FINAL REPORT

3.8 M Litre Water Storage Tank Cost Analysis City of St. John's, NL

fga Consulting Engineers Limited

Prepared for:
Greg Barton; Ken Tobin
fga Consulting Engineers Limited
2 Hunt's Lane
St. John's, NL
A1B 2L3

Prepared by:
SGMC Consultants
Civil Engineering Group 4:
Mark Sampson
Nikita Gibbons
Russell Murphy
Richard Chambers

Faculty of Engineering & Applied Science
Memorial University of Newfoundland
St. John's, NL
A1B 3X5
sgmc2010@gmail.com

Course and Instructor:
Civil Engineering Project – ENGI 8700
Dr. Steve Bruneau

Date:
5 April, 2010

SGMC Consultants
Faculty of Engineering and Applied Science
Memorial University of Newfoundland
St. John's, NL
A1B 3X5

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Subject: 3.8 M Litre Water Storage Tank Cost Analysis Progress Report

Dear Mr. Barton and Mr. Tobin:

SGMC Consultants were retained by fga Consulting Engineers Limited to carry out a design and cost analysis for a 3.8 M litre water storage tank. As a result, SGMC Consultants have prepared a final report describing all project components.

The final report consists of the design loads that were used in the design of the concrete and steel storage tanks. Detailed cost estimates are provided for both alternatives and were followed with a benefit cost analysis to determine the preferred construction material.

The enclosed progress report resulted from a request by Dr. Steve Bruneau, Engineering 8700 professor, to gain a better understanding of SGMC Consultant's final year capstone design project. This report was completed on schedule in an efficient and practical manner.

If there are any questions concerning this report, we would be pleased to discuss them with you.

Yours sincerely,

SGMC Consultants
Civil Engineering Group 4

cc: Dr. Steve Bruneau

SUMMARY

Water tank builders are faced with numerous options and when designing and planning the construction of a new storage tank. The first and foremost decision to be made is what material will be used to build the tank. There are many benefits to using some materials over others, but overall the two most common water storage tanks are made of concrete or steel. The question is, which design is optimal for the owners needs, the general public and the environment. The following report describes, in detail, the design – build process and associated costs of a 3.8M litre concrete vs. steel storage tank over a service life of 25 years.

After creating a material matrix and listing the pros and cons of each material, the steel and concrete tanks were selected for analysis. The next step was to determine how to construct each tank. After researching various construction schemes it was agreed upon a prestressed concrete shell with a concrete dome roof and a welded steel plate shell with an aluminum dome roof. A similar concrete slab foundation was used for both.

An unbalanced snow load of 2.72 kPa for the concrete tank and 2.27 kPa for the steel tank was calculated. The wind loads applied to both tanks was found to be 1.76 kPa of pressure on the walls and 3.52 kPa of suction on the roof. These forces, along with the hydrostatic pressure created by the liquid contained within, is the basis behind the design process.

For the walls, the design criteria was based on a maximum hydrostatic pressure of 133 KN/m applied at a height of 2.1 m. A shell thickness of 200 mm, ½ " horizontal and vertical wired reinforcement and 35 MPa concrete was used throughout the shell to counteract the hydrostatic pressure. The roof was designed to withstand snow, wind suction, maintenance loads and the self weight of the roof. When designed, the concrete roof was 240 mm thick, reinforced with temperature reinforcement and 35 MPa concrete. The concrete dome roof is placed on a neoprene pad, and is supported on a ring beam saddle, poured with the concrete shell. This simple connection eliminates large moments created if the shell and roof were to be connected by dowels. The slab foundation was designed to resist the tension forces created from the hydrostatic forces at the base of the shell. The finished slab will be 610 mm deep, containing only temperature reinforcement and poured with 35 MPa concrete. The shell and foundation connection is a simple bolted angle connection, eliminating moment transfer and a maintenance and inspection hatch was designed for access into the tank.

The design criteria for the steel shell was also based on the hydrostatic pressure, yielding a 25 mm thickness from the base to the middle of the shell and a 12.5 mm thickness for the other half. The steel tank aluminum roof will be designed and supplied by Ultrafloat, a certified consulting firm specializing in aluminum geodesic dome roofing systems. The roof is designed to withstand the same loading specified for the concrete roof. The shell and roof is connected by a simple bolted angle connection. The bolts, nuts and washers connecting the aluminum to steel must be stainless steel to eliminate corrosion. The samethickness, reinforcement and concrete compressive strength of the concrete tank foundation can also be utilized for the steel tank. The concrete and steel tanks share a similar shell and foundation connection and only a maintenance hatch will

be designed for the steel tank. The inspection hatch is located at the roof of the tank, which will be designed by Ultrafloat.

After designing both tanks a detailed cost estimate was completed. The cost estimate included quantity take-offs of all materials, along with associated costs. The labour costs required to construct each tank was also provided, yielding a total cost of $715,686 to construct the concrete tank and $828,878 to construct the steel tank.

The benefit/cost analysis was formulated to deduce a total cost of constructing each tank and the maintenance required over the 25 year service life. After analysis, it was determined that the concrete tank will cost $780,086 to construct and maintain and the steel tank will cost $957,678 for construction and maintenance. The benefits associated with the concrete tank is its cheap construction and maintenance and long service life. The steel tank is a more preferred design for most consultants and its prefabricated roof makes for a shorter schedule life. The final conclusion made by SGMC Consultants is to design and construct a concrete tank for the developing city of St. John's, Newfoundland and Labrador.

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1 INTRODUCTION

1.1 BACKROUND

fga Consulting Engineers Limited was established in 1983 and is a wholly owned and operated Newfoundland and Labrador firm. They provide a wide range of multi-disciplinary consulting engineering services in many areas with one of their specialties being storage tanks. fga Consulting Engineers Ltd. are capable of providing project management for tank cleaning, inspection, and repair design and execution.

1.2 PROJECT DESCRIPTION

SGMC Consultants have conducted a potable water storage tank option study to determine a preferred alternative for its design and construction. It is required that the water tank store 3.8 M litres of potable water to service the developing city of St. John's. The two options to be analyzed were an above ground reinforced concrete tank and an above ground structural steel plate tank. Different design schemes and materials for the roof have been considered along with various foundation designs, which correlate with the applied loadings to provide a list of options for consideration. SGMC Consultants have collaborated with fga Consulting Engineers Ltd. to determine two viable design options and a complete analysis of these two schemes have been conducted.

The scope of work for the design options include a preliminary design for each of the tanks considered. The preliminary designs are completed in significant detail to provide cost estimates for comparison purposes. AutoCAD 2010 software was used to construct design drawings detailing each tank option. The drawings are provided with enough detail to allow the client to determine design features and materials. A list of advantages and disadvantages for each design was developed to aid in determining the recommended option. The list identifies the life expectancy of material used, required maintenance, initial construction costs and a benefit/cost analysis for each option. The report contains detailed construction estimates for each option and a final recommendation based on gathered information and design options.

The preliminary design data for the water tank, geotechnical information, and environmental considerations have been provided by fga Consulting Engineers Ltd. and additional data was made available upon request. All environmental data was determined assuming the water tanks will be constructed in St. John's, Newfoundland and Labrador. The water tank has a known capacity of 3,800,000 litres, a total height of 16.6 m and a diameter of 18.6 m. The geotechnical information provided includes an ultimate bearing capacity of 1,500 kPa, allowable bearing capacity of 500 kPa and a maximum depth of foundation of 2.1 m. Any additional data required was discussed with fga Consulting Engineers Ltd. in weekly meetings, via e-mail, or by telephone depending on its urgency.

2 PRELIMINARY PROJECT COMPONENTS

2.1 STATEMENT OF QUALIFICATIONS

SGMC Consultants submitted a “Statement of Qualifications” on January 13, 2010. It contained a mission statement and information regarding the background of the team. The SOQ also included the title, expertise and previous work experience of each team member, as well as contact information.

2.2 RESEARCH

Research regarding conventional tank design, environmental, geotechnical, and building codes was completed. All environmental regulations and geotechnical investigations were related to the St. John’s area and were provided by fga ConsultingEngineers Limited. The building codes and tank design books essential for design and implementation of both tank options are as follows:

- Concrete Design Handbook, Third Edition *(Cement Association of Canada, 2006)*
- Handbook of Steel Construction, Ninth Edition *(Canadian Institute of Steel Construction, 2007)*
- National Building Code of Canada *(Canadian Commission on Building and Fire Codes, 2005)*.
- Prestressed Concrete; A Fundamental Approach, Fourth Edition
- Aboveground Storage Tanks.New York, NY: McGraw Hill.

2.3 BRAINSTORMING

Brainstorming played a major role in determining the material and design schemes considered in this project. Appendix A contains a list of suggested materials and dimensions to be used for tank analysis and design.

SGMC Consultants presented fga Consulting Engineers Limited with a tank material matrix. A decision was made to analyze two of the various tank options, due to time constraints. The two selected tank options are a cylindrical concrete shell with a concrete dome roof and a cylindrical steel shell with an aluminum geodesic dome roof.

A chart illustrating possible tank dimensions was provided to fga Engineering Consultants Limited during a client meeting. It was suggested that an economical tank height would be a multiple of the steel sheet heights being used to reduce steel cutting and preparation. A tank size was then selected with the following dimensions:

- Height of shell = 14.6 m

- Diameter of Tank = 18.6 m

With a shell material selected for both tank options, methods of constructing each tank were analyzed as follows:

- Using prestressed concrete as opposed to cast in place concrete for the shell of the concrete tank. After researching both methods, SGMC Consultants concluded that prestressing is a more conventional construction method (90% of North American concrete tanks) because the tensioned reinforcement is more suitable for the large hydrostatic loads present in such a tank.
- Using a welded metal shell as opposed to a bolted metal shell. Table 1 lists the advantages and disadvantages of both construction methods.

	ADVANTAGES	DISADVANTAGES
WELDS	• More resistance to earthquake damage • Can be built in any size and capacity (up to 20MG) • Tanks are made of thicker/heavier steel thus adding to useful life • Weld tanks can be easily and cost – effectively adapted for cathodic protection systems thus extends the useful life • Welded tanks are easier to coat • With proper maintenance, the useful life of a weld tank is **50 to 75** years	• Not all components of the tank can be coated due to its pre assembly thus causing corrosion. • Erection time is longer and more costly due to the need of cranes • More expensive at the time of construction i.e. material cost
BOLTS	• Coatings are applied in a controlled environment • Standardized parts meaning they have consistency and makes erection time easier • All erections are done from the ground up so costly cranes and lifts are not needed • Safety risks are greatly reduced • **20%** less cost (Construction cost)	• Every bolt is a potential point of weakness thus there are more catastrophic failures • Bolted tanks are gasketed thus expensive jumper connections must be used to bond together every stave • Bolted tanks are subjected more to corrosion • Greater maintenance time (tanks need to be taken apart and reassembled) • Life span of tank is between **25 to 30** years

Table 1: Weld vs. Bolted Tank Construction

After close consideration of both methods, welding was estimated to be the most beneficial from a benefit/cost perspective.

2.4 SCHEDULE

SGMC Consultants presented fga Consulting Engineers Limited with a work schedule in the initial stages of the project. The schedule was developed using Microsoft Project so the status of each item in the scope of work were readily available to all parties. The timeline assigned to each item were based on their estimated duration to complete the project in an efficient and realistic manner. The detailed schedule is provided in Appendix O.

The schedule was updated weekly to ensure all project deadlines and milestones would be completed on time. SGMC had a recovery plan to reassign manpower should the project fall behind schedule. This proved to be beneficial as SGMC Consultants had mid term examinations and assignments that were concentrated during several weeks of the semester.

Other notable information regarding the project schedule was the expected 4 week duration for cost estimating. SGMC Consultants were able to complete all quantity take offs and construction cost estimates over a 2 week period. It is recommended for future similar studies to decrease the duration for cost estimating and correspondingly increase the timeline for drafting requirements. The ability to review the schedule in weekly meetings aided SGMC Consultants in meeting project deadlines and completed all milestones in an effective and timely manner.

3 DESIGN LOADS

3.1 SNOW LOAD

The annual precipitation across Canada varies according to geographic location and is influenced by certain factors such as ground elevations, wind direction and the proximity to water bodies. Maximum annual snow depths are measured at over 1600 sites across the country and the National Building Code of Canada (2005) uses these values to predict the maximum 1-in-50-year snow accumulations, which occur at each site. The 1-in-50-year ground snow load (S_s) of 2.9 kPa and the 1-in-50-year rain load associated with snow (S_r) of 0.7 kPa determined from measured data in the City of St. John's, Newfoundland were used as a basis for the determination of the tank roof snow loads given by the formula: (3) (5)

- $S = I_s[S_s(C_bC_wC_sC_a) + S_r]$

SGMC Consultants assumed and calculated values for the parameters in the specified snow load equation are illustrated in Table 2.

SYMBOL	DESCRIPTION	VALUE
I_s	Importance Factor for Snow Load	1.00
S_s	1-in-50-year Ground Snow Load (kPa)	2.90
S_r	1-in-50-year Rain Load Associated with Snow (kPa)	0.70
C_b	Basic Snow Load Factor	0.80
C_w	Wind Exposure Factor	0.75
C_s	Slope Factor	1.00
C_a	Shape Factor	1.16

Table 2: Specified Snow Load Parameters

An importance factor for snow load (I_s) of 1.00 was used in the limit states design because it was assumed that the storage tank is ranked in the normal importance category to account for the low human use and occupancy. Storage tanks are not likely to cause injury or pose a hazard to human life should the tank fail and are therefore ranked in the normal importance category. (3) (5)

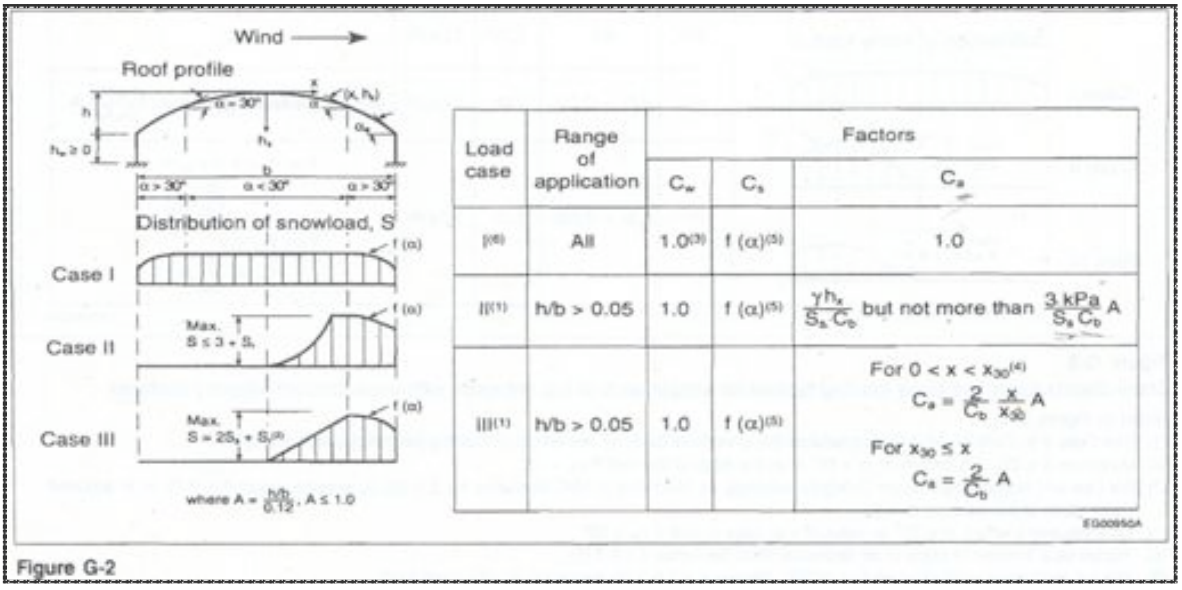
Snow loads on roofs are generally less than the measured ground snow loads due to factors such as wind erosion and drifting, sliding of the snow on sloped roofs, and melting that may occur from heat losses through the roof. The basic snow load factor (C_b) is typically taken as 0.80 to account for less snow on the roof, unless it is a large roof where the snow load may be greater than 80%. The tank roof has a characteristic length equal to its diameter of 18.6 m and is therefore not considered a large roof. (3)(4)

The wind exposure factor (C_w) of 0.75 was used in the calculation and based on several assumptions by SGMC Consultants. It was assumed the construction site will

be open terrain exposing the structure to wind on all sides and the roof being free of obstructions. There will be no accumulation of snow from adjacent structure and therefore the wind exposure will reduce the specified snow load. (3)

The slope of the roof effects are incorporated in the roof slope factor (C_s). SGMC Consultants designed the dome roof in the shape of a parabolic curve. The equation of a parabola was used to determine the slopes tangent to the dome roof. The maximum slope occurs along the circumference of the tank at the roof/wall connection and was calculated to be approximately 25 degrees. Concrete was assumed not to be a slippery material and hence C_s was taken as 1.0. The slope factor was reduced to 0.78 for the aluminum roof to account for the unobstructed slippery surface. (3) (4)

Uniform and unbalanced snow load distributions were considered to determine the shape factor (C_a). Figure 1 taken from Commentary G of the NBC (2005) illustrates the snow distributions for curved roofs and was used to calculate the shape factor. The typical value of 3.0 kN/m^3 for the density of snow on a roof was used in the calculation. The distribution of snow load for Case II governed with a value of 1.16 for C_a. (3) (4)



Load case	Range of application	Factors		
		C_w	C_s	C_a
I[6]	All	1.0[3]	f (α)[5]	1.0
II[1]	h/b > 0.05	1.0	f (α)[5]	$\frac{\gamma h_s}{S_s C_b}$ but not more than $\frac{3\ kPa}{S_s C_b} A$
III[1]	h/b > 0.05	1.0	f (α)[5]	For $0 < x < x_{30}$[4] $C_a = \frac{2}{C_b} \frac{x}{x_{30}} A$ For $x_{30} \le x$ $C_a = \frac{2}{C_b} A$

Figure 1: Snow Distribution and Snow Loading Factors for Simple Arch or Curved Roofs

The specified unfactored snow load (S) acting on the horizontal projection of the concrete dome roof was calculated to be 2.72 kPa and 2.27 kPa for the aluminum dome roof. Detailed snow load calculations are provided in Appendix B.

3.2 WINDLOAD

The mean wind speed used in design is the maximum time-averaged wind speed recorded over a one hour time period at an elevation of 10 meters above the ground surface. Wind pressures are the basis for structural design in Canada. The 1-in-50-year reference velocity pressure (q) of 0.80 from Appendix C of the National Building Code of

Canada (2005) was used to determine the wind loads on the wall and roof of both tanks in the following equations: (3) (4)

- **Total Force on Walls: $F_w = (C_f)(q)(C^*_g)(C^*_e)(A)$**
- **Total Force on Roof: $F_r = (p_i - p_e)(A)$**

Where; **$p_e = (C_p)(q)(C^*_g)(C^*_e)$**

The parameter values in the above equations that were used to calculate the external wind force on the tank walls and roof are summarized in Table 3. The static procedure was followed in the design because the tank has a height of less than 4 times the effective width and is less than 120 m. (5)

SYMBOL	DESCRIPTION	VALUE
I_w	Importance Factor for Wind Load	1.00
q	1-in-50-year Reference Velocity Pressure (kPa)	0.80
C_e	Exposure Factor	1.09
C^*_e	Corresponding Modified Factor Value for use on Hills or Escarpment	2.97
C_g	Gust Effect Factor	2.00
C^*_g	Corrected Factor for Hills and Escarpments	1.61
C_f	Force Coefficient	0.50
C_p	External Pressure Coefficient	-1.00

Table 3: Specified Wind Load Parameters

The exposure factor (C_e) incorporates the change in the mean wind speed with vertical height above ground level. The calculation for C_e is a function of the reference height, which is the height above ground level to the midpoint of the structure's roof. The reference height for the tank is 15.6 m, located in an assumed open terrain, resulting in a calculated exposure factor of 1.09. It is assumed that the tank will be constructed on a hill or escarpment, and therefore a modified exposure factor (C^*_e) value was calculated to account for the amplification of the wind speed. $C^*_e$was calculated to be 2.97 based on the assumptions that the shape is a 2-dimensional escarpment and the structure is on the crest of the hill where the wind amplification is the highest. (3) (5)

The external gust effect factor (C_g) is the ratio of the peak gust wind pressure to the 1-in-50-year mean hourly wind pressure. A typical value used for structures as a whole is 2.0 and hence was taken for C_g. The corrected gust factor (C^*_g) was calculated to be 1.61 which accounts for the speed-up of over hills and escarpments. (3) (4)

The force coefficient (C_f) of 0.50 was determined based on the slenderness ratio and the assumption of concrete being moderately smooth. Values for $C_f$are determined based on the structure slenderness ratio and the type of cross section and roughness. The external pressure coefficient (C_p) has a value of -1.0 and is used to calculate the suction pressure on the tank roof. (3) (4)

The total unfactored force on the walls (F_w) resulting from the wind load was calculated to be 477.5 kN or 1.76 kPa. The total unfactored force on the roof (F_r) due to wind load was calculated to be 955.4 kN or 3.52 kPa. Detailed wind load calculations are provided in Appendix C.

3.3 SEISMIC LOAD

The effect of earthquake load occurs at the contact surface with the ground and can be detrimental to a structure. The seismic load need not be considered if the design spectral acceleration has a value less than 0.2. Although the calculated spectral acceleration was 0.126, the seismic loading was not considered in design as the National Building Code of Canada (2005) states that the seismic load calculations do not apply to several structures, included storage tanks. Detailed seismic load calculations are provided in Appendix D. (3)

3.4 ROOF LIVE LOAD

The live load was determined based on the intended use and occupancy on the tank roof. Since the only probable live load on the roof shall be for maintenance purposes, the minimum specified uniform distributed live load of 1.0 kPa for roofs was assumed. (3)

3.5 DEAD LOAD

The self weight on the construction material was considered in the design process. The unit weight of 2,400 kg/m^3 for normal weight concrete was assumed in the design of the prestressed concrete tank. The unit weight of 7,850 kg/$m^3$for structural steel was assumed in the design of the welded steel tank. Point loads due to construction equipment were also included in the design calculations.

4 PRESTRESSED CONCRETE TANK DESIGN

The form in which the concrete tank will take is based on tank design convention, as determined during the research and brainstorming phases of the project and the design loads, as discussed in the previous two sections. Many assumptions were made to progress this design with respect to material choice and building system, all of which were based on economy, convention, and environmental factors. The design process can be distinctly divided into five components: the prestressed shell, the parabolic dome roof, the structural support foundation, shell and foundation connection and hatch design. Detailed construction drawings are provided in Appendix P.

4.1 SHELL DESIGN

The design of the shell is required to accommodate the hoop stresses and bending moments acting on it via the hydrostatic pressure of the potable water contained within. The connection system assumed is a hinged base connection with a freely moving top. This system eliminates the potential for large stresses due to bending moments at the wall-slab connection. Since the hinged connection does not carry the moments on the shell created by the hydrostatic force, it is necessary to provide vertical prestressing reinforcement to carry these moments, in addition to the horizontal prestressing reinforcement intended to carry the ring force created by hydrostatic pressure. The prestressing reinforcement was chosen to be 270 grade ½" 7 wire prestressing strand and concrete was chosen to have 35 MPa compressive strength.

It was found that the critical vertical moment was 29.1 kN·m/m and occurred at 13.3m water depth. The critical hoop force was determined to be 133 kN/m and occurred at 11.9m water depth. From these parameters it was determined that a shell thickness of 200mm was suitable for design.

It can justly be assumed that a 26% total prestress loss can occur after tendon jacking. Considering these losses, in relation to the hoop stresses found above it was determined that approximately 16 horizontal prestressing tendons per meter height are required. Assuming the same prestress efficiency it was found that vertical prestressing required a 66 mm centre to centre tendon spacing around the entire circumference of the tank. Detailed concrete shell design calculations are provided in Appendix E. (6)

4.2 PARABOLIC DOME ROOF DESIGN

The design of the dome roof is required to accommodate the snow loads, maintenance loads, and dead loads that have the potential to contribute to dome buckling; and wind loads that create suction forces with the potential to displace the dome roof from the top of the tank. The connection system assumed is a freely moving top resting on a saddle formed in to the top of the shell. A neoprene pad is provided at the point of contact between the dome and shell to reduce abrasive damage. This

system eliminates the potential for large stresses due to bending moments at the wall-dome connection. A ring beam is provided on the outer perimeter of the dome and is reinforced with prestressing strand. This ring beam is provided to counteract the reactive forces created by the shell-dome connection. The prestressing reinforcement was chosen to be 270 grade ½" 7 wire prestressing strand and concrete was chosen to have 35 MPa compressive strength. Detailed concrete saddle design calculations are provided in Appendix G.

The first mode of failure designed for was displacement of the dome due to suction created by the wind forces. A suction load of 3.5 kPa was found to act on the dome under the assumed environmental conditions. There were several options available to ensure that failure of this nature would not occur. The options discussed included thickening the dome to the required dead load, adding T-beams to the dome to stiffen it and add the required dead load, or making a rigid connection to the shell via dowels. It was decided that making the dome thicker would be the most desirable solution, adding T-beams would increase costs due to form work and a rigid connection would create moment and torsional forces at the connection that would require extensive reinforcing. After applying the applicable load factors to the abovementioned forces it was determined that a dome thickness of 242 mm is adequate.

The second mode of failure designed for was buckling due to snow loads, maintenance loads, dead loads, and dimensional characteristics. The dome radius was found to be 22 m and the dome thickness was assumed to be 242 mm from the calculations mentioned above. The angle that the dome makes with the top of the shell was found to be 25º. Because this angle is less than 51º it follows that the entire dome would be in compression and only temperature reinforcement is required in the dome. Finally, it was determined that a dome thickness of 242 mm was suitable to withstand buckling. Detailed concrete parabolic dome roof calculations are provided in Appendix F. (6)

4.3 FOUNDATION DESIGN

SGMC Consultants designed the foundation as a ring beam to withstand the tension forces created from the hydrostatic pressure applied uniformly to the tank shell. For ease of construction, the ring beam will be poured as a continuous slab. The self weight of the slab was considered, but would not be a determining factor in design, as the downward forces created from the slab weight would cancel with the upward bearing force created from the soil (bedrock in this case). As per a request from fga Consulting Engineers Ltd. the foundation will be 2.0 ft thick. When all of the necessary checks were completed it was established that reinforcement is not needed in the foundation to counteract the tension forces from the shell. The only reinforcement to be used is temperature reinforcement.

Calculation of the length in which the slab extends past the shell exterior resulted in 2 ft. This length allows for extra foundation strength, added surface area to offset moments produced at the shell base and provides the workers a level footing to construct the shell. Detailed concrete foundation design calculation are provided in Appendix H. (6)

4.4 SHELL AND FOUNDATION CONNECTION DESIGN

It was decided, with consultation with the client, that a hinged shell to slab connection would be used. A hinged connection allows only shear transfer and eliminates large moments created by rigid connections. SGMC Consultants decided the hinged connection would be an angle bolted to both the shell and foundation on the exterior face of the shell. This connection must be able to withstand the hydrostatic pressure created at the base of the tank, wind and tendon jacking, concrete break out resistance and pull out resistance.

The factored hydrostatic force applied at the base of the shell was 1587 KN, which is the determining factor of size and number of bolts in design. Substituting this force for the shear and bearing capacity determined that shear transfer governed. An angle of 203 mm x 203 mm x 13 mm, along with 8 – A490M, M24 bolts per meter length in each angle leg will be utilized to counteract the force.

The force due to wind and tendon jacking was 243 KN. Because this force is less than the hydrostatic pressure, shear at the angle – leg connection and shear/bearing failure of the bolt fastened to the foundation need not be checked. Necessary checks include torsion of both the angle and bolts and shear block tear out in the perpendicular and parallel plane, which all had a much greater resistance then the applied force.

The last two modes of failure SGMC Consultants had to verify was concrete break out resistance and pull out resistance. All necessary calculations were completed and the proposed connection will not fail under these conditions.

When reviewing the construction process of the shell and foundation connection it was determined that it would be nearly impossible to place the angle over the bolts if the shell and foundation bolts were both cast-in-place. A simple solution is to cast a steel sleeve into the foundation and slot the holes connecting the angle to the shell. This will allow the contractor to push the anglehorizontally over the cast-in-place bolts and the slotted hole can be utilized to align the other holes with the sleeve. Detailed concrete shell to foundation connection calculations are provided in Appendix I. (6)(7)

4.5 HATCH DESIGN

There are two steel hatches designed for the concrete tank:

1. A 915 mm diameter maintenance hatch is required to provide access for repainting, weld testing and cleaning. The hatch is located just above the foundation connected to the shell.

2. A 610 mm diameter inspection hatch provides access for testing purposes and to check water levels. It is fastened at the edge of the dome roof, to allow for ladder access.

The base of the maintenance hatch was placed 600 mm from the foundation and was designed to withstand a hydrostatic pressure and factored force of 164 kPa and

108 KN, respectfully. Using A325M, M16 bolts, it was determined that the hatch only required one bolt to successfully counteract the applied hydrostatic pressure. To create a good seal between the hatch flange and shell a spacing of 120 mm would be adequate. This spacing yielded 28 bolts evenly spaced around the circumference of the center of the flange. Other checks included concrete break out resistance and pull out resistance, which were both higher than the applied hydrostatic pressure.

The inspection hatch was designed to withstand snow and wind loading as well as self-weight of the steel door, flange and accessories. Detailed concrete hatch design calculations are provided in Appendix J.(Needs to be finished) (6)(7)

5 WELDED STEEL TANK DESIGN

The welded steel tank design is based on the American Water Works Association (AWWA D100-05) Standard. The design is typical for steel storage tanks, as determined through research and brainstorming and has been designed to withstand all of the design loads. The five main components of the design process are the welded steel shell, geodesic dome roof, structural support foundation, shell to roof and foundation connections and the maintenance hatch.Detailed construction drawings are provided in Appendix P.

5.1 SHELL DESIGN

The design of the shell is based on the requirements to accommodate the normal stresses in the circumferential or hoop direction developed from the hydrostatic pressures as well as the longitudinal or axial direction due to the loads from the self weight and environmental loads on the roof. The ratio of the tank radius to the plate thickness (R/t) was determined to be greater than 10 and therefore considered a thin wall vessel. The stress distribution throughout the thickness of a thin wall vessel does not vary significantly and hence was assumed to be uniform or constant. The connection system was established as a hinged connection to eliminate the development of large stresses due to bending moments at the wall-slab and wall-roof connection. (Hibbler)

The Von Mises criteria was the first method used to calculate an initial plate thickness. The internal gauge pressure developed by the contained water was calculated to produce 137.5 kPa. Geodesic dome research yielded a self weight assumption of 289 kN for the dome and components combined. The required thickness assuming 350 MPa structural steel was calculated to be 5.0 mm. (Hibbler)

Although the Von Mises criterion was used to estimate an initial slab thickness, the AWWA Standard was the final design method. This standard is based on working stress design and the steel members were designed so the maximum stresses would not exceed 99.3 MPa. The thickness of the cylindrical shell plates stressed by pressure of the tank contents was calculated to be 21 mm for the bottom plates of the shell and 25.4 mm (1 inch) thick plates were chosen for design. The stress by the pressure of the tank contents decreases as the height of the tank increases. SGMC Consultants decided to reduce the plate thickness at mid-height (7.3 m from ground elevation). The thickness of the cylindrical steel plates from mid-height to the top of the tank were calculated to be 10 mm and 12.7 mm thick plates (1/2 inch) were chosen for design. (12)

The combined stresses for members subject to both axial and bending stresses must be proportioned so that the ratio of actual unit stress to permitted axial unit stress added to the ratio of actual bending unit stress to permitted bending unit stress is less than 1.0. This check was performed to ensure that neither design thickness would be subjected to greater axial or bending unit stress than permitted by the standard and both design thicknesses met this requirement. (12)

The longitudinal and circumferential joints between the steel plates will be connected using a complete penetration double-V butt joint weld. Preparation time is greater compared to the single-V joint, but less filler metal is needed because of the narrower angle. The full panel welds to be used will develop the same resisting strength as the structural steel panels. Detailed weld design calculations are provided in Appendix N.

The storage tank will be equipped with a dome so a top shell girder is not required. It was determined intermediate girders were also not required as the calculated spacing between girders was 90.6 m. This spacing is greater than the height of the shell therefore no intermediate girder is required. All detailed steel shell design calculations are provided in Appendix K. (12)

5.2 ALUMINUM GEODESIC DOME ROOF

The parabolic aluminum geodesic dome roof was not designed by SGMC Consultants as it was decided through discussing with fga Consulting Engineers Limited to purchase the roof from a manufacturer. The aluminum roof is ideal for potable water storage tanks as it will prevent contamination from rust which is a common occurrence with steel roofs. The roof is designed based on the clear span of the tank as well as the loadings acting on the tank. The geodesic dome roof contains a pre engineered a 30 inch diameter inspection hatch. The recommended manufacturer is Ultraflote Corporation, as they supplied the domes for Kenmount Hill, in St. John's, NL. (13)

5.3 FOUNDATION DESIGN

The slab on grade foundation for the steel tank was designed assuming bedrock sub grade, an ultimate bearing capacity of 1,500 kPa and an allowable bearing capacity of 500 kPa, as provided by fga Consulting Engineers Limited. The top of the foundation will be 6 inches above finished grade and will be graded to slope uniformly downward to the centre of the tank at a slope of 2.0%.

The preliminary assumptions for the concrete slab were a sub grade modulus, k of 300 psi for bedrock, a slab thickness of 610 mm (2 ft) and a concrete strength of 35 MPa. The slab design calculations include an extension of 2 ft outside the tank walls for practical purposes.

The total pressure acting on the slab due to the weight of water and all tank components was calculated to be 160 kPa which is less than the allowable bearing capacity. The slab would be subjected to a line loading from the tank wall and a stationary uniformly distributed live load due to the contained water. The assumed slab thickness of 610 mm was capable of withstanding the applied loads without any reinforcement. However, temperature reinforcement is a minimum requirement for slab design and 4 No. 20 M bars at 250 mm spacing was determined to be placed in both the longitudinal and transverse direction with a concrete cover of 60 mm. All detailed concrete foundation design calculations are provided in Appendix L. (6) (7) (12)

5.4 SHELL CONNECTION DESIGN

The design of the connection of the roof to the tank wall resulted in using an L102X102X9.5 steel angle with bolts connecting the angle to the steel wall and to the aluminum roof. The design considered shear, bearing and tension forces along with shear block tear out and prying action. It was determined that 3 M22 A325 bolts per meter would be sufficient to resist the governing suction force due to wind.

Although the aluminum roof is typical in industry, SGMC Consultants were aware of the electric charge that will occur with the aluminum and steel contact in the presence of water and oxygen. This would result in corrosion with the aluminum potentially completely deteriorating around the bolt. It was decided that stainless steel bolts will be used in the roof to steel angle connection along with a neoprene pad separating the steel and aluminum.

The steel wall to tank connection is designed to be a pinned connection so no moment can be resisted by connecting the wall to the foundation using a steel angle and bolts. The anchor bolts required for connecting the steel walls into the concrete foundation were designed to resist the shear force of 1,596 kN per meter of circumference. It was determined that the L203X203X14 angle with 8 M24 A490 bolts per metre was capable of resisting the hydrostatic pressure an chosen for the wall to slab connection. The wind loading was considered for the bolts in the wall connection. I was determined that 1 M24 A490 bolt per meter would be sufficient to resist the loading however 7 bolts were used at equal spacing staggering the anchor bolts. All detailed steel connection design calculations are provided in Appendix M. (7) (12)

5.5 MAINTENANCE HATCH DESIGN

A maintenance and inspection hatch is required for access into the steel tank. The aluminum dome roof is to be designed by Ultrafloat, a certified consulting firm specializing in aluminum geodesic dome roofing system. The inspection hatch is located in the aluminum roof and is therefore pre-designed.

A 915 mm inspection hatch was designed to be located at 600 mm from the tank bottom. The hydrostatic pressure at this point was calculated to be 132 kPa, which applies a factored resultant force of 108 kN acting on the hatch area. The tension and bearing capacity of the hatch was analyzed and it was determined that 1 A325M, M16 bolt was required. However, to maintain a secure seal between the flange and the rubber gasket, 28 M 16 A325 M bolts was chosen at 120 mm spacing. All detailed hatch design calculations are provided in Appendix N. (7) (12)

6 DETAILED COST ESTIMATES

RSMeans Costworks construction estimator was used to estimate the cost of the steel and concrete tank. The software provides both material and labour cost estimates associated with the work. The quantities of material required for the construction of each tank were calculated from the tank designs and input into Costworks to obtain an estimate. The capital costs of each tank were compared during the benefit/cost analysis to determine which storage tank would be the most economical and practical for fga Consulting Engineers Limited.

6.1 PRESTRESSED CONCRETE TANK ESTIMATE

The prestressed concrete tank estimate includes six major items as summarized in Table 4. The concrete shell has the highest construction cost due to the large quantities of material required. The shell estimate contains 1,700 square metres of formwork along with 340 cubic meters of 34 MPa concrete. The horizontal and vertical prestressing strands are included and total approximately 26,500 kg of steel. The labour costs was determined for finishing 850 square meters of concrete on the inside and outside of the tank walls.

Concrete Tank		
Item	Cost	
Shell	$	467,530.00
Connection	$	44,686.00
Hatch	$	1,500.00
Slab	$	89,943.64
Roof	$	92,357.00
Ring Beam	$	19,669.00
Total	**$**	**715,685.64**

Table 4: Concrete Tank Cost Estimate Summary

The concrete roof requires 315 square meters of formwork and 90 cubic meters of 34 MPa concrete. The roof requires 620 kg of steel for the prestressing strands as well as 1.8 metric tonnes of reinforcing steel required for temperature reinforcement in the dome. Other notable items included in the roof estimate are the cost for placing the dome as well as the labour required for finishing the outside as well as sandblasting and finishing the inside portion.

The concrete slab item includes all necessary excavation and earthwork prior to the slab construction. It was assumed that 216 bank cubic meters of common earth would be excated and 108 loose cubic meters to be hauled and backfilled. 360 squared

meters of fine grading for the slab on grade was included in the cost estimate. The cost for forming and pouring of 178 cubic meters as well as placement of the concrete slab was a significant cost in the slab estimate. The labour and material cost for placing 5.47 metric tonnes of reinforcing steel were also considered as well as as 296 square meters of concrete finishing.

The slab to shell connection requires 24 square meters of formwork and 52 cubic meters of 34 MPa concrete for the water stop encasement. The ribbed PVC waterstop is 58 meters long with a thickness and width of 12 mm to 230 mm respectively. The structural steel angle L203x203x13 was designed and requires 120 meters of length to connect the shell to the slab. The connection details a total of 445, 200 mm high strength M25 A490 bolts for the top and bottom flanges combined.

The final two items in the cost estimate are the ring beam and the inspection and maintenance hatches. The ring beam requires 58 square meters of forming and finishing for 15 cubic meters of 34 MPa structural concrete. Other items include 0.2 metric tonnes of reinforcing steel for the saddle as well as 25 square meters of neoprene padding. The material and labour for the hatches have a total estimated cost of $1,500 as shown in Table 4. The total capital cost for the concrete tank is approximately $715,700 and the detailed cost estimates including all quantities of contruction material required for each major item are provided in Appendix Q.

6.2 WELDED STEEL TANK ESTIMATE

The welded steel tank estimate includes five major items as summarized in Table 5. Similar to the concrete tank, the shell has the highest construction cost due to the large quantities of material required. The steel plates used from the tank bottom to mid-height have a 446 square meter quantity of 1 inch thick structural steel plates. From the mid-height of the tank to the top it was designed to reduce the thickness of the plates to ½ inch. 446 square meters of ½ inch plates were incorporated into the shell estimate. The steel plates require 1,784 square meters to be sprayed with paints and protective coatings. The connection of the plates yielded 50 kg of stainless steel weld rod for the complete penetration Double-V butt welds.

Steel Tank		
Item	Cost	
Shell	$	408,822.00
Connection	$	40,612.00
Hatch	$	1,500.00
Slab	$	89,943.64
Roof	$	288,000.00
Total	**$**	**828,877.64**

Table 5: Steel Tank Cost Estimate Summary

The geodesic aluminum dome roof was estimated based on its 3,390 square foot surface area. The cost estimate includes shipping and the labour and equipment cost to install the roof. An inspection hatch is pre-designed in the aluminum roof and the cost for the maintenance hatch in the steel wall was estimated to be $1,500 as shown in Table 5.

The concrete slab for the steel tank was designed the same as the concrete tank resulting in all the same material and labour quantities. Therefore, the cost for the construction of the slab was identical however the connections differ.

The connection of the aluminum roof to steel shell requires 59 meters of the structural steel angle L103x103x9.5. The roof is designed to be connected to the angle using 177 high strength M22 A325 bolts with a 200 mm length and to the shell with 177 high strength M22 A325 bolts having 100 mm length. The connection of the steel shell to concrete foundation will require 59 meters of the structural steel angle L203x203x14. The shell is designed to be connected to the angle using 413 high strength M25 A490 bolts and to the concrete slab using 474 high strength anchor bolts. The total capital cost of the steel tank is approximately $828,900 and the detailed cost estimatesincluding all quantities of contruction material required for each major item are provided in Appendix R.

7 BENEFIT/COST ANALYSIS

Because a water storage tank is a long-term investment and is such a critical part of the water supply infrastructure, it is important for consulting engineers and their clients to evaluate the type of tank that they are purchasing and the maintenance that comes with it. To verify which storage tank is most cost efficient, the construction costs and maintenance, over a specified service life was analyzed. A list of maintenance procedures and related costs is provided in Appendix S.A future value was then deduced for each tank over a life expectancy of 25 years, provided to SGMC Consultants by fga Consulting Engineers Ltd.

7.1 PRESTRESSED CONCRETE TANK COST ANALYSIS

Prior to analyzing the maintenance costs of the concrete it was determined in the previous section that the concrete tank will cost approximately $ 715,686 to construct.

Over its service life the tank will need to be checked for cracks every 1 ½ years. If cracks are found the tank will need to be abrasively blasted, and then sealed with a water proofing material to prevent water intrusion into the tank.

There is a chance that the concrete roof could deteriorate, creating a structural concern. If so, the tank will need to be drained and the roof would be replaced. This is highly unlikely, as a reinforced concrete dome roof would typically have a life expectancy much greater than 25 years.

7.2 WELDED STEEL PLATE TANK COST ANALYSIS

As mentioned in the cost estimate section, materials and construction of the steel tank will cost approximately $828,878.

The welds of the steel tank are checked once a year to ensure all welded connections are free of erosion. Erosion of welds can cause leaks and create serious strength and safety issues.

Once a year the shell thickness is checked for deterioration and weak spots. If the shell is found to be thinner and weak spots occur, massive reconstruction will be needed to maintain the tanks structural integrity. This procedure can be quite costly, depending on the extent of deterioration.

Over the 25 year service life the steel tanks interior will need to be repainted with an epoxy coating. This process involves draining and cleaning the tank then applying an even coat of a CSA approved epoxy paint.

7.3 RESULTS OF COST ANALYSIS AND BENIFITS

The table below summarizes the capital and maintenance costs associated with the concrete and steel tank;

Costs	Concrete Tank	Steel Tank
Capital Costs	$715,686	$828,878
Maintenance Costs	$64,400	$128,800
Total Costs	**$780,086**	**$957,678**

Table 6: Capital and maintenance cost summary

After analyzing both tanks it was determined that the concrete tank will be cheaper to construct and also cheaper to maintain.

The benefits of a concrete tank include its cheap construction and maintenance. A concrete tank is also very reliable and has a long service life.

On the other hand, steel tanks are a preferred design in the St. John's area. SGMC Consultants conducted some field investigation and discovered steel tanks outnumber concrete tank approximately six to one. This would suggest that contractors in the St. John's region are more specialized and experienced in steel tank construction. In addition the prefabricated aluminum roof of the steel tank can be designed and constructed prior or during the construction of the foundation and shell. This will reduce the scheduling implications of the steel tank, decreasing costs and allowing a quick turnover.

The benefits of the steel tank look promising, but the cheap capital and maintenance costs of the concrete tank make it a more desirable design. SGMC Consultants recommends that a concrete storage tank be designed and constructed for the developing city of St. John's, Newfoundland and Labrador.

8 CONCLUSION

SGMC Consultants conducted a cost comparison for a 3.8 M litre capacity potable water storage tank for fga Consulting Engineers Ltd. Through research and brainstorming it was decided that the two viable design options to be analyzed in determine the preferred alternative for design and construction was a prestressed concrete tank and a welded steel tank. The concrete tank was designed with a parabolic concrete dome roof and the steel tank supports an aluminum geodesic dome roof.

The preliminary designs required significant detail for cost estimation. The dimensions consisted of a tank diameter of 18.6 m and a height of 14.6 m. These were chosen to accommodate the structural steel plates used in the construction of the steel tank and kept consistent for comparison purposes. The tanks were designed to resist the calculated snow loads, wind loads, live loads, dead loads and the hoop stress and moments developed by the hydrostatic pressure due to the contained water.

During the design process, it was determined that a true pinned connection between the tank shell with the foundation and roof would be used. This system eliminates the potential for the development of large stresses in these areas. The concrete shell and roof thicknesses required to resist the applied loadings were designed to be 200 mm and 240 mm respectively. The steel shell consists of 25.4 mm thick plates for the bottom half of the tank and reduced to 12.8 mm plates for the top half to account for the hoop stresses decreasing with height. The recommended roofing system specialists, Ultrafloat Corporation, would design the aluminum geodesic dome according to the specified loads. The concrete and steel tank both required similar uniform slab on grade foundation with a 610 mm height.

Construction drawings in AutoCad2010 were provided for both tanks and used to determine the quantities of material required for construction. A detailed cost analysis was performed based on the initial capital cost and individual maintenance activities costs over a specified life expectancy period of 25 years. The initial capital cost for the concrete tank was $715,686 compared to $828,878 for the steel tank. The maintenance costs for the steel tank had a total cost of $128,800, which includes yearly welding, and thickness testing and one paint/epoxy coating. The concrete tank maintenance cost was estimated to be $64,400 over the 25-year period and accounts for yearly crack inspections and two roof blasting/seal requirements.

SGMC Consultants considered other advantages and disadvantages of both options prior to concluding the recommended construction material. Field observations noted that steel is a preferred design by contractors in the St. John's area as the steel to concrete tank ratio is approximately 6:1. The prefabricated aluminum geodesic dome roof has the ability to be constructed at the same time as the foundation and shell. This is beneficially to the scheduling of the project and has the potential to be constructed in a shorter time period. The overall comparison revealed concrete to be the material of choice due to its initial cost efficiency, low maintenance, reliability and the long material life expectancy.

9 RECOMMENDATIONS

The prestressed concrete tank option is recommended based on the information documented in this water storage tank cost analysis study. SGMC Consultants verified which storage tank was most cost efficient from a capital and maintenace cost perspective and conclude that the prestressed concrete tank is preferred mainly due to its economic cost, low maintenance requirements and long service life.

The detailed cost estimates included all material and labour costs associated with the construction of both storage tanks analyzed. It was determined from these detailed cost estimates that the concrete tank had an initial capital cost of $113,192 lower than the steel tank. This results in an approximately 15% lower material and labour cost for the concrete tank compared to the steel tank. Although this is an appealing figure other considerations such as maintenance requirements and the life of material were necessary before SGMC Consultants could concluded a recommendation.

The analysis of the maintencance cost included the individual maintenance activities for both tanks as well as the total maintenance cost over a specified time period of 25 years for its service life. The maintenace analysis of the concrete tank included roof blasting and seal which was assumed to be required twice over the 25 year period and yearly crack inspections. The total cost for maintenance over the specified time period was $64,400 resulting in a 50% lower rate than the calculated cost for the steel tank. This conclusion was the second determining factor for SGMC Consultants recommendation.

Finally, the reliability and long material life expectancy of concrete were other factors considered in the study. Assuming the tanks are constructed to the specifications of the properly designed tanks, the reliability and material life expectancy is higher for concrete. It was concluded from this data that the advantages of the concrete water storage tank outweight those of the steel tank and hench the concrete tank is recommended for construction.

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APPENDICES

3.8 M Litre Water Storage Tank Cost Analysis City of St. John's, NL

fga Consulting Engineers Limited

Prepared for:
Greg Barton; Ken Tobin
fga Consulting Engineers Limited
2 Hunt's Lane
St. John's, NL
A1B 2L3

Prepared by:
SGMC Consultants
Civil Engineering Group 4:
Mark Sampson
Nikita Gibbons
Russell Murphy
Richard Chambers

Faculty of Engineering & Applied Science
Memorial University of Newfoundland
St. John's, NL
A1B 3X5
sgmc2010@gmail.com

Course and Instructor:
Civil Engineering Project – ENGI 8700
Dr. Steve Bruneau

Date:
5 April, 2010

Appendix A

	Roof				Shell				Bottom				Foundation			
	Material		Design		Material		Design		Material		Design		Material		Design	
1	Aluminum	Large strength to weight ratio, corrosion resistant.	Double deck floating pontoon	Reduces losses due to evaporation (mostly petroleum/chemical application).	Aluminum	Large strength to weight ratio, corrosion resistant.	Factory coated bolted sections	Can be relocated, quick assembly, capacity can be increased by adding shell courses.	Aluminum	Large strength to weight ratio, corrosion resistant.	Cone up	Centre of tank is crowned so that water drains to the outside of the tank for easy drainage.	Reinforced concrete	Cast in place	Slab on grade	Slab of specified thickness poured to grade.
2			Conical shaped	Simple and economical, widely used in tank design.	Carbon Steel	Most common, easily repairable.	Factory coated bolted sections	Can be relocated, quick assembly, capacity can be increased by adding shell courses.			Cone down	Bottom is sloped down towards the centre of the tank where water is drained by use of a sump and piping.			Thickened edge	Produces effect of ring wall and anchors tank down.
3			Geodesic dome	Simple and economical, no column support required.			Welded	High strength, economical, widely used in tank design.			Single slope	Bottom is sloped to one side for drainage at one point along the perifery.				
4	Carbon Steel	Most common, easily repairable.	Conical shaped	Simple and economical, widely used in tank design.	Reinforced Concrete	Fairly common, corrosion resistant.	Prestressed	Applies permanent compressive force using rods, cables or tendons, widely used in tank design.	Carbon Steel	Most common, easily repairable.	Cone up	Centre of tank is crowned so that water drains to the outside of the tank for easy drainage.				
5			Umbrella/Dome shaped	Simple and economical, good for internal coatings.			Cast in place	External strapping is used to generate hoop forces.			Cone down	Bottom is sloped down towards the centre of the tank where water is drained by use of a sump and piping.				
6	Reinforced Concrete	Fairly common, corrosion resistant.	Conical shaped	Simple and economical, widely used in tank design.	Fiberglass Reinforced Plastic	Completely corrosion resistant, more flexible than steel	Filament wound	Applied by continuous glass fiber roving in helical patterns, thickness can vary as hoop stresses dictate.			Single slope	Bottom is sloped to one side for drainage at one point along the perifery.				
7			Umbrella/Dome shaped	Simple and economical, good for internal coatings.			Contact molded	Multiple layers of fiberglass chopped strand mat are applied and built up to the desired thickness.	Reinforced Concrete	Fairly common, corrosion resistant.	Cone up	Centre of tank is crowned so that water drains to the outside of the tank for easy drainage.				
8	Fiberglass Reinforced Plastic	Completely corrosion resistant, more flexible than steel	Conical shaped	Simple and economical, widely used in tank design.							Cone down	Bottom is sloped down towards the centre of the tank where water is drained by use of a sump and piping.				
9			Umbrella/Dome shaped	Simple and economical, good for internal coatings.							Single slope	Bottom is sloped to one side for drainage at one point along the perifery.				
10									Fiberglass Reinforced Plastic	Completely corrosion resistant, more flexible than steel	Cone up	Centre of tank is crowned so that water drains to the outside of the tank for easy drainage.				
11											Cone down	Bottom is sloped down towards the centre of the tank where water is drained by use of a sump and piping.				
12											Single slope	Bottom is sloped to one side for drainage at one point along the perifery.				

