Wastewater Facilities Plan
Administrative Draft

MCSD Wastewater Management Facility
NPDES Permit No. CA0024490
Order No. WQ 2011-0008-DWQ

Prepared for:

McKinleyville Community Services District

SHN Consulting Engineers & Geologists, Inc.

812 W. Wabash Ave.
Eureka, CA 95501-2138
707-441-8855

January 2012
008189.300

CONSULTING ENGINEERS & GEOLOGISTS, INC.

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Reference: 008189.300

January 12, 2012

Mr. Norman Shopay, General Manager
McKinleyville Community Services District
P.O. Box 2037
McKinleyville, CA 95519

Subject: **MCSD Wastewater Management Facility, Facilities Plan Administrative Draft; NPDES Permit No. CA0024490, Order No. WQ 2011-0008-DWQ**

Dear Mr. Shopay:

Please find enclosed the final administrative draft of the facilities plan for the McKinleyville Community Services District (MCSD, the District) wastewater management facility.

This final plan incorporates updates to the revised draft submitted to MCSD for review and comment on August 10, 2011. Edits were made to the August draft based on comments received by MCSD staff and peer review comments from Kennedy/Jenks Consultants. Additional edits were made to the plan based on comments received during the public review and comment period for the plan, which extended from October 19, 2011 through December 14, 2011.

Public Review and Comment Summary

The administrative draft of the facilities plan was presented to the MCSD Board for review on October 19, 2011. A copy of the October 19th presentation is included in Appendix I of this plan. A public workshop was held on November 7th for the public to ask questions and provide comments. A copy of the November 7th presentation is also included in Appendix I.

On November 16, 2011, an update on the facilities planning process was presented to the Board. The presentation included a detailed review of the recommended alternative (an in-basin extended aeration system) for the treatment system upgrade. A copy of the November 16th presentation is included in Appendix I. On December 14, 2011, a tour of the City of Willits in-basin extended aeration facility was hosted for MCSD staff and interested community members.

Following the close of the public review and comment period, comments received were reviewed and considered by MCSD and SHN. SHN provided a response to the comments in a presentation to the MCSD Board on January 4, 2012. A copy of the January 4th presentation is also included in Appendix I of this plan.

CEQA Review Process

One of the comments received during the public review and comment period indicated that with the finalization of the plan, the District would be selecting a preferred project with which to proceed. There was concern that an environmental analysis complying with the California Environmental Quality Act (CEQA) has not been completed in parallel with the plan.

To clarify the CEQA requirements at this time, SHN has determined that the facilities plan document is statutorily exempt from CEQA because it is a planning study that will be accepted by the MCSD Board without any legally binding requirements (California Code of Regulations Title 14, Chapter 3, Article 18, Section 15262). Pursuant to the CEQA requirements, following MCSD Board acceptance of the plan, a Notice of Exemption (NOE) will be filed with the County Clerk, posted within 24 hours of receipt, and shall remain posted for 30 days. A copy will also be sent to the State Clearinghouse. Once the NOE is filed, a 35-day statute of limitations will be initiated for legal challenges to the decision.

SHN anticipates that any future actions that are legally binding, including, but not limited to commitment of funding for implementation, and/or discretionary permit approval for implementation, will require appropriate environmental documentation complying with the CEQA requirements. A clear and comprehensive description of the proposed project will be required prior to initiating the CEQA environmental review process. Board acceptance of the facilities plan will enable the District to define the "proposed project" pursuant to CEQA. Following Board acceptance of the plan, completion of the appropriate CEQA documentation for the preferred project is recommended.

Pre-Design Recommendations

In addition to completing the appropriate CEQA documentation for the preferred project, SHN recommends the District initiate completion of a pre-design report prior to completing any design work on the project. The development of a pre-design report will allow the District to review and analyze various design options associated with the preferred project prior to initiating design.

This plan is being submitted for presentation to the MCSD Board on February 1, 2012. If you have any questions, please call Mike Veach or me at 707-441-8855.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.

Lisa K. Stromme, P.E.
Water Resources Engineer

LKS:lms
Enclosure: Wastewater Facilities Plan Administrative Draft
c. w/Encl: Greg Orsini, MCSD

Reference: 008189.300

Wastewater Facilities Plan
Administrative Draft

MCSD Wastewater Management Facility
NPDES Permit No. CA0024490
Order No. WQ 2011-0008-DWQ

Prepared for:

McKinleyville Community Services District
McKinleyville, California

Prepared by:

SHN
Consulting Engineers & Geologists, Inc.
812 W. Wabash Ave.
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January 2012

QA/QC: MCV___

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List of Preparers

SHN Project Team

Lisa Stromme, P.E.
Mike Veach, P.E.
Susan Foreman, P.E.
Rose Patenaude, P.E.

Executive Summary

The McKinleyville Community Services District (MCSD, the District) maintains and operates a Wastewater Management Facility (WWMF) that serves the community of McKinleyville in Humboldt County, California. The WWMF discharges to surface waters, and the District is required to obtain a National Pollutant Discharge Elimination System permit that sets forth specific discharge requirements to ensure protection of public health, environmental health, and water quality. This permit is renewed every five years by the California Regional Water Quality Control Board. At each renewal, the permit may incorporate new treatment objectives and discharge standards that require an upgrade or modification to the facility to meet new regulatory requirements.

Facility Plan Objective

The objective of this facilities plan is to provide a clear, feasible, and appropriate "road map" to capital improvements, upgrades, and maintenance of the District's wastewater collection, treatment, and disposal facilities for the next 20 years. The plan is designed to be used in the development of a wastewater management system that addresses immediate permit requirements, anticipates future permit and regulatory requirements, accommodates anticipated growth and community needs, and provides flexibility for future expansion.

Current Regulatory Issues

The current area of concern for the existing WWMF is the presence of high ammonia concentrations in treated effluent. High nutrient loading is impacting the ability of the WWMF to comply consistently with current disposal and reclamation system requirements. Although the current permit does not directly limit ammonia in effluent discharges, the District anticipates ammonia regulatory compliance limits will be established in the next permit cycle.

Population Growth Forecasts

McKinleyville is the most populated unincorporated area in Humboldt County and is one of the fastest growing communities in the county. Population growth forecasts for McKinleyville were presented in the McKinleyville Community Plan (Humboldt County, 2002). For purposes of this facilities plan, the average growth rate used to develop 20-year flow projections was based on the alternative growth rate presented in the plan that projects a 1.8% annual increase in population. This projected increase is reflective of the 10-year historic growth rate in the community (MCSD, 2011).

Existing Wastewater Treatment System

The existing WWMF consists of a collection system, wastewater treatment facility, and effluent disposal and land reclamation systems. Community wastewater is collected at five lift stations for pumping to the WWMF. The existing WWMF is a secondary treatment process that consists of three aerated ponds and one stabilization pond followed by a two-stage treatment wetland. The average dry weather design flow of the treatment facility is 1.6 million gallons per day (MGD) and the wet weather design flow is 3.3 MGD.

Existing and Projected WWMF Flows

Based on analysis of the dry weather season data for May 2003 through October 2010, the current average dry weather flow is approximately 0.9 MGD. Based on analysis of the wet weather season data for November 2003 through May 2010, the average wet weather flow is approximately 1.1 MGD. The peak day flow was approximately 2.0 MGD.

