IN - PIPE TECHNOLOGY
COMPANY, LLC

## SYNOPSIS

**From information provided to Mr. Bennie J. Sellers on May 22, 2002**

**Subject: In-Pipe Technology™ Implementation**

- In-Pipe had discussions with Dennis Stack, consultant to USA Yeast, in preparing the following information.

- Since the yeast plant's wastewater will be a readily available food source for all types of bacteria, the likelihood of its creating severe odor problems is a virtual certainty because the soluble material in the yeast wastewater will diffuse throughout the lagoon at a very high rate.

- While the potential exists to utilize part or all of the plant's wastewater for an alternative recovery project (Ethanol manufacture), the plant must be up and running consistently for pilot studies prior to any commitment by an alternative recovery supplier.

- There is extremely large potential for generating large amounts of hydrogen sulfide in the pipeline between the plant and the lagoon.

- The current lagoon design and aeration strategy is inadequate because it is based upon a 5-Day BOD removal normally associated with domestic wastewater.

- The accumulation rate of solids in the lagoon will be approximately 40% faster than anticipated and require an increase in aeration capacity and cost.

- The current plan to treat yeast plant effluent (96-acre lagoon, 74 aerators in 20 acres and 12 aerators in 76 acres) will result in rapid accumulation of sludge in the 20 acre section.

- Sulfate reducing bacteria will populate the pipeline between the plant and the lagoons, producing significant amounts of hydrogen sulfide.

- This pipeline will serve as an incubator for these bacteria that will accumulate in the lagoon and produce more hydrogen sulfide than the aerators will be able to strip from the water.

- 1500 Hp of aeration capacity is probably too small by a factor of 1/3$^{rd}$ or more. Even at 2,100 Hp there is little chance to prevent major problems with hydrogen sulfide formation in the lagoons.

- At $0.05 per KWH, without any consideration for demand, the cost of operating just the 1,500 HP aerators (not including maintenance) will be 1,500 x .7457 x 0.05 x 24 = $1,363 / day. Increasing to 2,100 Hp would drive that number to $2,044 / day.

- Other financial considerations that cannot be assessed at this time include prevention of anticipated odors, periodic removal of sludge and the need for additional aeration capacity.

- IPT can perform a substantial amount of digestion without odors or the need for aeration and do so with a substantial savings.

- Since the yeast plant is not yet in operation, it is impossible to determine the ultimate costs to deal with the anticipated problems. We can only estimate these and call them 'avoided costs.'

- Similarly, it is impossible to forecast whether or not the lagoon system will be able to maintain compliance with effluent standards under this new loading condition.

- The critical aspect is to get IPT firmly established in the domestic wastewater collection system and lagoons as soon as possible. It will take several months for full IPT bacteria domination to occur.

- If IPT is applied to both the domestic wastewater system and the yeast plant effluent the potential for severe odors will be alleviated because the IPT facultative bacteria will dominate and out-compete the odor forming bacteria.

- Furthermore, the sludge accumulation rate will be very low and the need to add additional aeration will be avoided.

- If the yeast plant comes on line and the problems outlined herein are established prior to implementing IPT, the cost of remediation and mediation will be considerably higher in both financial and timeline terms.

- IPT can save money in avoided costs associated with the need for increased aeration, sludge removal and odor control.

- We offered to work with Ethanol manufactures of our acquaintance to establish a facility in Hattiesburg to take the wastewater from USA Yeast as raw material. This offer still stands, and we are prepared to move forward to bring this new business to Hattiesburg.

- Our proposal, at this time, was to engage in further dialogue on these critical matters with Hattiesburg. We submitted a request for additional information on ongoing sewer treatment operations in anticipation of preparing a budgetary proposal for our services.

- There was no response to this request or to our offer to continue our dialogue with the City.

**IN - PIPE TECHNOLOGY COMPANY, LLC**

May 22, 2002

Mr. Bennie J. Sellers, P.E., P.L.S.
City of Hattiesburg Public Services
P.O. Box 1898
Hattiesburg, MS 39403-1898

Subject: In-Pipe Technology™ Implementation
Technical Discussion and Proposal

Dear Mr. Sellers,

I am pleased to present the attached information for your review and consideration. This package details our recommendation for In-Pipe Technology™ implementation in Hattiesburg. We have broken this up into two documents, one covering the technical discussion and design considerations, and the other our Proposal for three stage implementation.

