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TECHNICAL MEMORANDUM

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REGISTERED
PROFESSIONAL ENGINEER
12-4-2023

To:	Diana Washington, P.E., Washington State Department of Ecology
From:	John Wells, P.E., Anderson Perry & Associates, Inc.
Subject:	Wastewater System Improvements for Permit Compliance – Othello, Washington
Date:	December 4, 2023
Job/File No.	6091-42
cc:	City of Othello

Background

The City of Othello, Washington's (City) wastewater collection, treatment, and disposal system was initially constructed in the 1950s. The existing wastewater treatment facility (WWTF) was completed in its current form in 1981 and has undergone many minor modifications since then.

The City's current wastewater treatment facility is an unlined lagoon treatment facility with two primary treatment lagoons, a cascade aerator, two secondary treatment lagoons, a polishing lagoon, chlorination, and no headworks. The treated effluent is discharged into Owl Creek. The City received new permit limits under NPDES Waste Discharge Permit No. WA0022357 requiring sampling for BOD, TSS, pH, dissolved oxygen, fecal coliform, total ammonia, copper, cyanide, mercury, nickel, zinc, and residual chlorine. The City has struggled to meet permit limits in the past, so interim limits were provided to allow the City time to refine their treatment process. However, since the permit became effective on October 1, 2020, the existing facility is not capable of consistently meeting the interim or final permit limits outlined in the City's NPDES permit.

Wastewater disposal into a surface water body is becoming more strictly regulated. This is most challenging with regard to metals and nutrient removal standards. It is likely that subsequent future permit updates would further tighten the requirements, and designing simply for the current given limits may not be adequate for long-term planning. The following memo outlines possible wastewater treatment and disposal options for Othello, explores treatment plan alternatives, and recommends those that are the most viable alternatives for the long-term treatment and disposal of the City's wastewater.

Nonstructural Alternatives

Nonstructural alternatives typically refer to operational changes that might help improve the City's treatment efficiencies. Unfortunately, facultative lagoons do not offer much in the way of operational flexibility. However, there are some minor structural changes, including constructing baffles in the lagoons, installing a floating cover over the final lagoon cell, or adding a rock filter dike at the final lagoon's outlet, which may help improve the City's existing operations if implemented. These modifications are anticipated to make the chlorination process more effective and reduce TSS and pollutant concentration; however, they will likely only assist in meeting the interim permit limits and will not aid in achieving all of the final metals effluent limits for the long-term solution. The nonstructural alternatives may be considered as near-term potential improvements, but these alternatives are not included for consideration for the long term solution.

Lagoon Treatment

Typically, lagoon treatment systems are relatively shallow earthen basins with an impermeable liner and either mechanical aerators on floats or subsurface bubble diffusers with air supplied by blowers on the bank. The aerators provide oxygen for the microbial activity, which reduces BOD and TSS by metabolization, and mixing to keep some portion of the microbes in suspension. Biosolids will accumulate over time in the bottom of the lagoon, particularly in dead spaces between aerators. Lagoon systems are simple to operate and maintain, have relatively inexpensive capital costs, and are often more resilient to upset than mechanical treatment plants. Disadvantages to lagoon systems include their large space requirements, the lack of operational flexibility, and the inability to produce effluent qualities as high as those produced by mechanical treatment plants without substantial tertiary treatment such as cloth media filters.

The City's existing lagoon treatment system could be updated by providing aeration. Typical options for providing aeration include mechanical surface aerators and submerged diffusers. Advantages of mechanical surface aerators include ease of maintenance, operational flexibility, better horizontal mixing, and cost. Disadvantages include greater susceptibility to ice damage during colder weather and lower power efficiencies than their diffused air counterparts. Advantages associated with diffused air include greater power efficiencies due to increased oxygen transfer per unit of horsepower; however, disadvantages include higher capital costs, substantially greater maintenance needs, and reduced operational flexibility. In addition to these general disadvantages, the uneven bottoms in the City's existing lagoons are anticipated to create challenges for mounting air diffuser hardware. For these reasons, any aeration upgrades for the City of Othello's wastewater treatment facility are recommended to be mechanical surface aerators. The lagoon treatment option is explored as an alternative treatment option later in this memo.