Projected 20-year flows for year 2030 were developed based on a 1.8% annual increase in population. The projected average dry weather flow for year 2030 is 1.4 MGD and the projected average wet weather flow is 1.7 MGD. The projected peak day flow for year 2030 is 3.1 MGD.

Existing Disposal and Reclamation System

During the discharge period, October 1 through May 14, treated wastewater effluent is discharged to the Mad River, or, if the flow in the river is less than 200 cubic feet per second, effluent is discharged to the percolation ponds adjacent to the river and/or to land for reclamation (use as irrigation water). During the discharge prohibition period, May 15 through September 30, effluent is discharged to the percolation ponds and/or to land for reclamation. Land discharge occurs at the Lower Fisher Ranch, Upper Fisher Ranch, the Hiller Parcel, and the Pialorsi Ranch.

Under current conditions, wastewater reuse on the existing wastewater reclamation areas does not conform to the current waste discharge requirements for reclamation activities. The Upper Fisher Ranch is not operated for reclamation; wastewater effluent is applied by overland flow irrigation methods in quantities that exceed agronomic rates for hay grass. Opportunities to increase irrigation on the lower pastures may balance these effects; however, based on current nitrogen loading rates, the existing available reclamation area is not sufficient to reclaim wastewater.

In order to accommodate the land application of effluent, modifications to the existing disposal management practices will need to include a reduction in total nitrogen in the plant effluent and an increase of the crop cover's ability to use the available nitrogen being applied through land application.

The District is in the process of studying alternatives to the continued use of the existing percolation ponds for effluent disposal during the summer discharge prohibition period. This facilities plan presents proposed upgrades to the existing treatment system that will enable the District to take the existing percolation ponds offline following completion of the upgrades to the secondary treatment system and the existing land reclamation system.

Treatment System Upgrades

Secondary treatment alternatives were evaluated with regard to treatment, cost, implementability, public acceptance, and regulatory issues. Nitrogen removal, in addition to secondary treatment, was considered a priority. Secondary treatment alternatives reviewed in detail included a high performance aeration system with a nitrifying filter; an in-basin extended aeration system; an oxidation ditch; an activated sludge system and a membrane treatment system.

The in-basin extended aeration system provides a high quality effluent that would reliably meet anticipated permit requirements for land application and discharge to Mad River. Of the high-reliability alternatives considered, the in-basin extended aeration system had the lowest capital and operational costs and was selected as the recommended treatment system upgrade. Costs for the in-basin extended aeration system were estimated to be $7.4M. Additional costs for a new headworks were estimated to be $1.1M.

Collection System Upgrades

The central gravity main line (Line 5) that crosses under Highway 101 and the southern gravity main line (Line 3) that extends west from Highway 101 have been identified as the critical areas in the collection system that will require upgrades under projected flow conditions. Recommended improvements to the collection system network include installing parallel pipe networks adjacent to each main line in these areas. Additional improvements are recommended at the system lift stations. Total costs for the proposed collection system upgrades were estimated to be $3.4M.

Disposal and Reclamation System Upgrades

To increase reclamation capabilities at the land reclamation sites, installation of a poplar forest is proposed. The proposed poplar forest disposal plan includes planting a minimum of 45 acres of the lower Fisher Ranch property with poplars in 4- to 5-acre plots. If poplars replaced the current crop mixture on the lower Fisher Ranch property, total acreage efficiency could be increased by 130%. Disposal costs also include decommissioning the existing percolation ponds. Total costs for the proposed disposal and reclamation system upgrades were estimated to be $1.9M.

Total Anticipated Project Cost

The opinion of probable cost to complete the recommended WWMF collection, treatment, and disposal system improvements is approximately $13.8M including planning and design.

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Abbreviations and Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
<	less than
>	greater than
ac. ft.	acre feet
BHP	Brake horsepower
BOD/ acre/day	Biochemical Oxygen Demand per acre per day
CF	cubic feet
cfs	cubic feet per second
cm	centimeter
CY	cubic yards
d	day
EA	each
ft	feet
ft/s	feet per second
g/EDU/d	gallons per Equivalent Dwelling Unit per day
g/kg	grams per kilogram
gpcd	gallons per capita per day
gpd/EDU	gallons per day per Equivalent Dwelling Unit
gpd/SF	gallons per day per square foot
gpm	gallons per minute
gpm/SF	gallons per minute per square foot
hp	horsepower
hp/MG	horsepower per Million Gallons
hp-hr	horsepower-hour
in	inch
in/day	inches per day
kg/ha	kilogram per hectare
kV	kilovolts
kWhr	kilowatt-hours
lbs	pounds
lbs/acre	pounds per acre
LF	Linear Foot
LS	Lump Sum
m	meter
MG	Million Gallons
mg/kg	milligrams per kilogram
mg/L	milligrams per Liter
MGD	Million Gallons per Day
ml/L	milliliters per Liter
mm	millimeter
MPN/100 ml	Most Probable Number per 100 milliliters
NTU	Nephelometric Turbidity Units
ppcd	pounds per capita per day
ppd	pounds per day
ppd/ac	pounds per day per acre

Abbreviations and Acronyms, Continued

ppd/EDU	pounds per day per Equivalent Dwelling Unit
psi	pounds per square inch
SF	square feet
t/yr	tons per year
TKN	Total Kjeldahl Nitrogen
TUc	Toxicity Unit
yr	year
μg/L	micrograms per Liter
μm	micrometer
4,4′-DDT	4,4′-Dichlorodiphenyltrichloroethane
AAF	Average Annual Flow
ACV	Arcata-Eureka Airport
ADWF	Average Dry Weather Flow
alpha-BHC	alpha-1,2,3,4,5,6-hexachlorocylohexane
ALR	Area Loading Rate
AWHC	Available Water Holding Capacity
AWWF	Average Wet Weather Flow
BHP	Brake Horsepower
BMID-MF	Alternative B with Multi-Family
BNR	Biological Nutrient Removal
BOD	Biochemical Oxygen Demand
CalARP	California Accidental Release Program
Cal-OSHA	California-Occupational Health and Safety Administration
CCC	California Coastal Commission
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CFR	U.S. Code of Federal Regulations
CIMIS	California Irrigation Management Information System
CIP	Capital Improvement Program
CIPP	Cured In-Place Pipe
Cl_2	Chloride
CMC	Criteria Maximum Concentration
CNDDB	California Natural Diversity Database
CO_2	Carbon Dioxide
CO_3	Carbon Trioxide
CoCC	Chronic or Continuous Concentration
COR	Coefficient of Reliability
CSD	Community Services District
CSLC	California State Lands Commission
CT	Chlorine Concentration over Time
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DHS	(California) Department of Health Services
DO	Dissolved Oxygen
DPMC	Dual Power Multicellular

