ARE OPTIONAL.

8. MASONRY CONSTRUCTION

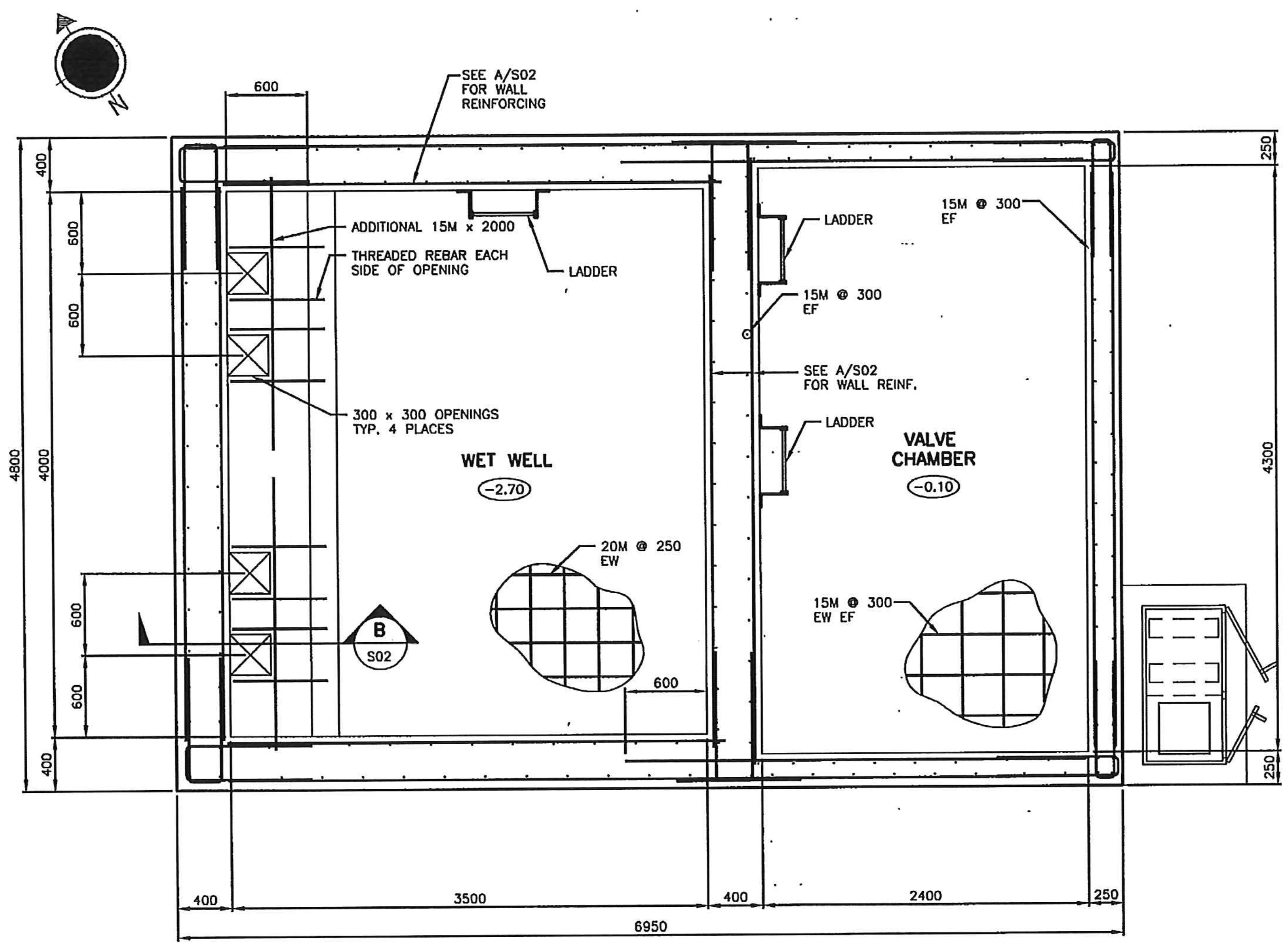
   - ALL MASONRY WORK SHALL CONFORM TO CSA CAN3-S304.1, CAN3-A371 AND TO DETAILS SHOWN. MASONRY BLOCK UNITS SHALL CONFORM TO CSA CAN3-A165
   - MASONRY BLOCK UNITS SHALL CONFORM TO CSA CAN3-A165 SERIES 94 CLASSIFICATION H/15/C/M WITH A MINIMUM STRENGTH OF 15 MPa.
   - PROVIDE LINTELS OVER ALL OPENINGS AND RECESSES IN MASONRY WALLS. FOR A MAX CLEAR SPAN OF 1200MM, USE 2-15M WITH 200 DP. BOND BEAM, FOR MAX CLEAR SPAN OF 2400, USE 2-15M WITH 400 DP. BOND BEAM.
   - MORTAR SHALL CONFORM TO CSA A179 AND BE TYPE 'S'.
   - HORZ. JOINT REINFORCING - 3.8mm TRUSS TYPE WIRE REINFORCING @ 200 o/c.

9. TIMBER CONSTRUCTION

   - PREFABRICATED TRUSSES TO PROFILES, DIMENSIONS & LOADS SHOWN ON THE DWGS. SUPPLIER TO DESIGN TRUSSES IN ACCORDANCE WITH BCBC PART 4 & CSA 086-M. SUBMIT SHOP DRAWINGS SEALED BY A P.ENG REGISTERED IN BC.
   - ALL TIMBER TO BE SPF NO.1 OR NO.2, KILN DRIED.
   - ROOF SHEATING TO BE SPRUCE PLYWOOD, SHEATING GRADE w/CLIPS.

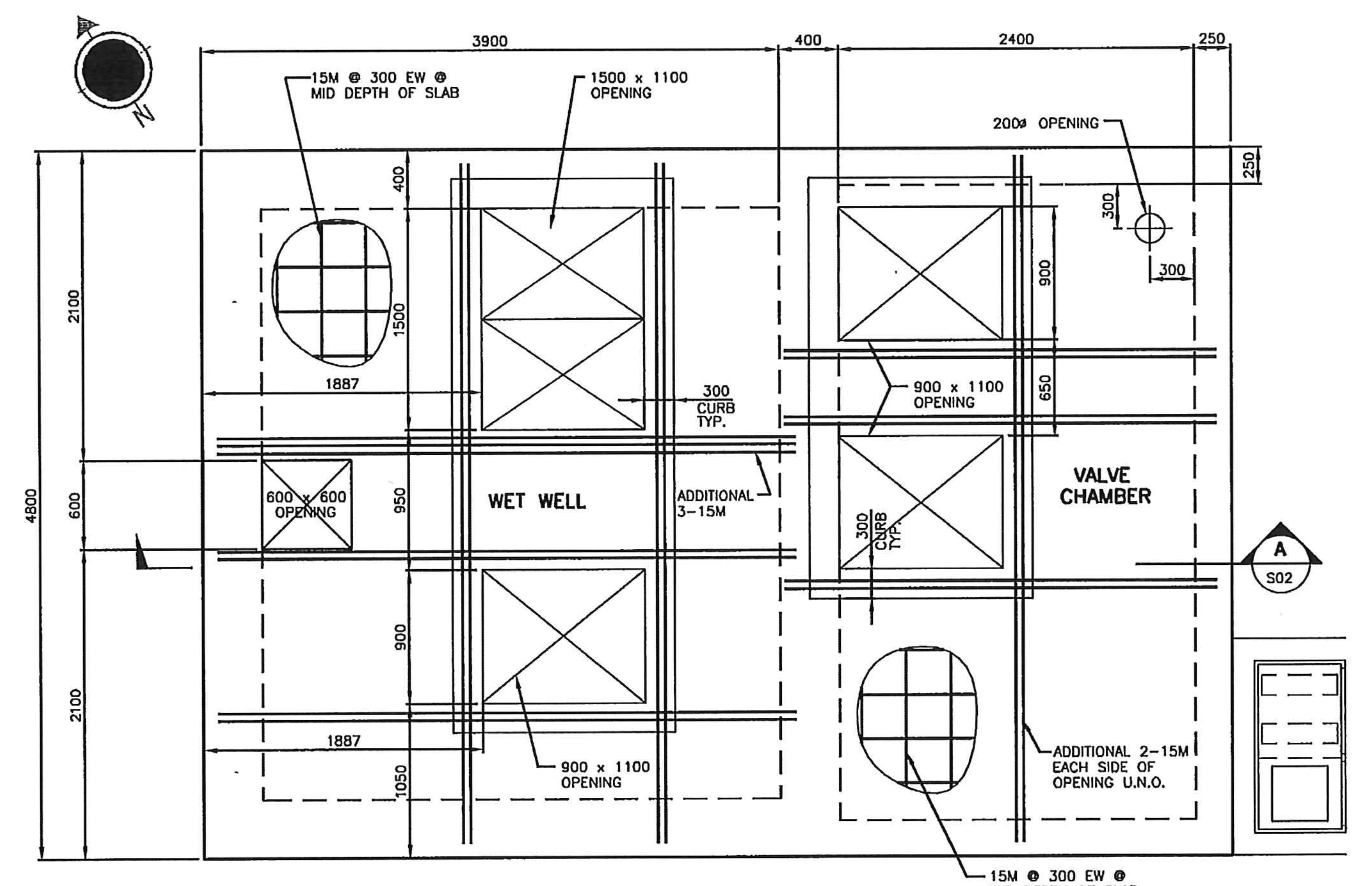
10. FOUNDATION CONSTRUCTION

   - ALL FOUNDATION CONSTRUCTION TO BE IN ACCORDANCE WITH THE RECOMMENDATIONS GIVEN IN THE GEOTECHNICAL REPORT PREPARED BY THURBER ENGINEERING, 9/20/2000
   - DRIVEN STEEL PIPE PILES SHALL CONFORM TO CSA A252 SEAMLESS STEEL PIPE, GRADE 2, CLOSED END & CONC. FILLED
   - PIPE PILES ARE TO BE DRIVEN TO REFUSAL (MINIMUM 1000mm INTO DENSE TILL LAYER FOR 500 KN WORKING LOAD CAPACITY)