Group 4
Richard Chambers
Mark Sampson
Nikita Gibbons
Russell Murphy

Water Tower Option Study
Capacity: 3,800,000 L (3,800 m^3)
Maximum Diameter: 20.0 m
Maximum Height: 25.0 m

Trial	Volume of Tank (m^3)	Diameter (m)	Radius (m)	Height (m)
1	3,800	20.00	10.00	12.10
2	3,800	19.90	9.95	12.22
3	3,800	19.80	9.90	12.34
4	3,800	19.70	9.85	12.47
5	3,800	19.60	9.80	12.59
6	3,800	19.50	9.75	12.72
7	3,800	19.40	9.70	12.86
8	3,800	19.30	9.65	12.99
9	3,800	19.20	9.60	13.12
10	3,800	19.10	9.55	13.26
11	3,800	19.00	9.50	13.40
12	3,800	18.90	9.45	13.54
13	3,800	18.80	9.40	13.69
14	3,800	18.70	9.35	13.84
15	3,800	18.60	9.30	13.99
16	3,800	18.50	9.25	14.14
17	3,800	18.40	9.20	14.29
18	3,800	18.30	9.15	14.45
19	3,800	18.20	9.10	14.61
20	3,800	18.10	9.05	14.77
21	3,800	18.00	9.00	14.93
22	3,800	17.90	8.95	15.10
23	3,800	17.80	8.90	15.27
24	3,800	17.70	8.85	15.44
25	3,800	17.60	8.80	15.62
26	3,800	17.50	8.75	15.80
27	3,800	17.40	8.70	15.98
28	3,800	17.30	8.65	16.17
29	3,800	17.20	8.60	16.35
30	3,800	17.10	8.55	16.55
31	3,800	17.00	8.50	16.74
32	3,800	16.90	8.45	16.94
33	3,800	16.80	8.40	17.14
34	3,800	16.70	8.35	17.35
35	3,800	16.60	8.30	17.56
36	3,800	16.50	8.25	17.77
37	3,800	16.40	8.20	17.99
38	3,800	16.30	8.15	18.21
39	3,800	16.20	8.10	18.44
40	3,800	16.10	8.05	18.67
41	3,800	16.00	8.00	18.90
42	3,800	15.90	7.95	19.14
43	3,800	15.80	7.90	19.38
44	3,800	15.70	7.85	19.63
46	3,800	15.50	7.75	20.14

Group 4
Richard Chambers
Mark Sampson
Nikita Gibbons
Russell Murphy

Water Tower Option Study Capacity: 3,800,000 L (3,800 m^3) Maximum Diameter: 20.0 m Maximum Height: 25.0 m				
Trial	Volume of Tank (m^3)	Diameter (m)	Radius (m)	Height (m)
47	3,800	15.40	7.70	20.40
48	3,800	15.30	7.65	20.67
49	3,800	15.20	7.60	20.94
50	3,800	15.10	7.55	21.22
51	3,800	15.00	7.50	21.50
52	3,800	14.90	7.45	21.79
53	3,800	14.80	7.40	22.09
54	3,800	14.70	7.35	22.39
55	3,800	14.60	7.30	22.70
56	3,800	14.50	7.25	23.01
57	3,800	14.40	7.20	23.33
58	3,800	14.30	7.15	23.66
59	3,800	14.20	7.10	23.99
60	3,800	14.10	7.05	24.34
61	3,800	14.00	7.00	24.69
62	3,800	13.90	6.95	25.04

Group 4
Richard Chambers
Mark Sampson
Nikita Gibbons
Russell Murphy

Water Tower Options

Capacity 3,800,000 L (3,800 m^3)

Maximum Diameter 20.0 m (65.62 ft) ; Maximum Height 25 m (82.02 ft)

Selection based on 20 ft X 8 ft steel panels

Selection	Capacity (m^3)	Capacity (ft^3)	Height (ft)	Height (m)	Radius (ft)	Radius (m)	Diameter (ft)	Diameter (m)
1	3,800	134195.70	40.00	12.19	32.68	9.96	65.36	19.92
2	3,800	134195.70	48.00	14.63	29.83	9.09	59.66	18.19
3	3,800	134195.70	56.00	17.07	27.62	8.42	55.24	16.84
4	3,800	134195.70	64.00	19.51	25.83	7.87	51.67	15.75
5	3,800	134195.70	72.00	21.95	24.36	7.42	48.71	14.85
6	3,800	134195.70	80.00	24.38	23.11	7.04	46.21	14.09

Note: Out of the 6 options SGMC have decided to go with option 2. This option has a height of 48 ft and and a diameter of approximately 60 ft. To give the tank extra space abovethe water line we have decided to increase the diameter to 61 ft. This extra foot in diameter would still hold the given water capacity and provide workable space during construction. Below are the exact values of our proposed tanks dimensions. To determine the diameter we decreased the water height by 2 ft. Thus using a water level of 46 ft compared to the actual tank height of 48 ft.

Volume	Height	Radius	Diameter
134195.70	46.00	30.47	61

Appendix B

SGMC

Date: Feb. 11th, 2010

Title: Snow Loads - Concrete Tank Sheet 1 of 4

Specified Snow Loading (S)

- $S = I_s [S_s (C_b C_w C_s C_a) + S_r]$ *NBC Clause 4.1.6

Where

I_s = importance factor for snow load

S_s = ground snow load in kPa with a 1-in-50 probability of exceedance per year

C_b = basic roof snow load factor

C_w = wind exposure factor

C_s = roof slope factor

C_a = shape factor

S_r = associated rain load in kPa (however, the rain load at any location on a roof need not be taken greater than the load due to snow, i.e. $S_r \leq S_s (C_b C_w C_s C_a)$)

- Importance factor (I_s)
  - Storage tank has importance category Normal
  - Limit States Design

  [For I_s $I_s = 1.0$]

- 1-in-50 year ground snow loads (S_s)
  - City of St. John's, Newfoundland
  - Table C-2, Appendix C, NBC 2005

  [For S_s $S_s = 2.9$ kPa]

- Associated rain load (S_r)
  - City of St. John's Newfoundland
  - Table C-2, Appendix C, NBC 2005

  [$S_r = 0.7$ kPa]

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Date: Feb. 11th, 2010

Title: Snow Loads - Concrete Tank Sheet 2 of 4

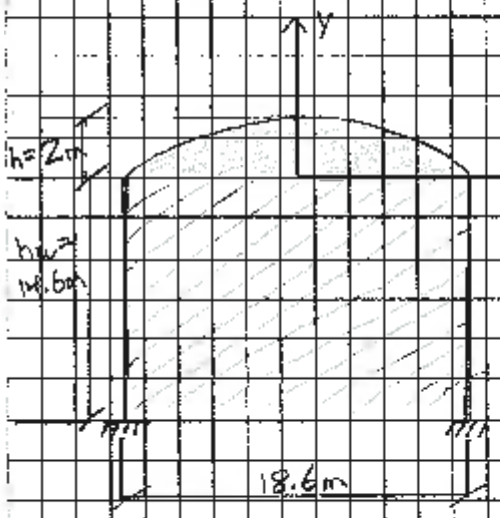
- Basic roof snow load factor (C_b) * NBC Clause 4.1.6.2(2)
  - Characteristic length = tank diameter = 18.6m
    - Not considered a large roof

[$C_b = 0.8$]

- Wind exposure Factor (C_w) * NBC clause 4.1.6.2 (4)
  - Assume exposed area (Unsheltered)
  - Building Exposed on all sides to wind over open terrain
  - No obstructions on roof
  - No accumulation of snow due to drifting from adjacent surfaces

[$C_w = 0.75$]

- Find Slope of Concrete Dome Roof: (Parabola)



Tank Dimensions

- Equation of Parabola → $x^2 = 4py + q$
- Constraints → @ $x=0$, $y=h$; @ $x=\pm r$, $y=0$
- Substitute Constraints → $y = h\left(1 - \frac{x^2}{r^2}\right)$
- Differentiating → Slope $= dy/dx = \frac{-2xh}{r^2}$

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Title: Snow Loads - Concrete Tank Sheet 3 of 4

- At slope x → $(dy/dx) = \left(\frac{\theta°}{180°}\right)\pi$ rad

- Solving for angle θ where $x = 9.3$ { highest slope of roof }

→ $x_{slope} = \left(\frac{(-\theta°\ \pi)}{180°}\right)\left(\frac{r^2}{2h}\right)$

$9.3m = \left(\frac{-\theta°\ \pi}{180°}\right)\left(\frac{9.3^2}{2(2)}\right)$

[$\theta = 24.6° \approx 25°$]

* Angle where $y = 0$ @ roof / wall connection [$= 25°$]

- Roof Slope Factor (C_s) * NBC clause 4.1.6.2 (5)

↳ Assume Concrete is not a slippery surface

↳ Roof Slope, $\alpha < 30°$

[$\alpha° \ C_s = 1.0$]

- Shape Factor (C_a) * Figure G-2 - Structural Commentary G to the NBC 2005

↳ Uniform and unbalanced load distributions

↳ Assume Snow Density, $\gamma = 3.0\ kN/m^3$

↳ $h/b = 2/18.6 = 0.11 > 0.05$ ∴ OK

↳ $A = \frac{h/b}{0.12} = 0.94 < 1.0$ ∴ OK

- Load Case I: $C_a = 1.0$ Balanced Loading

$S = I_s [S_s (C_b C_w C_s C_a) + S_r]$

$= 1.0 [2.9(0.8)(0.75)(1.0)(1.0) + 0.7]$

[$S = 2.44\ kPa$]

↳ check unbalanced loading conditions; Case II & III

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Title: Snow Loads - Concrete Tank Sheet 4 of 4

Load Case II: $C_a = \frac{\gamma h_x}{S_s C_b}$

$= \frac{(3)(2)}{(2.9)(0.8)}$

$= 2.6$

check: not more than $\frac{3\ kPa}{(2.6)(0.8)}$ (0.9)

C_a [= 1.16] Governs

Load Case III:

↳ x_{30} = value of x where $\alpha = 30°$ or value of x at edge of roof if $\alpha_a < 30°$

- for $0 < x < x_{30}$: $C_a = \frac{2}{C_b}\frac{x}{x_{30}}$ A

$= \frac{2}{0.8}\left(\frac{9.3}{9.3}\right)0.4$

[= 2.25]

Since Case II produces the lower total load per unit length of building perpendicular to the span $\therefore$ [C_a = 1.16] Governs

⇒ Specified Snow Loading (S)

$S = I_s[S_s(C_b C_w C_s C_a) + S_r]$

$= 1.0[2.9(0.8)(0.75)(1.0)(1.16) + 0.7]$

[S = 2.72 kPa]

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Date: Mar. 10th, 2010

Title: Snow Loads - Steel Tank Sheet 1 of 3

Specified Snow Loading (S)

* $S = I_s [S_s (C_b C_w C_s C_a) + S_r]$ * NBC Clause 4.1.6

Notes: - For detailed Snow Load Calculations & typical assumptions see "Snow Loads - Concrete Tank" Appendix

- The following calculations are based on the same typical assumptions as the concrete tank, however some assumptions differ due to the different material surface conditions

- $I_s = 1.0$
- $S_s = 2.9$ kPa
- $S_r = 0.7$ kPa
- $C_b = 0.8$
- $C_w = 0.75$

- Assume aluminum parabolic dome roof for steel tank has the same slope as the parabolic concrete dome roof.
  ∴ $\alpha \approx 25°$

- Roof Slope Factor (C_s) * NBC Clause 4.1.6.2 (6)

  L) Assume Aluminum roof has an unobstructed slippery surface

$$C_s = (60° - \alpha)/45°$$
$$= (60° - 25°)/45°$$

$$\boxed{C_s = 0.78}$$

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Date: Mar. 10th 2010

Title: Snow Loads - Steel Tank Sheet 2 of 3

- Shape Factor (C_a) * Figure G-3 - Structural Commentary G to the NBC 2005
  - Uniform and unbalanced load distributions
  - Assume Snow Density, $\gamma = 3.0\ kN/m^3$
  - $h/b = 2/18.6 = 0.11 > 0.05$ ∴ OK
  - $A = \frac{h/b}{0.12} = \frac{0.9}{0.12} \leq 1.0$ ∴ OK

Load Case II : $C_a = 1.0$ Balanced Loading

$$S = I_s[I_{Sa}(C_b C_w C_s C_a) + S_r]$$
$$= 1.0[2.9(0.8)(0.75)(0.78)(1) + 0.7]$$
$$S = 2.06\ kPa$$

- check unbalanced loading conditions; Cases II & III

Load Case II : $C_a = \frac{\gamma h_x}{S_a C_b}$

$$= \frac{(3)(2)}{(2.9)(0.8)}$$
$$= 2.6$$

check: not more than $\frac{3\ kPa}{(2.9)(0.8)} = 1.16$ (0.9) Governs

Load Case III :

- x_{30} = value of x where $\alpha = 30°$ or value of x at edge of roof if $\alpha < 30°$
- For $0 < x < x_{30}$: $C_a = \frac{2}{C_b}\left(\frac{x}{x_{30}}\right) A$

$$= \frac{2}{0.8}\left(\frac{9.3}{9.3}\right) 0.9$$
$$= 2.25$$

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Date: Mar 10th, 2010

Title: Snow Loads - Steel Tank Sheet 3 of 3

- Since Case II produces the lower total load per unit length of building perpendicular to the span ∴ [$C_w = 1.16$] Governs

⇒ Specified Snow Loading (S)

$$S = I_s [S_s (C_b C_w C_s C_a) + S_r]$$

$$= 1.0 [2.9 (0.8)(0.75)(0.78)(1.16) + 0.7]$$

$$[S = 2.27 \text{ KPa}]$$

Appendix C

SGMC

Date: Feb. 12th, 2010

Title: Wind on - Concrete & Steel Tank Sheet 1 of 5

Total Force on walls (F_w) * Figure I-24, Structural Commentary H

- $F_w = C_p \cdot q \cdot C_g \cdot C_e \cdot A$, where $A = d \cdot h$

Total Force on Roof (F_r) * Figure I-27, Structural Commentary I

- $F_r = (p_i + p_e) A$, where $p_e = C_p \cdot q \cdot C_g \cdot C_e$ and $A = \frac{1}{4} \pi d^2$

I_w = importance factor
q = 1-in-50 yr reference velocity pressure (kPa)
C_e = Exposure Factor
C^*_e = Corresponding modified Factor value for use on Hills or Escarpments
C_g = Gust effect factor
C^*_{fa} = Corrector gust factor for Hills or Escarpments
C_f = Force Coefficient
C_p = External pressure coefficient

- Importance factor (I_w)
  - Storage tank has importance category **Normal**
  - Limit States Design
  - $I_w = 1.0$
- 1-in-50-year reference velocity pressure (q)
  - City of St. John's, Newfoundland
  - Table C-2, Appendix C, NBC 2005
  - Determined for an elevation of 10 metres above the ground surface and represent one hour mean values
  - $q = 0.8$ kPa

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Date: Feb. 12th, 2010

Title: Wind Loads

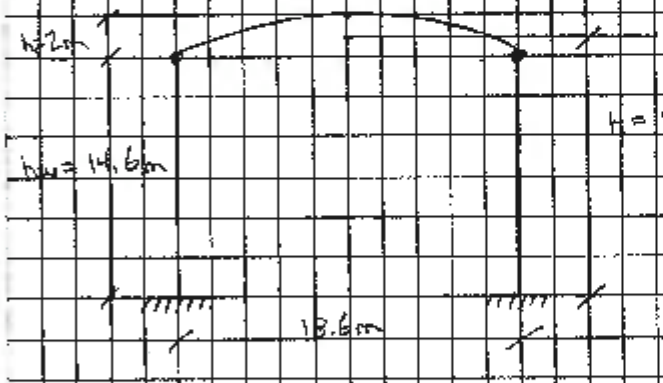
Sheet 2 of 5

- Exposure Factor (C_e) * NBC Clause 4.1.7.1 (5)
  - Assume open terrain

$C_e = (h/10)^{0.2}$ h = reference height (mid-height of roof for sloping roofs $\alpha \geq 7°$)

$C_e = (15.6/10)^{0.2}$

$C_e = 1.09$ } Governs > 0.9



h = 15.6m - Reference height

- Corresponding Modified exposure Factor (C^*_e)
  - Assumed Storage Tank Constructed on a escarpment
  - Assumed 2-dimensional escarpment
  - Structural Commentary I : Paragraph (14) & Fig I-6

$\Rightarrow C^*_e = C_e \left\{ 1 + \Delta S_{max} \left(1 - \frac{|x|}{KL} \right) e^{(-\alpha z/L)} \right\}^2$

$\Delta S_{max} = 1.3 \frac{H_h}{L_h}$ - assume $H_h = 30m$, $L_h = 15m$

$\frac{H_h}{L_h} = \frac{30m}{15m} = 2 > 0.5$ $\therefore$ assume $\frac{H_h}{L_h} = 0.5$

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Date: Feb. 12th, 2010

Title: Wind Loads

Sheet 3 of 5

- $S_{max} = 1.3\, H_h/L_h$
  $= 1.3(0.5)$
  $= 0.65$; $\alpha = 2.5$
- Assume tank is @ crest of escarpment
  - $x = 0$
  - $z = 0$

  } Conservative

- $C^*_e = C_e \left\{ 1 + 1.5\, S_{max} \left(1 - \frac{|x|}{L_u} \right) e^{-\alpha \frac{z}{H_h}} \right\}^2$
  $= C_e \left(1 + 1.5\, S_{max} \right)^2$
  $= (1.09)(1 + 0.65)^2$
  $C^*_e = 2.97$
- Gust effect factor (C_g) : NBC clause H.1.7.1(6)
  - Structure as a whole

  $\therefore C_g = 2.0$

- Corrected gust factor for Hills & Escarpments (C^*_g)
  - Structural Commentary J: Paragraph (7.1)

$$C^*_g = 1 + (C_g - 1)\sqrt{\frac{C_e}{C^*_e}}$$
$$= 1 + (2.0 - 1)\sqrt{\frac{1.09}{2.97}}$$
$$C^*_g = 1.61$$

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Date: Feb. 12th, 2010

Title: Wind Loads

- Total Force on Walls (F_w)
  - b) Figure F-24, Structural Commentary I

$$F_w = C_f \cdot q \cdot C^*_q \cdot C^*_e \cdot A$$

- C_f = Force Coefficient for $\frac{d\sqrt{q_s C_e}}{18.6\sqrt{0.8(2.97)}} = \frac{18.6}{28.7} > 0.167$ ∴ OK
- Slenderness $h/d = 14.6/18.6 = 0.78 < 1.0$
- Assume moderately smooth

∴ $C_f = 0.5$

- $A = d \cdot h$
  $= (18.6)(14.6)$
  $= 271.6\ m^2$

∴ $F_w = C_f \cdot q \cdot C^*_q \cdot C^*_e \cdot A$
$= (0.5)(0.8\ kPa)(1.6)(2.97)(271.6\ m^2)$
$= 477.5\ KN$

or $F_w / A = \frac{477.5\ KN}{271.6\ m^2} = 1.76\ kPa$

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Date: Feb. 12th, 2010

Title: Wind loads

Sheet 5 of 5

- Total Force on Roof (F_r)
  - Figure I-27, Structural Commentary I

$F_r = (p_i - p_e) A$

- Assume no internal pressure, $\therefore p_i = 0$

- $A = \frac{\pi}{4} d^2$

$= \frac{\pi}{4} (18.6)^2$

$A = 271.7\ m^2$

- $p_e = C_p \cdot q \cdot C^*_g \cdot C^*_e$

- External pressure coefficient, $C_p = -1.0$

$\therefore p_e = (-1)(0.80\ kPa)(1.61)(2.97)$

$= -3.52\ kPa$

$\therefore F_r = (p_i - p_e) A$

$= -(3.52\ kPa)(271.7\ m^2)$

$= 955.4\ kN$

$= 3.52\ kPa$

Appendix D

SGMC

Date: Feb. 12th, 2010

Title: Seismic Loading Sheet 1 of ____

- NBC 2005 (Clause 4.1.8.1(1)
  - └) The deflections and specified loading due to earthquake motions does not need to be considered $S(0.2)$ as defined in Sentence 4.1.8.4(6) is less than or equal to 0.12
- $S(T) = F_a S_a(0.2)$ for $T \leq 0.2s$
  - └) Assume Ground Profile as "Hard Rock", therefore Site Class A
  - └) 5% damped spectral response acceleration value for $S_a(0.2) = 0.18$ for St. John's, NL.
    - * Table J-2, Structural Commentary J
  - └) Since $S_a(0.2) < 0.25$, and Site Class A assumed, $F_a = 0.7$
    - * Table 4.1.8.4.B - NBC 2005

$$\therefore S(0.12) = F_a S_a(0.2) \text{ for } T \leq 0.2s$$
$$= (0.7)(0.18)$$
$$= 0.13$$

Appendix E

SGMC

Date: February 11, 10

Title: Concrete Tank Design (Shell) Sheet 1 of 7

Step 1: Define Parameters

d = 61 ft
H = 46 ft
r = 30.5 ft
h = 6.99 ft
a = 30.5 ft assumed
ϕ = 25°
b = 6.56 ft
γ = 62.4 lb/ft^3
P = 0
f_c' = 5080 psi
f_{ci} = 375 psi
F_{tc} = 2574 psi
f_c = .45 F_{ci} = 2250 psi
f_{cv} = 200 psi
f_{pu} = 270000 psi
f_{pi} = .7 f_{pu} = 188984 psi
f_{py} = 230000 psi
f_{ps} = 220000 psi
f_{pe} = 0.55 f_{pu} = 148520 psi

Step 2: Shell Design

Assume Shell wall thickness = 200 mm ≈ 7.87 in
≈ .655 ft

Compute $F = \gamma(H-Y)r$
$= 62.4(46-0)(30.5)$
$= 87547.2$ lb/ft

* Y = 0 in this case due to greatest pressure at H = 0 (Bottom of tank)

$\beta = \frac{[3(1-\mu^2)]^{1/4}}{(rt)^{1/2}}$ $\mu_{concrete} = 0.20$

$= \frac{[3(1-.2^2)]^{1/4}}{(30.5 \cdot .655)^{1/2}} = 0.29$

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Date: February 11, 10

Title: Concrete Tank Design (Shell) Sheet 2 of 7

Select membrane Coefficient, C, from Table 10.9-10.16.

$\frac{H^2}{Rt} = \frac{46^2}{61.655} = 52.96 \approx 53$

Using Table 11.6a & Interpolation.

C = 0.00087 ∴ .95H

= .95(46) = 43.7 Ft

Using Table 11.12a & Interpolation.

C = .907 ∴ .85H

= .85(46) = 39.1 Ft

Compute max M_y @ y above Base.

$M_y = C(\gamma H^3 + p H^2)$ * C from Table 11.6a used.

$= .00087(62.4)(46)^3 = 5284.18$ ft lb/ft

$M_o = 0$ Ft·lb/ft

Horizontal radial Ring Tension

$Q_o = +(2\beta H + 1)\frac{Yrt}{\sqrt{12(1-\mu^2)}} = +(2(.291)(46)-1)\frac{62.4(30.5)(.5)}{\sqrt{12(1-.2^2)}}$

$= +9465.59$ lb/ft

$\Delta Q_y = \frac{\gamma_c(1-\mu^2)}{\beta^3 r t^2}[\beta M_o \psi(\beta y) + Q_o \theta(\beta y)]$

Find y: Using C from Table 11.12a

C = .906 .85H = 39.1 ft ∴ y = 46 - 39.1

= 6.9 ft

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Date: February 11, 10

Title: Concrete Tank Design (Shell) Sheet 3 of 7

$\therefore$ $B_y = 6.9 \cdot .291 = 2.00$

Using Table 11.1. (Table of functions)

for $B_y = 2.00$ $\quad \phi = .0667$ $\quad \theta = -.0563$

$\psi = .1794$ $\quad \xi = .1230$

$$\therefore \Delta Q_y = + \frac{6(1-.2^2)}{.291^3 (30.5)(.655)^2} \left[0 + 9465.59(-.0563)(2) \right]$$

$$= -18651.91 \text{ lb/ft}$$

$$= 18651.91 \text{ lb/ft} \quad (\text{use } +)$$

$$Q_y = F - \Delta Q_y = 87547.2 - 18651.91$$

$$= 68895.29 \text{ lb/ft}$$

Step 3: Compute concrete fibre stresses at critical base sections.

Choose Vertical pressure P_y by Trial & Error

Trial 1 $P_y = 50000$ $\rightarrow$ Did Not Work

Trial 2 $P_y = 85000$ lb/ft $\checkmark$

Prestressing Effects using 200 psi Residual Radial Compression

$f = C \cdot f$

$= .906 (87547.2) = 79317.76$ lb/ft.

K (of Table 11.12a used)

Ring force

$X = 79317.76 + [200 \cdot 7.87 \times 12]$

$= 98205.76$ lb/ft.

$\therefore Q_{30.1} = 98205.76$ lb/ft

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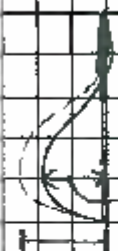
Date: Febuary 11, 10

Title: Concrete Tank Design (Shell) Sheet 4 of 7

Moment



$Y = \frac{My}{S} \times \beta_{39.1}$

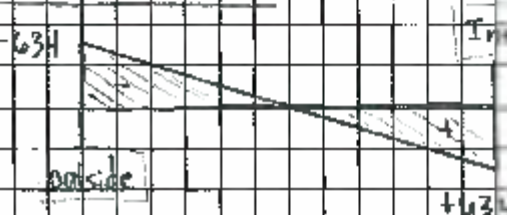
$= 5284.18 + \frac{98205.76}{79317.716} = 6542.5$ ft lb/ft

Wall Max Concrete Stresses (Hinged Base) at 43.7 ft from Top

* Using Table 11.6a C.

Wind loading = 36.76 lb/ft² = .225 lb/in² (Psi)

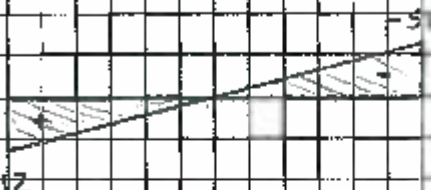
Ca taken from wind load calculations.



$F_t = \frac{Y}{S} = \frac{6542.5 \times 12}{\frac{12(7.87)^2}{6}} = 6339$ psi $= \pm 634$ psi

① Horizontal P/S moment.

$F_t = \frac{My}{S} = \frac{5284.18 \times 12}{\frac{12(7.87)^2}{6}} = 511.90$ psi $= \pm 512$ psi



② Liquid Moment.

$F_v = \frac{PV}{A_t} = \frac{-85000}{12 \times 7.87} = -900$ psi

$F_N = -.225$ Psi

Total $F_v = -900.225$ psi

③ Vertical P/S

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Date: February 11, 10

Title: Concrete Tank Design: (Shell) Sheet 5 of 7

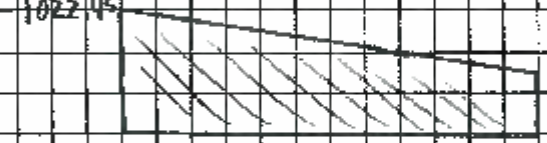
f_4 = ① + ③ = +634 + −900.225
= 266.225 psi
−634 + −900.225
= −1534.225 psi

** Wind Loads Added to Empty Tank ④ EMPTY TANK

Max F_t = $\frac{257}{3\sqrt{f_c'}}$ psi ≅ 266 psi ∴ OK

Max f_c = −1534.225 psi < .45 f_c' ∴ OK

F_5 = ① + ② + ③ = +634.225 + 512 + −900.225
Max f_c = −1022.45 psi < .45 f_c'
∴ OK



⑤ Full Tank

(−) Compression (+) Tension

Step 4 Is t adequate? Yes! Final t = 7.87 in
= 200mm

Step 5 Compute Factored Moment M_u using load factors;

Nominal Moment Strength Check of Tank wall;
↳ Initial liquid pressure = 1.3 (5#)
↳ Max Vertical Moment for A hinged Wall ⇒ M = 6542.51

M_u = SF · M = 1.3 × 6542.51
= 8505.89 Ft lb/ft

Req M_n = $\frac{M_u}{.9}$ = $\frac{8505.89}{.9}$ = 9450.32 Ft lb/ft

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Date: February 11, 10

Title: Concrete Tank Design (Shell) Sheet 6 of 7

Available $M_n = A_{ps} f_{ps} \left(d_p - \frac{a}{2}\right) + A_s f_y \left(d - \frac{a}{2}\right)$

$d = \frac{t}{2} = \frac{7.87}{2} = 3.935$ in

Assume A 26% loss in prestressed Concrete.

$\therefore$ 74% effective

$f_{pe} = .74 \times 188\,984 \text{ psi} = 139\,849.2$ psi

$A_{ps} = \frac{Q_{3911}}{f_{pe}} = \frac{98205.76}{139\,848.2} = .702$ / 1 Ft wall Height

Assume $\frac{1}{2}$ in diameter 270K 7 wire strand tendons

$\therefore$ Area = .144 in^2 / Strand

# of Horizontal Strands / 5 Ft Height = $\frac{.702 \times 5 \text{ ft}}{.144} \doteq 25$ tendons

# of Wire loops in 5 Ft band = $\frac{.702 \times 5}{.0289} = 122$

$\therefore$ 122 wire loops in the 5 Ft wall band whose base is 39.1 ft below water level.

Vertical Tendons

$A_{ps\,vert} = \frac{P_v}{f_{pe}} = \frac{85000}{139\,848.2} = .608$ in^2

use $\frac{1}{2}$ in diameter 270K 7 wire Strand A = .144 in^2

4 Per Ft of Circle

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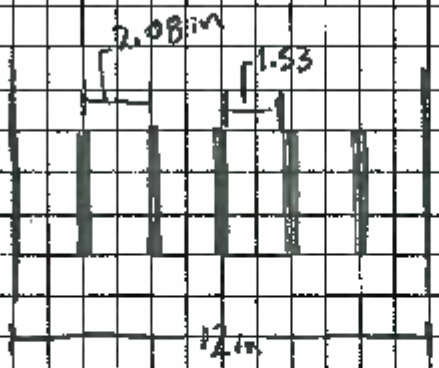
Date: February 11, 10

Title: Concrete Tank Design (shell) Sheet 7 of 7

.600 ÷ .144 = 5 Strands

Spacing



5 strands @ .5in diameter
+ .7 Sq inch of Steel
Centre to Centre
* equally Spaced.

12 - 2.5
= 9.5 in ÷ 6 = 1.58 in. Clear Space.

Centre to Centre Space = 2.08 in

Nominal Moment Strength Check cont. pg. 5

$A_{ps} = \frac{.144}{2.08} = 0.069 \text{ in}^2/\text{in width}$

$a = \frac{A_{ps} f_{ps}}{.85 f'_c} = \frac{.069 \times 220000}{.85 \times 5000 \times 1} = 3.58 \text{ in}$

$\therefore M_n = .069(220000)\left(3.935 - \frac{3.58}{2}\right) = 32561.1 \text{ ft-lb/ft}$

M_n >> Rqd Min ∴ OK

Step 6

$M_u < \phi M_n$

$8505.29 < .9(32561.1)$

$8505.29 < 29331.99$ ∴ OK

Appendix F

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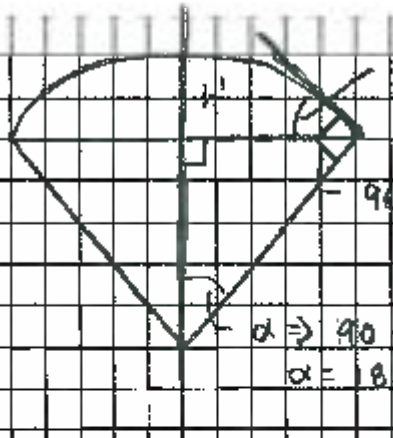
Date: February 11, 10

Title: Concrete Tank Design (Dome Roof) Sheet 1 of 5



$\alpha \Rightarrow 90 + 65 = 155$

$\alpha = 180 - 155$

$= 25°$

$h' = 6.56$ Ft.

$d = 61$ Ft

Radio

$\frac{h'}{d} = \frac{6.56}{61} = .1075 \leq .125$

$\therefore$ OK

Windload

Condition $.9D \geq 1.4 W_L$

$.9D \geq 1.4(75)$

$.90 \geq 105$

$D \geq 116.67$

$\therefore D \geq 117$ lb/ft $\Rightarrow$ Self weight of Roof

Wind load = 75 lb/ft

* Taken from wind load calculations.

$150 \times \frac{t}{12} \geq 117$ Solving for t.

$t \geq 9.35$ in.

$\therefore$ use t of 9.5 in

* This thickness would overcome the Suction Pressure. $\therefore$ OK

Snow Load

Assume Ring Beam Section $b \times h = A_c$

* Entire shell would be in Compression, and only temperature Reinforcement is needed (due to $\alpha = 25 \leq 51°49'$)

Shell Radius (a)

$a = \frac{d/2}{\sin\alpha} = \frac{30.5}{\sin 25} = 72.2$ Ft

SGMC

Date: February 12, 10

Title: Concrete Tank Design (Dome Roof) Sheet 2 of 5

Minimum shell thickness to withstand buckling

Use $t = 9.5$ in

Area of Roof = $\pi (65.6/2)^2 = 3382\ ft^2$

$P_{conc} = 150\ lb/ft^3$

Self weight = $150 \times 9.5/12 = 119\ psf$

$P_{snow} = 56.6\ lb/ft$

$P_{dead} = 119\ psf$

$P_{service} = 20.9\ lb/ft$

load Combinations

$P_u = 1.25D + 1.5L$

$= 1.25(119) + 1.5(77.9)$

$= 265.60\ lb/ft^3$

$L = 56.6 + 20.9$

$= 77.5\ lb/ft$

$DL = 119\ lb/ft$

$\phi = .65$ (Concrete)

$B_i = \left(\frac{a}{r_i}\right)^2 = \left(\frac{72.2}{1.4 \times 72.2}\right)^2 = .51$

$B_c = .44 + .003\ N_L \quad < .53$

$= .44 + .003(77.9)$

$= .674 \quad > .53$ $\therefore B_c = .53$

$E_c = 57000\sqrt{f_c'} = 57000\sqrt{5080}$

$= 4.06 \times 10^6\ psi$

$Min\ h = a\sqrt{\frac{1.5\ P_u}{\phi B_i\ \phi_c\ E_c}}$

$= 72.2\sqrt{\frac{1.5(248.05)}{.65(.51)(.53)}}$

$= 1.648 < 9.5\ inch$ $\therefore ok$

SGMC

Date: February 12, 10

Title: Concrete Tank Design (Dome Roof) Sheet 3 of 5

Use a shell of t = 9 in

$\sin\phi = \sin 25 = .4226$

$\sin\phi = \cos 25 = .906$

$a = 72.2$ ft

Tangential force per unit length of circumference

$$N_\theta = \frac{W_0 d}{2\sin\alpha}\left[\frac{1}{1+\cos\alpha} - \cos\theta\right] - \frac{w_1 d}{4\sin\alpha}(\cos 2\theta)$$

$$= \frac{119(61)}{2(.4226)}\left[\frac{1}{1.906} - .906\right] - \frac{77.9(61)}{4(.4226)}(.6942)$$

$$= -3221.46 - 1804.73$$

$$= -5026.19 \text{ lb/ft}$$

Meridional force per unit length of circumference

$$N_\phi = -a\left[\frac{w_0}{1+\cos\theta} + \frac{w_1}{2}\right]$$

$$= 72.2\left[\frac{119}{1.906} + \frac{77.9}{2}\right] = -7319.95 \text{ lb/ft}$$

Radial Prestressing in the Ring Beam required to produce compatibility of deformations with the shell wall is;

$$P = \frac{bh}{t}(N_\theta - \mu N_\phi) + \frac{d}{2}(N_\phi \cos\phi)$$

To Determine $\frac{bh}{t}$

$$P = \frac{d}{2}(N_\phi \cos\theta) = \frac{61}{2}(-7319.95 \times .906)$$

$$= -202,272.18 \text{ lb/ft}$$

Given that the total prestress loss = 26%

$$\gamma = 1 - .26 = .94$$

Date: February 12, 10

Title: Concrete Tank Design (Dome Roof) Sheet 4 of 5

$\therefore P_c = \frac{202\,272.18}{.74} = 273\,340.78$ lb/ft.

Use a maximum concrete compressive stress $f_c = 800$ psi in order to minimize excess strain in the edge

$A_c = b \cdot h = \frac{P_c}{f_c} = \frac{273\,340.78}{800} = 341.67 \approx 342$ in^2

Try $b = 16$ in $\quad h = 22$ in

$A_c = 16 * 22 = 352$ in^2 > 342 in^2 $\therefore$ OK

$P = \frac{35^2}{9.5} \cdot \frac{1}{12}\left[-5026.19 - 2(-7319.95)\left[1 + \frac{61}{2}\right](-7319.95 \times .906)\right]$

$= 3.08\,[-3562.2] + -202\,272.18$

$= -10971.576 + -202\,272.18$

$= -213\,243.76$ lb/ft

$f_{pi} = .7 f_{pu} = 188\,984$ psi

$P_i = \frac{P}{.74} = \frac{-213\,243.76}{.74} = -288\,167.24$ lb

$A_{ps} = \frac{P_i}{f_{pi}} = \frac{288\,167.24 \text{ lb}}{188\,984 \text{ psi}} = 1.52$ in^2

$\frac{1}{2}$ inch diameter 7 wire 270k strands

A_{ps}/strand $= .144$ in^2

# of strands $= \frac{1.52}{.144} = 10.56 \approx 11$ strands

SGMC

Date: February 12, 10

Title: Concrete Tank Design (Dome Roof) Sheet 5 of 5

Check the concrete stress in the critical section t = 9.5 of the shell Rim

$N_\phi = -7319.95$

$f_c = \frac{N_\phi}{12 \times t} = \frac{-7319.95}{12 \times 9.5} = -64.21$ psc Only

∴ OK

Appendix G

Date: _____

Title: Concrete Tank Design (Saddle) Sheet 1 of 3

P

← Treat as just a rectangle

Area of Roof = 3382 ft²

$P_{self} = 150(9.5/12)$ psf = 119 lb/ft²

P_E = 150 lb/ft²

P_{snow} = 56.6 lb/ft²

P_{Total} = 89 lb/ft²

- Weight taken by Ring Beam Saddle;

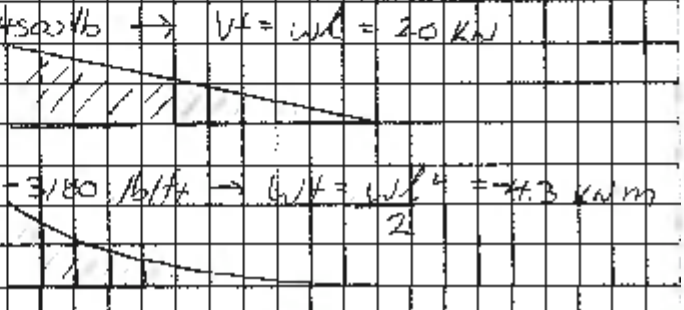
(150 + 89)(3382) = 794 370 lb

- Area of Ring Beam = $\pi(30.5)^2 - \pi(30.5 - 16/12)^2$ = 250 ft²

∴ Saddle will take $\frac{794\,370\text{ lb}}{250\text{ ft}^2}$ = 3180 lb/ft²

- Design per foot of circumference;

- Consider loading acting on entire length of Ring Beam



SGMC

Date: _____

Title: Concrete Tank Design (Saddle) Sheet 2 of 3

$M_r = K_r b d^2 \times 10^6$

Let $M_r = M_n = 3180$ lb·ft

$V_f = 20$ kN ; $M_f = -4.3$ kN·m

$K_r = \frac{M_r \times 10^6}{b d^2} = \frac{4.3 \times 10^6}{(305)^3}$ ∴ Assume $b = 305$ mm

$\Rightarrow K_r = 0.15$ ∴ USE $A_{s\,min}$ → Assume 20M Bars and clear cover = 60 mm

$A_{s\,min} = \frac{0.2\sqrt{f'_c}\, b h}{f_y} = \frac{0.2\sqrt{35}\,(305)(305 + 20/2 + 60)}{400} = 340\ mm^2$

$\rho = \frac{A_s}{bd} = \frac{340}{(305)^2} = 0.4\% \quad \therefore$ OK

- Check shear:

$V_c = 0.1\,\beta\,\lambda\,\phi_c\sqrt{f'_c}\, b_w d_v$ ∴ $d_v = .375(0.72) = 270$ mm

or

$d_v = 0.9(d) = 275$ mm ← Governs

∴ Assume $\beta_g > 30$ mm → $\beta = 0.18$

$V_c = (0.55)(1)(0.18)\sqrt{35}\,(305)(275) = 58$ kN $> V_f = 20$ kN ✓ OK

∴ No shear reinforcement needed

- 340 / 300 = 1.13 bars / ft

$l = \pi d_b = 19.2\ d_b$

Spacing (s) = 0.88 ft = 270 mm > 30 mm ✓ OK

SGMC

Date: _____

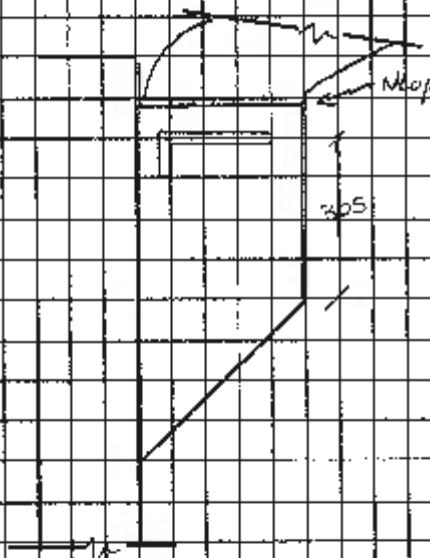
Title: Concrete Tank Design (Saddle) Sheet 3 of 3

$l_d = 0.45 \lambda_1 \lambda_2 \lambda_3 \lambda_4 \frac{f_y}{\sqrt{f'_c}} d_b = \frac{0.45(\phi 8)(400)(20)}{\sqrt{35}} = 933\ mm$

∴ must use a hook;

$l_d = \frac{100 d_b}{\sqrt{f'_c}} = 340\ mm$ ✓ OK

Use 20M - 300 mm x 40 mm Hook @ 220 mm c/c

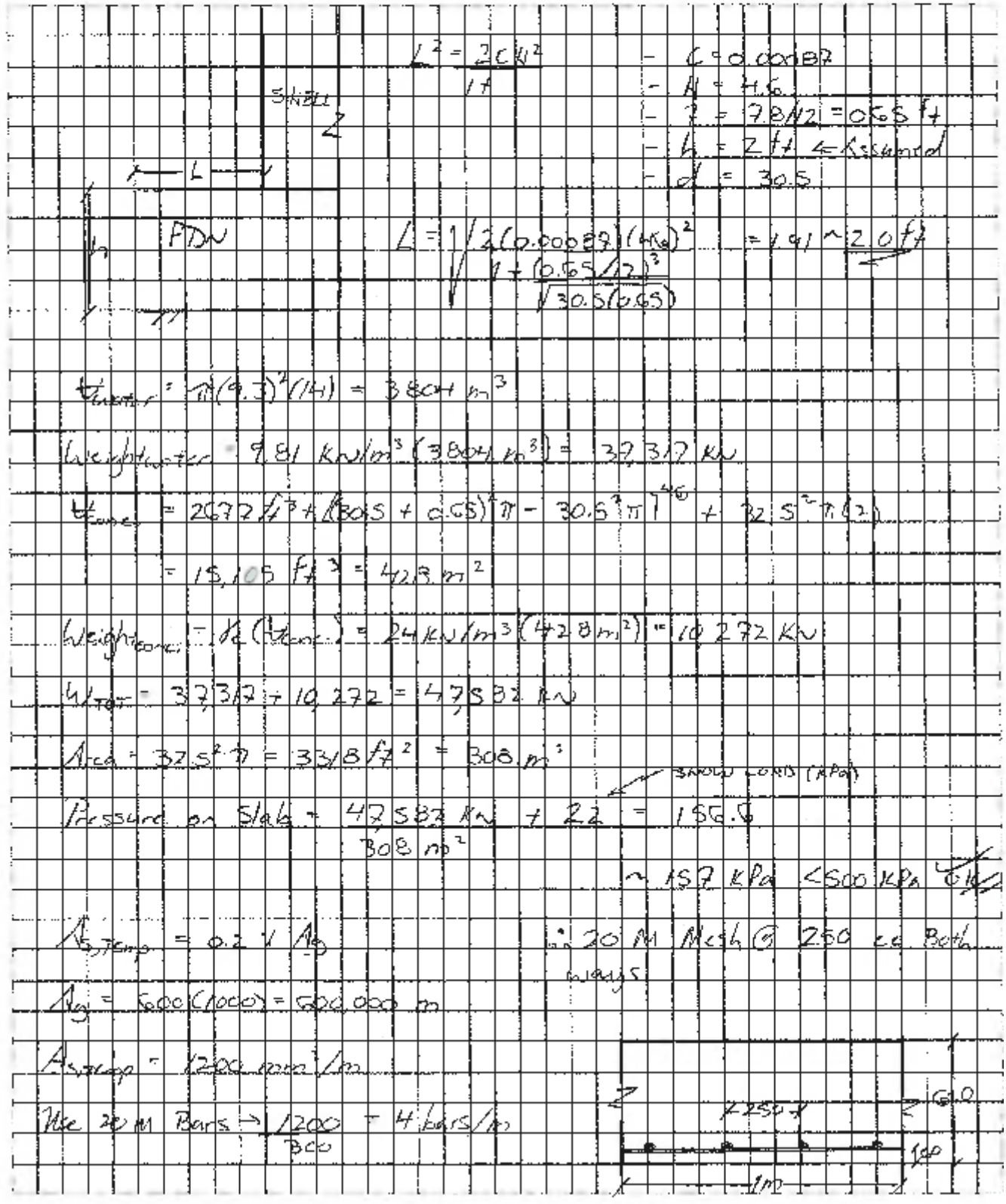


Appendix H

SGMC

Date: _____

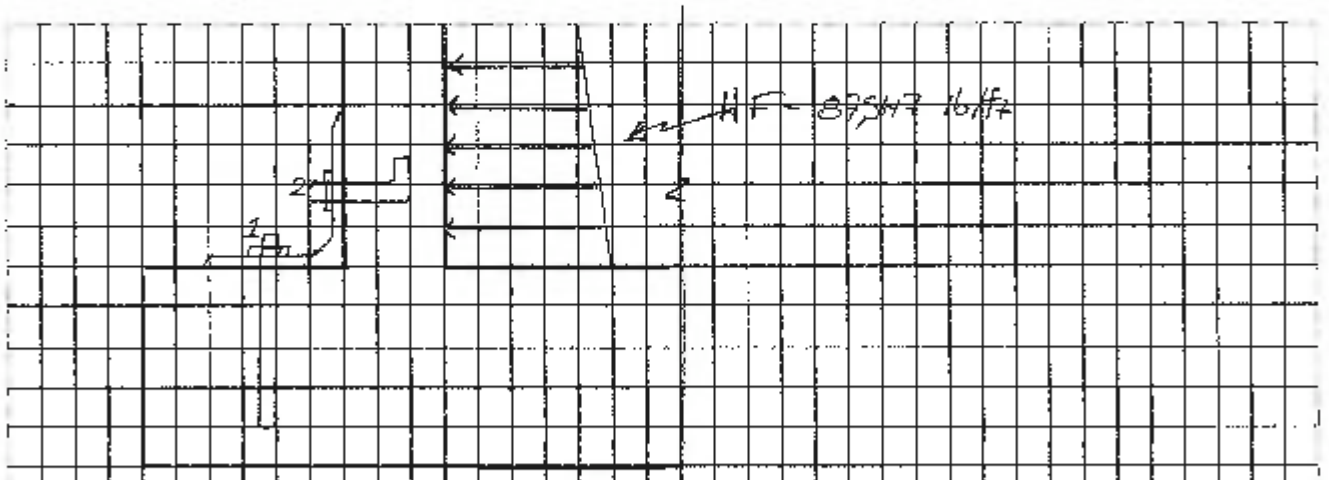
Title: Concrete Tank Design (Foundation) Sheet 1 of 1



Appendix I

Date: _____

Title: Concrete Tank Design (Slab & Shell Conn.) Sheet 1 of 5



- Design Per meter of Circumference (Bolt #2)

$$87{,}547 \frac{lbf}{ft} \times \frac{kN/m}{69.16 lbf/ft} = 1269 \text{ kN/m} = V$$

- Use A490M - M24 Bolts ; $F_u = 1040$ MPa, $\phi_b = 0.80$, $m = 1$

$V_r = 0.6 \phi_b n_s A_b F_u \rightarrow$ Let $V_r = V_f = 1.25(1269) = 1587$ kN

$$n = \frac{1587 \times 10^3}{250(0.8)(1040)(452)} = 7.03 \text{ bolts/m} = \underline{8 \text{ Bolts/m}}$$

- Use L 203 x 203 x 13

$B_r = 3 A_{br} 7 d_b n F_{up} \rightarrow F_u = 450$ MPa ; $\phi_{br} = 0.67$

Let $B_r = V_r = 1587$ kN

$$n = \frac{1587 \times 10^3}{3(0.65)(13)(24)(450)} = 5.6 \text{ Bolts/m} = \underline{6 \text{ Bolts/m}}$$

Date: _____

Title: Concrete Tank Design (Slab & Shell Conn.) Sheet 2 of 5

- Check shear @ Angle Leg Connection;

$V_n = 0.6 \phi_s A_{gv} F_y$ where; $\phi_s = 0.9$, $A_{gv} = 13k$, & $F_y = 35ksi$

Let $V_n = V_f$

$$L = \frac{1582 \times 10^3}{0.8(0.9)(350)(13)} = 646 \text{ k/m} \quad \text{OK!!}$$

Bolt spacing $= \frac{650 - 8(27)}{9} = 48mm + 27mm = 75mm$ c.c.

