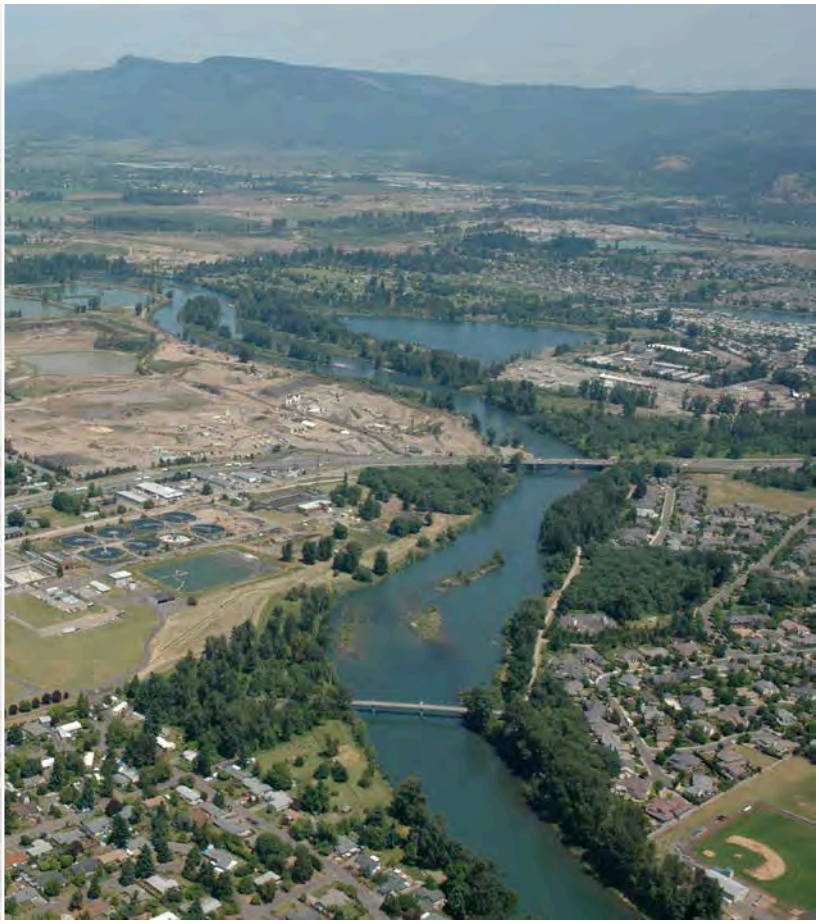
Industrial Aggregate Recycled Water Use Planning Study

Eugene-Springfield, Oregon

Final Report



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0 TABLE OF CONTENTS

1 Introduction and Background 1
1.1 Study Description 1
1.2 Study Goals 2
1.3 Study Partners and Stakeholders 3
1.3.1 Conceptual Project Partners 3
1.3.2 Water Resource Agencies 4
1.3.3 Watershed Conservation Organizations 5
2 Conceptual Project Planning StudIes 6
2.1 Water Quality Needs Assessment 6
2.1.1 Industrial Water Quantity Need 6
2.1.2 Industrial Water Quality Need 6
2.1.3 Recycled Water Quality Comparison 7
2.1.4 Recycled Water Use and Handling Requirements 7
2.2 Water Rights Management Assessment 8
2.2.1 Existing Water Rights Conditions 9
2.2.2 Water Rights Under Recycled Water Use 9
2.2.3 Instream Flow Management 10
2.3 Water Balance Modeling 10
2.3.1 Modeling Framework 11
2.3.2 Water Flows and Capacities 13
2.3.3 Industrial Water Demands 13
2.3.4 Recycled Water Use and Fate 14
2.3.5 Modeled Water Balances 15
2.3.6 Thermal Load Benefits 17
2.4 Engineering Feasibility Study 17
2.4.1 Conceptual Design Assumptions 18
2.4.2 Conceptual Design Specifications 19
2.4.3 Costing and Energy Demands 20

2.4.4 Permitting and Compliance Issues 21
2.5 Stakeholder Acceptability Evaluation 22
2.5.1 Industrial Operator Considerations 22
2.5.2 Water Resource Agency and Organization Input 23
2.5.3 Community Acceptability Assessment 23
2.6 Triple Bottom Line Cost-Benefit Analysis 24
2.6.1 Strategic Goals and SWOT Analysis 25
2.6.2 Triple Bottom Line Methods and Reporting 25
2.6.3 Project Cost-Benefit Overview 26
3 Study Conclusions and Recommendations 28
3.1 Overall Feasibility of Industrial Recycled Water use 29
3.2 Potential Assets/Drawbacks 29
3.3 Further Considerations to be Made 30
APPENDICES 31
Appendix A - Internal technical memoranda 32
Appendix B - Project Design and Cost-Benefit Analysis 33
Appendix C - Water Balance Model Documentation 34
Appendix D - Stakeholder Outreach 35

1 INTRODUCTION AND BACKGROUND

1.1 STUDY DESCRIPTION

The Eugene/Springfield Metropolitan Wastewater Management Commission (MWMC) will study the feasibility of expanding recycled water use to neighboring industrial aggregate partners in lieu of river and groundwater sources. The potential demand is over 3 million gallons per day (MGD) and could be the first recycled water use in Eugene/Springfield outside of MWMC's facilities. This use could potentially provide more efficient use of water resources, benefits to river temperature and habitat, and enhance green business practices. The proposed study includes analytical water balance modeling, engineering design scoping, water quality evaluations, water rights issues assessment, stakeholder acceptability, and triple bottom line (TBL) cost/benefit analysis. Potential industrial applications for recycled water include gravel washing, concrete and asphalt production, equipment rinsing, and dust control. These applications could demonstrate safe and effective recycled water use to the greater community, potentially expanding interest in regional use of recycled water for resource sustainability and water quality benefits.

The Industrial Aggregate Recycled Water Use Study employs several key, inter-related studies:

(1) Water Quality Needs Assessment. The water quality demands, capabilities, and management requirements for higher classes of recycled water production need to be assessed to ensure project feasibility and to inform design requirements. Questions to be answered via this assessment include: What are the water quality requirements for industrial uses? How do recycled water classes compare with user needs? What treatment modifications, monitoring, and testing are needed to ensure quality control? What are the recycled water handling requirements, including systems modifications and site control needs?

(2) Water Rights Management Assessment. Understanding the fate of water rights held by the industrial properties is essential to assessing the TBL project benefits and stakeholder acceptability of the project. Industrial partners will need to consider whether water rights remain available to them as a secondary source of water, and how any project impact on water rights could affect property values. Water rights retained as instream flow would add to the environmental benefits of the project and the goals of maintaining river flows and temperatures for habitat benefits.

(3) Water Balance Modeling. A carefully designed and executed computer model to simulate water mass balance and thermal loading will be developed under this study. The model will answer key questions regarding water flows and peak capacity between the treatment plant and the industrial operations, offsets to treatment plant discharge and industrial withdrawals from surface- and well-water, fate and transport of used process water to industrial site settling ponds, and thermal loading changes on the Willamette River.

(4) Engineering Feasibility Study. The most critical aspect of the overall study is an understanding of the engineering requirements to consistently produce the required class of recycled water at the treatment plant, pumping and delivering recycled water at required flows and pressures, connecting to one or more of the three 12-inch diameter recycled-water-ready pipelines via new piping on public and private property, ensuring appropriate utility clearances along the pipe route, energy

demand and pump station requirements, and site use distribution system requirements. The MWMC regional staff and consultant team will address all of these issues through critical engineering analyses and problem solving, providing findings and recommendations via technical memoranda that will be used to inform other study aspects (such as cost-benefit analysis) as well as future project design.

(5) Stakeholder Acceptability Evaluation. The political feasibility of the project is as important as the technical feasibility of construction for project implementation. The overall study includes a user and community Stakeholder Acceptability Evaluation to consider how both recycled water use requirements and stakeholder needs are drivers to project recommendations and design issues. Industrial operators and site personnel will be queried to determine operational and informational project needs. Local officials, agency partners, and community stakeholders will be engaged to ensure potential political hurdles are addressed and community support has been gained.

(6) Triple Bottom Line Cost-Benefit Analysis. The project addresses multiple potential benefits and involves multiple stakeholders; the study includes a cost/benefit analysis that evaluates the environmental, socio-cultural, and economic assets and impacts associated with the proposed recycled water use. Consultants with expertise in TBL economics will identify energy and life cycle costs, environmental impacts, value-added benefits, and financial requirements, among other factors, in assessing the overall project benefit for the local community.

1.2 STUDY GOALS

This planning study is part of a broader, longer-term study conducted by the MWMC. The MWMC has completed an initial recycled water implementation scoping phase of work followed by a first phase of implementation planning. Phase 1 study provided a conceptual alternative assessment of potential recycled water uses in the Eugene-Springfield area that could help the MWMC achieve regulatory compliance goals. Phase 1 recommended four conceptual uses for Phase 2 study of project feasibilities. Those four conceptual uses were (1) Delta Sand & Gravel uses for aggregate production, (2) Knife River Corporation use for concrete and asphalt production, (3) MWMC storage and irrigation use at its Beneficial Reuse Site, and (4) MWMC expanded use at its Biocycle Farm poplar plantation.

The Delta Sand & Gravel and Knife River projects are collocated. This study provides an initial feasibility assessment of both of those collocated projects. Given the context of this study as both a feasibility assessment of industrial aggregate recycled water use as well as component study informing a longer-term recycled water implementation planning study, its goals are both near-term and short-term.

Near-Term Goal: Determine the feasibility of a project to (1) provide reliable, cost-effective, and environmentally beneficial recycled water use of approximately 3 MGD for industrial aggregate and construction products, and (2) serve as a demonstration site for fostering community interest in future recycled water use.