Lagoon treatment technology is not anticipated to be capable of reaching the final effluent limitations outlined in the City's existing NPDES permit. As a result, all alternatives that consider the use of lagoons for secondary treatment of the City's wastewater will also include alternatives for disposal of the City's treated wastewater that cease all discharge to Owl Creek, including storage ponds and land application.

Fixed growth processes

Multiple fixed growth process technologies for wastewater treatment are available for consideration, including rotating biological contactors (RBCs), trickling filters, and various activated sludge processes with fixed film carriers (also known as integrated fixed film-activated sludge).

RBCs first became widespread in the United States in the 1970s; however, they have been shown to have lower performance at design loadings and substantial maintenance concerns that have led to a sharp decline in their use over the past 30 years. As a result, RBCs were not considered further.

Trickling filters have been used since the late 1800s and have shown initial success; however, they have been shown to have lower performance at design loadings than other technologies. Additionally, trickling filters struggle to accomplish biological nitrogen and phosphorus removal, and solids generated via trickling filter use are not easily removed from the waste stream without additional treatment due to poor settling characteristics. As a result, trickling filter technologies were also removed from consideration.

Integrated fixed film activated sludge (IFAS) processes have typically been implemented in recent years to improve existing activated sludge systems without the need to expand the footprint of said systems. IFAS uses a form of typical activated sludge process with submerged media for fixed growth. Though this technology provides reliable treatment in a smaller footprint than traditional activated sludge processes, it has substantial operational and maintenance costs. Power costs are typically higher due to the need for elevated dissolved oxygen levels for adequate fixed growth diffusion. The submerged media cause additional head loss through the basins and must often be removed for diffuser maintenance. Furthermore, capital costs for facility construction often struggle to compete with many traditional activated sludge technologies currently available in the market. While IFAS works well for retrofitting existing activated sludge facilities, it is not the most effective solution for new installations and has therefore been removed from consideration.

Suspended Growth Processes

Suspended growth treatment typically refers to a mechanical wastewater treatment process that provides enough mixing, often through aeration, to maintain the microorganisms responsible for treatment in suspension. The most common category of suspended growth processes is activated sludge. There are numerous forms of activated sludge processes. Sequencing batch reactors (SBRs), oxidation ditches, and extended aeration facilities have been frequently used successfully in smaller municipalities. In addition, some municipalities opting for the development of reclaimed water through the treatment of their wastewater have implemented membrane bioreactor (MBR) facilities.

Though SBRs have more operational flexibility than extended aeration facilities, the process controls and maintenance procedures are quite complicated. For this reason, SBRs were not considered further as a part of this evaluation. Oxidation ditches are proven to be highly reliable and lend to simple operation; however, they require larger footprints and are much more difficult to expand than other suspended growth processes. Othello is expected to grow beyond the 20-year planning horizon. Due to the difficulty of future expansion, oxidation ditches were excluded from further consideration.

Extended aeration facilities may have less operational flexibility than SBR facilities but are far simpler to operate and maintain. Furthermore, extended aeration facilities are capable of providing high-quality effluent and treating highly variable loads. Additional unit processes can be added to provide biological nitrogen and phosphorus removal if needed, as well as other tertiary treatment. This balance of flexibility and maintenance simplicity, along with the high effluent quality, prompted further consideration of an extended aeration facility for Othello.

The extended aeration-activated sludge facility is anticipated to be able to aid in consistently meeting a majority of the interim permit limits outlined in the City's NPDES permit; however, the extended aeration system is not anticipated to be capable of meeting several final permit requirements outlined in the City's NPDES permit without substantial tertiary treatment processes. These tertiary treatment processes for metal removal and temperature control are generally cost-prohibitive and require substantial maintenance attention. As a result, all viable options for the extended aeration-activated sludge facility assume that new methods of disposal must be pursued, and all discharge to Owl Creek must be eliminated.

Reverse Osmosis

The reverse osmosis (RO) process is a tertiary treatment process accomplished by using extremely fine membranes. It can filter the wastewater to such a level that it removes metals and nutrients from the wastewater, but it is very energy intensive. The City could continue disposal to Owl Creek, but at this level of treatment, the wastewater could also be reused elsewhere. Disadvantages to using an RO process include disposal of the brine produced by the filtered-out constituents, the high capital costs and operational costs due to energy consumption, and the complicated maintenance. While it is recognized that a mechanical treatment facility process followed by reverse osmosis treatment and discharge to Owl Creek would work, the expenses associated with this plan excluded this alternative from further consideration.