$2.7 d_b = 2.7(24) = 65mm < 75mm$ OK!!

Edge Dist. $= 48mm > 42mm$ OK!!

- Check Bolt Group #2 for effects of Wind & Tension Cracking;

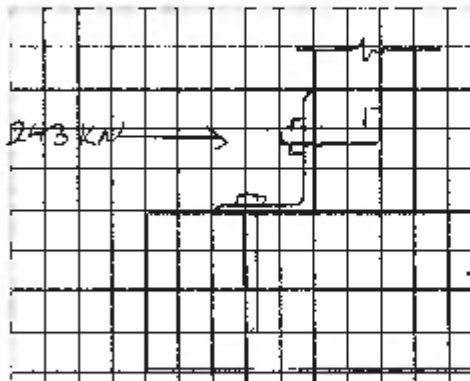
$V = 946.6 \frac{lb}{ft} \times \frac{1 kN/m}{68.9 lb/ft} + (1.76 kN/m^2)(14m) = 38.2 kN/m$

$V_f = 1.5(162) = 243 kN/m$

∴ 243 kN/m is much less than hydrostatic force, thus need not check shear @ Angle Leg Conn., Bearing of Bolt Group #1 and Shearing of Bolt Group #2

Date: _____

Title: Concrete Tank Design (Slab & Shell Conn.) Sheet 3 of 5



- Check Torsion on bolts;

$T_r = 0.75 \phi_b A_b F_u = 0.75(0.8)(1040)(452) = 282\ KN > 243 KN$ ✓OK!!

- Check Shear Block Failure;

$T_r + V_r = \phi A_{nt} F_u + 0.6 \phi A_{gv} F_y$

$= 0.8(7)(13)(48)(490) + 0.6(0.85)(13)(7)(95)(30) = 2138 KN$

OR

$T_r + V_r = \phi A_{nv} F_u + 0.6 \phi A_{gv} F_y = 1,792 KN$ ← Governs

$\therefore 1,792\ KN > 243 KN$ ✓OK

- Tension Failure In Angle;

$T_r = 0.75 \phi A_n F_y = 0.75(0.8)(13)(7)(48)(390) = 1032\ KN > 243 KN$ ✓OK

*Note; As per request from Fgal's Green Bahrain, the angle will be continuous around the tank shell (not 650mm Long W/ 350 mm Spaces)

New spacing = 1000 / 8 = 125 mm

Date: _____

Title: Concrete Tank Design (Slab & shell Conn.) Sheet 4 of 5

- Concrete breakout resistance;

$\psi_{c,N} = 1$

$h_{ef} = 200 - 25 - 23 = 116$ mm

$\psi_{ed,N} = 0.7 + 0.3\left(\frac{1}{1.5}\right) = 0.9 \approx 1$ OK

$\psi_{c,N} = 1.25$

$\psi_{cp,N} = 1$

$N_b = k_c \lambda_a \sqrt{f'_c}\, h_{ef}^{1.5}$ R where; $k = 10$, $\lambda_a = 0.85$, $R = 1.0$

$= 10(0.85)(1)(35)^{0.5}(116)^{1.5} = 148$ kN

$A_{co} = 9h_{ef}^2 = 9(116)^2 = 121,104$ mm^2

$A_N = [1000 + 48 + 3(116)][3(116)] = 493,056$ mm^2

$N_{cbg} = \frac{493,056}{121,104}(1)(1.25)(148) = 244$ kN > 243 kN OK

- Check pull out resistance;

$N_{cp} = \psi_{cp} N_{pr}$

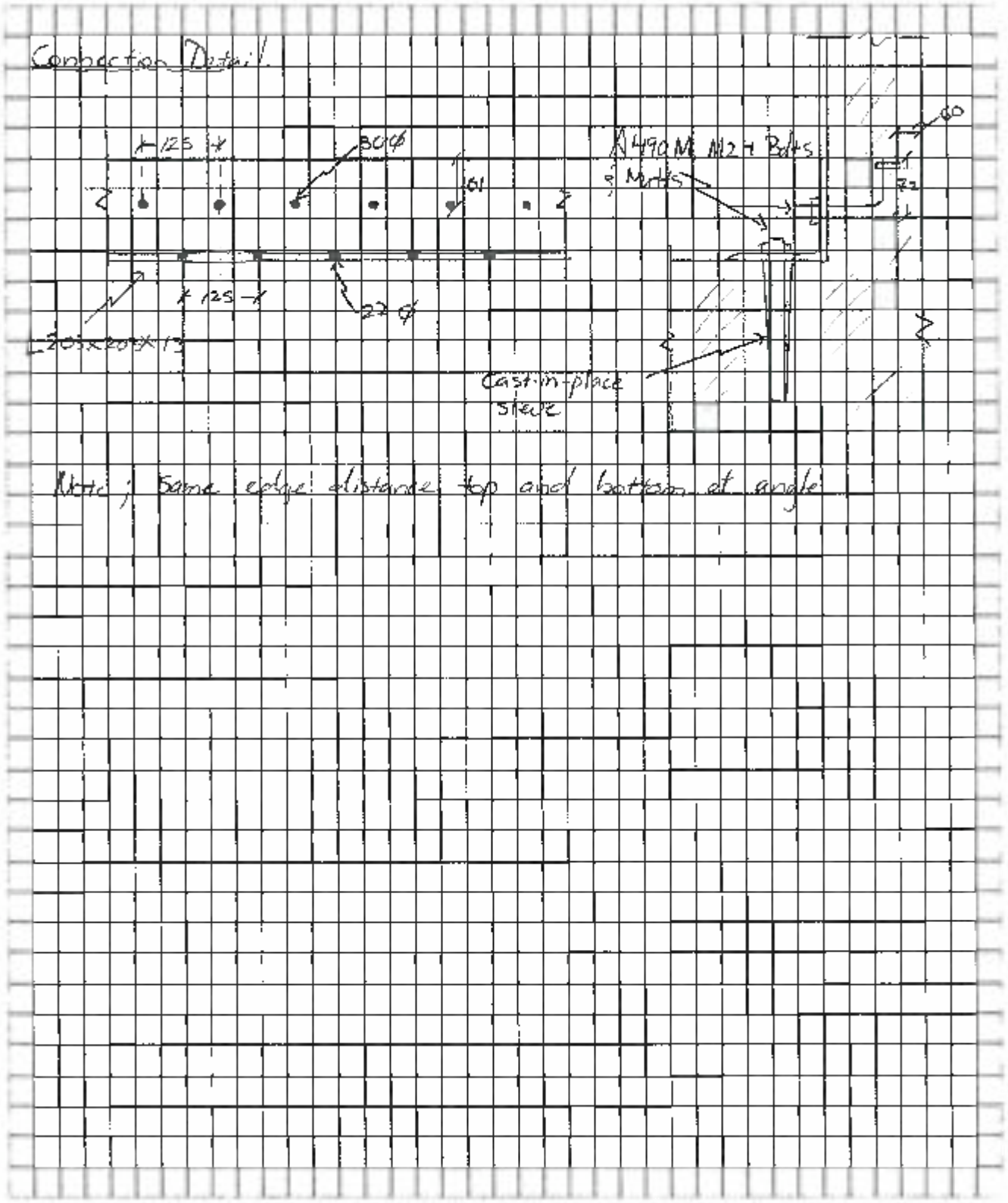
$N_{pr} = 0.9 \phi_c f_c e_{hd} A_b$ where, $e_h = 3d_a = 3(24) = 72$, $\phi_c = 0.85$, $R = 1.0$, $d_a = 24$

$\psi_{cp} = 1.4$

$\therefore N_{cp} = 1.4(35)(391) = 483.5$ kN/Anchor $\times$ 8 Anchors $= 3338$ kN > 243 kN OK

Date: _____

Title: Concrete Tank Design (Slab & Shell Conn.) Sheet 5 of 5



Note: Same edge distance top and bottom at angle

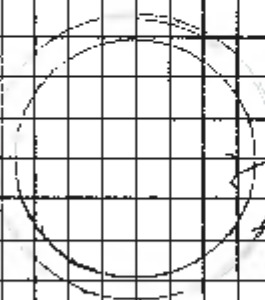
Appendix J

SGMC

Date: _____

Title: Concrete Tank Design (Hatch & Openings) Sheet 1 of ___

36" Inspection Hatch



- Pressure @ hatch;

∴ Assume hatch is 600 mm from bottom

$h_{water} = 14 - 0.6 = 13.4\,m \Rightarrow \gamma_w = 9.81\ kN/m^3$

$P_{water} = 13.4(9.81) = 132\ kPa \Rightarrow P_f = 1.25(132) = 164\ kPa$

$A_{area\ Hatch} = \pi(457.5)^2 = 0.656\ m^2$

∴ $F_f = 0.656(164) = 108\ kN$

- Use A325M, M16 Bolts

$T_r = 0.75\phi_b A_b F_u = 0.75(0.8)(1040)(161) = 100.5 \sim 101\ kN$

$B_r = 3\phi_b n_t t_p d F_u$ where, $t_p = 25\ mm$, $d = 15\ mm$, $F_u = 450\ MPa$

Let $F_f = B_r = 108\ kN$

$n = \frac{108 \times 10^3}{3(0.67)(25)(16)(450)} = 0.3 \sim 1\ Bolt$

∴ To maintain a secure seal btw/ the flange and the rubber gasket, space the bolts @ 120 mm cc.

∴ Use $3346/120 = 28$ Bolts

SGMC

Date: _____

Title: Concrete Tank Design (Hatch & Openings) Sheet 2 of ____

- Check concrete break-out resistance;

$N_{cbg} = \frac{A_{Nc}}{A_{Nc}} \psi_{ec,N} \psi_{g,N} \psi_{cp,N} N_{bc}$

$h_{ef} = 200 - 60 - 24 = 116\,mm$, $C_{min} = 75mm$

$A_{Nc} = 9(116)^2 = 121,104\ mm^2$

$A_N = 1,082,342\ mm^2$

$N_{bc} = k_c \lambda_a \sqrt{f'_c}\, h_{ef}^{1.5}$ where, $\lambda_a = 1$ & $k_c = 10$

$= 10(0.65)(\sqrt{35})(116)^{1.5}(1) = 44.3\,kN$

$\psi_{ec,N} = 1$

$\psi_{g,N} = 0.7 + 0.3\left(\frac{75}{(1.5)(116)}\right) = 0.83$

$\psi_{cp,N} = 1.25$

$\phi_{g,N} = 1.5/4 = 0.375$

$N_{cbg} = \frac{1,082,342}{121,104}(9)(0.83)(1.25)(0.375)(44.3) = 154\,kN > 108\,kN$ ✓

- Check pull-out resistance;

$N_{cp} = \psi_{cp} N_{pc}$

$N_{pc} = 0.9 \phi_c k_c \lambda_a \sqrt{f'_c} A_{brg} R$ → Let $h_b = 3d_b = 3(16) = 50\,mm$

$= 0.9(0.65)(35)(50)(16)(1) = 16,380$

$\psi_{cp} = 1.4$

SGMC

Date: _____

Title: Concrete Tank Design (Notch & Openings) Sheet 3 of ____

$N_{gc} = 16,380(14) = 23$ kN/Anchor → $23(28) = 644$ kN > 608 kN ✓

$\phi c = 75 - 12$ mm $= 63$ mm

$0.4hf = 0.4(1.6) = 46.4$ mm } $c > 0.4hef$ ∴ Need not check side-face blow-out

24" Inspection Notch

- $\phi_D = 610$ mm w/ 190 mm Flange

- Estimate Weight of Entire Notch; $\gamma_{steel} = 77$ kN/m³

Area of Door $= \pi(0.910/2)^2 = 0.65$ m²

Vol of Door $= 0.65(0.05)(1.5) = 0.049$ m³

$F = 77(0.049) = 3.78$ kN → $Pf = 1.25(3.78) = 4.70$ kN

Use A325M, M16 Bolts

→ Using the same spacing of 120 mm; # Bolts $= \frac{2300}{120} = 20$ Bolts

- Check wind; $P = 5.71$ kPa → $Pf = 8.6$ kPa

$F_y = 8.6(0.65) = 5.59$ kN ← Section Governs.

Appendix K

Date: Mar 8, 2010

Title: Steel Tank - Wall Design Sheet 1 of 14

inner radius = r "thin wall" $\approx (r/t \geq 10)$
wall thickness = t

⇒ When the vessel wall is "thin", the stress distribution throughout its thickness will not vary significantly and so we will assume that it is uniform or constant

⇒ pressure in vessel is gauge pressure

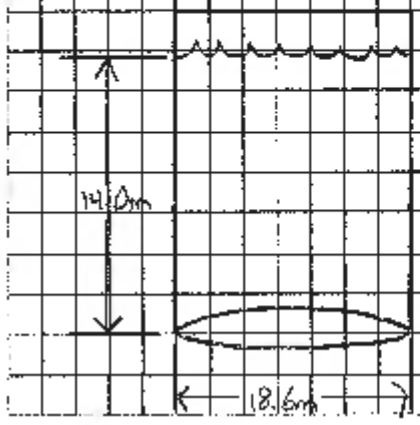
⇒ normal stresses, σ_1 in the circumferential or hoop direction
σ_2 in the longitudinal or axial direction

⇒ Method of Sections: σ_1 & σ_2 exert tension on the material

⇒ Note: Comparing σ_1 & σ_2 equations, it should be noted that the hoop or circumferential stresses is twice as large as the longitudinal or axial stress. Consequently, when fabricating cylindrical pressure vessels from rolled-formed plates, the longitudinal joints must be designed to carry twice as much stress as the circumferential joints.

⇒ Internal gauge pressure developed by the contained fluid, p:

$$p = \gamma H$$
$$= (9.81\ kN/m^3)(14.0\ m)$$
$$[p = 137.34\ kN/m^2]$$



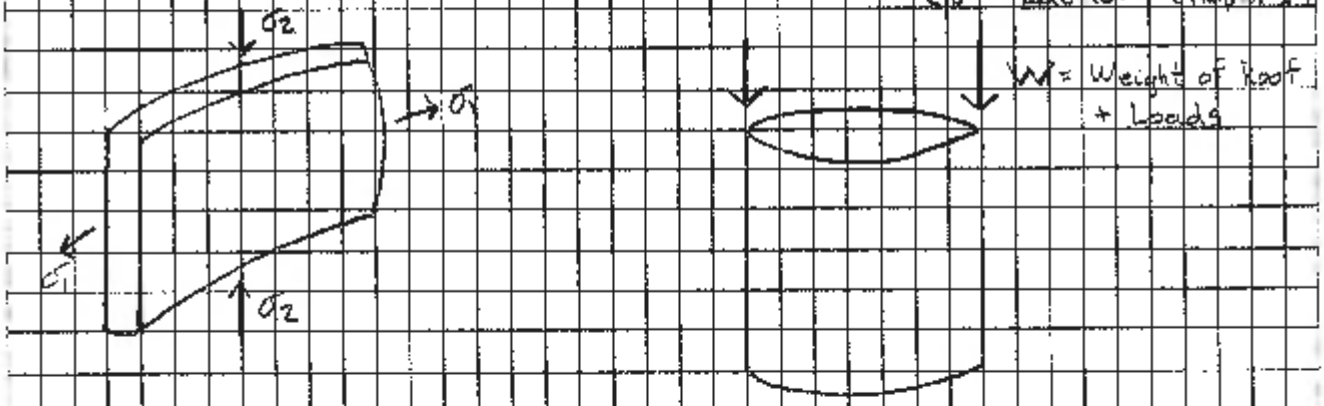
SGMC

Date: March 8, 2010

Title: Steel Tank - Wall Design Sheet 2 of 14

* Note: The outer surface of the shell is subjected to biaxial stress (normal stress in two directions)

* Previous Notes used in RC Hibbeler - Mechanics of Materials (6th Edition - Chapter 8)



* Based on Research - Assume Dome & Components weigh 65,000 lb = 289.13 kN

Uniform hoop stress: $\sigma_1 = \frac{\gamma H R}{t}$ (ok, LL) & $\sigma_2 = \frac{-W}{2\pi r t}$ (ok, DL)

* Von Mises Criteria: $\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2 \leq (\phi\sigma_y)^2$ - Limit State Design

$\sigma_1 = \frac{\gamma H R}{t}$, $\sigma_2 = \frac{-W}{2\pi r}$

$\sigma_1^2 + \sigma_2^2 + \sigma_1\sigma_2 \leq (\text{Unit Stress})^2$ + Working Stress Design

Area for loads on Roof: $A = \pi r^2 + \pi(9.3m)^2 = \boxed{271.7\ m^2}$

Date: March 8, 2010

Title: Steel Tank - Wall Design Sheet 3 of 14

Loads:

- Snow Load = 2.17 kPa × 271.7 m² = [589.6 kN]
- Wind Load (Walls) = 1.76 kPa × 271.7 m² = [478.2 kN]
- Wind Load (Roof) = 3.52 kPa × 271.7 m² = [956.4 kN]
- Self-Weight (Roof) = [289. kN]
- Self-Weight (Walls)
  - ↳ Assume 1 inch thick plate
  - (6.1 m)(2.44 m)(0.0254 m)(7,850 kg/m³)(58 panels)
    = 172,128 kg [= 1,688 kN]
- Internal gauge pressure developed by contained water. [p = 137.34 kPa]

⇒ **Load Combinations:**

Snow: 589.6 kN
Wind: 478.2 kN
Live Load = 271.7 kN (1 kPa)
Dead Load = 289.13 kN

Case 1: 1.4D = 1.4(289.13 kN) = [405 kN]

Case 2: 1.25D + 1.5L + 0.5S
= 1.25(289.13) + 1.5(271.7 kN) + 0.5(589.6 kN) = [1,064 kN]

Case 3: 1.25D + 1.5S + 0.5L
= 1.25(289.13) + 1.5(589.6) + 0.5(271.7) = [1382 kN]
Governs

Case 4: 1.25D + 1.4W + 0.5S
= 1.25(289.13) - 1.4(478.2) + 0.5(589.6 kN) = [-13.3 kN]

Date: March 8, 0

Title: Steel Tank - Wall Design Sheet 4 of 14

$$\sigma_{z1} = \frac{1,382\ kN}{2\pi r t} + \frac{1,488\ kN \times 1.25}{2\pi r t}$$

$$= \left[\frac{1,382\ kN}{(58.4\ t)\ m^2} + \frac{2,110\ kN}{(58.4\ t)\ m^2}\right]$$

$$\sigma_1 = \frac{\gamma H r\ (FS_{LL})}{t}$$

$$= \frac{(137.74\ kN/m^2)(9.3\ m)(1.25)}{t}$$

$$= \frac{1,597\ kN/m}{t\ (m)}$$

Von Mises Criteria: $\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2 \leq (\phi\sigma_y)^2$

$$\left(\frac{1,597}{t}\right)^2 + \left(\frac{3,492}{58.4\ t}\right)^2 - \left(\frac{1,597}{t}\right)\left(\frac{3,492}{58.4\ t}\right) \leq [(0.9)(350,000)]^2$$

$$\frac{2,550,409}{t^2} + \frac{12,194,064}{3,410.56\ t^2} - \frac{5,575,724}{58.4\ t^2} \leq 99,225 \times 10^9$$

$$\frac{2,550,409}{t^2} + \frac{3,575.4}{t^2} - \frac{95,491.8}{t^2} \leq 99,225 \times$$

$$\frac{2,458,493}{t^2} \leq 99,225 \times 10^9$$

$$\therefore t = 0.005\ m = 5.0\ mm$$

* Using AWWA Standard: Welded Carbon Steel Tanks for Water (2004)

=) Neglecting Balcony, Ladder & Stair Loads as well as handrail and guardrail assemblies in design (3.16 & 3.17)

Section 3.2 - Unit Stresses

- All steel members shall be designed and proportioned that during the application of any of the tables previously specified, or any required combination of these loads, the maximum stresses shall not exceed those specified in Tables 5 through 9.

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F_y = 350 MPa > 234.4 MPa ∴ Class 2

		Maximum Un. Stress
Table 5 :	Unit Stresses - Tension	103.4 MPa
Table 6 :	Unit Stresses - Compression	124.1 MPa
Table 7 :	Unit Stresses - Primary Bending	See Section 3.4
Table 8 :	Unit Stresses - Shearing	99.3 MPa
Table 9 :	Unit Stresses - Bearing	

Section 3.7 - Cylindrical Shell Plates

- The thickness of cylindrical shell plates stressed by pressure of the tank contents shall be calculated by the formula :

$$t = \frac{4.9\, h_p D G}{s E}$$

$$= \frac{4.9\,(14.0\text{m})(18.6\text{m})(1)(1.25)}{(99.3\text{MPa})(0.9)(0.85)}$$

t = shell-plate thickness (mm)
h_p = height of liquid to the bottom of the shell course being designed (m)
D = nominal tank diameter (m)
G = Specific Gravity (1.0 for water)
s = Allowable design stress (MPa)
E = joint efficiency

$t = 21\text{ mm} \approx 0.83$ inches

* Assume 1 inch thick plate ≈ 25.4mm

#) The stress by the pressure of the tank contents will decrease with height of the walls. ∴ Thickness of walls can be reduced. Reduce Walls @ mid height of tank, ie $h_p \approx 6.7$m

$$t = \frac{4.9\, H_p D G}{s E}$$

$$= \frac{4.9\,(6.7\text{m})(18.6\text{m})(1)(1.25)}{(99.3\text{MPa})(0.9)(0.85)}$$

$t = 10\text{ mm} \approx 0.39$ inches

* Assume 1/2 inch thick plate = 12.7mm beginning @ 7.3m Height from ground.

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Section B.B - Combined Stresses

Members subject to both axial and bending stresses shall be proportioned in accordance with:

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1$$

F_a = the axial unit stress that would be permitted by this standard if axial stress only existed

F_b = the bending unit stress that would be permitted by this standard if bending stress only existed

f_a = the axial unit stress (actual), equal to axial load divided by cross-sectional area of member

f_b = the bending unit stress (actual), equal to bending moment divided by section modulus of member

Method 2: A simplified design method that only applies to water-filled shells that meet the specified limitations.

- Analyzing 1 inch plates, $t = 25.4\,mm$
- $R = 9.3\,m$

$\therefore t/R = 0.0254/9.3 = 0.0027$

$$\Rightarrow F_L = K_D\, 12,066 \left(\frac{t}{R}\right) \left[1 + 50,000 \left(\frac{t}{R}\right)^2\right]$$

F_L (MPa)
t, R (mm)

$p \geq 10\,psi\ (0.0689\,MPa)$;

$$K_D = 1.0 + \left(\frac{0.25}{11.6}\right)\left(\frac{R}{t} - 334\right) \leq 1.25$$

$$= 1.0 + \left(\frac{0.25}{11.6}\right)\left(\frac{9.3}{0.0254} - 334\right)$$

$$= 1.07 \leq 1.25 \quad \therefore OK$$

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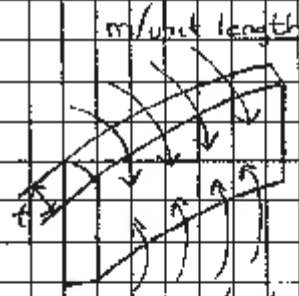
$$\Rightarrow F_b = 1.07\,(12.066)\left(\frac{t}{R}\right)\left[1 + 50{,}000\left(\frac{t}{R}\right)^2\right]$$

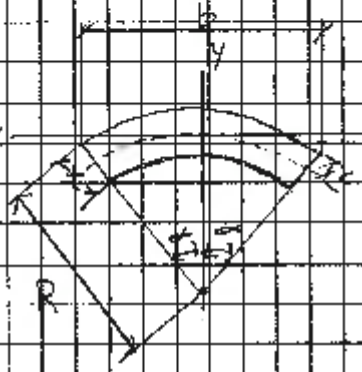
$$= 1.07\,(12.066)\left(\frac{25.4}{9{,}300}\right)\left[1 + 50{,}000\left(\frac{25.4}{9{,}300}\right)^2\right]$$

$$\boxed{F_b = 48.4\ \text{MPa} = F_b}$$

$\Rightarrow f_b =$ bending moment in the wall / Section Modulus of the wall thickness



Section Modulus, $S = I/c$ consider 1 m unit width



- $r = R - t$
  $= 9.3\text{m} - 0.0254\text{m}$
  $\boxed{r = 9.2746\text{m}}$

- $\alpha = \sin^{-1}\left(\frac{0.5}{4.3}\right)$
  $= 3.1°$

- $c = \dfrac{120\sin\alpha\,(R^3 - r^3)}{\pi\alpha\,(R^2 - r^2)} - \dfrac{(R+r)\cos\alpha}{2}$

$$= \frac{120\sin(3.1)(9.3^3 - 9.2746^3)}{\pi(3.1)(9.3^2 - 9.2746^2)} - \frac{(9.3 + 9.2746)\cos(3.1)}{2}$$

$$= 9.283 - 9.274$$

$$\boxed{= 0.009\text{m}}$$

- $I_y = \frac{1}{4}(R^4 - r^4)\left(\frac{\alpha\pi}{180} - \sin\alpha\cos\alpha\right)$

$$= \frac{1}{4}(9.3^4 - 9.2746^4)\left(\frac{3.1\pi}{180} - \sin 3.1\cos 3.1\right)$$

$$\boxed{I_y = 0.0021\ \text{m}^4}/\text{m}$$

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$$I_x = \frac{1}{4}(R^4 - r^4)\left(\frac{\pi\alpha}{180} + \sin\alpha\cos\alpha\right) - \frac{80\sin^2\alpha\,(R^3 - r^3)^2}{\pi\alpha(R^2 - r^2)}$$

$$= \frac{1}{4}(9.3^4 - 9.275^4)\left(\frac{\pi 3.1}{180} + \sin 3.1\cos 3.1\right) - \frac{80\sin^2 3.1\,(9.3^3 - 9.275^3)^2}{\pi(3.1)(9.3^2 - 9.275^2)}$$

$$= 2.165 - \frac{9.71}{4.57}$$

$$\boxed{I_x = 0.017\ m^4}/m$$

⇒ check weak axis section modulus, S_y, section modulus when section is oriented for maximum bending resistance.

$$S_y = \frac{I_y}{c} = \frac{0.0021}{0.009} = 0.23\ m^2$$

Moment = 5.284 ft-lb/ft = 23.5 kN-m/m

$$f_b = \frac{23.5\ kN\cdot m/m}{0.23\ m^2} + 102\ kPa \quad \boxed{= 0.102\ MPa}$$

⇒ $f_a = \sigma_z = \frac{1.382\ kN}{58.4(.0254)} + \frac{2.110\ kN}{58.4(.0254)}$

$$\boxed{f_a = 2.354\ kPa = 2.35\ MPa}$$

⇒ $F_a = F_L \cdot K \cdot \varphi$

- $C_c' = \sqrt{\frac{\pi^2 E}{F_L}}$

$$= \sqrt{\frac{\pi^2(200{,}000\ MPa)}{48.4\ MPa}}$$

$$\boxed{C_c' = 202}$$

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- $\frac{KL}{r}$

K = effective column length factor, 1.0 for pinned end columns or struts, 2.0 for cantilever columns, such as the shafts of a single-pedestal tank

L = member length

r = radius of gyration of the section

$r = \sqrt{\frac{I}{A}}$

$A = bt$

$I = \frac{bt^3}{12}$

$\therefore r = \frac{t}{\sqrt{12}}$ $\quad L = 1.0\,m$

$= \frac{0.0254}{\sqrt{12}}$

$r = 0.0073$

- $\frac{KL}{r}$

$= \frac{(1)(1)}{(.0073)} = 137$

$\Rightarrow 25 < \frac{KL}{r} \leq C_c$ $\quad \therefore K_\varphi = 1 - \frac{1}{2}\left(\frac{\frac{KL}{r}}{C_c}\right)^2$

$= 1 - \frac{1}{2}\left(\frac{137}{202}\right)^2$

$K_\varphi = 0.77$

$\Rightarrow F_A = 48.4\,(0.77)$

$= 37.3\ MPa$

$f_a + \frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1$

$= \frac{3.35\ MPa}{37.3\ MPa} + \frac{.102\ MPa}{48.4\ MPa} = 0.099 \leq 1$ ∴ OK

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Method 1: Method 1 shall be used with $4\sqrt{Rt}$ of the lower boundary

$$4\sqrt{Rt} = 4\sqrt{(9.3m)(.025)} \quad [= 1.94m]$$

$\Rightarrow$ Class 2 Material $\Rightarrow$ $(t/R)_c = [0.0035372]$

$$t/R = \frac{25.4}{9,300} = 0.0027$$

When $0 \leq t/R \leq (t/R)_c$, elastic buckling controls

$$\hookrightarrow F_L = 12,066\,(t/R)\left[1 + 50,000\,(t/R)^2\right]$$

$$= 12,066\,(.0027)\left[1 + 50,000\,(.0027)^2\right]$$

$$[F_L = 44.5\ MPa] = F_b$$

$f_b = .102$ MPa

$f_a = 2.35$ MPa

$\Rightarrow F_a$ (Table 13)

- $t/R = 0.0027$
- $\frac{KL}{r} = 137$

Interpolating:

$$\frac{6.031 - 4.842}{.003 - .0025} = \frac{6.031 - X}{.003 - .0027}$$

$$0.3567 = -0.0005X + 3.0155$$

$$[X = 5.318]$$

$$\frac{5.335 - 4.446}{0.003 - .0025} = \frac{5.335 - Y}{.003 - .0027}$$

$$0.2667 = -0.0005Y + 2.6675$$

$$[Y = 4.802]$$

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$$\frac{4,802 - 5,318}{150 + 12.5} = \frac{4,802 - z}{150 - 137}$$

$$-6,708 = -252 + 120,050$$

$$[z = 5,070]$$

$$\therefore F_a = 5,070 / 145 = [35\ MPa]$$

So, $\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1$

$$\frac{8.35}{35} + \frac{1.152}{44.5} \leq 0.07 \leq 1 \quad \therefore OK$$

Note: It was determined that the thickness may be reduced at mid-height of the tank @ 7.3m from the ground to 0.39 inches. Use 1/2 inch plates from mid-height to top of tank.

Method 2: Analyzing 1/2 inch plates $t = 12.7mm$ @ 7.3m from bottom of tank.

$$\therefore t/R = 12.7 / 9,300 = [0.0014]$$

$$p = \gamma H$$
$$= (9.81\ kN/m^3)(6.7m)(1.25)$$
$$= 82.2\ kPa\ [= 0.082\ MPa]$$

$p \geq 10\ psi\ (0.069)$

$$K_b = 1.0 + \left(\frac{0.25}{1.6}\right)\left(\frac{R}{t} - 334\right) \leq 1.25$$

$$= 1.0 + \left(\frac{0.25}{1.6}\right)\left(\frac{9.3}{0.27} - 334\right) \leq 1.25$$

$$= 1.85 \not\leq 1.25$$

$$[\therefore K_b = 1.25]$$

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$\Rightarrow F_L = K_a\, 12,066 \left(\frac{t}{R}\right)\left[1 + 50,000\left(\frac{t}{R}\right)^2\right]$

$= 1.25\,(12,066)\left(\frac{12.7}{9,300}\right)\left[1 + 50,000\left(\frac{12.7}{9,300}\right)^2\right]$

$\boxed{F_L = 22.9\ MPa = F_b}$

$\Rightarrow f_b = \frac{\text{bending moment in the wall}}{\text{Section Modulus of the wall thickness}}$

Section Modulus, $S = I/c$, consider 1m unit width

- $r = R - t$
  $= 9.3m - .0127m$
  $\boxed{= 9.287m}$
- $\alpha = \sin^{-1}\left(\frac{0.5}{9.3}\right)$
  $\boxed{= 3.1^\circ}$

- $c = \frac{120\sin(3.1)\left(9.3^3 - 9.287^3\right)}{\pi(3.1)\left(9.3^2 - 9.287^2\right)} - \frac{(9.3 + 9.287)\cos(3.1)}{2}$
  $= 9.289 - 9.280$
  $\boxed{c = 0.009}$

- $I_y = \frac{1}{4}\left(R^4 - r^4\right)\left(\frac{\alpha\pi}{180} - \sin\alpha\cos\alpha\right)$
  $= \frac{1}{4}\left(9.3^4 - 9.287^4\right)\left(\frac{3.1\pi}{180} - \sin 3.1\cos 3.1\right)$
  $\boxed{= 0.0011\ m^4}/m$

- $I_x = \frac{1}{4}\left(R^4 - r^4\right)\left(\frac{\pi\alpha}{180} + \sin\alpha\cos\alpha\right) - \frac{80\sin^2 3.1\left(9.3^3 - 9.287^3\right)^2}{\pi(3.1)\left(9.3^2 - 9.275^2\right)}$

$= \frac{1}{4}\left(9.3^4 + 9.287^4\right)\left(\frac{\pi(3.1)}{180} + \sin 3.1\cos 3.1\right) - \frac{80\sin^2 3.1\left(9.3^3 - 9.287^3\right)^2}{\pi(3.1)\left(9.3^2 - 9.287^2\right)}$

$= 1.128 - \frac{2.632}{2.353}$

$\boxed{= 0.0094}$

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=) check weak axis section modulus, S_y, section modulus when section is oriented for maximum bending resistance.

$$S_y = \frac{I_x}{C} = \frac{9.0011}{0.009} \left[0.12\ m^3\right]$$

a) $F_b = \frac{2.1\ kN\cdot m/m}{.12\ m^3} = 17.5\ kPa$ $\left[= 0.0175\ MPa\right]$

=) $F_a = \sigma_2 = \frac{1,382\ kN}{58.4(.0127)} + \frac{3,110\ kN}{58.4(.0127)}$

$= 4,708\ kPa = \left[4.71\ MPa\right]$

=) $F_a = F_L K_\psi$

- $C_c' = \sqrt{\frac{\pi^2 E}{F_L}} = \sqrt{\frac{\pi^2(200,000)}{22.5}}$

$\left[C_c' = 296\right]$

- $\frac{K_\psi L}{r}$ $\quad r = \sqrt{\frac{I}{A}}$ $\quad A = bt$ $\quad I = \frac{bt^3}{12}$ $\quad$ so $r = \frac{t}{\sqrt{12}} = \frac{.0127}{\sqrt{12}}$ $\quad L = 1.0m$

$\left[= 0.0037\right]$

- $\frac{(1)(1)}{.0037} = \left[270\right]$

- When $25 < \frac{KL}{r} < C_c$ $\quad K_\psi = 1 - \frac{1}{4}\left(\frac{\frac{KL}{r}}{C_c}\right)^2$

$= 1 - 1/2\left(\frac{270}{296}\right)^2$

$\left[K_\psi = 0.58\right]$

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→ $F_a = 22.5\,(0.581)$

$(= 13.1\ MPa)$

So, $\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq$

$= \frac{4.71\ MPa}{13.1\ MPa} + \frac{.02\ MPa}{22.5\ MPa} = 0.36 \leq 1.0$ OK

Section 3.5: Shell Girder, Intermediate Stiffeners & Compression Rings

- No Top shell girder required

- Intermediate shell girders:

$$h = \frac{8.025\,D\,t}{P_{ew}\left(\frac{D}{t}\right)^{1.5}}$$

h, D (m)

P_{ew} (N/m²)

t = mm - average thickness

* Neglect corrosion allowance

$P_{e,w}$ - weighted average wind pressure

$$= \frac{8.025\,(19.1)}{(1,760\ N/m^2)\left(\frac{18.6m}{19.1mm}\right)^{1.5}}$$

$h = 90.6\ m$

So No Intermediate shell girders not required

↳ If h is greater than the height of the shell no intermediate girder is required.

Appendix L

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Title: Slab Design (Steel Tank) Sheet 1 of 7

References:

1) "Concrete Floor Slabs on grade Subject to Heavy loads" Army Technical Manual TM 5-809-12 Air Force Manual AFM 88-3, Chapter 15 (1987)

2) "Slab Thickness Design for Industrial Concrete Floors on grade" (IS195.01D) by Robert G. Packard (Portland Cement Association 1976)

Concrete Slab on Grade Analysis

- Slab Subject to Stationary Uniformly Distributed live load/Line loading from wall

Assumptions:

1) Subgrade Modulus, K.

Subgrade for our design is given as bedrock. Thus this would give high support with no settlement.

Modulus of Subgrade Reaction Ranges From 50 - 700 psi. BedRock is not stated within given chart however for high support (Sands and sand-gravel mixures relatively free of plastic fines) have a Range of 180 - 220 psi. Considering BedRock has a much higher support we have assumed a value of 300 psi. This value is Not high however should give us a Conservative answer.

2) thickness of Slab, t = 24 in (.610 m)

3) At edge of slab at 2 ft (4 ft added to diameter)
∴ a = 65 Ft (19.05 m) → Practical Purposes.

4) Concrete Strength f'_c = 35 MPa

5) Factor of Safety = 2.0
→ Can be used as a conservative value.

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Title: Slab Design (Steel Tank)

Sheet 2 of 7

Given $q_{allowable} = 500 kpa$

$V_{water} = \pi r^2 \cdot h$ $\quad 46ft = 14m$

$= \pi(9.3)^2 \cdot 14\,m$

$= 3864.02\,m^3$

Weight of Water $= \gamma \cdot V_{water}$ $\quad (LL)$

$= 9.81\,kN/m^3 \cdot (3864.02\,m^3) = 37917.43\,kN \times 1.25$ (Liquid)

$= 46646.79\,kN$

Weight of Roof $= 65000\,lb$

$\therefore$ From previous calcs $= 289.1\,kN$

Self Weight of Walls $= 1688\,kN$

Snow load $= 2.27\,kPa \times 271.7\,m^2 = 616.759\,kN \times 1.5$ (SL)

$= 925.13\,kN$

Total $= 46646.79 + 289.1 + 1688 = 48621.475\,kN$

$A = \pi r^2 = \pi(9.9)^2 = 307.9\,m^2$ (overall)

Pressure on slab $= \frac{48621.475\,kN}{307.9\,m^2} + 2.27\,kpa = 160.18\,kPa \leq 500\,kpa$

$\therefore$ OK

A) Slab subjected to Line loading From Wall

Slab thickness $= 24\,in$

$f'_c = 35\,Mpa = 5076.3\,psi$

$K = 300\,pci$

Wall loading $= 1688\,kN = \frac{379477\,lb}{191.63\,ft}$

$= 1980.25\,lb/ft$

$A_c = 2\pi r$

$= 2\pi(30.5)$

$= 191.63\,ft$

Check P_e

P_e = Wall load near free edge of slab

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Title: Slab Design (Steel Tank) Sheet 3 of 7

1) Modulus of Rupture, f_r

$f_r = 9\sqrt{f_c'} = 9\sqrt{5076.3}\ psi = 641.2\ psi$

2) Allow Bending stress, F_b

$F_b = 1.6\sqrt{f_c'} = 1.6\sqrt{5076.3}\ psi = 113.99\ psi$

3) $FS = \frac{f_r}{F_b} = \frac{641.2}{113.99} = 5.62$

4) Section Modulus, S b = 12" Assume

$S = b\frac{t^2}{6} = 12\ in \times \frac{24\ in^2}{6} = 1152\ in^3$

5) Modulus of Elasticity, E_c

$E_c = 57000\sqrt{f_c'} = 57000\sqrt{5076.3} = 4061144.98\ psi$

6) Moment of Inertia, I

$I = \frac{b t^3}{12} = \frac{12 \times 24^3}{12} = 13824\ in^4$

* Coefficient, B_x (Coef for Beam on elastic Foundation)
= .3224 (Code)

∴ Allowable Wall load, Pc

$P_c = F_b S \cdot \lambda / B \lambda x$

$= 9.9256\sqrt{f_c'} \cdot t^2 (K/19000)\sqrt{\frac{E_c}{I}} \cdot (3)^{.25}$

$= 9.9256\sqrt{5076.3}\,(24^2)\left[\frac{300}{(19000\sqrt{5076.3}\cdot 24^3)}\right]^{.25}$

$= (407336.09)(.01125)$

$= 4583.45\ lb/FL$

$P_c(allow) >> P_c$ ∴ OK

Much Larger than it needs to be ∴ Calc t_{min}

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Title: Slab Design (Steel Tank) Sheet 4 of 7

for 4mm use P in place of Pe.

$$\therefore \quad 1980.25 = 9.9256\sqrt{5076.3}\; t^2 \left[\frac{300}{1000\sqrt{5076.3}\; t^3} \right]^{.25}$$

$$2.8 = t^2 \left[\frac{1220}{(t^3)^{.25}} \right]$$

$$2.8 = t^2 \left[\frac{1220}{t^{3/4}} \right]$$

$$22.95 = t^{1.25}$$

$$t = 12.26 \text{ inches}$$

B) Slab subjected to Stationary Uniformly Distributed Live load
LL = Water

Assume Slab thickness = 7½ in. (t)

$f_c' = 5076.3$ psi

$K = 300$ pci

Factor of Safety = 2.0

1) Uniform Live load, WLL (water)

$$\frac{46446.77}{307.9} = 151.49 \text{ kpa} = 3163.94 \text{ lb/ft}^2 \text{ (psf)}$$

2) Modulus of Rupture Mr

$$Mr = 9\sqrt{f_c'} = 9\sqrt{5076.3} = 641.2 \text{ psi}$$

3) Allowable Bending Stress F_b

$$F_b = \frac{MR}{FS} = \frac{641.2}{2} = 320.6 \text{ psi}$$

4) Modulus of Elasticity $E_c = 4061144.99$

5) Poisson's Ratio, $\mu = .15$ (assumed for Concrete)

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Title: Slab Design (Steel Tank) Sheet 5 of 7

6) Radius of Stiffness, l_r

$$l_r = \left[\frac{E_c t^3}{12(1-\mu^2)k}\right]^{.25} = \left[\frac{(4061144.99)(24)^3}{12(1-.15^2)(300)}\right]^{.25}$$

$$= 63.20 \text{ in}$$

7) Critical Aisle width, W_{cr}

$$W_{cr} = \frac{2.209\, l_r}{12} = \frac{2.209(63.20)}{12} = 11.63 \text{ Ft.}$$

8) Stationary Uniformly Distributed Live load, WLL (allow)

$$WLL(allow) = 257.876\, F_b \sqrt{\frac{K t}{E_c}}$$

$$= 257.876(320.6)\sqrt{\frac{300.24}{4061144.99}}$$

$$= 3481.09 \text{ psF}$$

$WLL_{allow} = 3481.09$ lb/ft^2 > WLL = 3163.94 lb/ft^2 ∴ OK.

Slab thickness for LL will govern.

∴ Slab thickness for System = 24 in = (1.609 m)

* Slab on grade of thickness of 24 in will work without Reinforcement! However slab required to have minimum Temperature Reinforcement

Temperature Reinforcement (Limit design strip)

$A_{s\,temp\,(min)} = .2\% A_g$

$A_g = b \cdot t$
$= 1000 \cdot 610$ mm
$= 610000$ mm^2

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$\therefore A_{stemp} = .2\% (610000\ mm^2) = 1220\ mm^2/m$

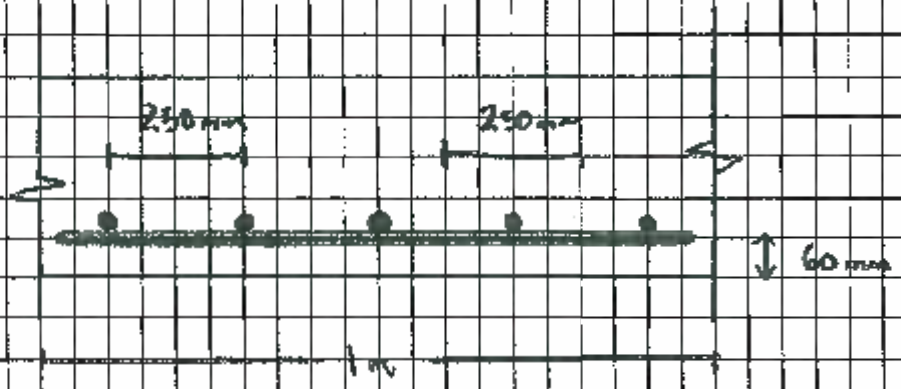
Use 2h M bars $d_b = 19.5\ mm$

$A = 300\ mm^2$

$\frac{1220\ mm^2}{300\ mm} = 4.06$

$\therefore$ use 5 No 20 M $A_{prov} = 1500\ mm^2$

Spacing (center-to-center)



* use Cover of 60
* Temperature Reinforcement in both directions.

Spacing = 1000/4 = 250 mm

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Title: Steel Tank - Foundation Design Sheet 1 of 7

- Construction drawings shall include dimensions, loadings used in the design, design & construction standards used, materials of construction & allowable soil pressure.
- Water load shall be considered as live loads ($\alpha_{LL} = 1.25$)
- Snow load need not be combine with wind or seismic soil-bearing pressures for design of footings, slabs or piers.

=> Geotechnical Information: Ultimate Bearing Capacity = 1,500 kPa
Allowable Bearing Capacity = 500 kPa

- Top of foundation shall be a minimum of 6 inches (152mm)
- Foundation shall be graded to slope uniformly upward to the center of the tank with a minimum slope of 12mm vertical to 3.0m horizontal

=> Type 2 Foundation for ground supported flat-bottom tank

4> Sand cushion not less than 25mm thick shall be provided between the flat bottom and the concrete slab foundation

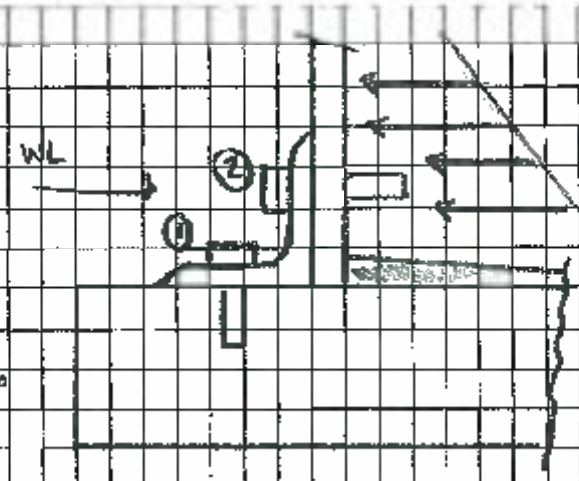
Appendix M

SGMC

Date: March

Title: Slab to Shell Connection (Steel Tank) Sheet 1 of 9

Connection



Design per meter of circumference

Hydrostatic Force ⇒ Bolt 1

Hydrostatic Force = 137.34 kPa = 137.34 $\frac{kN}{m^2}$ x 9.3 m

= 1277.26

≈ 1277 kN/m

∴ V = 1277 kN/m

V_f = V · 1.25 = 1277 x 1.25 = 1596.25 kN

Bolt Selection

M24 d_b = 24 mm A_b = 452 mm^2 F_u = 1040 MPa

A490M $A_b \cdot F_u$ = 470

Check Bolt in shear

⇒ Assume threads excluded from shear plane.

Factored Resistance ⇒ V_r = .60 $\phi_b n_s A_b F_u$

Mod. Factored Resistance ⇒ V_r = .48 F_u

SGMC

Date: March

Title: Slab to Shell connection (Steel Tank) Sheet 2 of 4

$V_r = .60 \phi_b m n A_b F_u$

$V_r = V_F$

$1596.25\,kN = (.60)(.80)(1)n(470)$

$n = 7.09$

$\therefore$ use 8 bolts

$\phi_b = .80$

$m = 1$ (Single Shear)

$A_b = 452\ mm^2$

$F_u = 1040\ MPa$

$A_b F_u = 470$

Select Angle to use

$F_y = 350$

MSE $T_r = V_{er}$

$\therefore V_r = \phi_s A_g F_y$

$596.25 \times 10^3 = .9 A_g (350)$

$A_g = 5065\ mm^2$

$\therefore$ use L 203 x 203 x 14

$A_g = 5600\ mm^2$

Check Bearing on Main Material (# Bolts)

$B_r = 3 \phi_{br} t d_n F_{u\,plate}$

$1596.25 = 3(.65)(14)(24)(450)n$

$n = 5.4$

$n = 6$ bolts

$B_r = V_r$

$\phi_{br} = .65$

$F_{u\,plate} = 450\ MPa$

$t = 14$

$d_{bo} = 24m$

V_r bolt calculation governs $\therefore$ use 8 bolts/m

Check shear at angle leg connection

$V_r = 6 \phi_s A_{gv} F_y$

$\phi_s = .9$

$A_{gv} = (14)(L)$

$F_y = 350$

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Date: March

Title: Slab to shell Connection (Steel tank) Sheet 3 of 4

Use $V_f < V_f$ = 1596.25 kN

$1596.25 = .6(.9)(13 \cdot L)(350)$

$L = 649.67$ mm

≈ 650 mm/m

$24 + 2 = 26 = d_h$

Bolt spacing = $\frac{L - nd_b}{n+1} = \frac{650 - 8(26)}{9} = 49.11$ mm

Use 49 mm

Center to center = 49 + 26 = 75 mm

Check 2.7 d_b

$= 2.7(24) = 65\text{mm} < 75$ ∴ OK

Min edge distance = 42 < 49 mm ∴ OK

* Spacing is sufficient

∴ use 8 bolts on the Base side of angle.

Check bolt group 2 for effects of wind

$V_f = 1.76\text{kPa} \times 14.6\text{ m} = 25.696$ KN/m

∴ $V_f = 1.5(25.696) = 38.544$ << hydrostatic Pressure.