Abbreviations and Acronyms, Continued

DPS	Distinct Population Segment
DT	Detention Time
E1UBL	Estuarine Subtidal Unconsolidated Bottom Permanently Flooded
E2US2N	Estuarine Intertidal Unconsolidated Shore San Regularly Flooded
EDU	Equivalent Dwelling Unit
effl	effluent
EPA	U.S. Environmental Protection Agency
EQ	Excellent Quality biosolids, as defined in 40 CFR Part 503
ESU	Evolutionary Significant Unit
ET	Evapotranspiration
FC	Fecal Coliform
FES	Freshwater Environmental Services
FS Re.	Removal in facultative system preceding wetlands
FWS	Free Water Surface
FY	Fiscal Year
HBMWD	Humboldt Bay Municipal Water District
HDD	Horizontal Directional Drilling
HPAS	High Performance Aerated Pond System
HRT	Hydraulic Retention Time
I/I	Infiltration and Inflow
KT	Removal Rate
K_x	Crop Coefficient
LAFCo	Local Agency Formation Commission
MAD	Management Allowable Depletion
MBR	Membrane Bioreactors
MCL	Maximum Concentration Limit
MCSD	McKinleyville Community Services District
MLE	Modified Ludzack-Ettinger (process)
MLRS	Mixed Liquor Recycle (pumps)
MMDWF	Maximum Month Dry Weather Flow
MMWWF	Maximum Month Wet Weather Flow
MRfz	Mad River fault zone
MSL	Mean Sea Level
N:P:K	Nitrogen:Phosphorous:Potassium
N_2	Nitrogen gas
NA	Not Applicable
NC	Not Calculated
NCUAQMD	North Coast Unified Air Quality Management District
NF	Nitrifying Filter
NFPA	National Fire Protection Association
NFR	Non-filterable Residue
NH_3	Ammonia
NH_3-N	Ammonia-Nitrogen
NH_4	Ammonium
NH_4-N	Ammonium-Nitrogen
NO_3–N	Nitrate-Nitrogen
NOAA	National Oceanic and Atmospheric Administration

Abbreviations and Acronyms, Continued

NPDES	National Pollutant Discharge Elimination System
NR	No Reference
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
O&M	Operations and Maintenance
O_2	Oxygen
OLA	Oscar Larson & Associates
Org-N	Organic Nitrogen
PAN	Plant-Available Nitrogen
PC	Pollutant Concentration biosolids, as defined in 40 CFR Part 503
PDAF	Peak Day Average Flow
PEMIC	Palustrine Emergent Persistent Seasonally Flooded
PFO1C	Palustrine Forested Broad Leaved Deciduous Seasonally Flooded
PFRP	Processes to Further Reduce Pathogens
PG&E	Pacific Gas and Electric Company
PIF	Peak Instantaneous Flow
PLC	Programmable Logic Controller
PM-10	Particulate Matter of less than 10 micrometers in diameter
POTW	Publicly Owned Treatment Works
PSRP	Processes to Significantly Reduce Pathogens
PSS1C	Palustrine Scrub-Shrub Broad Leaved Deciduous Seasonally Flooded
PUBHx	Palustrine Unconsolidated Bottom Permanently Flooded
R3UBH	Riverine Upper Perennial Unconsolidated Bottom Permanently Flooded
RAS	Return Activated Sludge
RDII	Rainfall Derived Infiltration and Inflow
Re	Percent Removal
RGF	Recirculating Gravel Filter
RMZ	Regulatory Mixing Zone
RWQCB	California Regional Water Quality Control Board
SAV	Submerged Aquatic Vegetation
SHN	SHN Consulting Engineers & Geologists, Inc.
SO_2	Sulfide
SRT	Solids Retention Time
SSO	Sanitary Sewer Overflows
SWRCB	State Water Resources Control Board
TBD	To Be Determined
TCDD	Tetrachlorobenzeno-p-dioxin
TDZ	Toxic Dilution Zone
TMDL	Total Maximum Daily Loads
TN	Total Nitrogen
TRE	Toxicity Reduction Evaluation
TSS	Total Suspended Solids
UH	Unit Hydrograph
USA	Urban Study Area
USC	United States Code
USDA	United States Department of Agriculture
USDI	United States Department of the Interior

Abbreviations and Acronyms, Continued

USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	Ultraviolet
VSS	Volatile Suspended Solids
W&K	Winzler & Kelly Consulting Engineers
WAS	Waste Activated Sludge
WDR	Waste Discharge Requirement
WEF	Water Environment Federation
WER	Water Effects Ratio
WRCC	Western Regional Climate Center
WSA	Water Study Area
WWMF	Wastewater Management Facility

Part 1 Background

1.0 Introduction

The McKinleyville Community Services District (MCSD, the District) maintains and operates a Wastewater Management Facility (WWMF) that serves the community of McKinleyville in Humboldt County, California (Figure 1-1). The WWMF discharges to surface waters, and the District is required to obtain a National Pollutant Discharge Elimination System (NPDES) permit that sets forth specific discharge requirements to ensure protection of public health, environmental health, and water quality. This permit is renewed every five years by the California Regional Water Quality Control Board (RWQCB). At each renewal, the permit may incorporate new treatment objectives and discharge standards that require an upgrade or modification to the facility to meet new regulatory requirements.

The current permit for the MCSD Wastewater Management Facility (WWMF), NPDES Permit No. CA0024490, Order No. WQ 2011-0008-DWQ, was adopted April 19, 2011, and includes Waste Discharge Requirements (WDRs) for effluent treatment, discharge, and reclamation. The current permit went into effect on April 19, 2011, and expires on April 18, 2016. The previous NPDES permit for the WWMF, Order No. R1-2008-0039, was adopted by the RWQCB on June 12, 2008, and became effective on August 1, 2008. Order No. R1-2008-0039 was set to expire on August 1, 2013; however, the permit was superseded by the new NPDES permit effective April 19, 2011. A copy of the NPDES permit is included in Appendix A.

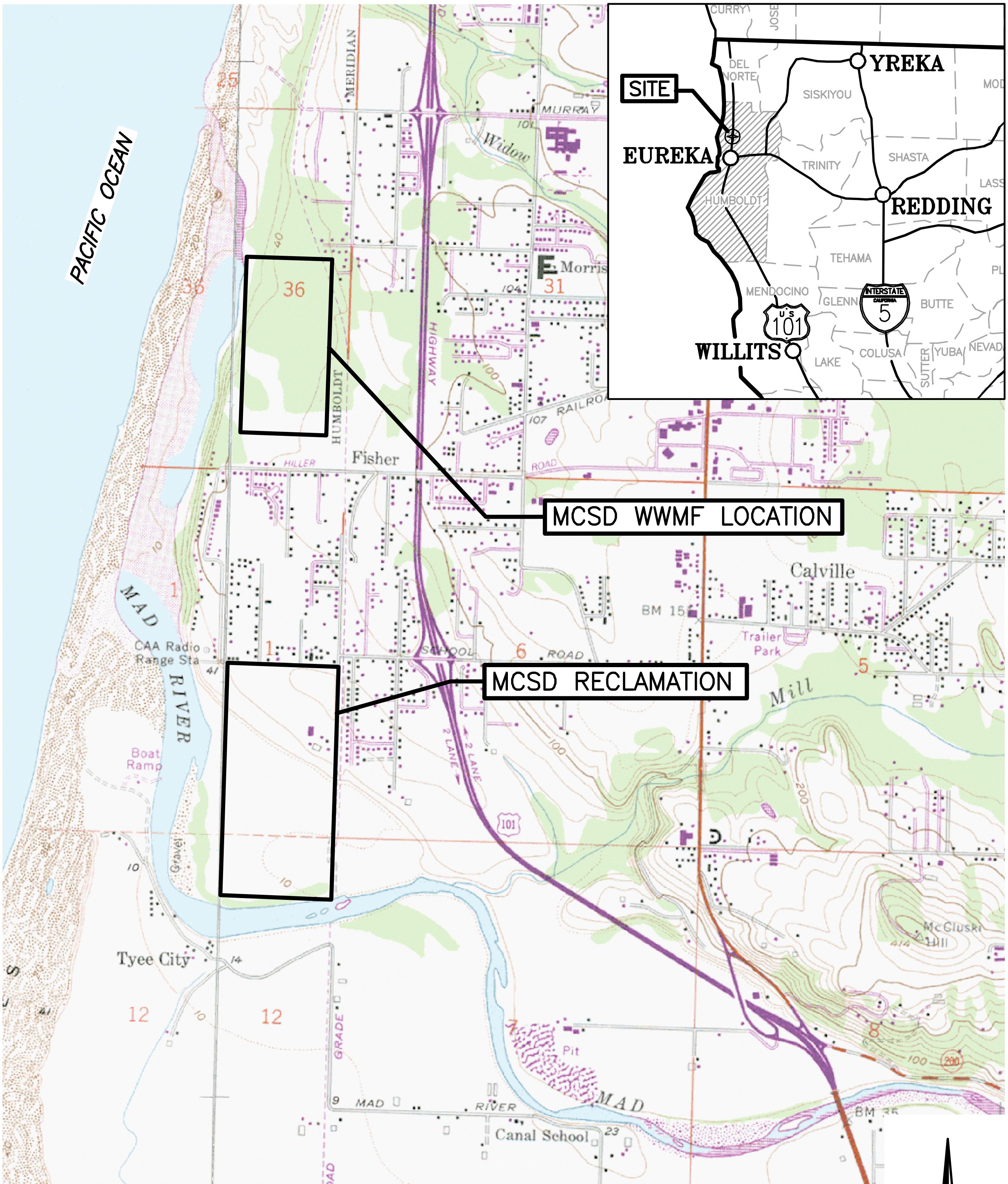
Figure 1-2 shows the existing treatment, surface water discharge, groundwater discharge, and reclamation areas for the MCSD WWMF. Figure 1-3 is a general site plan for the existing treatment system and Figure 1-4 presents a general overview of the collection system.

