Plant Peak Capacity Improvements
Primary Tanks 1 and 2 Rehabilitation
54" Primary Influent Rehabilitation
East-West Plant Flow Metering


Project Purpose:

The purpose of this project is to increase the peak flow capacity of NSWWTP, to prevent overflows during peak flow events, and to improve peak flow operational flexibility and performance.

Project History and Status:

This project was included in the 2016 Liquid Processing Facilities Plan. The proposed improvements were identified based on an analysis of existing and future peak flows, existing plant hydraulics, and future capacity needs at NSWWTP. District staff has encountered hydraulic bottlenecks in the plant that have resulted in tank overflows during peak flow events. This project would relieve these bottlenecks and provide better treatment reliability and flexibility during peak flows.

Additional related supporting goals include replacing the existing 54" East Primary Influent pipe, addressing structural issues and concrete deterioration associated with Primary Settling Tanks Nos. 1 and 2 and metering flows to the East and West plants.

Alternatives:

The following alternatives were evaluated in detail in the 2016 Liquid Processing Facilities Plan:

<u>Alternative PF0–No Change (Null Alternative)</u>
In this alternative, peak flow management at NSWWTP would remain unchanged and there is no investment in additional infrastructure to handle peak flows. As described earlier, the existing

plant is not capable of passing the anticipated future peak flows and hydraulic analyses indicate that structure overflows would result from flows over approximately 145 mgd. This would result in untreated or partially treated wastewater overflowing to the NSWWTP site and potentially flooding buildings or flowing off-site and discharging to surface waters.

Alternative PF4–Aggressive I/I Removal

This alternative describes a program to aggressively reduce I/I in MMSD's conveyance system and the community customer systems tributary to MMSD's system. This I/I reduction alternative was included to help define the level of effort and high level costs to establish, implement, and administer a program to aggressively reduce I/I.

Alternative PF6–Influent Equalization at NSWWTP and pass 145 MGD through NSWWTP

In this alternative, peak flows up to 145 mgd (the approximate hydraulic capacity of the existing NSWWTP facilities) will be conveyed to the plant. Future peak flows above 145 mgd will be stored in a new influent equalization structure and released to the plant as flows subside following high flow events. Included in this alternative are the following modifications:

- Construct new influent equalization tank (approximately 10 million gallons)
- Install a new interceptor to convey peak flows above about 145 mgd to the equalization tank from the splitter structure upstream of the primary clarifiers at NSWWTP
- Install a drain line from the equalization tank to Pump Station No. 11 and flushing system
- Alternative Consideration: If the tank were constructed near Pump Station No. 11, flow could be diverted directly to the tank from the pump station.

Alternative PF7–Upgrade NSWWTP Hydraulics to Pass 180 mgd

In this alternative, all wet weather flows are conveyed to and through the NSWWTP in a manner that minimizes plant operational impacts and process overflows and provides the capability to have a more equitable flow split between the west and east plants during peak flow events to better utilize the capacity within the west plant. This alternative achieves the goals of better utilizing the west plant, better controlling the flow split between the west and east plants, better controlling the flow to the lagoons and the disinfection building, and preventing in-plant overflows.

Included in this alternative are the following modifications to improve plant hydraulics at peak flows:

- Construct bypass channel for west primary clarifiers
- Raise west final clarifier influent channel walls
- Construct new lagoon diversion structure to provide flexible flow control to the lagoons and flow conveyed from the east plant to the disinfection building
- Upgrade lagoon return pump station and force main

Alternative PF8–Double NSWWTP Effluent Pumping Capacity and Upgrade Plant Hydraulics to Pass 180 mgd

This alternative would eliminate diversions to the lagoons and Nine Springs Creek by improving plant hydraulics and increasing process capacities so that the 180 mgd peak flow can be disinfected and pumped to the discharges at Badfish Creek and Badger Mill Creek. The west plant hydraulic improvements included in PF7 are also included in this alternative. An additional secondary effluent pipe to convey flow from the east plant to the disinfection building would also be required. In addition, the UV disinfection capacity of the plant would be increased from the current capacity of approximately 100 mgd to the future peak flow of 180 mgd. This alternative includes larger and/or more effluent pumps and a second force main from NSWWTP to the outfall location at Badfish Creek. A second force main was assumed to be necessary based on the age of the existing piping (approximately 60 years) and a surge analysis conducted to the effluent force main for this planning project.