PLAN @ ELEV. 0.50

SCALE: 1:25



PLAN @ ELEV. 2.25

SCALE: 1:25

					6	MICROFILMED		
					5	PLAN OF RECORD		
					4	APPROVAL FOR CONSTRUCTION		
					3	FOR TENDER	06.21.02	TB
					2	FOR APPROVAL	02.05.13	TB
7	05.03	RECORD DRAWING			1	PRELIMINARY	00.08.25	RAF

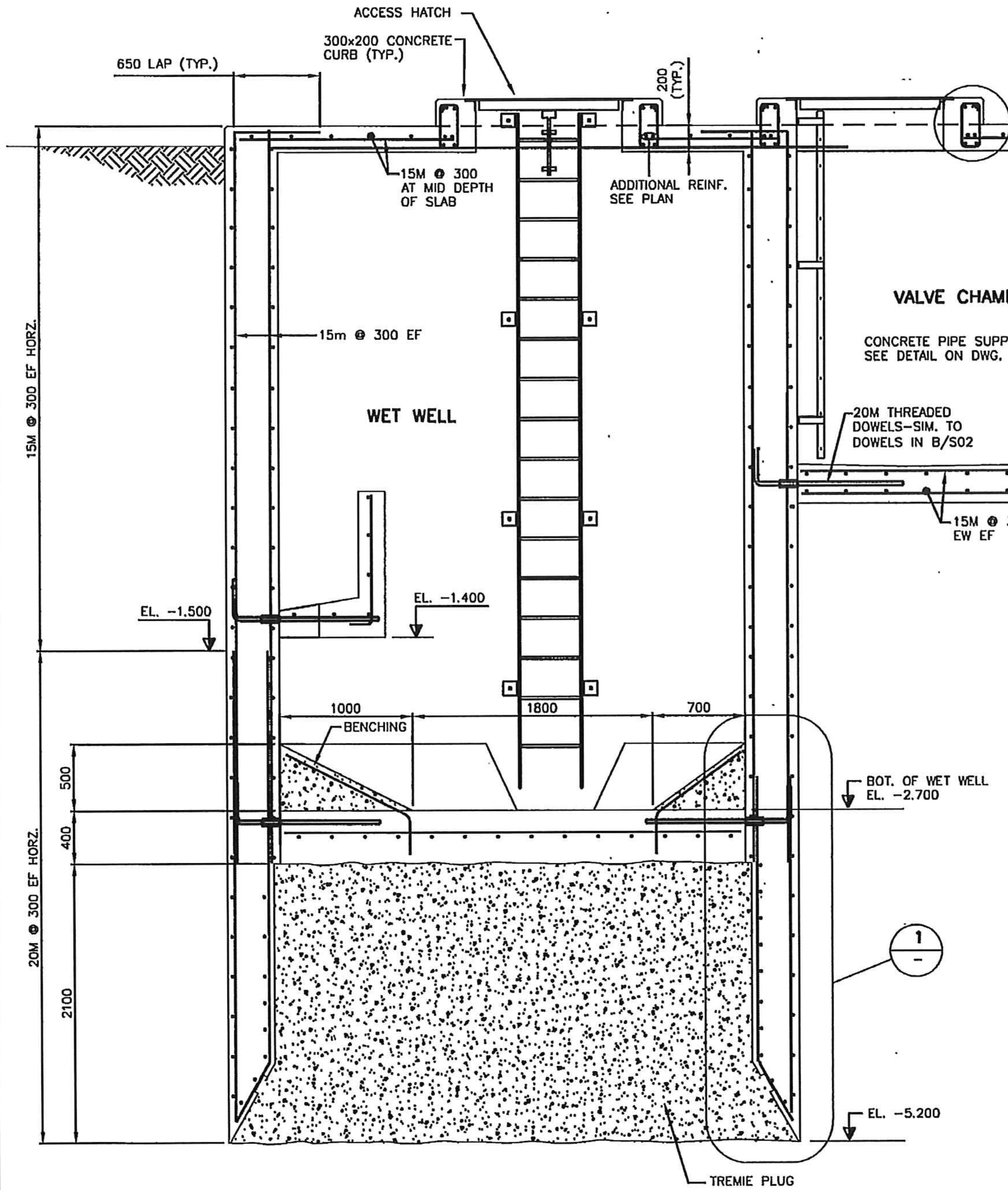
SEAL:

Stantec Consulting Ltd.
1007 - 7445 - 132 Street
Surrey BC Canada V3W IJ8
Tel: (604) 597-0422
Fax: (604) 591-1856
email: surrey@stantec.com

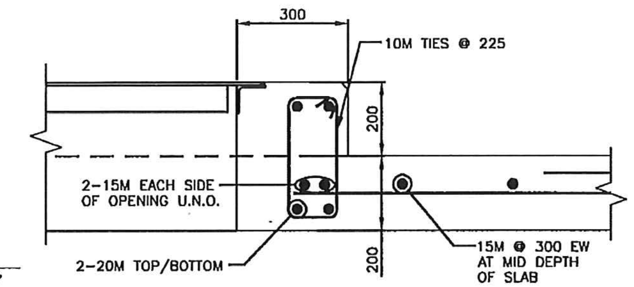
DESIGNED: KJS	DRAWN: aa	CLIENT: CITY OF COLWOOD	DATE: 00.08.25
CHECKED: RAF	APPROVED: TB	TITLE: OCEAN BLVD. PUMP STATION	JOB No. 12030700
SCALE: AS NOTED		WET WELL & VALVE CHAMBERS	REVISION: / DRAWING:

SHEET:

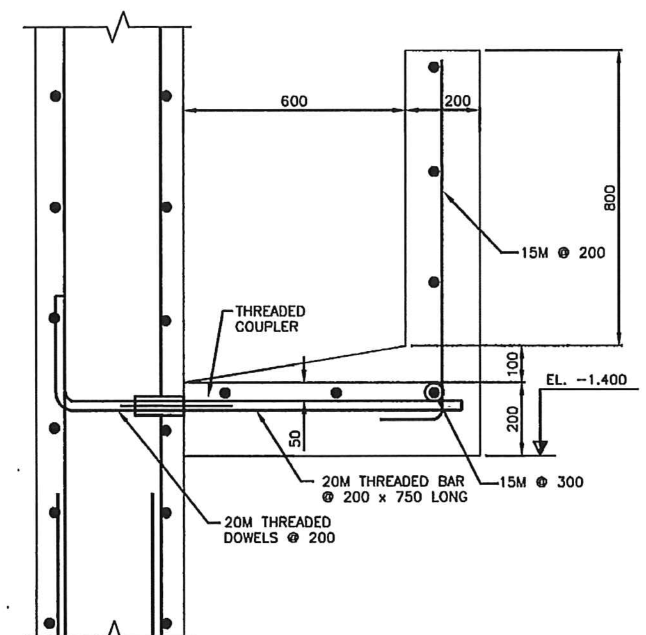
PRECAST.DWG: V:\1203\ACTIVE\12030700\DRAWINGS\TENDER\S01.DWG 8, 2002 9:31 a.m.