1.1 Facilities Planning Process

A wastewater facilities plan is a comprehensive document that examines the existing wastewater system from collection through discharge. The goal of a facilities plan is to identify, evaluate, and select the most reasonable wastewater treatment and disposal options to address not only the immediate permit requirements, but also provide for the long term needs of a community.

This facilities plan evaluates viable options for the District's wastewater collection, treatment, and disposal facilities. This facilities plan also provides the following benefits:

- serves as an educational tool for the public, community decision makers, and state and federal funding and regulatory agencies;
- documents, investigates, and addresses environmental and regulatory issues associated with the WWMF; and
- provides the research, data, and analyses necessary to develop the next NPDES permit.



SOURCE: ARCATA NORTH & TYEE CITY USGS 7.5 MINUTE QUADRANGLE

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SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California		Site Location Map SHN 008189
	August 2011	008189-SITE-LCTN	Figure 1-1

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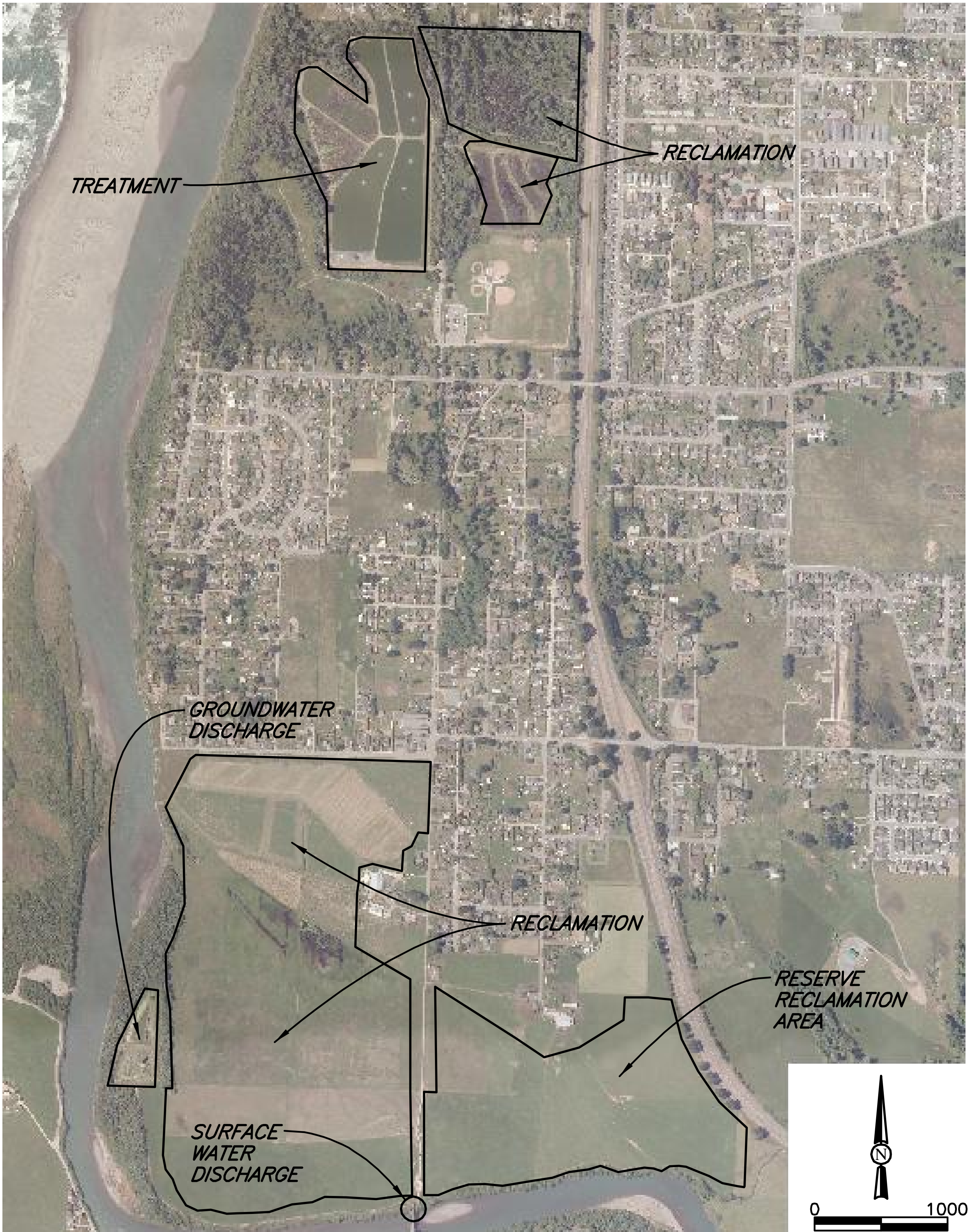

SOURCE: 2010 NAIP IMAGERY

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Site Plan SHN 008189
January 2012	008189-300-SITE	Figure 1-2

