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March 29th, 2022

SCM 502: Professor Gregory Collins

National Cranberry Cooperative
1996 Process Analysis & Recommendations

Business Problem

Due to the constraints of the wet-harvest cranberry production process at Receiving Plant No. 1 (hereafter RP1), and delivery tempo during peak harvest season, storage bins no. 17-27 reach their maximum capacity during operating hours, causing a queue of trucks to form. **As a result of this queuing, financial losses are incurred in the combined forms of idle wages paid to delivery drivers, and overtime wages paid to plant operators**. Analysis reveals the cause of the storage capacity issue currently experienced as the processing bottleneck formed at the wet berry dryer, whose limited capacity becomes the operating constraint of the entire processing operation of RP1, resulting in an inventory build-up of unprocessed wet berries.

Analysis

Beginning at 7:00am, RP1 is expected to receive 19,000 barrels of harvested cranberries per day, 13,300 barrels of which are derived from wet-harvesting practices. The expected average demand on the delivery process (after accounting for samples removed for weight and quality assessment) is 1200 barrels per hour of wet berries[1].

Due to the limited operational capacity of the drying units for wet-berry production (3 units at 200 bbl/hr ea.), <u>the operational capacity for our wet-berry processing operation is capped at 600 bbl/hr, based upon the operational principle that the capacity of the bottleneck is the capacity for the system</u>. As a result of this constraint, wet cranberries begin accumulating in storage bins 17-27 at a rate of 600 bbl/hr. Given the total capacity of the bins[2] of 3200 bbls, this accumulation results in maximum capacity achieved after 5.33 hrs, or 12:20pm. At this point, cranberry delivery and dumping operations are stalled, and a queue begins to form.

Using Little's Law for averages, (I=RT) we can determine the estimated total duration of this que. Knowing that RP1 only allows trucks to enter the line between 7am-7pm, and owing to the fact

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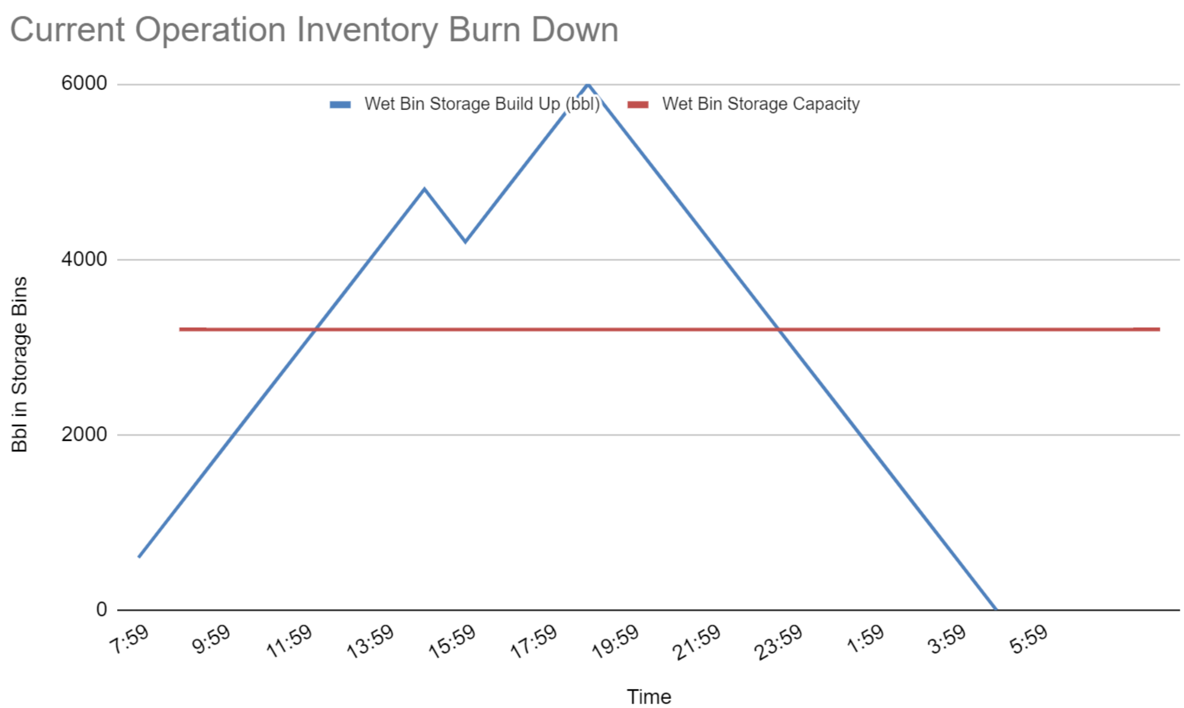
[1] It should be noted that two .3 bbl samples are taken from each truck for color and grading. Giving us a yield of 99.2% for each truck. 74.4 bbl / 75 bbl = .992. With this in mind we will now input 19,000(.7)(.992) = 13193.6 bbl of wet berries and 19,000(.3)(.992) = 5654.4 bbl of dry berries per day into RP1.

Per hour delivery of wet berries can be found by taking 13193.6/11 = 1199.42 bbl/hr

[2] Bins 17-24 have a capacity of 250 bbls. Bins 25, 26, and 27 have a capacity of 400 bbls. Total storage capacity for wet berries equals 8(250)+3(400) = 3200 bbls.

that the build-up begins to form at 12:20pm, we know that we have 6 hours 40 minutes, or 6.67 hours, remaining until the line no longer allows new entrants. Accounting for a one-hour lunch, this allows for 5.67 hours for trucks to enter the queue, less the 600 bbl capacity achieved by plant operations which ran concurrently to the delivery driver lunch period, and depleted the inventory of the wet-berry storage bins. At an inventory build-up rate of 600 bbl/hr, maximum inventory in the queue will be reached at 7:00pm, with a total equivalent to 2802 bbls of wet-harvest cranberries waiting to be unloaded. Knowing that our system throughput is also 600 bbl/hr, we can determine a total queue reduction time of 5.67hrs, with the last truck dumping its load at 11:40pm. The duration of the queue from its commencement at 12:20pm to its subsequent dissolution at 11:40pm results in 11 hrs 20 minutes of total queuing time, or 11.33 hours.