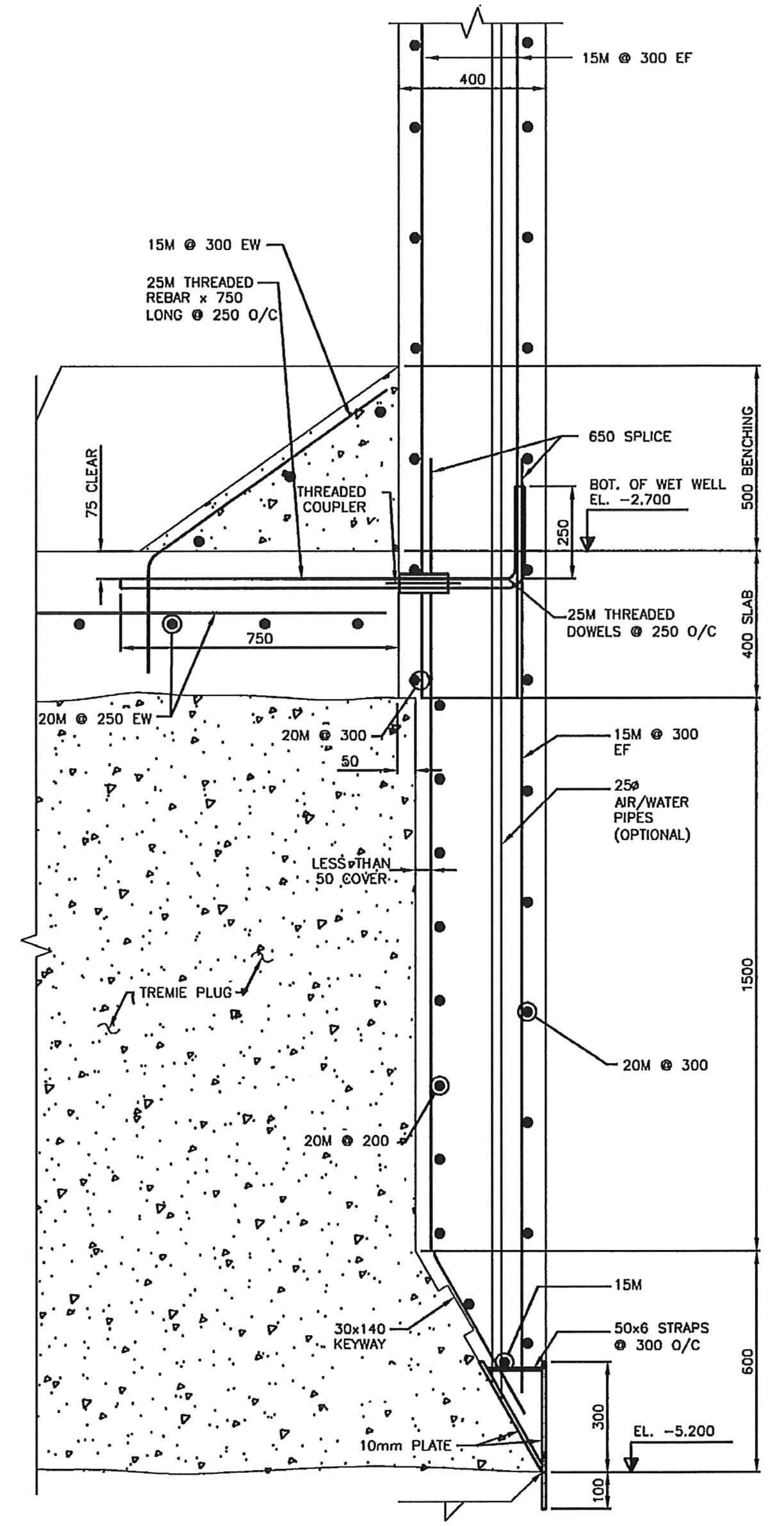
SECTION A
SCALE: 1:25 S01



TYPICAL CURB REINF. 2
SCALE: 1:10



SECTION B
SCALE: 1:10 S01



DETAIL 1
SCALE: 1:10

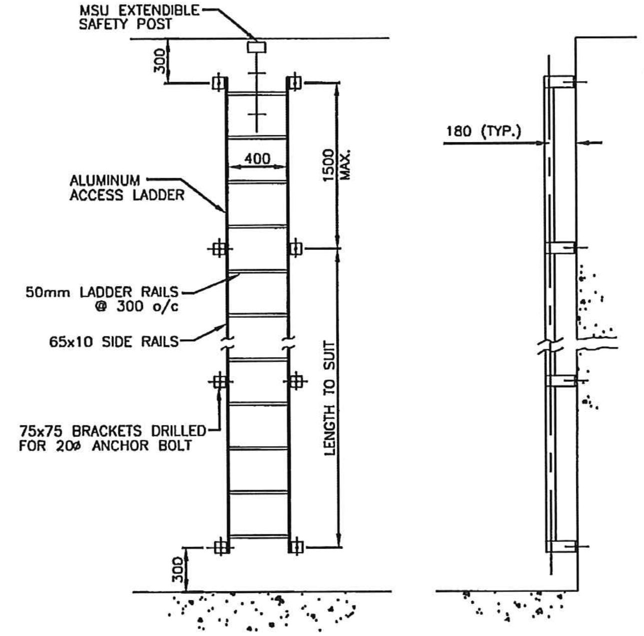
					6	MICROFILMED		
					5	PLAN OF RECORD		
					4	APPROVAL FOR CONSTRUCTION		
					3	FOR TENDER	06.21.02	TB
					2	FOR APPROVAL	02.05.13	TB
7	05.03	RECORD DRAWING			1	PRELIMINARY	00.08.25	RAF

SEAL:

Stantec Consulting Ltd.
1007 - 7445 - 132 Street
Surrey BC Canada V3W 1J8
Tel: (604) 597-0422
Fax: (604) 591-1856
email: surrey@stantec.com

DESIGNED: KJS	DRAWN: AA	CLIENT: CITY OF COLWOOD		DATE: 00.08.25	SHEET:
CHECKED: RAF	APPROVED: TB	TITLE: OCEAN BLVD. PUMP STATION		JOB No. 12030700	
SCALE: AS NOTED		WET WELL & VALVE CHAMBERS		REVISION:	DRAWING:

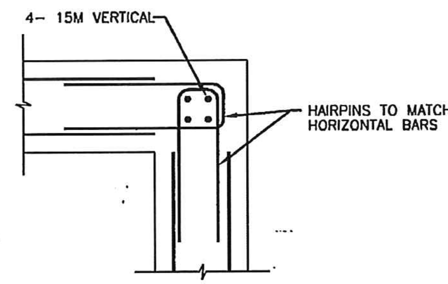
PRECAST.DWG; V:\1203\ACTIVE\12030700\DRAWINGS\TENDER\S02.DWG



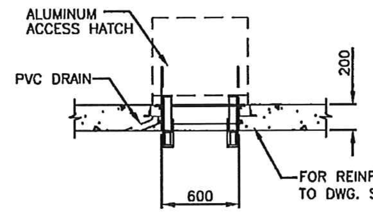
ELEVATION

SECTION

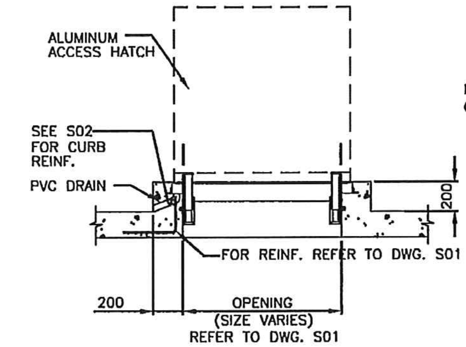
TYPICAL LADDER DETAIL
SCALE: NTS



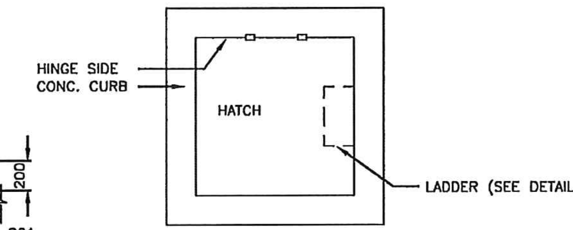
TYPICAL CORNER REINFORCING
SCALE: NTS



600x600 HATCH OPENING
SCALE: N.T.S.

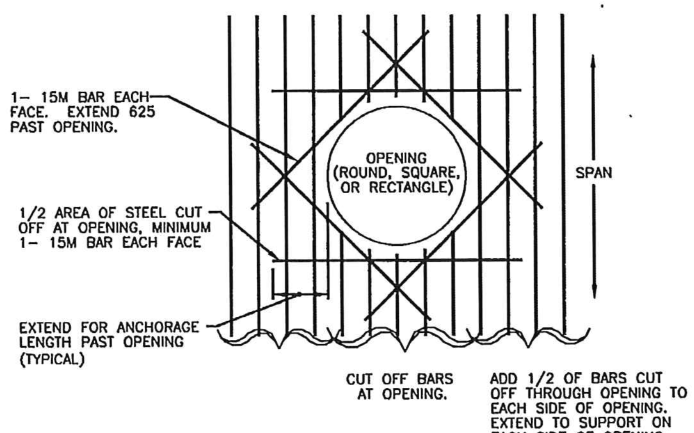


SECTION
SCALE: 1:25



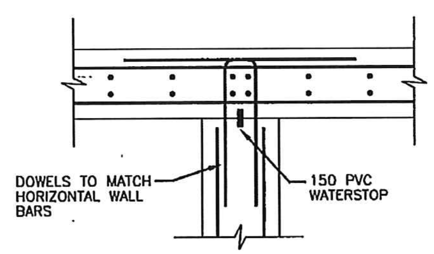
PLAN
SCALE: 1:25

ROOF ACCESS HATCH DETAIL
SCALE: AS SHOWN

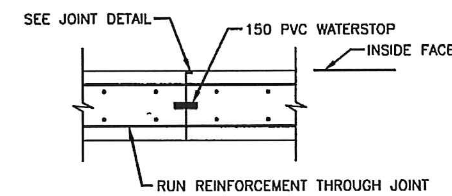


REINFORCEMENT OF OPENINGS IN WALLS & SLABS

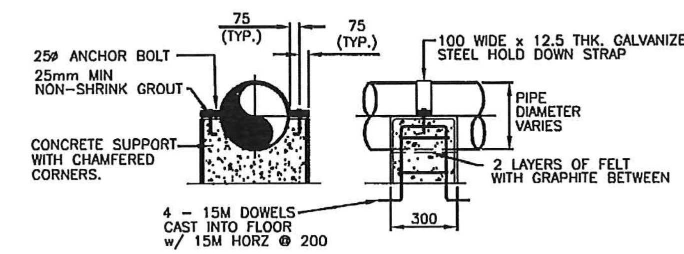
NOTE: NO ADDITIONAL REINFORCING REQUIRED FOR OPENINGS 150mm OR LESS.



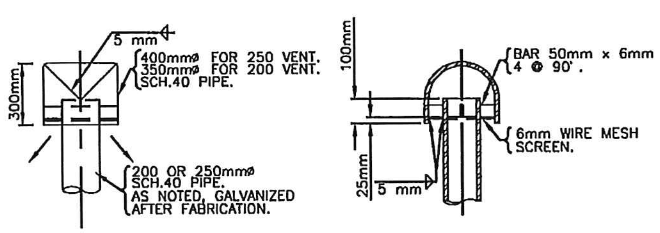
TYPICAL WALL INTERSECTION REINFORCING
SCALE: NTS



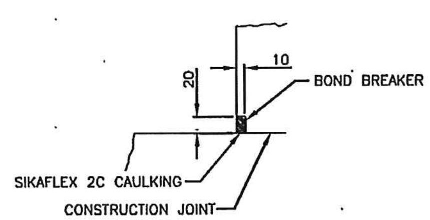
TYPICAL CONSTRUCTION/ CONTROL JOINT THROUGH WALLS & SLABS
SCALE: NTS



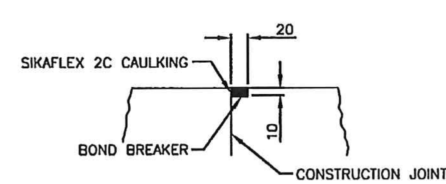
CONCRETE PIPE SUPPORT DETAIL
SCALE: NTS



AIR VENT DETAILS
N.T.S.