Since V_f wind is much smaller than the hydrostatic pressure you do not need to check Shear at the upper angle leg connection.

Check Tension on Bolts.

$T_r = .75 \phi_b n A_b f_u$

$= .75(.8)(1)(470) = 282$ kN/m > 38.544 kN/m ∴ OK

4 per Bolt

Check Shear Block Tear out

$T_r + V_r = \phi A_{nt} f_u + .6 \phi A_{gv} f_y$

$= .9(7)(14)(450) + .6(.9)(4)(2)(75)(360) = 2341.70$ kN

(49)

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Date: March

Title: Slab to Shell Connection (Steel Tank) Sheet 4 of 4

$T_r + V_r = \phi A_{nv} F_u + .6\phi A_{gv} F_y$

$= .9(7)(14)(99) + .6(.9)(1000 - 8(26))(350) = 2094.4$ kN

(+450)

use 8 screws

$d \geq 38.64$ ∴ OK

Tension failure in Angle:

$T_r = .75\,\phi A_n F_y$

$= .75(.9)(4)(7)(49)(350) = 1134.4$ kN ∴ OK

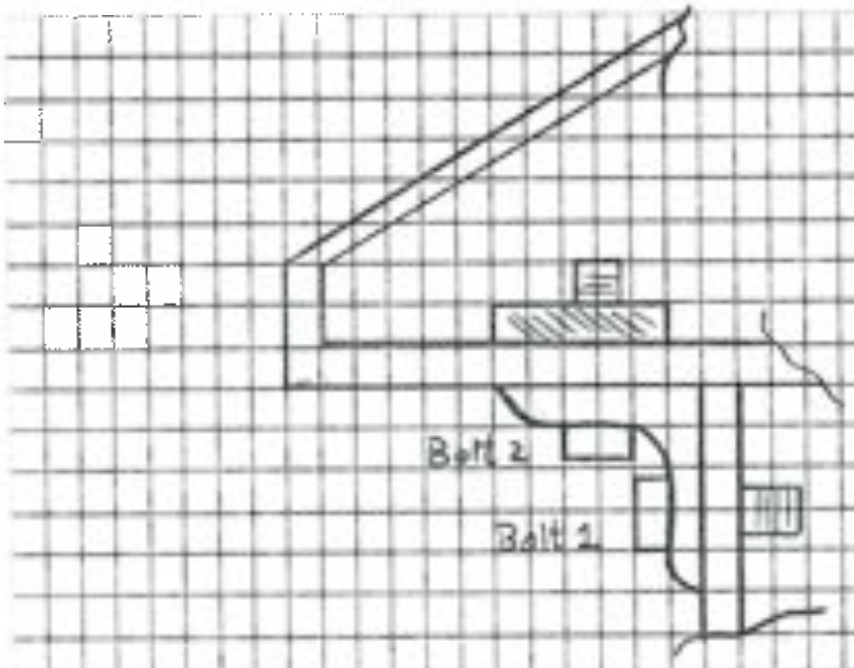
Checks work. However would only need 1 bolt in upper section of the angle.

∴ For design sake, practical Application use 7 bolts in upper section as well in a staggered formation

Detail

Date: March

Title: Shell to Roof Connection (Steel Tank) Sheet 1 of 6



$A_p = 2\pi rh$
$= 2\pi(9.3)(4)$
$= 233.23\ m^2$

$C = 2\pi r$
$= 2\pi(9.3)$
$= 58.4\ m$

Snow load = $2.17\ kN/m^2 \times 233.23\ m^2$ = 506.109 KN
Wind load (Roof) = $3.52\ kN/m^2 \times 233.23\ m^2$ = 820.96 KN
DL Self Weight (Roof) = 289.1 KN
Live Load = $1\ kPa \times 233.23\ m^2$ = 233.23 KN

Load Combinations

1) $1.4DL = 1.4(289.1\ KN) = 404.74\ KN$
2) $1.25\ DL + 1.5\ L + .5S + .5W = 1.25(289.1) + 1.5(233.23) + .5(506.109) = 961.27\ KN$
$+.4(820.96) = 382.83\ KN$
3) $1.05\ DL + 1.5\ S + .5L + .4W = 1.25(289.1) + 1.5(506.109) + .5(233.23) = 1237.15\ KN$
$-.4(820.96) = 792.15\ KN$
4) $1.25\ DL - 1.4W + .5L + .5S = 1.25(289.1) + 1.4(820.96) + .5(233.23) = -691.35\ KN$
$+.5(506.109) = +534.91$

CASE #3 governs : Base Load 1237.15 KN

Pressure = $1237.15\ KN / 233.23\ m^2 = 5.293\ kN/m^2$

$5.293\ kN/m^2 \cdot 58.4\ m = 309.11\ kN/m = V_f$

SCMC

Date: March

Title: Shell to Roof Connection (Steel Tank) Sheet 2 of 6

Bolt Selection

Use M22 A325 M $d_b = 22$ mm, $d_h = 24$ mm, $A_{bfu} = 310$ MPa

Bolt Group 1

Check Shear in Bolts (Per 1m length)

* Assume threads excluded from shear plane

$V_r = .60 \phi_b n m A_b F_u$

$309.11 \text{ kN} = .6(.8)(1)n(310)$

$n = 2.03$ bolts

$\phi_b = .8$

$m = 1$ (Single Shear)

$V_f = V_r$

∴ Use 3 Bolts / 1m

Select Angle to use

$T_r = V_f = \phi_s A_g F_y$

$309.11 = .9 A_g (350)$

$A_g = 981.30 \text{ mm}^2$

Use L 76 × 76 × 11 t = 11.1

b = 76.2

d = 76.2

$A_g = 1570 \text{ mm}^2$

Check Bearing on Bolts (# Bolts)

$B_r = 3 d_b t \phi_{bn} F_{u\,plate}$

$309.87 = 3(.65)(11)(16)(450)n$

$n = 2$ Bolts.

Use 3 M22 A325 M L 76 × 76 × 11

Date: March

Title: Shell to Roof Connection (Steel Tank) Sheet 3 of 6

Check Shear at angle leg Connection

$V_n = .6 A_{gv} F_y$ $\phi_s = .9$

$309.11 = .6(11.2)(350)(.9)$ $A_{gv} = 11.2$

$L = .149\ m$ $F_y = 350$

$+ 149\ mm$

Bolt spacing $= \frac{149 - 3(22)}{4} = 20.7$

C to C $= 20.75 + 22 = 42.75$

$2.7 d_b = 43.2 > 42.75 \Rightarrow$ Not ok.

Change Angle.

L 102x102x6.4

$309.11 = .6(6.4)L(350).9$

$L = 256$

$\frac{256 - 3(22)}{4} = 47.5$

C to C $= 47.5 + 22 = 69.5$

$2.7 d_b = 43.2 < 69.5 \therefore$ ok.

Min edge $= 28 < 47.5 \therefore$ ok.

Check Tension (Bolt 1)

$T_r = .75 \phi_{bn} A_b f_u$

$= .75(.8)(3)(3.6) = 568.9 > 309.11 \therefore$ ok.

Check Shear Block Tear out

$T_r = V_r = \phi A_{nt} f_u + .6 \phi A_{gv} F_y$

$= .9(3)(6.4)(450)(.48) + (.6)(.9)(6.4)(2)(69.5)(350)$

$= 5463$

Date: March

Title: Shell to Tank Connection (Steel Tank) Sheet 4 of 6

$T_r = \phi_{bs} T_u + \phi_{bf} A_{pe} F_u$

$= .9(3)(6.4)(48)(450) + .6(.9)(1000 + 3(24))(350)$

$= 548.6$ kN ← governs > 309.11 ∴ OK

Tension failure in Angle:

$T_r = .75(.9)(6.4)(3)(48)(350) = 217.1$ kN < 309.11 ∴ Not OK

Need $309.11 = .75(.9)(3)(48)(350)t$

$t = 9.1$ mm

∴ use L102 × 102 × 9.5

Bolt group #2 ⇒ Check For prying.

Number of Bolts would be same as Bolt group #1.

∴ 3 Bolts

$V_f = V_c = 309.11$ kN

Applied Load per bolt = 309.11/3

= 103.04 kN

= p_f

Assume M22 bolts ⇒ 22 mm bolt diameter

$T_r = p_f \times 1.25$

$= 103. \times 1.25 = 128.75$ kN

Date: March

Title: Shell to Tank Connection (Steel Tank) Sheet 5 of 6

Available prying ratio $T_r/P_t = 128.75/103 = 1.25$

$b = [4.5 - 9.5]/2 = 17.75$

$b' = 17.75 - 22/2 = 6.75$

$\alpha = \frac{4.4 b'^3}{d p^2 F_y} = \frac{4(6.75^3)(10^3)}{(.9 \times 6.95 \times 3.50)} = 1.23$

$\delta = 1 - \frac{d'}{p} = 1 - \frac{2.2}{6.95} = .683$

$t_{min} = \left[\frac{1.23 \times 103}{1.683}\right]^{1/2} = 8.67$

$t_{max} = \left[\frac{1.23 \times 103}{1}\right]^{1/2} = 11.5$

∴ angle is OK

Flange width = 10.2 (6)

∴ gage = 4.5

Spacing pitch = 6.95

Date: _____

Title: Shell to Tank Connection (Steel Tank) Sheet 6 of 6

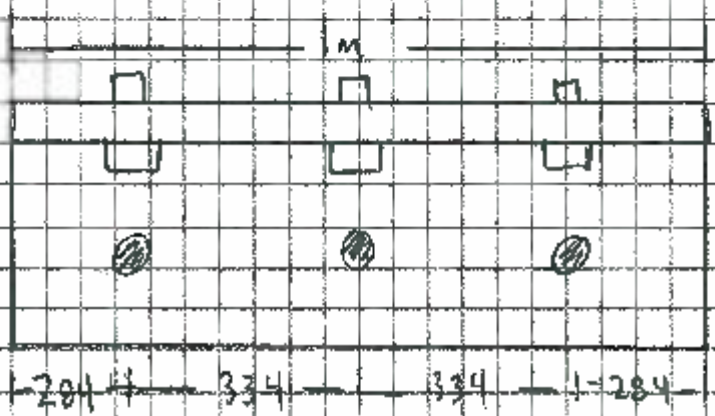
$$\alpha = \left[\frac{1.23 \times 128.75 + 1}{9.5^2} \right] \times \frac{29.5}{.683 \times 43} = .755$$

$0 \leq \alpha \leq 1.0$

$S_{ra} = .683 \times .755 = .515$

Connection Capacity $= (9.5^2/1.23)(1.515)^3 = 333.48 > 309.11$ ∴ ok

Detailing



3 M22 A325M

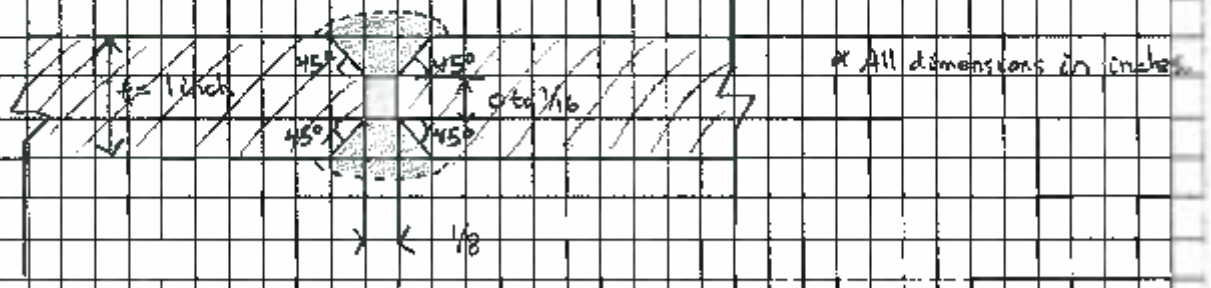
1 102 x 120 x 9.5

Appendix N

Date: March 24, 2010

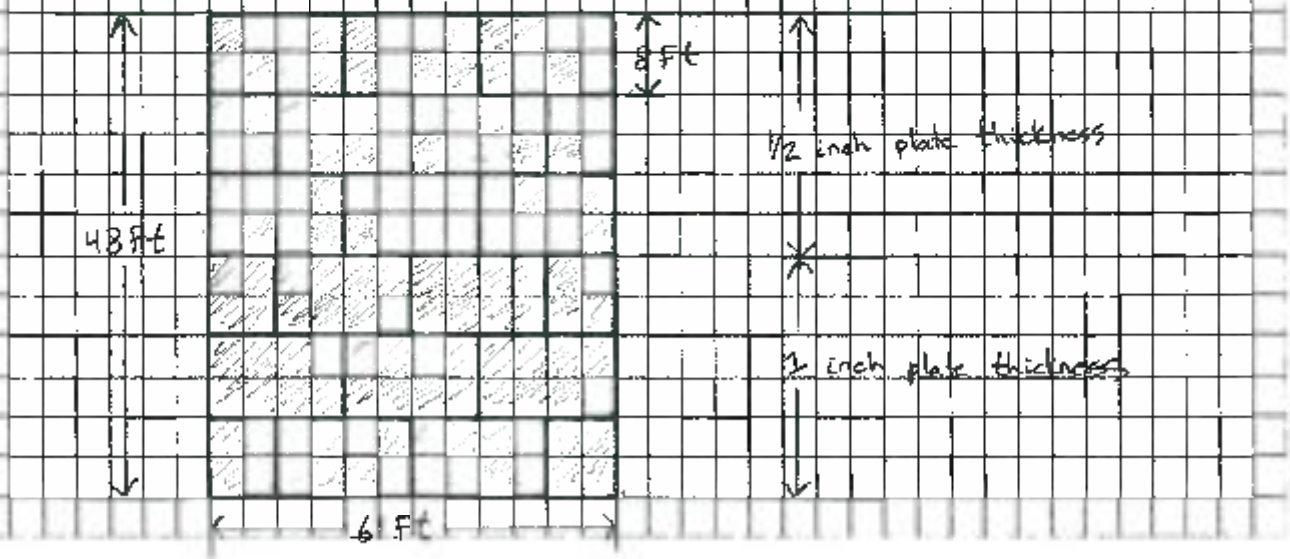
Title: Steel Tank - Weld Connections Sheet 1 of 2

- Use Double-V Butt Joint (Complete penetration weld)
  - Compared to the single-V joint, preparation time is greater, but you use less filler metal because of the narrower included angle.



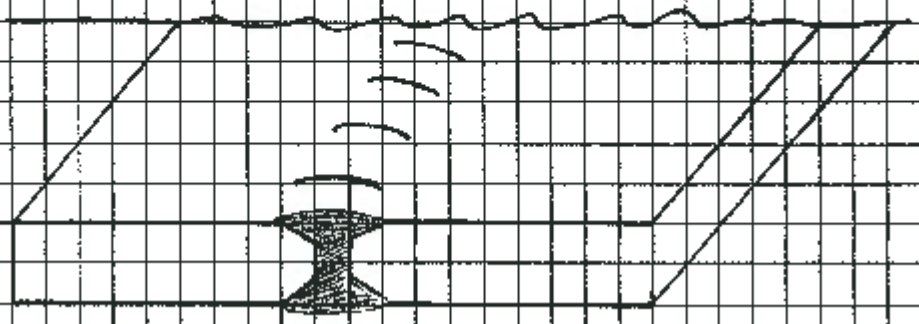
=> Steel Plates: - 20 ft x 8 ft x 1 inch
  - First 3 Tears
- 20 ft x 8 ft x 1/2 inch
  - Last 3 Tears

Layout:

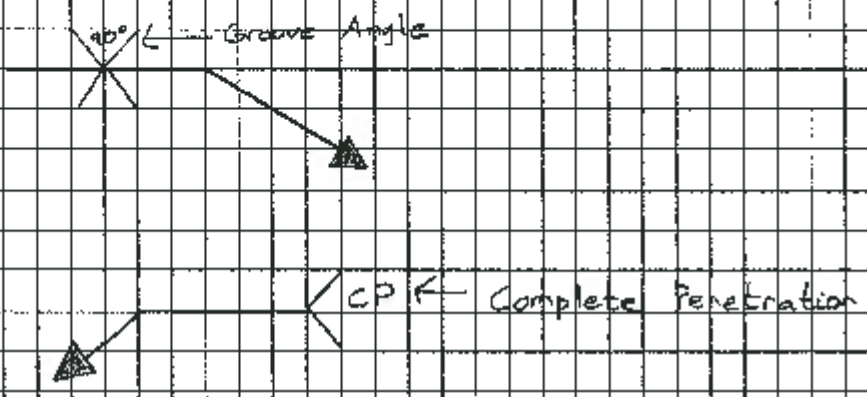


Date: March 24, 2010

Title: Steel Tank - Weld Connections Sheet 2 of 2



Welding Symbol : Double - V



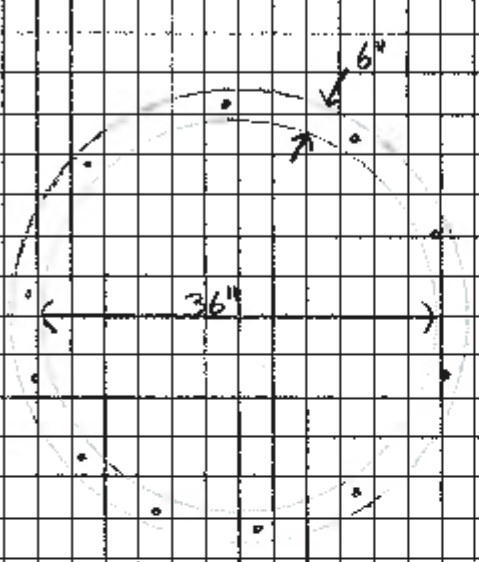
⇒ Full Pane Welds to be used

↳ The panel welds will develop the same resisting strength as the structural steel panels is OK

SGMC

Date: March 24, 2010

Title: Steel Tank - Hatches & Openings Sheet 1 of 2



- Diameter = 915mm
- W_f = 150mm
- 36" Inspection Hatch

⇒ Pressure on Hatch (600mm from bottom)

- Height of water = 14m - 0.6m = 13.4m, $\gamma_w = 9.81\ kN/m^3$

∴ $P = (13.4m)(9.81\ kN/m^3) = [131.2\ kPa]$

$P_F = (1.25)(131.2) = [164\ kPa]$

Area of Hatch = $\pi (915/2)^2 = [0.66\ m^2]$

$F_R = (164\ kN/m^2)(0.66m^2) = [108\ kN]$

⇒ Required # of Bolts (M16 bolts) → d_b = 16mm
4A325M A_b = 201mm

$T_r = 0.75 \phi_b A_b F_u$

$= 0.75(0.8)(167)$

$[T_r = 100\ kN]$ per bolt

⇒ Let $F_R = B_r$

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Date: March 24, 2010

Title: Steel Tank - Hatches & Openings

$\Rightarrow Br = 3\Phi_w \div d\, n\, F_b$

$108\,kN = 3(0.67)(0.025)(0.016)(450)\, n$

$n = \dfrac{108 \times 10^3}{3(0.67)(25)(16)(450)} = 0.3 \sim 1\ Bolt$

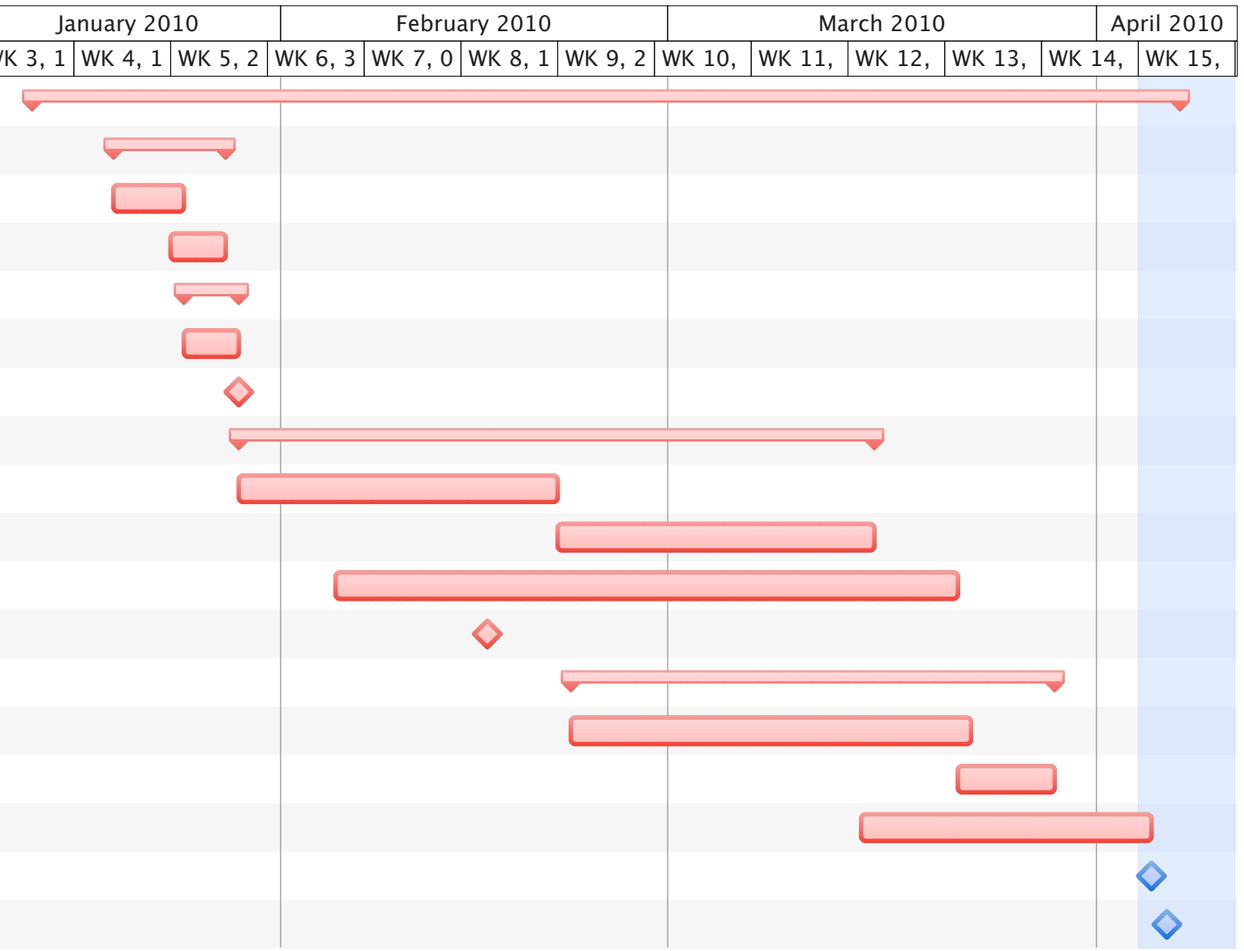
* To maintain a secure seal between the flange and the rubber gasket, space bolts @ 120mm C.C.

$\therefore$ Use $3,346 / 120 = \boxed{28\ Bolts}$

Appendix O

3.8 M Litre Water Storage Tank Cost Analysis

Title	Additional Title	Expected Start	Planned End
3.8 M Litre Water Storage Tank Cost Analysis		**14/01/10**	**06/04/10**
Research		**20/01/10**	**28/01/10**
Environmental, Building Codes and Geotechnical		20/01/10	25/01/10
Conventional Tank Design & Maintenance		24/01/10	28/01/10
Brainstorming and Tank Selection		**25/01/10**	**29/01/10**
Various Tank Options and Tank Design Schemes		25/01/10	29/01/10
Submit Work Plan		29/01/10	29/01/10
Design and Structural Analysis		**29/01/10**	**16/03/10**
Tank Option 1)		29/01/10	21/02/10
Tank Option 2)		21/02/10	16/03/10
Preliminary Drawings		05/02/10	22/03/10
Midterm Progress Reports and Presentations		16/02/10	16/02/10
Cost Estimating		**22/02/10**	**29/03/10**
Quantity Estimation		22/02/10	23/03/10
Productivity Analysis		22/03/10	29/03/10
Benefit/Cost Analysis		15/03/10	05/04/10
Final Report Submission		05/04/10	05/04/10
Final Presentation		06/04/10	06/04/10



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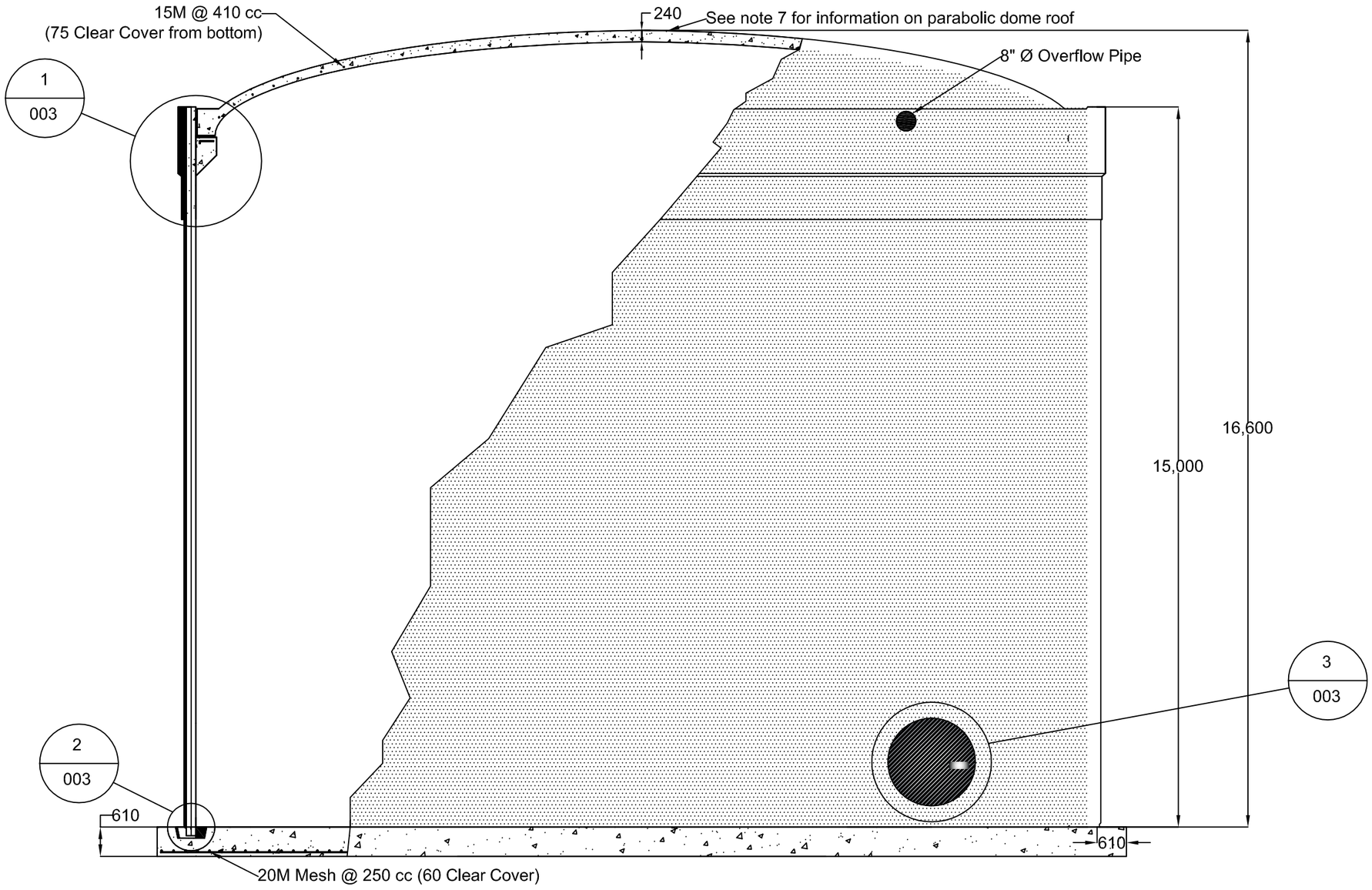
Appendix P



X-Sec View

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Notes:

1. See Notes on Drawing C-001-03

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Date of Approval:	

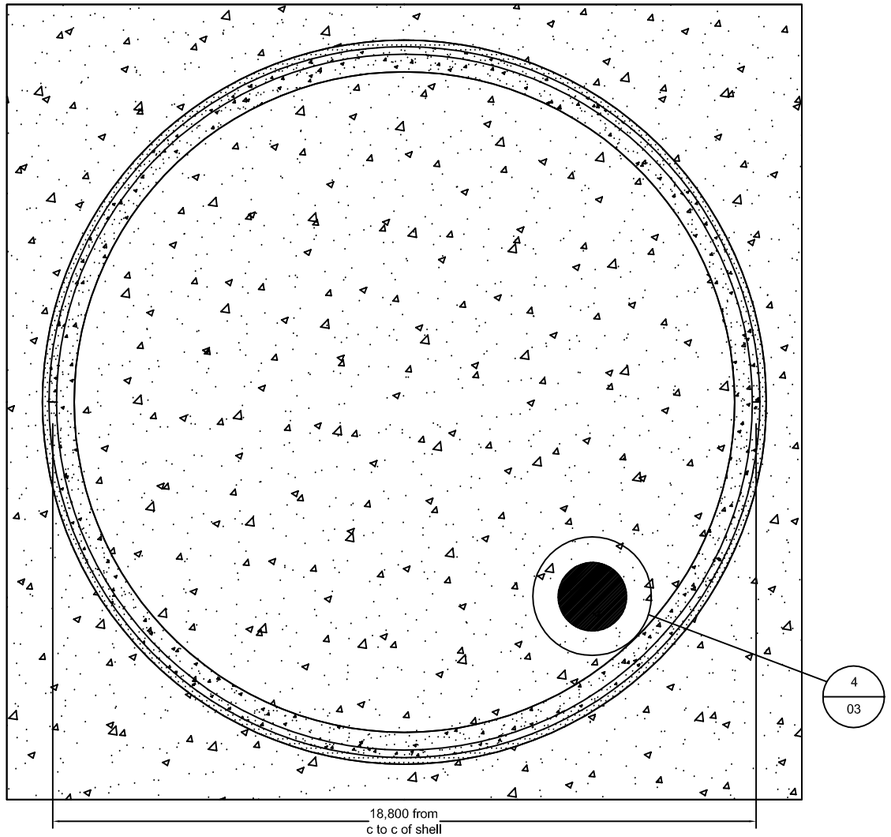
3.8 M Litre Water Storage Tank Cost Analysis
City of St. John's NL

Drawing:

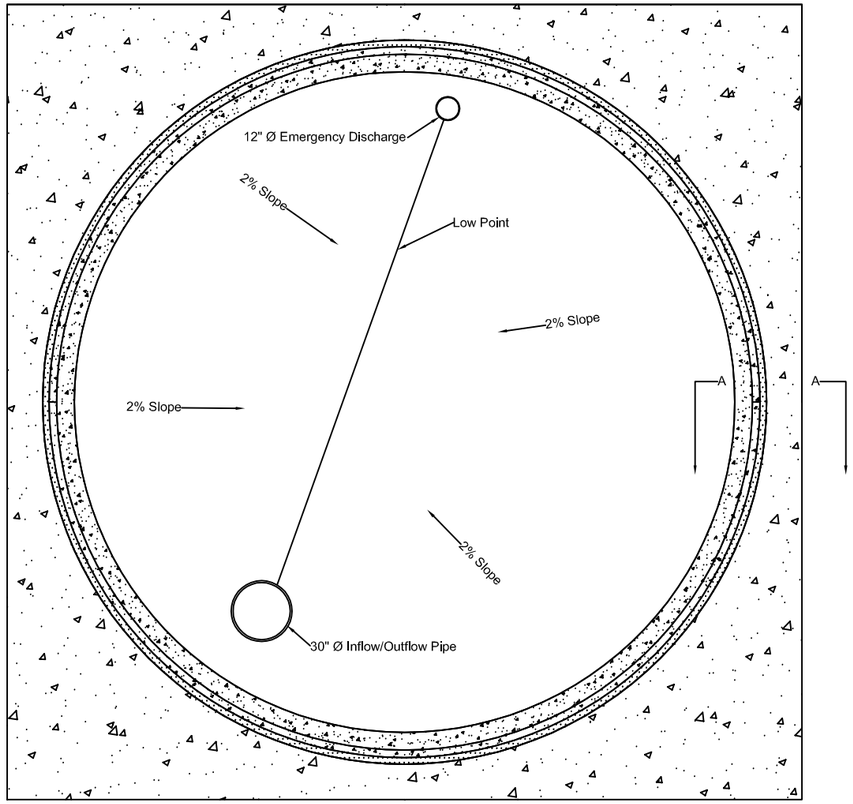
Concrete tank - Cross-section View

Course: Engineering 8700	Title: Civil Project
Group No.: Group 4	Instructor: Dr. S Bruneau
Drawing By:	Design By:

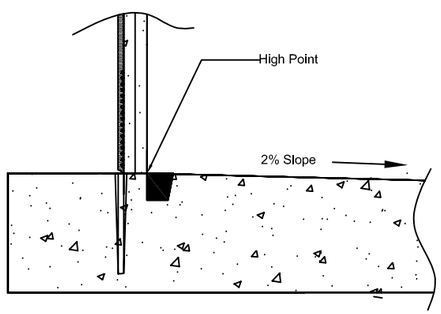
Project No.	Drawing No.	Rev.
C-001	C-001-01	A



Plan View
Roof



Plan View
Tank Bottom



Section A

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Notes:

1. See Notes on Drawing C-001-03

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Approved by:	Signature:
Date of Approval:	

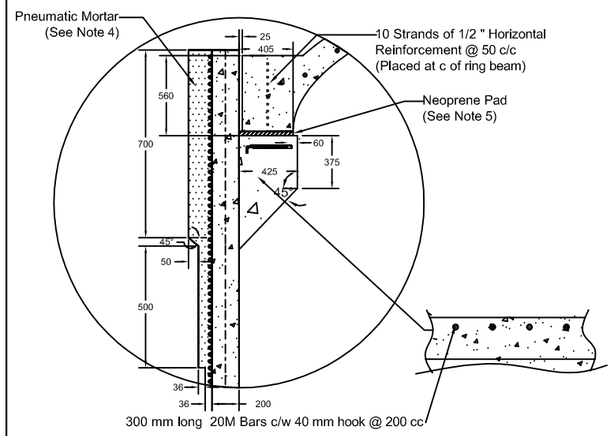
3.8 M Litre Water Storage Tank Cost Analysis
City of St. John's NL

Drawing:

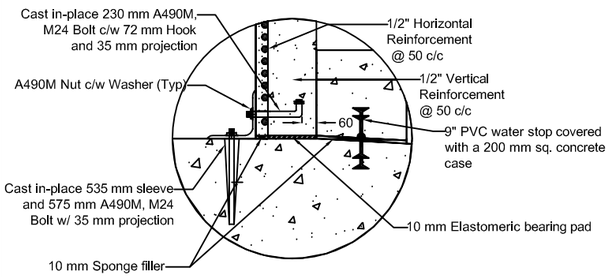
Concrete tank - Details

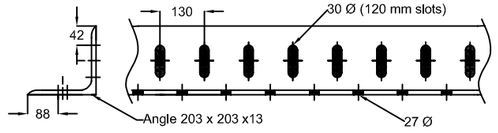
Course: Engineering 8700	Title: Civil Project
Group No.: Group 4	Instructor: Dr. S Bruneau
Drawing By:	Design By:

Project No.	Drawing No.	Rev.
C-001	C-001-02	A



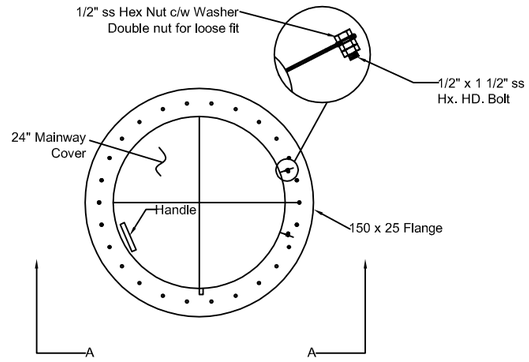
Detail 1
01

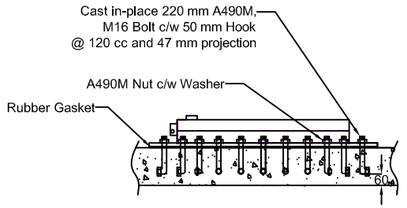




X-Sec of Angle

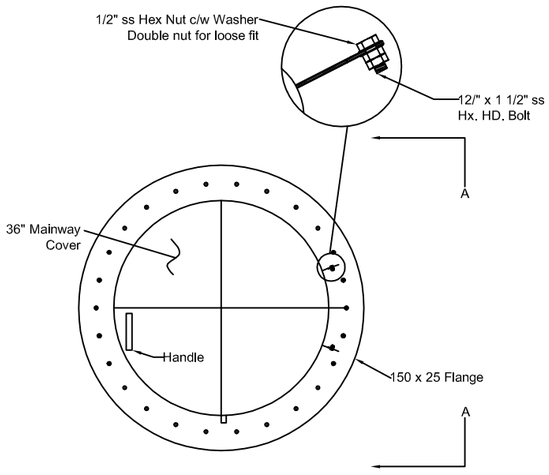
Detail 2
01

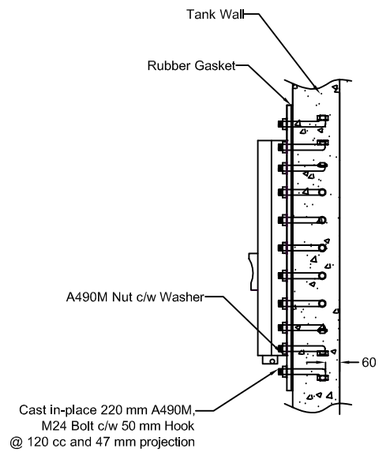




Section A

Detail 4
02





Section A

Detail 3
01

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Notes:

1. All dimensions are in millimeters unless otherwise stated
2. Concrete clear cover = 60 mm unless otherwise stated
3. Use 35 MPa concrete
4. Use Pneumatic Mortar to coat the exterior of the tank shell
5. Use a 10 mm Neoprene Pad to support the dome roof on the tank shell
6. Special shoring in the shape of the parabolic dome roof must be supplied by a vendor of the contractors choice. The shoring must be engineered to bear all loading applied to the roof.

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Date of Approval:	

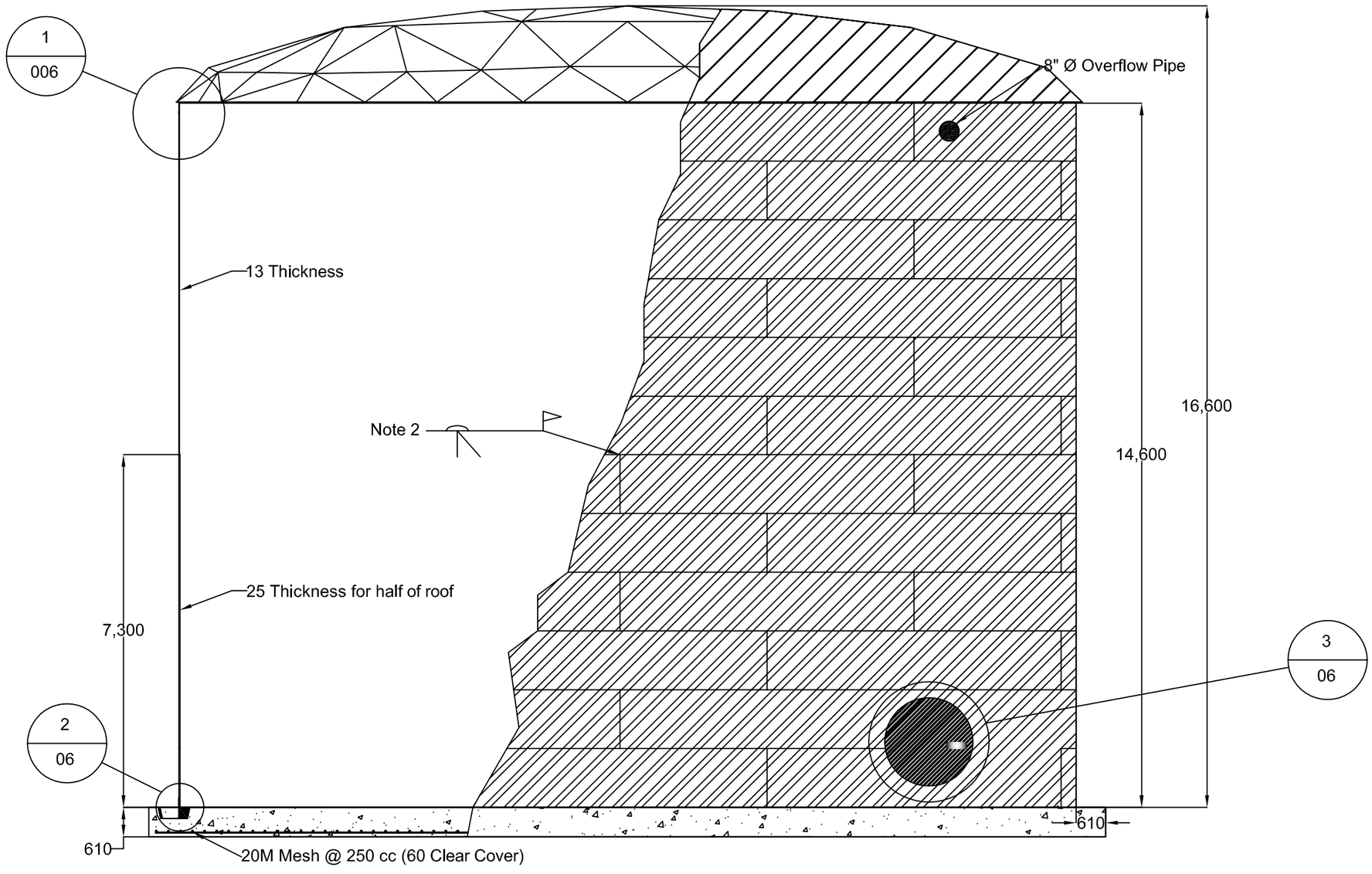
3.8 M Litre Water Storage Tank Cost Analysis
City of St. John's NL

Drawing:

Concrete tank - Cross-section View

Course: Engineering 8700	Title: Civil Project
Group No.: Group 4	Instructor: Dr. S Bruneau
Drawing By:	Design By:

Project No.	Drawing No.	Rev.
C-001	C-001-03	A



X-Sec View

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Notes:

1. See Notes on Drawing C-001-06
2. Full penetration welds at all steel wall joints
3. Use 35 MPa Concrete

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Date of Approval:	

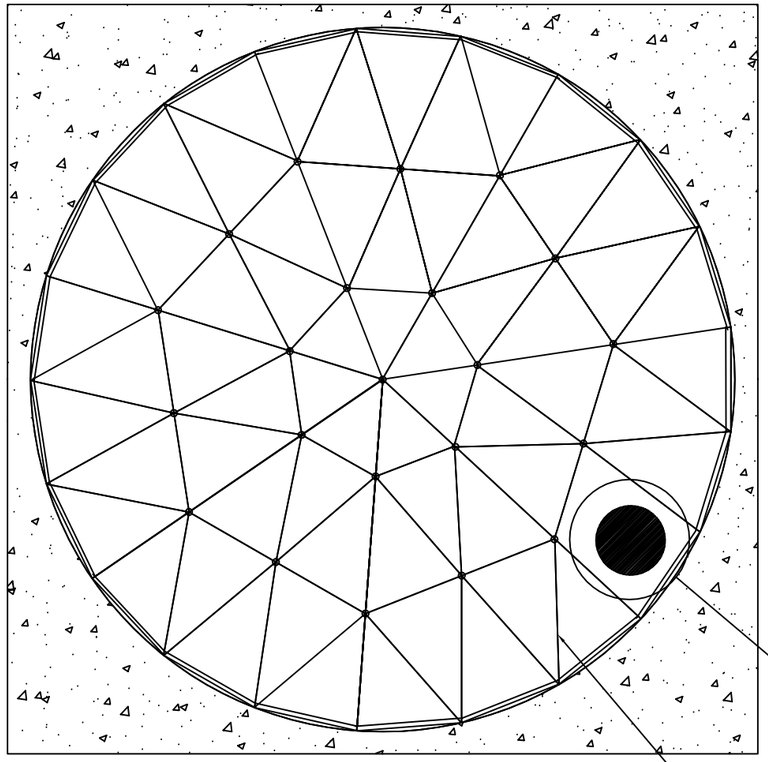
3.8 M Litre Water Storage Tank Cost Analysis
City of St. John's NL

Drawing:

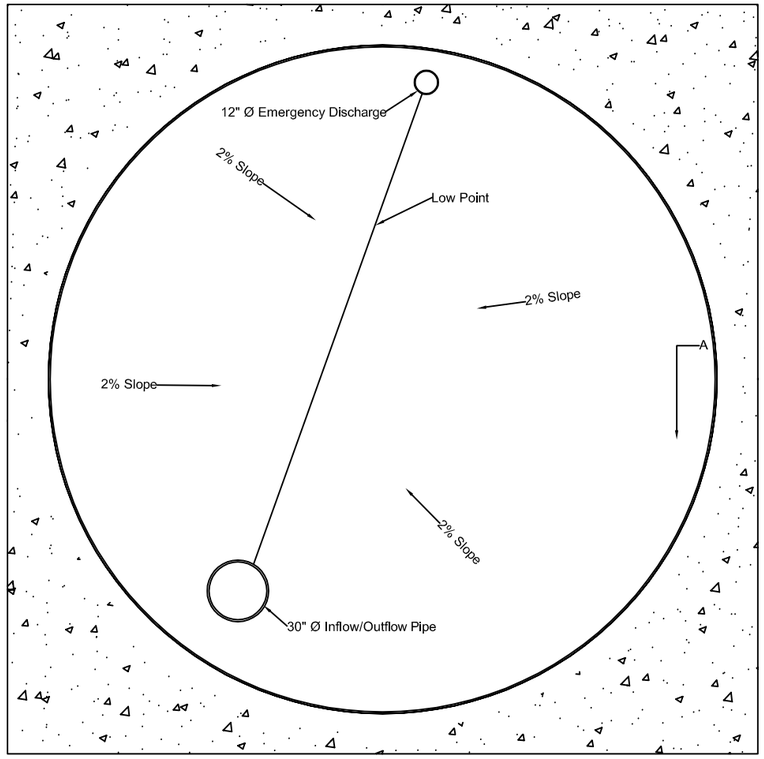
Concrete tank - Cross-section View

Course: Engineering 8700	Title: Civil Project
Group No.: Group 4	Instructor: Dr. S Bruneau
Drawing By:	Design By:

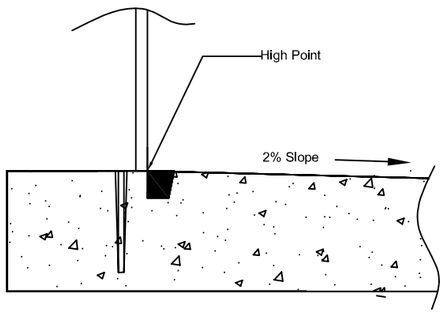
Project No.	Drawing No.	Rev.
C-001	C-001-04	A



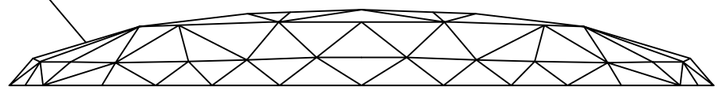
Plan View
Roof



Plan View
Tank Bottom



Section A



Aluminum Geodesic Roof
See Note 2

SGMC Consultants

Notes:

1. See Notes on Drawing C-001-03
2. Aluminum geodesic roof to be designed and supplied by Ultraflote as per provided dimensions and specified loading.