Land Treatment

Land treatment alternatives are typically implemented to provide nutrient removal or other polishing of wastewater that may or may not be treated by other sources. In addition to treatment, it also serves as a wastewater disposal option. Typical land treatment systems refer to the application of wastewater that has been treated to secondary treatment standards to a crop for additional nutrient removal. Per the Washington State Department of Ecology's (Ecology) Guidance on Land Treatment of Nutrients in Wastewater, with Emphasis on Nitrogen, published in 2004, "Ecology approves as AKART the design, and operation and maintenance for land treatment systems that includes: 1) the application of wastewater and its nutrients at rates, times, and durations that do not exceed the crop's agronomic rates, and 2) the storage of wastewater in properly lined lagoons that is produced in excess of the crop's requirement or outside of the growing season." Because the agronomic rate for crops varies with crop type, soil quality, and location, the required sizes for land treatment sites will also vary. Additionally, due to nutrient uptake only occurring during the growing season, storage facilities must be provided for the off-season storage of wastewater. Aside from water volume, nitrogen is the primary agronomic rate of concern, as nitrate is the only nutrient readily available and used by crops that is regulated by the Ground Water Quality Standards. As a result, total nitrogen must be considered when determining loading rates applied to the land treatment system. However, it has been consistently shown that concentrations of nitrogen and other nutrients typically found in municipal wastewater are low enough that wastewater application rates are governed more by hydraulic agronomic rates, not nutrient agronomic rates. In Othello, three forms of land treatment systems are anticipated to be feasible depending on the amount and type of land available: alfalfa crop, pasture grass, and constructed wetlands.

1. Alfalfa is a commonly grown crop with well-documented agronomic rates for both nitrogen and water; alfalfa can remove 150-250 pounds of nitrogen per acre per year, depending on hay production. Many land treatment facilities use alfalfa due to high demands for alfalfa hay and its flexibility in regard to irrigation management. Additionally, alfalfa is a perennial crop with relatively deep root systems which provide protection against groundwater leaching. Disadvantages include the need for deeper soils to provide a good crop and therefore effective nitrogen removal. If appropriate soils for alfalfa growth were located, up to 400 acres of alfalfa are anticipated to be needed to accommodate the hydraulic loading from the City's treated wastewater.

2. Pasture grass is another commonly grown crop due to its demand for cattle feed coupled with the ease of maintenance. Grazed pasture grass typically consumes 25-50 pounds of nitrogen per acre per grazing per year, with approximately three grazing equivalents available per year.

Assuming a total nitrogen concentration of 15 mg/L after lagoon treatment and a nitrogen uptake of 40 pounds/acre/grazing/year, or 120 pounds of nitrogen per year, up to 500 acres of pastureland would be required. However, for pasture grass, hydraulic loading is still the limiting agronomic rate for the crop grown. As a result, 600 acres of pasture grass are required to allow application of the City's projected wastewater production.

3. Constructed wetlands are gaining substantial popularity in many parts of the United States for both treatment and disposal of wastewater. Wetlands consume and reduce nutrients through a variety of processes. Direct consumption of nitrogen occurs as wetland plants grow, and wetlands provide environments for a polyculture of micro- and macroorganisms that contribute to the nitrogen cycle. The EPA's *Design Manual – Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment* indicates a detention time of five to seven days can reduce TKN to less than 10 mg/L. Wetlands can function as both a wastewater final treatment component and a disposal method.

   At Othello's future design average annual flow of 1.25 MGD, a wetland with total volume of 7.5 million gallons will be required to provide an average 6-day detention time. At an average depth of 1 foot per the guidance in the EPA Design Manual, the treatment wetlands would have a total surface area of approximately 23 acres if no biological nutrient removal were to be used for nitrogen reduction as a part of the City's treatment facilities. These treatment wetlands, if needed, would be lined to prevent the disposal of untreated wastewater. Following any treatment wetlands, unlined disposal wetlands would be provided to allow the treated wastewater to percolate back into the shallow groundwater. The size of the disposal wetland varies based on existing depth to groundwater, soil transmissivity rates, and other environmental factors, such as evaporation and precipitation. Soils surveys and past experience with the soils in the vicinity of the existing treatment lagoons show concerns with shallow, unweathered bedrock. If a potential wetland disposal site were identified, preliminary geotechnical investigations and transmissivity testing would be required to determine the viability of this option. Total acreage for wetland disposal is likely 200 to 300 acres, although it could be smaller depending on infiltration and existing groundwater conditions.