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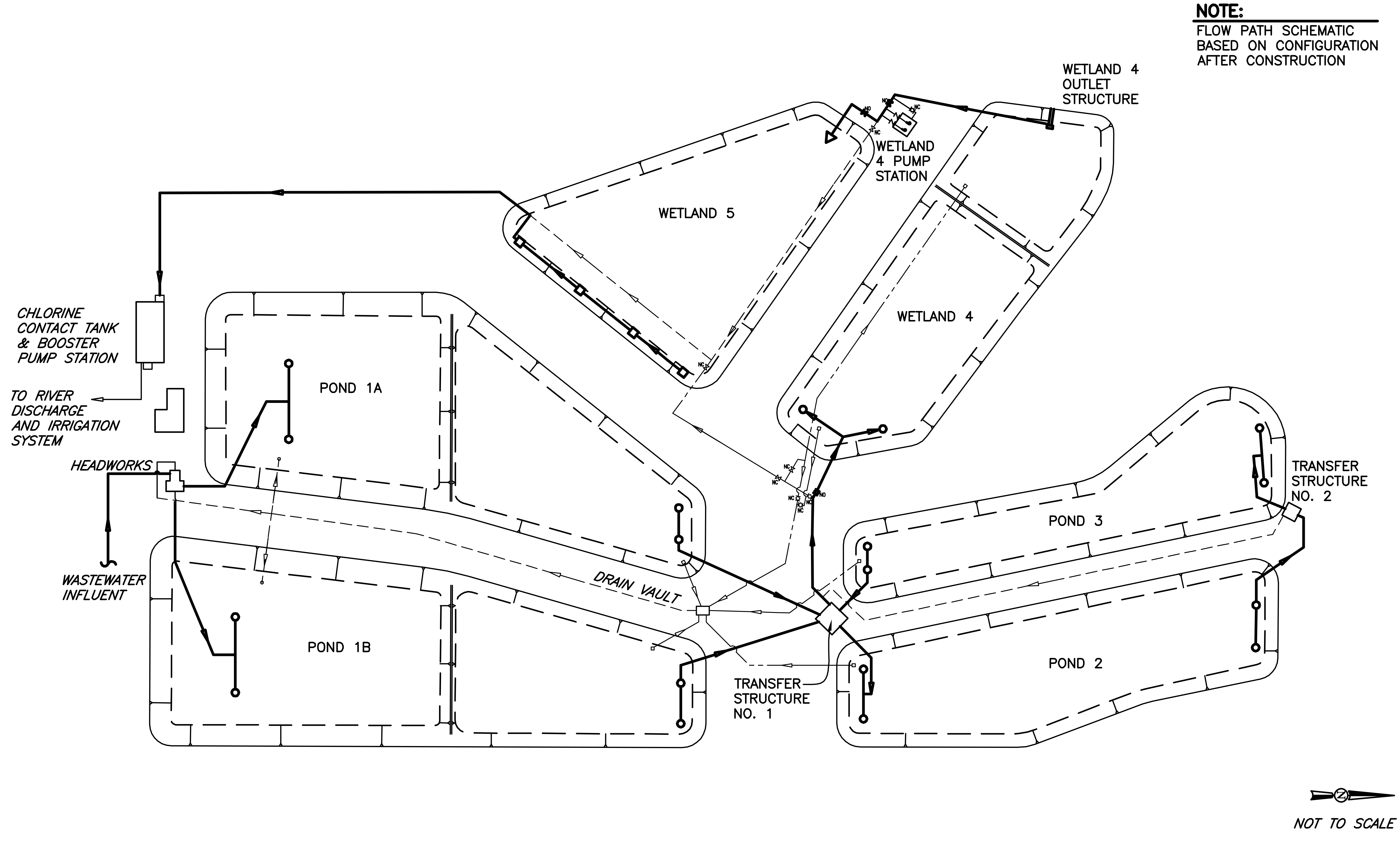

BASE MAP PROVIDED BY :
WINZLER & KELLY, DATED JUNE 2005

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Existing Wastewater Treatment System SHN 008189
	August 2011 008189-300-SITE-PLAN	Figure 1-3

SOURCE: 2010 NAIP IMAGERY

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1"=2000'

Consulting Engineers
& Geologists, Inc.

McKinleyville Community Services District
Wastewater Management Facility
McKinleyville, California

Existing Wastewater
Collection System

SHN 008189

August 2011

008189-300-E-WWCS

Figure 1-4

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This facilities plan document is statutorily exempt from the California Environmental Quality Act (CEQA), because it is a planning study that will be accepted by the MCSD Board without any legally binding requirements (California Code of Regulations Title 14, Chapter 3, Article 18, Section 15262).

1.2 Purpose and Need

The objective of this facilities plan is to provide a clear, feasible, and appropriate "road map" to capital improvements, upgrades, and maintenance of the District's wastewater collection, treatment, and disposal facilities for the next 20 years. The plan is designed to be used in the development of a wastewater management system that addresses immediate permit requirements, anticipates future permit and regulatory requirements, accommodates anticipated growth and community needs, and provides flexibility for future expansion.

1.2.1 System Ownership

Wastewater collection, treatment, and disposal services are provided in McKinleyville by the MCSD. The District was formed in 1970 as an independent governmental unit organized under the Community Services District Law, pursuant to Title 6 Division 3 of the Government Code Section 61000 et seq. The District is governed by a five-member Board of Directors locally elected on four-year rotating terms (MCSD, 2011). Currently, the District serves approximately 6,100 customers. There are 5,315 lateral water connections, and the District maintains 6,042 active water accounts. The number of current sewer connections is 4,495 (Willdan, 2011).

1.2.2 Capital Improvement Program

The District maintains a multi-year Capital Improvement Program (CIP) that identifies capital equipment purchases and project funding needs for a 10-year planning period. A copy of the most recent CIP approved for Fiscal Year (FY) 2012 is included in Appendix B.

A water and sewer capacity fee study was also recently completed by Willdan Financial Services for the District's water and wastewater systems (Willdan, 2011). The study includes a detailed review of the sewer CIP allocation based on capital project requirements to meet projected growth. A copy of the 2011 Final Water and Sewer Capacity Fee Study is included in Appendix C. The District is also currently working on developing a water and sewer rate study (MCSD, 2011).

This facilities plan includes recommendations for improvements to the collection and treatment systems and estimated operation and capital costs. As applicable, updates to the CIP planning documents presented in Appendices B and C will be addressed to account for any differences between estimated project costs and the costs presented in this study for the preferred project.

1.2.3 Project Funding Sources

Publicly owned wastewater utilities in California have sources of public funds for grants and loans available to them for the planning design and construction of wastewater systems. This facilities plan will be instrumental if the MCSD decides to pursue funding from such sources as the Clean Water State Revolving Fund and the U.S. Department of Agriculture's Rural Development loan programs. A facilities plan that has been approved by the RWQCB is required by all funding agencies in order for the utility to be able to obtain funding. This wastewater facilities plan has been structured to meet the requirements of the RWQCB, which administers the Clean Water State Revolving Fund (CWSRF). It also complies with the requirements for a Preliminary Engineering Report (PER) as outlined by the Rural Utilities Services (RUS, 2008).

2.0 Study Area Characteristics

This section of the facilities plan provides an overview of the characteristics for the general McKinleyville study area. Information presented in this section is based on review of the following documents and additional special studies where referenced in the text:

- Draft Program Environmental Impact Report for the 1999 McKinleyville Community Plan Update of the Humboldt County General Plan prepared by Humboldt County (June 7, 1999) (Humboldt County, 1999)
- McKinleyville Community Plan prepared by Humboldt County in December 2002 (Humboldt County, 2002)
- Draft Municipal Service Review prepared by the Local Agency Formation Commission (LAFCo) in January 2009 (LAFCo, 2009)

2.1 Study Area

McKinleyville is an unincorporated community located in Humboldt County, California, approximately five miles north of Humboldt Bay. McKinleyville is situated along the Pacific Ocean on a coastal terrace located between the Mad River and Little River drainage basins. Elevations range from approximately 50 feet to 500 feet above Mean Sea Level (MSL). The coastal terrace is crossed by six creeks: from north to south—Bullwinkle Creek, Patrick Creek, Strawberry Creek, Norton Creek, Widow White Creek, and Mill Creek (Humboldt County, 1999).