Long-Term Goals: (1)Maintain thermal load compliance to meet Willamette River water quality and habitat needs; (2) make more efficient use of water resources through recycled water use in lieu of

freshwater sources; (3) contribute to local energy efficiency and recycled material content goals; and (4) gain visibility, recognition, and community support for recycled water use.

This study helps achieve the near-term and long-term goals by providing answers to (1) thermal load and water use benefits through water balance modeling, (2) operational benefits through engineering and water quality management studies, (3) constructability through engineering assessments and cost-benefit analyses, and (4) community acceptability through stakeholder engagement and demonstrations.

1.3 STUDY PARTNERS AND STAKEHOLDERS

1.3.1 CONCEPTUAL PROJECT PARTNERS

The direct stakeholders in this study are the MWMC, Delta Sand & Gravel, and Knife River Corporation.

MWMC - The MWMC is the sponsoring agency funding and managing the study. The MWMC has been pursuing recommendations prescribed in its *2004 Facilities Plan* for implementing and expanding recycled water use. The MWMC has implemented recycled water use at its own agricultural management operations, but has not yet expanded use to non-MWMC partners. The MWMC needs to consider its regulatory compliance costs, long-term recycled water production and use strategy, and factors favorable to increasing sustainable resource recovery from the wastewater treatment plant.

Delta Sand & Gravel - As one of the industrial users under study, Delta Sand & Gravel could benefit or be impacted by operating costs, water reliability, health and safety requirements, community sustainability, and water rights impacts. Delta proudly touts its involvement in projects of significance in the local community. On its website (*www.deltasg.com*), Delta cites the following community projects in which Delta played a role:

- Springfield's MLK Parkway Roundabout and the Jasper Trunk sewer upgrade
- Willamalane Park & Recreation's Clearwater Park Boat Landing
- University of Oregon's PK Park baseball stadium and Matthew Knight Arena basketball and entertainment venue.
- Eugene Water & Electric Board's Roosevelt Operations Center
- Sacred Heart's RiverBend regional medical center in Springfield
- The Justice Department's Wayne Morse federal courthouse in Eugene

Delta management has expressed support and enthusiasm for potentially being a partner in a project that helps the community meet regulatory goals in a cost-effective way and in protecting the Willamette River. Delta's long-term vision is reclamation of gravel pits for recreational and habitat value.

Knife River - As one of the potential industrial users participating in the study, Knife River could benefit or be impacted by operating costs, water quality and reliability, product performance, health and safety requirements, customer satisfaction, green product assets, and water rights impacts. Knife River cites its potential partnership with the MWMC in its *2012 Corporate Responsibility Report*, stating:

We have just started testing the use of wastewater from the joint Eugene/Springfield wastewater treatment plant. That plant puts millions of gallons of treated water in the Willamette River each day, some of which could be a potential source for making concrete. We also may be able to use the water for dust control in our yard.

1.3.2 WATER RESOURCE AGENCIES

Eugene Water & Electric Board (EWEB) - EWEB is the local drinking water utility in Eugene providing service to urban water users around the wastewater treatment plant and recycled water pipelines. EWEB is interested in recycled water as a complementary water source, has a stake in local water quality and reliability, and considerations for future water conservation/supply strategy.

EWEB's *Water Management Conservation Plan* (December 2011) references the MWMC's recycled water planning as follows:

> *Reuse, Recycling, and Non-Potable Water Opportunities. For residential and commercial/industrial customers, EWEB provides technical assistance to customers interested in rainwater harvesting. EWEB also coordinated design and installation of a rainwater harvesting system in mid-2010 at the Water Wise Demonstration Garden. EWEB and the Metropolitan Wastewater Management Commission (MWMC) currently are involved in the implementation planning phase of a recycled water program; the initial phase of work will include community involvement, demonstrations, and alternatives evaluation. For commercial and industrial customers, EWEB provides technical assistance for graywater reuse projects upon request.*
>
> *Five-Year Benchmark: Within the next 5 years, EWEB will continue to explore opportunities for water reuse and recycling, such as on playing fields and golf courses.*

Oregon Association of Clean Water Agencies (ACWA) - As the statewide organization of stormwater management and wastewater treatment facilities, ACWA promotes advances in community integration in wastewater management and sharing of information and models that help other wastewater treatment facilities cost-effectively and efficiently meet their compliance and operating goals. ACWA is supportive of recycled water project advances in Oregon and was supportive of this study effort to further the understanding of recycled water use and feasibility.

Oregon Department of Environmental Quality (ODEQ) - The ODEQ is the agency responsible for administering many aspects of the Clean Water Act, including the issuance of National Pollutant Discharge Elimination System (NPDES) and Water Pollution Control Facility (WPCF) discharge permits to wastewater producers, development of water quality standards including the total maximum daily loads (TMDLs) for the Willamette basin, and for ensuring recycled water use compliance with state rules. The DEQ will ultimately approve the MWMC's NPDES permit, including a recycled water use plan, which will address the Willamette TMDL for temperature.

Oregon Water Resources Department (OWRD) - The OWRD administers water rights including instream flow requirements; registers uses of recycled water; and promotes water conservation, reuse, and storage to meet Oregon's water resource needs.

1.3.3 WATERSHED CONSERVATION ORGANIZATIONS

The Freshwater Trust (TFT) - As the organization promoting water rights leasing incentives to maintain instream flows for habitat benefits, TFT supports the concept of recycling water for uses that currently require water withdrawals. TFT could play a role in the outcome and management of water rights under the proposed project. TFT is currently actively engaged with the MWMC's riparian restoration projects to mitigate river temperature loading.

McKenzie Watershed Council (MWC) - The McKenzie Watershed Council is the parent host to the McKenzie Confluence Group, an advisory panel of stakeholders concerned about water quality, restoration, and land management issues in and around the confluence of the McKenzie and Willamette Rivers. The Eugene-Springfield wastewater treatment plant and the industrial aggregate operations considered for conceptual recycled water use are part of the confluence area.

Long Tom Watershed Council (LTWC) - The Long Tom Watershed Council includes stewardship of the Willamette/Flat Creek drainage, in which all of the MWMC's facilities are located. The Council was engaged as a Phase 1 stakeholder and has been involved for the past several years in exploring the potential interest and concerns for recycled water use, including potential for stream flow augmentation to benefit local habitat and water quality. There is interest in the environmental benefits of water recycling from the Council. There may also be additional outreach benefits for the MWMC in building a stronger awareness of the MWMC and wastewater management in the Amazon Creek and Flat Creek basins of the watershed.

This section summarizes the key findings and important details comprising the Industrial Aggregate Recycled Water Use Planning Study. The sub-sections below present each of the six main study elements completed in fulfillment of the Water Conservation, Reuse, and Storage grant agreement:

- Water Quality Needs Assessment
- Water Rights Management Assessment
- Water Balance Modeling
- Engineering Feasibility Study
- Stakeholder Acceptability Evaluation
- Triple Bottom Line Cost-Benefit Analysis

Various technical memoranda (tech memos), reports, and other documents were developed during each study element. Each of the documents as referenced in the sections below are included as appendices to this report.

2 CONCEPTUAL PROJECT PLANNING STUDIES

2.1 WATER QUALITY NEEDS ASSESSMENT

Purpose: The purpose of this study element was to assess the water quality and quantity requirements of the industrial aggregate operations to match recycled water production needs.

Finding: Based on this assessment, the study team recommends Class A recycled water (the highest class of recycled water) produced and delivered at rates of up to at least 6 MGD to the industrial facilities. Additionally, better understanding of the comparative water quality of Willamette River water at the point of use and the MWMC's recycled water is needed to better communicate the safety of recycled water use.

Studies: The following reports were developed in documenting the findings of this study element:

- Internal Tech Memo 08: Industrial Aggregate Water Quantity, Quality, and Handling Requirements

The results of these studies are described below in the following sub-sections:

- Industrial Water Quantity Need
- Industrial Water Quality Need
- Recycled Water Quality Comparison
- Recycled Water Use and Handling Requirements

2.1.1 INDUSTRIAL WATER QUANTITY NEED

The combined pumping capacities of Delta Sand & Gravel and Knife River for river and groundwater, equals 5,150 gpm, equivalent to 7.41 MGD. However, based on a 10-hour operational day of maximum pumping, the demand is 3.09 MGD (over 24 hours). This distinction between instantaneous flow rate and average flow rate over a 24-hour day is important for the MWMC's recycled water production considerations and the net daily thermal load benefits from diverting effluent for water recycling. The 3.09 MGD use is a maximum. Due to seasonal reductions in construction demands during winter months and other operational constraints, demand could be significantly reduced.

2.1.2 INDUSTRIAL WATER QUALITY NEED

For most of the industrial aggregate operations, water quality demands are fairly basic in that water must be of quality to adequately clean gravel, rinse equipment, and provide dust control. The exceptions are concrete and asphalt batching, which have specific water quality limitations. Concrete batching is understood to be the most critical as water chemistry plays a role in how concrete cures. Knife River's groundwater well (assumed to be the 200-foot deep well in OWRD records) may supply higher quality water for concrete batching than can be supplied by the Willamette River. The basic

water chemistry of well water, as tested for critical concrete parameters by Knife River, appears identical to that of river water.

Temperature is important to the production of aggregate. In winter, the Delta Sand & Gravel operation typically slows considerably due to low demand for construction materials as well as cold weather conditions, which may cause icing of equipment (per discussions with Delta personnel). Knife River reportedly uses the warmer water provided by the groundwater well in the winter and also heats water for use – including washing of aggregate to warm materials up to more optimal temperatures for production.