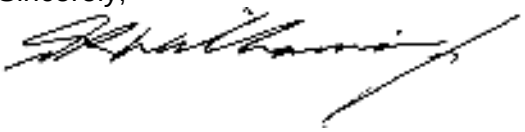
Based on the discussions that you had with our Rod Dickerson and Jack Hampton, as well as information obtained from USA Yeast's consultant Mr. Dennis Stack in St. Louis, MO, we believe that we can make a positive impact on your operations. We are concerned from the data supplied in that the yeast plant effluent may have the equivalent organic loading of a 16 MGD domestic collection system. In order to handle this additional loading, we propose the following key steps:

1. Implementation of In-Pipe treatment in the North Collection and Lagoon System, which will improve performance, improve effluent quality, and reduce the biosolids accumulation in the lagoons;
2. Implementation of In-Pipe treatment in the South Collection and Lagoon System which will prepare the system for the additional organic load anticipated later in the year. We are concerned by the equivalent loadings that this future addition will contribute;
3. Implementation of In-Pipe treatment at the yeast plant outfall, providing maximum impact on the organic load to be contributed. This will reduce the overall cost of treatment, and provide the maximum life cycle for your lagoon system.

Please review the following information and let us know when you would like to discuss this project implementation. We believe that it is critical to get the South Lagoon System ready now for the yeast plant addition later in the year. We also want to help you now to improve the operation of the North Lagoon System.

We thank you for your interest in our innovative and cost-reduction technology, and we look forward to assisting you and the City of Hattiesburg.

Sincerely,



Daniel R. Williamson Jr.
President

Our Representative Is:

Mr. Jack Hampton
1503 Glendell Circle
Columbia, MS 39429
Phone: 601.310.1808
Fax: 601.736.0199

DRW/jn
Encl.

# TECHNICAL DISCUSSION

## 1. Background

In-Pipe coordinated a discussion with Dennis Stack, consultant from St. Louis to USA Yeast, provided the following additional information concerning the expected wastewater:

1. The process produces what is known as cream yeast or liquid yeast that is sold in tankers. As such, the wastewater contains principally the remnants of nutrients at the end point of yeast growth and some small yeast cellular products.
2. The plant will use molasses as the food source and the principal contaminant of molasses is inert solids from soil. The molasses has quality standards but always contains some inert solids. These are the main components of the TSS in the wastewater.
3. Removal of TSS would not make a substantial reduction in the BOD or COD.
4. Because nearly all the BOD and COD are soluble, it is readily available food for bacteria. Some facilities utilize the wastewater in anaerobic digesters to produce methane gas for recovery; however, the capital cost of digesters often prevents this option.
5. Even though the 5-Day BOD is 6,300 mg/l and the COD is 10,000 mg/l, the ultimate BOD (that which could be digested beyond the 5-Day period) will approach the COD value. (It should be noted that other published references cite the potential to have higher organic loadings from a yeast plant than those stated above. If indeed the loading is higher, In-Pipe can easily adjust the microbe dosing to accommodate the future loadings. Conversely, if the effluent loadings are lower, adjustments can also be made in the microbe dosing.)

The conclusions that can be drawn from the foregoing are the following:

1. Removal of TSS may not be cost justified.
2. The potential for generating large amounts of hydrogen sulfide in the pipeline between the plant and the lagoon is extremely large.
3. The current lagoon design and aeration strategy is inadequate because it is based upon a 5-Day BOD removal normally associated with domestic wastewater where the difference between BOD and COD is mostly insoluble. That will not be the case in this instance.
4. Conversion of the full COD to biomass, under aerobic conditions, will result in approximately 1.0 dry weight ton of biomass per dry weight ton of COD and require considerably longer aeration time and horsepower input. The accumulation rate of solids in the lagoon will be approximately 40% faster than anticipated and require an increase in aeration capacity and cost.