AT CORNERS



FLAT SURFACES

JOINT DETAIL AT SURFACES WHICH ARE IN CONTACT WITH LIQUIDS
SCALE: NTS

					6	MICROFILMED		
					5	PLAN OF RECORD		
					4	APPROVAL FOR CONSTRUCTION		
					3	FOR TENDER	06.21.02	TB
					2	FOR APPROVAL	02.05.13	TB
7	05.03	RECORD DRAWING			1	PRELIMINARY	00.08.25	RAF

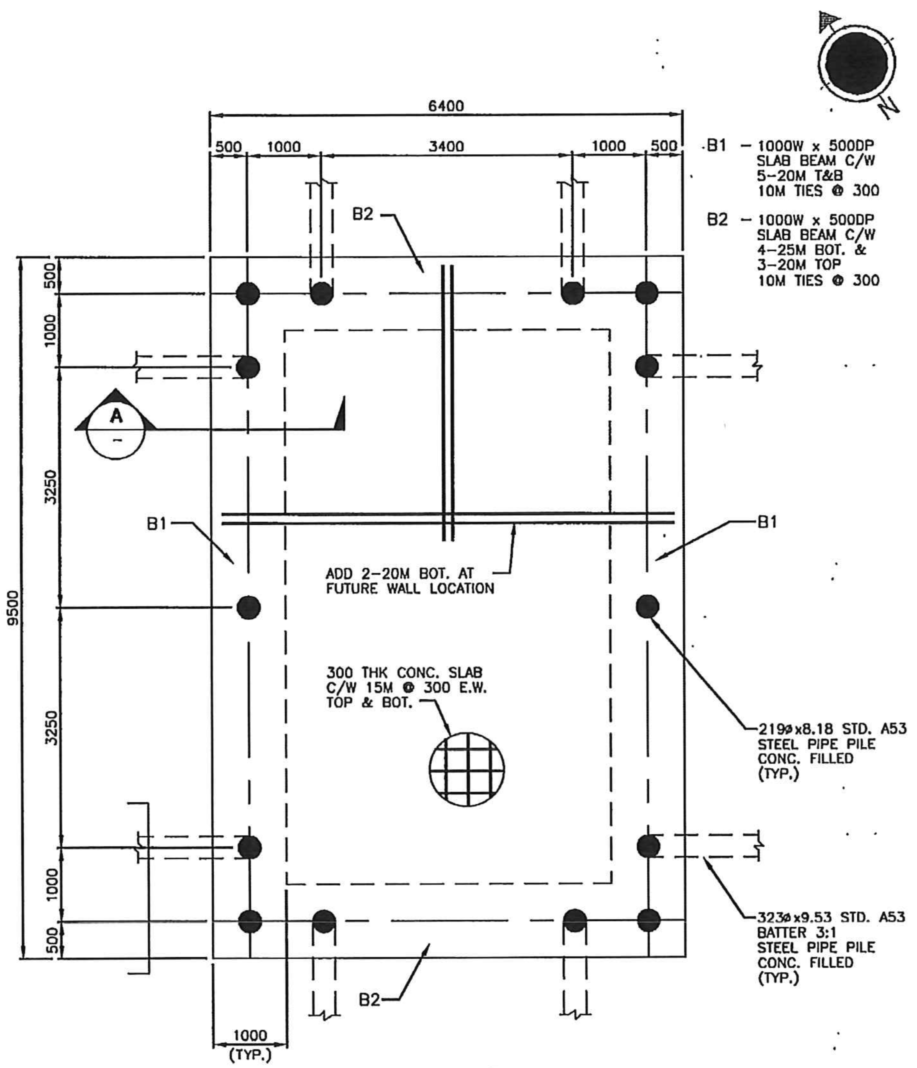
SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com

DESIGNED: KJS	DRAWN: AA	CLIENT: CITY OF COLWOOD	DATE: 00.08.25
CHECKED: RAF	APPROVED: TB	TITLE: OCEAN BLVD. PUMP STATION	JOB No. 12030700
SCALE: AS NOTED		MISCELLANEOUS DETAILS	REVISION: / DRAWING:

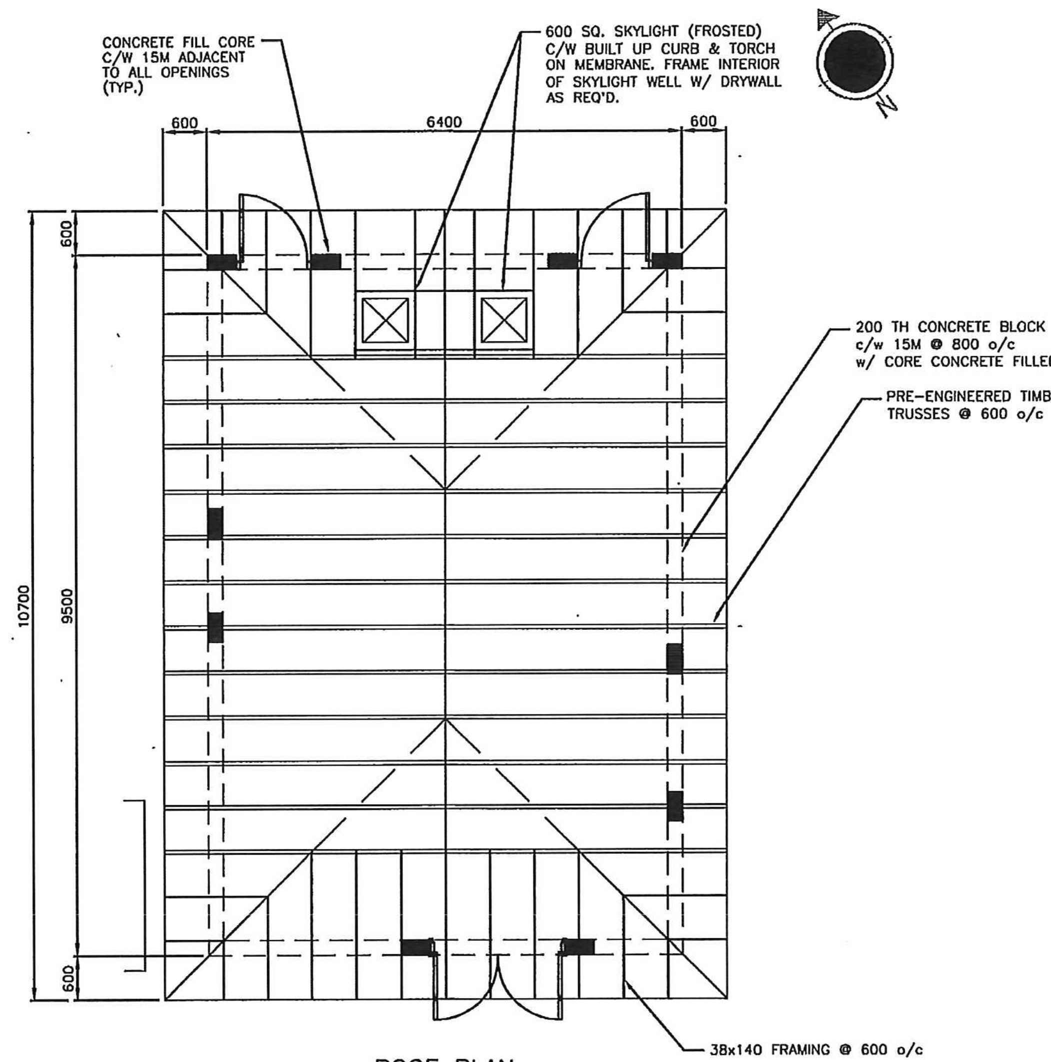
SHEET:

Drawing: V:\120\ACTIVE\12030700\DRAWINGS\TENDER\S03.DWG June 18, 2002 9:33 a.m.