2.1.3 RECYCLED WATER QUALITY COMPARISON

The Oregon recycled water use rules approve the use of Class C recycled water for all of the industrial aggregate processes in use at the Delta Sand & Gravel and Knife River sites. The MWMC's recycled water is similar in water quality to the Willamette River source currently used for aggregate product production with the exception of total dissolved solids, which are an order of magnitude higher in recycled water. However, the total solids count in recycled water is well below the 50,000 parts per million total solids limit for concrete batching. The MWMC's median Class D recycled water analysis for bacteria as *E. coli* (at 3 colonies/100 mL) is also below that of the Willamette River (at 55 colonies/100 mL) as reported by the ODEQ (2006 *Willamette Basin TMDL*)..

Furthermore, recycled water meets the critical water quality parameters for concrete batching (ASTM 1602) by orders of magnitude (for each chloride, sulfate, total solids, and alkalinity). The MWMC partnered with Knife River in 2011 to pour a test batch of concrete mixed with the MWMC's Class C recycled water (produced on a trial basis). The results of that trial were positive, with concrete water quality needs and cured concrete strength testing thresholds having been met. Further understanding of Willamette River water quality would be helpful to provide a better comparison of recycled water and river water characteristics

The thermal load of treatment plant effluent could be a water quality benefit for industrial aggregate use. The average daily temperature of treatment plant effluent is approximately 5°C (3°F) greater than that of the Willamette River. That temperature difference could play a valuable role for reducing energy requirements to meet winter temperature needs for concrete and aggregate production.

2.1.4 RECYCLED WATER USE AND HANDLING REQUIREMENTS

The industrial aggregate facilities currently use non-potable river water for their operations. Therefore, substituting recycled water for industrial processes would not face the typical concerns of moving from a potable to a non-potable water supply in terms of historical use practices. The Oregon recycled water use rules approve the use of Class C recycled water for all of the industrial aggregate processes at the Delta Sand & Gravel and Knife River sites. However, the amount of worker exposure to water at the Delta facility, in particular, generated discussion between the project study team and

the industrial operation managers (April 30, 2013 meeting) about worker safety, permissible exposure levels, and overall risks. Class C recycled water use carries the following requirements:

- Controlled site access through fencing, etc.
- Setbacks of water use from fenced perimeters
- Signage notifying visitors and personnel of recycled water use
- Informing of site personnel of recycled water impotability and safety precautions

The ODEQ's Recycled Water Use Plan Internal Management Directive (IMD) requires additional notification to site workers, the public, and other potentially affected parties. The IMD's suggested notification practices include a facilities health and safety training program. Consultant recommendations call for a Site Supervisor Training program as part of the project implementation.

The facilities are already fenced and isolated from public use. However, modifications to practices or equipment, or use of a non-recycled water source for some applications, may be necessary. The EPA *Guidelines for Recycled Water Use* recommends that for industrial sites with high potential for worker exposure, disinfection of recycled water should reduce total coliform levels to a median of less than 14 colonies per 100 milliliter (mL) – a value between that specified for Oregon's Class C and Class A and B waters. Quality control assurances are required under an approved recycled water use plan. These assurances include a formal monitoring, testing, and reporting program (responsibility of the MWMC as recycled water producer).

These considerations suggest that a minimum of Class B water would be needed for the industrial aggregate uses. Given that the disinfection requirements are identical for Class B and Class A, and that the MWMC has tertiary filtration capacity capable of 10 MGD, the study team recommends designing for Class A recycled water (filtered, highly disinfected) production, thereby ensuring ease of permitting and operator acceptance, as well as demonstration of highest quality recycled water for the MWMC's first outside-the-fence application. Furthermore, better understanding of the comparative water quality of Willamette River water at the point of use and the MWMC's recycled water is needed to better communicate the safety of recycled water use.

2.2 WATER RIGHTS MANAGEMENT ASSESSMENT

Purpose: The purpose of this study element is to understand the implications of using recycled water for industrial use in lieu of river water; specifically, what impact does this use have on the operators' water rights, what obligations are required of the MWMC and the users in complying with water rights, and what impact does the conceptual project have on managing instream flow in the Willamette River?

Finding: Based on this assessment, the use of recycled water in place of river or groundwater by the industrial aggregate operators neither conflicts with nor necessarily provides a benefit to their existing water rights. The industrial operators are not at risk of forfeiting unused water rights when substituted with recycled water. Given a theoretical design recycled-water flow of 6 MGD, the equivalent flow limit is 9.3 cubic feet per second (cfs), less than the 12 cfs maximum total site combined water rights. Should infrastructure capacities limit maximum recycled water flow,

additional water needs could be supplemented with existing river water supply. An instream flow lease is not practical given need for backup water supply; however, any unused water right capacity would be an instream flow benefit to the Willamette River.

Studies: The following tech memo was developed in documenting the findings of this study element:

- Internal Tech Memo 07: Industrial Aggregate Water Rights Management Assessment

The results of these studies are described below in the following sub-sections:

- Existing Water Rights Conditions
- Water Rights Under Recycled Water Use
- Instream Flow Management

2.2.1 EXISTING WATER RIGHTS CONDITIONS

The water rights associated with the industrial aggregate properties are represented in Table 2-1, below. Water rights are maximum flow rates in cfs. These water rights are presented as total daily flows converted to MGD based on instantaneous flow rate and daily total flow based on a 10-hour period of operation (the assumed average operational condition).

Table 3-1: Summary of Industrial Aggregate Water Rights

Water Right User	Water Right (cfs)	Equivalent pumping rate (gpm)	Instantaneous Flow Rate (MGD)	Typical Daily Flow (10-hour day; MGD)
Delta (river)	7.14	3,204	4.6	1.9
Knife River (river)	4.5	2,019	2.9	1.2
Knife River (well)	0.33	150	0.22	0.1
Total Industrial Rate	12	5,385	7.75	3.2

The industrial users have water rights adequate to meet their current and forecasted demands for water use. Any use of recycled water would be in lieu of either river water or groundwater. That unused river or groundwater would therefore, remain instream (or in the aquifer). The typical daily water use for industrial aggregate, 3.2 MGD, is virtually equal to the amount of recycled water diversion required for the MWMC's thermal load mitigation (3.1 MGD, under historical conditions).

2.2.2 WATER RIGHTS UNDER RECYCLED WATER USE

The users would not be at risk of forfeiting unused water rights under a recycled water use scenario. Oregon water law specifically protects the water rights of users adopting recycled water use (OAR 540.610(2)(h)). The users would register the use of recycled water with the OWRD, but no water right for recycled water use is applicable. Oregon law allows water rights holders to sell, lease, or donate water rights to be converted to instream water rights. Section 2.2.3 provides further discussion of instream flow management.

Downstream water rights holders are not expected to be impacted by the conceptual recycled water project. The MWMC's discharge constituents under 5% of the Willamette River flow at the site, well under the 50% flow threshold for consideration of injury to downstream water rights users. Furthermore, the site is within two miles upstream of the confluence of the McKenzie River with the Willamette River. Downstream of the McKenzie River, the Willamette is under-allocated, with no risk to junior use curtailment.

2.2.3 INSTREAM FLOW MANAGEMENT

Recycled water use has the potential to both benefit and detract from total stream flow. The Willamette River at the project location has an instream flow water right of 2000 cfs (summer) and 2500 cfs (winter) to support aquatic life and minimize pollution impacts. Given a review of Willamette River flow data, it appears river flows may not be at or below these flows 25-50% of the time in early February and early July. Managing instream flow to prevent further reductions could be important in project considerations.

One method of preserving instream flow is through an instream flow lease on conserved water right withdrawals (as replaced by recycled water). Such leases require defined periods of time that the water lease is in effect, typically on a seasonal basis or longer. Leases can be renegotiated on that periodic basis, but any water right leased for instream use is not available to the certified water right holder during the lease period. Given that the industrial operators view the ongoing availability of river water for industrial use as a critical backup supply to recycled water it appears that an instream lease is not an option, at least for initial project implementation. However, non-withdrawn water would, in effect, remain as instream flow and balance any effluent diverted for recycled water use at the aggregate facilities.

2.3 WATER BALANCE MODELING

Purpose: The purpose of this study element is to provide calculations to ensure a conceptual design balances recycled water supply and demand, determine the net downstream river flow impacts, account for terrestrial pathways of recycled water applied to industrial use, and estimate thermal load discharge benefits.

Finding: Based on this assessment, recycled water supply can meet demand. Thermal load can be significantly reduced through this application of recycled water, despite lower water use need proportionate to operational slow down in late fall through early spring. However, better information is needed to fully evaluate thermal load benefits that may or may not be realized given dynamics of silt settling pond discharge and infiltration.

Studies: The following reports were developed in documenting the findings of this study element:

- Internal Tech Memo 05: Water Balance Model Boundaries, Inputs, and Outputs Definition
- Internal Tech Memo 09: Industrial Aggregate Water Fate Assessment
- UO Student Project Report

- Water Balance Model (alpha, Excel workbooks)

The results of these studies are described below in the following sub-sections:

- Modeling Framework
- Water Flows and Capacities
- Industrial Water Demands
- Recycled Water Use and Fate
- Modeled Water Balances
- Thermal Load Benefits

2.3.1 MODELING FRAMEWORK

The Industrial Aggregate Recycled Water Use Study resulted in the initial development of a water balance model specifically to understand the flow demands for industrial aggregate use and impacts to WPCF effluent and river flows. The model is considered the "alpha" model as it is the initial construct for building in more model sophistication to help the MWMC understand its overall recycled water production needs. The next step "beta" model will include expanded MWMC facilities use and operational demands for multiple recycled water applications, all of which are conceptual or theoretical at this point.

The basic formula of water balance is:

$$\Delta S = \Sigma I - \Sigma O,$$

where:

ΔS = change in water storage,
ΣI = sum of all water inflows, and
ΣO = sum of all water outflows.