The MCSD service area encompasses approximately 12,140 acres and extends north from the Mad River to Patrick Creek and east from the Pacific Ocean to the foothills bordering the community of Fieldbrook (LAFCo, 2009). The MCSD service area encompasses both an Urban Study Area (USA) and a Water Study Area (WSA), as delineated by Humboldt County and shown on Figure 1-5. The McKinleyville USA encompasses approximately 5,521 acres, and the WSA encompasses 1,683 acres. Water and sewer services are provided by MCSD within the USA and only water services are provided within the WSA.

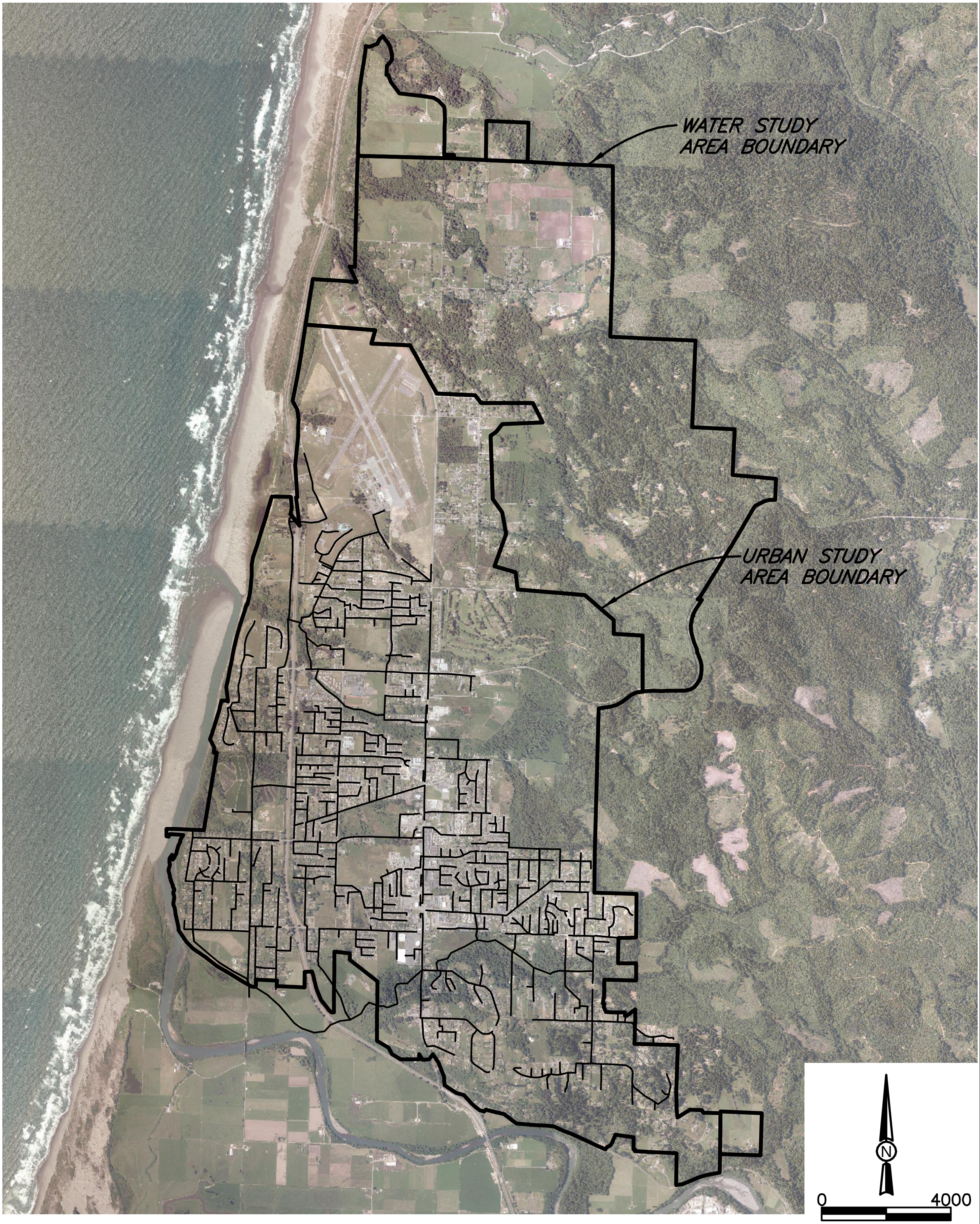
The existing collection system network currently extends throughout most of the USA as shown on Figure 1-5. However there are areas in the USA where the existing collection system network would need to be extended to provide sewer collection services.

MCSD's present economic base is primarily that of a residential community with local and regional commercial services along a centralized strip. Limited agricultural production and light manufacturing is also pursued in the area. McKinleyville is the site of the County's only regional airport facility, the Arcata-Eureka Airport.

2.2 Physical Environment

2.2.1 Climate

The climate of the vicinity is characterized by mild, rainy winters and cool, dry summers, with an average temperature of 55 °F (13 °C). Average daily temperatures range from about 48 °F during



SOURCE: 2010 NAIP IMAGERY

1"=4000'±

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California		MCSD Study Area Boundaries SHN 008189
	October 2011	008189-300-MCSD-STUDY-BOUND	Figure 1-5

the winter to about 60 °F during the summer. The extreme low observed temperatures in the winter are in the range of 20 °F and the extreme high temperatures in the summer are in the vicinity of 90 °F. The dominant climatic features of the area are governed by the Pacific Ocean.

The greatest precipitation generally occurs in the month of December with an average rainfall of 6.35 inches. The least occurs in July. The wet weather season is considered to be November through April, and the dry weather season is considered to be May through October. Average annual precipitation is approximately 38.1 inches per year. Coastal fog is common throughout the year. The morning fog is influenced by the presence of the ocean, and develops as the moist air above the sea meets the cooler land surfaces when the breeze moves the air onshore.

Generally, the wind direction is from the northwest during the drier months of the year (May through September) and from the east from October through April, with the northwesterly winds being slightly stronger than the northeasterly winds. The presence of the Pacific Ocean to the west directly affects prevailing local wind patterns in the region. As the land mass heats during the day, warmer air temperatures inland establish a convective pattern that leads to the development of onshore winds. Cooling of the landmass during the night results in the reverse thermal pattern and a local offshore breeze develops.

2.2.2 Soils, Geologic Resources, and Geologic Hazards

Basement rock in the McKinleyville region is composed of late Jurassic to late Cretaceous age mélange of the Franciscan Complex (McLaughlin et al, 2000; Clarke, 1992). The mélange is part of the Central belt subunit of the Franciscan Complex, and typically consists of blocks of conglomerate, graywacke sandstone, radiolarian chert, blueschist facies metamorphic rock, greenstone, and ophiolitic plutonic rock in an intensely sheared argillite matrix. Throughout the region, Franciscan basement rock is overlain by a variety of late Cenozoic age sedimentary rocks. In the northern Humboldt Bay/McKinleyville region, Franciscan bedrock is unconformably overlain by early to middle Pleistocene age marine and continental deposits of the Falor formation (Carver, Stephens, and Young, 1985).