   The primary pathways for wetland disposal in Washington typically require at least Class B reclaimed water to be produced prior to wetland disposal. As a result, any alternatives considered for wetland disposal that do not produce reclaimed water quality effluent will require agency coordination to determine if a permitting pathway under a state waste discharge permit could be identified.

Feasible Alternatives

Based on the viability of the processes discussed above, several long-term alternatives for treating and disposing of the City's wastewater have been prepared. Tables A and B show alternatives for stabilizing and disposing of wastewater. Alternatives 1, 2, and 3 discussed below should be further considered. Alternatives 4 through 7 were evaluated and rejected from further consideration primarily for reasons stated previously. Due to the anticipated costs and potential for additional expansion, each alternative has been prepared assuming that the City will cease discharge to Owl Creek and develop new methods of beneficial use or disposal of treated wastewater. Feasible identified alternatives include the following: reclaimed water production via suspended growth with biological nutrient removal (BNR) and disposal via an existing wetland or beneficial reuse; wastewater treatment via suspended growth with BNR, lined wetland polishing, and ultimate disposal via unlined wetlands; and aerated lagoon improvements with land treatment of the City's treated wastewater. Each of these alternatives is outlined in greater detail below.

Alternative 1 - Suspended Growth with BNR, Disposal to Existing Wetland or Reuse

The first recommended alternative for Othello's wastewater treatment facility utilizes a suspended growth process with tertiary treatment to remove nitrogen and phosphorus as needed, and wastewater disposal to either existing wetlands or through reclaimed water uses. Under this alternative, the City's existing lagoons would be replaced with either an extended aeration-activated sludge process with tertiary filtration or a membrane bioreactor treatment facility. This facility would require new headworks, the secondary treatment process itself, BNR processes, effluent disinfection, sludge digestion, and sludge drying capabilities.

After disinfection, the wastewater may either be pumped to an existing wetland for disposal or conveyed to another location for reuse. Both options require the discharged water to meet Class A reclaimed water standards or consistently meet high treatment requirements for BOD, TSS, TKN, and phosphorus content, as stated in WAC 173-219-390(16) and (17). The available tertiary treatment options that are easily integrated with the extended aeration process are able to meet these standards. There are several wetlands located close to the City's existing wastewater treatment facilities that may be ideal candidates for reclaimed water disposal; however, site classification of the existing wetlands would be required prior to design of the treatment facilities. Per WAC 173-219-390, Category I wetlands and Category II wetlands with special characteristics are not permitted for reclaimed water use under normal circumstances.

Potential options for reuse include irrigation of City turf or delivery to a farmer for irrigation. For this use, the City must obtain a Reclaimed Water Permit. Any wastewater not used for beneficial reuse would then be sent to the wetlands.

It is estimated that 10-15 acres of land would be required for the construction of the treatment facility. Some of the existing lagoons would be lined and repurposed for equalization storage and emergency storage during treatment upset or other maintenance procedures as needed to protect the wetlands and reclaimed water users in the event of a temporary decrease in reclaimed water quality. If needed, some of the existing lagoons could also be lined and repurposed to provide reclaimed water storage if enough demand for reclaimed water was identified.

Advantages of this alternative include the following:

- High flexibility with reuse options due to the high quality of reclaimed water proposed for production.
- Easier to expand into the future to accommodate growth than other alternatives.
- Lower footprint requirements than Alternatives 2 and 3.
- New water resource.

Disadvantages of this alternative include the following:

- Higher operating costs.
- Anticipated to receive a level 3 operator classification per WAC 173-230-330.
- Water Right Impairment analysis required.