The alpha model assumes zero water in storage, so water balance requires that all water inputs equal all water outputs. The model is based on steps of single, 24-hour days for a theoretical 365-day year. That theoretical year is overlaid with the 20-year historical effluent and river flow data set within the Waste Load Allocation Tool (described more fully in 2.3.6 below).

Figure 2-1 presents the basic schematic of water flow paths involved in the model. Four primary areas of flow are recognized: (1) treatment plant effluent is filtered and disinfected in a channel of the chlorine contact basin (CCB) to produce Class A recycled water, and unfiltered effluent is disinfected in the CCB and discharged to the river (the MWMC also produces recycled water for its own facilities, but that use is ignored in the alpha model to gain specific understanding of the flow path for industrial aggregate use); (2) recycled water is distributed to industrial aggregate facilities where it is put to use, potentially with river and groundwater sources; (3) runoff water from the operations travels through settling ponds and recharges the river via hyporheic flow; and, (4) treatment plant effluent enters the river mixing zone, and downstream the river flow may be withdrawn for industrial aggregate use and be recharged via settling pond hyporheic flow.

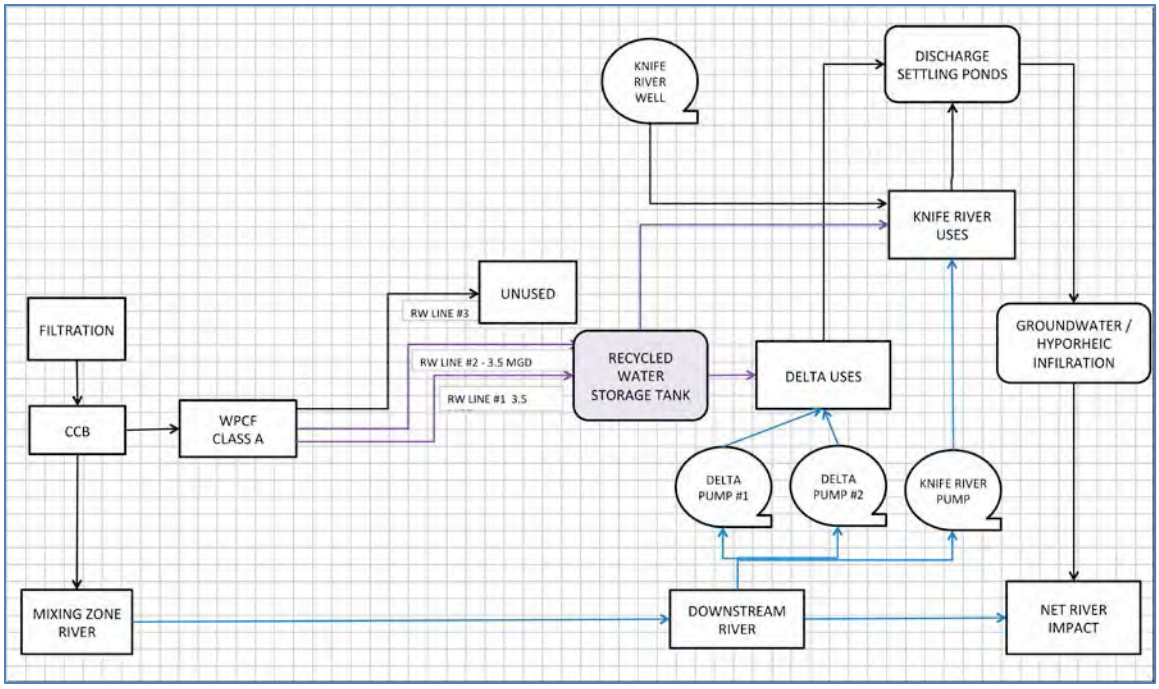

Figure 3-1: System Schematic of Industrial Aggregate Water Throughput

The model constructed for the study is based in Microsoft Excel. Five workbooks compose the model:

1) WBM_Regions.xlsx
2) IndustrialBalance.xlsx
3) EffluentBalance.xlsx
4) RiverBalance.xlsx
5) WLA_Tool.xlsm

TM05 presents the initial basis for development of the model, defining model purpose, boundaries, inputs, and outputs. The subsequent alpha model Excel workbooks developed for the study are presented as a separate file to this report. The base model layout is based on the simple block diagram illustrated in Figure 2-2. Each of the sub-model tools (Industrial Balance, Effluent Balance, and River Balance) provides additional block diagram schematics of all flows accounted for in each sub-region.

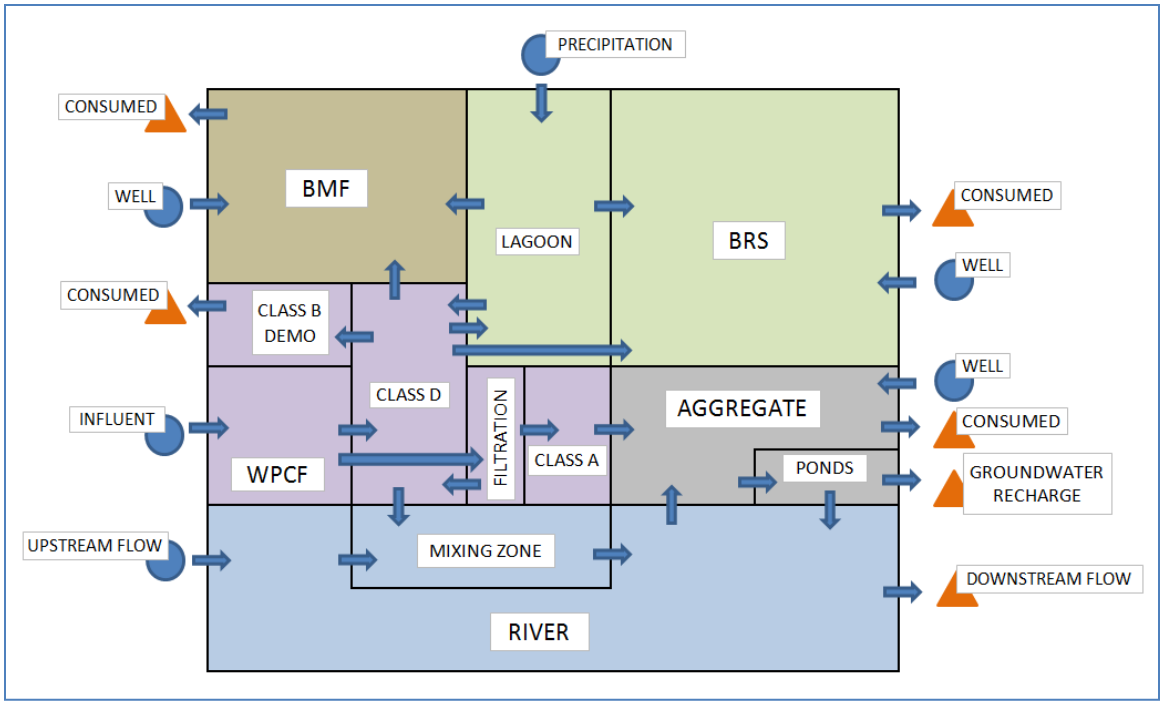

Figure 3-2: Block Diagram of Water Balance Model Boundaries, Inputs, Flowpaths, and Outputs

2.3.2 WATER FLOWS AND CAPACITIES

Recycled water supply for industrial aggregate use is limited by several factors:

- Maximum WPCF filtration capacity for Class A recycled water is 10 MGD (equivalent to 5 million gallons per 12 hour period of use, or a net 5 MGD).
- The existing conveyance lines (West Bank Trail pipeline; three 12-inch diameter pipes) between the WPCF and the aggregate facilities are designed for 3.5 MGD per line (theoretically higher flows are possible).

2.3.3 INDUSTRIAL WATER DEMANDS

Recycled water demand for industrial use is based on the total daily demand for industrial processes up to the limits of recycled water production. Table 2-2 presents monthly variations in the estimated daily total water demand, in MGD, for industrial use. Water demand estimates are based on the following assumptions:

- Concrete mixing will use colder groundwater sources for summer batching
- All other applications will use recycled water as a first source
- Operations are 12 hours per day of continuous use

- Seasonal variations in production ramp down from 100% capacity in summer to 10% capacity in winter.

Table 3-2: Approximation of Industrial Processes Water Demands on a Seasonal (Monthly) Basis

VOLUME OF WATER USE (DEMAND)													
Period: (MM format for lookup)		1	2	3	4	5	6	7	8	9	10	11	12
Application	Baseline*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% Operational	50%	10%	15%	40%	75%	80%	100%	100%	100%	90%	70%	40%	10%
Total Water Use (mgd)	7.75	0.39	0.58	1.55	2.91	3.10	3.88	3.88	3.88	3.49	2.71	1.55	0.39
Rock & Gravel Processing	40%	0.16	0.23	0.62	1.16	1.24	1.55	1.55	1.55	1.40	1.09	0.62	0.16
Dust Control and Washing	40%	0.16	0.23	0.62	1.16	1.24	1.55	1.55	1.55	1.40	1.09	0.62	0.16
Asphalt	15%	0.06	0.09	0.23	0.44	0.47	0.58	0.58	0.58	0.52	0.41	0.23	0.06
Concrete	5%	0.02	0.03	0.08	0.15	0.16	0.19	0.19	0.19	0.17	0.14	0.08	0.02
Total Non-Concrete (Qi8)	95%	0.37	0.55	1.47	2.76	2.95	3.68	3.68	3.68	3.31	2.58	1.47	0.37
Concrete demand for recycled water (Qi4C)		0.02	0.03	0.08	0.15	0.16	0.00	0.00	0.00	0.00	0.14	0.08	0.02
Concrete demand for well water (Qi5)		0.00	0.00	0.00	0.00	0.00	0.19	0.19	0.19	0.17	0.00	0.00	0.00
* Baseline operation is 12 hrs/day (i.e. 50% of full day) and water demand equivalent to peak water right capacity.													
Monthly operations is percent of baseline.													