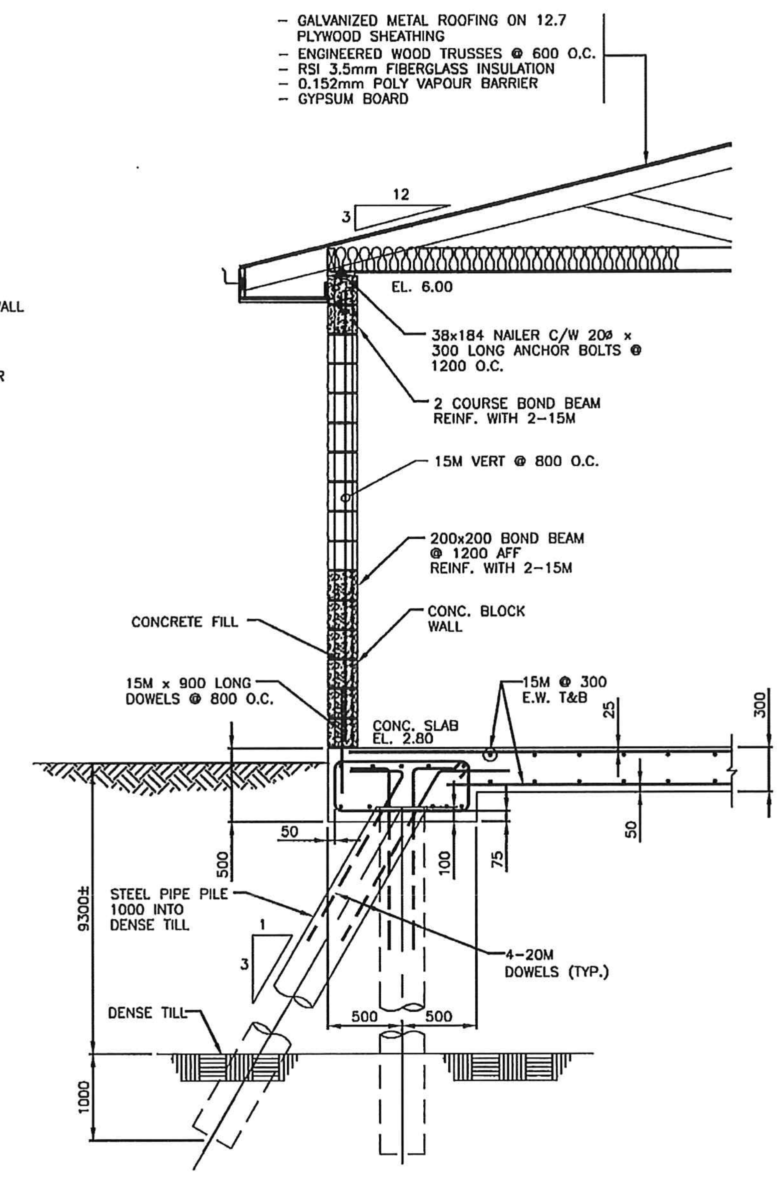
FOUNDATION PLAN

SCALE: 1:50



ROOF PLAN

SCALE: 1:50



SECTION A

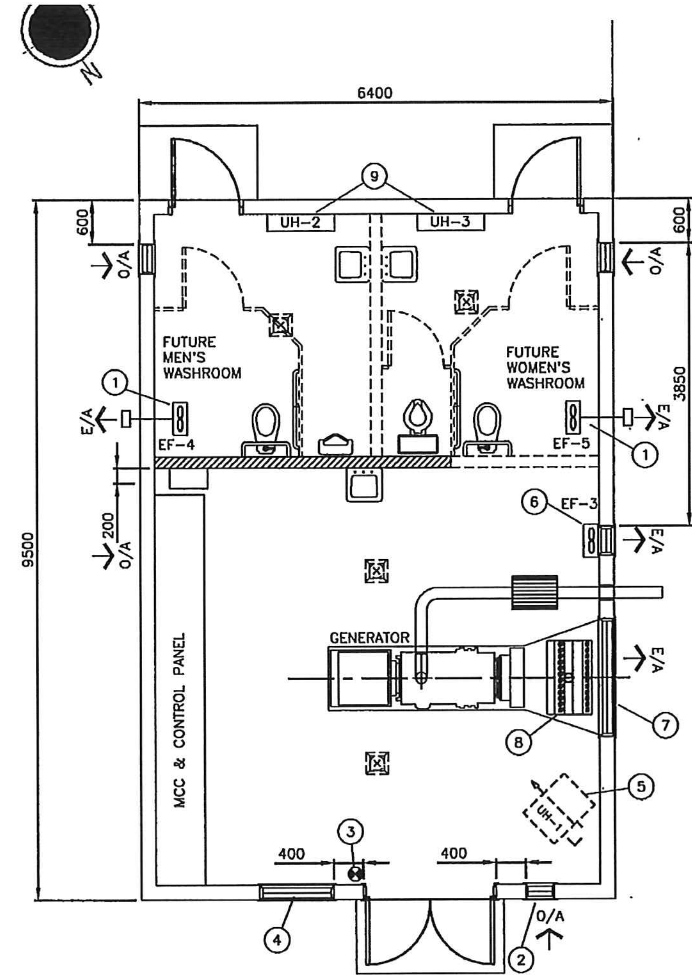
SCALE: 1:25

					No.	DESCRIPTION	DATE	APPROVED
					6	MICROFILMED		
					5	PLAN OF RECORD		
					4	APPROVAL FOR CONSTRUCTION		
					3	FOR TENDER	06.21.02	TB
					2	FOR APPROVAL	02.05.13	TB
7	05.03	RECORD DRAWING			1	PRELIMINARY	00.08.25	RAF
No.	DATE	DESCRIPTION	BY	APPROVED				

SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com

DESIGNED: RC	DRAWN: TJ	CLIENT: CITY OF COLWOOD	DATE: 00.08.25
CHECKED: RC	APPROVED: KJS	TITLE: OCEAN BLVD. PUMP STATION	JOB No. 120307000
SCALE: AS NOTED		CONTROL BUILDING	REVISION: / DRAWING: / SHEET:



HVAC PLAN

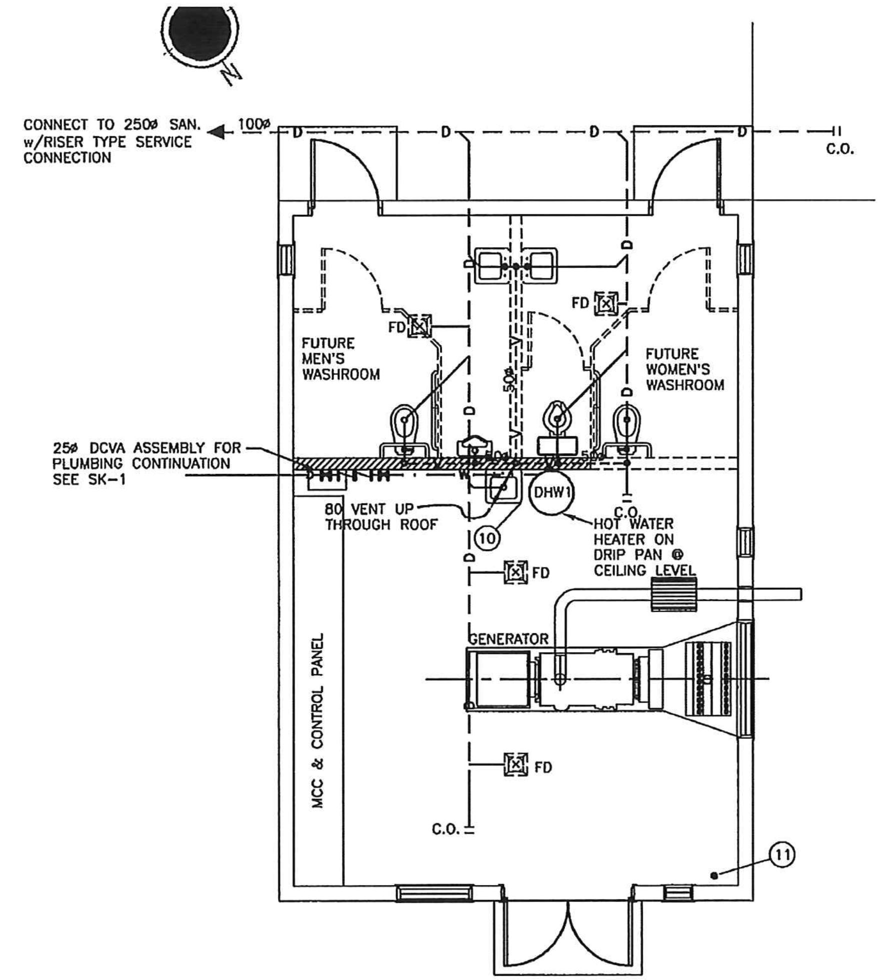
SCALE: 1:50

NOTE:

ALL ELECTRICAL/CONTROL WIRING/CONDUITS/BOXES TO BE CONCEALED IN BLOCK WALLS. NO SURFACE MOUNTING.

KEY NOTES

1. CEILING MOUNTED EXHAUST FAN c/w DUCTING AND GRILL AT SOFFIT (2 REQ'D).
2. 400 SQ. INTAKE LOUVRE c/w MANUAL BACKDRAFT DAMPER MOUNT AT 2200 A.F.F.
3. FIRE EXTINGUISHER
4. 1000W x 2000H GENERATOR INTAKE LOUVRE (SPLIT INTO 2 SECTIONS 400 C/A, 1600 O/A) c/w MOTORIZED DAMPER. MOUNT AT 400 A.F.F.
5. UNIT HEATER (SUSPENDED FROM CEILING).
6. BUILDING EXHAUST FAN c/w 400 SQ. LOUVRE AND MANUAL DAMPER MOUNT AT 2200 A.F.F.
7. 1600W x 2000H GENERATOR EXHAUST LOUVRE, c/w MOTORIZED DAMPER MOUNT AT 400 A.F.F.
8. 1000 x 600 MOTORIZED GENERATOR RETURN AIR DAMPER.
9. WALL MOUNTED UNIT HEATER
10. WORK SINK WALL MOUNTED (PIPING TO BE CONCEALED IN BLOCK/CEILING).
11. 25ø HOSE BIB C/W 15m RUBBER HOSE, ADJUSTABLE NOZZLE & HOSE RACK.