JGA Consulting Engineers Limited	Issued for Review
Approved by:	Signature:
Date of Approval:	

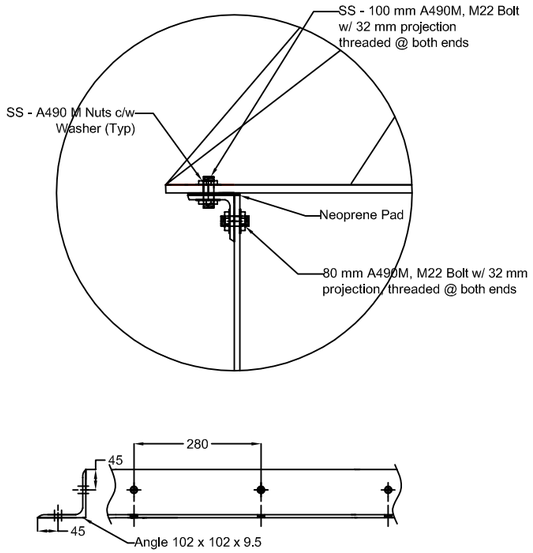
3.8 M Litre Water Storage Tank Cost Analysis
City of St. John's NL

Drawing:

Concrete tank - Details

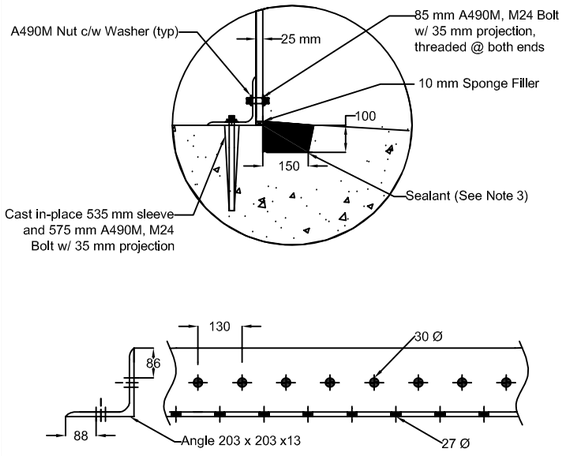
Course: Engineering 8700	Title: Civil Project
Group No.: Group 4	Instructor: Dr. S Bruneau
Drawing By:	Design By:

Project No.: C-001	Drawing No.: C-001-05	Rev.: A



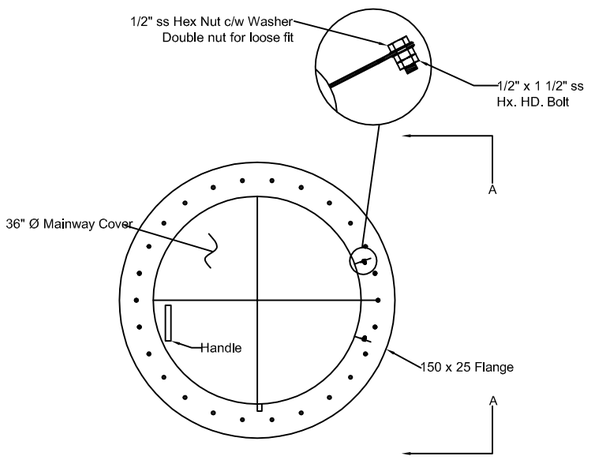
X-Sec of Angle

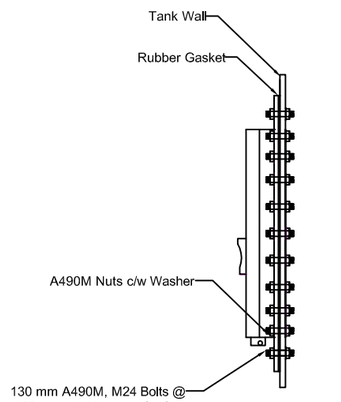
Detail 1
04



X-Sec of Angle

Detail 2
04





Section A

Detail 3
04

Top Hatch to be designed by Aluminum Geodesic Roof Supplier

Detail 4
05

SGMC Consultants

Notes:

1. All dimensions are in millimeters unless otherwise stated
2. Concrete clear cover = 60 mm unless otherwise stated
3. Use Sika Sealant to seal the shell to foundation connection. Ensure the sealant is 10 mm above the base of the interior wall of the shell and sloped for proper drainage
4. All structural steel plates to conform to CSA G40.21, w/ a minimum yield strength of 350 MPa
5. All welding shall be completed by qualified welders of companies in compliance w/ CSA standards W 47.1 and in accordance w/ CSA standard W 59
6. Paint tank shell with one coat primer and two coats epoxy paint

jga Consulting Engineers Limited

	Issued for Review
Approved by:	Signature:
Date of Approval:	

3.8 M Litre Water Storage Tank Cost Analysis
City of St. John's NL

Drawing:

Concrete tank - Cross-section View

Course: Engineering 8700	Title: Civil Project
Group No.: Group 4	Instructor: Dr. S Bruneau
Drawing By:	Design By:

Project No.	Drawing No.	Rev.
C-001	C-001-06	D

Appendix Q

Slab-Concrete Tank
fga Consultants

Paradise Newfoundland A1L-2X9

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubCo	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes
216	312316130060			Excavating, trench or continuous footing, common earth, 0.38 m3 excavator, 300 mm to 1200 mm deep, excludes sheeting or dewatering	B11M	153	0.105	Bm3	$ -	$ 3.91	$ 2.58	$ 6.49	$ -	$ 844.56	$ 557.28	$ 1,401.84	$ -	$ 5.94	$ 2.85	$ 8.79	$ -	$ 1,283.04	$ 615.60	$ 1,898.64	STD	Year 2010	C15	Excavation for slab on grade
108	312323200016			Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic meters, 10 min wait/load/unload, 6.12 m3 truck, cycle 1.6 km, 24kmh, excludes loading equipment	B34A	208	0.038	Lm3	$ -	$ 1.25	$ 1.97	$ 3.22	$ -	$ 135.00	$ 212.76	$ 347.76	$ -	$ 1.91	$ 2.16	$ 4.07	$ -	$ 206.28	$ 233.28	$ 439.56	STD	Year 2010	C15	Haul excess from site, assumed half of excavation
108	312323130015			Backfill, light soil, by hand, no compaction	1 Clab	10.7	0.747	Lm3	$ -	$ 24.06	$ -	$ 24.06	$ -	$ 2,598.48	$ -	$ 2,598.48	$ -	$ 37.32	$ -	$ 37.32	$ -	$ 4,030.56	$ -	$ 4,030.56	STD	Year 2010	C15	Backfill around slab, assume half of excavation
360	312216101100			Fine grading, fine grade for slab on grade, machine	B11L	870	0.018	m2	$ -	$ 0.69	$ 0.74	$ 1.43	$ -	$ 248.40	$ 266.40	$ 514.80	$ -	$ 1.04	$ 0.81	$ 1.85	$ -	$ 374.40	$ 291.60	$ 666.00	STD	Year 2010	C15	Grading for slab on grade
37	031113653060			C.I.P. concrete forms, slab on grade, edge, wood, over 305 mm, 4 use, includes erecting, bracing, stripping and cleaning	C1	32.52	0.984	m2CA	$ 6.30	$ 23.87	$ -	$ 30.17	$ 233.10	$ 883.19	$ -	$ 1,116.29	$ 6.82	$ 36.72	$ -	$ 43.54	$ 252.34	$ 1,358.64	$ -	$ 1,610.98	STD	Year 2010	C15	Slab on grade forms.
178	033105704300			Structural concrete, placing, slab on grade, direct chute, up to 150 mm thick, includes strike off & consolidation, excludes material	C6	84.11	0.571	m3	$ -	$ 14.50	$ 0.74	$ 15.24	$ -	$ 2,581.00	$ 131.72	$ 2,712.72	$ -	$ 22.08	$ 0.81	$ 22.89	$ -	$ 3,930.24	$ 144.18	$ 4,074.42	STD	Year 2010	C15	Placing of slab concrete, assume ok for 600mm thick
178	033105350400			Structural concrete, ready mix, normal weight, 34 MPa, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments				m3	$ 246.53	$ -	$ -	$ 246.53	$ 43,882.34	$ -	$ -	$ 43,882.34	$ 270.67	$ -	$ -	$ 270.67	$ 48,179.26	$ -	$ -	$ 48,179.26	STD	Year 2010	C15	Concrete material for slab
5.47	032110600600			Reinforcing Steel, in place, slab on grade, #10 to #22, A615M, grade 400, incl labor for accessories, excl material for accessories	4 Rodm	2.09	15.336	Met. Ton	$ 1,408.68	$ 395.28	$ -	$ 1,803.96	$ 7,705.48	$ 2,162.18	$ -	$ 9,867.66	$ 1,542.84	$ 631.35	$ -	$ 2,174.19	$ 8,439.33	$ 3,453.48	$ -	$ 11,892.82	STD	Year 2010	C15	All rebar in place
296	033529300200			Concrete finishing, floors, basic finishing for unspecified flatwork, bull float, manual float & manual steel trowel, excludes placing, striking off & consolidating	C10	118	0.203	m2	$ -	$ 5.63	$ -	$ 5.63	$ -	$ 1,666.48	$ -	$ 1,666.48	$ -	$ 8.32	$ -	$ 8.32	$ -	$ 2,462.72	$ -	$ 2,462.72	STD	Year 2010	C15	Wet finish, top of floor and slab
37	033529600050			Concrete finishing, walls, burlap rub with grout, includes breaking ties and patching voids	1 Cefi	41.81	0.191	m2	$ 0.55	$ 5.59	$ -	$ 6.14	$ 20.35	$ 206.83	$ -	$ 227.18	$ 0.74	$ 8.17	$ -	$ 8.91	$ 27.38	$ 302.29	$ -	$ 329.67	STD	Year 2010	C15	Dry finish on sides
296	033913500400			Curing, curing blankets, buy, minimum, 25 mm to 50 mm thick				m2	$ 6.12	$ -	$ -	$ 6.12	$ 1,811.52	$ -	$ -	$ 1,811.52	$ 6.69	$ -	$ -	$ 6.69	$ 1,980.24	$ -	$ -	$ 1,980.24	STD	Year 2010	C15	Curing to of slab
455	031505357350			Insert, loop ferrule type, 22 mm diameter bolt	1 Carp	84	0.095	Ea.	$ 16.40	$ 2.42	$ -	$ 18.82	$ 7,462.00	$ 1,101.10	$ -	$ 8,563.10	$ 18.06	$ 3.73	$ -	$ 21.79	$ 8,217.30	$ 1,697.15	$ -	$ 9,914.45	STD	Year 2010	C15	Assumed fine for 24mm sleeves
272	071919100300			Silicone water repellants, sprayed on, 2 coat	1 Rofc	279	0.029	m2	$ 7.34	$ 0.61	$ -	$ 7.95	$ 1,996.48	$ 165.92	$ -	$ 2,162.40	$ 8.04	$ 1.02	$ -	$ 9.06	$ 2,186.88	$ 277.44	$ -	$ 2,464.32	STD	Year 2010	C15	Protective coating
Total									**$63111.27**	**$12593.14**	**$1168.16**	**$76872.57**									**$69282.73**	**$19376.24**	**$1284.66**	**$89943.64**				

Shell - Concrete Tank
fga Consultants

Paradise Newfoundland A1L-2X9

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubCc	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes	
1700	031113854000			C.I.P. concrete forms, wall, radial, smooth curved, plywood, to 2.44 m high, 1 use, includes erecting, bracing, stripping and cleaning	C2	22.76	2.109	m2CA	$ 20.61	$ 52.33	$ -	$ 72.94	$ 35,037.00	$ 88,961.00	$ -	$ 123,998.00	$ 22.38	$ 80.78	$ -	$ 103.16	$ 38,046.00	$ 137,326.00	$ -	$ 175,372.00	STD	Year 2010	C15	Curved forms, one use because the wall is assumed to be done in one pour.	
1	031113850100			C.I.P. concrete forms, wall, box out for opening, to 405 mm thick, to 0.93 m2, includes erecting, bracing, stripping and cleaning	C2	24	2	Ea.	$ 17.54	$ 49.57	$ -	$ 67.11	$ 17.54	$ 49.57	$ -	$ 67.11	$ 19.31	$ 76.50	$ -	$ 95.81	$ 19.31	$ 76.50	$ -	$ 95.81	STD	Year 2010	C15	For access hatch	
340	033105701550			Structural concrete, placing, elevated slab, with crane and bucket, 150 mm to 254 mm thick, includes strike off & consolidation, excludes material	C7	84.11	0.856	m3	$ -	$ 22.45	$ 15.67	$ 38.12	$ -	$ 7,633.00	$ 5,327.80	$ 12,960.80	$ -	$ 34.22	$ 17.20	$ 51.42	$ -	$ 11,634.80	$ 5,848.00	$ 17,482.80	STD	Year 2010	C15	Nothing for walls, assume similar pour	
340	033105350400			Structural concrete, ready mix, normal weight, 34 MPa, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments				m3	$ 246.53	$ -	$ -	$ 246.53	$ 83,820.20	$ -	$ -	$ 83,820.20	$ 270.67	$ -	$ -	$ 270.67	$ 92,027.80	$ -	$ -	$ 92,027.80	STD	Year 2010	C15	Material for walls	
26678	032305501650			Prestressing steel, ungrouted strand, 60 m span, 135 metric ton	C4	771	0.042	kg	$ 2.25	$ 1.08	$ 0.04	$ 3.37	$ 60,025.50	$ 28,812.24	$ 1,067.12	$ 89,904.86	$ 2.48	$ 1.73	$ 0.04	$ 4.25	$ 66,161.44	$ 46,152.94	$ 1,067.12	$ 113,381.50	STD	Year 2010	C15	Horizontal plus vertical prestressing strand, 1/2" diameter	
6	033529600600			Concrete finishing, walls, float finish, 1.6 mm thick	1 Cefi	27.87	0.287	m2	$ 5.57	$ 8.39	$ -	$ 13.96	$ 33.42	$ 50.34	$ -	$ 83.76	$ 5.93	$ 12.25	$ -	$ 18.18	$ 35.58	$ 73.50	$ -	$ 109.08	STD	Year 2010	C15	Wet finish on top of wall	
850	033529600700			Concrete finishing, walls, sandblast, light penetration	E11	102	0.314	m2	$ 14.14	$ 8.61	$ 2.27	$ 25.02	$ 12,019.00	$ 7,318.50	$ 1,929.50	$ 21,267.00	$ 15.60	$ 14.24	$ 2.50	$ 32.34	$ 13,260.00	$ 12,104.00	$ 2,125.00	$ 27,489.00	STD	Year 2010	C15	Inside finish of tank walls	
850	033529600050			Concrete finishing, walls, burlap rub with grout, includes breaking ties and patching voids	1 Cefi	41.81	0.191	m2	$ 0.55	$ 5.59	$ -	$ 6.14	$ 467.50	$ 4,751.50	$ -	$ 5,219.00	$ 0.74	$ 8.17	$ -	$ 8.91	$ 629.00	$ 6,944.50	$ -	$ 7,573.50	STD	Year 2010	C15	Outside wall finish	
6	033913500400			Curing, curing blankets, buy, minimum, 25 mm to 50 mm thick				m2	$ 6.12	$ -	$ -	$ 6.12	$ 36.72	$ -	$ -	$ 36.72	$ 6.69	$ -	$ -	$ 6.69	$ 40.14	$ -	$ -	$ 40.14	STD	Year 2010	C15	Cure top of Wall	
59	033529350160			Control joint, concrete floor slab, sawcut in green concrete, 50 mm depth	C27	488	0.033	m	$ 0.67	$ 0.96	$ 0.34	$ 1.97	$ 39.53	$ 56.64	$ 20.06	$ 116.23	$ 0.74	$ 1.40	$ 0.37	$ 2.51	$ 43.66	$ 82.60	$ 21.83	$ 148.09	STD	Year 2010	C15	Construction joint between shell and slab	
59	033529350200			Control joint, blow construction debris out of control joint	C28	1829	0.004	m	$ -	$ 0.13	$ 0.01	$ 0.14	$ -	$ 7.67	$ 0.59	$ 8.26	$ -	$ 0.18	$ 0.01	$ 0.19	$ -	$ 10.62	$ 0.59	$ 11.21	STD	Year 2010	C15	Construction joint prep between shell and slab	
44	040513302650			Mortar, pre-mixed, type S or N				m3	$ 320.86	$ -	$ -	$ 320.86	$ 14,117.84	$ -	$ -	$ 14,117.84	$ 354.05	$ -	$ -	$ 354.05	$ 15,578.20	$ -	$ -	$ 15,578.20	STD	Year 2010	C15	Pneumatic mortar, assumed	
445	050523251550			High strength bolt, 25 mm dia x 200 mm L, A490, incl washer & nut	1 Sswk	85	0.094	Ea.	$ 16.05	$ 3.25	$ -	$ 19.30	$ 7,142.25	$ 1,446.25	$ -	$ 8,588.50	$ 17.62	$ 5.72	$ -	$ 23.34	$ 7,840.90	$ 2,545.40	$ -	$ 10,386.30	STD	Year 2010	C15	Embedded, bent bolts, shell to slab connection	
28	050523250190			High strength bolt, 16 mm dia x 75 mm L, A325 Type 1, incl washer & nut	1 Sswk	115	0.07	Ea.	$ 2.25	$ 2.41	$ -	$ 4.66	$ 63.00	$ 67.48	$ -	$ 130.48	$ 2.48	$ 4.24	$ -	$ 6.72	$ 69.44	$ 118.72	$ -	$ 188.16	STD	Year 2010	C15	Embedded bent bolts for access hatch	
844	071919100300			Silicone water repellants, sprayed on, 2 coat	1 Rofc	279	0.029	m2	$ 7.34	$ 0.61	$ -	$ 7.95	$ 6,194.96	$ 514.84	$ -	$ 6,709.80	$ 8.04	$ 1.02	$ -	$ 9.06	$ 6,785.76	$ 860.88	$ -	$ 7,646.64	STD	Year 2010	C15	Interior protective coating	
Total													**$219014.46**	**$139669.03**	**$8345.07**	**$367028.56**					**$240537.23**	**$217930.46**	**$9062.54**	**$467530.23**					

Edge Beam Saddle - Concrete Tank
fga Consultants

Paradise Newfoundland A1L-2X9

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubCd	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes
58	031113201000			C.I.P. concrete forms, beams and girders, exterior spandrel, plywood, 460 mm wide, 1 use, includes shoring, erecting, bracing, stripping and cleaning	C2	23.23	2.067	m2CA	$ 31.23	$ 51.10	$ -	$ 82.33	$ 1,811.34	$ 2,963.80	$ -	$ 4,775.14	$ 34.35	$ 78.95	$ -	$ 113.30	$ 1,992.30	$ 4,579.10	$ -	$ 6,571.40	STD	Year 2010	C15	ring beam forms including sloped forms
15	033105350400			Structural concrete, ready mix, normal weight, 34 MPa, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments				m3	$ 246.53	$ -	$ -	$ 246.53	$ 3,697.95	$ -	$ -	$ 3,697.95	$ 270.67	$ -	$ -	$ 270.67	$ 4,060.05	$ -	$ -	$ 4,060.05	STD	Year 2010	C15	Concrete material for ring beam saddle
15	033105700250			Structural concrete, placing, beam, large, elevated, with crane and bucket, includes strike off & consolidation, excludes material	C7	49.7	1.449	m3	$ -	$ 38.27	$ 26.55	$ 64.82	$ -	$ 574.05	$ 398.25	$ 972.30	$ -	$ 57.78	$ 29.10	$ 86.88	$ -	$ 866.70	$ 436.50	$ 1,303.20	STD	Year 2010	C15	Placing concrete material for ring beam saddle
58	033529600750			Concrete finishing, walls, sandblast, heavy penetration	E11	34.84	0.919	m2	$ 28.36	$ 25.39	$ 6.64	$ 60.39	$ 1,644.88	$ 1,472.62	$ 385.12	$ 3,502.62	$ 31.20	$ 41.58	$ 7.30	$ 80.08	$ 1,809.60	$ 2,411.64	$ 423.40	$ 4,644.64	STD	Year 2010	C15	Dry finish inside of ring beam saddle
25	033529300200			Concrete finishing, floors, basic finishing for unspecified flatwork, bull float, manual float & manual steel trowel, excludes placing, striking off & consolidating	C10	118	0.203	m2	$ -	$ 5.63	$ -	$ 5.63	$ -	$ 140.75	$ -	$ 140.75	$ -	$ 8.32	$ -	$ 8.32	$ -	$ 208.00	$ -	$ 208.00	STD	Year 2010	C15	Wet finish at top of ringbeam saddle
25	033913500400			Curing, curing blankets, buy, minimum, 25 mm to 50 mm thick				m2	$ 6.12	$ -	$ -	$ 6.12	$ 153.00	$ -	$ -	$ 153.00	$ 6.69	$ -	$ -	$ 6.69	$ 167.25	$ -	$ -	$ 167.25	STD	Year 2010	C15	Top of ring beam saddle curing
266	033529350140			Control joint, concrete floor slab, sawcut in green concrete, 38 mm depth	C27	549	0.029	m	$ 0.52	$ 0.85	$ 0.30	$ 1.67	$ 138.32	$ 226.10	$ 79.80	$ 444.22	$ 0.57	$ 1.24	$ 0.33	$ 2.14	$ 151.62	$ 329.84	$ 87.78	$ 569.24	STD	Year 2010	C15	CJ Prep
266	033529350200			Control joint, blow construction debris out of control joint	C28	1829	0.004	m	$ -	$ 0.13	$ 0.01	$ 0.14	$ -	$ 34.58	$ 2.66	$ 37.24	$ -	$ 0.18	$ 0.01	$ 0.19	$ -	$ 47.88	$ 2.66	$ 50.54	STD	Year 2010	C15	CJ prep
0.2	032110600100			Reinforcing Steel, in place, beams and girders, #10 to #22, A615M, grade 400, incl labor for accessories, excl material for accessories	4 Rodm	1.45	22.046	Met. Ton	$ 1,475.76	$ 562.73	$ -	$ 2,038.49	$ 295.15	$ 112.55	$ -	$ 407.70	$ 1,626.69	$ 905.85	$ -	$ 2,532.54	$ 325.34	$ 181.17	$ -	$ 506.51	STD	Year 2010	C15	Saddle reinforcement
25	071353101300			Elastomeric sheet waterproofing, neoprene sheets, plain, 1.5 mm thick	2 Rofc	52.95	0.302	m2	$ 28.99	$ 6.43	$ -	$ 35.42	$ 724.75	$ 160.75	$ -	$ 885.50	$ 31.79	$ 10.70	$ -	$ 42.49	$ 794.75	$ 267.50	$ -	$ 1,062.25	STD	Year 2010	C15	neoprene dome to ring beam softener
58	071919100300			Silicone water repellants, sprayed on, 2 coat	1 Rofc	279	0.029	m2	$ 7.34	$ 0.61	$ -	$ 7.95	$ 425.72	$ 35.38	$ -	$ 461.10	$ 8.04	$ 1.02	$ -	$ 9.06	$ 466.32	$ 59.16	$ -	$ 525.48	STD	Year 2010	C15	Interior protective coating
Total													**$8891.11**	**$5720.58**	**$865.83**	**$15477.52**					**$9767.23**	**$8950.99**	**$950.34**	**$19668.56**				

Dome Roof - Concrete Tank
fga Consultants

Paradise Newfoundland A1L-2X9

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubCc	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes	
315	031113351600			C.I.P. concrete forms, elevated slab, flat plate, plywood, 6.2 m to 11 m high ceilings, includes shoring, erecting, bracing, stripping and cleaning	C2	41.81	1.148	m2	$ 27.07	$ 28.46	$ -	$ 55.53	$ 8,527.05	$ 8,964.90	$ -	$ 17,491.95	$ 29.67	$ 43.76	$ -	$ 73.43	$ 9,346.05	$ 13,784.40	$ -	$ 23,130.45	STD	Year 2010	C15	soffit forms for dome	
0.65	031113355000			C.I.P. concrete forms, elevated slab, box-out for wall openings, over 405 mm deep, 1 use, includes shoring, erecting, bracing, stripping and cleaning	C2	17.65	2.719	m2CA	$ 40.60	$ 67.32	$ -	$ 107.92	$ 26.39	$ 43.76	$ -	$ 70.15	$ 44.24	$ 104.04	$ -	$ 148.28	$ 28.76	$ 67.63	$ -	$ 96.38	STD	Year 2010	C15	Blockout for access hatch	
33	031113357000			C.I.P. concrete forms, elevated slab, edge forms, to 150 mm high, 4 use, includes shoring, erecting, bracing, stripping and cleaning	C1	152	0.211	m	$ 0.41	$ 5.08	$ -	$ 5.49	$ 13.53	$ 167.64	$ -	$ 181.17	$ 0.45	$ 7.83	$ -	$ 8.28	$ 14.85	$ 258.39	$ -	$ 273.24	STD	Year 2010	C15	outside of ring beam form	
90	033105350400			Structural concrete, ready mix, normal weight, 34 MPa, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments				m3	$ 246.53	$ -	$ -	$ 246.53	$ 22,187.70	$ -	$ -	$ 22,187.70	$ 270.67	$ -	$ -	$ 270.67	$ 24,360.30	$ -	$ -	$ 24,360.30	STD	Year 2010	C15	Dome concrete material	
90	033105701550			Structural concrete, placing, elevated slab, with crane and bucket, 150 mm to 254 mm thick, includes strike off & consolidation, excludes material	C7	84.11	0.856	m3	$ -	$ 22.45	$ 15.67	$ 38.12	$ -	$ 2,020.50	$ 1,410.30	$ 3,430.80	$ -	$ 34.22	$ 17.20	$ 51.42	$ -	$ 3,079.80	$ 1,548.00	$ 4,627.80	STD	Year 2010	C15	Dome concrete placing	
1.8	032110600400			Reinforcing Steel, in place, elevated slabs, #13 to #22, A615M, grade 400, incl labor for accessories, excl material for accessories	4 Rodm	2.63	12.163	Met. Ton	$ 1,568.00	$ 312.93	$ -	$ 1,880.93	$ 2,822.40	$ 563.27	$ -	$ 3,385.67	$ 1,718.93	$ 502.34	$ -	$ 2,221.27	$ 3,094.07	$ 904.21	$ -	$ 3,998.29	STD	Year 2010	C15	Temp reinforcement in dome	
620	032305501650			Prestressing steel, ungrouted strand, 60 m span, 135 metric ton	C4	771	0.042	kg	$ 2.25	$ 1.08	$ 0.04	$ 3.37	$ 1,395.00	$ 669.60	$ 24.80	$ 2,089.40	$ 2.48	$ 1.73	$ 0.04	$ 4.25	$ 1,537.60	$ 1,072.60	$ 24.80	$ 2,635.00	STD	Year 2010	C15	ring beam prestressing reinforcement	
315	033529300200			Concrete finishing, floors, basic finishing for unspecified flatwork, bull float, manual float & manual steel trowel, excludes placing, striking off & consolidating	C10	118	0.203	m2	$ -	$ 5.63	$ -	$ 5.63	$ -	$ 1,773.45	$ -	$ 1,773.45	$ -	$ 8.32	$ -	$ 8.32	$ -	$ 2,620.80	$ -	$ 2,620.80	STD	Year 2010	C15	top of dome wet finish	
315	033529600750			Concrete finishing, walls, sandblast, heavy penetration	E11	34.84	0.919	m2	$ 28.36	$ 25.39	$ 6.64	$ 60.39	$ 8,933.40	$ 7,997.85	$ 2,091.60	$ 19,022.85	$ 31.20	$ 41.58	$ 7.30	$ 80.08	$ 9,828.00	$ 13,097.70	$ 2,299.50	$ 25,225.20	STD	Year 2010	C15	Sandblast finish for inside of dome	
33	033529600050			Concrete finishing, walls, burlap rub with grout, includes breaking ties and patching voids	1 Cefi	41.81	0.191	m2	$ 0.55	$ 5.59	$ -	$ 6.14	$ 18.15	$ 184.47	$ -	$ 202.62	$ 0.74	$ 8.17	$ -	$ 8.91	$ 24.42	$ 269.61	$ -	$ 294.03	STD	Year 2010	C15	edge of ring beam finish	
315	033913500400			Curing, curing blankets, buy, minimum, 25 mm to 50 mm thick				m2	$ 6.12	$ -	$ -	$ 6.12	$ 1,927.80	$ -	$ -	$ 1,927.80	$ 6.69	$ -	$ -	$ 6.69	$ 2,107.35	$ -	$ -	$ 2,107.35	STD	Year 2010	C15	Top of dome curing	
20	050523250190			High strength bolt, 16 mm dia x 75 mm L, A325 Type 1, incl washer & nut	1 Sswk	115	0.07	Ea.	$ 2.25	$ 2.41	$ -	$ 4.66	$ 45.00	$ 48.20	$ -	$ 93.20	$ 2.48	$ 4.24	$ -	$ 6.72	$ 49.60	$ 84.80	$ -	$ 134.40	STD	Year 2010	C15	Bolts for access hatch	
315	071919100300			Silicone water repellants, sprayed on, 2 coat	1 Rofc	279	0.029	m2	$ 7.34	$ 0.61	$ -	$ 7.95	$ 2,312.10	$ 192.15	$ -	$ 2,504.25	$ 8.04	$ 1.02	$ -	$ 9.06	$ 2,532.60	$ 321.30	$ -	$ 2,853.90	STD	Year 2010	C15	Protective Interior coating	
Total													**$48208.52**	**$22625.79**	**$3526.70**	**$74361.01**					**$52923.60**	**$35561.24**	**$3872.30**	**$92357.14**					

Shell to Slab Connection - Concrete Tank
fga Consultants

Paradise Newfoundland A1L-2X9

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubCo	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes
24	031113200500			C.I.P. concrete forms, beams and girders, exterior spandrel, plywood, 300 mm wide, 1 use, includes shoring, erecting, bracing, stripping and cleaning	C2	20.9	2.296	m2CA	$ 38.52	$ 56.92	$ -	$ 95.44	$ 924.48	$ 1,366.08	$ -	$ 2,290.56	$ 42.16	$ 87.52	$ -	$ 129.68	$ 1,011.84	$ 2,100.48	$ -	$ 3,112.32	STD	Year 2010	C15	Concrete water stop casing
52	033105350400			Structural concrete, ready mix, normal weight, 34 MPa, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments				m3	$ 246.53	$ -	$ -	$ 246.53	$ 12,819.56	$ -	$ -	$ 12,819.56	$ 270.67	$ -	$ -	$ 270.67	$ 14,074.84	$ -	$ -	$ 14,074.84	STD	Year 2010	C15	Water stop encasement
52	033105700050			Structural concrete, placing, beam, small, elevated, pumped, includes strike off & consolidation, excludes material	C20	45.88	1.395	m3	$ -	$ 36.43	$ 17.77	$ 54.20	$ -	$ 1,894.36	$ 924.04	$ 2,818.40	$ -	$ 55.57	$ 19.55	$ 75.12	$ -	$ 2,889.64	$ 1,016.60	$ 3,906.24	STD	Year 2010	C15	Water stop encasement
58	031513500600			Waterstop, PVC, ribbed, with center bulb, 10 mm thick x 230 mm wide	1 Carp	38.1	0.21	m	$ 16.55	$ 5.32	$ -	$ 21.87	$ 959.90	$ 308.56	$ -	$ 1,268.46	$ 18.17	$ 8.23	$ -	$ 26.40	$ 1,053.86	$ 477.34	$ -	$ 1,531.20	STD	Year 2010	C15	water stop
12	033529300200			Concrete finishing, floors, basic finishing for unspecified flatwork, bull float, manual float & manual steel trowel, excludes placing, striking off & consolidating	C10	118	0.203	m2	$ -	$ 5.63	$ -	$ 5.63	$ -	$ 67.56	$ -	$ 67.56	$ -	$ 8.32	$ -	$ 8.32	$ -	$ 99.84	$ -	$ 99.84	STD	Year 2010	C15	wet finish
12	033529600700			Concrete finishing, walls, sandblast, light penetration	E11	102	0.314	m2	$ 14.14	$ 8.61	$ 2.27	$ 25.02	$ 169.68	$ 103.32	$ 27.24	$ 300.24	$ 15.60	$ 14.24	$ 2.50	$ 32.34	$ 187.20	$ 170.88	$ 30.00	$ 388.08	STD	Year 2010	C15	dry finish
12	033913500400			Curing, curing blankets, buy, minimum, 25 mm to 50 mm thick				m2	$ 6.12	$ -	$ -	$ 6.12	$ 73.44	$ -	$ -	$ 73.44	$ 6.69	$ -	$ -	$ 6.69	$ 80.28	$ -	$ -	$ 80.28	STD	Year 2010	C15	water stop encasement curing
445	050523251550			High strength bolt, 25 mm dia x 200 mm L, A490, incl washer & nut	1 Sswk	85	0.094	Ea.	$ 16.05	$ 3.25	$ -	$ 19.30	$ 7,142.25	$ 1,446.25	$ -	$ 8,588.50	$ 17.62	$ 5.72	$ -	$ 23.34	$ 7,840.90	$ 2,545.40	$ -	$ 10,386.30	STD	Year 2010	C15	Slab to shell connection
120	051223200300			Curb edging, structural steel angle w/ anchors, on concrete forms, 8.2 plf, 100x100 mm, shop fabricated	E4	83.82	0.382	m	$ 40.50	$ 13.30	$ 1.78	$ 55.58	$ 4,860.00	$ 1,596.00	$ 213.60	$ 6,669.60	$ 44.82	$ 23.52	$ 1.95	$ 70.29	$ 5,378.40	$ 2,822.40	$ 234.00	$ 8,434.80	STD	Year 2010	C15	203x203x13 angle, multiplied 100x100 length by 2, adjust this for curvature
1	051223200300	A		Curb edging, structural steel angle or channel w/ anchors, on concrete forms, shop fabricated, for curved edging, add				m	$ 14.18	$ 1.33	$ -	$ 15.51	$ 1,701.00	$ 159.60	$ -	$ 1,861.20	$ 15.69	$ 2.35	$ -	$ 18.04	$ 1,882.44	$ 282.24	$ -	$ 2,164.80	STD	Year 2010	C15	[Adjusted by 051223202000]
18	071353100400			Elastomeric sheet waterproofing, EPDM, plain, nylon reinforced sheets, 1.5 mm thick	2 Rofc	52.95	0.302	m2	$ 15.90	$ 6.43	$ -	$ 22.33	$ 286.20	$ 115.74	$ -	$ 401.94	$ 17.53	$ 10.70	$ -	$ 28.23	$ 315.54	$ 192.60	$ -	$ 508.14	STD	Year 2010	C15	elastomeric bearing pad for shell to slab connection
Total													**$28937.11**	**$7057.47**	**$1164.88**	**$37159.46**					**$31825.66**	**$11580.58**	**$1280.60**	**$44686.84**				

Appendix R

Steel Tank (Shell)

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubC	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes
446	051223650400			Steel plate, structural, for connections & stiffeners, 13 mm T, shop fabricated, incl shop primer				m2	$ 261.36	$ -	$ -	$ 261.36	$ 116,566.56	$ -	$ -	$ 116,566.56	$ 287.28	$ -	$ -	$ 287.28	$ 128,126.88	$ -	$ -	$ 128,126.88	STD	Year 2010	C15	
446	051223650500			Steel plate, structural, for connections & stiffeners, 25 mm T, shop fabricated, incl shop primer				m2	$ 523.80	$ -	$ -	$ 523.80	$ 233,614.80	$ -	$ -	$ 233,614.80	$ 572.40	$ -	$ -	$ 572.40	$ 255,290.40	$ -	$ -	$ 255,290.40	STD	Year 2010	C15	
50	050523902100			Weld rod, stainless steel, 3 mm dia, 225 kg to 450 kg, type 316/316L				kg	$ 16.76	$ -	$ -	$ 16.76	$ 838.00	$ -	$ -	$ 838.00	$ 18.38	$ -	$ -	$ 18.38	$ 919.00	$ -	$ -	$ 919.00	STD	Year 2010	C15	
1784	099713236610			Paints and protective coatings, epoxy primer, sprayed	2 Psst	279	0.057	m2	$ 2.84	$ 1.34	$ -	$ 4.18	$ 5,066.56	$ 2,390.56	$ -	$ 7,457.12	$ 3.08	$ 2.40	$ -	$ 5.48	$ 5,494.72	$ 4,281.60	$ -	$ 9,776.32	STD	Year 2010	C15	2 Coats
892	099713236520			Paints and protective coatings, alkyd primer, sprayed	2 Psst	334	0.048	m2	$ 0.72	$ 1.12	$ -	$ 1.84	$ 642.24	$ 999.04	$ -	$ 1,641.28	$ 0.83	$ 2.00	$ -	$ 2.83	$ 740.36	$ 1,784.00	$ -	$ 2,524.36	STD	Year 2010	C15	1 Coat
1784	099713237010			Paints and protective coatings, organic zinc rich primer, epoxy, sprayed	2 Psst	167	0.096	m2	$ 2.49	$ 2.23	$ -	$ 4.72	$ 4,442.16	$ 3,978.32	$ -	$ 8,420.48	$ 2.84	$ 3.99	$ -	$ 6.83	$ 5,066.56	$ 7,118.16	$ -	$ 12,184.72	STD	Year 2010	C15	2 Coats
Total													**$361170.32**	**$7367.92**	**$.00**	**$368538.24**					**$395637.92**	**$13183.76**	**$.00**	**$408821.68**				

Steel Tank (Connections)

Data Release : Year 2010 **Unit Cost Estimate**

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes
177	050523250370	High strength bolt, 22 mm dia x 100 mm L, A325 Type 1, incl washer & nut	1 Sswk	105	0.076	Ea.	$ 5.20	$ 2.63	$ -	$ 7.83	$ 920.40	$ 465.51	$ -	$ 1,385.91	$ 5.73	$ 4.65	$ -	$ 10.38	$ 1,014.21	$ 823.05	$ -	$ 1,837.26	STD	Year 2010	C15	Angle to Shell Connection (Top)
177	050523250390	High strength bolt, 22 mm dia x 200 mm L, A325 Type 1, incl washer & nut	1 Sswk	90	0.089	Ea.	$ 10.32	$ 3.08	$ -	$ 13.40	$ 1,826.64	$ 545.16	$ -	$ 2,371.80	$ 11.35	$ 5.42	$ -	$ 16.77	$ 2,008.95	$ 959.34	$ -	$ 2,968.29	STD	Year 2010	C15	Angle to Roof Connection
413	050523251450	High strength bolt, 25 mm dia x 100 mm L, A490, incl washer & nut	1 Sswk	95	0.084	Ea.	$ 7.51	$ 2.92	$ -	$ 10.43	$ 3,101.63	$ 1,205.96	$ -	$ 4,307.59	$ 8.27	$ 5.13	$ -	$ 13.40	$ 3,415.51	$ 2,118.69	$ -	$ 5,534.20	STD	Year 2010	C15	Angle to Shell Connection (Bottom)
472	050523251550	High strength bolt, 25 mm dia x 200 mm L, A490, incl washer & nut	1 Sswk	85	0.094	Ea.	$ 16.05	$ 3.25	$ -	$ 19.30	$ 7,575.60	$ 1,534.00	$ -	$ 9,109.60	$ 17.62	$ 5.72	$ -	$ 23.34	$ 8,316.64	$ 2,699.84	$ -	$ 11,016.48	STD	Year 2010	C15	Angle to Slab Connection
59	051223751900	Structural steel member, 90 metric ton project, 1 to 2 story building, W360x39, A992 steel, shop fabricated, incl shop primer, bolted connections	E2	302	0.185	m	$ 111.24	$ 6.21	$ 5.41	$ 122.86	$ 6,563.16	$ 366.39	$ 319.19	$ 7,248.74	$ 123.12	$ 10.51	$ 5.97	$ 139.60	$ 7,264.08	$ 620.09	$ 352.23	$ 8,236.40	STD	Year 2010	C15	L 203x203x14 A=4990 mm^2 similar properties as W member selected.
59	051223750300	Structural steel member, 90 metric ton project, 1 to 2 story building, W200x15, A992 steel, shop fabricated, incl shop primer, bolted connections	E2	183	0.306	m	$ 42.66	$ 10.25	$ 8.98	$ 61.89	$ 2,516.94	$ 604.75	$ 529.82	$ 3,651.51	$ 46.98	$ 17.27	$ 9.85	$ 74.10	$ 2,771.82	$ 1,018.93	$ 581.15	$ 4,371.90	STD	Year 2010	C15	L 103x102x9.5 A = 1850 mm^2 similar to the W section selected.
236	079116104500	Pre-formed joint seals, joint gaskets, neoprene, closed cell, 6mm x 19mm, adhered	1 Bric	65.53	0.122	m	$ 2.08	$ 3.10	$ -	$ 5.18	$ 490.88	$ 731.60	$ -	$ 1,222.48	$ 2.30	$ 4.68	$ -	$ 6.98	$ 542.80	$ 1,104.48	$ -	$ 1,647.28	STD	Year 2010	C15	Seal for bolt connection area.
Total											**$22995.25**	**$5453.37**	**$849.01**	**$29297.63**					**$25334.01**	**$9344.42**	**$933.38**	**$35611.81**				

Steel Tank (Hatch)

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubC	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes
28	050523251500			High strength bolt, 25 mm dia x 150 mm L, A490, incl washer & nut	1 Sswk	90	0.089	Ea.	$ 10.11	$ 3.08	$ -	$ 13.19	$ 283.08	$ 86.24	$ -	$ 369.32	$ 11.13	$ 5.42	$ -	$ 16.55	$ 311.64	$ 151.76	$ -	$ 463.40	STD	Year 2010	C15	
4	079116104500			Pre-formed joint seals, joint gaskets, neoprene, closed cell, 6mm x 19mm, adhered	1 Bric	65.53	0.122	m	$ 2.08	$ 3.10	$ -	$ 5.18	$ 8.32	$ 12.40	$ -	$ 20.72	$ 2.30	$ 4.68	$ -	$ 6.98	$ 9.20	$ 18.72	$ -	$ 27.92	STD	Year 2010	C15	
Total													**$291.40**	**$98.64**	**$.00**	**$390.04**					**$320.84**	**$170.48**	**$.00**	**$491.32**				

Slab - Steel Tank
fga Consultants

Paradise Newfoundland A1L-2X9

Data Release : Year 2010

Unit Cost Estimate

Quantity	LineNumber	Source	SubCo	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Labor Type	Data Release	Zip Code	Notes
216	312316130060			Excavating, trench or continuous footing, common earth, 0.38 m3 excavator, 300 mm to 1200 mm deep, excludes sheeting or dewatering	B11M	153	0.105	Bm3	$ -	$ 3.91	$ 2.58	$ 6.49	$ -	$ 844.56	$ 557.28	$ 1,401.84	$ -	$ 5.94	$ 2.85	$ 8.79	$ -	$ 1,283.04	$ 615.60	$ 1,898.64	STD	Year 2010	C15	Excavation for slab on grade
108	312323200016			Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic meters, 10 min wait/load/unload, 6.12 m3 truck, cycle 1.6 km, 24kmh, excludes loading equipment	B34A	208	0.038	Lm3	$ -	$ 1.25	$ 1.97	$ 3.22	$ -	$ 135.00	$ 212.76	$ 347.76	$ -	$ 1.91	$ 2.16	$ 4.07	$ -	$ 206.28	$ 233.28	$ 439.56	STD	Year 2010	C15	Haul excess from site, assumed half of excavation
108	312323130015			Backfill, light soil, by hand, no compaction	1 Clab	10.7	0.747	Lm3	$ -	$ 24.06	$ -	$ 24.06	$ -	$ 2,598.48	$ -	$ 2,598.48	$ -	$ 37.32	$ -	$ 37.32	$ -	$ 4,030.56	$ -	$ 4,030.56	STD	Year 2010	C15	Backfill around slab, assume half of excavation
360	312216101100			Fine grading, fine grade for slab on grade, machine	B11L	870	0.018	m2	$ -	$ 0.69	$ 0.74	$ 1.43	$ -	$ 248.40	$ 266.40	$ 514.80	$ -	$ 1.04	$ 0.81	$ 1.85	$ -	$ 374.40	$ 291.60	$ 666.00	STD	Year 2010	C15	Grading for slab on grade
37	031113653060			C.I.P. concrete forms, slab on grade, edge, wood, over 305 mm, 4 use, includes erecting, bracing, stripping and cleaning	C1	32.52	0.984	m2CA	$ 6.30	$ 23.87	$ -	$ 30.17	$ 233.10	$ 883.19	$ -	$ 1,116.29	$ 6.82	$ 36.72	$ -	$ 43.54	$ 252.34	$ 1,358.64	$ -	$ 1,610.98	STD	Year 2010	C15	Slab on grade forms.
178	033105704300			Structural concrete, placing, slab on grade, direct chute, up to 150 mm thick, includes strike off & consolidation, excludes material	C6	84.11	0.571	m3	$ -	$ 14.50	$ 0.74	$ 15.24	$ -	$ 2,581.00	$ 131.72	$ 2,712.72	$ -	$ 22.08	$ 0.81	$ 22.89	$ -	$ 3,930.24	$ 144.18	$ 4,074.42	STD	Year 2010	C15	Placing of slab concrete, assume ok for 600mm thick
178	033105350400			Structural concrete, ready mix, normal weight, 34 MPa, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments				m3	$ 246.53	$ -	$ -	$ 246.53	$ 43,882.34	$ -	$ -	$ 43,882.34	$ 270.67	$ -	$ -	$ 270.67	$ 48,179.26	$ -	$ -	$ 48,179.26	STD	Year 2010	C15	Concrete material for slab
5.47	032110600600			Reinforcing Steel, in place, slab on grade, #10 to #22, A615M, grade 400, incl labor for accessories, excl material for accessories	4 Rodm	2.09	15.336	Met. Ton	$ 1,408.68	$ 395.28	$ -	$ 1,803.96	$ 7,705.48	$ 2,162.18	$ -	$ 9,867.66	$ 1,542.84	$ 631.35	$ -	$ 2,174.19	$ 8,439.33	$ 3,453.48	$ -	$ 11,892.82	STD	Year 2010	C15	All rebar in place
296	033529300200			Concrete finishing, floors, basic finishing for unspecified flatwork, bull float, manual float & manual steel trowel, excludes placing, striking off & consolidating	C10	118	0.203	m2	$ -	$ 5.63	$ -	$ 5.63	$ -	$ 1,666.48	$ -	$ 1,666.48	$ -	$ 8.32	$ -	$ 8.32	$ -	$ 2,462.72	$ -	$ 2,462.72	STD	Year 2010	C15	Wet finish, top of floor and slab
37	033529600050			Concrete finishing, walls, burlap rub with grout, includes breaking ties and patching voids	1 Cefi	41.81	0.191	m2	$ 0.55	$ 5.59	$ -	$ 6.14	$ 20.35	$ 206.83	$ -	$ 227.18	$ 0.74	$ 8.17	$ -	$ 8.91	$ 27.38	$ 302.29	$ -	$ 329.67	STD	Year 2010	C15	Dry finish on sides
296	033913500400			Curing, curing blankets, buy, minimum, 25 mm to 50 mm thick				m2	$ 6.12	$ -	$ -	$ 6.12	$ 1,811.52	$ -	$ -	$ 1,811.52	$ 6.69	$ -	$ -	$ 6.69	$ 1,980.24	$ -	$ -	$ 1,980.24	STD	Year 2010	C15	Curing to of slab
455	031505357350			Insert, loop ferrule type, 22 mm diameter bolt	1 Carp	84	0.095	Ea.	$ 16.40	$ 2.42	$ -	$ 18.82	$ 7,462.00	$ 1,101.10	$ -	$ 8,563.10	$ 18.06	$ 3.73	$ -	$ 21.79	$ 8,217.30	$ 1,697.15	$ -	$ 9,914.45	STD	Year 2010	C15	Assumed fine for 24mm sleeves
272	071919100300			Silicone water repellants, sprayed on, 2 coat	1 Rofc	279	0.029	m2	$ 7.34	$ 0.61	$ -	$ 7.95	$ 1,996.48	$ 165.92	$ -	$ 2,162.40	$ 8.04	$ 1.02	$ -	$ 9.06	$ 2,186.88	$ 277.44	$ -	$ 2,464.32	STD	Year 2010	C15	Protective coating
Total									**$63111.27**	**$12593.14**	**$1168.16**	**$76872.57**									**$69282.73**	**$19376.24**	**$1284.66**	**$89943.64**				

Aluminum Dome Roof

Data Release: Year 2010 **Unit Cost Estimate**

Quanity	Description	Uniit	Material	Total
3390	Geodesic Aluminum Dome Aluminum plates, aluminum strut connections.	S.F	$ 85.00	$ 288,150.00

Appendix S

Group 4
Richard Chambers
Mark Sampson
Nikita Gibbons
Russell Murphy

Cost Analysis

Steel Tank			Concrete Tank		
Item	Cost		Item	Cost	
Shell	$	408,822.00	Shell	$	467,530.00
Connection	$	40,612.00	Connection	$	44,686.00
Hatch	$	1,500.00	Hatch	$	1,500.00
Slab	$	89,943.64	Slab	$	89,943.64
Roof	$	288,000.00	Roof	$	92,357.00
			Ring Beam	$	19,669.00
Total	$	828,877.64	Total	$	715,685.64

Result	Concrete

Maintenance analysis

Steel Tank

Activity	Crew	Labour (hr.)	Rate(per/hr.)	Total
Weld Testing	2	16	$ 68.00	$ 2,176.00
Thickness Testing	2	16	$ 68.00	$ 2,176.00
Paint/Epoxy Coating	/	/	/	$ 20,000.00
			Total	$ 24,352.00

For Lifetime (25 yr)

Activity	Cost	Occurance	Life Cost	Total
Weld Testing	$ 2,176.00	25	$ 54,400.00	
Thickness Testing	$ 2,176.00	25	$ 54,400.00	$128,800.00
Paint/Epoxy Coating	$ 20,000.00	1	$ 20,000.00	

Note: Occurance refers to number of times activity must be conducted during the life span.

Result (Maintenance cost per year)	$ 5,152.00

Group 4
Richard Chambers
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Nikita Gibbons
Russell Murphy

Concrete Tank

Activity	Crew	Labour (hr.)	Rate(per/hr.)	Total
Roof Blasting/Seal	/	/	/	$ 5,000.00
Crack Inspection	2	16	$ 68.00	$ 2,176.00
			Total	$ 7,176.00

For Lifetime (25 yr)

Activity	Cost	Occurance	Life Cost	Total
Roof Blasting/Seal	$ 5,000.00	2	$ 10,000.00	$ 64,400.00
Crack Inspection	$ 2,176.00	25	$ 54,400.00	

Note: Occurance refers to number of times activity must be conducted during the life span.