The total daily water demand under these assumptions ranges from 0.39 MGD in winter to 3.88 MGD in summer. No water metering is in place to verify the assumptions. A study involving water metering over long-term use of the facilities would be helpful for developing a better accounting of water use.

2.3.4 RECYCLED WATER USE AND FATE

Definitions of how recycled water will be used and the subsequent fate of the water after use are important for environmental, health and safety, and regulatory compliance considerations. For water balance modeling, the important aspect of water use and fate is an understanding of where water flow is distributed and how it is consumed, evaporated, discharged, or otherwise accounted for after applied use.

Water is recycled to supply demand for beneficial uses. For most recycled water uses, water balance models ensure that recycled water is produced at a rate in balance with water storage and beneficial use consumption. Non-beneficial discharge to groundwater or surface water is not allowed without a discharge permit (separate from registration of recycled water use). The current industrial aggregate practices result in used wash water running into a series of channels, pits, and settling ponds to remove silt. The clean water then seeps out of the settling ponds into subsurface gravels. Ultimately, this water becomes part of the hyporheic flow of the river system.

A University of Oregon master's student project team interested in this topic of water balance accounting for industrial use of recycled water provided additional study research. The team researched the conceptual project water demands to determine values of water use, water losses, water consumption, and water runoff, infiltration, and discharge. Given the lack of site monitoring,

field investigation studies, or representative case study examples, the team provided best estimates of water use. The team's report, presented in Appendix C, also offers evaluation of potential project benefits.

Better understanding of the regulatory requirements for this handling of recycled water as well as the ultimate understanding of thermal load balance from point of effluent diversion for recycled water use to point of return to the river will be important. Given the industrial water demand assumptions of the study and very high level approximations of water runoff from each application, the study team developed a preliminary estimate of recycled water fate associated with industrial aggregate process application, which is summarized in Table 2-3.

Table 3-3: Estimation of Industrial Processes Water Demands and Proportionate Site Runoff

Water Use Application	Environmental Fate	Assumed Overall Site Water Usage	Assumed Runoff Discharge	Net Water Discharge to Settling Ponds
Gravel washing	Evaporation, adhesion, soil infiltration, discharge runoff (settling ponds)	25%	90%	22.5%
Rock crushing	Adhesion, discharge runoff (settling ponds)	15%	90%	13.5%
Concrete batching	Incorporated in product, minimal other losses	5%	10%	0.5%
Asphalt production	Primarily steam/evaporation	15%	10%	1.5%
Equipment wash rack	Mostly runoff (settling ponds), some equipment adhesion/evaporation	19%	60%	11.4%
Wheel wash	Virtually all evaporation, vehicle adhesion, and soil infiltration	1%	10%	0.1%
Dust control	Virtually all evaporation, vehicle adhesion, and soil infiltration	20%	0%	0%
All processes	**All of the above**	**100%**	**→**	**49.5%**

2.3.5 MODELED WATER BALANCES

Two key objectives of water balance modeling are: (1) assurance that all water flows are accounted for, and (2) determination of final output of flow rates.

Water Balance Accounting

Three key areas of water balance checks exist within the model: (1) industrial use balance, (2) effluent balance, and (3) river flow balance. A fourth area of the model, facilities use balance, is not included in the alpha model but will account for the MWMC's internal site use of recycled water in the beta model development. The following expressions define these balances. The symbol Q represents water flow rate.

Industrial Balance:

$$(Q_{wr} + Q_{gw} + Q_{rw}) = (Q_c + Q_{ro})$$

where:

Q_{wr} = input from river water rights sources
Q_{gw} = input from groundwater sources
Q_{rw} = input from recycled water sources
Q_c = output of water consumed in use (incorporated in product, evaporated, etc.)
Q_{ro}= output of water runoff to settling ponds

Effluent Balance:

$$(Q_e) = (Q_{rw} + Q_d)$$

where:

Q_e = input of treatment plant effluent into final filtration and disinfection
Q_{rw} = output of final treated effluent for recycled water use
Q_d = output of final treated effluent for discharge to the Willamette River

River Balance:

$$(Q_{us} + Q_d + Q_{sp}) = (Q_{wr} + Q_{ds})$$

where:

Q_{us} = input to river as flow upstream of the treatment plant
Q_d = input to river from discharged treatment plant effluent
Q_{sp} = input to river from settling pond infiltration
Q_{wr} = output from river as water right withdrawals
Q_{ds} = output of river as final downstream flow

Flow Rate Output

The key flow rates calculated are the industrial water demands as described in Section 2.3.3. The net daily (24 hour) water demand ranges from 0.39 to 3.88 MGD. For the alpha water balance model, recycled water production is assumed able to meet all industrial demand. The model user can adjust the maximum recycled water flow rate to limit the total demand that can be met by recycled water supply; in that case, the model accounts for river and/or groundwater sources to make up the difference.

In the alpha model, the total recycled water demand for industrial use dictates the flow of effluent diverted for Class A recycled water production. If demand exceeds the limit of Class A production, the total diverted effluent for recycled water use is set equal to the limit; the remainder of industrial water demand is made up through river or groundwater withdrawals. The diverted effluent flow for recycled water production is subtracted from total effluent flow to model the reduced effluent

discharge to the river that would occur. Effluent and river flows are modeled based on a 20-year historical period of record from 1991 – 2011.

2.3.6 THERMAL LOAD BENEFITS

The precursor to the water balance model was the Waste Load Allocation Tool (WLA Tool) developed by the ODEQ for calculating point-source excess thermal load. The MWMC study team modified the WLA Tool to test theoretical conditions and the tool's sensitivity to changes in flows, temperatures, and recycled water diversion. The MWMC is interested in meeting its currently understood near-term regulatory requirement to offset 3.1 MGDof effluent as well as meeting potentially more stringent, future regulatory scenarios. For this reason, the study team developed a "Base Case" scenario, which results in more frequent and widespread days of theoretical excess thermal load. The scenario, based on increasing stresses to river temperature from climate change, federal dam management changes, and population growth, projected to the year 2035, is represented as a calendar showing days of excess.

The alpha model output for recycled water demand and resulting effluent river discharge was plugged into the WLA Tool base case scenario. The thermal load benefits of the conceptual recycled water use are significant. The 2035 Base Case indicates high recurrence intervals of thermal load excess from mid-July through end of October. The modeled recycled water diversion for industrial aggregate use indicates complete temperature mitigation for all occurrences except for one extreme situation in late October. Should that situation continue to be a model result as better information and project design progresses, it may be possible to engineer mitigation through temporary recycled water storage at the WPCF on critical dates. Appendix C presents both the *2035 Base Case* thermal risk calendar and the resulting *Industrial Aggregate Use under 2035 Base Case Conditions* risk calendar.

A critical note is that the model assumes 100% of recycled water's thermal load is diverted from the Willamette River to realize a temperature benefit. Without full understanding of thermal balance involved in water use and discharge at the aggregate facilities, it is unknown whether the silt settling ponds provide additional thermal load reduction benefit, a neutral impact, or a complete pass through of recycled water thermal load back to the river. If the latter is the case, the thermal load mitigation capacity of the project is reduced by approximately 50% (the estimated amount of total water used on site that results in runoff to the settling ponds).

2.4 ENGINEERING FEASIBILITY STUDY

Purpose: The purpose of this study element is to identify all the project infrastructure components, constructability issues, equipment specification, and costs to build, operate, and maintain the conceptual recycled water use project.

Finding: Based on this assessment, the design recommendation is to utilize existing tertiary filtration, CCB, and West Bank Trail pipeline infrastructure to produce and convey Class A recycled

water to the industrial aggregate facilities. Water stored in a hydropneumatic pressure tank would be distributed directly to points of use through a dedicated recycled water service loop. Total 20-year life cycle cost is estimated to be $7,698,000, and approximate thermal load mitigation value is $0.08/kilo-calories per day(kcal/day).

Studies: The following reports were developed in documenting the findings of this study element:

Engineering Reviews

- Internal Tech Memo 10: Industrial Aggregate Use Operating Assumptions
- Kennedy/Jenks Consultants Technical Memorandum: Delta Sand/Knife River Industrial Aggregate Site Recycled Water Conceptual Design

Permitting Reviews

- Internal Tech Memo 11: Environmental Compliances Review Checklist
- Internal Tech Memo 12: Industrial Aggregate Environmental Issues Review
- Kennedy/Jenks Consultants Technical Memorandum: Environmental Regulatory Feasibility Review – Industrial Aggregate Site

The results of these studies are described below in the following sub-sections:

- Conceptual Design Assumptions
- Conceptual Design Specifications
- Costing and Energy Demands
- Permitting and Construction Issues

2.4.1 CONCEPTUAL DESIGN ASSUMPTIONS

The following design assumptions are the basis for the engineering design produced during the study. More detailed design assumptions are presented in TM10: Industrial Aggregate Use Operating Assumptions.

The concept for Industrial Aggregate Recycled Water Use, as updated during the study, assumes Class A recycled water production and delivery directly to each point of use. A tank reservoir system is added to buffer instantaneous peak demands on the supply to economize recycled water system sizing, production, and pumping rates. Pumps for each distribution system needed at the facilities would provide the instantaneous flow rates and pressures as needed. Only one of the West Bank Trail pipelines is deemed to be necessary to accommodate flow demands, but redundant pump systems would provide system reliability.

