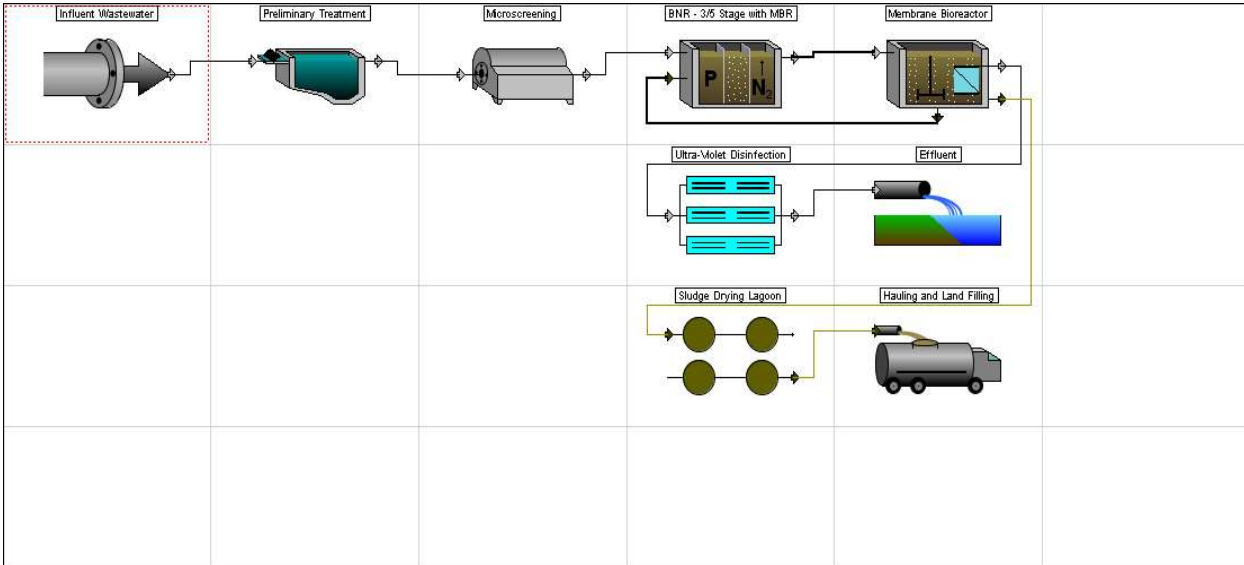


**Layout - Richmond City**



**Summary**

**Equipment Database**

Hydromantis 2014,(USA Avg)

**Layout Summary**

Description	Value	Units
<b>CONSTRUCTION COSTS</b>		
Unit process construction cost:	\$4,210,000	\$
Other direct construction costs	\$1,330,000	\$
Other indirect construction costs	\$4,290,000	\$
<b>Total construction costs</b>	<b>\$9,830,000</b>	<b>\$</b>

**ANNUAL COSTS**

**LABOR COSTS**

Administration labor cost	\$10,400	\$/yr
Laboratory labor cost	\$114,000	\$/yr
Unit process operation labor cost	\$320,000	\$/yr
Unit process maintenance labor cost	\$154,000	\$/yr
<b>Total labor costs</b>	<b>\$598,000</b>	<b>\$/yr</b>

**MATERIAL COSTS**

Total material cost	\$162,000	\$/yr
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**CHEMICAL COSTS**

Total chemical cost	\$11,000	\$/yr
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**ENERGY COSTS**

Total energy cost	\$83,300	\$/yr
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Total operation and maintenance	\$855,000	\$/yr
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**CONSTRUCTION COST AMC**

Amortization cost for total construction	\$952,000	\$/yr
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<b>Total annual project cost</b>	<b>\$1,810,000</b>	<b>\$/yr</b>
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**PROJECT SUMMARY**

Present worth	\$21,700,000	\$
Total project cost	\$9,830,000	\$
Total operation labor cost	\$444,000	\$/yr
Total maintenance labor cost	\$154,000	\$/yr
Total material cost	\$162,000	\$/yr
Total chemical cost	\$11,000	\$/yr
Total energy cost	\$83,300	\$/yr
Total amortization cost	\$952,000	\$/yr

**Process Summary**

Process	Construction (\$)	Operation (\$/yr)	Maintenance (\$/yr)	Material (\$/yr)	Chemical (\$/yr)	Energy (\$/yr)	Amortization (\$/yr)
Preliminary Treatment	246000	24400	11200	6140	0	1160	20600
Microscreening	307000	4120	2070	27800	0	9770	32900
BNR - 3/5 Stage with MBR	759000	128000	64300	17500	0	29600	71000
Ultra-Violet Disinfection	215000	0	2180	2150	747	5360	18200