Result (Maintenance cost per year)	$ 2,576.00

Result	Concrete

Appendix T

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew A-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Concrete saw, gas manual		63.20		69.52	7.90	8.69
8 L.H., Daily Totals		$316.00		$461.52	$39.50	$57.69
Crew A-1A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Skilled Worker	$40.85	$326.80	$63.25	$506.00	$40.85	$63.25
1 Shot Blaster, 20″		217.80		239.58	27.23	29.95
8 L.H., Daily Totals		$544.60		$745.58	$68.08	$93.20
Crew A-1B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Concrete Saw		141.00		155.10	17.63	19.39
8 L.H., Daily Totals		$393.80		$547.10	$49.23	$68.39
Crew A-1C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Chain saw, gas, 18″		25.80		28.38	3.23	3.55
8 L.H., Daily Totals		$278.60		$420.38	$34.83	$52.55
Crew A-1D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Vibrating plate, gas, 18″		31.80		34.98	3.98	4.37
8 L.H., Daily Totals		$284.60		$426.98	$35.58	$53.37
Crew A-1E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Vibratory Plate, Gas, 21″		39.20		43.12	4.90	5.39
8 L.H., Daily Totals		$292.00		$435.12	$36.50	$54.39
Crew A-1F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Rammer/tamper, gas, 8″		43.40		47.74	5.42	5.97
8 L.H., Daily Totals		$296.20		$439.74	$37.02	$54.97
Crew A-1G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Rammer/tamper, gas, 15″		49.40		54.34	6.17	6.79
8 L.H., Daily Totals		$302.20		$446.34	$37.77	$55.79
Crew A-1H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Exterior Steam Cleaner		51.20		56.32	6.40	7.04
8 L.H., Daily Totals		$304.00		$448.32	$38.00	$56.04
Crew A-1J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Cultivator, Walk-Behind, 5 H.P.		57.05		62.76	7.13	7.84
8 L.H., Daily Totals		$309.85		$454.76	$38.73	$56.84
Crew A-1K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Cultivator, Walk-Behind, 8 H.P.		91.10		100.21	11.39	12.53
8 L.H., Daily Totals		$343.90		$492.21	$42.99	$61.53
Crew A-1M	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Snow Blower, Walk-Behind		52.70		57.97	6.59	7.25
8 L.H., Daily Totals		$305.50		$449.97	$38.19	$56.25

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew A-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.38	$48.55
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84	8.10	8.91
24 L.H., Daily Totals		$947.60		$1379.04	$39.48	$57.46
Crew A-2A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.38	$48.55
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84		
1 Concrete Saw		141.00		155.10	13.98	15.37
24 L.H., Daily Totals		$1088.60		$1534.14	$45.36	$63.92
Crew A-2B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (light)	$30.95	$247.60	$47.65	$381.20	$30.95	$47.65
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84	24.30	26.73
8 L.H., Daily Totals		$442.00		$595.04	$55.25	$74.38
Crew A-3A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (light)	$30.95	$247.60	$47.65	$381.20	$30.95	$47.65
1 Pickup truck, 4 x 4, 3/4 ton		128.20		141.02	16.02	17.63
8 L.H., Daily Totals		$375.80		$522.22	$46.98	$65.28
Crew A-3B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (medium)	$41.35	$330.80	$62.15	$497.20	$36.65	$55.65
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Dump Truck, 12 C.Y., 400 H.P.		533.00		586.30		
1 F.E. Loader, W.M.,2.5 C.Y.		395.80		435.38	58.05	63.85
16 L.H., Daily Totals		$1515.20		$1912.08	$94.70	$119.51
Crew A-3C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Loader, Skid Steer, 78 H.P.		259.60		285.56	32.45	35.70
8 L.H., Daily Totals		$572.00		$755.16	$71.50	$94.39
Crew A-3D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver, Light	$30.95	$247.60	$47.65	$381.20	$30.95	$47.65
1 Pickup truck, 4 x 4, 3/4 ton		128.20		141.02		
1 Flatbed Trailer, 25 Ton		102.00		112.20	28.77	31.65
8 L.H., Daily Totals		$477.80		$634.42	$59.73	$79.30
Crew A-3E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.25	$56.55
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Pickup truck, 4 x 4, 3/4 ton		128.20		141.02	8.01	8.81
16 L.H., Daily Totals		$724.20		$1045.82	$45.26	$65.36
Crew A-3F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.25	$56.55
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Pickup truck, 4 x 4, 3/4 ton		128.20		141.02		
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68		
1 Lowbed Trailer, 75 Ton		203.00		223.30	50.63	55.69
16 L.H., Daily Totals		$1406.00		$1795.80	$87.88	$112.24

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew A-3G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.25	$56.55
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Pickup truck, 4 x 4, 3/4 ton		128.20		141.02		
1 Truck Tractor, 6x4, 450 H.P.		581.20		639.32		
1 Lowbed Trailer, 75 Ton		203.00		223.30	57.02	62.73
16 L.H., Daily Totals		$1508.40		$1908.44	$94.28	$119.28
Crew A-3H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$42.55	$63.95
1 Hyd. crane, 12 Ton (daily)		1018.00		1119.80	127.25	139.97
8 L.H., Daily Totals		$1358.40		$1631.40	$169.80	$203.93
Crew A-3I	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$42.55	$63.95
1 Hyd. crane, 25 Ton (daily)		1054.00		1159.40	131.75	144.93
8 L.H., Daily Totals		$1394.40		$1671.00	$174.30	$208.88
Crew A-3J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$42.55	$63.95
1 Hyd. crane, 40 Ton (daily)		1058.00		1163.80	132.25	145.47
8 L.H., Daily Totals		$1398.40		$1675.40	$174.80	$209.43
Crew A-3K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$39.67	$59.63
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. crane, 55 Ton (daily)		1491.00		1640.10		
1 P/U Truck, 3/4 Ton (daily)		137.80		151.58	101.80	111.98
16 L.H., Daily Totals		$2263.60		$2745.68	$141.47	$171.60
Crew A-3L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$39.67	$59.63
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. crane, 80 Ton (daily)		1704.00		1874.40		
1 P/U Truck, 3/4 Ton (daily)		137.80		151.58	115.11	126.62
16 L.H., Daily Totals		$2476.60		$2979.98	$154.79	$186.25
Crew A-3M	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$39.67	$59.63
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. crane, 100 Ton (daily)		2399.00		2638.90		
1 P/U Truck, 3/4 Ton (daily)		137.80		151.58	158.55	174.41
16 L.H., Daily Totals		$3171.60		$3744.48	$198.22	$234.03
Crew A-3N	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$42.55	$63.95
1 Tower crane (monthly)		1022.00		1124.20	127.75	140.53
8 L.H., Daily Totals		$1362.40		$1635.80	$170.30	$204.47
Crew A-3P	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper., Light	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 A.T. Forklift, 42' lift		446.00		490.60	55.75	61.33
8 L.H., Daily Totals		$758.40		$960.20	$94.80	$120.03
Crew A-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$39.95	$639.20	$61.95	$991.20	$38.37	$58.88
1 Painter, Ordinary	35.20	281.60	52.75	422.00		
24 L.H., Daily Totals		$920.80		$1413.20	$38.37	$58.88

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew A-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.53	$48.85
.25 Truck Driver (light)	30.95	61.90	47.65	95.30		
.25 Flatbed Truck, Gas, 1.5 Ton		48.60		53.46	2.70	2.97
18 L.H., Daily Totals		$616.10		$932.76	$34.23	$51.82
Crew A-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Instrument Man	$40.85	$326.80	$63.25	$506.00	$39.73	$60.80
1 Rodman/Chainman	38.60	308.80	58.35	466.80		
1 Laser Transit/Level		70.10		77.11	4.38	4.82
16 L.H., Daily Totals		$705.70		$1049.91	$44.11	$65.62
Crew A-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Chief Of Party	$50.20	$401.60	$77.15	$617.20	$43.22	$66.25
1 Instrument Man	40.85	326.80	63.25	506.00		
1 Rodman/Chainman	38.60	308.80	58.35	466.80		
1 Laser Transit/Level		70.10		77.11	2.92	3.21
24 L.H., Daily Totals		$1107.30		$1667.11	$46.14	$69.46
Crew A-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Chief of Party	$50.20	$401.60	$77.15	$617.20	$42.06	$64.28
1 Instrument Man	40.85	326.80	63.25	506.00		
2 Rodmen/Chainmen	38.60	617.60	58.35	933.60		
1 Laser Transit/Level		70.10		77.11	2.19	2.41
32 L.H., Daily Totals		$1416.10		$2133.91	$44.25	$66.68
Crew A-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Foreman	$44.60	$356.80	$69.90	$559.20	$44.16	$69.20
7 Asbestos Workers	44.10	2469.60	69.10	3869.60		
64 L.H., Daily Totals		$2826.40		$4428.80	$44.16	$69.20
Crew A-10A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Foreman	$44.60	$356.80	$69.90	$559.20	$44.27	$69.37
2 Asbestos Workers	44.10	705.60	69.10	1105.60		
24 L.H., Daily Totals		$1062.40		$1664.80	$44.27	$69.37
Crew A-10B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Foreman	$44.60	$356.80	$69.90	$559.20	$44.23	$69.30
3 Asbestos Workers	44.10	1058.40	69.10	1658.40		
32 L.H., Daily Totals		$1415.20		$2217.60	$44.23	$69.30
Crew A-10C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Asbestos Workers	$44.10	$1058.40	$69.10	$1658.40	$44.10	$69.10
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84	8.10	8.91
24 L.H., Daily Totals		$1252.80		$1872.24	$52.20	$78.01
Crew A-10D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Asbestos Workers	$44.10	$705.60	$69.10	$1105.60	$41.89	$64.36
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hydraulic Crane, 33 Ton		818.80		900.68	25.59	28.15
32 L.H., Daily Totals		$2159.20		$2960.28	$67.47	$92.51
Crew A-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Foreman	$44.60	$356.80	$69.90	$559.20	$44.16	$69.20
7 Asbestos Workers	44.10	2469.60	69.10	3869.60		
2 Chip. Hammers, 12 Lb., Elec.		34.00		37.40	.53	.58
64 L.H., Daily Totals		$2860.40		$4466.20	$44.69	$69.78

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew A-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Foreman	$44.60	$356.80	$69.90	$559.20	$44.16	$69.20
7 Asbestos Workers	44.10	2469.60	69.10	3869.60		
1 Trk-mtd vac, 14 CY, 1500 Gal.		561.60		617.76		
1 Flatbed Truck, 20,000 GVW		197.40		217.14	11.86	13.05
64 L.H., Daily Totals		$3585.40		$5263.70	$56.02	$82.25
Crew A-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Trk-mtd vac, 14 CY, 1500 Gal.		561.60		617.76		
1 Flatbed Truck, 20,000 GVW		197.40		217.14	94.88	104.36
8 L.H., Daily Totals		$1071.40		$1304.50	$133.93	$163.06
Crew B-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.27	$50.03
2 Laborers	31.60	505.60	49.00	784.00		
24 L.H., Daily Totals		$774.40		$1200.80	$32.27	$50.03
Crew B-1A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$32.27	$50.03
2 Laborers	31.60	505.60	49.00	784.00		
2 Cutting Torches		34.00		37.40		
2 Gases		151.20		166.32	7.72	8.49
24 L.H., Daily Totals		$959.60		$1404.52	$39.98	$58.52
Crew B-1B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$34.84	$53.51
2 Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
2 Cutting Torches		34.00		37.40		
2 Gases		151.20		166.32		
1 Hyd. Crane, 12 Ton		768.80		845.68	29.81	32.79
32 L.H., Daily Totals		$2068.80		$2761.80	$64.65	$86.31
Crew B-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.00	$49.62
4 Laborers	31.60	1011.20	49.00	1568.00		
40 L.H., Daily Totals		$1280.00		$1984.80	$32.00	$49.62
Crew B-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.67	$51.76
2 Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Crawler Loader, 3 C.Y.		990.00		1089.00		
2 Dump Trucks 12 C.Y., 400 H.P.		1066.00		1172.60	42.83	47.12
48 L.H., Daily Totals		$3672.40		$4746.00	$76.51	$98.88
Crew B-3A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
4 Laborers	$31.60	$1011.20	$49.00	$1568.00	$33.55	$51.63
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Hyd. Excavator, 1.5 C.Y.		865.80		952.38	21.65	23.81
40 L.H., Daily Totals		$2207.80		$3017.58	$55.20	$75.44
Crew B-3B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$34.13	$52.33
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Backhoe Loader, 80 H.P.		345.00		379.50		
1 Dump Truck, 12 C.Y., 400 H.P.		533.00		586.30	27.44	30.18
32 L.H., Daily Totals		$1970.00		$2640.20	$61.56	$82.51

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-3C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$31.60	$758.40	$49.00	$1176.00	$34.04	$52.29
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Crawler Loader, 4 C.Y.		1450.00		1595.00	45.31	49.84
32 L.H., Daily Totals		$2539.20		$3268.20	$79.35	$102.13
Crew B-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$31.99	$49.54
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Truck Tractor, 220 H.P.		288.40		317.24		
1 Flatbed Trailer, 40 Ton		139.60		153.56	8.92	9.81
48 L.H., Daily Totals		$1963.60		$2848.80	$40.91	$59.35
Crew B-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.67	$53.20
4 Laborers	31.60	1011.20	49.00	1568.00		
2 Equip. Oper. (med.)	41.35	661.60	62.15	994.40		
1 Air Compressor, 250 cfm		162.40		178.64		
2 Breakers, Pavement, 60 lb.		16.40		18.04		
2 -50' Air Hoses, 1.5"		12.60		13.86		
1 Crawler Loader, 3 C.Y.		990.00		1089.00	21.10	23.21
56 L.H., Daily Totals		$3123.00		$4278.74	$55.77	$76.41
Crew B-5A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Foreman	$33.60	$268.80	$52.10	$416.80	$34.07	$52.28
6 Laborers	31.60	1516.80	49.00	2352.00		
2 Equip. Oper. (med.)	41.35	661.60	62.15	994.40		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Air Compressor, 365 cfm		211.20		232.32		
2 Breakers, Pavement, 60 lb.		16.40		18.04		
8 -50' Air Hoses, 1"		32.80		36.08		
2 Dump Trucks, 8 C.Y., 220 H.P.		652.80		718.08	9.51	10.46
96 L.H., Daily Totals		$4184.00		$6023.72	$43.58	$62.75
Crew B-5B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Powderman	$40.85	$326.80	$63.25	$506.00	$36.57	$55.83
2 Equip. Oper. (med.)	41.35	661.60	62.15	994.40		
3 Truck Drivers (heavy)	31.95	766.80	49.15	1179.60		
1 F.E. Loader, W.M.,2.5 C.Y.		395.80		435.38		
3 Dump Trucks, 12 C.Y., 400 H.P.		1599.00		1758.90		
1 Air Compressor, 365 cfm		211.20		232.32	45.96	50.55
48 L.H., Daily Totals		$3961.20		$5106.60	$82.53	$106.39
Crew B-5C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$31.60	$758.40	$49.00	$1176.00	$34.92	$53.34
1 Equip. Oper. (medium)	41.35	330.80	62.15	497.20		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
2 Dump Trucks, 12 C.Y., 400 H.P.		1066.00		1172.60		
1 Crawler Loader, 4 C.Y.		1450.00		1595.00		
1 S.P. Crane, 4x4, 25 Ton		716.80		788.48	50.51	55.56
64 L.H., Daily Totals		$5468.00		$6969.68	$85.44	$108.90
Crew B-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$34.08	$52.23
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Backhoe Loader, 48 H.P.		293.80		323.18	12.24	13.47
24 L.H., Daily Totals		$1111.80		$1576.78	$46.33	$65.70

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-6A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.5 Labor Foreman (outside)	$33.60	$134.40	$52.10	$208.40	$35.90	$54.88
1 Laborer	31.60	252.80	49.00	392.00		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Vacuum Trk.,5000 Gal.		395.20		434.72	19.76	21.74
20 L.H., Daily Totals		$1113.20		$1532.32	$55.66	$76.62
Crew B-6B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Labor Foremen (out)	$33.60	$537.60	$52.10	$833.60	$32.27	$50.03
4 Laborers	31.60	1011.20	49.00	1568.00		
1 S.P. Crane, 4x4, 5 Ton		258.20		284.02		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84		
1 Butt Fusion Machine		199.80		219.78	13.59	14.95
48 L.H., Daily Totals		$2201.20		$3119.24	$45.86	$64.98
Crew B-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.56	$51.71
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Brush Chipper, 12", 130 H.P.		225.60		248.16		
1 Crawler Loader, 3 C.Y.		990.00		1089.00		
2 Chain Saws, Gas, 36" Long		75.60		83.16	26.90	29.59
48 L.H., Daily Totals		$2902.00		$3902.32	$60.46	$81.30
Crew B-7A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$34.08	$52.23
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Rake w/Tractor		257.70		283.47		
2 Chain Saws, gas, 18"		51.60		56.76	12.89	14.18
24 L.H., Daily Totals		$1127.30		$1593.83	$46.97	$66.41
Crew B-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.02	$53.50
2 Laborers	31.60	505.60	49.00	784.00		
2 Equip. Oper. (med.)	41.35	661.60	62.15	994.40		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Hyd. Crane, 25 Ton		789.40		868.34		
1 Crawler Loader, 3 C.Y.		990.00		1089.00		
2 Dump Trucks, 12 C.Y., 400 H.P.		1066.00		1172.60	44.46	48.91
64 L.H., Daily Totals		$5087.00		$6553.94	$79.48	$102.41
Crew B-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.00	$49.62
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Air Compressor, 250 cfm		162.40		178.64		
2 Breakers, Pavement, 60 lb.		16.40		18.04		
2 -50' Air Hoses, 1.5"		12.60		13.86	4.79	5.26
40 L.H., Daily Totals		$1471.40		$2195.34	$36.78	$54.88
Crew B-9A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.72	$49.05
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Water Tanker, 5000 Gal.		136.00		149.60		
1 Truck Tractor, 220 H.P.		288.40		317.24		
2 -50' Discharge Hoses, 3"		3.50		3.85	17.83	19.61
24 L.H., Daily Totals		$1189.10		$1647.89	$49.55	$68.66

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-9B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.72	$49.05
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
2 -50' Discharge Hoses, 3"		3.50		3.85		
1 Water Tanker, 5000 Gal.		136.00		149.60		
1 Truck Tractor, 220 H.P.		288.40		317.24		
1 Pressure Washer		53.00		58.30	20.04	22.04
24 L.H., Daily Totals		$1242.10		$1706.19	$51.75	$71.09
Crew B-9D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (Outside)	$33.60	$268.80	$52.10	$416.80	$32.00	$49.62
4 Common Laborers	31.60	1011.20	49.00	1568.00		
1 Air Compressor, 250 cfm		162.40		178.64		
2 -50' Air Hoses, 1.5"		12.60		13.86		
2 Air Powered Tampers		48.00		52.80	5.58	6.13
40 L.H., Daily Totals		$1503.00		$2230.10	$37.58	$55.75
Crew B-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
12 L.H., Daily Totals		$457.20		$693.20	$38.10	$57.77
Crew B-10A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Roller, 2-Drum, W.B., 7.5 H.P.		145.20		159.72	12.10	13.31
12 L.H., Daily Totals		$602.40		$852.92	$50.20	$71.08
Crew B-10B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 200 H.P.		1082.00		1190.20	90.17	99.18
12 L.H., Daily Totals		$1539.20		$1883.40	$128.27	$156.95
Crew B-10C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 200 H.P.		1082.00		1190.20		
1 Vibratory Roller, Towed, 23 Ton		411.00		452.10	124.42	136.86
12 L.H., Daily Totals		$1950.20		$2335.50	$162.52	$194.63
Crew B-10D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 200 H.P.		1082.00		1190.20		
1 Sheepsft. Roller, Towed		465.40		511.94	128.95	141.85
12 L.H., Daily Totals		$2004.60		$2395.34	$167.05	$199.61
Crew B-10E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Tandem Roller, 5 Ton		137.80		151.58	11.48	12.63
12 L.H., Daily Totals		$595.00		$844.78	$49.58	$70.40
Crew B-10F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Tandem Roller, 10 Ton		233.00		256.30	19.42	21.36
12 L.H., Daily Totals		$690.20		$949.50	$57.52	$79.13

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-10G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Sheepsft. Roll., 240 H.P.		1142.00		1256.20	95.17	104.68
12 L.H., Daily Totals		$1599.20		$1949.40	$133.27	$162.45
Crew B-10H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Diaphragm Water Pump, 2"		63.20		69.52		
1 -20' Suction Hose, 2"		1.95		2.15		
2 -50' Discharge Hoses, 2"		2.20		2.42	5.61	6.17
12 L.H., Daily Totals		$524.55		$767.28	$43.71	$63.94
Crew B-10I	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Diaphragm Water Pump, 4"		86.20		94.82		
1 -20' Suction Hose, 4"		3.45		3.79		
2 -50' Discharge Hoses, 4"		4.70		5.17	7.86	8.65
12 L.H., Daily Totals		$551.55		$796.99	$45.96	$66.42
Crew B-10J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Centrifugal Water Pump, 3"		69.40		76.34		
1 -20' Suction Hose, 3"		3.05		3.36		
2 -50' Discharge Hoses, 3"		3.50		3.85	6.33	6.96
12 L.H., Daily Totals		$533.15		$776.75	$44.43	$64.73
Crew B-10K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Centr. Water Pump, 6"		309.40		340.34		
1 -20' Suction Hose, 6"		11.90		13.09		
2 -50' Discharge Hoses, 6"		12.60		13.86	27.82	30.61
12 L.H., Daily Totals		$791.10		$1060.49	$65.92	$88.37
Crew B-10L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 80 H.P.		399.20		439.12	33.27	36.59
12 L.H., Daily Totals		$856.40		$1132.32	$71.37	$94.36
Crew B-10M	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 300 H.P.		1423.00		1565.30	118.58	130.44
12 L.H., Daily Totals		$1880.20		$2258.50	$156.68	$188.21
Crew B-10N	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, T.M., 1.5 C.Y		367.00		403.70	30.58	33.64
12 L.H., Daily Totals		$824.20		$1096.90	$68.68	$91.41
Crew B-10O	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, T.M., 2.25 C.Y.		767.40		844.14	63.95	70.34
12 L.H., Daily Totals		$1224.60		$1537.34	$102.05	$128.11

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-10P	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Crawler Loader, 3 C.Y.		990.00		1089.00	82.50	90.75
12 L.H., Daily Totals		$1447.20		$1782.20	$120.60	$148.52
Crew B-10Q	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Crawler Loader, 4 C.Y.		1450.00		1595.00	120.83	132.92
12 L.H., Daily Totals		$1907.20		$2288.20	$158.93	$190.68
Crew B-10R	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, W.M., 1 C.Y.		239.00		262.90	19.92	21.91
12 L.H., Daily Totals		$696.20		$956.10	$58.02	$79.67
Crew B-10S	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, W.M., 1.5 C.Y.		328.20		361.02	27.35	30.09
12 L.H., Daily Totals		$785.40		$1054.22	$65.45	$87.85
Crew B-10T	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, W.M.,2.5 C.Y.		395.80		435.38	32.98	36.28
12 L.H., Daily Totals		$853.00		$1128.58	$71.08	$94.05
Crew B-10U	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, W.M., 5.5 C.Y.		854.40		939.84	71.20	78.32
12 L.H., Daily Totals		$1311.60		$1633.04	$109.30	$136.09
Crew B-10V	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 700 H.P.		4232.00		4655.20	352.67	387.93
12 L.H., Daily Totals		$4689.20		$5348.40	$390.77	$445.70
Crew B-10W	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 105 H.P.		600.60		660.66	50.05	55.06
12 L.H., Daily Totals		$1057.80		$1353.86	$88.15	$112.82
Crew B-10X	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 410 H.P.		1849.00		2033.90	154.08	169.49
12 L.H., Daily Totals		$2306.20		$2727.10	$192.18	$227.26
Crew B-10Y	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Vibr. Roller, Towed, 12 Ton		469.60		516.56	39.13	43.05
12 L.H., Daily Totals		$926.80		$1209.76	$77.23	$100.81

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-11A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$36.48	$55.58
1 Laborer	31.60	252.80	49.00	392.00		
1 Dozer, 200 H.P.		1082.00		1190.20	67.63	74.39
16 L.H., Daily Totals		$1665.60		$2079.40	$104.10	$129.96
Crew B-11B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (light)	$39.05	$312.40	$58.70	$469.60	$35.33	$53.85
1 Laborer	31.60	252.80	49.00	392.00		
1 Air Powered Tamper		24.00		26.40		
1 Air Compressor, 365 cfm		211.20		232.32		
2 -50' Air Hoses, 1.5"		12.60		13.86	15.49	17.04
16 L.H., Daily Totals		$813.00		$1134.18	$50.81	$70.89
Crew B-11C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$36.48	$55.58
1 Laborer	31.60	252.80	49.00	392.00		
1 Backhoe Loader, 48 H.P.		293.80		323.18	18.36	20.20
16 L.H., Daily Totals		$877.40		$1212.38	$54.84	$75.77
Crew B-11J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$36.48	$55.58
1 Laborer	31.60	252.80	49.00	392.00		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Ripper, beam & 1 shank		79.60		87.56	39.36	43.30
16 L.H., Daily Totals		$1213.40		$1581.98	$75.84	$98.87
Crew B-11K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$36.48	$55.58
1 Laborer	31.60	252.80	49.00	392.00		
1 Trencher, Chain Type, 8' D		1777.00		1954.70	111.06	122.17
16 L.H., Daily Totals		$2360.60		$2843.90	$147.54	$177.74
Crew B-11L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$36.48	$55.58
1 Laborer	31.60	252.80	49.00	392.00		
1 Grader, 30,000 Lbs.		550.20		605.22	34.39	37.83
16 L.H., Daily Totals		$1133.80		$1494.42	$70.86	$93.40
Crew B-11M	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$36.48	$55.58
1 Laborer	31.60	252.80	49.00	392.00		
1 Backhoe Loader, 80 H.P.		345.00		379.50	21.56	23.72
16 L.H., Daily Totals		$928.60		$1268.70	$58.04	$79.29
Crew B-11N	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$34.22	$52.37
2 Equipment Operators (med.)	41.35	661.60	62.15	994.40		
6 Truck Drivers (hvy.)	31.95	1533.60	49.15	2359.20		
1 F.E. Loader, W.M., 5.5 C.Y.		854.40		939.84		
1 Dozer, 410 H.P.		1849.00		2033.90		
6 Dump Trucks, Off Hwy., 50 Ton		9492.00		10441.20	169.38	186.32
72 L.H., Daily Totals		$14659.40		$17185.34	$203.60	$238.69
Crew B-11Q	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 140 H.P.		682.00		750.20	56.83	62.52
12 L.H., Daily Totals		$1139.20		$1443.40	$94.93	$120.28

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-11R	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 200 H.P.		1082.00		1190.20	90.17	99.18
12 L.H., Daily Totals		$1539.20		$1883.40	$128.27	$156.95
Crew B-11S	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 300 H.P.		1423.00		1565.30		
1 Ripper, beam & 1 shank		79.60		87.56	125.22	137.74
12 L.H., Daily Totals		$1959.80		$2346.06	$163.32	$195.51
Crew B-11T	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 410 H.P.		1849.00		2033.90		
1 Ripper, beam & 2 shanks		89.40		98.34	161.53	177.69
12 L.H., Daily Totals		$2395.60		$2825.44	$199.63	$235.45
Crew B-11U	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 Dozer, 520 H.P.		2464.00		2710.40	205.33	225.87
12 L.H., Daily Totals		$2921.20		$3403.60	$243.43	$283.63
Crew B-11V	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$31.60	$758.40	$49.00	$1176.00	$31.60	$49.00
1 Roller, 2-Drum, W.B., 7.5 H.P.		145.20		159.72	6.05	6.66
24 L.H., Daily Totals		$903.60		$1335.72	$37.65	$55.66
Crew B-11W	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$32.70	$50.22
1 Common Laborer	31.60	252.80	49.00	392.00		
10 Truck Drivers (hvy.)	31.95	2556.00	49.15	3932.00		
1 Dozer, 200 H.P.		1082.00		1190.20		
1 Vibratory Roller, Towed, 23 Ton		411.00		452.10		
10 Dump Trucks, 8 C.Y., 220 H.P.		3264.00		3590.40	49.55	54.51
96 L.H., Daily Totals		$7896.60		$10053.90	$82.26	$104.73
Crew B-11Y	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (Outside)	$33.60	$268.80	$52.10	$416.80	$35.07	$53.73
5 Common Laborers	31.60	1264.00	49.00	1960.00		
3 Equipment Operators (med.)	41.35	992.40	62.15	1491.60		
1 Dozer, 80 H.P.		399.20		439.12		
2 Rollers, 2-Drum, W.B., 7.5 H.P.		290.40		319.44		
4 Vibratory Plates, Gas, 21"		156.80		172.48	11.76	12.93
72 L.H., Daily Totals		$3371.60		$4799.44	$46.83	$66.66
Crew B-12A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, 1 C.Y.		669.20		736.12	41.83	46.01
16 L.H., Daily Totals		$1262.40		$1639.72	$78.90	$102.48
Crew B-12B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, 1.5 C.Y.		865.80		952.38	54.11	59.52
16 L.H., Daily Totals		$1459.00		$1855.98	$91.19	$116.00

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-12C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, 2 C.Y.		1182.00		1300.20	73.88	81.26
16 L.H., Daily Totals		$1775.20		$2203.80	$110.95	$137.74
Crew B-12D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, 3.5 C.Y.		2162.00		2378.20	135.13	148.64
16 L.H., Daily Totals		$2755.20		$3281.80	$172.20	$205.11
Crew B-12E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, .5 C.Y.		394.60		434.06	24.66	27.13
16 L.H., Daily Totals		$987.80		$1337.66	$61.74	$83.60
Crew B-12F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, .75 C.Y.		598.60		658.46	37.41	41.15
16 L.H., Daily Totals		$1191.80		$1562.06	$74.49	$97.63
Crew B-12G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 15 Ton		615.30		676.83		
1 Clamshell Bucket, .5 C.Y.		36.60		40.26	40.74	44.82
16 L.H., Daily Totals		$1245.10		$1620.69	$77.82	$101.29
Crew B-12H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 25 Ton		1052.00		1157.20		
1 Clamshell Bucket, 1 C.Y.		46.20		50.82	68.64	75.50
16 L.H., Daily Totals		$1691.40		$2111.62	$105.71	$131.98
Crew B-12I	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 20 Ton		789.05		867.96		
1 Dragline Bucket, .75 C.Y.		20.00		22.00	50.57	55.62
16 L.H., Daily Totals		$1402.25		$1793.56	$87.64	$112.10
Crew B-12J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Gradall, 5/8 C.Y.		958.80		1054.68	59.92	65.92
16 L.H., Daily Totals		$1552.00		$1958.28	$97.00	$122.39
Crew B-12K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Gradall, 3 Ton, 1 C.Y.		1130.00		1243.00	70.63	77.69
16 L.H., Daily Totals		$1723.20		$2146.60	$107.70	$134.16

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-12L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 15 Ton		615.30		676.83		
1 F.E. Attachment, .5 C.Y.		52.80		58.08	41.76	45.93
16 L.H., Daily Totals		$1261.30		$1638.51	$78.83	$102.41
Crew B-12M	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 20 Ton		789.05		867.96		
1 F.E. Attachment, .75 C.Y.		58.20		64.02	52.95	58.25
16 L.H., Daily Totals		$1440.45		$1835.58	$90.03	$114.72
Crew B-12N	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 25 Ton		1052.00		1157.20		
1 F.E. Attachment, 1 C.Y.		64.00		70.40	69.75	76.72
16 L.H., Daily Totals		$1709.20		$2131.20	$106.83	$133.20
Crew B-12O	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 40 Ton		1055.00		1160.50		
1 F.E. Attachment, 1.5 C.Y.		74.20		81.62	70.58	77.63
16 L.H., Daily Totals		$1722.40		$2145.72	$107.65	$134.11
Crew B-12P	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 40 Ton		1055.00		1160.50		
1 Dragline Bucket, 1.5 C.Y.		32.80		36.08	67.99	74.79
16 L.H., Daily Totals		$1681.00		$2100.18	$105.06	$131.26
Crew B-12Q	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, 5/8 C.Y.		517.20		568.92	32.33	35.56
16 L.H., Daily Totals		$1110.40		$1472.52	$69.40	$92.03
Crew B-12S	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Hyd. Excavator, 2.5 C.Y.		1619.00		1780.90	101.19	111.31
16 L.H., Daily Totals		$2212.20		$2684.50	$138.26	$167.78
Crew B-12T	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 75 Ton		1496.00		1645.60		
1 F.E. Attachment, 3 C.Y.		97.60		107.36	99.60	109.56
16 L.H., Daily Totals		$2186.80		$2656.56	$136.68	$166.04
Crew B-12V	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$37.08	$56.48
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 75 Ton		1496.00		1645.60		
1 Dragline Bucket, 3 C.Y.		46.20		50.82	96.39	106.03
16 L.H., Daily Totals		$2135.40		$2600.02	$133.46	$162.50

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.19	$52.48
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. Crane, 25 Ton		789.40		868.34	14.10	15.51
56 L.H., Daily Totals		$2704.20		$3807.14	$48.29	$67.98
Crew B-13A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Foreman	$33.60	$268.80	$52.10	$416.80	$34.77	$53.24
2 Laborers	31.60	505.60	49.00	784.00		
2 Equipment Operators (med.)	41.35	661.60	62.15	994.40		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Crawler Crane, 75 Ton		1496.00		1645.60		
1 Crawler Loader, 4 C.Y.		1450.00		1595.00		
2 Dump Trucks, 8 C.Y., 220 H.P.		652.80		718.08	64.26	70.69
56 L.H., Daily Totals		$5546.00		$6940.28	$99.04	$123.93
Crew B-13B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.19	$52.48
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. Crane, 55 Ton		1125.00		1237.50	20.09	22.10
56 L.H., Daily Totals		$3039.80		$4176.30	$54.28	$74.58
Crew B-13C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.19	$52.48
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 100 Ton		1611.00		1772.10	28.77	31.64
56 L.H., Daily Totals		$3525.80		$4710.90	$62.96	$84.12
Crew B-13D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$37.08	$56.48
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Excavator, 1 C.Y.		669.20		736.12		
1 Trench Box		113.40		124.74	48.91	53.80
16 L.H., Daily Totals		$1375.80		$1764.46	$85.99	$110.28
Crew B-13E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$37.08	$56.48
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Excavator, 1.5 C.Y.		865.80		952.38		
1 Trench Box		113.40		124.74	61.20	67.32
16 L.H., Daily Totals		$1572.40		$1980.72	$98.28	$123.80
Crew B-13F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$37.08	$56.48
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Excavator, 3.5 C.Y.		2162.00		2378.20		
1 Trench Box		113.40		124.74	142.21	156.43
16 L.H., Daily Totals		$2868.60		$3406.54	$179.29	$212.91
Crew B-13G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$37.08	$56.48
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Excavator, .75 C.Y.		598.60		658.46		
1 Trench Box		113.40		124.74	44.50	48.95
16 L.H., Daily Totals		$1305.20		$1686.80	$81.58	$105.43

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-13H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$37.08	$56.48
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Gradall, 5/8 C.Y.		958.80		1054.68		
1 Trench Box		113.40		124.74	67.01	73.71
16 L.H., Daily Totals		$1665.40		$2083.02	$104.09	$130.19
Crew B-13I	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$37.08	$56.48
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Gradall, 3 Ton, 1 C.Y.		1130.00		1243.00		
1 Trench Box		113.40		124.74	77.71	85.48
16 L.H., Daily Totals		$1836.60		$2271.34	$114.79	$141.96
Crew B-13J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$37.08	$56.48
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Excavator, 2.5 C.Y.		1619.00		1780.90		
1 Trench Box		113.40		124.74	108.28	119.10
16 L.H., Daily Totals		$2325.60		$2809.24	$145.35	$175.58
Crew B-14	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.17	$51.13
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Backhoe Loader, 48 H.P.		293.80		323.18	6.12	6.73
48 L.H., Daily Totals		$1886.20		$2777.58	$39.30	$57.87
Crew B-14A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$38.90	$58.97
.5 Laborer	31.60	126.40	49.00	196.00		
1 Hyd. Excavator, 4.5 C.Y.		2635.00		2898.50	219.58	241.54
12 L.H., Daily Totals		$3101.80		$3606.10	$258.48	$300.51
Crew B-14B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$38.90	$58.97
.5 Laborer	31.60	126.40	49.00	196.00		
1 Hyd. Excavator, 6 C.Y.		3080.00		3388.00	256.67	282.33
12 L.H., Daily Totals		$3546.80		$4095.60	$295.57	$341.30
Crew B-14C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$38.90	$58.97
.5 Laborer	31.60	126.40	49.00	196.00		
1 Hyd. Excavator, 7 C.Y.		3256.00		3581.60	271.33	298.47
12 L.H., Daily Totals		$3722.80		$4289.20	$310.23	$357.43
Crew B-14F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$38.90	$58.97
.5 Laborer	31.60	126.40	49.00	196.00		
1 Hyd. Shovel, 7 C.Y.		3090.00		3399.00	257.50	283.25
12 L.H., Daily Totals		$3556.80		$4106.60	$296.40	$342.22
Crew B-14G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$42.55	$340.40	$63.95	$511.60	$38.90	$58.97
.5 Laborer	31.60	126.40	49.00	196.00		
1 Hyd. Shovel, 12 C.Y.		4148.00		4562.80	345.67	380.23
12 L.H., Daily Totals		$4614.80		$5270.40	$384.57	$439.20

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-14J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, 8 C.Y.		1497.00		1646.70	124.75	137.22
12 L.H., Daily Totals		$1954.20		$2339.90	$162.85	$194.99
Crew B-14K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.10	$57.77
.5 Laborer	31.60	126.40	49.00	196.00		
1 F.E. Loader, 10 C.Y.		2225.00		2447.50	185.42	203.96
12 L.H., Daily Totals		$2682.20		$3140.70	$223.52	$261.73
Crew B-15	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Oper. (med)	$41.35	$330.80	$62.15	$497.20	$34.59	$52.84
.5 Laborer	31.60	126.40	49.00	196.00		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
2 Dump Trucks, 12 C.Y., 400 H.P.		1066.00		1172.60		
1 Dozer, 200 H.P.		1082.00		1190.20	76.71	84.39
28 L.H., Daily Totals		$3116.40		$3842.40	$111.30	$137.23
Crew B-16	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.19	$49.81
2 Laborers	31.60	505.60	49.00	784.00		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Dump Truck, 12 C.Y., 400 H.P.		533.00		586.30	16.66	18.32
32 L.H., Daily Totals		$1563.00		$2180.30	$48.84	$68.13
Crew B-17	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$33.55	$51.46
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Backhoe Loader, 48 H.P.		293.80		323.18		
1 Dump Truck, 8 C.Y., 220 H.P.		326.40		359.04	19.38	21.32
32 L.H., Daily Totals		$1693.80		$2329.02	$52.93	$72.78
Crew B-17A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborer Foremen	$33.60	$537.60	$52.10	$833.60	$34.05	$52.78
6 Laborers	31.60	1516.80	49.00	2352.00		
1 Skilled Worker Foreman	42.85	342.80	66.35	530.80		
1 Skilled Worker	40.85	326.80	63.25	506.00		
80 L.H., Daily Totals		$2724.00		$4222.40	$34.05	$52.78
Crew B-18	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.27	$50.03
2 Laborers	31.60	505.60	49.00	784.00		
1 Vibratory Plate, Gas, 21"		39.20		43.12	1.63	1.80
24 L.H., Daily Totals		$813.60		$1243.92	$33.90	$51.83
Crew B-19	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pile Driver Foreman	$40.50	$324.00	$65.75	$526.00	$39.55	$62.37
4 Pile Drivers	38.50	1232.00	62.50	2000.00		
2 Equip. Oper. (crane)	42.55	680.80	63.95	1023.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 40 Ton		1055.00		1160.50		
1 Lead, 90' high		118.80		130.68		
1 Hammer, Diesel, 22k Ft-Lb		590.00		649.00	27.56	30.32
64 L.H., Daily Totals		$4295.00		$5931.78	$67.11	$92.68

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-19A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pile Driver Foreman	$40.50	$324.00	$65.75	$526.00	$39.55	$62.37
4 Pile Drivers	38.50	1232.00	62.50	2000.00		
2 Equip. Oper. (crane)	42.55	680.80	63.95	1023.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 75 Ton		1496.00		1645.60		
1 Lead, 90' high		118.80		130.68		
1 Hammer, Diesel, 41k Ft-Lb		677.60		745.36	35.82	39.40
64 L.H., Daily Totals		$4823.60		$6513.24	$75.37	$101.77
Crew B-20	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (out)	$33.60	$268.80	$52.10	$416.80	$35.35	$54.78
1 Skilled Worker	40.85	326.80	63.25	506.00		
1 Laborer	31.60	252.80	49.00	392.00		
24 L.H., Daily Totals		$848.40		$1314.80	$35.35	$54.78
Crew B-20A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$38.24	$58.20
1 Laborer	31.60	252.80	49.00	392.00		
1 Plumber	48.75	390.00	73.15	585.20		
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
32 L.H., Daily Totals		$1223.60		$1862.40	$38.24	$58.20
Crew B-21	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (out)	$33.60	$268.80	$52.10	$416.80	$36.38	$56.09
1 Skilled Worker	40.85	326.80	63.25	506.00		
1 Laborer	31.60	252.80	49.00	392.00		
.5 Equip. Oper. (crane)	42.55	170.20	63.95	255.80		
.5 S.P. Crane, 4x4, 5 Ton		129.10		142.01	4.61	5.07
28 L.H., Daily Totals		$1147.70		$1712.61	$40.99	$61.16
Crew B-21A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$39.10	$59.35
1 Laborer	31.60	252.80	49.00	392.00		
1 Plumber	48.75	390.00	73.15	585.20		
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 S.P. Crane, 4x4, 12 Ton		601.80		661.98	15.05	16.55
40 L.H., Daily Totals		$2165.80		$3035.98	$54.15	$75.90
Crew B-21B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$34.19	$52.61
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 12 Ton		768.80		845.68	19.22	21.14
40 L.H., Daily Totals		$2136.40		$2950.08	$53.41	$73.75
Crew B-21C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$34.19	$52.48
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
2 Cutting Torches		34.00		37.40		
2 Gases		151.20		166.32		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10	34.40	37.84
56 L.H., Daily Totals		$3841.00		$5057.62	$68.59	$90.31

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-22	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (out)	$33.60	$268.80	$52.10	$416.80	$36.79	$56.62
1 Skilled Worker	40.85	326.80	63.25	506.00		
1 Laborer	31.60	252.80	49.00	392.00		
.75 Equip. Oper. (crane)	42.55	255.30	63.95	383.70		
.75 S.P. Crane, 4x4, 5 Ton		193.65		213.01	6.46	7.10
30 L.H., Daily Totals		$1297.35		$1911.52	$43.24	$63.72
Crew B-22A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (out)	$33.60	$268.80	$52.10	$416.80	$35.70	$55.01
1 Skilled Worker	40.85	326.80	63.25	506.00		
2 Laborers	31.60	505.60	49.00	784.00		
.75 Equipment Oper. (crane)	42.55	255.30	63.95	383.70		
.75 S.P. Crane, 4x4, 5 Ton		193.65		213.01		
1 Generator, 5 kW		40.20		44.22		
1 Butt Fusion Machine		199.80		219.78	11.41	12.55
38 L.H., Daily Totals		$1790.15		$2567.51	$47.11	$67.57
Crew B-22B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Skilled Worker	$40.85	$326.80	$63.25	$506.00	$36.23	$56.13
1 Laborer	31.60	252.80	49.00	392.00		
1 Electro Fusion Machine		146.80		161.48	9.18	10.09
16 L.H., Daily Totals		$726.40		$1059.48	$45.40	$66.22
Crew B-23	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.00	$49.62
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Drill Rig, Truck-Mounted		2533.00		2786.30		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	69.39	76.33
40 L.H., Daily Totals		$4055.60		$5037.96	$101.39	$125.95
Crew B-23A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.52	$54.42
1 Laborer	31.60	252.80	49.00	392.00		
1 Equip. Operator (medium)	41.35	330.80	62.15	497.20		
1 Drill Rig, Truck-Mounted		2533.00		2786.30		
1 Pickup Truck, 3/4 Ton		116.80		128.48	110.41	121.45
24 L.H., Daily Totals		$3502.20		$4220.78	$145.93	$175.87
Crew B-23B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.52	$54.42
1 Laborer	31.60	252.80	49.00	392.00		
1 Equip. Operator (medium)	41.35	330.80	62.15	497.20		
1 Drill Rig, Truck-Mounted		2533.00		2786.30		
1 Pickup Truck, 3/4 Ton		116.80		128.48		
1 Centr. Water Pump, 6"		309.40		340.34	123.30	135.63
24 L.H., Daily Totals		$3811.60		$4561.12	$158.82	$190.05
Crew B-24	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Cement Finisher	$38.30	$306.40	$56.05	$448.40	$36.62	$55.67
1 Laborer	31.60	252.80	49.00	392.00		
1 Carpenter	39.95	319.60	61.95	495.60		
24 L.H., Daily Totals		$878.80		$1336.00	$36.62	$55.67
Crew B-25	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$34.44	$52.87
7 Laborers	31.60	1769.60	49.00	2744.00		
3 Equip. Oper. (med.)	41.35	992.40	62.15	1491.60		
1 Asphalt Paver, 130 H.P.		1936.00		2129.60		
1 Tandem Roller, 10 Ton		233.00		256.30		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58	28.15	30.96
88 L.H., Daily Totals		$5507.60		$7376.88	$62.59	$83.83

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-25B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$35.02	$53.64
7 Laborers	31.60	1769.60	49.00	2744.00		
4 Equip. Oper. (medium)	41.35	1323.20	62.15	1988.80		
1 Asphalt Paver, 130 H.P.		1936.00		2129.60		
2 Tandem Rollers, 10 Ton		466.00		512.60		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58	28.23	31.05
96 L.H., Daily Totals		$6071.40		$8130.38	$63.24	$84.69
Crew B-25C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$35.18	$53.90
3 Laborers	31.60	758.40	49.00	1176.00		
2 Equip. Oper. (medium)	41.35	661.60	62.15	994.40		
1 Asphalt Paver, 130 H.P.		1936.00		2129.60		
1 Tandem Roller, 10 Ton		233.00		256.30	45.19	49.71
48 L.H., Daily Totals		$3857.80		$4973.10	$80.37	$103.61
Crew B-26	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.34	$54.48
6 Laborers	31.60	1516.80	49.00	2352.00		
2 Equip. Oper. (med.)	41.35	661.60	62.15	994.40		
1 Rodman (reinf.)	44.55	356.40	72.85	582.80		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Paving Mach. & Equip.		2500.00		2750.00	34.66	38.13
88 L.H., Daily Totals		$6160.20		$8149.62	$70.00	$92.61
Crew B-26A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.34	$54.48
6 Laborers	31.60	1516.80	49.00	2352.00		
2 Equip. Oper. (med.)	41.35	661.60	62.15	994.40		
1 Rodman (reinf.)	44.55	356.40	72.85	582.80		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Paving Mach. & Equip.		2500.00		2750.00		
1 Concrete Saw		141.00		155.10	36.26	39.89
88 L.H., Daily Totals		$6301.20		$8304.72	$71.60	$94.37
Crew B-26B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.84	$55.12
6 Laborers	31.60	1516.80	49.00	2352.00		
3 Equip. Oper. (med.)	41.35	992.40	62.15	1491.60		
1 Rodman (reinf.)	44.55	356.40	72.85	582.80		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Paving Mach. & Equip.		2500.00		2750.00		
1 Concrete Pump, 110' Boom		977.00		1074.70	41.95	46.15
96 L.H., Daily Totals		$7468.00		$9721.52	$77.79	$101.27
Crew B-27	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.10	$49.77
3 Laborers	31.60	758.40	49.00	1176.00		
1 Berm Machine		271.40		298.54	8.48	9.33
32 L.H., Daily Totals		$1298.60		$1891.34	$40.58	$59.10
Crew B-28	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$39.95	$639.20	$61.95	$991.20	$37.17	$57.63
1 Laborer	31.60	252.80	49.00	392.00		
24 L.H., Daily Totals		$892.00		$1383.20	$37.17	$57.63

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-29	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.19	$52.48
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Gradall, 5/8 C.Y.		958.80		1054.68	17.12	18.83
56 L.H., Daily Totals		$2873.60		$3993.48	$51.31	$71.31
Crew B-30	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$35.08	$53.48
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Hyd. Excavator, 1.5 C.Y.		865.80		952.38		
2 Dump Trucks, 12 C.Y., 400 H.P.		1066.00		1172.60	80.49	88.54
24 L.H., Daily Totals		$2773.80		$3408.58	$115.58	$142.02
Crew B-31	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.67	$52.21
3 Laborers	31.60	758.40	49.00	1176.00		
1 Carpenter	39.95	319.60	61.95	495.60		
1 Air Compressor, 250 cfm		162.40		178.64		
1 Sheeting Driver		5.75		6.33		
2 -50' Air Hoses, 1.5"		12.60		13.86	4.52	4.97
40 L.H., Daily Totals		$1527.55		$2287.22	$38.19	$57.18
Crew B-32	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$38.91	$58.86
3 Equip. Oper. (med.)	41.35	992.40	62.15	1491.60		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Tandem Roller, 10 Ton		233.00		256.30		
1 Dozer, 200 H.P.		1082.00		1190.20	58.29	64.12
32 L.H., Daily Totals		$3110.40		$3935.32	$97.20	$122.98
Crew B-32A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$38.10	$57.77
2 Equip. Oper. (medium)	41.35	661.60	62.15	994.40		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Roller, Vibratory, 25 Ton		594.60		654.06	47.70	52.47
24 L.H., Daily Totals		$2059.20		$2645.68	$85.80	$110.24
Crew B-32B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$38.10	$57.77
2 Equip. Oper. (medium)	41.35	661.60	62.15	994.40		
1 Dozer, 200 H.P.		1082.00		1190.20		
1 Roller, Vibratory, 25 Ton		594.60		654.06	69.86	76.84
24 L.H., Daily Totals		$2591.00		$3230.66	$107.96	$134.61
Crew B-32C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$36.81	$56.09
2 Laborers	31.60	505.60	49.00	784.00		
3 Equip. Oper. (medium)	41.35	992.40	62.15	1491.60		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Tandem Roller, 10 Ton		233.00		256.30		
1 Dozer, 200 H.P.		1082.00		1190.20	38.86	42.74
48 L.H., Daily Totals		$3632.00		$4744.12	$75.67	$98.84
Crew B-33A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.5 Laborer	31.60	126.40	49.00	196.00		
.25 Equip. Oper. (med.)	41.35	82.70	62.15	124.30		
1 Scraper, Towed, 7 C.Y.		102.20		112.42		
1.25 Dozers, 300 H.P.		1778.75		1956.63	134.35	147.79
14 L.H., Daily Totals		$2420.85		$2886.55	$172.92	$206.18

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-33B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.5 Laborer	31.60	126.40	49.00	196.00		
.25 Equip. Oper. (med.)	41.35	82.70	62.15	124.30		
1 Scraper, Towed, 10 C.Y.		153.60		168.96		
1.25 Dozers, 300 H.P.		1778.75		1956.63	138.03	151.83
14 L.H., Daily Totals		$2472.25		$2943.09	$176.59	$210.22
Crew B-33C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.5 Laborer	31.60	126.40	49.00	196.00		
.25 Equip. Oper. (med.)	41.35	82.70	62.15	124.30		
1 Scraper, Towed, 15 C.Y.		168.80		185.68		
1.25 Dozers, 300 H.P.		1778.75		1956.63	139.11	153.02
14 L.H., Daily Totals		$2487.45		$2959.80	$177.68	$211.41
Crew B-33D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.5 Laborer	31.60	126.40	49.00	196.00		
.25 Equip. Oper. (med.)	41.35	82.70	62.15	124.30		
1 S.P. Scraper, 14 C.Y.		1509.00		1659.90		
.25 Dozer, 300 H.P.		355.75		391.32	133.20	146.52
14 L.H., Daily Totals		$2404.65		$2868.72	$171.76	$204.91
Crew B-33E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.5 Laborer	31.60	126.40	49.00	196.00		
.25 Equip. Oper. (med.)	41.35	82.70	62.15	124.30		
1 S.P. Scraper, 21 C.Y.		1924.00		2116.40		
.25 Dozer, 300 H.P.		355.75		391.32	162.84	179.12
14 L.H., Daily Totals		$2819.65		$3325.22	$201.40	$237.52
Crew B-33F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.5 Laborer	31.60	126.40	49.00	196.00		
.25 Equip. Oper. (med.)	41.35	82.70	62.15	124.30		
1 Elev. Scraper, 11 C.Y.		1095.00		1204.50		
.25 Dozer, 300 H.P.		355.75		391.32	103.63	113.99
14 L.H., Daily Totals		$1990.65		$2413.32	$142.19	$172.38
Crew B-33G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.5 Laborer	31.60	126.40	49.00	196.00		
.25 Equip. Oper. (med.)	41.35	82.70	62.15	124.30		
1 Elev. Scraper, 22 C.Y.		2127.00		2339.70		
.25 Dozer, 300 H.P.		355.75		391.32	177.34	195.07
14 L.H., Daily Totals		$3022.65		$3548.53	$215.90	$253.47
Crew B-33H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.5 Laborer	$31.60	$126.40	$49.00	$196.00	$38.56	$58.39
1 Equipment Operator (med.)	41.35	330.80	62.15	497.20		
.25 Equipment Operator (med.)	41.35	82.70	62.15	124.30		
1 S.P. Scraper, 44 C.Y.		3452.00		3797.20		
.25 Dozer, 410 H.P.		462.25		508.48	279.59	307.55
14 L.H., Daily Totals		$4454.15		$5123.18	$318.15	$365.94
Crew B-33J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$41.35	$62.15
1 S.P. Scraper, 14 C.Y.		1509.00		1659.90	188.63	207.49
8 L.H., Daily Totals		$1839.80		$2157.10	$229.97	$269.64