Alternative 2 - Suspended Aeration Treatment Facility, Disposal to Constructed Wetlands

The second recommended alternative also uses mechanical treatment with an activated sludge, extended aeration process. The facility itself would be built as described in Alternative 1; however, due to the proposed method of disposal, tertiary treatment for nitrogen and phosphorus removal would not be needed within the facility. This alternative proposes discharge to a constructed, lined wetland for further nutrient treatment, followed by disposal to either a constructed, unlined wetland or an existing wetland. Depending on the effluent quality from the mechanical treatment facility, additional treatment from the lined wetland may not be necessary, only requiring space for an unlined wetland. It is estimated that 200-300 acres of land may be required for the facility and wetland areas, though the area could be smaller depending on soil depth. The existing lagoons would be repurposed for equalization and emergency storage as outlined in Alternative 1. This alternative would require further discussion with Ecology and the Washington State Department of Health to identify if a State Waste Discharge Permit pathway could be identified, or if a Reclaimed Water Permit would be required. Should a State Waste Discharge permit be used, groundwater quality standards consistent with WAC 173-200 must be met.

Advantages of this alternative include the following:

- Potential for regulation under a State Waste Discharge Permit.
- Anticipated to receive a level 2 operator classification per WAC 173-230-330.
- Lower capital costs than Alternative 1.

Disadvantages of this alternative include the following:

- Higher operating costs.
- Lower flexibility for disposal options than Alternative 1.
- Higher footprint requirements than Alternative 1.

Alternative 3 - Aerated Lagoon Improvements, Land Treatment

The third recommended alternative for Othello consists of aerated lagoon improvements coupled with land treatment. Under this alternative, the existing lagoon facility would require the construction of a new headworks to provide mechanical screening; power and controls improvements to facilitate the installation of the new aerators; installation of a liner in the lagoon bottoms; and the potential raising of the lagoon dike heights to facilitate aerator installation while allowing for appropriate oxygenation. For disposal, a new effluent storage pond would need to be constructed for storing effluent during the non-growing season, and conveyance and irrigation equipment would be required to deliver the effluent to the land treatment site. Land requirements depend primarily on the crop and soil quality. However, a preliminary estimate suggests 450-600 acres may be needed. This alternative would require a State Waste Discharge Permit since it is unlikely a lagoon treatment system could reliably and consistently meet Class B Reclaimed Water quality standards.

Advantages of this alternative include the following:

- Regulation under a State Waste Discharge Permit.
- Lower operating costs than Alternatives 1 and 2.

- Anticipated to receive a level 2 operator classification per WAC 173-230-330.

Disadvantages of this alternative include the following:

- Most challenging to expand as the City grows.
- Largest footprint requirements.
- May require the largest wastewater conveyance system, depending on land availability.
- Only feasible if suitable land can be located.

Alternative 4 - Fixed Film Treatment, Constructed, Unlined Wetland

As discussed previously, this alternative was rejected from further consideration because the fixed film treatment process is not the most effective for new facilities or converting existing lagoon for utilities.

Alternative 5 – Mechanical Treatment, Tertiary Treatment, Discharge to Owl Creek

As discussed previously, this alternative was rejected from further consideration because of the difficulty of meeting potential future NPDES discharge limits to discharge to Owl Creek.

Alternative 6 – Mechanical Treatment, Reverse Osmosis, Discharge to Owl Creek

As discussed previously, this alternative was rejected because of the high cost of treatment to be able to discharge to Owl Creek.

Alternative 7 - No Action

This alternative was rejected because it was not able to meet current or future Owl Creek discharge limits. A “no action” alternative is commonly considered to help frame the range of possible decisions. However, the City’s existing infrastructure cannot meet either the interim or final NPDES Permit limits without improvements. Leaving the facilities as they are, may result in formal enforcement action, including assessment of civil penalties and/or a Department order. Therefore, the no-action alternative is not considered feasible for wastewater treatment and effluent disposal for long-term planning and will not be discussed further.

Next Steps

The City is looking for guidance from Ecology regarding the alternative analysis presented in this memorandum. If Ecology agrees that the above outlined alternatives are feasible for consideration, then additional evaluation will proceed for the three selected alternatives and a recommended alternative will be selected from the feasible alternatives. The completed analysis will be included in the facility plan to be submitted to Ecology for review and approval.