In order to determine the total queuing time for all trucks, regardless of their individual wait time, we can take the average of the starting inventory (0 bbls) and the ending inventory, 2802 bbls, for an average of 1401 bbls in the system. With an average dump size of 74.4 bbls/truck (after extracting samples), we can determine an average of 18.83 trucks in the line throughout the 11.33 hr duration, resulting in 213.35 hours of que time. At a rate of $18.00/hr, the cost to our operation is $3,840.30/day during peak season, with a resultant total **from September 1-December 15 of $407,072 in wages paid to drivers waiting in que**.

In addition, overtime wages must be paid in order to fully process the day's inventory of wet berry deliveries, as they cannot be stored overnight, for risk of spoilage. At 11:40 pm, all deliveries are complete, with storage bins at a maximum capacity of 3200 barrels. Again factoring in a throughput based upon the constraint of the bottleneck (dryer) capacity of 600 bbl/hr, we can determine a processing time of 5.33 hours, or 5 hours and 20 minutes, with the conclusion of plant operations at 5:00am.

Considering an overtime staffing model with an average of 8.5 employees to operate the plant between 11:00pm and 5:00am, at an average overtime rate of $15.75/hr[3], our daily overtime operating costs are $803.25 *just to staff the plant between 11:00pm and 5:00am* (additional overtime costs are accrued on the weekends, as workers surpass their 40/hr work week[4]). For "busy" season, with 7-day-week operating tempo, **overtime expenses total $85,144.50 for the 11pm-5am daily period from September 1-December 15.**

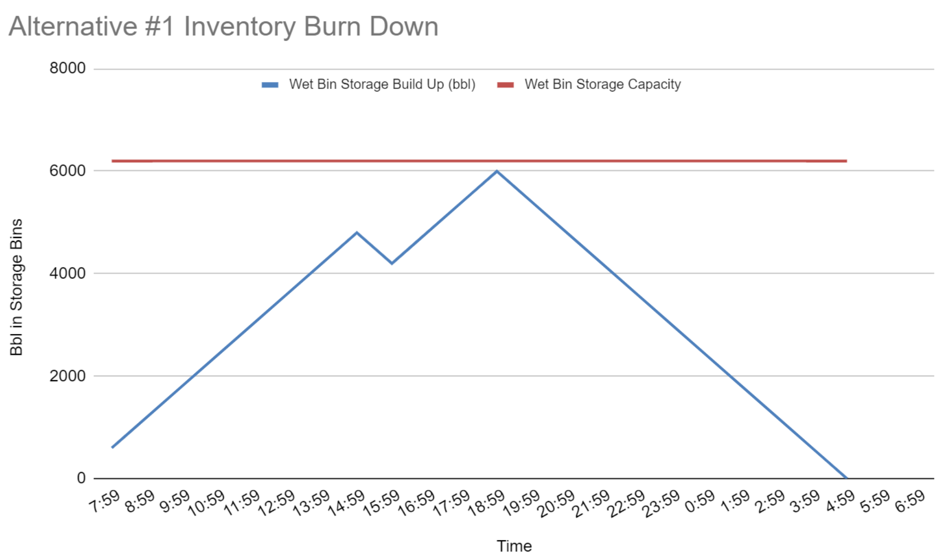
Total financial losses due to the queuing trucks and the resultant overtime expenses (appx): **$4,644/day** or **$492,216 total during peak season.**

Alternatives Considered

Alternative Solution No. 1: Increase Storage Capacity

If we accept that the most significant financial yoke placed upon the daily operations of RP1 as the costs incurred by wages paid to queuing delivery drivers, the single fastest straight-line alleviation of this burden is a method to increase the capacity of wet-berry storage, eliminating the waiting time for trucks to unload at the Kiwanee Dumpers. By converting (12) dry storage bins to wet storage capabilities, at a cost of $10,000 each, for a **total capital investment of $120,000**, wet berry temporary holding capacity can be increased to 6,200 barrels.

Given our known inventory build-up rate of 600 bbl/hr, and an equivalent throughput of 600 bbl/hr, and assuming 11 hours of delivery arrivals coursed throughout a 12-hr operating schedule, all trucks will be able to empty the contents of their loads *before* the end of the delivery window (7am-7pm). At 7:00pm, 6,000 barrels worth of berries will be temporarily stored in the newly configured wet berry storage bins. Given our 600 bbl/hr throughput, processing operations will cease after an additional 10 hours, or 5:00 am.



[5]

[3] (Full-time employee overtime rate of $19.50/hr + part-time overtime rate of $12.00/hr) ÷ 2 = $15.75/hr
[4] Weekend Scheduled Overtime Costs: 8 hrs/worker x $15.75/hr x 53 workers (first + second shifts) x 2 days = $13,356
[5] Completion time at hour's end: i.e. processing is complete at 4:59:59 am.

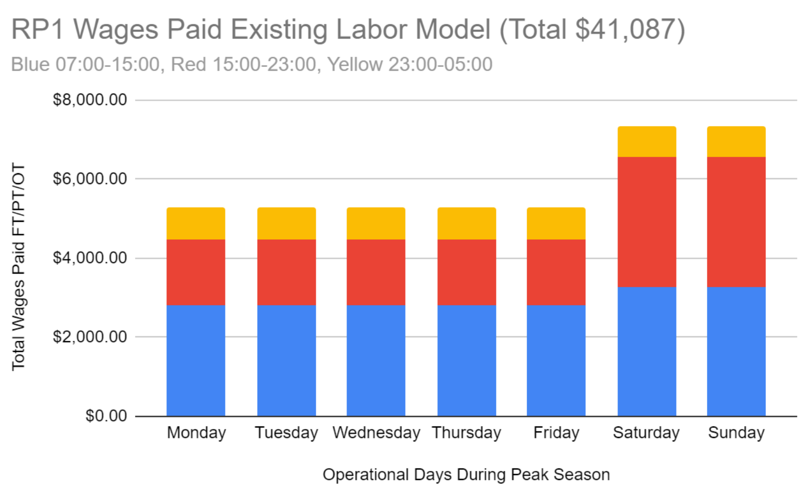
While this solution does not alleviate our $803.25/day overtime costs, it completely eliminates our queuing costs of $3840.30/day, or $407,072/season, for a capital investment of $120,000. The resultant **ROI is a factor of 2.4 (240%) in season one**. Additionally, the increased capacity of our storage operations provides a buffer against the random nature of driver arrivals, as there is no time in which trucks would be unable to off-load within their optimal 7-8 minute turnaround time.