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-33K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$41.35	$330.80	$62.15	$497.20	$38.56	$58.39
.25 Equipment Operator (med.)	41.35	82.70	62.15	124.30		
.5 Laborer	31.60	126.40	49.00	196.00		
1 S.P. Scraper, 31 C.Y.		2878.00		3165.80		
.25 Dozer, 410 H.P.		462.25		508.48	238.59	262.45
14 L.H., Daily Totals		$3880.15		$4491.77	$277.15	$320.84
Crew B-34A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, 8 C.Y., 220 H.P.		326.40		359.04	40.80	44.88
8 L.H., Daily Totals		$582.00		$752.24	$72.75	$94.03
Crew B-34B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, 12 C.Y., 400 H.P.		533.00		586.30	66.63	73.29
8 L.H., Daily Totals		$788.60		$979.50	$98.58	$122.44
Crew B-34C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68		
1 Dump Trailer, 16.5 C.Y.		115.60		127.16	74.30	81.73
8 L.H., Daily Totals		$850.00		$1047.04	$106.25	$130.88
Crew B-34D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68		
1 Dump Trailer, 20 C.Y.		130.20		143.22	76.13	83.74
8 L.H., Daily Totals		$864.60		$1063.10	$108.08	$132.89
Crew B-34E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, Off Hwy., 25 Ton		1280.00		1408.00	160.00	176.00
8 L.H., Daily Totals		$1535.60		$1801.20	$191.95	$225.15
Crew B-34F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, Off Hwy., 35 Ton		1144.00		1258.40	143.00	157.30
8 L.H., Daily Totals		$1399.60		$1651.60	$174.95	$206.45
Crew B-34G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, Off Hwy., 50 Ton		1582.00		1740.20	197.75	217.53
8 L.H., Daily Totals		$1837.60		$2133.40	$229.70	$266.68
Crew B-34H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, Off Hwy., 65 Ton		1594.00		1753.40	199.25	219.18
8 L.H., Daily Totals		$1849.60		$2146.60	$231.20	$268.32
Crew B-34J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, Off Hwy., 100 Ton		2047.00		2251.70	255.88	281.46
8 L.H., Daily Totals		$2302.60		$2644.90	$287.82	$330.61
Crew B-34K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Truck Tractor, 6x4, 450 H.P.		581.20		639.32		
1 Lowbed Trailer, 75 Ton		203.00		223.30	98.03	107.83
8 L.H., Daily Totals		$1039.80		$1255.82	$129.97	$156.98

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-34L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84	24.30	26.73
8 L.H., Daily Totals		$506.80		$683.44	$63.35	$85.43
Crew B-34N	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Dump Truck, 8 C.Y., 220 H.P.		326.40		359.04		
1 Flatbed Trailer, 40 Ton		139.60		153.56	58.25	64.08
8 L.H., Daily Totals		$721.60		$905.80	$90.20	$113.22
Crew B-34P	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pipe Fitter	$49.35	$394.80	$74.05	$592.40	$40.55	$61.28
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Equip. Oper. (medium)	41.35	330.80	62.15	497.20		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Backhoe Loader, 48 H.P.		293.80		323.18	22.35	24.59
24 L.H., Daily Totals		$1509.60		$2060.84	$62.90	$85.87
Crew B-34Q	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pipe Fitter	$49.35	$394.80	$74.05	$592.40	$40.95	$61.88
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Eqip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Flatbed Trailer, 25 Ton		102.00		112.20		
1 Dump Truck, 8 C.Y., 220 H.P.		326.40		359.04		
1 Hyd. Crane, 25 Ton		789.40		868.34	50.74	55.82
24 L.H., Daily Totals		$2200.60		$2824.78	$91.69	$117.70
Crew B-34R	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pipe Fitter	$49.35	$394.80	$74.05	$592.40	$40.95	$61.88
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Eqip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Flatbed Trailer, 25 Ton		102.00		112.20		
1 Dump Truck, 8 C.Y., 220 H.P.		326.40		359.04		
1 Hyd. Crane, 25 Ton		789.40		868.34		
1 Hyd. Excavator, 1 C.Y.		669.20		736.12	78.63	86.49
24 L.H., Daily Totals		$2869.80		$3560.90	$119.58	$148.37
Crew B-34S	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Pipe Fitters	$49.35	$789.60	$74.05	$1184.80	$43.30	$65.30
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Eqip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Flatbed Trailer, 40 Ton		139.60		153.56		
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68		
1 Hyd. Crane, 80 Ton		1296.00		1425.60		
1 Hyd. Excavator, 2 C.Y.		1182.00		1300.20	96.76	106.44
32 L.H., Daily Totals		$4482.00		$5495.64	$140.06	$171.74
Crew B-34T	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Pipe Fitters	$49.35	$789.60	$74.05	$1184.80	$43.30	$65.30
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Eqip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Flatbed Trailer, 40 Ton		139.60		153.56		
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68		
1 Hyd. Crane, 80 Ton		1296.00		1425.60	59.83	65.81
32 L.H., Daily Totals		$3300.00		$4195.44	$103.13	$131.11

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-35	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman (out)	$33.60	$268.80	$52.10	$416.80	$39.02	$59.46
1 Skilled Worker	40.85	326.80	63.25	506.00		
1 Welder (plumber)	48.75	390.00	73.15	585.20		
1 Laborer	31.60	252.80	49.00	392.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Welder, electric, 300 amp		55.70		61.27		
1 Hyd. Excavator, .75 C.Y.		598.60		658.46	13.63	14.99
48 L.H., Daily Totals		$2527.50		$3573.73	$52.66	$74.45
Crew B-35A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman (out)	$33.60	$268.80	$52.10	$416.80	$37.96	$57.96
2 Laborers	31.60	505.60	49.00	784.00		
1 Skilled Worker	40.85	326.80	63.25	506.00		
1 Welder (plumber)	48.75	390.00	73.15	585.20		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Welder, gas engine, 300 amp		134.20		147.62		
1 Crawler Crane, 75 Ton		1496.00		1645.60	29.11	32.02
56 L.H., Daily Totals		$3756.20		$5039.22	$67.08	$89.99
Crew B-36	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.90	$54.88
2 Laborers	31.60	505.60	49.00	784.00		
2 Equip. Oper. (med.)	41.35	661.60	62.15	994.40		
1 Dozer, 200 H.P.		1082.00		1190.20		
1 Aggregate Spreader		35.00		38.50		
1 Tandem Roller, 10 Ton		233.00		256.30	33.75	37.13
40 L.H., Daily Totals		$2786.00		$3680.20	$69.65	$92.00
Crew B-36A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$37.46	$56.96
2 Laborers	31.60	505.60	49.00	784.00		
4 Equip. Oper. (med.)	41.35	1323.20	62.15	1988.80		
1 Dozer, 200 H.P.		1082.00		1190.20		
1 Aggregate Spreader		35.00		38.50		
1 Tandem Roller, 10 Ton		233.00		256.30		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58	29.60	32.56
56 L.H., Daily Totals		$3755.40		$5013.18	$67.06	$89.52
Crew B-36B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.77	$55.98
2 Laborers	31.60	505.60	49.00	784.00		
4 Equip. Oper. (medium)	41.35	1323.20	62.15	1988.80		
1 Truck Driver, Heavy	31.95	255.60	49.15	393.20		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 F.E. Loader, crl, 1.5 C.Y.		463.00		509.30		
1 Dozer, 300 H.P.		1423.00		1565.30		
1 Roller, Vibratory, 25 Ton		594.60		654.06		
1 Truck Tractor, 6x4, 450 H.P.		581.20		639.32		
1 Water Tanker, 5000 Gal.		136.00		149.60	58.56	64.42
64 L.H., Daily Totals		$6101.20		$7705.60	$95.33	$120.40

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-36C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$37.92	$57.54
3 Equip. Oper. (medium)	41.35	992.40	62.15	1491.60		
1 Truck Driver, Heavy	31.95	255.60	49.15	393.20		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Dozer, 300 H.P.		1423.00		1565.30		
1 Roller, Vibratory, 25 Ton		594.60		654.06		
1 Truck Tractor, 6x4, 450 H.P.		581.20		639.32		
1 Water Tanker, 5000 Gal.		136.00		149.60	82.13	90.34
40 L.H., Daily Totals		$4801.80		$5915.10	$120.05	$147.88
Crew B-37	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.17	$51.13
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Tandem Roller, 5 Ton		137.80		151.58	2.87	3.16
48 L.H., Daily Totals		$1730.20		$2605.98	$36.05	$54.29
Crew B-38	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.44	$54.19
2 Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Equip. Oper. (medium)	41.35	330.80	62.15	497.20		
1 Backhoe Loader, 48 H.P.		293.80		323.18		
1 Hyd.Hammer, (1200 lb.)		153.00		168.30		
1 F.E. Loader, W.M., 4 C.Y.		541.00		595.10		
1 Pavt. Rem. Bucket		56.80		62.48	26.11	28.73
40 L.H., Daily Totals		$2462.20		$3316.66	$61.56	$82.92
Crew B-39	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.17	$51.13
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Compressor, 250 cfm		162.40		178.64		
2 Breakers, Pavement, 60 lb.		16.40		18.04		
2 -50' Air Hoses, 1.5"		12.60		13.86	3.99	4.39
48 L.H., Daily Totals		$1783.80		$2664.94	$37.16	$55.52
Crew B-40	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pile Driver Foreman (out)	$40.50	$324.00	$65.75	$526.00	$39.55	$62.37
4 Pile Drivers	38.50	1232.00	62.50	2000.00		
2 Equip. Oper. (crane)	42.55	680.80	63.95	1023.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 40 Ton		1055.00		1160.50		
1 Vibratory Hammer & Gen.		2257.00		2482.70	51.75	56.92
64 L.H., Daily Totals		$5843.20		$7634.80	$91.30	$119.29
Crew B-40B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$34.63	$53.06
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Lattice Boom Crane, 40 Ton		1327.00		1459.70	27.65	30.41
48 L.H., Daily Totals		$2989.00		$4006.50	$62.27	$83.47
Crew B-41	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.70	$50.53
4 Laborers	31.60	1011.20	49.00	1568.00		
.25 Equip. Oper. (crane)	42.55	85.10	63.95	127.90		
.25 Equip. Oper. Oiler	36.80	73.60	55.30	110.60		
.25 Crawler Crane, 40 Ton		263.75		290.13	5.99	6.59
44 L.H., Daily Totals		$1702.45		$2513.43	$38.69	$57.12

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-42	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.51	$55.88
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Welder	44.70	357.60	79.65	637.20		
1 Hyd. Crane, 25 Ton		789.40		868.34		
1 Welder, gas engine, 300 amp		134.20		147.62		
1 Horz. Boring Csg. Mch.		444.20		488.62	21.37	23.51
64 L.H., Daily Totals		$3640.20		$5080.58	$56.88	$79.38
Crew B-43	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.63	$53.06
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Drill Rig, Truck-Mounted		2533.00		2786.30	52.77	58.05
48 L.H., Daily Totals		$4195.00		$5333.10	$87.40	$111.11
Crew B-44	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pile Driver Foreman	$40.50	$324.00	$65.75	$526.00	$38.90	$61.58
4 Pile Drivers	38.50	1232.00	62.50	2000.00		
2 Equip. Oper. (crane)	42.55	680.80	63.95	1023.20		
1 Laborer	31.60	252.80	49.00	392.00		
1 Crawler Crane, 40 Ton		1055.00		1160.50		
1 Lead, 60' high		69.60		76.56		
1 Hammer, diesel, 15K Ft.-Lbs.		578.60		636.46	26.61	29.27
64 L.H., Daily Totals		$4192.80		$5814.72	$65.51	$90.86
Crew B-45	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$36.65	$55.65
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Dist. Tanker, 3000 Gallon		304.20		334.62		
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68	48.94	53.83
16 L.H., Daily Totals		$1369.40		$1751.70	$85.59	$109.48
Crew B-46	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pile Driver Foreman	$40.50	$324.00	$65.75	$526.00	$35.38	$56.29
2 Pile Drivers	38.50	616.00	62.50	1000.00		
3 Laborers	31.60	758.40	49.00	1176.00		
1 Chain Saw, Gas, 36" Long		37.80		41.58	.79	.87
48 L.H., Daily Totals		$1736.20		$2743.58	$36.17	$57.16
Crew B-47	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Blast Foreman	$33.60	$268.80	$52.10	$416.80	$34.75	$53.27
1 Driller	31.60	252.80	49.00	392.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Track Drill, 4"		850.60		935.66		
1 Air Compressor, 600 cfm		434.40		477.84		
2 -50' Air Hoses, 3"		32.40		35.64	54.89	60.38
24 L.H., Daily Totals		$2151.40		$2727.54	$89.64	$113.65
Crew B-47A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Drilling Foreman	$33.60	$268.80	$52.10	$416.80	$37.65	$57.12
1 Equip. Oper. (heavy)	42.55	340.40	63.95	511.60		
1 Oiler	36.80	294.40	55.30	442.40		
1 Air Track Drill, 5"		974.00		1071.40	40.58	44.64
24 L.H., Daily Totals		$1877.60		$2442.20	$78.23	$101.76

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-47C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$35.33	$53.85
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Compressor, 750 cfm		439.60		483.56		
2 -50' Air Hoses, 3"		32.40		35.64		
1 Air Track Drill, 4"		850.60		935.66	82.66	90.93
16 L.H., Daily Totals		$1887.80		$2316.46	$117.99	$144.78
Crew B-47E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$32.10	$49.77
3 Laborers	31.60	758.40	49.00	1176.00		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	7.58	8.34
32 L.H., Daily Totals		$1269.80		$1859.66	$39.68	$58.11
Crew B-47G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$33.96	$52.20
2 Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Track Drill, 4"		850.60		935.66		
1 Air Compressor, 600 cfm		434.40		477.84		
2 -50' Air Hoses, 3"		32.40		35.64		
1 Grout Pump		166.40		183.04	46.37	51.01
32 L.H., Daily Totals		$2570.60		$3302.58	$80.33	$103.21
Crew B-48	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.26	$53.86
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Centr. Water Pump, 6"		309.40		340.34		
1 -20' Suction Hose, 6"		11.90		13.09		
1 -50' Discharge Hose, 6"		6.30		6.93		
1 Drill Rig, Truck-Mounted		2533.00		2786.30	51.08	56.19
56 L.H., Daily Totals		$4835.00		$6163.06	$86.34	$110.05
Crew B-49	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.65	$56.48
3 Laborers	31.60	758.40	49.00	1176.00		
2 Equip. Oper. (crane)	42.55	680.80	63.95	1023.20		
2 Equip. Oper. Oilers	36.80	588.80	55.30	884.80		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
2 Pile Drivers	38.50	616.00	62.50	1000.00		
1 Hyd. Crane, 25 Ton		789.40		868.34		
1 Centr. Water Pump, 6"		309.40		340.34		
1 -20' Suction Hose, 6"		11.90		13.09		
1 -50' Discharge Hose, 6"		6.30		6.93		
1 Drill Rig, Truck-Mounted		2533.00		2786.30	41.48	45.63
88 L.H., Daily Totals		$6875.20		$8985.40	$78.13	$102.11
Crew B-50	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Pile Driver Foremen	$40.50	$648.00	$65.75	$1052.00	$37.76	$59.76
6 Pile Drivers	38.50	1848.00	62.50	3000.00		
2 Equip. Oper. (crane)	42.55	680.80	63.95	1023.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
3 Laborers	31.60	758.40	49.00	1176.00		
1 Crawler Crane, 40 Ton		1055.00		1160.50		
1 Lead, 60' high		69.60		76.56		
1 Hammer, diesel, 15K Ft.-Lbs.		578.60		636.46		
1 Air Compressor, 600 cfm		434.40		477.84		
2 -50' Air Hoses, 3"		32.40		35.64		
1 Chain Saw, Gas, 36" Long		37.80		41.58	19.71	21.68
112 L.H., Daily Totals		$6437.40		$9122.18	$57.48	$81.45

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-51	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$31.82	$49.29
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84	4.05	4.46
48 L.H., Daily Totals		$1722.00		$2579.84	$35.88	$53.75
Crew B-52	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman	$41.95	$335.60	$65.05	$520.40	$36.85	$56.79
1 Carpenter	39.95	319.60	61.95	495.60		
3 Laborers	31.60	758.40	49.00	1176.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
.5 Rodman (reinf.)	44.55	178.20	72.85	291.40		
.5 Equip. Oper. (med.)	41.35	165.40	62.15	248.60		
.5 Crawler Loader, 3 C.Y.		495.00		544.50	8.84	9.72
56 L.H., Daily Totals		$2558.60		$3724.90	$45.69	$66.52
Crew B-53	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Trencher, Chain, 12 H.P.		59.60		65.56	7.45	8.20
8 L.H., Daily Totals		$372.00		$535.16	$46.50	$66.89
Crew B-54	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Trencher, Chain, 40 H.P.		301.00		331.10	37.63	41.39
8 L.H., Daily Totals		$613.40		$800.70	$76.67	$100.09
Crew B-54A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.17 Labor Foreman (outside)	$33.60	$45.70	$52.10	$70.86	$40.22	$60.69
1 Equipment Operator (med.)	41.35	330.80	62.15	497.20		
1 Wheel Trencher, 67 H.P.		1009.00		1109.90	107.80	118.58
9.36 L.H., Daily Totals		$1385.50		$1677.96	$148.02	$179.27
Crew B-54B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.25 Labor Foreman (outside)	$33.60	$67.20	$52.10	$104.20	$39.80	$60.14
1 Equipment Operator (med.)	41.35	330.80	62.15	497.20		
1 Wheel Trencher, 150 H.P.		1753.00		1928.30	175.30	192.83
10 L.H., Daily Totals		$2151.00		$2529.70	$215.10	$252.97
Crew B-54C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$36.48	$55.58
1 Equipment Operator (med.)	41.35	330.80	62.15	497.20		
1 Wheel Trencher, 67 H.P.		1009.00		1109.90	63.06	69.37
16 L.H., Daily Totals		$1592.60		$1999.10	$99.54	$124.94
Crew B-55	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.38	$48.55
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Truck-mounted earth auger		706.60		777.26		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	39.55	43.51
24 L.H., Daily Totals		$1702.40		$2209.32	$70.93	$92.06
Crew B-56	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$35.33	$53.85
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Track Drill, 4"		850.60		935.66		
1 Air Compressor, 600 cfm		434.40		477.84		
1 -50' Air Hose, 3"		16.20		17.82	81.33	89.46
16 L.H., Daily Totals		$1866.40		$2292.92	$116.65	$143.31

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-57	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.87	$54.67
2 Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 25 Ton		1052.00		1157.20		
1 Clamshell Bucket, 1 C.Y.		46.20		50.82		
1 Centr. Water Pump, 6"		309.40		340.34		
1 -20' Suction Hose, 6"		11.90		13.09		
20 -50' Discharge Hoses, 6"		126.00		138.60	32.20	35.42
48 L.H., Daily Totals		$3267.10		$4324.45	$68.06	$90.09
Crew B-58	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$34.08	$52.23
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Backhoe Loader, 48 H.P.		293.80		323.18		
1 Small Helicopter, w/pilot		2587.00		2845.70	120.03	132.04
24 L.H., Daily Totals		$3698.80		$4422.48	$154.12	$184.27
Crew B-59	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Truck Driver (heavy)	$31.95	$255.60	$49.15	$393.20	$31.95	$49.15
1 Truck Tractor, 220 H.P.		288.40		317.24		
1 Water Tanker, 5000 Gal.		136.00		149.60	53.05	58.35
8 L.H., Daily Totals		$680.00		$860.04	$85.00	$107.51
Crew B-59A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.72	$49.05
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Water Tanker, 5000 Gal.		136.00		149.60		
1 Truck Tractor, 220 H.P.		288.40		317.24	17.68	19.45
24 L.H., Daily Totals		$1185.60		$1644.04	$49.40	$68.50
Crew B-60	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.32	$55.25
2 Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
2 Equip. Oper. (light)	39.05	624.80	58.70	939.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 40 Ton		1055.00		1160.50		
1 Lead, 60' high		69.60		76.56		
1 Hammer, diesel, 15K Ft.-Lbs.		578.60		636.46		
1 Backhoe Loader, 48 H.P.		293.80		323.18	35.66	39.23
56 L.H., Daily Totals		$4031.00		$5290.70	$71.98	$94.48
Crew B-61	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.49	$51.56
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Cement Mixer, 2 C.Y.		187.80		206.58		
1 Air Compressor, 160 cfm		138.80		152.68	8.16	8.98
40 L.H., Daily Totals		$1666.20		$2421.66	$41.66	$60.54
Crew B-62	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$34.08	$52.23
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Loader, Skid Steer, 30 H.P., gas		149.20		164.12	6.22	6.84
24 L.H., Daily Totals		$967.20		$1417.72	$40.30	$59.07

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-63	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
4 Laborers	$31.60	$1011.20	$49.00	$1568.00	$33.09	$50.94
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Loader, Skid Steer, 30 H.P., gas		149.20		164.12	3.73	4.10
40 L.H., Daily Totals		$1472.80		$2201.72	$36.82	$55.04
Crew B-64	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$31.27	$48.33
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Power Mulcher (small)		136.60		150.26		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84	20.69	22.76
16 L.H., Daily Totals		$831.40		$1137.30	$51.96	$71.08
Crew B-65	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$31.27	$48.33
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Power Mulcher (large)		271.80		298.98		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84	29.14	32.05
16 L.H., Daily Totals		$966.60		$1286.02	$60.41	$80.38
Crew B-66	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Loader-Backhoe		231.20		254.32	28.90	31.79
8 L.H., Daily Totals		$543.60		$723.92	$67.95	$90.49
Crew B-67	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Millwright	$41.60	$332.80	$61.05	$488.40	$40.33	$59.88
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Forklift, R/T, 4,000 Lb.		281.20		309.32	17.57	19.33
16 L.H., Daily Totals		$926.40		$1267.32	$57.90	$79.21
Crew B-68	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Millwrights	$41.60	$665.60	$61.05	$976.80	$40.75	$60.27
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Forklift, R/T, 4,000 Lb.		281.20		309.32	11.72	12.89
24 L.H., Daily Totals		$1259.20		$1755.72	$52.47	$73.16
Crew B-69	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.63	$53.06
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. Crane, 80 Ton		1296.00		1425.60	27.00	29.70
48 L.H., Daily Totals		$2958.00		$3972.40	$61.63	$82.76
Crew B-69A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$34.67	$52.88
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (medium)	41.35	330.80	62.15	497.20		
1 Concrete Finisher	38.30	306.40	56.05	448.40		
1 Curb/Gutter Paver, 2-Track		754.40		829.84	15.72	17.29
48 L.H., Daily Totals		$2418.80		$3368.24	$50.39	$70.17
Crew B-69B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$34.67	$52.88
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (medium)	41.35	330.80	62.15	497.20		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Curb/Gutter Paver, 4-Track		855.80		941.38	17.83	19.61
48 L.H., Daily Totals		$2520.20		$3479.78	$52.50	$72.50

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-70	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.06	$55.08
3 Laborers	31.60	758.40	49.00	1176.00		
3 Equip. Oper. (med.)	41.35	992.40	62.15	1491.60		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Ripper, beam & 1 shank		79.60		87.56		
1 Road Sweeper, S.P., 8' wide		601.60		661.76		
1 F.E. Loader, W.M., 1.5 C.Y.		328.20		361.02	27.85	30.64
56 L.H., Daily Totals		$3579.20		$4799.96	$63.91	$85.71
Crew B-70A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$39.40	$59.52
4 Equip. Oper. (med.)	41.35	1323.20	62.15	1988.80		
1 Grader, 40,000 Lbs.		961.00		1057.10		
1 F.E. Loader, W.M.,2.5 C.Y.		395.80		435.38		
1 Dozer, 80 H.P.		399.20		439.12		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58	51.59	56.75
40 L.H., Daily Totals		$3639.80		$4650.98	$91.00	$116.27
Crew B-71	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.06	$55.08
3 Laborers	31.60	758.40	49.00	1176.00		
3 Equip. Oper. (med.)	41.35	992.40	62.15	1491.60		
1 Pvmt. Profiler, 750 H.P.		5503.00		6053.30		
1 Road Sweeper, S.P., 8' wide		601.60		661.76		
1 F.E. Loader, W.M., 1.5 C.Y.		328.20		361.02	114.87	126.36
56 L.H., Daily Totals		$8452.40		$10160.48	$150.94	$181.44
Crew B-72	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.73	$55.96
3 Laborers	31.60	758.40	49.00	1176.00		
4 Equip. Oper. (med.)	41.35	1323.20	62.15	1988.80		
1 Pvmt. Profiler, 750 H.P.		5503.00		6053.30		
1 Hammermill, 250 H.P.		1850.00		2035.00		
1 Windrow Loader		1197.00		1316.70		
1 Mix Paver 165 H.P.		1996.00		2195.60		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58	169.59	186.55
64 L.H., Daily Totals		$13204.20		$15520.78	$206.32	$242.51
Crew B-73	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$37.94	$57.61
2 Laborers	31.60	505.60	49.00	784.00		
5 Equip. Oper. (med.)	41.35	1654.00	62.15	2486.00		
1 Road Mixer, 310 H.P.		1896.00		2085.60		
1 Tandem Roller, 10 Ton		233.00		256.30		
1 Hammermill, 250 H.P.		1850.00		2035.00		
1 Grader, 30,000 Lbs.		550.20		605.22		
.5 F.E. Loader, W.M., 1.5 C.Y.		164.10		180.51		
.5 Truck Tractor, 220 H.P.		144.20		158.62		
.5 Water Tanker, 5000 Gal.		68.00		74.80	76.65	84.31
64 L.H., Daily Totals		$7333.90		$9082.85	$114.59	$141.92

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-74	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.81	$56.00
1 Laborer	31.60	252.80	49.00	392.00		
4 Equip. Oper. (med.)	41.35	1323.20	62.15	1988.80		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Ripper, beam & 1 shank		79.60		87.56		
2 Stabilizers, 310 H.P.		2688.00		2956.80		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Chem. Spreader, Towed		48.00		52.80		
1 Roller, Vibratory, 25 Ton		594.60		654.06		
1 Water Tanker, 5000 Gal.		136.00		149.60		
1 Truck Tractor, 220 H.P.		288.40		317.24	72.30	79.53
64 L.H., Daily Totals		$6983.40		$8674.14	$109.12	$135.53
Crew B-75	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$37.51	$56.98
1 Laborer	31.60	252.80	49.00	392.00		
4 Equip. Oper. (med.)	41.35	1323.20	62.15	1988.80		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Grader, 30,000 Lbs.		550.20		605.22		
1 Ripper, beam & 1 shank		79.60		87.56		
2 Stabilizers, 310 H.P.		2688.00		2956.80		
1 Dist. Tanker, 3000 Gallon		304.20		334.62		
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68		
1 Roller, Vibratory, 25 Ton		594.60		654.06	83.85	92.23
56 L.H., Daily Totals		$6795.80		$8355.74	$121.35	$149.21
Crew B-76	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Dock Builder Foreman	$40.50	$324.00	$65.75	$526.00	$39.43	$62.38
5 Dock Builders	38.50	1540.00	62.50	2500.00		
2 Equip. Oper. (crane)	42.55	680.80	63.95	1023.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 50 Ton		1110.00		1221.00		
1 Barge, 400 Ton		746.40		821.04		
1 Hammer, diesel, 15K Ft.-Lbs.		578.60		636.46		
1 Lead, 60' high		69.60		76.56		
1 Air Compressor, 600 cfm		434.40		477.84		
2 -50' Air Hoses, 3"		32.40		35.64	41.27	45.40
72 L.H., Daily Totals		$5810.60		$7760.14	$80.70	$107.78
Crew B-76A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman	$33.60	$268.80	$52.10	$416.80	$33.87	$52.04
5 Laborers	31.60	1264.00	49.00	1960.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 50 Ton		1110.00		1221.00		
1 Barge, 400 Ton		746.40		821.04	29.01	31.91
64 L.H., Daily Totals		$4024.00		$5372.84	$62.88	$83.95
Crew B-77	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$31.87	$49.35
3 Laborers	31.60	758.40	49.00	1176.00		
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Crack Cleaner, 25 H.P.		54.80		60.28		
1 Crack Filler, Trailer Mtd.		194.20		213.62		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	12.29	13.52
40 L.H., Daily Totals		$1766.40		$2514.76	$44.16	$62.87

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-78	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$31.82	$49.29
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Paint Striper, S.P.		147.00		161.70		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Pickup Truck, 3/4 Ton		116.80		128.48	10.55	11.61
48 L.H., Daily Totals		$2034.00		$2923.04	$42.38	$60.90
Crew B-78A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Line Rem. (metal balls) 115 H.P.		828.60		911.46	103.58	113.93
8 L.H., Daily Totals		$1141.00		$1381.06	$142.63	$172.63
Crew B-78B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$32.43	$50.08
.25 Equip. Oper. (light)	39.05	78.10	58.70	117.40		
1 Pickup Truck, 3/4 Ton		116.80		128.48		
1 Line Rem., 11 H.P., walk behind		54.00		59.40		
.25 Road Sweeper, S.P., 8' wide		150.40		165.44	17.84	19.63
18 L.H., Daily Totals		$904.90		$1254.72	$50.27	$69.71
Crew B-79	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$31.87	$49.35
3 Laborers	31.60	758.40	49.00	1176.00		
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Thermo. Striper, T.M.		703.20		773.52		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
2 Pickup Trucks, 3/4 Ton		233.60		256.96	29.48	32.43
40 L.H., Daily Totals		$2454.20		$3271.34	$61.35	$81.78
Crew B-79A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1.5 Equip. Oper. (light)	$39.05	$468.60	$58.70	$704.40	$39.05	$58.70
.5 Line Remov. (grinder) 115 H.P.		440.20		484.22		
1 Line Rem. (metal balls) 115 H.P.		828.60		911.46	105.73	116.31
12 L.H., Daily Totals		$1737.40		$2100.08	$144.78	$175.01
Crew B-80	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$33.80	$51.86
1 Laborer	31.60	252.80	49.00	392.00		
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Earth Auger, Truck-Mtd.		412.00		453.20	20.46	22.50
32 L.H., Daily Totals		$1736.20		$2379.66	$54.26	$74.36
Crew B-80A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$31.60	$758.40	$49.00	$1176.00	$31.60	$49.00
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	10.11	11.12
24 L.H., Daily Totals		$1001.00		$1442.86	$41.71	$60.12
Crew B-80B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$31.60	$758.40	$49.00	$1176.00	$33.46	$51.42
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Crane, Flatbed Mounted, 3 Ton		225.00		247.50	7.03	7.73
32 L.H., Daily Totals		$1295.80		$1893.10	$40.49	$59.16

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-80C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$31.38	$48.55
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84		
1 Manual fence post auger, gas		7.40		8.14	8.41	9.25
24 L.H., Daily Totals		$955.00		$1387.18	$39.79	$57.80
Crew B-81	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$34.97	$53.43
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Hydromulcher, T.M.		291.00		320.10		
1 Truck Tractor, 220 H.P.		288.40		317.24	24.14	26.56
24 L.H., Daily Totals		$1418.60		$1919.74	$59.11	$79.99
Crew B-82	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$35.33	$53.85
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Horiz. Borer, 6 H.P.		77.60		85.36	4.85	5.34
16 L.H., Daily Totals		$642.80		$946.96	$40.17	$59.19
Crew B-82A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$35.33	$53.85
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Flatbed Trailer, 25 Ton		102.00		112.20		
1 Horiz. Dir. Drill, 20k lb. thrust		628.20		691.02	60.80	66.88
16 L.H., Daily Totals		$1538.00		$1931.68	$96.13	$120.73
Crew B-82B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$34.08	$52.23
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Flatbed Trailer, 25 Ton		102.00		112.20		
1 Horiz. Dir. Drill, 30k lb. thrust		896.60		986.26	51.72	56.89
24 L.H., Daily Totals		$2059.20		$2618.92	$85.80	$109.12
Crew B-82C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$31.60	$505.60	$49.00	$784.00	$34.08	$52.23
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Flatbed Trailer, 25 Ton		102.00		112.20		
1 Horiz. Dir. Drill, 50k lb. thrust		1183.00		1301.30	63.65	70.02
24 L.H., Daily Totals		$2345.60		$2933.96	$97.73	$122.25
Crew B-82D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$39.05	$58.70
1 Mud Trailer for HDD, 1500 gallon		283.20		311.52	35.40	38.94
8 L.H., Daily Totals		$595.60		$781.12	$74.45	$97.64
Crew B-83	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Tugboat Captain	$41.35	$330.80	$62.15	$497.20	$36.48	$55.58
1 Tugboat Hand	31.60	252.80	49.00	392.00		
1 Tugboat, 250 H.P.		663.40		729.74	41.46	45.61
16 L.H., Daily Totals		$1247.00		$1618.94	$77.94	$101.18
Crew B-84	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$41.35	$62.15
1 Rotary Mower/Tractor		273.40		300.74	34.17	37.59
8 L.H., Daily Totals		$604.20		$797.94	$75.53	$99.74

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-85	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$31.60	$758.40	$49.00	$1176.00	$33.62	$51.66
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Aerial Lift Truck, 80'		640.40		704.44		
1 Brush Chipper, 12", 130 H.P.		225.60		248.16		
1 Pruning Saw, Rotary		6.50		7.15	21.81	23.99
40 L.H., Daily Totals		$2217.30		$3026.15	$55.43	$75.65
Crew B-86	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$41.35	$62.15
1 Stump Chipper, S.P.		201.10		221.21	25.14	27.65
8 L.H., Daily Totals		$531.90		$718.41	$66.49	$89.80
Crew B-86A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (medium)	$41.35	$330.80	$62.15	$497.20	$41.35	$62.15
1 Grader, 30,000 Lbs.		550.20		605.22	68.78	75.65
8 L.H., Daily Totals		$881.00		$1102.42	$110.13	$137.80
Crew B-86B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (medium)	$41.35	$330.80	$62.15	$497.20	$41.35	$62.15
1 Dozer, 200 H.P.		1082.00		1190.20	135.25	148.78
8 L.H., Daily Totals		$1412.80		$1687.40	$176.60	$210.93
Crew B-87	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$39.40	$59.52
4 Equip. Oper. (med.)	41.35	1323.20	62.15	1988.80		
2 Feller Bunchers, 100 H.P.		1122.80		1235.08		
1 Log Chipper, 22" Tree		588.40		647.24		
1 Dozer, 105 H.P.		600.60		660.66		
1 Chain Saw, Gas, 36" Long		37.80		41.58	58.74	64.61
40 L.H., Daily Totals		$3925.60		$4965.36	$98.14	$124.13
Crew B-88	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$39.96	$60.27
6 Equip. Oper. (med.)	41.35	1984.80	62.15	2983.20		
2 Feller Bunchers, 100 H.P.		1122.80		1235.08		
1 Log Chipper, 22" Tree		588.40		647.24		
2 Log Skidders, 50 H.P.		1795.20		1974.72		
1 Dozer, 105 H.P.		600.60		660.66		
1 Chain Saw, Gas, 36" Long		37.80		41.58	74.01	81.42
56 L.H., Daily Totals		$6382.40		$7934.48	$113.97	$141.69
Crew B-89	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$35.00	$53.17
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86		
1 Concrete Saw		141.00		155.10		
1 Water Tank, 65 Gal.		18.45		20.30	25.13	27.64
16 L.H., Daily Totals		$962.05		$1293.06	$60.13	$80.82
Crew B-89A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Skilled Worker	$40.85	$326.80	$63.25	$506.00	$36.23	$56.13
1 Laborer	31.60	252.80	49.00	392.00		
1 Core Drill (large)		110.20		121.22	6.89	7.58
16 L.H., Daily Totals		$689.80		$1019.22	$43.11	$63.70

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-89B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$39.05	$312.40	$58.70	$469.60	$35.00	$53.17
1 Truck Driver, Light	30.95	247.60	47.65	381.20		
1 Wall Saw, Hydraulic, 10 H.P.		96.00		105.60		
1 Generator, Diesel, 100 kW		327.20		359.92		
1 Water Tank, 65 Gal.		18.45		20.30		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	42.77	47.04
16 L.H., Daily Totals		$1244.25		$1603.47	$77.77	$100.22
Crew B-90	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.80	$51.85
3 Laborers	31.60	758.40	49.00	1176.00		
2 Equip. Oper. (light)	39.05	624.80	58.70	939.20		
2 Truck Drivers (heavy)	31.95	511.20	49.15	786.40		
1 Road Mixer, 310 H.P.		1896.00		2085.60		
1 Dist. Truck, 2000 Gal.		277.20		304.92	33.96	37.35
64 L.H., Daily Totals		$4336.40		$5708.92	$67.76	$89.20
Crew B-90A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$37.46	$56.96
2 Laborers	31.60	505.60	49.00	784.00		
4 Equip. Oper. (medium)	41.35	1323.20	62.15	1988.80		
2 Graders, 30,000 Lbs.		1100.40		1210.44		
1 Tandem Roller, 10 Ton		233.00		256.30		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58	29.31	32.24
56 L.H., Daily Totals		$3738.80		$4994.92	$66.76	$89.19
Crew B-90B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman	$33.60	$268.80	$52.10	$416.80	$36.81	$56.09
2 Laborers	31.60	505.60	49.00	784.00		
3 Equip. Oper. (medium)	41.35	992.40	62.15	1491.60		
1 Tandem Roller, 10 Ton		233.00		256.30		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58		
1 Road Mixer, 310 H.P.		1896.00		2085.60	50.77	55.84
48 L.H., Daily Totals		$4203.60		$5372.88	$87.58	$111.94
Crew B-91	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$36.77	$55.98
2 Laborers	31.60	505.60	49.00	784.00		
4 Equip. Oper. (med.)	41.35	1323.20	62.15	1988.80		
1 Truck Driver (heavy)	31.95	255.60	49.15	393.20		
1 Dist. Tanker, 3000 Gallon		304.20		334.62		
1 Truck Tractor, 6x4, 380 H.P.		478.80		526.68		
1 Aggreg. Spreader, S.P.		855.20		940.72		
1 Roller, Pneum. Whl, 12 Ton		307.80		338.58		
1 Tandem Roller, 10 Ton		233.00		256.30	34.05	37.45
64 L.H., Daily Totals		$4532.20		$5979.70	$70.82	$93.43
Crew B-92	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.10	$49.77
3 Laborers	31.60	758.40	49.00	1176.00		
1 Crack Cleaner, 25 H.P.		54.80		60.28		
1 Air Compressor, 60 cfm		122.60		134.86		
1 Tar Kettle, T.M.		83.15		91.47		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	15.72	17.30
32 L.H., Daily Totals		$1530.35		$2146.26	$47.82	$67.07
Crew B-93	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (med.)	$41.35	$330.80	$62.15	$497.20	$41.35	$62.15
1 Feller Buncher, 100 H.P.		561.40		617.54	70.17	77.19
8 L.H., Daily Totals		$892.20		$1114.74	$111.53	$139.34

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew B-94A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Diaphragm Water Pump, 2″		63.20		69.52		
1 -20' Suction Hose, 2″		1.95		2.15		
2 -50' Discharge Hoses, 2″		2.20		2.42	8.42	9.26
8 L.H., Daily Totals		$320.15		$466.08	$40.02	$58.26
Crew B-94B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Diaphragm Water Pump, 4″		86.20		94.82		
1 -20' Suction Hose, 4″		3.45		3.79		
2 -50' Discharge Hoses, 4″		4.70		5.17	11.79	12.97
8 L.H., Daily Totals		$347.15		$495.79	$43.39	$61.97
Crew B-94C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Centrifugal Water Pump, 3″		69.40		76.34		
1 -20' Suction Hose, 3″		3.05		3.36		
2 -50' Discharge Hoses, 3″		3.50		3.85	9.49	10.44
8 L.H., Daily Totals		$328.75		$475.55	$41.09	$59.44
Crew B-94D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$31.60	$49.00
1 Centr. Water Pump, 6″		309.40		340.34		
1 -20' Suction Hose, 6″		11.90		13.09		
2 -50' Discharge Hoses, 6″		12.60		13.86	41.74	45.91
8 L.H., Daily Totals		$586.70		$759.29	$73.34	$94.91
Crew C-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Carpenters	$39.95	$958.80	$61.95	$1486.80	$37.86	$58.71
1 Laborer	31.60	252.80	49.00	392.00		
32 L.H., Daily Totals		$1211.60		$1878.80	$37.86	$58.71
Crew C-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$38.89	$60.31
4 Carpenters	39.95	1278.40	61.95	1982.40		
1 Laborer	31.60	252.80	49.00	392.00		
48 L.H., Daily Totals		$1866.80		$2894.80	$38.89	$60.31
Crew C-2A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$38.62	$59.33
3 Carpenters	39.95	958.80	61.95	1486.80		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Laborer	31.60	252.80	49.00	392.00		
48 L.H., Daily Totals		$1853.60		$2847.60	$38.62	$59.33
Crew C-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Rodman Foreman	$46.55	$372.40	$76.10	$608.80	$40.88	$65.53
4 Rodmen (reinf.)	44.55	1425.60	72.85	2331.20		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
2 Laborers	31.60	505.60	49.00	784.00		
3 Stressing Equipment		27.60		30.36		
.5 Grouting Equipment		75.80		83.38	1.62	1.78
64 L.H., Daily Totals		$2719.40		$4307.34	$42.49	$67.30
Crew C-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Rodman Foreman	$46.55	$372.40	$76.10	$608.80	$45.05	$73.66
3 Rodmen (reinf.)	44.55	1069.20	72.85	1748.40		
3 Stressing Equipment		27.60		30.36	.86	.95
32 L.H., Daily Totals		$1469.20		$2387.56	$45.91	$74.61

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew C-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Rodman Foreman	$46.55	$372.40	$76.10	$608.80	$43.44	$69.54
4 Rodmen (reinf.)	44.55	1425.60	72.85	2331.20		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. Crane, 25 Ton		789.40		868.34	14.10	15.51
56 L.H., Daily Totals		$3222.20		$4762.34	$57.54	$85.04
Crew C-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.05	$50.69
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
2 Gas Engine Vibrators		52.00		57.20	1.08	1.19
48 L.H., Daily Totals		$1638.40		$2490.40	$34.13	$51.88
Crew C-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.23	$52.29
5 Laborers	31.60	1264.00	49.00	1960.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Equip. Oper. (oiler)	36.80	294.40	55.30	442.40		
2 Gas Engine Vibrators		52.00		57.20		
1 Concrete Bucket, 1 C.Y.		20.20		22.22		
1 Hyd. Crane, 55 Ton		1125.00		1237.50	16.63	18.29
72 L.H., Daily Totals		$3661.60		$5081.72	$50.86	$70.58
Crew C-7A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$31.94	$49.42
5 Laborers	31.60	1264.00	49.00	1960.00		
2 Truck Drivers (Heavy)	31.95	511.20	49.15	786.40		
2 Conc. Transit Mixers		1772.80		1950.08	27.70	30.47
64 L.H., Daily Totals		$3816.80		$5113.28	$59.64	$79.89
Crew C-7B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.87	$52.04
5 Laborers	31.60	1264.00	49.00	1960.00		
1 Equipment Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equipment Oiler	36.80	294.40	55.30	442.40		
1 Conc. Bucket, 2 C.Y.		32.00		35.20		
1 Lattice Boom Crane, 165 Ton		2240.00		2464.00	35.50	39.05
64 L.H., Daily Totals		$4439.60		$5830.00	$69.37	$91.09
Crew C-7C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.29	$52.67
5 Laborers	31.60	1264.00	49.00	1960.00		
2 Equipment Operators (medium)	41.35	661.60	62.15	994.40		
2 F.E. Loaders, W.M., 4 C.Y.		1082.00		1190.20	16.91	18.60
64 L.H., Daily Totals		$3276.40		$4561.40	$51.19	$71.27
Crew C-7D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.28	$51.32
5 Laborers	31.60	1264.00	49.00	1960.00		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Concrete Conveyer		179.00		196.90	3.20	3.52
56 L.H., Daily Totals		$2042.60		$3070.90	$36.48	$54.84

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew C-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.19	$53.34
3 Laborers	31.60	758.40	49.00	1176.00		
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Concrete Pump (small)		737.80		811.58	13.18	14.49
56 L.H., Daily Totals		$2708.60		$3798.38	$48.37	$67.83
Crew C-8A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.17	$51.87
3 Laborers	31.60	758.40	49.00	1176.00		
2 Cement Finishers	38.30	612.80	56.05	896.80		
48 L.H., Daily Totals		$1640.00		$2489.60	$34.17	$51.87
Crew C-8B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.95	$52.25
3 Laborers	31.60	758.40	49.00	1176.00		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Vibrating Power Screed		70.35		77.39		
1 Roller, Vibratory, 25 Ton		594.60		654.06		
1 Dozer, 200 H.P.		1082.00		1190.20	43.67	48.04
40 L.H., Daily Totals		$3104.95		$4011.65	$77.62	$100.29
Crew C-8C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$34.67	$52.88
3 Laborers	31.60	758.40	49.00	1176.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Shotcrete Rig, 12 C.Y./Hr		237.80		261.58	4.95	5.45
48 L.H., Daily Totals		$1902.20		$2799.98	$39.63	$58.33
Crew C-8D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.64	$53.96
1 Laborer	31.60	252.80	49.00	392.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equipment Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Compressor, 250 cfm		162.40		178.64		
2 -50' Air Hoses, 1"		8.20		9.02	5.33	5.86
32 L.H., Daily Totals		$1311.00		$1914.46	$40.97	$59.83
Crew C-8E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.64	$53.96
1 Laborer	31.60	252.80	49.00	392.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equipment Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Compressor, 250 cfm		162.40		178.64		
2 -50' Air Hoses, 1"		8.20		9.02		
1 Concrete Pump (small)		737.80		811.58	28.39	31.23
32 L.H., Daily Totals		$2048.80		$2726.04	$64.03	$85.19
Crew C-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$36.07	$53.70
2 Cement Finishers	38.30	612.80	56.05	896.80		
24 L.H., Daily Totals		$865.60		$1288.80	$36.07	$53.70
Crew C-10B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$31.60	$758.40	$49.00	$1176.00	$34.28	$51.82
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Concrete Mixer, 10 C.F.		155.20		170.72		
2 Trowels, 48" Walk-Behind		84.80		93.28	6.00	6.60
40 L.H., Daily Totals		$1611.20		$2336.80	$40.28	$58.42

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew C-10C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$36.07	$53.70
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Trowel, 48" Walk-Behind		42.40		46.64	1.77	1.94
24 L.H., Daily Totals		$908.00		$1335.44	$37.83	$55.64
Crew C-10D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$36.07	$53.70
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Vibrating Power Screed		70.35		77.39		
1 Trowel, 48" Walk-Behind		42.40		46.64	4.70	5.17
24 L.H., Daily Totals		$978.35		$1412.83	$40.76	$58.87
Crew C-10E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$31.60	$252.80	$49.00	$392.00	$36.07	$53.70
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Vibrating Power Screed		70.35		77.39		
1 Cement Trowel, 96" Ride-On		166.60		183.26	9.87	10.86
24 L.H., Daily Totals		$1102.55		$1549.44	$45.94	$64.56
Crew C-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$43.81	$75.59
6 Struc. Steel Workers	44.70	2145.60	79.65	3823.20		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Lattice Boom Crane, 150 Ton		1890.00		2079.00	26.25	28.88
72 L.H., Daily Totals		$5044.00		$7521.80	$70.06	$104.47
Crew C-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$39.33	$60.64
3 Carpenters	39.95	958.80	61.95	1486.80		
1 Laborer	31.60	252.80	49.00	392.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 12 Ton		768.80		845.68	16.02	17.62
48 L.H., Daily Totals		$2656.40		$3756.48	$55.34	$78.26
Crew C-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Worker	$44.70	$357.60	$79.65	$637.20	$43.12	$73.75
1 Welder	44.70	357.60	79.65	637.20		
1 Carpenter	39.95	319.60	61.95	495.60		
1 Welder, gas engine, 300 amp		134.20		147.62	5.59	6.15
24 L.H., Daily Totals		$1169.00		$1917.62	$48.71	$79.90
Crew C-14	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$39.01	$60.75
5 Carpenters	39.95	1598.00	61.95	2478.00		
4 Laborers	31.60	1011.20	49.00	1568.00		
4 Rodmen (reinf.)	44.55	1425.60	72.85	2331.20		
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. Crane, 80 Ton		1296.00		1425.60	9.00	9.90
144 L.H., Daily Totals		$6914.00		$10174.00	$48.01	$70.65

