PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2017

Drainage Water Recycling

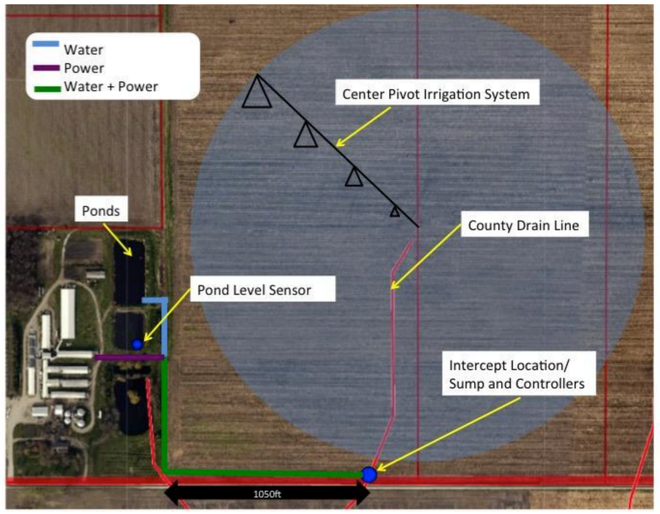
Agricultural & Biological ENGINEERING

Sherly Chen (Machine Systems), Stephen Kines (ENRE), Neil Underwood (ASM), and Stephen Ussery (ENRE)

Background/Problem:

The project site for this design is located in southern Tippecanoe County and belongs to Jim Moseley. The primary field is 160 acres and is currently tile drained. The field is equipped with a center pivot irrigation system, which covers 137 acres.

Potential Farm Layout



Mr. Moseley's farm also currently has two ponds, which are filled by a well and supply the irrigation water. The total volume of these ponds is approximately 7.7 million gallons. Mr. Moseley is interested in rerouting the water from the subsurface drainage and using this water to fill the ponds, so that it can be reused as irrigation water for the field.

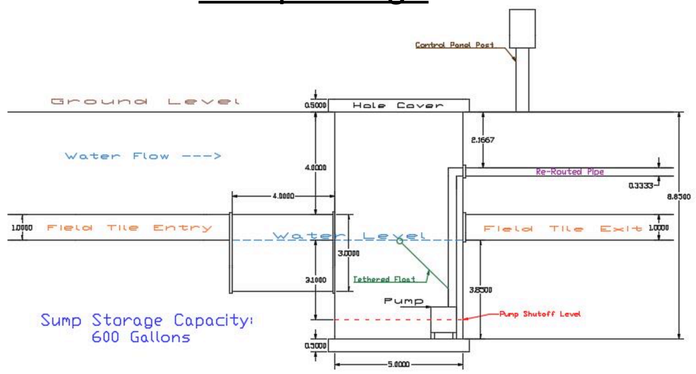
Design Criteria/Constraints:

- Must be fully automated with control system that turns on the pump when water is in the sump and water level is below maximum capacity in the ponds
- Must maximize efficiency by capturing largest amount of water possible to be held in ponds
- Cannot impact tile drainage flow when system is not in service or malfunctions
- Can only use single phase electricity with less than a five volt voltage drop
- Cannot disturb current agricultural operations
- Must be easily operational and repairable if necessary
- Must be cost effective over the life of the product

Design Elements:

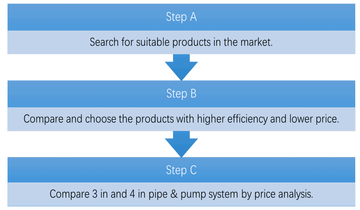
- Holds a minimum of 600 gallons
- Constructed by ADS
- Made of triple wall polypropylene pipe
- Large enough to enter for maintenance

Sump Design



Pump and Piping

- Target flow rate:
  - 100 GPM
- Calculated head loss
  - 3 in pipe-32 ft
  - 4 in pipe-65 ft



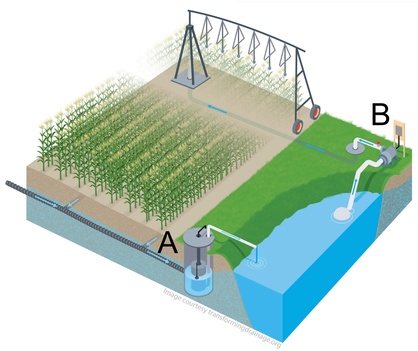
- BJM R 1520 with 4 in pipe
- Motor power 2HP
- Estimated bearing life 20 years.

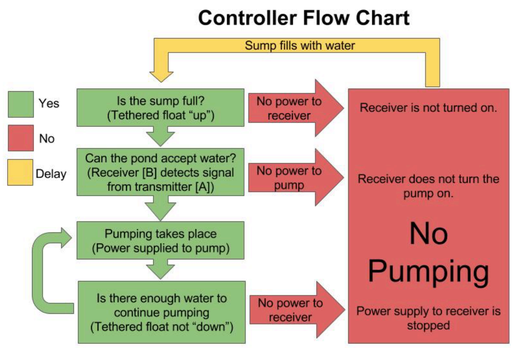
Wiring and Conduit

Wire Size	Length (ft)	Resistance (ohms/Kft)	Total Resistance (ohms)	Voltage Drop (percent)
1 AWG	2195	.1239	.5439	3.31
2 AWG	2195	.1563	.6862	4.17
3 AWG	2195	.1970	.8648	5.27

- 4.17 volts of voltage drop
- 2 AWG THHN Wire
- ¾ inch Schedule 40 PVC Conduit

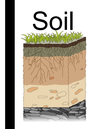
Controller and Sensor Logic

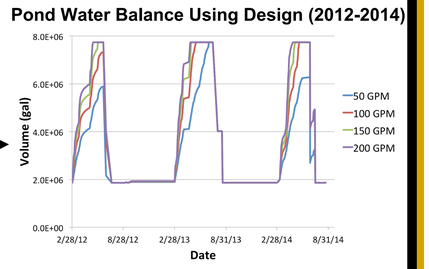




- Power at the sump location must run through the float sensor and receiver in order to reach the pump.
- Piggyback water level sensors at the pond and sump will restrict power when desired conditions are not met
- This setup will make future repair and maintenance easy to implement

Water Balance:





- 100 GPM = Min flow rate that achieves max efficiency
- 19% of drain flow would be captured annually
- 32% of irrigation water would be provided via drainage

Cost Breakdown:

Design Element	Cost ($)
Sump	2,493
Pump	1,725
Controller	2,374
Piping	3,480
Wiring	2,350
Conduit	440
Excavation	4,775
Approx. Total Design Cost	17,637

Global/Social Impact:

- Nitrogen runoff causes $82 million (Indiana = 11%) in losses annually to Gulf fishing and tourist industries.
- This design will help reduce nutrient runoff by allowing Mr. Moseley to capture it and reapply on his fields.
- This model of drainage water recycling will demonstrate benefits firsthand to local farmers.

Client:
Jim Moseley
Former Deputy Secretary of Agriculture

Sponsor:
Jane Frankenberger Ph.D

Technical Advisor:
Margaret Gitau Ph.D

Instructors:
Robert Stwalley Ph.D, PE
Bernard Engel Ph.D, PE

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