Sludge Drying Lagoon	22600	2720	1160	0	0	0	1900
Membrane Bioreactor	1890000	159000	73000	18200	10300	37400	251000
Effluent	0	0	0	0	0	0	0
Hauling and Land Filling	287000	2040	0	90400	0	0	61600
Blower System	486000	0	0	0	0	0	40700
Other Costs	5620000	124000	0	0	0	0	455000

#### Summary of Other Costs for Layout

Description	Value	Units
Other Costs		
Quantities		
Required land	10	acre
Administration labor hours	203	hr/yr
Laboratory labor hours	2210	hr/yr
Costs		
<b>DIRECT COSTS</b>		
Mobilization	114000	\$
Site preparation	217000	\$
Site electrical	292000	\$
Yard piping	204000	\$
Instrumentation and control	131000	\$
Lab and administration building	374000	\$
Total direct construction costs	1330000	\$
<b>INDIRECT COSTS</b>		
Cost of land	200000	\$
Miscellaneous cost	319000	\$
Legal cost	127000	\$
Engineering design fee	956000	\$
Inspection cost	127000	\$
Contingency	637000	\$
Technical	127000	\$
Interest during construction	964000	\$
Profit	831000	\$
Total indirect construction cost	4290000	\$
Total of other construction costs	5620000	\$
<b>LABOR COSTS</b>		
Administration labor cost	10400	\$/yr
Laboratory labor cost	114000	\$/yr

#### Summary of Air Supply System

Description	Value	Units
Blower System for Entire Plant		
Design Information		
Minimum air flow capacity	3210	scfm
Safety factor	1.5	
Requested air flow capacity	4810	scfm
Total capacity of blowers	4810	scfm
Number of blowers in use	1	
Total number of blowers	2	
Capacity of individual blowers	4810	scfm
Estimated cost of an installed blower	157000	\$
Blower building area	1120	sqft
Costs		
Construction and equipment cost	486000	\$
Installed Blower Cost	314000	\$
Building Cost	123000	\$
Misc Costs	48200	\$
Operational labor cost	0	\$/yr
Maintenance labor cost	0	\$/yr
Material and supply cost	0	\$/yr
Chemical cost	0	\$/yr
Energy cost	0	\$/yr
Amortization cost	40700	\$/yr

#### Notes

Energy costs are shown at the individual unit processes that require air

#### Influent Wastewater

#### Preliminary Treatment

#### Design Output Data

Description	Value	Units
Preliminary Treatment		
Design Information		
Mechanically Cleaned Bar Screen		
Bar size	0.25	in
Bar spacing	1.5	in
Slope of bars from horizontal	30	degrees
Head loss through screen	0.0206	ft
Approach velocity	2.5	ft/s
Average flow through velocity	2.5	ft/s

Maximum flow through velocity	3 ft/s
Screen channel width	0.308 ft
Average channel depth	1 ft
Horizontal Flow Grit Chamber	
Maximum flow	3.08 cuft/s
Average flow	0.77 cuft/s
Minimum flow	0.385 cuft/s
Temperature	10 deg C
Maximum flow through velocity	1.5 ft/s
Average flow through velocity (	1 ft/s
Size of smallest particle 100%	0.2 mm
Specific gravity of particle	2.65
Number of units	2
Maximum flow/unit	1.54 cuft/s
Width of channel	0.257 ft
Depth of channel	4 ft
Length of channel	144 ft
Settling velocity of particle	0.0707 ft/s
Slope of channel bottom	0.00952
Allowance for currents	1.7
Manning coefficient	0.035
Hydraulic retention time	1.6 min
Volume of grit	2 cuft/d
Costs	
Construction and equipment cc	246000 \$
Operational labor cost	24400 \$/yr
Maintenance labor cost	11200 \$/yr
Material and supply cost	6140 \$/yr
Chemical cost	0 \$/yr
Energy cost	1160 \$/yr
Amortization cost	20600 \$/yr