The primary operating principles are:

1. The MWMC will produce Class A recycled water by adding additional disinfection and pumping capabilities to the tertiary effluent train. The existing tertiary filtration system is capable of producing up to 10 MGD to blend into effluent at the CCB. A segregated disinfection area within the CCB will provide additional chemical disinfection to reach Class A standards.

2. A new recycled water pump station is added to distribute Class A recycled water to service lines feeding away from the WPCF.
3. Class A recycled water service pipelines consist of new piping connected to the existing West Bank Trail pipeline system – the three parallel 12-inch diameter pipes connecting MWMC property with the public easement immediately south of the industrial aggregate property line. Only one or two of the pipes is needed to deliver the required flow.
4. Recycled water delivered to the aggregate site is stored in a buffer tank and distributed via a dedicated recycled water plumbing system to each point of use throughout the facilities.

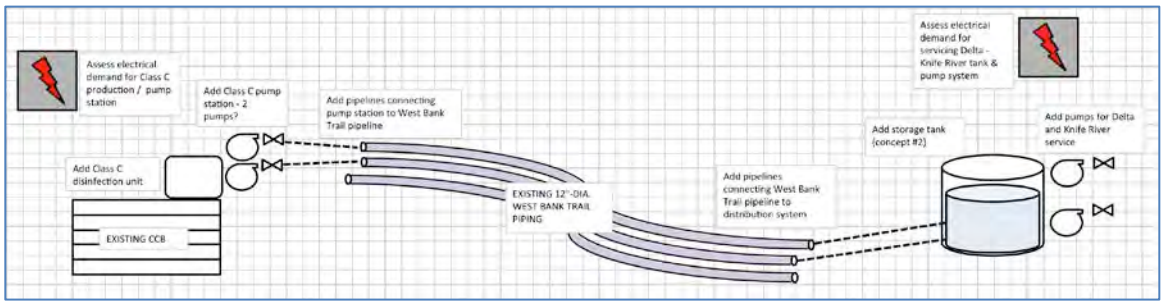

Figure 3-3: Preliminary Conceptual Design Assumption

2.4.2 CONCEPTUAL DESIGN SPECIFICATIONS

Kennedy/Jenks Consultants developed a conceptual design drawing and system specification based on refined assumptions and technical analysis of the required project. The conceptual design is presented in the draft Technical Memorandum - Delta Sand/Knife River Industrial Aggregate Site Recycled Water Conceptual Design (Appendix B).

The produced design specifies the following elements:

- Peak recycled water flow of 7.2 MGD (5,000 gpm)
- Operating pressures ranging 65 to 95 psig (average 80 psig)
- 10 points of use, each with equal distribution flow at 450 gpm, except for asphalt batching, which has the highest peak demand requirement, and was allocated twice the flow rate of other points of use (900 gpm).
- Three cyclical variable speed drive pumps delivering water to a 12,500 gallon hydropneumatic tank
- Ductile iron above-grade and HDPE below-grade 12-inch diameter piping (conveyance line and service loop)
- 6- and 10-inch diameter service lines with buried isolation valves to each location of use
- Reduced pressure principle backflow preventer in non-recycled water service lines to prevent cross-connection of recycled water with river water or groundwater.

The resulting design is presented as Figure 2-4. A larger scale design figure is presented with the consultant Technical Memorandum.

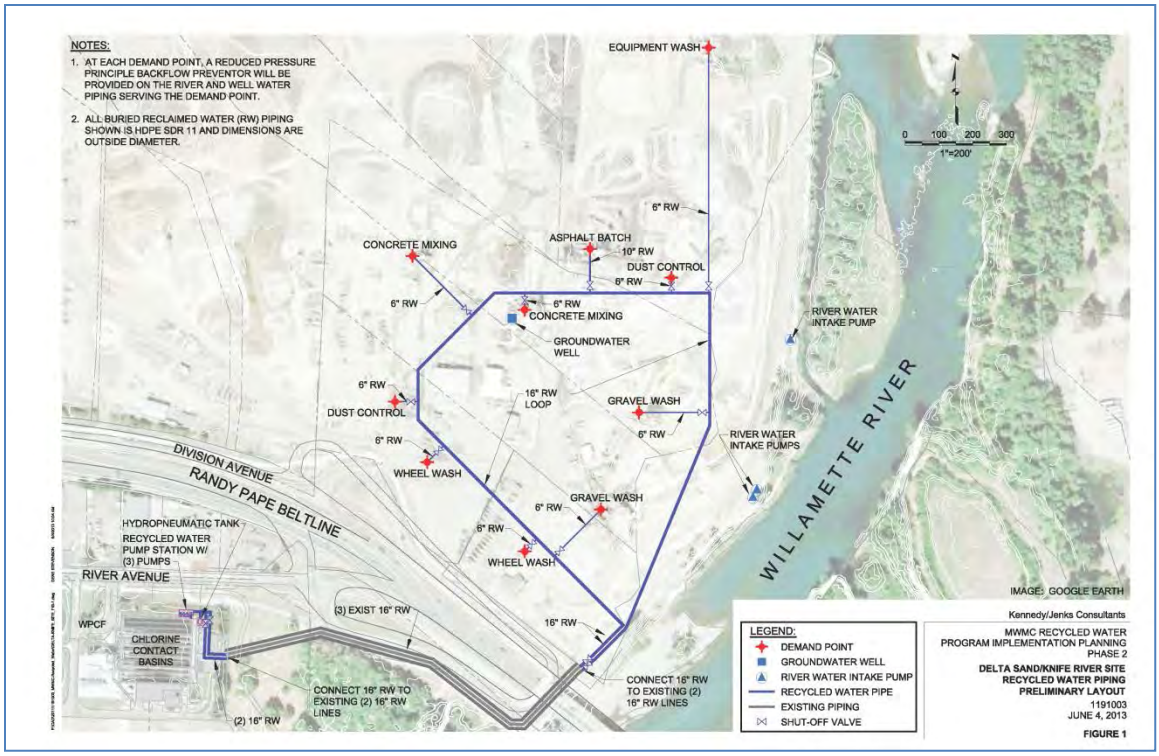

Figure 3-4: Final Conceptual Design Layout

2.4.3 COSTING AND ENERGY DEMANDS

The Phase 1 conceptual project assessment study completed previous to the current study resulted in an engineering cost estimate of $3,074,000, with a total 20-year life cycle cost of $4,701,000 (including $797,000 of consulting and administrative costs). However, the scope of work assumptions underlying the Phase 1 estimate were revised substantially in Phase 2 to address revised aggregate industrial process needs. The Phase 2 design update produced for the current study adds several cost items, bringing the total capital cost to $4,299,000, with a 20-year life cycle cost of $6,801,000. With consulting and administrative costs, the total project value is estimated to be $7,698,000 (approximately 60% increase in estimated cost over Phase 1 assumptions). A complete cost breakdown is presented in the conceptual design technical memorandum (Appendix B).

The primary drivers for increased costs are:

- Production of Class A in place of Class C recycled water
- Additional 3.6 MGDpump
- Increase pump motor sizes from 150 to 200 horsepower
- Addition of hydropneumatic tank
- Addition of site distribution loop, service lines, and backflow preventers

The total energy requirement for the distribution pumps, assumed to be running two at a time for 10 hours per day at 173 horsepower is estimated to be 2,580 kwh/day, resulting in an annual energy cost of $55,563. Additional pumping costs would be associated with pumping effluent through the tertiary filtration unit specifically for Class A water production. Treatment plant staff estimates total cost to run filters is $100/day at 10 MGD. Further analysis will be needed to determine cost of tertiary filtration dedicated to recycled water production.

2.4.4 PERMITTING AND COMPLIANCE ISSUES

An environmental compliance review was conducted as part of the study to understand potential land use, water quality, and other environmental regulatory compliances the project may need to document. Permits for construction and use of recycled water may be contingent on several of these compliance issues. Understanding the permitting complexities, compliance triggers, and overall environmental impacts of the conceptual industrial aggregate recycled water use project is key to evaluating overall cost, TBL benefits, and feasibility of the project. Furthermore, a thorough evaluation of environmental impacts is important for addressing issues most important to various community stakeholders.

The Environmental Compliances Review Checklist (TM11) and Industrial Aggregate Conceptual Project Environmental and Permitting Compliances Review (TM12) provide detailed background, review, and evaluation of potential permitting and construction issues to be considered in evaluating the project feasibility. The primary findings include:

- Industrial aggregate processes are an approved use of Class C recycled water in Oregon
- Federal recycled water use guidance suggest treatment to Class A or B disinfection levels is appropriate for the operational conditions specific to Delta Sand & Gravel
- Plumbing codes and guidelines indicate installation of dedicated, labeled, recycled water piping ("purple pipe") to each point of use is required
- Discharge of used recycled water to silt settling ponds could prompt an NPDES discharge permit requirement – or generate increased third-party scrutiny or watershed interest-group objections over continued discharge under a WPCF permit.
- Most or all construction would be within existing construction/disturbed ground footprint, largely reducing further documentation or action for many sensitive resources.
- The thermal load mitigation benefits of the project provide overall positive habitat impacts to the project
- No water rights would be interfered with or prevent project feasibility
- No particular land use or constructability issues are noted as potential barriers to project feasibility.

Many of the environmental review processes identified in the checklist are driven by requirements of the National Environmental Policy Act (NEPA). NEPA is only required on projects having a federal nexus (either implemented, permitted, or funded by a federal agency). The NEPA consideration is useful in understanding the potential documentation required for securing potential project funding, particularly for grant opportunities that could enhance the project feasibility.

2.5 STAKEHOLDER ACCEPTABILITY EVALUATION

Purpose: The purpose of this study element is to evaluate how well the proposed project would be received by various stakeholder interests and what project modifications or mitigations could be made to better meet stakeholder objectives.