Alternative PF9–Upgrade NSWWTP Hydraulics to Pass 180 mgd with Increased Nine Springs Creek (NSC) Discharge Frequency

This alternative is nearly the same as Alternative PF7 except that some flow would be directly discharged to NSC during wet weather/peak flow events in addition to overflows from the lagoons. The current UV disinfection capacity of 100 mgd and effluent pumping capacity of approximately 80 mgd will be maintained in this alternative. Effluent from the disinfection building in excess of the effluent pumping capacity will continue to be conveyed to the Effluent Storage Reservoirs. The flow from these reservoirs will combine with any secondary effluent from the east plant at a new effluent diversion structure as described in PF7. Peak flows from this structure will be split to two locations: a portion of the flow may be sent to the lagoons and a portion discharged directly to NSC. During peak flow events above the effluent pumping capacity of 80 mgd, but less than about 100 mgd, all diversion flow at this structure will be sent to the lagoons. When flows exceed 100 mgd, the flow in excess of 100 mgd will be sent to a high rate disinfection system located near the diversion structure and discharged directly to NSC. Therefore, during a peak flow event of 180 mgd, approximately 80 mgd would be discharged using the existing effluent pumping system, 80 mgd would be disinfected and discharged to NSC, and 20 mgd would be discharged to the lagoons.

Based on WDNR's draft water quality memorandum received on February 13, 2017, any permitted discharge to NSC would also need to receive tertiary treatment and would need to improve water quality in the phosphorus impaired segment, which would require limits that are less than the water quality criteria. These requirements are based on NSC being listed as impaired for phosphorus and TSS. Therefore, this alternative would also require a new tertiary treatment facility to receive secondary effluent. For planning purposes, these include a new filter influent pumping station, new deep bed granular media filters, chemical addition facilities, and chemical coagulation facilities.

Alternative PF10–High-Rate Treatment at NSWWTP

This alternative includes the implementation of a biological contact (BC) high-rate treatment process in which mixed liquor or return activated sludge (RAS) is combined with wet weather flows in a small contact chamber. This would occur in Pass 3 of each of the 10 aeration basin trains. The BC process relies on the removal of particulate and colloidal material by biological flocculation in the contact chamber and provides limited soluble substrate uptake. Biological contact has generally been shown to be a cost-effective solution for WWTPs with flow peaking factors up to approximately three to four times the average design flow rate.

Effluent quality from the BC process is expected to achieve less than 15 mg/L of TSS and $cBOD_5$ in a well operating clarifier. Daily effluent NH_3-N and TP could be higher than conventional secondary treatment depending upon the level of dilution and treatment and would need to be further investigated during preliminary design if this alternative is selected for implementation.

Included in this alternative are the modifications that are included in PF7, along with new slide gates and control valves with electric actuators at pass 3 of each aeration train

Key Risks and Issues

The key social, environmental, and other nonmonetary considerations of each alternative are summarized in Table 1.