### Microscreening

#### Design Output Data

Description	Value	Units
Microscreening		
Design Information		
Microscreen loading rate	7	gal(US)/(sqft·min)
Quantity of wash water require	4	%
Area of microscreens required	198	sqft
Quantities		
Number of batteries	1	
Number of units/battery	2	
Drum diameter	6	ft
Drum width	6	ft
Area of selected unit	108	sqft
Area of building	155	sqft
Operation labor required	80	pers-hrs/yr
Maintenance labor required	51.5	pers-hrs/yr
Electrical energy required	97700	kWh/yr
Volume of wall concrete requir	2600	cuft
Volume of earthwork required	5850	cuft
Costs		
Construction and equipment cc	307000	\$
Earthwork Cost	1730	\$
Slab Concrete Cost	62500	\$
Building Cost	17000	\$
Installed Equipment Cost	186000	\$
Misc Costs	40000	\$
Operational labor cost	4120	\$/yr
Maintenance labor cost	2070	\$/yr
Material and supply cost	27800	\$/yr
Chemical cost	0	\$/yr
Energy cost	9770	\$/yr
Amortization cost	32900	\$/yr

### BNR - 3/5 Stage with MBR

#### Design Output Data

Description	Value	Units
BNR System for BIO-P and N Removal		
Design Information		
3-Stage Biological Phosphorus		
Design aerobic SRT for nitrific:	12.5	d
Total reactor SRT	25	d
Design SS	9000	mg/L
Calculated VSS	6490	mg/L
Calculated VSS:TSS ratio	0.721	mg VSS/mg SS
Total volume of anaerobic reac	11	m3
Total volume of anoxic reactor:	266	m3
Total volume of aerobic reacto:	277	m3
Total volume of all reactors	554	m3
Width of parallel train	10	m

Sidewater depth	5 m
Number of batteries	1
Number of parallel trains per battery	2
Number of anoxic cells within each battery	1
Number of aerobic cells within each battery	1
Anaerobic hydraulic retention time	0.14 hr
Anoxic hydraulic retention time	3.37 hr
Aerobic hydraulic retention time	3.51 hr
Amount of sludge generated	199 kg/d
Sludge recycle ratio	300 %
Sludge recycle rate	5680 m <sup>3</sup> /d
Nitrogen required for biomass	12.9 mg/L
Phosphorus required for biomass	2.58 mg/L
Oxygen required to meet average demand	397 kg/d
Air flow required to meet average demand	659 N m <sup>3</sup> /hr
Design air flow	39.7 N m <sup>3</sup> /min/1000 m <sup>3</sup>
Quantities	
Operation labor required	1210 pers-hrs/yr
Maintenance labor required	567 pers-hrs/yr
Electrical energy required	162000 kWh/yr
Volume of earthwork required	24400 cuft
Volume of slab concrete required	5040 cuft
Volume of wall concrete required	4530 cuft
Handrail length	126 ft
Number of diffusers per train	106
Fine bubble diffuser floor coverage	14.5 %
Number of swing arm headers	1
Required mixing power	5.2 kW
Total number of mixers	4
Design mixing power per mixer	1.49 kW
Mixing power for each unaerated tank	1.3 kW
Costs	
Construction and equipment costs	356000 \$
Earthwork Cost	7220 \$
Wall Concrete Cost	109000 \$
Slab Concrete Cost	65400 \$
Handrail Cost	9450 \$
Installed Aerator Equipment	53800 \$
Air Piping Cost	17600 \$
Installed Mixer Equipment Costs	58000 \$
Misc Costs	35300 \$
Operational labor cost	62500 \$/yr
Maintenance labor cost	22900 \$/yr
Material and supply cost	14700 \$/yr
Chemical cost	0 \$/yr
Energy cost	16200 \$/yr
Amortization cost	32800 \$/yr
Internal Recycle Pumping	
Design Information	
Average daily pumping rate	0.75 MGD(US)
Total pumping capacity	0.75 MGD(US)
Design capacity per pump	260 gpm(US)
Number of pumps	6
Number of batteries	1
Firm pumping capacity	0.75 MGD(US)
Quantities	
Operation labor required	424 pers-hrs/yr
Maintenance labor required	345 pers-hrs/yr
Electrical energy required	50300 kWh/yr
Volume of earthwork required	1720 cuft
Area of pump building	215 sqft
Costs	
Construction and equipment costs	159000 \$
Earthwork Cost	1020 \$
Pump Building Cost	47300 \$
Installed Pump Cost	86300 \$
Misc Costs	24200 \$
Operational labor cost	21800 \$/yr
Maintenance labor cost	13900 \$/yr
Material and supply cost	1110 \$/yr
Chemical cost	0 \$/yr
Energy cost	5030 \$/yr
Amortization cost	15000 \$/yr
Internal Recycle Pumping	
Design Information	
Average daily pumping rate	1 MGD(US)
Total pumping capacity	1 MGD(US)
Design capacity per pump	347 gpm(US)
Number of pumps	6
Number of batteries	1
Firm pumping capacity	1 MGD(US)
Quantities	