Finding: Based on this assessment, the premise of conceptual use of recycled water for industrial aggregate use and thermal load mitigation is strongly supported by regulatory agencies and is well-received by water resource interests and conservation groups. However, the key stakeholders – the potential recycled water users at the industrial aggregate site, have expressed doubt and lack of interest in pursuing the project, given perceived business risks without benefits.

Studies: The following reports were developed in documenting the findings of this study element:

- Briefing Sheet for Elected Officials
- MIG Memo: Stakeholder Questionnaire Results and Next Steps

The results of these studies are described below in the following sub-sections:

- Industrial Operator Considerations
- Water Resources Stakeholders Input
- Community Acceptability Assessment

Local elected officials were not directly surveyed for the Industrial Aggregate Feasibility Study, but continue to be apprised of the MWMC's study efforts. Elected officials were engaged and provided input to the MWMC's Phase 1 study considerations. For this study, project managers distributed a briefing sheet to keep elected officials informed (Appendix D).

2.5.1 INDUSTRIAL OPERATOR CONSIDERATIONS

Management personnel from Delta Sand & Gravel and Knife River have been regularly engaged in the MWMC's exploration into a potential recycled water use partnership. Both companies expressed support for the OWRD's funding of this study. In April 2013, the MWMC project team, including consultants and student research team, toured the facilities and interviewed the site managers to better understand water use, needs, and concerns. The key aggregate operator considerations are:

- River water supplies would be relied upon to ensure critical water supply is always met, and need to be available at the flip of a switch.
- Would not be able to convert existing plumbing to recycled water use; would require separate service lines directly to points of use.
- Proven recycled water quality and concrete product performance is absolutely critical for production considerations.
- Customer satisfaction and perception of product is critical to business.
- Need to understand relative risks of recycled water use (particularly compared to current practice of river water use).

- Worker safety and acceptance of recycled water is key.
- Overall concern about cost of implementing, worker health and safety, and regulatory compliance.

Given the lack of identified business benefits (particularly cost savings), and the mounting overall concerns about unproven recycled water reliability, both Delta and Knife River opted late in the study to withdraw from further participation. Should the MWMC identify project benefits and risk reduction, the project could be feasible for further consideration.

2.5.2 WATER RESOURCE AGENCY AND ORGANIZATION INPUT

The study project manager delivered presentations and hosted roundtable discussions with water resource stakeholders in April and May 2013 to gather input on project feasibility and community acceptability. Given the preliminary stage of the MWMC's overall recycled water conceptual alternatives assessment and the focus on the industrial aggregate alternative for this study in particular, stakeholder engagement was targeted to three specific audiences:

1. Water resource and aquatic habitat agencies (Eugene Water & Electric Board (EWEB), ODEQ, OWRD, and Oregon Department of Fish & Wildlife (ODFW))
2. Watershed conservation interests (local watershed councils)
3. Sustainable water resource interests (University of Oregon urban water planning students)

2.5.3 COMMUNITY ACCEPTABILITY ASSESSMENT

Communications consultant MIG reviewed the stakeholder survey results and input received from various stakeholder meetings. The summary of survey results is presented in MIG's memo report *Stakeholder Questionnaire Results and Next Steps* (Appendix D). The key findings of the assessment are:

- All respondents felt somewhat to very well informed about recycled water use and the MWMC's interest in water recycling.
- Most respondents were very supportive (92%) of the concept of water recycling. All agency staff is very supportive (100%).
- All respondents were supportive of the potential use of recycled water by industrial aggregate operations adjacent to the Eugene-Springfield wastewater treatment plant (91% were supportive or very supportive; 9% were somewhat supportive). Of agency staff, 100% were very supportive.
- Major concerns about recycled water use are avoiding human health and safety risks and protecting groundwater.
- Based on the questionnaire results, the presentations by program staff appear to be effective in informing stakeholders about recycled water and obtaining support for potential directions. In addition, this effort has helped identify areas where more information should be provided or messaging refined in the future to increase stakeholder support.

Key consultant recommendation: The MWMC should continue emphasizing recycled water objectives that have strong stakeholder agreement to gain support, and should further research and emphasize where recycled water is an asset to:

- Protect the Willamette River
- Conserve water resources
- Meet regulatory requirements
- Increase community sustainability
- Provide flexibility to adapt to future water resource needs
- Restore watershed health
- Diversify water resource practices

2.6 TRIPLE BOTTOM LINE COST-BENEFIT ANALYSIS

Purpose: The purpose of this study element is to evaluate the full costs of the project as well as potential project benefits, both internal and external to the MWMC, particularly in the interest of the Eugene-Springfield community. The TBL assessment of economic, environmental, and social impacts of the project can be used to make an informed decision on project value based on organizational mission and community values.

Finding: Based on this assessment, the Industrial Aggregate Recycled Water Use alternative presents potentially higher cost of thermal load compliance than riparian shade credits would, but also presents the potential for significant energy costs and greenhouse gas emission reduction, lower pollutant loading in general, reduced pressure on river water withdrawal, and investment in sustainable water resource infrastructure for the future. Riparian shade projects would provide more aesthetic value and a broader range of ecosystem benefits, but a dispersed thermal load reduction in the watershed, as opposed to reduction at the point source.

Studies: The following reports were developed in documenting the findings of this study element:

- SWOT Assessment Matrix
- Good Company Report: Triple Bottom Line Assessment: Recycled Water Use at Industrial Aggregate Facilities

The results of this study are described below in the following sub-sections:

- Strategic Goals and SWOT Analysis
- Triple Bottom Line Methods and Reporting
- Project Cost-Benefit Overview

2.6.1 STRATEGIC GOALS AND SWOT ANALYSIS

The MWMC has strategic goals associated with recycled water use and implementation planning. These goals continue to serve as a basis for steering and evaluating conceptual recycled water uses. The seven primary goals are:

- **Goal 1: COMMUNITY VALUES** Develop a recycled water program that reflects community values, responds to community needs and provides opportunities to obtain community input.
- **Goal 2: REGULATORY COMPLIANCE** Help meet environmental regulatory discharge requirements of the WPCF through reduction of thermal load, nutrients, suspended solids and/or other constituents to the Willamette River by diverting high-quality, treated effluent (recycled water) to beneficial reuse applications.
- **Goal 3: COST EFFECTIVENESS** Meet recycled water usage goals through applications that are cost effective to the MWMC.
- **Goal 4: COST BENEFITS** Maximize cost offsets through fee-based recycled water delivery by developing recycled water applications that meet water supply interests and demands.
- **Goal 5: ENVIRONMENTAL BENEFITS** The recycled water program and applications will enhance surface water quality and protect water resources.
- **Goal 6: REGIONAL WATER SUPPLY BENEFITS** Develop recycled water applications that reduce stresses on local surface water and groundwater supplies.
- **Goal 7: SUSTAINABILITY** Develop a recycled water program that enhances future regulatory compliance, offsets needs for future treatment system infrastructure, is economically balanced, and is flexible to meet challenges of triple bottom line methods and reporting.

Given the study's strategic goals, a TBL cost-benefit evaluation was proposed for the Phase 2 study. The Industrial Aggregate Recycled Water Use conceptual alternative was selected to pilot a TBL methodology and assessment. To initiate the TBL process, program staff developed a SWOT matrix (SWOT stands for Strengths, Weaknesses, Opportunities, and Threats). SWOT analysis is a common element of organizational strategic planning. The SWOT matrix, presented in Appendix B, identifies in quick reference of initially recognized potential project pros and cons for further consideration through TBL assessment.

2.6.2 TRIPLE BOTTOM LINE METHODS AND REPORTING

Kennedy/Jenks Consultants teamed with Good Company, a local sustainable business consultant, to lead the TBL evaluation for the study. The TBL process for this study included the following steps:

1. Use study strategic planning goals and SWOT matrix as starting point of evaluation.
2. Identify project metrics to evaluate under Economic, Environmental, and Social aspects of benefit analysis.

3. Gather existing data and study results to assess metric values.
4. Identify data gaps and seek new information as available.
5. Recommend mitigation for potential project impacts.
6. Present findings report.

The next step of the TBL analysis will be to review the findings with project decision-makers and determine how to appropriately weight metrics and rank alternatives to best reflect the over project TBL benefit based on the MWMC's objectives and its stakeholders' values.

The key TBL aspects for the recycled water study identified by Good Company are as follows.

Economic Aspects

- Capital Costs and 20-Year Net Present Value
- Operational Change and Risk

Environmental Aspects

- Habitat and Biodiversity
- Water Quality and Regulatory Compliance
- Greenhouse Gas Emissions

Social Aspects

- Human Health and Safety
- Community Development

For this study, the Industrial Aggregate Recycled Water Use Conceptual Alternative was evaluated in comparison with "existing conditions" (the without-project alternative), and "riparian shade credits" (the most likely thermal load mitigation alternative to recycled water use).

2.6.3 PROJECT COST-BENEFIT OVERVIEW

The TBL assessment resulted in the following statement of findings.

> The Industrial Aggregate site and operations provide a unique opportunity for development of recycled water infrastructure in our community as the site is close to the WPCF and that Industrial Aggregate's water demand matches the WPCF's compliance needs and ODEQ's approved uses for recycled water. For Industrial Aggregate specifically, the project offers installation of recycled water infrastructure potentially at no cost and reduced energy costs (associated with pumping water). Recycled water offers a revenue/cost recovery opportunity for the MWMC through the sale of recycled water and it offers the community a means for adapting to the possibility of increased frequency of low-flow river conditions due to climate change. By developing infrastructure and experience within the Industrial Aggregate project, the MWMC is better positioned to produce recycled water in the future.
>
> However, there are numerous, significant and potentially insurmountable financial and operational barriers to overcome. These include: an additional 20-year cost of $2.3 million

to MWMC (compared to the 20-year net present value of purchasing riparian shade credits); neither Delta nor Knife River are water limited for production; the likelihood of new permits being needed by Industrial Aggregate or the WPCF; production concerns about product quality, liability and supply disruptions; insuring the health and safety of Industrial Aggregate employees who would be routinely and significantly exposed to the recycled water; and a limited lifetime of Delta's production at the site (estimated between 10 -12 years).