5. While the potential exists to utilize part or all of the wastewater for an alternative recovery project, the plant must be up and running consistently for pilot studies prior to any commitment by an alternative recovery supplier.

2. Lagoon Impact Calculations

At 10,000 mg/l of ultimate BOD and a flow rate of 800,000 GPD, the ultimate BOD is 66,720 lbs per day. Assuming conversion to biomass yields a 3% solids content in the sludge, then the 'volume' of sludge that will be produced each day is 2,224,000 gallons or 10,983 cubic yards.

10,983 cubic yards will cover an area of 395,378 square feet 1-inch thick each day. That is roughly 9 acres at 1-inch per day accumulation. A 96-acre lagoon will accumulate 1-inch of sludge in approximately 10 days or 3 inches per month or 3 feet per year (ongoing 'digestion' at some rate by anaerobic and facultative bacteria notwithstanding). The 20-acre lagoon will accumulate sludge at a rate almost 5 times as fast due to the 66-day average detention time.

The current plan to treat the plant effluent, principally in a single 96-acre lagoon with 74 primary aerators in 20 acres and 12 aerators 76 acres will likely result in rapid accumulation of sludge in the 20 acre section. Sulfate reducing bacteria (SRB) will also likely populate the pipeline between the plant and the lagoons, serving not only a source of hydrogen sulfide, but also an incubator for SRB from sloughing that will accumulate in the sludge and produce more hydrogen sulfide that the aerators will strip from the water.

Furthermore, the 1500 Hp of aeration capacity is probably too small by a factor of 1/3$^{rd}$ or more, even assuming a very good efficiency. Even at 2,100 Hp there is little chance to prevent major problems with hydrogen sulfide formation in the lagoons, especially when sludge begins to accumulate, in addition to that formed in the pipeline.

At $0.05 per KWH without any consideration for demand, the cost of operating just the 1,500 HP aerators (not including maintenance) will be 1,500 x .7457 x 0.05 x 24 = $1,363 / day. Increasing to 2,100 Hp would drive that number to $2,044 / day.

Other financial considerations that cannot be assessed at this time include prevention of anticipated odors and the periodic removal of sludge that will accumulate together with the potential need for additional aeration capacity.

## 3. In-Pipe Technology Company, LLC

Our patented process, called In-Pipe Technology (IPT), involves the addition of extremely high concentrations of facultative bacteria to the outer reaches of the collection system to rapidly degrade organics in the wastewater while en route to the treatment facility. In so doing the bacteria multiply under all conditions within the collection system such that in addition to the pretreatment that is achieved in the treatment system, the impact on the treatment facility itself is profound. Because our bacteria operate with or without oxygen, and do not produce

noxious gases, they will become the dominant species in both the collection system and the treatment process.

Since they do not require oxygen, the demands for oxygen to achieve treatment are reduced. Furthermore, under anaerobic conditions noxious gases are not present. A second benefit of the anaerobic digestion with facultative bacteria is that the final amount of biomass that is produced is greatly reduced, often by a factor of 5 or more in the short-term and to nearly complete mineralization in the long-term.

IPT has been and continues to be applied to sewer systems serving treatment facilities that utilize aerobic digesters such as Lynn Haven, Florida for over one year. With IPT in place Lynn Haven was able to turn off the aeration of the digesters and save the substantial electrical energy used for aeration. Furthermore, the reduction in sludge of over 50% was achieved over and above the prior operation of the digesters under aerated conditions. The presence of our facultative bacteria prevented the formation of odors that would otherwise occur in such digesters if they were not properly aerated.

Given the fact that IPT can perform a substantial amount of digestion, without odors or the need for aeration in the fairly limited residence time in formal digesters, we believe that IPT can solve the potential problems Hattiesburg faces in processing the wastewater from the yeast facility and do so with a substantial savings.

## Proposal

The cost of IPT to clients is dependent upon a number of factors; however, we always generate a real cost savings in excess of our monthly fee. Furthermore, our service agreements are all performance oriented such that if a client becomes dissatisfied with the benefits being achieved the contract may be terminated.