The time-horizon on this solution may be limited, however, by the continued increase in total volume of cranberries from wet-berry harvesting techniques, as indicated by the historical data. One may consider increasing the capacity of wet-berry storage at a rate commensurate with the pace of farming yields; however, the maximum capacity of single-plant operations at RP1 is exhausted in the above scenario, given the maximum processing time of 22hrs/day.

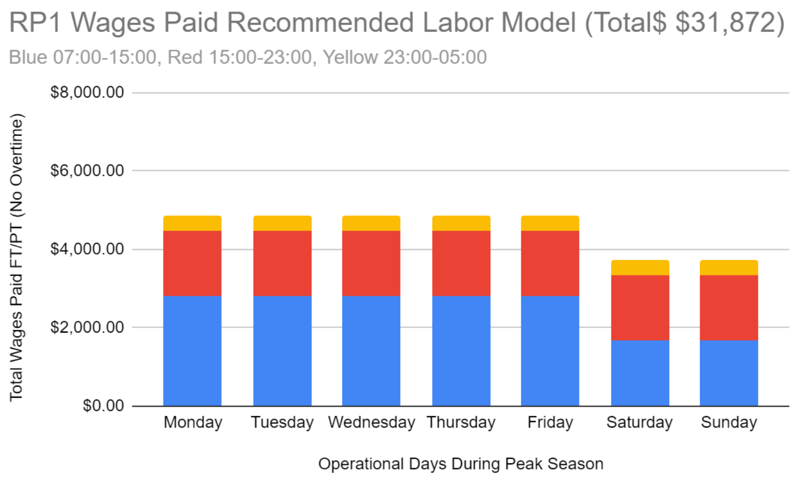
Finally, with an excess capacity of 200 barrels wet-berry storage (6200 bbl total capacity - 6000 bbl peak demand), spread at a rate of 16.67 barrels per hour over the 12 hour delivery period, allows for the reduction of load factor on the dryers by a roughly equivalent amount, reducing the utilization from its maximum of 600 bbl/hr (100% load factor) to a more responsible ~584 bbl/hr, with a resultant load factor of 97.33%. This attempt to avoid over-saturating the capacity of the drying units should provide a "capacity cushion" as a hedge against variability.

Alternative Solution No. 2: Decrease Overtime Labor Expenses

A considered alternative with no capital expenditure requirement would be the hiring of additional part time employees to meet all of the staffing requirements of the plant operation *without* incurring overtime costs. Under current operating conditions, total overtime expenditures are estimated at $18,596 per week, including weekend overtime wages paid to both full and part time staff (at $19.50/hr and $12.00/hr, respectively), for a **seasonal expenditure of $281,597.**



Assuming a rate of $8.00/hr for all seasonal staff, and assuming the current 22-hr processing operations schedule, we can reduce this figure by hiring an additional 8 employees to work a 30 hour work week (11pm-5am, M-F), as well as 60 employees who can work weekends (26 employees 7am-3pm, 26 employees 3pm-11pm, 8 employees 11pm-5am). These additional part-time hours result in a cost of $1,920.00 in M-F labor, and $7,424.00 in weekend-shift labor costs, for a total of $9,344.00/wk in additional part-time employee labor expenses. The difference between these figures is a saving of $9,252/week, or **a seasonal savings of $140,102** for the period from September 1-December 15.



While this solution does not account for a reduction in queuing time, it also does not require any further financial investment by the National Cranberry Cooperative; all savings in labor expense can be passed straight through to the balance sheet. This savings could then be used to finance the $120,000 needed for wet-storage capacity conversion referenced in Alternative Solution No. 1.

Alternative Solution No. 3: Hybrid Solution for Space-Constrained Plants

By combining the finds of Alternative Solutions No. 1 and No. 2, we believe that RP1 can solve *both* its queuing costs *and* its overtime expenditures, without incurring any additional costs. The investment in the conversion of (12) storage bins, amortized over the course of the year, is offset by the savings in labor expenses during peak season. The implementation of a third shift, as well as the hiring of part-time "weekend" employees, forecasts a net savings for peak season 1996 of **+$427,174**[6] without the need to purchase additional equipment. Furthermore, the ability to reduce the load on the dryer units by appx. 3% allows for a capacity buffer, so that our system is not running at 100% capacity, thus reducing the likelihood of variable failure. Finally, this solution requires no increase in the footprint, or change in the physical layout, of our plant.

This solution solves our business problem for 1996; however, given expected increases in harvest yields moving forward, based on the historical data (37.3% increase in "process" cranberries from 1990-1995, for an average of 7.5% per year), we propose a reinvestment of our cost savings in increasing both dryer capacity and separator capacity, so that our throughput can increase along with industry demand.