The findings presented in the TBL Assessment are summarized in Table 2.4..

Table 3-4: Summary of TBL Findings of Thermal Load Mitigation Alternatives

	Industrial Aggregate Recycled Water Use Alternative	**Riparian Shading Credit Alternative**
Economic Aspects	• 20-year NPV: $6.8 million • $0.08/kcal/day • Annual energy cost reduction of $66,000/year	• 20-year NPV: $4.5 million • $0.05/kcal/day
Environmental Aspects	• Reduces thermal load at point source location • Reduces discharge of additional pollutants • Net greenhouse gas (GHG) emission reduction of roughly 25% of the MWMC's current emissions • Requires use of additional materials (filter media and chlorine) • Reduces withdrawal of water from river and groundwater sources	• Reduces thermal load elsewhere in watershed (non-local) • Provides temperature benefit directly on salmon habitat stream channel • Newly planted trees provide carbon sequestration (no net GHG impact yet determined) • Provides multiple habitat/ecosystem benefits • May require use of herbicides
Social Aspects	• Increases human exposure to recycled water • Class A recycled water is highest quality; likely exceeds quality of river water in many ways • Invests in development of recycled water infrastructure to meet future community water resource needs and adaptability	• Improved landscape aesthetics

3 STUDY CONCLUSIONS AND RECOMMENDATIONS

Recommendations are based on evaluation of study findings and the near-term and long-term goals of the planning study. Goals are described in Section 1. The capacities of the project to meet those goals are summarized in Table 3-1 below.

Near-Term Goals	Project Capacity
Provide reliable, cost-effective, and environmentally beneficial recycled water use of approximately 3 MGD for industrial aggregate and construction products.	The project appears to be feasible from a constructability standpoint for the target use and flow rate. Further confirmation of energy savings and securing of funding partnerships could make the project cost effective. The project would have water resource, habitat, and greenhouse gas benefits.
Serve as a demonstration site for fostering community interest in future recycled water use.	The site provides excellent potential to demonstrate Class A recycled water safety and benefits to the community. However, smaller demonstrations of "outside the fence" recycled water applications may be necessary to achieve critical stakeholder support for the conceptual project prior to implementation.
Long-Term Goals	**Project Capacity**
Maintain thermal load compliance to meet Willamette River water quality and habitat needs.	The project exhibits high capacity to meet the MWMC's full thermal load mitigation needs for theoretically amplified temperature conditions through the year 2035. However, Delta Sand & Gravel's projected gravel supply will be depleted by 2025, greatly reducing recycled water demand and therefore thermal load mitigation capacity. However, recycled water use for habitat or water quality treatment through reclaimed gravel pits could offer future thermal mitigation benefits. Better understanding of the fate and thermal balance of water discharged to silt settling ponds needs to be evaluated.
Make more efficient use of water resources through recycled water use in lieu of freshwater sources.	The project is supported by water resource agencies as a step toward providing freshwater resource alternatives. The project would result in reduced withdrawal of river water and groundwater. However, the project does not offset potable water use, which would exhibit a greater community benefit.
Contribute to local energy efficiency and recycled material content goals.	The project potentially could reduce energy demands for pumping and water heating costs. However, there is not a LEED or other sustainable building material recognition given for recycled water content in concrete. Despite that, some community interests may value the practice.
Gain visibility, recognition, and community support for recycled water use.	The project garners strong initial stakeholder support. Given the endorsement of diverse water resource agency and conservation groups, the project appears well poised to continue gaining support from the larger community, and could be a good initial demonstration of recycled water use beyond the MWMC's fenceline.

3.1 OVERALL FEASIBILITY OF INDUSTRIAL RECYCLED WATER USE

From a construction and project implementation standpoint, the conceptual project is highly feasible. The project makes use of key existing infrastructure (tertiary filtration, CCB, and West Bank Trail recycled water pipeline). Almost all new construction would occur either on MWMC or Delta Sand & Gravel property. A short segment of pipeline would go through a public easement right-of-way. Although a large diameter potable water line exists in the right of way, the recycled water piping would cross beneath and perpendicular to the potable water line in full compliance with required regulations.

With the key exception of further understanding of how used recycled water discharged to settling ponds would be regulated, all other environmental compliance and permitting of the conceptual project does not appear to present any feasibility challenges . The situation is unique in that no single recycled water use rule or water discharge regulation appears to directly address the concept of beneficial recycled water use and subsequent discharge. Negotiation with the site owner, regulatory agencies, and affected stakeholders may need to occur. Permitting complexity could impact the project feasibility.

There is good initial stakeholder acceptance and support for the project concept, with the key exception of the industrial aggregate operators. Based on discussions of project issues, but not conclusions, operators have identified only business risks in adopting recycled water use and no actual benefits. Given positive energy cost projections from the project, strong regulatory agency support, and potential for Class A recycled water to exceed Willamette River water quality, there is potential to better identify operational benefits and mitigate risk to the industrial aggregate operators.

3.2 POTENTIAL ASSETS/DRAWBACKS

The project study identified the following key assets and potential drawbacks.

<u>Assets</u>

- Industrial partners supportive of sustainable product practices and community improvement
- Trial concrete mixing with Class C recycled water was positive
- Good utilization of existing infrastructure
- Demonstration of high quality Class A recycled water use
- Reduction of river and groundwater withdrawals
- Thermal load reduction capacity to meet most projected, exacerbated temperature conditions
- Additional discharge pollutant load reductions
- Reduced greenhouse gas emission and energy footprint
- Reduced pumping and heating costs can be achieved
- Step toward future expansion of recycled water infrastructure
- Cost for thermal load reduction may be competitive with riparian shade, depending on further verification of riparian shade credit costs.

Drawbacks

- No track record with Class A recycled water quality or known potential impacts to concrete or other products
- Recycled water use rules and protections imply recycled water presents risks to worker health and safety
- Potential regulatory umbrella of an NPDES discharge permit requirement for recycled water runoff to silt settling ponds
- Lack of thermal balance data on settling pond infiltration and river recharge. Discounting 100% of settling pond discharge from recycled water diversion of thermal load could reduce the thermal load benefit of the project by approximately 50%.
- Lack of direct business or water supply benefit to operators presents no incentive for industrial partners to cost share in construction or to pay for recycled water service
- Insufficient water use data to fully estimate water use with the accuracy needed to determine the precise thermal load benefits of project
- Recycled water demand in late October may drop during the period when thermal load compliance is at greatest risk
- Potentially costlier than riparian shade credits

3.3 FURTHER CONSIDERATIONS TO BE MADE

The following key assessments need follow-up to address the project assets and drawbacks listed above.

- Comparison of Class A recycled water with Willamette River water quality at point of use.
- Assessment of settling pond discharge fate and compliance with recycled water use rules and Clean Water Act (NPDES) discharge requirements.
- Consideration of supplying only high-volume, low-exposure, and low-runoff applications with recycled water to control for worker exposure and settling pond discharge concerns. This could include sole supply to Knife River operations for concrete and asphalt production.
- Case study examples of concrete production with recycled water having similar qualities to the MWMC's potential Class A recycled water quality to demonstrate product integrity, operational safety, and customer satisfaction.
- Exploration of agreements that would retain as much instream water flow as practical in the Willamette River (among the MWMC, industrial aggregate operators, water resource agencies, and water trust organizations).
- More detailed energy and material demand analysis to determine potential energy and cost savings and how the bottom line could result in a win-win opportunity for a public-private partnership.
- Continued engagement with community stakeholders to ensure project acceptability and support.

APPENDICES

CLICK ON LINKS TO VIEW DOCUMENTS

APPENDIX A - INTERNAL TECHNICAL MEMORANDA

Tech Memo 05: Water Balance Model Boundaries, Inputs, and Outputs Definition

Tech Memo 07: Industrial Aggregate Water Rights Management Assessment

Tech Memo 08: Industrial Aggregate Water Quantity, Quality, and Handling Requirements

Tech Memo 09: Industrial Aggregate Water Fate Assessment

Tech Memo 10: Operational Assumptions for Conceptual Industrial Aggregate Recycled Water Use

Tech Memo 11: Environmental Compliances Review Checklist

Tech Memo 12: Industrial Aggregate Conceptual Project Environmental and Permitting Compliances Review

APPENDIX B - PROJECT DESIGN AND COST-BENEFIT ANALYSIS

Delta Sand/Knife River Industrial Aggregate Site Recycled Water Conceptual Design (Kennedy/Jenks Consultants Technical Memorandum)

SWOT Matrix

Triple Bottom Line Assessment: Recycled Water Use for Industrial Aggregate (Good Company, June 2013)

APPENDIX C - WATER BALANCE MODEL DOCUMENTATION

UO Student Project Report (June 2013)

Water Balance Model (Alpha version, Excel workbook files)

Regions

Industrial Balance

Effluent Balance

River Balance

WLA Tool Base 2035

Thermal Load Risk Calendars (Base Case and Conceptual Recycled Water Use)

Base Case

Conceptual Recycled Water Use

APPENDIX D - STAKEHOLDER OUTREACH

MWMC Resource Recovery: Water Recycling – Phase 2 Recycled Water Study (briefing sheet)

Stakeholder Questionnaire Results and Next Steps (MIG, June 2013)