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew C-14A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$40.09	$62.55
16 Carpenters	39.95	5113.60	61.95	7929.60		
4 Rodmen (reinf.)	44.55	1425.60	72.85	2331.20		
2 Laborers	31.60	505.60	49.00	784.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Gas Engine Vibrator		26.00		28.60		
1 Concrete Pump (small)		737.80		811.58	3.82	4.20
200 L.H., Daily Totals		$8781.40		$13350.98	$43.91	$66.75
Crew C-14B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$40.02	$62.30
16 Carpenters	39.95	5113.60	61.95	7929.60		
4 Rodmen (reinf.)	44.55	1425.60	72.85	2331.20		
2 Laborers	31.60	505.60	49.00	784.00		
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Gas Engine Vibrator		26.00		28.60		
1 Concrete Pump (small)		737.80		811.58	3.67	4.04
208 L.H., Daily Totals		$9087.80		$13799.38	$43.69	$66.34
Crew C-14C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$38.25	$59.61
6 Carpenters	39.95	1917.60	61.95	2973.60		
2 Rodmen (reinf.)	44.55	712.80	72.85	1165.60		
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Gas Engine Vibrator		26.00		28.60	.23	.26
112 L.H., Daily Totals		$4309.60		$6704.60	$38.48	$59.86
Crew C-14D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$39.72	$61.68
18 Carpenters	39.95	5752.80	61.95	8920.80		
2 Rodmen (reinf.)	44.55	712.80	72.85	1165.60		
2 Laborers	31.60	505.60	49.00	784.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Gas Engine Vibrator		26.00		28.60		
1 Concrete Pump (small)		737.80		811.58	3.82	4.20
200 L.H., Daily Totals		$8707.80		$13176.58	$43.54	$65.88
Crew C-14E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$39.38	$62.13
2 Carpenters	39.95	639.20	61.95	991.20		
4 Rodmen (reinf.)	44.55	1425.60	72.85	2331.20		
3 Laborers	31.60	758.40	49.00	1176.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Gas Engine Vibrator		26.00		28.60	.30	.33
88 L.H., Daily Totals		$3491.20		$5495.80	$39.67	$62.45
Crew C-14F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman (out)	$33.60	$268.80	$52.10	$416.80	$36.29	$54.04
2 Laborers	31.60	505.60	49.00	784.00		
6 Cement Finishers	38.30	1838.40	56.05	2690.40		
1 Gas Engine Vibrator		26.00		28.60	.36	.40
72 L.H., Daily Totals		$2638.80		$3919.80	$36.65	$54.44

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew C-14G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer Foreman (out)	$33.60	$268.80	$52.10	$416.80	$35.71	$53.47
2 Laborers	31.60	505.60	49.00	784.00		
4 Cement Finishers	38.30	1225.60	56.05	1793.60		
1 Gas Engine Vibrator		26.00		28.60	.46	.51
56 L.H., Daily Totals		$2026.00		$3023.00	$36.18	$53.98
Crew C-14H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$39.38	$61.14
2 Carpenters	39.95	639.20	61.95	991.20		
1 Rodman (reinf.)	44.55	356.40	72.85	582.80		
1 Laborer	31.60	252.80	49.00	392.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Gas Engine Vibrator		26.00		28.60	.54	.60
48 L.H., Daily Totals		$1916.40		$2963.40	$39.92	$61.74
Crew C-14L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$37.20	$57.40
6 Carpenters	39.95	1917.60	61.95	2973.60		
4 Laborers	31.60	1011.20	49.00	1568.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Gas Engine Vibrator		26.00		28.60	.27	.30
96 L.H., Daily Totals		$3596.80		$5539.00	$37.47	$57.70
Crew C-15	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (out)	$41.95	$335.60	$65.05	$520.40	$37.53	$57.88
2 Carpenters	39.95	639.20	61.95	991.20		
3 Laborers	31.60	758.40	49.00	1176.00		
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Rodman (reinf.)	44.55	356.40	72.85	582.80		
72 L.H., Daily Totals		$2702.40		$4167.20	$37.53	$57.88
Crew C-16	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$37.27	$57.67
3 Laborers	31.60	758.40	49.00	1176.00		
2 Cement Finishers	38.30	612.80	56.05	896.80		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
2 Rodmen (reinf.)	44.55	712.80	72.85	1165.60		
1 Concrete Pump (small)		737.80		811.58	10.25	11.27
72 L.H., Daily Totals		$3421.40		$4963.98	$47.52	$68.94
Crew C-17	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.25	$63.87
8 Skilled Workers	40.85	2614.40	63.25	4048.00		
80 L.H., Daily Totals		$3300.00		$5109.60	$41.25	$63.87
Crew C-17A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.27	$63.87
8 Skilled Workers	40.85	2614.40	63.25	4048.00		
.125 Equip. Oper. (crane)	42.55	42.55	63.95	63.95		
.125 Hyd. Crane, 80 Ton		162.00		178.20	2.00	2.20
81 L.H., Daily Totals		$3504.55		$5351.75	$43.27	$66.07
Crew C-17B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.28	$63.87
8 Skilled Workers	40.85	2614.40	63.25	4048.00		
.25 Equip. Oper. (crane)	42.55	85.10	63.95	127.90		
.25 Hyd. Crane, 80 Ton		324.00		356.40		
.25 Trowel, 48" Walk-Behind		10.60		11.66	4.08	4.49
82 L.H., Daily Totals		$3719.70		$5605.56	$45.36	$68.36

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew C-17C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.30	$63.87
8 Skilled Workers	40.85	2614.40	63.25	4048.00		
.375 Equip. Oper. (crane)	42.55	127.65	63.95	191.85		
.375 Hyd. Crane, 80 Ton		486.00		534.60	5.86	6.44
83 L.H., Daily Totals		$3913.65		$5836.05	$47.15	$70.31
Crew C-17D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.31	$63.87
8 Skilled Workers	40.85	2614.40	63.25	4048.00		
.5 Equip. Oper. (crane)	42.55	170.20	63.95	255.80		
.5 Hyd. Crane, 80 Ton		648.00		712.80	7.71	8.49
84 L.H., Daily Totals		$4118.20		$6078.20	$49.03	$72.36
Crew C-17E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.25	$63.87
8 Skilled Workers	40.85	2614.40	63.25	4048.00		
1 Hyd. Jack with Rods		85.70		94.27	1.07	1.18
80 L.H., Daily Totals		$3385.70		$5203.87	$42.32	$65.05
Crew C-18	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.125 Labor Foreman (out)	$33.60	$33.60	$52.10	$52.10	$31.82	$49.34
1 Laborer	31.60	252.80	49.00	392.00		
1 Concrete Cart, 10 C.F.		55.20		60.72	6.13	6.75
9 L.H., Daily Totals		$341.60		$504.82	$37.96	$56.09
Crew C-19	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.125 Labor Foreman (out)	$33.60	$33.60	$52.10	$52.10	$31.82	$49.34
1 Laborer	31.60	252.80	49.00	392.00		
1 Concrete Cart, 18 C.F.		86.40		95.04	9.60	10.56
9 L.H., Daily Totals		$372.80		$539.14	$41.42	$59.90
Crew C-20	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.91	$51.91
5 Laborers	31.60	1264.00	49.00	1960.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
2 Gas Engine Vibrators		52.00		57.20		
1 Concrete Pump (small)		737.80		811.58	12.34	13.57
64 L.H., Daily Totals		$2959.80		$4191.18	$46.25	$65.49
Crew C-21	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$33.91	$51.91
5 Laborers	31.60	1264.00	49.00	1960.00		
1 Cement Finisher	38.30	306.40	56.05	448.40		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
2 Gas Engine Vibrators		52.00		57.20		
1 Concrete Conveyer		179.00		196.90	3.61	3.97
64 L.H., Daily Totals		$2401.00		$3576.50	$37.52	$55.88
Crew C-22	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Rodman Foreman	$46.55	$372.40	$76.10	$608.80	$44.70	$72.84
4 Rodmen (reinf.)	44.55	1425.60	72.85	2331.20		
.125 Equip. Oper. (crane)	42.55	42.55	63.95	63.95		
.125 Equip. Oper. Oiler	36.80	36.80	55.30	55.30		
.125 Hyd. Crane, 25 Ton		98.67		108.54	2.35	2.58
42 L.H., Daily Totals		$1976.03		$3167.79	$47.05	$75.42

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew C-23	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.02	$63.15
6 Skilled Workers	40.85	1960.80	63.25	3036.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10	21.76	23.94
80 L.H., Daily Totals		$5022.20		$6966.70	$62.78	$87.08
Crew C-23A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$35.23	$53.87
2 Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Crawler Crane, 100 Ton		1611.00		1772.10		
3 Conc. Buckets, 8 C.Y.		603.00		663.30	55.35	60.88
40 L.H., Daily Totals		$3623.20		$4590.20	$90.58	$114.76
Crew C-24	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Worker Foremen	$42.85	$685.60	$66.35	$1061.60	$41.02	$63.15
6 Skilled Workers	40.85	1960.80	63.25	3036.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Lattice Boom Crane, 150 Ton		1890.00		2079.00	23.63	25.99
80 L.H., Daily Totals		$5171.20		$7130.60	$64.64	$89.13
Crew C-25	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Rodmen (reinf.)	$44.55	$712.80	$72.85	$1165.60	$34.95	$57.77
2 Rodmen Helpers	25.35	405.60	42.70	683.20		
32 L.H., Daily Totals		$1118.40		$1848.80	$34.95	$57.77
Crew C-27	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Cement Finishers	$38.30	$612.80	$56.05	$896.80	$38.30	$56.05
1 Concrete Saw		141.00		155.10	8.81	9.69
16 L.H., Daily Totals		$753.80		$1051.90	$47.11	$65.74
Crew C-28	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Cement Finisher	$38.30	$306.40	$56.05	$448.40	$38.30	$56.05
1 Portable Air Compressor, Gas		19.10		21.01	2.39	2.63
8 L.H., Daily Totals		$325.50		$469.41	$40.69	$58.68
Crew D-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Bricklayer	$40.50	$324.00	$61.45	$491.60	$36.33	$55.10
1 Bricklayer Helper	32.15	257.20	48.75	390.00		
16 L.H., Daily Totals		$581.20		$881.60	$36.33	$55.10
Crew D-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Bricklayers	$40.50	$972.00	$61.45	$1474.80	$37.41	$56.88
2 Bricklayer Helpers	32.15	514.40	48.75	780.00		
.5 Carpenter	39.95	159.80	61.95	247.80		
44 L.H., Daily Totals		$1646.20		$2502.60	$37.41	$56.88
Crew D-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Bricklayers	$40.50	$972.00	$61.45	$1474.80	$37.29	$56.64
2 Bricklayer Helpers	32.15	514.40	48.75	780.00		
.25 Carpenter	39.95	79.90	61.95	123.90		
42 L.H., Daily Totals		$1566.30		$2378.70	$37.29	$56.64

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew D-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Bricklayer	$40.50	$324.00	$61.45	$491.60	$35.96	$54.41
2 Bricklayer Helpers	32.15	514.40	48.75	780.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Grout Pump, 50 C.F./Hr.		126.80		139.48	3.96	4.36
32 L.H., Daily Totals		$1277.60		$1880.68	$39.92	$58.77
Crew D-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Bricklayer	$40.50	$324.00	$61.45	$491.60	$40.50	$61.45
8 L.H., Daily Totals		$324.00		$491.60	$40.50	$61.45
Crew D-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Bricklayers	$40.50	$972.00	$61.45	$1474.80	$36.47	$55.37
3 Bricklayer Helpers	32.15	771.60	48.75	1170.00		
.25 Carpenter	39.95	79.90	61.95	123.90		
50 L.H., Daily Totals		$1823.50		$2768.70	$36.47	$55.37
Crew D-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Tile Layer	$38.10	$304.80	$55.80	$446.40	$34.08	$49.90
1 Tile Layer Helper	30.05	240.40	44.00	352.00		
16 L.H., Daily Totals		$545.20		$798.40	$34.08	$49.90
Crew D-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Bricklayers	$40.50	$972.00	$61.45	$1474.80	$37.16	$56.37
2 Bricklayer Helpers	32.15	514.40	48.75	780.00		
40 L.H., Daily Totals		$1486.40		$2254.80	$37.16	$56.37
Crew D-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Bricklayers	$40.50	$972.00	$61.45	$1474.80	$36.33	$55.10
3 Bricklayer Helpers	32.15	771.60	48.75	1170.00		
48 L.H., Daily Totals		$1743.60		$2644.80	$36.33	$55.10
Crew D-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Bricklayer Foreman	$42.50	$340.00	$64.45	$515.60	$39.42	$59.65
1 Bricklayer	40.50	324.00	61.45	491.60		
1 Bricklayer Helper	32.15	257.20	48.75	390.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 S.P. Crane, 4x4, 12 Ton		601.80		661.98	18.81	20.69
32 L.H., Daily Totals		$1863.40		$2570.78	$58.23	$80.34
Crew D-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Bricklayer Foreman	$42.50	$340.00	$64.45	$515.60	$38.38	$58.22
1 Bricklayer	40.50	324.00	61.45	491.60		
1 Bricklayer Helper	32.15	257.20	48.75	390.00		
24 L.H., Daily Totals		$921.20		$1397.20	$38.38	$58.22
Crew D-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Bricklayer Foreman	$42.50	$340.00	$64.45	$515.60	$36.83	$55.85
1 Bricklayer	40.50	324.00	61.45	491.60		
2 Bricklayer Helpers	32.15	514.40	48.75	780.00		
32 L.H., Daily Totals		$1178.40		$1787.20	$36.83	$55.85
Crew D-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Bricklayer Foreman	$42.50	$340.00	$64.45	$515.60	$38.30	$58.22
1 Bricklayer	40.50	324.00	61.45	491.60		
2 Bricklayer Helpers	32.15	514.40	48.75	780.00		
1 Carpenter	39.95	319.60	61.95	495.60		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 S.P. Crane, 4x4, 12 Ton		601.80		661.98	12.54	13.79
48 L.H., Daily Totals		$2440.20		$3456.38	$50.84	$72.01

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew E-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Welder Foreman	$46.70	$373.60	$83.20	$665.60	$43.48	$73.85
1 Welder	44.70	357.60	79.65	637.20		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Welder, gas engine, 300 amp		134.20		147.62	5.59	6.15
24 L.H., Daily Totals		$1177.80		$1920.02	$49.08	$80.00
Crew E-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$43.55	$74.44
4 Struc. Steel Workers	44.70	1430.40	79.65	2548.80		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10	31.09	34.20
56 L.H., Daily Totals		$4179.80		$6083.50	$74.64	$108.63
Crew E-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$45.37	$80.83
1 Struc. Steel Worker	44.70	357.60	79.65	637.20		
1 Welder	44.70	357.60	79.65	637.20		
1 Welder, gas engine, 300 amp		134.20		147.62	5.59	6.15
24 L.H., Daily Totals		$1223.00		$2087.62	$50.96	$86.98
Crew E-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$45.20	$80.54
3 Struc. Steel Workers	44.70	1072.80	79.65	1911.60		
1 Welder, gas engine, 300 amp		134.20		147.62	4.19	4.61
32 L.H., Daily Totals		$1580.60		$2724.82	$49.39	$85.15
Crew E-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Struc. Steel Foremen	$46.70	$747.20	$83.20	$1331.20	$44.09	$76.36
5 Struc. Steel Workers	44.70	1788.00	79.65	3186.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Welder	44.70	357.60	79.65	637.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10		
1 Welder, gas engine, 300 amp		134.20		147.62	23.44	25.78
80 L.H., Daily Totals		$5402.80		$8171.12	$67.53	$102.14
Crew E-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Struc. Steel Foremen	$46.70	$1120.80	$83.20	$1996.80	$44.09	$76.50
9 Struc. Steel Workers	44.70	3218.40	79.65	5734.80		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Welder	44.70	357.60	79.65	637.20		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10		
1 Welder, gas engine, 300 amp		134.20		147.62		
1 Air Compressor, 160 cfm		138.80		152.68		
2 Impact Wrenches		32.40		35.64	15.99	17.59
128 L.H., Daily Totals		$7690.40		$12043.44	$60.08	$94.09
Crew E-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$44.09	$76.36
4 Struc. Steel Workers	44.70	1430.40	79.65	2548.80		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Welder Foreman	46.70	373.60	83.20	665.60		
2 Welders	44.70	715.20	79.65	1274.40		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10		
2 Welders, gas engine, 300 amp		268.40		295.24	25.12	27.63
80 L.H., Daily Totals		$5537.00		$8318.74	$69.21	$103.98

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew E-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$43.80	$75.50
4 Struc. Steel Workers	44.70	1430.40	79.65	2548.80		
1 Welder Foreman	46.70	373.60	83.20	665.60		
4 Welders	44.70	1430.40	79.65	2548.80		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10		
4 Welders, gas engine, 300 amp		536.80		590.48	21.90	24.09
104 L.H., Daily Totals		$6833.00		$10357.98	$65.70	$99.60
Crew E-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Struc. Steel Foremen	$46.70	$747.20	$83.20	$1331.20	$44.09	$76.50
5 Struc. Steel Workers	44.70	1788.00	79.65	3186.00		
1 Welder Foreman	46.70	373.60	83.20	665.60		
5 Welders	44.70	1788.00	79.65	3186.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Lattice Boom Crane, 90 Ton		1741.00		1915.10		
5 Welders, gas engine, 300 amp		671.00		738.10	18.84	20.73
128 L.H., Daily Totals		$8056.00		$12445.60	$62.94	$97.23
Crew E-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Welder Foreman	$46.70	$373.60	$83.20	$665.60	$45.70	$81.42
1 Welder	44.70	357.60	79.65	637.20		
1 Welder, gas engine, 300 amp		134.20		147.62		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	23.55	25.91
16 L.H., Daily Totals		$1108.00		$1717.28	$69.25	$107.33
Crew E-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Painters, Struc. Steel	$36.00	$576.00	$65.35	$1045.60	$35.66	$59.60
1 Building Laborer	31.60	252.80	49.00	392.00		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Air Compressor, 250 cfm		162.40		178.64		
1 Sandblaster, portable, 3 C.F.		20.60		22.66		
1 Set Sand Blasting Accessories		12.75		14.03	6.12	6.73
32 L.H., Daily Totals		$1336.95		$2122.53	$41.78	$66.33
Crew E-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Welder Foreman	$46.70	$373.60	$83.20	$665.60	$42.88	$70.95
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Welder, gas engine, 300 amp		134.20		147.62	8.39	9.23
16 L.H., Daily Totals		$820.20		$1282.82	$51.26	$80.18
Crew E-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Welder Foreman	$46.70	$373.60	$83.20	$665.60	$44.15	$75.03
.5 Equip. Oper. (light)	39.05	156.20	58.70	234.80		
1 Welder, gas engine, 300 amp		134.20		147.62	11.18	12.30
12 L.H., Daily Totals		$664.00		$1048.02	$55.33	$87.33
Crew E-14	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Welder Foreman	$46.70	$373.60	$83.20	$665.60	$46.70	$83.20
1 Welder, gas engine, 300 amp		134.20		147.62	16.77	18.45
8 L.H., Daily Totals		$507.80		$813.22	$63.48	$101.65
Crew E-16	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Welder Foreman	$46.70	$373.60	$83.20	$665.60	$45.70	$81.42
1 Welder	44.70	357.60	79.65	637.20		
1 Welder, gas engine, 300 amp		134.20		147.62	8.39	9.23
16 L.H., Daily Totals		$865.40		$1450.42	$54.09	$90.65

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew E-17	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Structural Steel Foreman	$46.70	$373.60	$83.20	$665.60	$45.70	$81.42
1 Structural Steel Worker	44.70	357.60	79.65	637.20		
16 L.H., Daily Totals		$731.20		$1302.80	$45.70	$81.42
Crew E-18	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Structural Steel Foreman	$46.70	$373.60	$83.20	$665.60	$44.43	$76.86
3 Structural Steel Workers	44.70	1072.80	79.65	1911.60		
1 Equipment Operator (med.)	41.35	330.80	62.15	497.20		
1 Lattice Boom Crane, 20 Ton		1080.00		1188.00	27.00	29.70
40 L.H., Daily Totals		$2857.20		$4262.40	$71.43	$106.56
Crew E-19	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Structural Steel Worker	$44.70	$357.60	$79.65	$637.20	$43.48	$73.85
1 Structural Steel Foreman	46.70	373.60	83.20	665.60		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Lattice Boom Crane, 20 Ton		1080.00		1188.00	45.00	49.50
24 L.H., Daily Totals		$2123.60		$2960.40	$88.48	$123.35
Crew E-20	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Structural Steel Foreman	$46.70	$373.60	$83.20	$665.60	$43.69	$75.09
5 Structural Steel Workers	44.70	1788.00	79.65	3186.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Oiler	36.80	294.40	55.30	442.40		
1 Lattice Boom Crane, 40 Ton		1327.00		1459.70	20.73	22.81
64 L.H., Daily Totals		$4123.40		$6265.30	$64.43	$97.90
Crew E-22	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Skilled Worker Foreman	$42.85	$342.80	$66.35	$530.80	$41.52	$64.28
2 Skilled Workers	40.85	653.60	63.25	1012.00		
24 L.H., Daily Totals		$996.40		$1542.80	$41.52	$64.28
Crew E-24	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Structural Steel Workers	$44.70	$1072.80	$79.65	$1911.60	$43.86	$75.28
1 Equipment Operator (medium)	41.35	330.80	62.15	497.20		
1 Hyd. Crane, 25 Ton		789.40		868.34	24.67	27.14
32 L.H., Daily Totals		$2193.00		$3277.14	$68.53	$102.41
Crew E-25	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Welder Foreman	$46.70	$373.60	$83.20	$665.60	$46.70	$83.20
1 Cutting Torch		17.00		18.70		
1 Gases		75.60		83.16	11.57	12.73
8 L.H., Daily Totals		$466.20		$767.46	$58.27	$95.93
Crew F-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
4 Carpenters	$39.95	$1278.40	$61.95	$1982.40	$40.47	$62.35
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 12 Ton		768.80		845.68	19.22	21.14
40 L.H., Daily Totals		$2387.60		$3339.68	$59.69	$83.49
Crew F-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
4 Carpenters	$39.95	$1278.40	$61.95	$1982.40	$39.86	$61.17
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. Crane, 55 Ton		1125.00		1237.50	23.44	25.78
48 L.H., Daily Totals		$3038.20		$4173.90	$63.30	$86.96
Crew F-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman	$41.95	$335.60	$65.05	$520.40	$40.45	$62.73
3 Carpenters	39.95	958.80	61.95	1486.80		
32 L.H., Daily Totals		$1294.40		$2007.20	$40.45	$62.73

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew F-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$39.95	$639.20	$61.95	$991.20	$37.13	$57.17
2 Building Laborers	31.60	505.60	49.00	784.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 12 Ton		768.80		845.68	19.22	21.14
40 L.H., Daily Totals		$2254.00		$3132.48	$56.35	$78.31
Crew F-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$39.95	$639.20	$61.95	$991.20	$35.77	$55.48
2 Building Laborers	31.60	505.60	49.00	784.00		
32 L.H., Daily Totals		$1144.80		$1775.20	$35.77	$55.48
Crew G-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Roofer Foreman	$36.25	$290.00	$61.10	$488.80	$31.99	$53.90
4 Roofers, Composition	34.25	1096.00	57.70	1846.40		
2 Roofer Helpers	25.35	405.60	42.70	683.20		
1 Application Equipment		173.20		190.52		
1 Tar Kettle/Pot		97.20		106.92		
1 Crew Truck		169.60		186.56	7.86	8.64
56 L.H., Daily Totals		$2231.60		$3502.40	$39.85	$62.54
Crew G-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plasterer	$36.15	$289.20	$54.55	$436.40	$33.35	$50.77
1 Plasterer Helper	32.30	258.40	48.75	390.00		
1 Building Laborer	31.60	252.80	49.00	392.00		
1 Grout Pump, 50 C.F./Hr.		126.80		139.48	5.28	5.81
24 L.H., Daily Totals		$927.20		$1357.88	$38.63	$56.58
Crew G-2A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Roofer, composition	$34.25	$274.00	$57.70	$461.60	$30.40	$49.80
1 Roofer Helper	25.35	202.80	42.70	341.60		
1 Building Laborer	31.60	252.80	49.00	392.00		
1 Foam spray rig, trailer-mtd.		488.20		537.02		
1 Pickup Truck, 3/4 Ton		116.80		128.48	25.21	27.73
24 L.H., Daily Totals		$1334.60		$1860.70	$55.61	$77.53
Crew G-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Sheet Metal Workers	$47.20	$755.20	$72.65	$1162.40	$39.40	$60.83
2 Building Laborers	31.60	505.60	49.00	784.00		
32 L.H., Daily Totals		$1260.80		$1946.40	$39.40	$60.83
Crew G-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$33.60	$268.80	$52.10	$416.80	$32.27	$50.03
2 Building Laborers	31.60	505.60	49.00	784.00		
1 Flatbed Truck, Gas, 1.5 Ton		194.40		213.84		
1 Air Compressor, 160 cfm		138.80		152.68	13.88	15.27
24 L.H., Daily Totals		$1107.60		$1567.32	$46.15	$65.31
Crew G-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Roofer Foreman	$36.25	$290.00	$61.10	$488.80	$31.09	$52.38
2 Roofers, Composition	34.25	548.00	57.70	923.20		
2 Roofer Helpers	25.35	405.60	42.70	683.20		
1 Application Equipment		173.20		190.52	4.33	4.76
40 L.H., Daily Totals		$1416.80		$2285.72	$35.42	$57.14
Crew G-6A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Roofers Composition	$34.25	$548.00	$57.70	$923.20	$34.25	$57.70
1 Small Compressor, Electric		11.35		12.48		
2 Pneumatic Nailers		43.20		47.52	3.41	3.75
16 L.H., Daily Totals		$602.55		$983.21	$37.66	$61.45

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew G-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter	$39.95	$319.60	$61.95	$495.60	$39.95	$61.95
1 Small Compressor, Electric		11.35		12.48		
1 Pneumatic Nailer		21.60		23.76	4.12	4.53
8 L.H., Daily Totals		$352.55		$531.85	$44.07	$66.48
Crew H-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Glaziers	$38.60	$617.60	$58.35	$933.60	$41.65	$69.00
2 Struc. Steel Workers	44.70	715.20	79.65	1274.40		
32 L.H., Daily Totals		$1332.80		$2208.00	$41.65	$69.00
Crew H-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Glaziers	$38.60	$617.60	$58.35	$933.60	$36.27	$55.23
1 Building Laborer	31.60	252.80	49.00	392.00		
24 L.H., Daily Totals		$870.40		$1325.60	$36.27	$55.23
Crew H-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Glazier	$38.60	$308.80	$58.35	$466.80	$34.45	$52.58
1 Helper	30.30	242.40	46.80	374.40		
16 L.H., Daily Totals		$551.20		$841.20	$34.45	$52.58
Crew J-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Plasterers	$36.15	$867.60	$54.55	$1309.20	$34.61	$52.23
2 Plasterer Helpers	32.30	516.80	48.75	780.00		
1 Mixing Machine, 6 C.F.		126.60		139.26	3.17	3.48
40 L.H., Daily Totals		$1511.00		$2228.46	$37.77	$55.71
Crew J-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Plasterers	$36.15	$867.60	$54.55	$1309.20	$34.77	$52.29
2 Plasterer Helpers	32.30	516.80	48.75	780.00		
1 Lather	35.55	284.40	52.60	420.80		
1 Mixing Machine, 6 C.F.		126.60		139.26	2.64	2.90
48 L.H., Daily Totals		$1795.40		$2649.26	$37.40	$55.19
Crew J-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Terrazzo Worker	$37.70	$301.60	$55.20	$441.60	$34.27	$50.17
1 Terrazzo Helper	30.85	246.80	45.15	361.20		
1 Terrazzo Grinder, Electric		81.60		89.76		
1 Terrazzo Mixer		171.60		188.76	15.82	17.41
16 L.H., Daily Totals		$801.60		$1081.32	$50.10	$67.58
Crew K-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter	$39.95	$319.60	$61.95	$495.60	$35.45	$54.80
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	15.16	16.68
16 L.H., Daily Totals		$809.80		$1143.66	$50.61	$71.48
Crew K-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$40.78	$70.17
1 Struc. Steel Worker	44.70	357.60	79.65	637.20		
1 Truck Driver (light)	30.95	247.60	47.65	381.20		
1 Flatbed Truck, Gas, 3 Ton		242.60		266.86	10.11	11.12
24 L.H., Daily Totals		$1221.40		$1950.86	$50.89	$81.29
Crew L-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician	$47.00	$376.00	$69.95	$559.60	$47.88	$71.55
1 Plumber	48.75	390.00	73.15	585.20		
16 L.H., Daily Totals		$766.00		$1144.80	$47.88	$71.55

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew L-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter	$39.95	$319.60	$61.95	$495.60	$35.13	$54.38
1 Carpenter Helper	30.30	242.40	46.80	374.40		
16 L.H., Daily Totals		$562.00		$870.00	$35.13	$54.38
Crew L-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter	$39.95	$319.60	$61.95	$495.60	$43.52	$66.63
.5 Electrician	47.00	188.00	69.95	279.80		
.5 Sheet Metal Worker	47.20	188.80	72.65	290.60		
16 L.H., Daily Totals		$696.40		$1066.00	$43.52	$66.63
Crew L-3A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$41.95	$335.60	$65.05	$520.40	$43.70	$67.58
.5 Sheet Metal Worker	47.20	188.80	72.65	290.60		
12 L.H., Daily Totals		$524.40		$811.00	$43.70	$67.58
Crew L-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Workers	$40.85	$653.60	$63.25	$1012.00	$37.33	$57.77
1 Helper	30.30	242.40	46.80	374.40		
24 L.H., Daily Totals		$896.00		$1386.40	$37.33	$57.77
Crew L-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$44.68	$77.91
5 Struc. Steel Workers	44.70	1788.00	79.65	3186.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 25 Ton		789.40		868.34	14.10	15.51
56 L.H., Daily Totals		$3291.40		$5231.54	$58.77	$93.42
Crew L-5A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Structural Steel Foreman	$46.70	$373.60	$83.20	$665.60	$44.66	$76.61
2 Structural Steel Workers	44.70	715.20	79.65	1274.40		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 S.P. Crane, 4x4, 25 Ton		716.80		788.48	22.40	24.64
32 L.H., Daily Totals		$2146.00		$3240.08	$67.06	$101.25
Crew L-5B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Structural Steel Foreman	$46.70	$373.60	$83.20	$665.60	$45.35	$72.19
2 Structural Steel Workers	44.70	715.20	79.65	1274.40		
2 Electricians	47.00	752.00	69.95	1119.20		
2 Steamfitters/Pipefitters	49.35	789.60	74.05	1184.80		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. Oiler	36.80	294.40	55.30	442.40		
1 Hyd. Crane, 80 Ton		1296.00		1425.60	18.00	19.80
72 L.H., Daily Totals		$4561.20		$6623.60	$63.35	$91.99
Crew L-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber	$48.75	$390.00	$73.15	$585.20	$48.17	$72.08
.5 Electrician	47.00	188.00	69.95	279.80		
12 L.H., Daily Totals		$578.00		$865.00	$48.17	$72.08
Crew L-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$39.95	$639.20	$61.95	$991.20	$38.57	$59.39
1 Building Laborer	31.60	252.80	49.00	392.00		
.5 Electrician	47.00	188.00	69.95	279.80		
28 L.H., Daily Totals		$1080.00		$1663.00	$38.57	$59.39
Crew L-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$39.95	$639.20	$61.95	$991.20	$41.71	$64.19
.5 Plumber	48.75	195.00	73.15	292.60		
20 L.H., Daily Totals		$834.20		$1283.80	$41.71	$64.19

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew L-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (inside)	$32.10	$256.80	$49.80	$398.40	$36.33	$58.32
2 Building Laborers	31.60	505.60	49.00	784.00		
1 Struc. Steel Worker	44.70	357.60	79.65	637.20		
.5 Electrician	47.00	188.00	69.95	279.80		
36 L.H., Daily Totals		$1308.00		$2099.40	$36.33	$58.32
Crew L-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Structural Steel Foreman	$46.70	$373.60	$83.20	$665.60	$44.65	$75.60
1 Structural Steel Worker	44.70	357.60	79.65	637.20		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 12 Ton		768.80		845.68	32.03	35.24
24 L.H., Daily Totals		$1840.40		$2660.08	$76.68	$110.84
Crew L-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Wreckers	$31.60	$505.60	$54.15	$866.40	$36.20	$57.74
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Equip. Oper. (light)	39.05	312.40	58.70	469.60		
1 Hyd. Excavator, 2.5 C.Y.		1619.00		1780.90		
1 Loader, Skid Steer, 78 H.P.		259.60		285.56	58.71	64.58
32 L.H., Daily Totals		$3037.00		$3914.06	$94.91	$122.31
Crew M-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Elevator Constructors	$56.60	$1358.40	$84.30	$2023.20	$53.77	$80.09
1 Elevator Apprentice	45.30	362.40	67.45	539.60		
5 Hand Tools		57.00		62.70	1.78	1.96
32 L.H., Daily Totals		$1777.80		$2625.50	$55.56	$82.05
Crew M-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman (out)	$49.00	$392.00	$72.90	$583.20	$45.37	$68.04
1 Common Laborer	31.60	252.80	49.00	392.00		
.25 Equipment Operator, Medium	41.35	82.70	62.15	124.30		
1 Elevator Constructor	56.60	452.80	84.30	674.40		
1 Elevator Apprentice	45.30	362.40	67.45	539.60		
.25 S.P. Crane, 4x4, 20 Ton		175.15		192.66	5.15	5.67
34 L.H., Daily Totals		$1717.85		$2506.17	$50.52	$73.71
Crew M-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman (out)	$49.00	$392.00	$72.90	$583.20	$44.96	$67.44
1 Common Laborer	31.60	252.80	49.00	392.00		
.25 Equipment Operator, Crane	42.55	85.10	63.95	127.90		
.25 Equipment Operator, Oiler	36.80	73.60	55.30	110.60		
1 Elevator Constructor	56.60	452.80	84.30	674.40		
1 Elevator Apprentice	45.30	362.40	67.45	539.60		
.25 S.P. Crane, 4x4, 40 Ton		234.30		257.73	6.51	7.16
36 L.H., Daily Totals		$1853.00		$2685.43	$51.47	$74.60
Crew Q-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber	$48.75	$390.00	$73.15	$585.20	$43.88	$65.85
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
16 L.H., Daily Totals		$702.00		$1053.60	$43.88	$65.85
Crew Q-1A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.25 Plumber Foreman (out)	$50.75	$101.50	$76.20	$152.40	$49.15	$73.76
1 Plumber	48.75	390.00	73.15	585.20		
10 L.H., Daily Totals		$491.50		$737.60	$49.15	$73.76

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew Q-1C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber	$48.75	$390.00	$73.15	$585.20	$43.03	$64.62
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
1 Equip. Oper. (medium)	41.35	330.80	62.15	497.20		
1 Trencher, Chain Type, 8' D		1777.00		1954.70	74.04	81.45
24 L.H., Daily Totals		$2809.80		$3505.50	$117.08	$146.06
Crew Q-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Plumbers	$48.75	$780.00	$73.15	$1170.40	$45.50	$68.28
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
24 L.H., Daily Totals		$1092.00		$1638.80	$45.50	$68.28
Crew Q-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber Foreman (inside)	$49.25	$394.00	$73.90	$591.20	$46.44	$69.69
2 Plumbers	48.75	780.00	73.15	1170.40		
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
32 L.H., Daily Totals		$1486.00		$2230.00	$46.44	$69.69
Crew Q-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber Foreman (inside)	$49.25	$394.00	$73.90	$591.20	$46.44	$69.69
1 Plumber	48.75	390.00	73.15	585.20		
1 Welder (plumber)	48.75	390.00	73.15	585.20		
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
1 Welder, electric, 300 amp		55.70		61.27	1.74	1.91
32 L.H., Daily Totals		$1541.70		$2291.27	$48.18	$71.60
Crew Q-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Steamfitter	$49.35	$394.80	$74.05	$592.40	$44.42	$66.67
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
16 L.H., Daily Totals		$710.80		$1066.80	$44.42	$66.67
Crew Q-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Steamfitters	$49.35	$789.60	$74.05	$1184.80	$46.07	$69.13
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
24 L.H., Daily Totals		$1105.60		$1659.20	$46.07	$69.13
Crew Q-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Steamfitter Foreman (inside)	$49.85	$398.80	$74.80	$598.40	$47.01	$70.55
2 Steamfitters	49.35	789.60	74.05	1184.80		
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
32 L.H., Daily Totals		$1504.40		$2257.60	$47.01	$70.55
Crew Q-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Steamfitter Foreman (inside)	$49.85	$398.80	$74.80	$598.40	$47.01	$70.55
1 Steamfitter	49.35	394.80	74.05	592.40		
1 Welder (steamfitter)	49.35	394.80	74.05	592.40		
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
1 Welder, electric, 300 amp		55.70		61.27	1.74	1.91
32 L.H., Daily Totals		$1560.10		$2318.87	$48.75	$72.46
Crew Q-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Sheet Metal Worker	$47.20	$377.60	$72.65	$581.20	$42.48	$65.38
1 Sheet Metal Apprentice	37.75	302.00	58.10	464.80		
16 L.H., Daily Totals		$679.60		$1046.00	$42.48	$65.38
Crew Q-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Sheet Metal Workers	$47.20	$755.20	$72.65	$1162.40	$44.05	$67.80
1 Sheet Metal Apprentice	37.75	302.00	58.10	464.80		
24 L.H., Daily Totals		$1057.20		$1627.20	$44.05	$67.80

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew Q-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Sheet Metal Foreman (inside)	$47.70	$381.60	$73.40	$587.20	$44.96	$69.20
2 Sheet Metal Workers	47.20	755.20	72.65	1162.40		
1 Sheet Metal Apprentice	37.75	302.00	58.10	464.80		
32 L.H., Daily Totals		$1438.80		$2214.40	$44.96	$69.20
Crew Q-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Sprinkler Installer	$48.15	$385.20	$72.25	$578.00	$43.33	$65.03
1 Sprinkler Apprentice	38.50	308.00	57.80	462.40		
16 L.H., Daily Totals		$693.20		$1040.40	$43.33	$65.03
Crew Q-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Sprinkler Foreman (inside)	$48.65	$389.20	$73.00	$584.00	$45.86	$68.83
2 Sprinkler Installers	48.15	770.40	72.25	1156.00		
1 Sprinkler Apprentice	38.50	308.00	57.80	462.40		
32 L.H., Daily Totals		$1467.60		$2202.40	$45.86	$68.83
Crew Q-14	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Worker	$44.10	$352.80	$69.10	$552.80	$39.70	$62.20
1 Asbestos Apprentice	35.30	282.40	55.30	442.40		
16 L.H., Daily Totals		$635.20		$995.20	$39.70	$62.20
Crew Q-15	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber	$48.75	$390.00	$73.15	$585.20	$43.88	$65.85
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
1 Welder, electric, 300 amp		55.70		61.27	3.48	3.83
16 L.H., Daily Totals		$757.70		$1114.87	$47.36	$69.68
Crew Q-16	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Plumbers	$48.75	$780.00	$73.15	$1170.40	$45.50	$68.28
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
1 Welder, electric, 300 amp		55.70		61.27	2.32	2.55
24 L.H., Daily Totals		$1147.70		$1700.07	$47.82	$70.84
Crew Q-17	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Steamfitter	$49.35	$394.80	$74.05	$592.40	$44.42	$66.67
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
1 Welder, electric, 300 amp		55.70		61.27	3.48	3.83
16 L.H., Daily Totals		$766.50		$1128.07	$47.91	$70.50
Crew Q-17A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Steamfitter	$49.35	$394.80	$74.05	$592.40	$43.80	$65.77
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 12 Ton		768.80		845.68		
1 Welder, electric, 300 amp		55.70		61.27	34.35	37.79
24 L.H., Daily Totals		$1875.70		$2485.35	$78.15	$103.56
Crew Q-18	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Steamfitters	$49.35	$789.60	$74.05	$1184.80	$46.07	$69.13
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
1 Welder, electric, 300 amp		55.70		61.27	2.32	2.55
24 L.H., Daily Totals		$1161.30		$1720.47	$48.39	$71.69
Crew Q-19	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Steamfitter	$49.35	$394.80	$74.05	$592.40	$45.28	$67.77
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
1 Electrician	47.00	376.00	69.95	559.60		
24 L.H., Daily Totals		$1086.80		$1626.40	$45.28	$67.77

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew Q-20	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Sheet Metal Worker	$47.20	$377.60	$72.65	$581.20	$43.38	$66.29
1 Sheet Metal Apprentice	37.75	302.00	58.10	464.80		
.5 Electrician	47.00	188.00	69.95	279.80		
20 L.H., Daily Totals		$867.60		$1325.80	$43.38	$66.29
Crew Q-21	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Steamfitters	$49.35	$789.60	$74.05	$1184.80	$46.30	$69.34
1 Steamfitter Apprentice	39.50	316.00	59.30	474.40		
1 Electrician	47.00	376.00	69.95	559.60		
32 L.H., Daily Totals		$1481.60		$2218.80	$46.30	$69.34
Crew Q-22	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber	$48.75	$390.00	$73.15	$585.20	$43.88	$65.85
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
1 Hyd. Crane, 12 Ton		768.80		845.68	48.05	52.85
16 L.H., Daily Totals		$1470.80		$1899.28	$91.92	$118.71
Crew Q-22A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber	$48.75	$390.00	$73.15	$585.20	$40.48	$61.16
1 Plumber Apprentice	39.00	312.00	58.55	468.40		
1 Laborer	31.60	252.80	49.00	392.00		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Hyd. Crane, 12 Ton		768.80		845.68	24.02	26.43
32 L.H., Daily Totals		$2064.00		$2802.88	$64.50	$87.59
Crew Q-23	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plumber Foreman	$50.75	$406.00	$76.20	$609.60	$46.95	$70.50
1 Plumber	48.75	390.00	73.15	585.20		
1 Equip. Oper. (medium)	41.35	330.80	62.15	497.20		
1 Lattice Boom Crane, 20 Ton		1080.00		1188.00	45.00	49.50
24 L.H., Daily Totals		$2206.80		$2880.00	$91.95	$120.00
Crew R-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$41.52	$62.36
3 Electricians	47.00	1128.00	69.95	1678.80		
2 Helpers	30.30	484.80	46.80	748.80		
48 L.H., Daily Totals		$1992.80		$2993.20	$41.52	$62.36
Crew R-1A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician	$47.00	$376.00	$69.95	$559.60	$38.65	$58.38
1 Helper	30.30	242.40	46.80	374.40		
16 L.H., Daily Totals		$618.40		$934.00	$38.65	$58.38
Crew R-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$41.66	$62.59
3 Electricians	47.00	1128.00	69.95	1678.80		
2 Helpers	30.30	484.80	46.80	748.80		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 S.P. Crane, 4x4, 5 Ton		258.20		284.02	4.61	5.07
56 L.H., Daily Totals		$2591.40		$3788.82	$46.27	$67.66
Crew R-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$46.31	$69.05
1 Electrician	47.00	376.00	69.95	559.60		
.5 Equip. Oper. (crane)	42.55	170.20	63.95	255.80		
.5 S.P. Crane, 4x4, 5 Ton		129.10		142.01	6.46	7.10
20 L.H., Daily Totals		$1055.30		$1523.01	$52.77	$76.15

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew R-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman	$46.70	$373.60	$83.20	$665.60	$45.56	$78.42
3 Struc. Steel Workers	44.70	1072.80	79.65	1911.60		
1 Electrician	47.00	376.00	69.95	559.60		
1 Welder, gas engine, 300 amp		134.20		147.62	3.36	3.69
40 L.H., Daily Totals		$1956.60		$3284.42	$48.91	$82.11
Crew R-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$40.97	$61.60
4 Electrician Linemen	47.00	1504.00	69.95	2238.40		
2 Electrician Operators	47.00	752.00	69.95	1119.20		
4 Electrician Groundmen	30.30	969.60	46.80	1497.60		
1 Crew Truck		169.60		186.56		
1 Flatbed Truck, 20,000 GVW		197.40		217.14		
1 Pickup Truck, 3/4 Ton		116.80		128.48		
.2 Hyd. Crane, 55 Ton		225.00		247.50		
.2 Hyd. Crane, 12 Ton		153.76		169.14		
.2 Earth Auger, Truck-Mtd.		82.40		90.64		
1 Tractor w/Winch		354.80		390.28	14.77	16.25
88 L.H., Daily Totals		$4905.36		$6850.54	$55.74	$77.85
Crew R-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$40.97	$61.60
4 Electrician Linemen	47.00	1504.00	69.95	2238.40		
2 Electrician Operators	47.00	752.00	69.95	1119.20		
4 Electrician Groundmen	30.30	969.60	46.80	1497.60		
1 Crew Truck		169.60		186.56		
1 Flatbed Truck, 20,000 GVW		197.40		217.14		
1 Pickup Truck, 3/4 Ton		116.80		128.48		
.2 Hyd. Crane, 55 Ton		225.00		247.50		
.2 Hyd. Crane, 12 Ton		153.76		169.14		
.2 Earth Auger, Truck-Mtd.		82.40		90.64		
1 Tractor w/Winch		354.80		390.28		
3 Cable Trailers		531.30		584.43		
.5 Tensioning Rig		175.35		192.88		
.5 Cable Pulling Rig		1049.50		1154.45	34.73	38.20
88 L.H., Daily Totals		$6661.51		$8782.30	$75.70	$99.80
Crew R-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$33.17	$50.78
5 Electrician Groundmen	30.30	1212.00	46.80	1872.00		
1 Crew Truck		169.60		186.56	3.53	3.89
48 L.H., Daily Totals		$1761.60		$2624.16	$36.70	$54.67
Crew R-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$41.52	$62.36
3 Electrician Linemen	47.00	1128.00	69.95	1678.80		
2 Electrician Groundmen	30.30	484.80	46.80	748.80		
1 Pickup Truck, 3/4 Ton		116.80		128.48		
1 Crew Truck		169.60		186.56	5.97	6.56
48 L.H., Daily Totals		$2279.20		$3308.24	$47.48	$68.92
Crew R-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$38.71	$58.47
1 Electrician Lineman	47.00	376.00	69.95	559.60		
2 Electrician Operators	47.00	752.00	69.95	1119.20		
4 Electrician Groundmen	30.30	969.60	46.80	1497.60		
1 Pickup Truck, 3/4 Ton		116.80		128.48		
1 Crew Truck		169.60		186.56	4.47	4.92
64 L.H., Daily Totals		$2764.00		$4057.04	$43.19	$63.39

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew R-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$44.30	$66.22
4 Electrician Linemen	47.00	1504.00	69.95	2238.40		
1 Electrician Groundman	30.30	242.40	46.80	374.40		
1 Crew Truck		169.60		186.56		
3 Tram Cars		380.55		418.61	11.46	12.61
48 L.H., Daily Totals		$2676.55		$3783.57	$55.76	$78.82
Crew R-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$44.24	$66.21
4 Electricians	47.00	1504.00	69.95	2238.40		
1 Equip. Oper. (crane)	42.55	340.40	63.95	511.60		
1 Common Laborer	31.60	252.80	49.00	392.00		
1 Crew Truck		169.60		186.56		
1 Hyd. Crane, 12 Ton		768.80		845.68	16.76	18.43
56 L.H., Daily Totals		$3415.60		$4739.84	$60.99	$84.64
Crew R-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman	$40.45	$323.60	$62.75	$502.00	$37.52	$58.94
4 Carpenters	39.95	1278.40	61.95	1982.40		
4 Common Laborers	31.60	1011.20	49.00	1568.00		
1 Equip. Oper. (med.)	41.35	330.80	62.15	497.20		
1 Steel Worker	44.70	357.60	79.65	637.20		
1 Dozer, 200 H.P.		1082.00		1190.20		
1 Pickup Truck, 3/4 Ton		116.80		128.48	13.62	14.98
88 L.H., Daily Totals		$4500.40		$6505.48	$51.14	$73.93
Crew R-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$44.94	$67.02
3 Electricians	47.00	1128.00	69.95	1678.80		
.25 Equip. Oper. (crane)	42.55	85.10	63.95	127.90		
1 Equipment Oiler	36.80	294.40	55.30	442.40		
.25 Hydraulic Crane, 33 Ton		204.70		225.17	4.87	5.36
42 L.H., Daily Totals		$2092.20		$3039.87	$49.81	$72.38
Crew R-15	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$45.76	$68.20
4 Electricians	47.00	1504.00	69.95	2238.40		
1 Equipment Oper. (light)	39.05	312.40	58.70	469.60		
1 Aerial Lift Truck		328.80		361.68	6.85	7.54
48 L.H., Daily Totals		$2525.20		$3635.28	$52.61	$75.73
Crew R-18	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.25 Electrician Foreman	$47.50	$95.00	$70.70	$141.40	$36.76	$55.76
1 Electrician	47.00	376.00	69.95	559.60		
2 Helpers	30.30	484.80	46.80	748.80		
26 L.H., Daily Totals		$955.80		$1449.80	$36.76	$55.76
Crew R-19	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.5 Electrician Foreman	$47.50	$190.00	$70.70	$282.80	$47.10	$70.10
2 Electricians	47.00	752.00	69.95	1119.20		
20 L.H., Daily Totals		$942.00		$1402.00	$47.10	$70.10
Crew R-21	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$47.50	$380.00	$70.70	$565.60	$46.98	$69.94
3 Electricians	47.00	1128.00	69.95	1678.80		
.1 Equip. Oper. (med.)	41.35	33.08	62.15	49.72		
.1 S.P. Crane, 4x4, 25 Ton		71.68		78.85	2.19	2.40
32.8 L.H., Daily Totals		$1612.76		$2372.97	$49.17	$72.35

Crew No.	Bare Costs		Incl. Subs O & P		Cost Per Labor-Hour	
Crew R-22	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.66 Electrician Foreman	$47.50	$250.80	$70.70	$373.30	$39.90	$60.12
2 Helpers	30.30	484.80	46.80	748.80		
2 Electricians	47.00	752.00	69.95	1119.20		
37.28 L.H., Daily Totals		$1487.60		$2241.30	$39.90	$60.12
Crew R-30	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.25 Electrician Foreman (out)	$49.00	$98.00	$72.90	$145.80	$37.68	$57.28
1 Electrician	47.00	376.00	69.95	559.60		
2 Laborers, (Semi-Skilled)	31.60	505.60	49.00	784.00		
26 L.H., Daily Totals		$979.60		$1489.40	$37.68	$57.28
Crew R-31	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician	$47.00	$376.00	$69.95	$559.60	$47.00	$69.95
1 Core Drill, Electric, 2.5 H.P.		52.95		58.24	6.62	7.28
8 L.H., Daily Totals		$428.95		$617.85	$53.62	$77.23
Crew W-41E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.5 Plumber Foreman (out)	$50.75	$203.00	$76.20	$304.80	$42.29	$64.10
1 Plumber	48.75	390.00	73.15	585.20		
1 Laborer	31.60	252.80	49.00	392.00		
20 L.H., Daily Totals		$845.80		$1282.00	$42.29	$64.10