In coastal central Humboldt County, Franciscan basement rock and Falor formation deposits are overlain by a series of late Pleistocene marine terraces. McKinleyville is located on a particularly well-developed flight of marine terraces, which extend from the modern coastline to the hills along the eastern margin of town. These terraces typically consist of an abrasion platform cut across bedrock, covered by sediments typically consisting of near-shore marine deposits and terrestrial alluvial, colluvial, and eolian deposits. No datable material has been recovered from the marine terraces, so age assignments are based on elevation distributions and comparisons with global sea level chronologies, as well as comparisons of relative amounts of pedogenic soil development. Based on these analyses, the McKinleyville terrace sequence is correlated to the Sangamon interglacial period, between approximately 83,000 and 125,000 years ago.

The terrace underlying central McKinleyville correlates to the 96,000-year-old Stage 5b sea level high stand by Carver and Burke (1992); this surface is referred to as the "McKinleyville terrace."

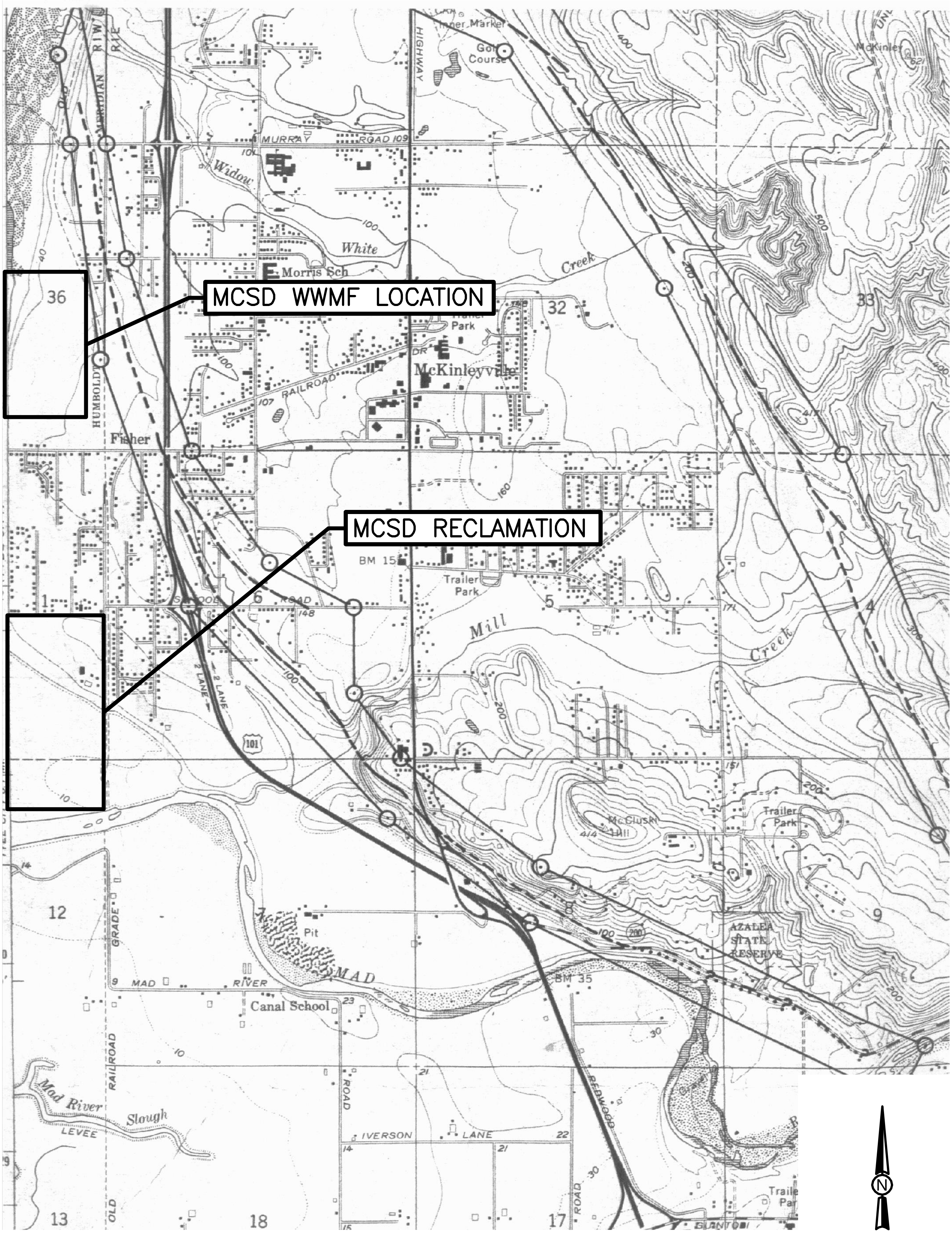
The most comprehensive soil survey work performed within McKinleyville remains the *Soils of Western Humboldt County* (U. C. Davis, 1965). Numerous soil series occur in McKinleyville, including "prime" agriculturally productive members of the Arcata, Ferndale, and Rohnerville series. Many of these productive areas have already undergone conversion to non-agricultural uses, mainly for residential subdivisions and commercial uses within the central McKinleyville terraces, and public facility development at the Arcata-Eureka Airport. The remaining areas of intact prime soils are located primarily in the Dows-Prairie-Crannell area, between Strawberry and Patrick Creeks. These areas are planned and zoned for agricultural and timber production as their "highest and best use."

2.2.2.1 Seismic Hazards

The Humboldt Bay region occupies a complex geologic environment characterized by very high rates of active tectonic deformation and seismicity. The area lies just north of the Mendocino Triple Junction, the intersection of three crustal plates (the North American, Pacific, and Gorda plates). North of Cape Mendocino, the Gorda plate is being actively subducted beneath North America, forming what is commonly referred to as the Cascadia Subduction Zone (CSZ). In the Humboldt Bay region, secondary deformation associated with plate convergence is manifested on-land as a series of northwest-trending, southwest-vergent thrust faults, and intervening folds ("fold and thrust belt"). The geomorphic landscape of the Humboldt Bay region is largely a manifestation of the active tectonic processes and the setting in this dynamic coastal environment.

McKinleyville is located within the Mad River fault zone (MRfz). This zone consists of several major northwest-trending thrust faults and numerous minor, secondary synthetic and antithetic faults. Major faults within the MRfz include, from north to south, the Trinidad, McKinleyville, Mad River, and Fickle Hill faults. The McKinleyville and Mad River faults both pass through McKinleyville. Earthquake Fault Zones (EFZs), as defined by the State's "Alquist-Priolo Earthquake Fault Zoning Act," are associated with both of these faults. Individual faults within the MRfz commonly exhibit variable strikes, which is common along thrust faults, and shallow to moderate dips ranging from as little as 10° to 55°. At least 5 kilometers (3 miles) of middle and late Pleistocene displacement has occurred across the MRfz since deposition of the Falor formation (Carver, 1987). In the McKinleyville area, the MRfz crosses, and displaces, the flight of marine terraces described above. The faults typically are well expressed across the terraces as west- and southwest-facing scarps separating the displaced, relatively flat terrace surfaces. Antithetic faults within the MRfz typically are associated with lesser amounts of cumulative displacement, and form subtle northeast-facing scarps. Figure 1-6 shows the location of MCSD facilities relative to the active faults in the McKinleyville area.