Table 1 - Peak Flow Management Alternative Nonmonetary Considerations Summary

Alternative	Benefits	Limitations
Alternative PF0–No Change (Null Alternative)	▪ No changes in plant equipment or processes for staff to become accustomed to.	▪ Does not address hydraulic constraints in the plant that will lead to tank overflows at future peak flows. ▪ Does not improve the level of service of any processes. ▪ Does not improve the level of service with respect to diversion to lagoons and overflow of lagoons to NSC. ▪ Health and safety concerns associated with overflows of untreated wastewater on site. ▪ Potential to discharge untreated wastewater to the environment as a result of tank overflows running off-site. ▪ Risk of damage to structures and equipment during overflow events. ▪ Legal and regulatory opposition to overflows and operating a plant without adequate capacity. ▪ Negative public perception from lack of action related to plant capacity issues.
Alternative PF4–Aggressive I/I Removal	▪ Addresses peak flow problem at the source so costs for correcting problem are aligned with the source of the problem. ▪ Promotes local responsibility for addressing peak flows at the community customer and property owner level. ▪ Reduces the risk of basement backups (costs, health risks, and emotional stress). ▪ If successful, can reduce or eliminate the costs associated with collection system and treatment plant infrastructure upgrades associated with hydraulic capacity. ▪ Improves system resiliency if successful. ▪ Potentially reduces energy consumption as a result of reduced pumping. ▪ Could help to promote/improve public perception of MMSD as a good steward of the environment and resources. ▪ Could help to promote customer community/MMSD cooperation.	▪ Long-time frame is required for implementation. ▪ Success is difficult to demonstrate in the short-term. ▪ Requires significant cooperation among numerous governmental entities; difficult to coordinate. ▪ There may be resistance from property owners if they are required to undertake private property repairs. ▪ Public perception of MMSD could be negative if benefits of program are not properly communicated or if the program does not meet expectations. ▪ Could create tension between community customers and MMSD if requirements for I/I reduction at community customer level are perceived as onerous. ▪ Successful results and outcomes cannot be assumed, and infrastructure capacity upgrades may, therefore, still be required before I/I reduction success can be demonstrated. ▪ MMSD's overall wet weather peaking factors are relatively low, which equates to lower confidence in achieving desired outcomes.
Alt. PF6–Influent Equalization at NSWWTP and pass 145 MGD through NSWWTP	▪ Provides improved peak flow management, flexibility, and control to operations staff for both short-term and long-term operations. ▪ Reduces extreme peak flow rates through the NSWWTP, which could improve overall treatment performance during extreme wet weather events and eliminate in-plant overflows. ▪ Provides more efficient use of the West Plant facilities, which should improve treatment efficiency during wet weather events. ▪ Low construction risk and low risk of failure; relatively simple to construct. ▪ Does not require significant space at the plant. ▪ Dual-purpose site could become a public recreational asset (soccer fields, etc.)	▪ Does not significantly improve the level of service with respect to diversion to lagoons and overflow of lagoons to NSC. ▪ Potential staff safety and public aesthetics concerns during tank cleaning. ▪ Requires staff to go off-site for maintenance activities. ▪ Tank cleaning will result in solids handling and management requirements; may be able to flush to Pump Station 11. ▪ Repumping of influent wastewater is required (higher energy). ▪ Likely would be constructed on a greenfield site; loss of farmland and the natural setting. May be public concerns regarding siting. ▪ Potential odors following wet weather events. ▪ Discharges to NSC might be permitted differently in the future.
Alt. PF7–Upgrade NSWWTP Hydraulics to Pass 180 mgd	▪ Provides improved peak flow management, flexibility, and control to operations staff for both short-term and long-term operations. ▪ Provides more efficient use of the West Plant facilities, which should improve treatment efficiency during wet weather events. ▪ Low construction risk and low risk of failure; relatively simple to construct. ▪ Does not require additional space at the plant or greenfield development. ▪ Eliminates in-plant overflows, protecting existing equipment and facilities. ▪ Public perception of alternative likely to be positive	▪ Does not improve the level of service with respect to diversion to lagoons and overflow of lagoons to NSC. ▪ Discharges to NSC might be permitted differently in the future. ▪ Does not meet process objective of maintaining acceptable clarifier solids loading rates at high flows