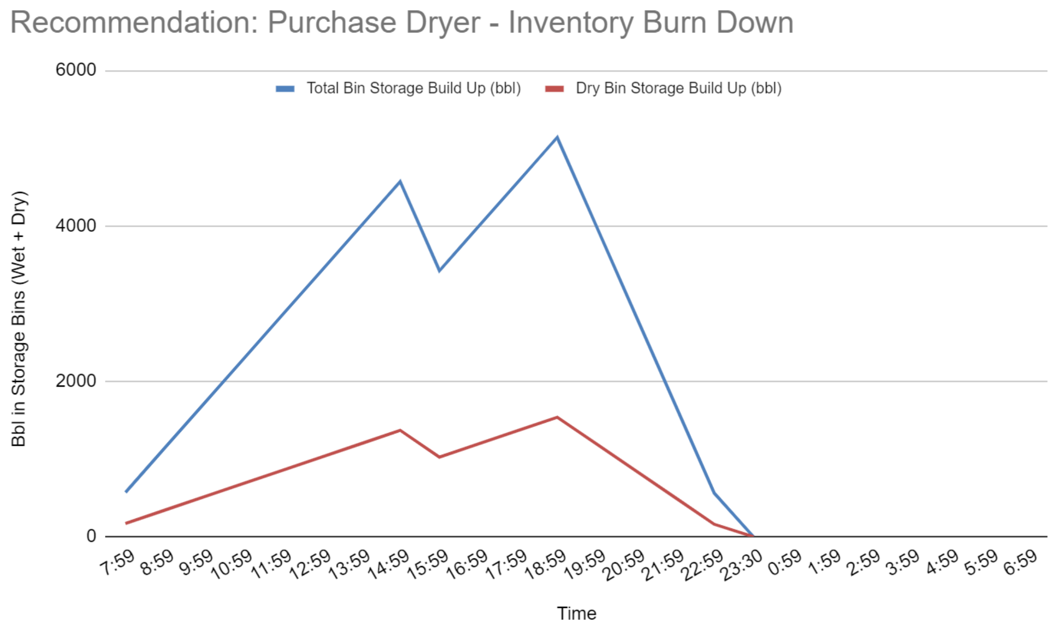
Recommendations

Recommend Solution: Increasing 1 Dryer Capacity and 2 Bins conversion via Capital Expenditure

Owing to our current process constraint of 600 bbl/hr, limited by our bottleneck of total dryer capacity, consideration can be given to increasing this capacity by 200/bbl, for a total

[6] $407,072 queuing cost savings + $140,102 OT savings - $120,000 bin conversions

production capacity of 800 bbl/hr, with a capital expenditure of $60,000 for one dryer unit. By increasing the limitation of the constraint on our system, we can receive our daily delivery of 19,000 barrels and complete processing at 11:30 pm.



The result of this capacity change is the accruing of only 30 min of overtime expenses per plant operator, resulting in a savings of $736.31/day in labor costs, or $78,049 during peak season. This solution also produces 1 hour of queue time for 6 trucks, occurring at 18:59-19:59. At this point the plant is just short of 400 bbl in bin capacity to remove the entire queuing time. So, we recommend converting 2 dry bins to wet bins at $20,000 in capital expenditure. This results in a savings of $3840.32/day, or $407,074 during peak season. **The total savings from this investment of $80,000 during the peak season in 1996 is $485,123, with the ROI of this investment being a factor of 6.06, or 606%.** We considered merely adding the additional dryer, in which case our ROI would increase to 6.89% for 1996, but with the the projected increase in wet-berry harvesting practices, queue time for *at least* 6 trucks per day would have occurred every subsequent year resulting in a *minimum* of $11,448 expenses per season, which will be somewhat offset in the near future due to conversion in 1996 of 2 bins to wet-storage capacities.

Additional Recommendation: Purchase a Light-Meter System

It is estimated that NCC paid $675,000 in premiums for grade No.3 berries in 1995, with approximately 50% of that being unwarranted expenditure- approximately $337,500 in wasted inventory purchase. Considering a one-time capital expense of $40,000 for the unit, whose operating employee comes with the same labor cost as the extant Chief Berry Receiver, this expense seems warranted, regardless of the operating process solution selected. The implementation would result in an ROI of 744%.[7]

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[7] $337,500 savings - $40,000 CapEx = $297,500/$40,000 = 7.44 ROI Factor
For in-depth analysis of solution computations and operational data, please see Appendix

Considerations for the Future:

The findings and recommendations contained herein have strong implications for the further development of RP1, enumerated below.

1. The purchase of three (3) additional drying units *beyond* the above recommendation, with a capital investment of $180,000. Doing so will increase the capacity of RP1 from 600 bbl/hour under the current operating conditions, to 1400/bbl. These additional units will reduce the load placed upon the drying process. Considerations will have to be given to the footprint and housing of these machines; plant expansion may be warranted.
2. It is recommended to add two additional adjoining separating facilities. The addition of these operations will increase the separating capacity of RP1 to 2000 bbl/hr.
3. In combination, these investments (4 x drying units, 2 x separating operations), will allow RP1 to lower system utilization to approximately 85.75%, thus reducing the risk of process saturation.
4. The conversion of an additional 6 bins to wet-storage capabilities will increase RP1's capacity for wet berries, as that method of harvesting is projected to continue its growth as the preferred technique of choice for our farming and harvesting suppliers to employ. Obtaining this increased capacity will require a capital investment of an additional $60,000, but will help meet expected demand for 1997-2001, preventing the reemergence of queuing costs.
5. With these recommendations, and assuming no changes in the size of truck loads or dumping times, these improvements will shift the constraint on RP1's operational process to the *demand* placed upon the system via berry delivery rate, as excess processing capacity can be found in our system.

Appendix

Assumptions List:

It is assumed that once capacity is filled in the wet berry bins that dry berry trucks are still able to access the Kiwanee Dumpers and are not held up in the line. Therefore, management should consider keeping a portion of dumping capacity (truck lanes) allocated for dry berries only to prevent further back ups.

1. 19,000 barrel inputs a day
2. 70% of input are wet berries. 30% are considered dry
3. Assumed that average input is 1200 bbl/hr of wet berries. This number is rounded for simplicity.
4. Assumed that average input is 515 bbl/hr of dry berries. This number is rounded for simplicity.
5. Assume that once Wet Berries bins are full, the queueing of wet berry trucks will not prevent the dumping and delivery of dry berries. Therefore, the dry berry system is bottlenecked by its delivery rate of the trucks.
6. Assumed that truck drivers will take a one hour break to eat lunch. No unloading for that hour will occur.
7. Plant will continue to run and assumed that staff will trade off lunches depending on position to allow for continuous operation
8. It is assumed that the $100/hr cost of trailer leasing is the responsibility of the growers and not that of RP1.
9. We assumed 106 days in peak season.