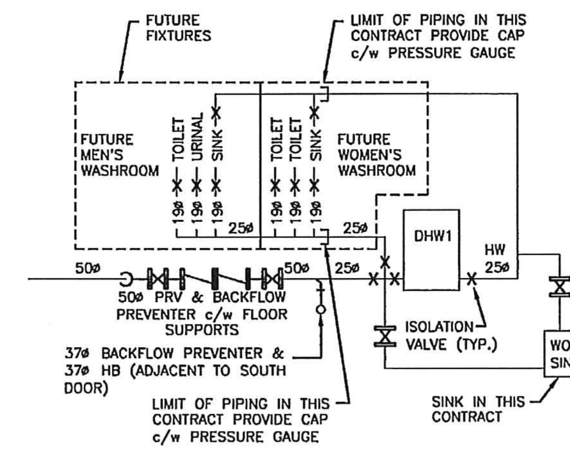
PLUMBING PLAN

SCALE: 1:50

TO VALVE CHAMBER TRAP PRIMER

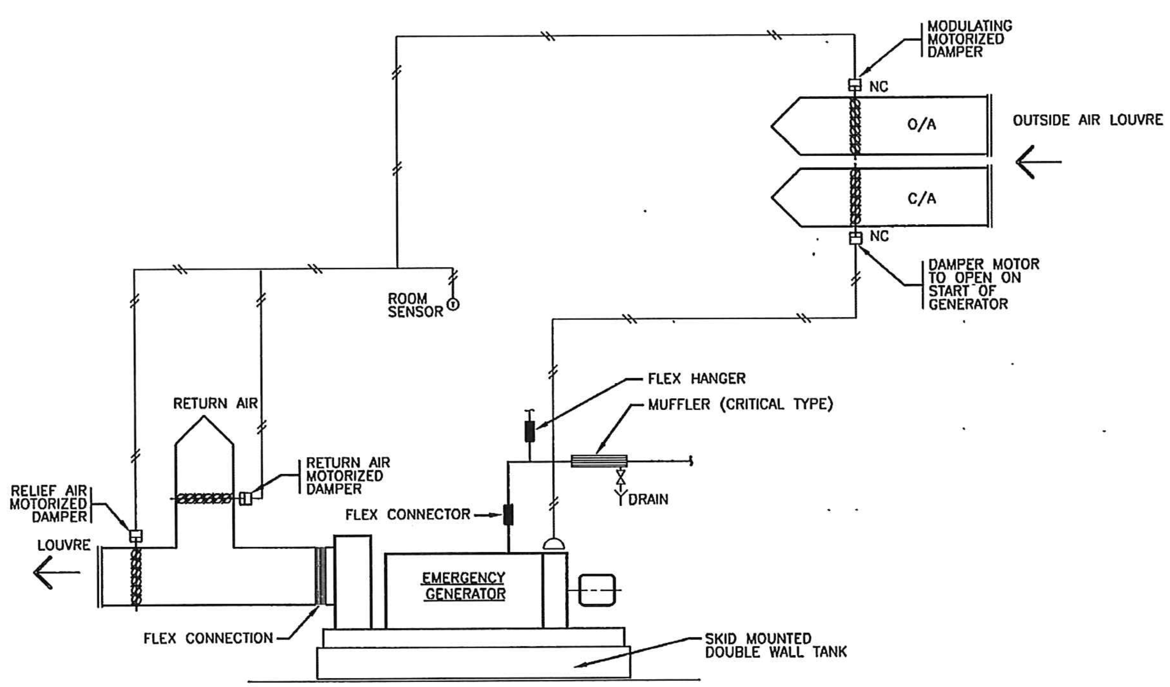
NOTE:

ROUGH-IN ALL PLUMBING FIXTURES AS REQ'D. PROVIDE BLOCKOUT & COVER AT ALL TOILETS, URINAL & SINK CONNECTIONS. ALL FLOOR DRAINS TO HAVE TRAP PRIMERS.



SK-1 DETAIL

N.T.S.



EMERGENCY GENERATOR MECHANICAL SCHEMATIC

N.T.S.

REVISIONS

No.	DATE	DESCRIPTION	BY	APPROVED
7	05.03	RECORD DRAWING		

DRAWING STATUS

No.	DESCRIPTION	DATE	APPROVED
6	MICROFILMED		
5	PLAN OF RECORD		
4	APPROVAL FOR CONSTRUCTION		
3	FOR TENDER	06.21.02	TB
2	FOR APPROVAL	02.05.13	TB
1	PRELIMINARY	00.08.25	RAF

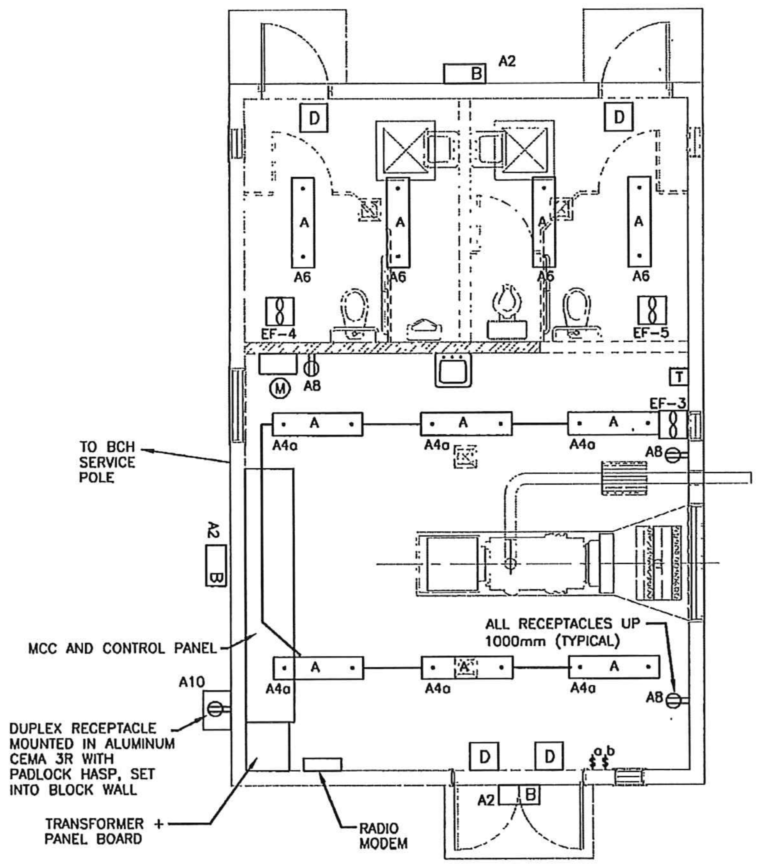
SEAL:

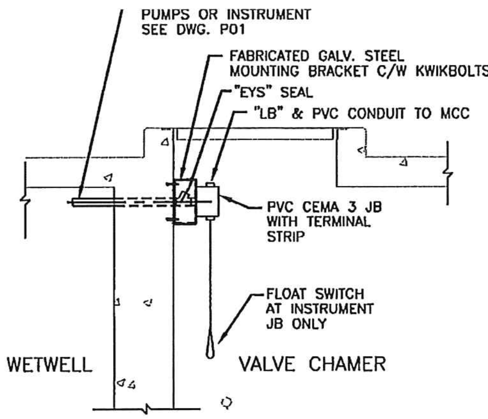
Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com
www.stantec.com

DESIGNED: MC/KJS	DRAWN: AA	CLIENT: CITY OF COLWOOD	DATE: 00.08.25
CHECKED: RAF	APPROVED: TB	TITLE: OCEAN BLVD. PUMP STATION	JOB No. 12030700
SCALE: AS NOTED		PLAN & SECTIONS	REVISION: 7 / DRAWING: M01 / SHEET:

Xrefs: PRECAST.DWG; Drawing: V:\1201\ACTIVE\12030700\DRAWINGS\TENDER\M01.DWG June 18, 2002 4:51 p.m.

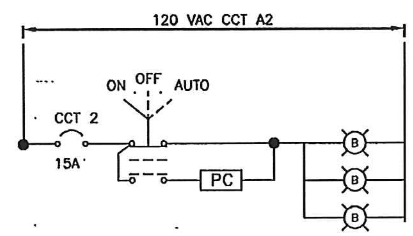
AS-BUILT FOLDER NO. V-S1-09





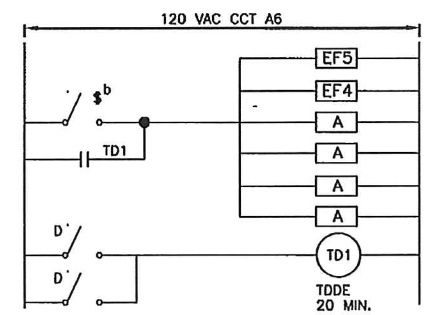
JUNCTION BOX DETAIL

SCALE: 1:25



OUTSIDE LIGHT CONTROL

N.T.S.



WASHROOM LIGHT CONTROL

N.T.S.

CABLE SCHEDULE IS PROVIDED FOR ASSISTANCE & DOES NOT SHOW ALL CONDUCTORS OR CONDUITS. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION.