Operation labor required	440 pers-hrs/yr
Maintenance labor required	360 pers-hrs/yr
Electrical energy required	67000 kWh/yr
Volume of earthwork required	1760 cuft
Area of pump building	220 sqft
Costs	
Construction and equipment cost	174000 \$
Earthwork Cost	1040 \$
Pump Building Cost	48300 \$
Installed Pump Cost	98000 \$
Misc Costs	26500 \$
Operational labor cost	22700 \$/yr
Maintenance labor cost	14500 \$/yr
Material and supply cost	1220 \$/yr
Chemical cost	0 \$/yr
Energy cost	6700 \$/yr
Amortization cost	16400 \$/yr
Sludge Recycle Pumping	
Design Information	
Average daily pumping rate	0.5 MGD(US)
Total pumping capacity	0.5 MGD(US)
Design capacity per pump	174 gpm(US)
Number of pumps	3
Number of batteries	1
Firm pumping capacity	0.5 MGD(US)
Quantities	
Operation labor required	403 pers-hrs/yr
Maintenance labor required	325 pers-hrs/yr
Electrical energy required	16800 kWh/yr
Volume of earthwork required	1680 cuft
Area of pump building	210 sqft
Costs	
Construction and equipment cost	70400 \$
Earthwork Cost	497 \$
Pump Building Cost	23100 \$
Installed Pump Cost	36100 \$
Misc Costs	10700 \$
Operational labor cost	20700 \$/yr
Maintenance labor cost	13100 \$/yr
Material and supply cost	493 \$/yr
Chemical cost	0 \$/yr
Energy cost	1680 \$/yr
Amortization cost	6660 \$/yr

### Ultra-Violet Disinfection

#### Design Output Data

Description	Value	Units
Ultra-Violet Disinfection		
Design Information		
Design based on a model calculation	2.12	gal(US)/(min·W)
Total number of lamps needed	49	
Number of spare channels	1	
Total number of lamps used in	72	
Number of excess lamps	23	
Number of lamps/modules	2	
Number of modules/bank	3	
Number of banks/channel	3	
Number of channels	4	
Calculated headloss	10.8	in
Costs		
Construction and equipment cost	215000	\$
Cost of installation	129000	\$
Total cost of UV lamps	85900	\$
Operational labor cost	0	\$/yr
Maintenance labor cost	2180	\$/yr
Material and supply cost	2150	\$/yr
Chemical cost	747	\$/yr
Energy cost	5360	\$/yr
Amortization cost	18200	\$/yr

### Sludge Drying Lagoon

#### Design Output Data

Description	Value	Units
Sludge Drying Lagoon		
Design Information		
Sludge flow	4260	gpd(US)
Initial solids content in sludge	1.2	%
Sludge depth in lagoon	1	ft
Dry solids produced	156000	lb/yr
Lagoon volume	67700	cuft
Total lagoon surface area	67700	sqft
Number of lagoons required	2	

Quantities	
Operation labor required	52.9 pers-hrs/yr
Maintenance labor required	28.9 pers-hrs/yr
Volume of earthwork required	54600 cuft
Volume of wall concrete requir	80 cuft
Surface area per lagoon	33800 sqft
Length of lagoon at top of leve	196 ft
Depth of cut	0.82 ft
Depth of fill	2.18 ft
Costs	
Construction and equipment cc	22600 \$
Earthwork Cost	16200 \$
Wall Concrete Cost	1930 \$
Misc Costs	4520 \$
Operational labor cost	2720 \$/yr
Maintenance labor cost	1160 \$/yr
Material and supply cost	0 \$/yr
Chemical cost	0 \$/yr
Energy cost	0 \$/yr
Amortization cost	1900 \$/yr