Calculations Appendix:

Trucks Incoming:

19,000 BBLs arrive on a busy day. 13,300 BBLs are wet berries. 5700 berries are dry. This 19,000 is assumed to be the peak delivery volume for RP1.

It should be noted that two .3 bbl samples are taken from each truck for color and grading. Giving us a yield of 99.2% for each truck. 74.4 bbl / 75 bbl = .992. With this in mind we will now input 19,000(.7)(.994) = 13220.2 bbl of wet berries and 19,000(.3)(.994) = 5665.8 bbl of dry berries per day into RP1.

Per hour delivery of wet berries can be found by taking 13220.2/11 = 1201.84 bbl/hr

Per hour delivery of dry berries can be found by taking 5665.8/11 = 515.036 bbl/hr

We assume these delivery rates are on average 1200 wet berries per hour by truck and 515 dry berries per hour by truck. (Note: These quantities are rounded slightly for computations sake)

Trucks will deliver for a 12 hour window with a 1 hour lunch where they will not deliver. This gives us a distribution of 11 hours to deliver berries by truck. See inventory model for schedule of deliveries.
Kiwanee Dumpers:

We have 5 Kiwanee dumpers onsight with a capacity of 600 bbl/hr for each unit. This gives us a capacity of 3000 bbl/hr dumping capacity.

Our average capacity utilization is (515+1200)/3000 = 57.16% where 515 is bbl of dry berries dumped and 1200 is bbl of wet berries dumped per hour.

<u>Dry Berry Storage:</u>
Bins 1-16 are currently dedicated to dry berry storage. Each bin has a capacity of 250 bbl. Therefore we have 16(250) = 4000 bbls of dry berry capacity.

<u>Wet Berry Storage:</u>

Bins 17-27 we assume are dedicated to wet berry storage. Bins 17-24 have a capacity of 250 bbls. Bins 25, 26, and 27 have a capacity of 400 bbls. Giving us a total storage capacity for wet berries of 8(250)+3(400) = 3200 bbls.

<u>Destoners:</u>

It is given that only dry berries need to be destoned. We have 3 destoners on premises with a capacity of 1500 bbl/hr each. Therefore, our total capacity for destoning is 4500 bbl/hr. Our throughput of berries flowing to the destoner will be that of the 515 bbl/hr that is being delivered by the trucks. Therefore, utilization of the destoners is considered to be 515/4500 = 11.44%.

<u>Dechaffers:</u>

It is given that three dechaffers are located on site. Each dechaffer is capable of 1500 bbl/hr. To simplify our model we assumed that all three dechaffers can simultaneously de-chaff both dry and wet berries. Therefore we have a total capacity of dechaffing of 3(1500) = 4500 bbl/hr. In our model 514 bbl of dry berries per hour will flow into the dechaffer and 600 bbls per hour of wet berries will flow from the storage bins. Note that in a non-bottlenecked world more berries could flow through but we must choose to limit wet berry capacity to 600 bbl due to limits placed on us by the dryers.

Therefore our utilization is (515+600)/4500 = 24.77%. In a non constrained world 1200 bbls of wet berries per hour could flow through the dechaffer giving us a potential (515+1200)/4500 = 38.11% utilization. However, at this time this rate is not possible.

<u>Dryers:</u>

It is given that only wet berries need to be dried in RP1. Therefore only the flow of wet berries out of the dechaffer is our input to the drying system. Three dryers are located on site with a capacity of 200 bbl/hr each. Therefore, we have a total of 600 bbl/hr drying capacity. In terms of utilization all

600 bbl/hr will be utilized. Giving us 600/600=100% utilization. The dryers are the bottleneck to our system. They are the Herbie at RP1.

<u>Separator:</u>

Three separators are located on site with a capacity of 400 bbl/hr each. Therefore our total usable capacity is 3(400)=1200 bbl/hr at the separator. Flowing into the separating step will be 515 bbl of dry berries leaving the dechaffer and 600 bbl of berries leaving the dryer. Summing for a total of 515+600=1115 bbl/hr entering the separator. This gives us a utilization of 1115/1200=92.91%.

<u>Bulk and Bag:</u>

It is assumed that not all berries will yield out of the RP1 plant. We assumed that 12.4% of all bbls would become waste. Next, 75.6% would be considered grade 3. Lastly, the remaining 12% would be considered grade 2.

We calculated the waste assumption by referencing Table A. It is given that economic abandonment (waste) is considered to be waste = production - process - fresh production. Doing this calculation:

Waste = 2038600 - 1418600 - 367000 = 253000 bbl

Then we can calculate the waste percentage by taking

Waste % = Waste / Production = 253000/2038600 = 12.41%

We used this assumption in the constraints of our plant RP1.

This confirms the given explanation of ~12% waste in the case.

<u>**Wet Berry Storage Fill Time Capacity Calculation:**</u>

Using Little's Law I=RT where I is assumed to be the capacity of Bins 17-27 which is equal to 3200bbl. WHere R is the flow rate of 600 bbl/hr which is derived from the difference in truck delivery rate of 1200 bbl/hr and plant consumption rate of wet berries per hour equal to 600 bbl. Therefore, R = 1200 - 600 = 600.

Solving for T (time to fill capacity) we find T = I/R → 3200 bbl / 600 bbl/hr = 5.33 hrs to fill the wet berry capacity.

Therefore, if production begins at 7:00AM then Wet Bins will reach capacity at around 12:20pm. At this time Queuing of wet berries in the trucks will begin assuming delivery is averaged out over the 11 hours.