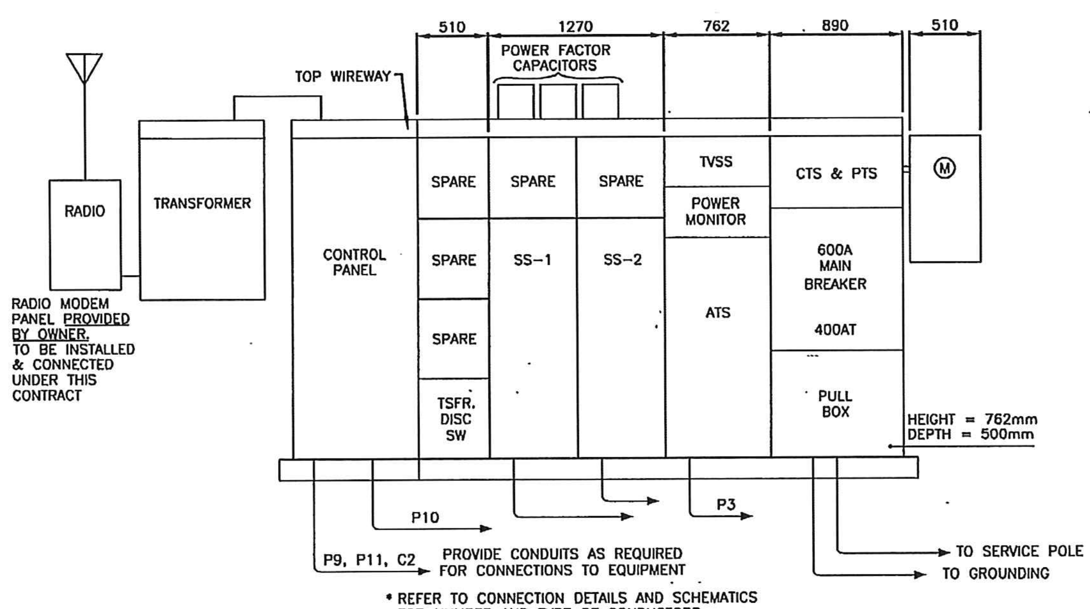
PANEL A — LOCATION MCC

120/240 V. 1 PH. 3 W 200A A. MAINS

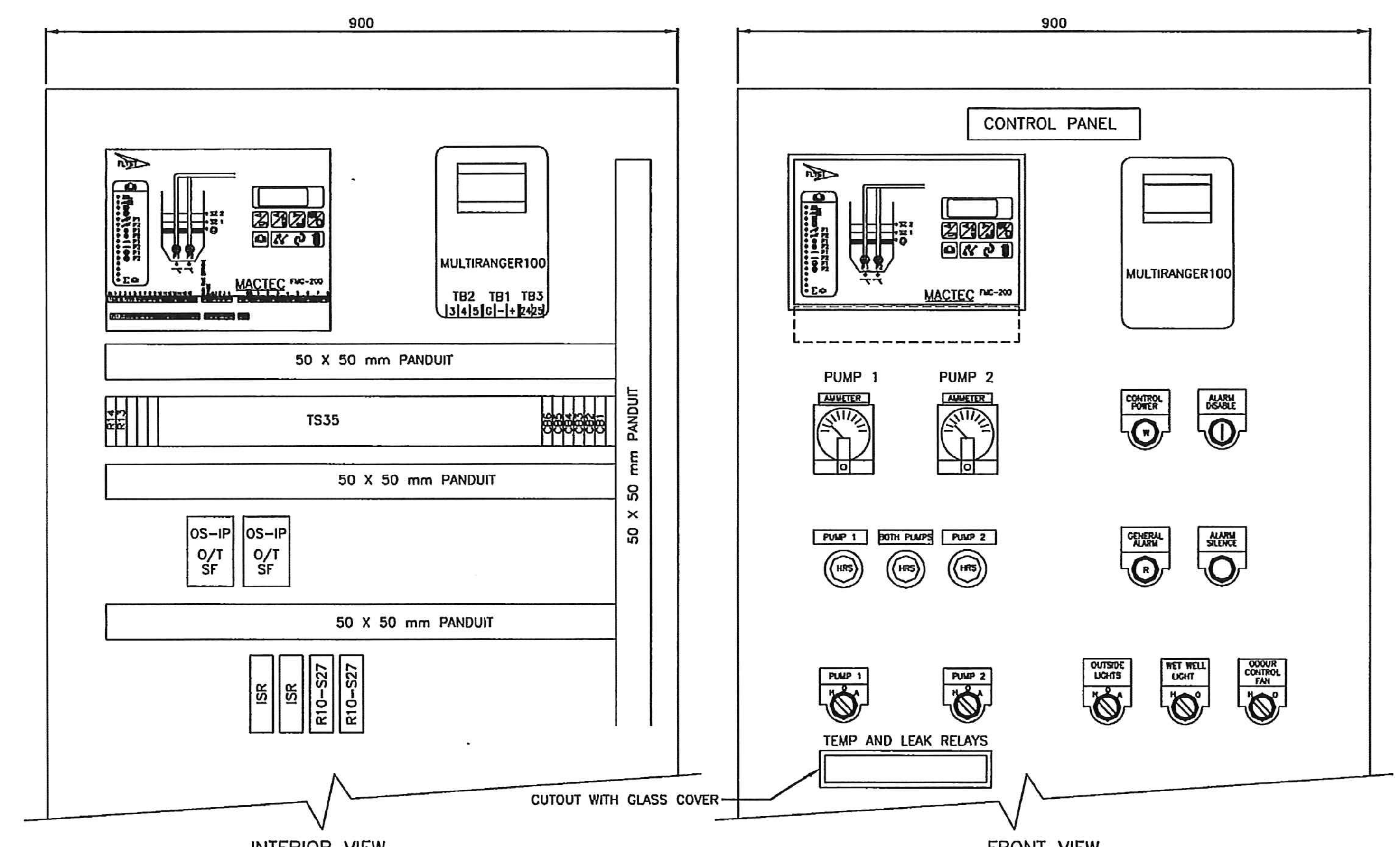
DESIGNATION	LOAD (W)	CKT. BKR. TRIP	CKT. BKR. NO.	Ø	CKT. BKR. NO.	CKT. BKR. TRIP	LOAD (W)	DESIGNATION
CONTROL PANEL		15	1	A	2	15		OUTSIDE LIGHTS
UPS		15	3	B	4	15		CONTROL RM LIGHTS
GEN. CONTROL POWER		15	5	A	6	15		WASHROOM LIGHTS
GEN. BLOCK HEATER		15	7	B	8	15		INT. RECEPTACLES
SPARE		15	9	A	10	15		EXT. RECEPTACLES
SPARE		15	11	B	12	15		WET WELL & V. CHAMBER LIGHTS
SPARE		15	13	A	14	15		ODOUR CONTROL FAN
SPARE		15	15	B	16	15		EF-3
			17	A	18			
			19	B	20			
			21	A	22			
			23	B	24			
			25	A	26			
			27	B	28			
			29	A	30			

CABLE SCHEDULE

CABLE NO.	NO. CONDUCT.	CONDUCT SIZE	CONDUIT SIZE	TO	FROM	REMARKS
P1	8	4/0	2-103mm	MAIN SW. & METER	HYDRO SERVICE	
P2	2	#8	27mm	TRANSFORMER	DISC. SW.	
P3	4	3/0	53mm	GENERATOR	AUTO TRANSFER SWITCH	
P4	3	#1+G	53mm	PUMP #1	MCC	
P5	3	#1+G	53mm	PUMP #2	MCC	
P6	3	#6	TECK	30 kVAR CAP.#1	MCC	
P7	3	#6	TECK	30 kVAR CAP.#2	MCC	
P8	3	#12	TECK	2 kVAR CAP.#3	MCC	
P9	2	#10	27mm	FAN KIOSK	MCC	
P10	4	#12	27mm	GENERATOR POWER	MCC	CCTS A5 & A7
P11	2	#12	27mm	W.W. & V.C. LIGHTS	MCC	
C1	6	#14	27mm	FLOAT SWITCH	CONTROL PANEL	
C2	14	#14	27mm	GENERATOR C.P.	CONTROL PANEL	
C3	6	#14	27mm	LEAK/TEMP SENSOR #1	CONTROL PANEL	
C4	6	#14	21mm	LEAK/TEMP SENSOR #2	CONTROL PANEL	
C5	2	#18 UTP	27mm	TRANSDUCER (LEVEL)	CONTROL PANEL	



SOUTH WALL



CONTROL PANEL LAYOUT

SCALE: NTS

RECORD DRAWING

No.	DATE	DESCRIPTION	BY	APPROVED
REVISIONS				

No.	DESCRIPTION	DATE	APPROVED
6	MICROFILMED		
5	PLAN OF RECORD	03.15.07	
4	APPROVAL FOR CONSTRUCTION	02.09.10	TB
3	FOR TENDER	06.21.02	TB
2	FOR APPROVAL	02.05.13	TB
1	PRELIMINARY	00.08.25	RAF

DRAWING STATUS

SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com
www.stantec.com

Stantec

DESIGNED: TF	DRAWN: AA
CHECKED: PB	APPROVED: TB
SCALE: N.T.S.	