Alternative	Benefits	Limitations
Alt. PF8–Double NSWWTP Effluent Pumping Capacity and Upgrade Plant Hydraulics to Pass 180 mgd	▪ Provides improved peak flow management, flexibility, and control to operations staff for both short-term and long-term operations. ▪ Provides more efficient use of the West Plant facilities, which should improve treatment efficiency during wet weather events. ▪ Provides full treatment of all flows. ▪ Eliminates lagoon overflow concerns; significantly reduces or eliminates the associated unknown future permit requirements associated with a NSC discharge. ▪ Provides redundant effluent pumping capacity for improved reliability of that critical system. ▪ Provides redundant effluent force main. Allows for more cost-effective maintenance and rehabilitation work. ▪ Maintains discharge flow to Badfish Creek.	▪ Difficult construction of additional large diameter piping to the disinfection building, as well as for the additional effluent pump station and effluent force main through the NSWWTP site. ▪ Requires some additional space at the plant in congested areas. ▪ Requires significant infrastructure investment that would largely be unutilized or underutilized during much of its life. ▪ Construction impacts through environmental corridors and green fields for the force main installation ▪ Potential public perception issues related to construction and traffic impacts. ▪ Potential impacts to Badfish Creek with respect to streambank erosion from higher peak flows; uncertainty if increased flow would be able to be permitted. ▪ Potentially takes the District in a direction away from a potential future local discharge to NSC and the Madison Lakes. ▪ Potentially takes the District in a direction away from decentralized treatment opportunities because of the significant cost to implement. ▪ Does not meet process objective of maintaining acceptable clarifier solids loading rates at high flows
Alt. PF9–Upgrade NSWWTP Hydraulics to Pass 180 mgd with Increased Nine Springs Creek Discharge Frequency	▪ Eliminates effluent pumping costs, which would enable the District to better meet its energy and efficiency goals. It is noted, however, that any future tertiary treatment on site will likely require the addition of an intermediate pump station. Power use will decrease overall, however. ▪ Eliminates the significant risk associated with a potential failure of the effluent force main to BFC. ▪ Would provide the ability to meet future low level phosphorus limits if BFC and BMC discharges continue and adaptive management and/or trading programs are not deemed to be cost-effective. ▪ Directs resources at the District to towards initiating a long-term plan and program to establish a future local discharge to NSC and the Madison Lakes on a continuous basis. It changes the concept of peak flow management and potential long-term discharge locations. ▪ Provides improved peak flow management, flexibility, and control to operations staff for both short-term and long-term operations.	▪ The regulatory viability of a local NSC discharge is unknown at this time. ▪ May require political strategies to change state statues related to a NSC discharge. ▪ Requires significant additional space at the plant. ▪ Would likely require load trading for the relatively small amount of phosphorus and TSS discharged to NSC through the new outfall ▪ Does not meet process objective of maintaining acceptable clarifier solids loading rates at high flows
Alt. PF10–High-Rate Treatment at NSWWTP	▪ Low construction impact. Installation of West Primary Clarifier high flow channel to the primary effluent channel significantly less disruptive than alternatives requiring additional tankage and processes. Significantly less large diameter piping required. Less construction will translate into fewer impacts on neighbors from dust, traffic, and noise. ▪ Maximizes investment in existing infrastructure while improving peak flow treatment by utilizing existing tankage and aeration equipment for treatment. ▪ The environmental impacts of new storage or treatment facilities construction are avoided. ▪ Saves NSWWTP space for other uses or future construction. ▪ No chemicals required. ▪ Fast start-up under wet weather conditions. ▪ Simple operations compared to operating a dedicated wet weather treatment plant. ▪ Reduces asset management requirements and maintenance requirements compared to a dedicated wet weather treatment facility. ▪ Proven wet weather treatment system. ▪ Nonproprietary. ▪ Similar or better treatment efficiency anticipated. ▪ Eliminates concerns with permitting a wet weather treatment facility. ▪ Meets both process and hydraulic capacity goals	▪ Does not increase overall NSWWTP wet weather treatment capacity relative to a dedicated excess flow treatment technology; however, the existing plant has adequate hydraulic capacity with the improvements included in this alternative to treat peak flows in existing tankage.

Economic Analysis

The present worth analysis completed for the Liquid Processing Facilities Plan is presented below.

	PF0 Null	**PF4 Aggressive I/I[a]**	**PF6 Influent EQ**	**PF7 NSWWTP Hydraulic Upgrades**	**PF8 Effluent Pumping Upgrades**	**PF10 Biological Contact**
Total Opinion of Capital Cost	**$0**	**$4,100,000**	**$65,300,000**	**$4,100,000**	**$71,300,000**	**$ 5,200,000**
Annual O&M	$773,000	$11,000,000 to $16,000,000	$777,000	$ 774,000	$738,000	$782,000
O&M Cost PW	$10,200,000	$80,000,000 to $175,000,000	$10,200,000	$10,200,000	$9,700,000	$10,300,000
Salvage PW	$0	($400,000)	($7,300,000)	($400,000)	($6,500,000)	($400,000)
Total Opinion of Present Worth	**$10,200,000**	**$84,100,000 to $179,100,000**	**$68,200,000**	**$13,900,000**	**$74,500,000**	**$ 15,100,000**

[a] Annual O&M and present worth costs are the total projected program costs for the District, its customers, and private efforts.