Trucks in Queue and Queuing Cost Calculations:

Using Little's Law I=RT we can use assumptions to solve for the amount of truck queue hours. Assuming that we have a storage capacity of 3200bbl which will fill in 5.33 hours we understand that we still have 6.67 hours in the day for trucks to queue. Assuming that a one hour lunch is taken 5.67 hours remain for a queue to form. Additionally, during the lunch break where trucks do not deliver the plant is able to make a 600bbl additional capacity that the trucks can unload into. This is an additional hour where queueing will not occur. Therefore we have 4.67 hours for queueing to occur. At our build up rate of 600 bbl/hr this maxes out at an inventory of 2802 bbls in the queue assuming 4.67 hrs (600 bbl/hr) = 2802 bbl. If we assume that we will reduce this queue at a rate of 600 bbl/hr then T=I/R → 2802 bbl / 600 bbl/hr = 4.67 hrs to reduce the remaining queue of truck capacity. The Queue will stop building at 7:00pm. Therefore, the queue will have been completely processed by 4.67hrs after 7:00pm. At roughly 11:40am the queue of wet berry trucks will cease. This will have allowed the queue to build from 12:20pm to 11:40am an elapsed time of 11.33 hours.

Solving:

T = 11.33 hours.

Average inventory = (2802 - 0) /2 = 1401 bbl (assuming max inventory is 2802bbl and minimum is zero)

Average truck size = 74.4 bbls

We can find that average truck hours elapsed in the queue is equal to 11.33(1401/74.4) = 213.35 trucking hours in the queue.

Assuming truck hours cost $18 per hour this accounts for a total cost of 213.35($18) = $3840.32 per day of plant operation.

Assuming that the season runs for 106 days this is a total season cost of $407074.

Overtime Math:

Assuming:

Full Time Employee = 13 per hour
Seasonal Employee = 8 per hour
Overtime Multiplier = 1.5 per hour
Full Time Employee on Overtime = 19.5 per hour
Seasonal Employee on Overtime = 12 per hour
Average Cost of employee on Overtime = 19.5 + 12 / 2 = $15.75

Two shifts of 8 hrs per day are run at a straight time. Total of 16 hours of straight time a day.

After the second shift is complete we assume that 8.5 employees on average are kept on overtime to complete the operation of the plant. They will operate the plant from 11pm to 5am when the plant closes. This is a time span of 6 hours each day.

We assume that the plant operates for 22 hours a day 7 days a week. With two shifts run each day totalling 16 hours of straight time.

We assume a mix of seasonal and full time employees on each shift

To calculate weekly overtime hours we assume:

22hrs/day(7days/week)= 154 hours per week of plant operation.

Less the 80 hours of straight-time

Overtime hours = 154 - 80 = 74 hours of overtime per operating week

Weekend scheduled overtime (1st and 2nd shift on the weekend) consists of 53 employees working two 8 hour shifts. This cost is → 16 hrs (15.75 $/hr)(53 employees) = $13,356 per weekend.

This number is inclusive of weekend hours and hours worked after the second shift. We will now focus on hours worked after the second shift.

To find daily cost of overtime after shift work we take:

15.75 $/hr (6 hrs)(8.5 Employees) = $803.25 per each 6 hour shift overage. This breaks down to $133.88 per hour of plant overage → $803.25/6 = $133.88

In a week this plant overage will cost ($803.25)(7) = $5,622.75

Total overtime costs for the week total 5,622.75+13,356 = $18,978.75 ~ $19,000 per week.

Assuming a 106 day season the plant overage alone costs us $85144.5 per season.

Recommendation Adding Wet Bin Capacity:

To alleviate a queueing issue of trucks delivering wet berries, let us consider the idea of converting 12 bins of dry storage to wet berry storage. Each bin has a capacity of 250 bbl. Therefore this will increase our capacity of wet berry storage by 12(250 bbl) = 3000 bbl. Overall, this will increase our wet-berry storage capacity to 3200bbl + 3000bbl = 6200 bbl.

Assuming that our wet berry capacity of the plant is still limited by the dryer at a rate of 600bbl/hr of wet berries this will cause an accrual of wet berries at 600 bbl/hr into the storage bins.

Therefore, we will see a max build up of 6000 berries in the wet storage bins at 7pm. This is accounting for the delivery of 1200 bbl/hr for 11 hrs over a 12 hr plant operating schedule.

Recommendation Adding Additional Drying Capacity:

Truck cost savings are calculated by taking the 400bbls that occur in the queue at 18:59 - 19:59 and dividing by 74.4. This results in 5.37 or ~6 Trucks. At a Labor cost of $18/hr this results in 18(6) = $108 / day in truck labor.

OT savings are calculated by understanding that the plant will need to work .5hrs of overtime for 8.5 operators. Assuming that the operators are paid $15.75 OT.

$15.75(6 hrs)(8.5 operators) = $803.25 a day at normal operation.
$15.75(0.5 hrs)(8.5 operators) = $66.94 a day at new operation.
Resulting in a daily savings of $803.25 - $66.94 = $736.31 per day.