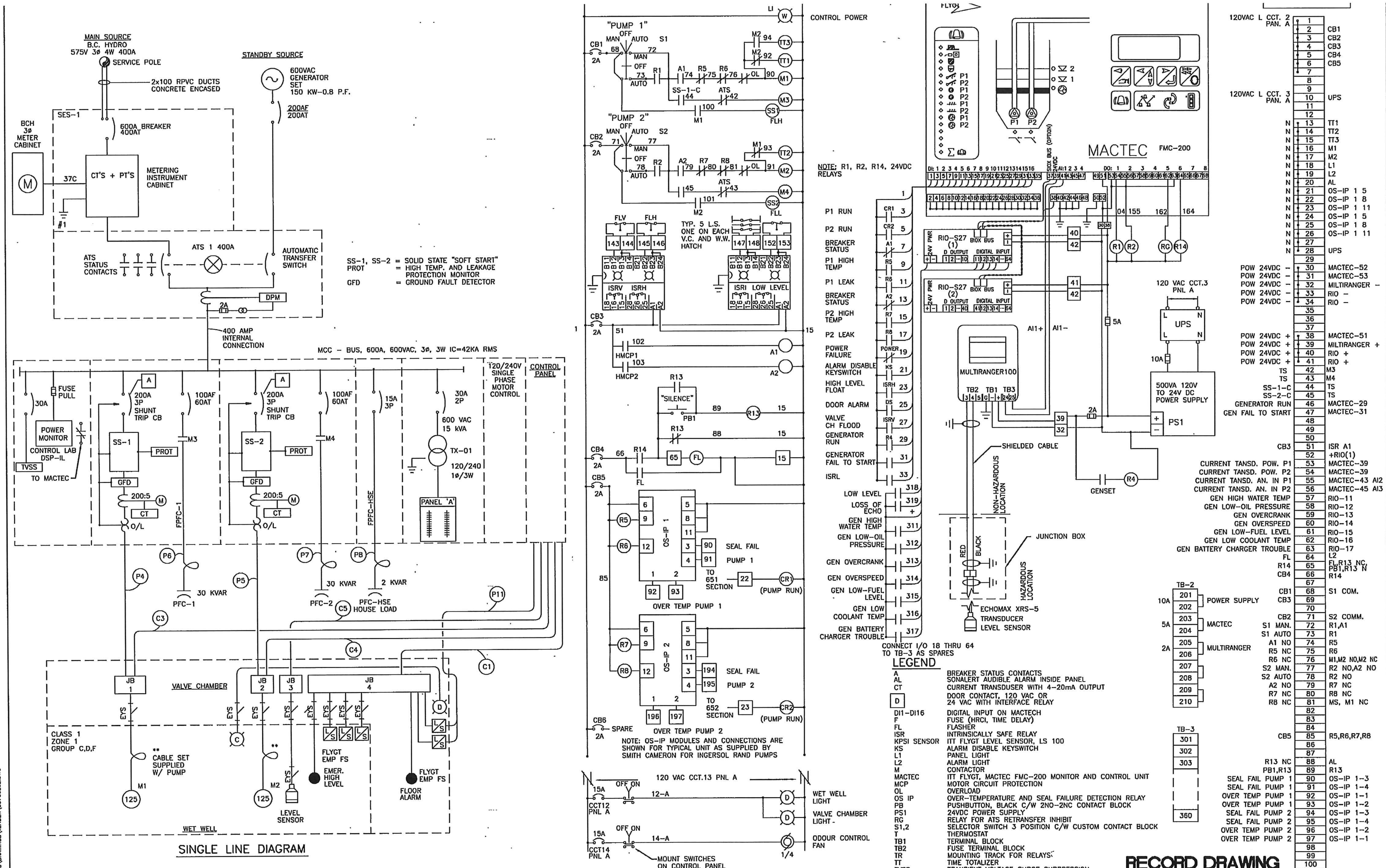
CLIENT: CITY OF COLWOOD

TITLE: OCEAN BLVD. PUMP STATION — EQUIPMENT LAYOUT

DATE: 00.08.25	SHEET:
JOB No. 12030700	
REVISION: 5	DRAWING: E01

AS-BUILT FOLDER NO. V-S1-09

Xrefs: PRECAST.DWG; Drawing: V:\1200\ACTIVE\12030700\DRAWINGS\TENDER\30700E01.DWG June 19, 2002 1:57 p.m.



RECORD DRAWING

No.	DATE	DESCRIPTION	BY	APPROVED
		REVISIONS		

No.	DESCRIPTION	DATE	APPROVED
6	MICROFILMED		
5	PLAN OF RECORD	03.15.07	
4	APPROVAL FOR CONSTRUCTION	02.09.10	TB
3	FOR TENDER	06.21.02	PB
2	FOR APPROVAL	02.05.13	PB
1	PRELIMINARY	00.08.25	RAF
	DRAWING STATUS		

SEAL:

Stantec Consulting Ltd.
977 Fort Street
Victoria BC Canada V8V 3K3
Tel: (250) 388-9161
Fax: (250) 382-0514
email: victoria@stantec.com
www.stantec.com

DESIGNED: TF	DRAWN: AA	CLIENT: CITY OF COLWOOD	DATE: 00.08.25	SHEET:
CHECKED: PB	APPROVED: TB	TITLE: OCEAN BLVD. PUMP STATION	JOB No. 12030700	
SCALE: N.T.S.		SINGLE LINE DIAGRAM	REVISION: 5	DRAWING: E02

AS-BUILT FOLDER NO. V-S1-09

Drawing: V:\1203\ACTIVE\12030700\DRAWINGS\TENDER\30700E02.DWG June 19, 2002 1:54 p.m.

KERR WOOD LEIDAL
consulting engineers

Appendix B

Cost Estimates

City of Colwood
Conceptual Level Cost Opinion
2417-006

Ocean Boulevard Pump Station Protection Plan
10/5/2015

CAPITAL COSTS- Phase 1 Berm and Floodproofing

Item	Description	Unit	Estimated Quantity	Material Unit Rate	Material Cost	Crew	Crew Rate $/day	Duration (Days)	LabourEquip Cost $	TOTAL PRICE $	Comment
1	**Phase 1 Berm**										
1.01	Riprap	m3	420	$ 160.00	$ 67,200.00	incl.			0	$ 67,200	
1.02	Lock Blocks	m3	77	$ 600.00	$ 46,200.00	C2	4,320	3.00	12,960	$ 59,160	
	Subtotal				**$ 113,400**				**$ 12,960**	**$ 126,360**	
	SUBTOTAL									**$ 126,360**	
	Engineering								20%	$ 25,300	
	Contingency								30%	$ 45,500	
	TOTAL AMOUNT (excl. GST)									**$ 198,000**	
2	**Phase 1 Floodproofing**										
2.01	Raise Ventilation/Odour Control Kiosk	allow	1	$ 8,000	$ 8,000	incl.			0	$ 8,000	
	Subtotal				**$ 8,000**			**0**	**$ -**	**$ 8,000**	
	SUBTOTAL									**$ 8,000**	
	Engineering								15%	$ 1,200	
	Contingency								30%	$ 2,800	
	TOTAL AMOUNT (excl. GST)									**$ 12,000**	
									Grand Total	**$ 210,000**	

Note: Preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long-term capital plans and for preliminary discussion of proposed capital projects.

Prepared by:

PROFESSIONAL PROVINCE OF BRITISH COLUMBIA E. R. MORRIS # 28480 ENGINEER
JUL 04 2016

Seal

City of Colwood
Conceptual Level Cost Opinion
2417-006

Ocean Boulevard Pump Station Protection Plan

10/5/2015

CAPITAL COSTS- Phase 2 Berm and Floodproofing

Item	Description	Unit	Estimated Quantity	Material Unit Rate	Material Cost	Crew	Crew Rate $/day	Duration (Days)	LabourEquip Cost $	TOTAL PRICE $	Comment
1	**Phase 2 Berm**										
1.01	Riprap	m3	460	$ 180.00	$ 82,800.00	incl.			0	$ 82,800	
1.02	Lock Blocks	m3	88	$ 1,000.00	$ 87,500.00	incl.			0	$ 87,500	
	Subtotal				**$ 170,300**				**$ -**	**$ 170,300**	
	SUBTOTAL									**$ 170,300**	
	Engineering								20%	$ 34,100	
	Contingency								30%	$ 61,300	
	TOTAL AMOUNT (excl. GST)									**$ 266,000**	
2	**Phase 2 Floodproofing**										
2.01	Floodproof Wetwell Hatches	allow	1	$ 30,000	$ 30,000	C31	3,040	5.00	15,200	$ 45,200	Assume replacement with watertight models
2.02	Floodproof Pump Station Electrical Room Doors	allow	1	$ 8,000	$ 8,000	C31	3,040	2.00	6,080	$ 14,080	Assume replacement with watertight model
	Subtotal				**$ 38,000**			**7**	**$ 21,280**	**$ 59,280**	
	SUBTOTAL									**$ 59,280**	
	Engineering								15%	$ 8,900	
	Contingency								30%	$ 20,500	
	TOTAL AMOUNT (excl. GST)									**$ 89,000**	
									Grand Total	**$ 355,000**	

Note: Preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long-term capital plans and for preliminary discussion of proposed capital projects.

Prepared by:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
E. R. MORRIS
28480
JUL 04 2016

Seal

City of Colwood
Conceptual Level Cost Opinion
2417-006

Ocean Boulevard Pump Station Protection Plan
10/5/2015

CAPITAL COSTS- Emergency Planning

Item	Description	Unit	Estimated Quantity	Material Unit Rate	Material Cost	Crew	Crew Rate $/day	Duration (Days)	LabourEquip Cost $	TOTAL PRICE $	Comment
1	**Emergency Planning**										
1.01	Submersible Pump	L.S.	1	$ 20,000.00	$ 20,000.00	incl.			0	$ 20,000	
1.02	Generator Set	L.S.	1	$ 50,000.00	$ 50,000.00	incl.			0	$ 50,000	
1.03	Control Kiosk	L.S.	1	$ 30,000.00	$ 30,000.00	incl.			0	$ 30,000	
1.04	Forcemain Adapter	L.S.	1	$ 5,000.00	$ 5,000.00	incl.			0	$ 5,000	
	Subtotal				**$ 105,000**				**$ -**	**$ 105,000**	
	SUBTOTAL									**$ 105,000**	
	Engineering								15%	$ 15,800	
	Contingency								30%	$ 36,200	
	TOTAL AMOUNT (excl. GST)									**$ 157,000**	

Note: Preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long-term capital plans and for preliminary discussion of proposed capital projects.

Prepared by:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
E. R. MORRIS
28480
JUL 04 2016

Seal

City of Colwood
Conceptual Level Cost Opinion
2417-006

Ocean Boulevard Pump Station Protection Plan
10/5/2015

CAPITAL COSTS- Move the Pump Station

Item	Description	Unit	Estimated Quantity	Material Unit Rate	Material Cost	Crew	Crew Rate $/day	Duration (Days)	LabourEquip Cost $	TOTAL PRICE $	Comment
1	**Relocate Pump Station**										
1.01	New Pump Station with Public Washrooms	L.S.	1	$ 1,500,000.00	$ 1,500,000.00	incl.			0	$ 1,500,000	
	Subtotal				**$ 1,500,000**				**$ -**	**$ 1,500,000**	
	SUBTOTAL									**$ 1,500,000**	
	Engineering								15%	$ 225,000	
	Contingency								30%	$ 517,500	
	TOTAL AMOUNT (excl. GST)									**$ 2,243,000**	
2	**Gravity Sewers**										
2.01	200 mm diameter gravity sewer	m	305	$ 500	$ 152,500	incl.			0	$ 152,500	Richmond costs- no dewater
2.02	250 mm diamater forcemain	m	235	$ 500	$ 117,500	incl.			0	$ 117,500	
	Subtotal				**$ 270,000**			**0**	**$ -**	**$ 270,000**	
	SUBTOTAL									**$ 270,000**	
	Engineering								15%	$ 40,500	
	Contingency								30%	$ 93,200	
	TOTAL AMOUNT (excl. GST)									**$ 404,000**	
									Grand Total	**$ 2,647,000**	

Note: Preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long-term capital plans and for preliminary discussion of proposed capital projects.

Prepared by:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
E. R. MORRIS
20480
JUL 04 2016

Seal