### Membrane Bioreactor

#### Design Output Data

Description	Value	Units
Membrane Bioreactor		
Design Information		
Total volume of reactors	12400	cuft
Length of parallel train	22.4	ft
Width of parallel train	11.2	ft
Sidewater depth	16.4	ft
Number of batteries	1	
Number of parallel trains per b	3	
Total Membrane Area	15800	m2
Total Scour Air Requirement	3150	N m3/hr
Quantities		
Operation labor required	2380	pers-hrs/yr
Maintenance labor required	1250	pers-hrs/yr
Electrical energy required	359000	kWh/yr
Volume of earthwork required	15800	cuft
Volume of slab concrete requir	3170	cuft
Volume of wall concrete requir	4400	cuft
Handrail length	253	ft
Number of diffusers per train	78	
Number of swing arm headers	1	
Costs		
Construction and equipment cc	1680000	\$
Earthwork Cost	4680	\$
Wall Concrete Cost	106000	\$
Slab Concrete Cost	41100	\$
Handrail Cost	19000	\$
Membrane Cost	1360000	\$
Installed Aerator Equipment	69000	\$
Air Piping Cost	43000	\$
Misc Cost	38700	\$
Operational labor cost	123000	\$/yr
Maintenance labor cost	50200	\$/yr
Material and supply cost	16800	\$/yr
Chemical cost	10300	\$/yr
Energy cost	35900	\$/yr
Amortization cost	231000	\$/yr
Permeate Pumping		
Design Information		
Average daily pumping rate	0.25	MGD(US)
Total pumping capacity	1	MGD(US)
Design capacity per pump	386	gpm(US)
Number of pumps	6	
Number of batteries	1	
Firm pumping capacity	2.22	MGD(US)
Quantities		
Operation labor required	488	pers-hrs/yr
Maintenance labor required	405	pers-hrs/yr
Electrical energy required	15100	kWh/yr
Volume of earthwork required	1780	cuft
Area of pump building	222	sqft
Costs		
Construction and equipment cc	180000	\$
Earthwork Cost	1050	\$
Pump Building Cost	48800	\$
Installed Pump Cost	103000	\$
Misc Costs	27500	\$
Operational labor cost	25100	\$/yr
Maintenance labor cost	16300	\$/yr

Material and supply cost	1260 \$/yr
Chemical cost	0 \$/yr
Energy cost	1510 \$/yr
Amortization cost	17000 \$/yr
Waste Sludge Pumping	
Design Information	
Average daily pumping rate	0.00426 MGD(US)
Total pumping capacity	0.00426 MGD(US)
Design capacity per pump	1.48 gpm(US)
Number of pumps	3
Number of batteries	1
Firm pumping capacity	0.00426 MGD(US)
Quantities	
Operation labor required	218 pers-hrs/yr
Maintenance labor required	161 pers-hrs/yr
Electrical energy required	145 kWh/yr
Volume of earthwork required	1600 cuft
Area of pump building	200 sqft
Costs	
Construction and equipment cost	31800 \$
Earthwork Cost	474 \$
Pump Building Cost	22000 \$
Installed Pump Cost	4430 \$
Misc Costs	4840 \$
Operational labor cost	11200 \$/yr
Maintenance labor cost	6470 \$/yr
Material and supply cost	222 \$/yr
Chemical cost	0 \$/yr
Energy cost	14 \$/yr
Amortization cost	3000 \$/yr

#### Effluent

##### Design Output Data

Description	Value	Units
Costs		
Construction and equipment cost	0 \$	
Operational labor cost	0 \$/yr	
Maintenance labor cost	0 \$/yr	
Material and supply cost	0 \$/yr	
Chemical cost	0 \$/yr	
Energy cost	0 \$/yr	
Amortization cost	0 \$/yr	

#### Hauling and Land Filling

##### Design Output Data

Description	Value	Units
Sludge Hauling and Land Filling		
Design Information		
Volume of sludge hauled	0.844	cuyd/d
Truck capacity	19	cuyd
Round trip time to disposal site	1	hr
Truck loading time	0.75	hr
Operational hours per day	8	hr
Number of trucks required	1	
Distance to disposal site	30	miles
Quantities		
Total sludge volume hauled	0.844	cuyd/d
Maximum anticipated landfill duration	30	d
Anticipated sludge storage height	8	ft
Sludge storage shed area	85.5	sqft
Width of sludge storage shed	6.54	ft
Length of sludge storage shed	13.1	ft
Volume of earthwork required	356	cuft
Volume of slab concrete required	175	cuft
Surface area of canopy roof	85.5	sqft
Round trip haul distance	60	miles
Round trips per day per truck	1	
Distance traveled per year per truck	15000	miles
Sludge hauled	0.747	ton(short)/d
Operation labor required	39.6	pers-hrs/yr
LandFilling cost	35200	\$/yr
Costs		
Construction and equipment cost	287000	\$
Earthwork Cost	106	\$
Slab Concrete Cost	2270	\$
Canopy Roof Cost	1710	\$
Vehicle Cost	283000	\$
Operational labor cost	2040	\$/yr
Maintenance labor cost	0	\$/yr
Material and supply cost	90400	\$/yr
Chemical cost	0	\$/yr
Energy cost	0	\$/yr

Amortization cost

61600 \$/yr