Process Flow Chart

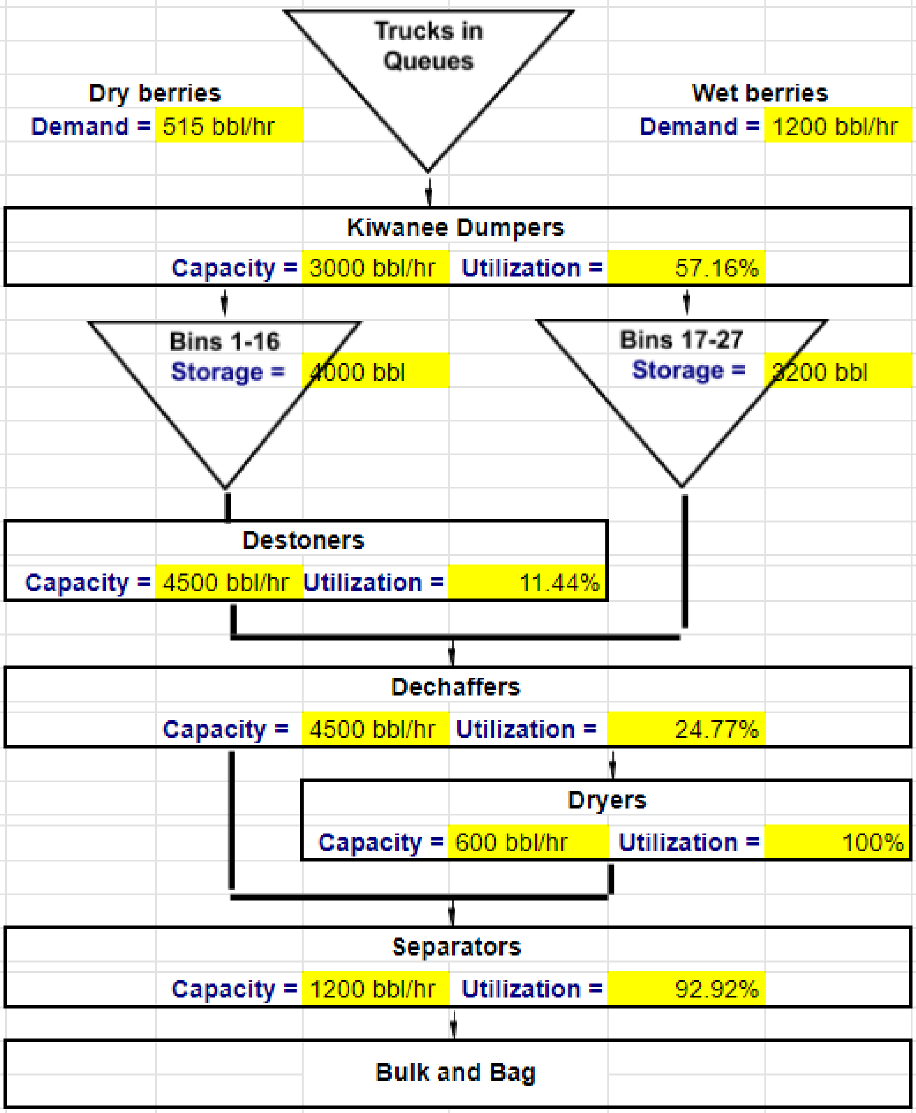
National Cranberry Flow Chart

Requirements

1. Please fill the number in each yellow shadow area

Assumption

1. All the processes (including Destone, Dechaff, and Dry) start from 7am
2. On an average "busy" day, there are 19,000 bbls delivered over 11-hr period (7am-7pm), with one hour for lunch
3. Holding Bins 17-24 are dedicated to wet berries
4. Wet berries are **70%** of all berries
5. Capacity of **each of five dumpers** is **600 bbl/hr**
6. Capacities for Dechaffers and Separators are not divided for dry and wet berries
7. Truck drivers are paid $18/hr



Inventory Analysis: Current Operation

Events	Time	Hour	Shift	Truck Inflow Dry Berries (bbl/hr)	Truck Inflow Wet Berries (bbl/hr)	Plant Consumption Dry (bbl/hr)	Plant Consumption Wet Berries (bbl/hr)	Dry Bin Capacity (bbl)	Wet Bin Capacity (bbl)	Wet Berries in Trucks (bbl/hr)	Inventory Wet Berries (bbl/hr)	Inflow to Seperator (bbl/hr)	Total Output (bbl)	Cum Output (bbl)
	6:59	0	0	0	0		0	0	0	0	0	0	0	0
Trucks Start	7:59	1	1	515	1200	515	600	0	600	-2600	600	1115	976.74	976.74
	8:59	2	1	515	1200	515	600	0	1200	-2000	1200	1115	976.74	1953.48
	9:59	3	1	515	1200	515	600	0	1800	-1400	1800	1115	976.74	2930.22
	10:59	4	1	515	1200	515	600	0	2400	-800	2400	1115	976.74	3906.96
	11:59	5	1	515	1200	515	600	0	3000	-200	3000	1115	976.74	4883.7
	12:59	6	1	515	1200	515	600	0	3200	400	3600	1115	976.74	5860.44
	13:59	7	1	515	1200	515	600	0	3200	1000	4200	1115	976.74	6837.18
	14:59	8	1	515	1200	515	600	0	3200	1600	4800	1115	976.74	7813.92
Truck Lunch	15:59	9	2	0	0	0	600	0	3200	1000	4200	600	525.6	8339.52
	16:59	10	2	515	1200	515	600	0	3200	1600	4800	1115	976.74	9316.26
	17:59	11	2	515	1200	515	600	0	3200	2200	5400	1115	976.74	10293
Trucks End / Dry Berries End	18:59	12	2	515	1200	515	600	0	3200	2800	6000	1115	976.74	11269.74
	19:59	13	2	0	0	0	600	0	3200	2200	5400	600	525.6	11795.34
	20:59	14	2	0	0	0	600	0	3200	1600	4800	600	525.6	12320.94
	21:59	15	2	0	0	0	600	0	3200	1000	4200	600	525.6	12846.54
	22:59	16	2	0	0	0	600	0	3200	400	3600	600	525.6	13372.14
OT Starts	23:59	17	OT	0	0	0	600	0	3000	-200	3000	600	525.6	13897.74
	0:59	18	OT	0	0	0	600	0	2400	-800	2400	600	525.6	14423.34
	1:59	19	OT	0	0	0	600	0	1800	-1400	1800	600	525.6	14948.94
	2:59	20	OT	0	0	0	600	0	1200	-2000	1200	600	525.6	15474.54
	3:59	21	OT	0	0	0	600	0	600	-2600	600	600	525.6	16000.14
Wet Berry Line Ends	4:59	22	OT	0	0	0	600	0	0	-3200	0	600	525.6	16525.74
	5:59	23	Maint	0	0	0	0	0	0	-3200	0	0	0	0
	6:59	24	Maint	0	0	0	0	0	0	-3200	0	0	0	0