Normal domestic wastewater has an approximate average BOD content of 300 mg/l. The yeast plant wastewater will have a BOD content roughly 20 times that of normal domestic wastewater. The 800,000 gallons per day of wastewater is the equivalent of 16 MGD of domestic wastewater from an organic loading standpoint.

Since the yeast plant is not yet in operation, it is impossible to determine the ultimate costs to deal with the anticipated problems, if such problems as odor and sludge accumulation could be dealt with at all regardless of cost. We can only estimate what these costs might be and call them ‘avoided costs.’ Similarly, it is impossible to forecast whether or not the lagoon system will be able to maintain compliance with effluent standards under this new loading condition.

What we do know is that domestic wastewater in lagoon systems can and do encounter problems with odors and sludge accumulation in addition to algae. Since the yeast plant wastewater will be readily available food for all types of bacteria, the likelihood of the section of the lagoon system where the yeast plant wastewater meets the domestic wastewater creating severe odor problems is a virtual certainty because the soluble material in the yeast wastewater will diffuse throughout the lagoon at a very high rate.

If IPT is applied to both the domestic wastewater system and the yeast plant effluent the potential for severe odors will be alleviated because the IPT facultative bacteria will dominate and out-compete the odor forming bacteria. Furthermore, the sludge accumulation rate will be very low and the need to add additional aeration will be avoided.

The critical aspect is to get IPT firmly established in the domestic wastewater collection system and lagoons as soon as possible. It will take several months for full IPT bacteria domination to occur. If the yeast plant comes on line and the problems outlined herein are established prior to implementing IPT, the cost of remediation and mediation will be considerably higher in both financial and timeline terms.

IPT can save money in avoided costs associated with the need for increased aeration, sludge removal and odor control. Because we must get IPT in place now and do not have the current operational / cost data, we can only provide our 'not to exceed' pricing for consideration with the understanding that the actual monthly service fee will be substantially lower.

The pricing structure is provided under separate cover that outlines the timelines required for implementation.

# TECHNICAL REPORT ON HATTIESBURG, MS

**May 24, 2007**

**(Modified May 31, 2008)**

**J. RODNEY DICKERSON, P.E.**

Meeting held this morning at 9:00 AM with USA Yeast, Inc, City of Hattiesburg and In-Pipe Technology (Rod Dickerson & Jack Hampton) to better understand the problem as it currently exists and consider options on dealing with the problem.

The problems, in order of importance according to COH, are sludge accumulation in lagoons, aeration capacity in lagoons and odors; however, the degree of separation between these is very small. There is also concern regarding pH of the wastewater. USA suggests, according to their sampling, the pH range is between 5.5 and 6.0. COH claims their sampling indicates the range, at both the pump station by the plant and at the end of the pipe in the lagoons, is closer to 4.0 most of the time. Estimated water temperature is 80 to 90 degrees Fahrenheit.

The pumps in the pump station have steel impellers and have required replacement seven times since the plant started five years ago. COH will investigate going with stainless steel because pump failures impacts plant production.

The pipeline from the plant to the lagoons is 16-inch and approximately 16,000 feet in length.

The plant operates 5 days at 24 hours per day, hoping to go to 24/7 in coming years. At the current production level, they generate (according to estimates because there is no effluent meter) approximately 700,000 gallons per day. They take the average fresh water meter reading and subtract approximately 200,000 gallons per day due to evaporation in cooling tower. They estimate full production flow rate to be in the 800,000 gallons per day range.

They are going to email some analytical data done by Bonner Analytical Laboratories regarding BOD, TSS, COD, nutrients and the like. Their best estimate of the BOD is 5,000 to 21,000 mg/l and the average is about 6,300 mg/l. The TSS is estimated at 600 to 700 mg/l. There are significant nutrients in the wastewater and Bonner will have those numbers.

There are approximately 120 surface aerators in the lagoons, averaging 15 Hp each. Only about half are running at any one time due to maintenance. (According to US Water Report Dec-07 it costs $250 per Hp to replace aerators and COH are all “due for replacement”…… 120 x 15 x 250 = $562,500).