JW/tb

CITY OF OTHELLO, WASHINGTON
WASTEWATER FACILITIES PLAN
WASTEWATER TREATMENT AND DISPOSAL CONCEPTS

Concept Relations:

Green — **Treatment Method**
Orange — **Anticipated Tertiary Treatment**
Blue — **Effluent Disposal Method**

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Overall Concept	**Mechanical Treatment Facility** **Biological Phosphorus Removal** **Existing Wetland or Reuse***	**Mechanical Treatment Facility** **Constructed, Lined Polishing Wetland (if required)** **Constructed, Unlined Wetland**	**Aerated Lagoon Improvements** **Land Treatment*****	**Fixed Film Treatment** **Constructed, Unlined Wetland**
Regulatory Requirements	Discharged water must be Class A or consistently meet high BOD, TSS, TKN, and phosphorus requirements. Reclaimed Water Permit	Discharged water must be Class A or Class B to be disposed of in a constructed wetland. It may be a lower quality if it meets the requirements of RCW 90.46.090(2). Reclaimed Water Permit or State Waste Discharge Permit	Must meet Technology-Based Effluent Limit requirements and be applied at agronomic rates. State Waste Discharge Permit	Discharged water must be Class A or Class B to be disposed of in a constructed wetland. It may be a lower quality if it meets the requirements of RCW 90.46.090(2). Reclaimed Water Permit or State Waste Discharge Permit
Capital Improvements	New Headworks Activated Sludge Treatment with BNR Biological Phosphorus Removal Pumping and Conveyance to Existing Wetland or Reuse Sludge Dewatering and Storage	New Headworks Activated Sludge Treatment Lined Polishing Wetland (if required) Unlined Disposal Wetland Sludge Dewatering and Storage	Headworks Upgrade Aeration Improvements Effluent Storage Pond Land Treatment System (Irrigation)***	New Headworks Fixed Film Treatment with BNR Unlined Disposal Wetland Sludge Dewatering and Storage
Land Requirements	10 to 15 acres Use Existing Ponds for Equalization Storage	200 to 300 acres** Use Existing Ponds for Equalization Storage	450 to 600 acres***	200 to 300 acres**

*Reuse options may include City turf irrigation or delivery to farmer.
**Area could be much greater depending on soil depth.
***Land requirements depend on crop and soil types/quality.

BNR = biological nutrient removal
BOD = biochemical oxygen demand
Ecology = Washington State Department of Ecology
NPDES = National Pollutant Discharge Elimination System
RCW = Revised Code of Washington
TKN = total Kjeldahl nitrogen
TSS = total suspended solids

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CITY OF
OTHELLO, WASHINGTON
WASTEWATER FACILITIES PLAN
WASTEWATER TREATMENT AND DISPOSAL CONCEPTS

TABLE
A

CITY OF OTHELLO, WASHINGTON
WASTEWATER FACILITIES PLAN
WASTEWATER TREATMENT AND DISPOSAL CONCEPTS

Concept Relations:

Green **Treatment Method**
Orange **Anticipated Tertiary Treatment**
Blue **Effluent Disposal Method**

	Alternative 5	Alternative 6	Alternative 7
Overall Concept	**Mechanical Treatment Facility** **Significant Tertiary Treatment Necessary** **Discharge to Owl Creek**	**Mechanical Treatment Facility** **Reverse Osmosis Plant** **Discharge to Owl Creek**	**Existing Lagoon Treatment** **Discharge to Owl Creek**
Regulatory Requirements	Must meet all standards of the NPDES Permit issued by Ecology, with limits subject to change with every permit renewal cycle. NPDES Permit	Must meet all standards of the NPDES Permit issued by Ecology, with limits subject to change with every permit renewal cycle. NPDES Permit	Must meet all standards of the NPDES Permit issued by Ecology, with limits subject to change with every permit renewal cycle. NPDES Permit
Capital Improvements	New Headworks Activated Sludge Treatment with BNR Phosphorus Removal Metals Removal Temperature Control Sludge Dewatering and Storage	New Headworks Activated Sludge Treatment with BNR Reverse Osmosis Treatment Facility Brine Disposal Sludge Dewatering and Storage	No Action Option
Land Requirements	10 to 15 acres	10 to 15 acres	

*Reuse options may include City turf irrigation or delivery to farmer.
**Area could be much greater depending on soil depth.
***Land requirements depend on crop and soil types/quality.

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TABLE
B