Inventory Analysis: Bin Conversion

Events	Time	Hour	Shift	Truck Inflow Dry Berries (bbl/hr)	Truck Inflow Wet Berries (bbl/hr)	Plant Consumption Dry (bbl/hr)	Plant Consumption Wet Berries (bbl/hr)	Dry Bin Capacity (bbl)	Wet Bin Capacity (bbl)	Wet Berries in Trucks (bbl/hr)	Inventory Wet Berries (bbl/hr)	Inflow Seperator (bbl/hr)	Total Output (bbl)	Cumm Output (bbl)
	6:59	0	0	0	0	0	0	0	0	0	0	0	0	0
Trucks Start / Plant Starts	7:59	1	1	515	1200	515	600	0	600	-5600	600	1115	976.74	976.74
	8:59	2	1	515	1200	515	600	0	1200	-5000	1200	1115	976.74	1953.48
	9:59	3	1	515	1200	515	600	0	1800	-4400	1800	1115	976.74	2930.22
	10:59	4	1	515	1200	515	600	0	2400	-3800	2400	1115	976.74	3906.96
	11:59	5	1	515	1200	515	600	0	3000	-3200	3000	1115	976.74	4883.7
	12:59	6	1	515	1200	515	600	0	3600	-2600	3600	1115	976.74	5860.44
	13:59	7	1	515	1200	515	600	0	4200	-2000	4200	1115	976.74	6837.18
	14:59	8	1	515	1200	515	600	0	4800	-1400	4800	1115	976.74	7813.92
Truck Lunch	15:59	9	2	0	0	0	600	0	4200	-2000	4200	600	525.6	8339.52
	16:59	10	2	515	1200	515	600	0	4800	-1400	4800	1115	976.74	9316.26
	17:59	11	2	515	1200	515	600	0	5400	-800	5400	1115	976.74	10293
Trucks End / Dry Berry Line Ends	18:59	12	2	515	1200	515	600	0	6000	-200	6000	1115	976.74	11269.74
	19:59	13	2	0	0	0	600	0	5400	-800	5400	600	525.6	11795.34
	20:59	14	2	0	0	0	600	0	4800	-1400	4800	600	525.6	12320.94
	21:59	15	2	0	0	0	600	0	4200	-2000	4200	600	525.6	12846.54
	22:59	16	2	0	0	0	600	0	3600	-2600	3600	600	525.6	13372.14
OT Starts	23:59	17	OT	0	0	0	600	0	3000	-3200	3000	600	525.6	13897.74
	0:59	18	OT	0	0	0	600	0	2400	-3800	2400	600	525.6	14423.34
	1:59	19	OT	0	0	0	600	0	1800	-4400	1800	600	525.6	14948.94
	2:59	20	OT	0	0	0	600	0	1200	-5000	1200	600	525.6	15474.54
	3:59	21	OT	0	0	0	600	0	600	-5600	600	600	525.6	16000.14
Wet Berry Line Ends	4:59	22	OT	0	0	0	600	0	0	-6200	0	600	525.6	16525.74
	5:59	23	Maint	0	0	0	0	0	0	-6200	0	0	0	0
	6:59	24	Maint	0	0	0	0	0	0	-6200	0	0	0	0

Inventory Analysis: Add Dryer

Events	Time	Hour	Shift	Truck Inflow Dry Berries (bbl/hr)	Truck Inflow Wet Berries (bbl/hr)	Plant Consumption Dry (bbl/hr)	Plant Consumption Wet Berries (bbl/hr)	Dry Bin Capacity (bbl)	Wet Bin Capacity (bbl)	Wet Berries in Trucks (bbl)	Inventory Wet Berries (bbl/hr)	Total Berry Inventory	Inflow to Seperator (bbl/hr)	Total Output (bbl)	Cumm Output (bbl)
	6:59	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trucks Start / Plant Starts	7:59	1	1	515	1200	344	800	171	400	-2800	400	571	1144	1002.144	1002.144
	8:59	2	1	515	1200	344	800	342	800	-2400	800	1142	1144	1002.144	2004.288
	9:59	3	1	515	1200	344	800	513	1200	-2000	1200	1713	1144	1002.144	3006.432
	10:59	4	1	515	1200	344	800	684	1600	-1600	1600	2284	1144	1002.144	4008.576
	11:59	5	1	515	1200	344	800	855	2000	-1200	2000	2855	1144	1002.144	5010.72
	12:59	6	1	515	1200	344	800	1026	2400	-800	2400	3426	1144	1002.144	6012.864
	13:59	7	1	515	1200	344	800	1197	2800	-400	2800	3997	1144	1002.144	7015.008
	14:59	8	1	515	1200	344	800	1368	3200	0	3200	4568	1144	1002.144	8017.152
Truck Lunch	15:59	9	2	0	0	344	800	1024	2400	-800	2400	3424	1144	1002.144	9019.296
	16:59	10	2	515	1200	344	800	1195	2800	-400	2800	3995	1144	1002.144	10021.44
	17:59	11	2	515	1200	344	800	1366	3200	0	3200	4566	1144	1002.144	11023.584
Trucks End	18:59	12	2	515	1200	344	800	1537	3200	400	3600	5137	1144	1002.144	12025.728
	19:59	13	2	0	0	344	800	1193	2800	0	2800	3993	1144	1002.144	13027.872
	20:59	14	2	0	0	344	800	849	2000	0	2000	2849	1144	1002.144	14030.016
	21:59	15	2	0	0	344	800	505	1200	0	1200	1705	1144	1002.144	15032.16
	22:59	16	2	0	0	344	800	161	400	0	400	561	1144	1002.144	16034.304
OT Starts 23:00 / Wet/Dry Berry Ends at 23:30	23:30	17	OT	0	0	161	400	0	0	0	0	0	561	491.436	16525.74
	0:59	18	OT	0	0	0	0	0	0	0	0	0	0	0	0
	1:59	19	OT	0	0	0	0	0	0	0	0	0	0	0	0
	2:59	20	OT	0	0	0	0	0	0	0	0	0	0	0	0
	3:59	21	OT	0	0	0	0	0	0	0	0	0	0	0	0
	4:59	22	OT	0	0	0	0	0	0	0	0	0	0	0	0
	5:59	23	Maint	0	0	0	0	0	0	0	0	0	0	0	0
	6:59	24	Maint	0	0	0	0	0	0	0	0	0	0	0	0