They currently have no way to estimate the sludge accumulation; however, it is believed to be extremely large in the lagoon where USA discharges. The other lagoons have approximately 1-foot of sludge; however, this is spread over 93 acres of lagoons. (US Water Report also mentions need to remove “sludge mounds” but no estimate on how much to remove or cost……...if we use 1-foot over 93 acres we get 151,556 cubic yards……using a range of $10 to $25 per cubic yard for removal and disposal we get a value of $1,515,560 to $3,788,900 for sludge removal and disposal cost).

Odors are perceived at USA discharge into the lagoon and elsewhere in the lagoon. There are significant differences in opinion regarding the frequency and severity of the odor events. COH (Bennie Sellers) believes the odors to be low and infrequent; however, nearby citizen complaints indicate otherwise.

(No current money spent on odor control…..so this is an “avoided cost”……..no way to determine how much it would cost to control the odors but it will be substantial without IPT.)

We requested sewer maps, list of pump stations and KwH consumption on the pump stations and lagoon aerators. They currently spend almost nothing on odor control and only have a couple of "hot spots" --- according to Bennie Sellers. They also have several places with significant FOG troubles.
(Electrical billing does not reflect all 120 x 15 = 1800 installed Hp……..which is insufficient, even if all were "working and properly maintained"……$591,300 per year at $0.05 per KwH.)

USA is very agreeable to working with us, but is fearful of bacteria moving upstream into the plant and contaminating the product. They fight intruders from the air, raw materials and water constantly. The general agreement was that to the best way to ensure IPT does not go backwards into the plant is to inject our bacteria immediately downstream of the check valve in the force main. They have a tap located there for sampling that we can use.

There are approximately 60 pump stations in COH, plus several in Petal. The gross flow is estimated at 10 MGD, including USA. (However, due to USA Yeast loading it is closer to 20 MGD in "strength…….or "organic loading"……see below).

We have requested the information on pump stations including KwH per location and KwH consumption at the lagoons. We have also requested sewer maps, including those for Petal. COH has assured us that they will make those available ASAP. Jack will follow up with Bennie Sellers and Mark Jordan to get this information early next week and forward to Wheaton.

The total amount of sludge presents a challenge and we agreed to think about how we might estimate it. My rough calculations show USA alone puts out 36,000 lbs/day of BOD at about 20X "normal" domestic loading. If we assume 1,800 to 2,000 per MGD for city, we have a total BOD load approaching 60,000 lbs/day.

At roughly 1.0 lbs of solids per 1.0 lbs of BOD we can easily see that there are, literally, millions of pounds of sludge in those lagoons.

I will perform calculations when I get back to Homer and get a better handle on the situation and what we can do to help.

Based upon everything I can see so far, the city is faced with spending somewhere between $2.5 and $5.0 Million in capital expense to clean up the lagoons, do mechanical repairs and get aerators going……plus another $1.0M or so to try and get enough aeration going to meet effluent compliance.

The additional aeration electrical cost will add another $500K per year in electrical, not to mention maintenance, boosting electrical cost to well over $1.0M per year at lagoons and this is at $0.05 per KwH.

I have no idea how much they would have to spend on alternative odor control.

It will take IPT dosing about 60 to 90 days to get odors under control at lagoons, including cleaning out most of the sewer piping and up to 6 months to remove most of the sludge in the lagoons and bring effluent into compliance. There may still be some excursions during this time as the bacteria consume the accumulation of sludge while working on new organic loading entering the system from ongoing loading plus sewer cleaning.

After 6 months a review and evaluation must be made to determine what, if any, modifications to aeration are needed to achieve maximum treatment, in addition to the installation of baffles to control flow through lagoons. It can't be determined at this time if anything will need to be done in that regard; however, I do not believe that much, if anything, will need to be done.

If IPTC were going to propose this one (and we are talking about two lagoons with combined flow of about 10 MGD) with estimated loading of at least 20 MGD…..we would propose at $3,000 per MGD or $60K per month and probably discount is to $50K per month.

This would give COH a positive savings on immediate capital costs along with an equal savings on avoided costs associated with increased electrical costs……..not even counting the cost of odor control and compliance.

It will take you about two to three weeks to get installed and IPTC will need at some lead time on that many panels……I don't know how long or what we have in the pipeline…….my guess is at least a month of lead time.