Project Recommendation

The following recommendations are provided with respect to peak flow management for the District and at the NSWWTP:

1. Implement Alternative PF10, which includes the hydraulic capacity upgrades at the NSWWTP included in Alternative PF7, as well as upgrades to allow the activated sludge process to operate in a biological contact process mode during high flow events. This alternative provides protection against in-plant tank overflows and will provide improved treatment under high flow conditions.

2. Begin evaluating in more detail potential paths forward related to implementing Alternative PF9, which includes initiation of a local permitted discharge to NSC. This alternative would be a first step towards a potential continuous future discharge to NSC at the District, which could significantly reduce energy consumption at the NSWWTP by eliminating the effluent pump station, and would account for a large percentage of the needed energy reduction goals to ultimately attain electrical neutrality at the NSWWTP. Our recommendation is to begin planning with the WDNR for an approximate 5 or 10 mgd tertiary treatment facility that would provide acceptable effluent for discharge to NSC for wet weather events. Added benefits of this alternative include the ability to

evaluate low level phosphorus removal over a long term to develop costs for comparison to the adaptive management planning program and to act a first step in establishing a continuous, local discharge to NSC.

3. Consider initiating an aggressive I/I reduction pilot study (Alternative PF4). The study would be focused on identifying one or more areas with high I/I rates, and then implementing aggressive I/I reduction measures with the goal of quantifying successes and challenges for future additional measures in other areas. In addition to the pilot study, The District should consider evaluating a monetized triple bottom line for this alternative to help compare the potential total costs with other alternatives. An aggressive I/I program will require public and private investment, significant coordination and collaboration from multiple communities and entities, and a concentrated long-term effort from the District, and a triple bottom line analysis would help in quantifying the significant social and environmental benefits and costs.

It is also recommended that the 54-inch East Primary Influent pipe be replaced as part of this project due to its critical role in conveying flows to the East Primary Tanks at an approximate cost of $800,000. Additionally, concrete rehabilitation of East Primary Tank Nos. 1 and 2 is recommended to maintain the usefulness of these tanks before the deterioration becomes too severe at an approximate cost of $450,000. Finally, the issue of metering flows to the east and west plants was discussed during facilities planning and it was agreed that flow metering would provide Operations staff with valuable information. A cost of $150,000 will be allocated for this initiative based on an in-pipe flow metering technology which is discussed further in the facilities plan.

Project Schedule:

	Start	Completion
Planning	2016	2017
Design	2018	2019
Construction	2019	2020

Financial Summary (2019$):

Total Project Cost – Plant Peak Capacity Improvements	
District Staff & Engineering	$917,000
Contractor	$4,593,000
Total	$5,510,000

Total Project Cost – Primary Tanks 1 & 2 Rehabilitation	
District Staff & Engineering	$84,000
Contractor	$392,000
Total	$476,000

Total Project Cost – 54” Primary Influent Rehabilitation	
District Staff & Engineering	$138,000
Contractor	$711,000
Total	$849,000

Total Project Cost – East-West Plant Flow Metering	
District Staff & Engineering	$25,000
Contractor	$138,000
Total	$163,000

Fiscal Year Allocation (2019$):

Plant Peak Capacity Improvements

	2017	**2018**	**2019**	**2020**
Engineering	$9,000	$255,000	$262,000	$391,000
Construction	$0	$0	$459,000	$4,134,000
Total	$9,000	$255,000	$721,000	$4,525,000

Primary Tanks 1 and 2 Rehabilitation

	2017	**2018**	**2019**	**2020**
Engineering	$1,000	$22,000	$23,000	$38,000
Construction	$0	$0	$39,000	$353,000
Total	$1,000	$22,000	$62,000	$391,000

54” Primary Influent Rehabilitation

	2017	**2018**	**2019**	**2020**
Engineering	$1,000	$39,000	$40,000	$58,000
Construction	$0	$0	$71,000	$640,000
Total	$1,000	$39,000	$111,000	$698,000

East-West Plant Flow Metering

	2018	**2019**	**2020**
Engineering	$7,000	$8,000	$10,000
Construction	$0	$14,000	$124,000
Total	$7,000	$22,000	$134,000