Only one moderate historic earthquake may have been generated within the MRfz, but all the faults within the zone are considered active based on deformation of Holocene-age soils overlying the faults. By association, the principal faults within the MRfz are considered active by the State of California, and are included within Alquist-Priolo Earthquake Fault Zones. Of primary concern relative to MCSD facilities, the Mad River fault passes through the "Hiller Reclamation" area, just east of the WWMF treatment ponds. If a moderate or large magnitude earthquake were to occur along the Mad River fault, ground shaking at the facilities would be severe. In addition, if fault rupture were to be generated in such an event, it would presumably significantly impact piping and other infrastructure that crosses the fault trace.



SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Fault Map Alquist-Priolo SHN 008189
	August 2011 / 008189-FAULT	Figure 1-6

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Due to the proximity to active seismic sources, localized areas in McKinleyville may be subject to secondary seismic effects, such as liquefaction, lateral spread, and seismically-induced landsliding. Liquefaction is the sudden loss of soil shear strength due to a rapid increase of soil pore water pressures caused by cyclic loading from a seismic event. In simple terms, it means that a liquefied soil acts more like a fluid than a solid when shaken during an earthquake. In order for liquefaction to occur, the following are needed:

- granular soils (sand, silty sand, sandy silt, and some gravels),
- a high groundwater table, and
- a low density of the granular soils (usually associated with young geologic age).

In the McKinleyville area, these conditions generally are confined to recent alluvial deposits along streams, and recent beach deposits. The adverse effects of liquefaction include local and regional ground settlement, ground cracking and expulsion of water and sand, the partial or complete loss of bearing and confining forces used to support loads, amplification of seismic shaking, and lateral spreading. Lateral spreading is defined as lateral earth movement of liquefied soils, or competent strata riding on a liquefied soil layer, downslope toward an unsupported slope face, such as a creek bank, or an inclined slope face. For the most part, lateral spreading has been observed on low to moderate gradient slopes, but has been noted on slopes inclined as flat as one degree.

2.2.2.2 Landslides

Slope stability hazards are a significant concern in Humboldt County, due to the steeply sloping terrain and unconsolidated bedrock, combined with heavy seasonal rains. The majority of McKinleyville is located on the flat, relatively stable McKinleyville Terrace, where slope stability concerns are negligible. The potential for instability increases on steep slopes along creeks, in the upland areas of eastern McKinleyville, and along coastal bluffs. Landsliding relative to MCSD facilities is primarily a concern relative to water tanks and other storage or transmission facilities that may occupy upland areas east of McKinleyville. Figure 1-7 shows the locations of MCSD facilities relative to known geologic and geomorphic features in the McKinleyville area.

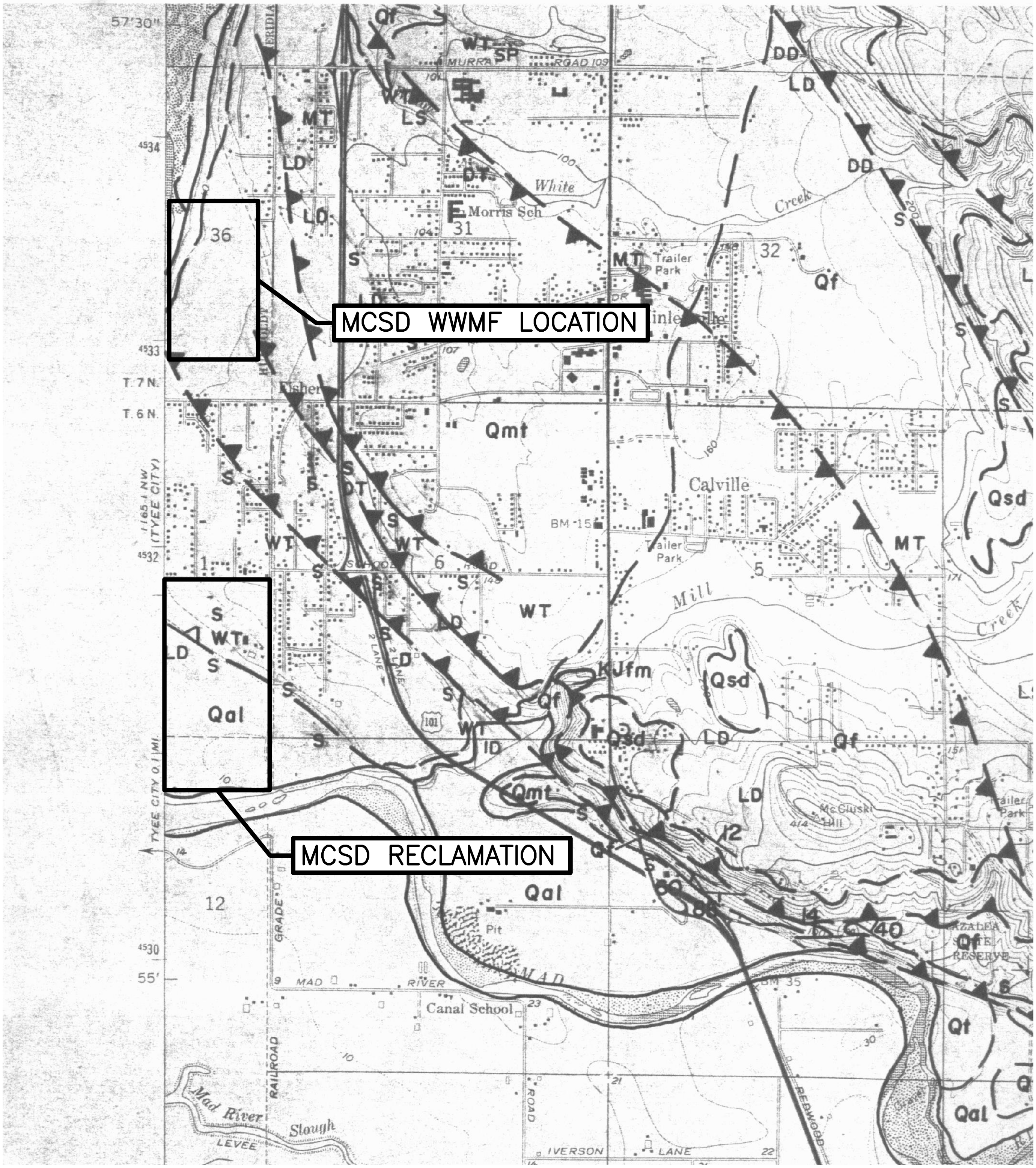
2.2.2.3 Tsunami and Seiche

Tsunamis are very large ocean waves produced by underwater earthquakes, landslides, or volcanic eruptions. Bores are high, often dangerous waves, traveling up river valleys caused by water surges in narrowing estuaries associated with tsunamis or tides. Seiches are oscillating waves in confined bodies of water, such as lakes, bays, or gulfs, generated by seismic activity.

McKinleyville coastal regions and river valley areas less than 100 feet MSL are susceptible to the effects of large tsunami waves. Portions of McKinleyville, including the WWMF's percolation ponds, lie within the Tsunami Inundation Zone, as identified on available maps (Redwood Coast Tsunami Working Group). Figure 1-8 shows the location of MCSD facilities relative to the Tsunami Inundation Zone for the McKinleyville area.

2.2.2.4 Flooding

Low lying areas along the Mad River are subject to flooding impacts. These floods may result from natural high flow conditions, or more severely, from a dam failure at Matthews Dam (Ruth Lake

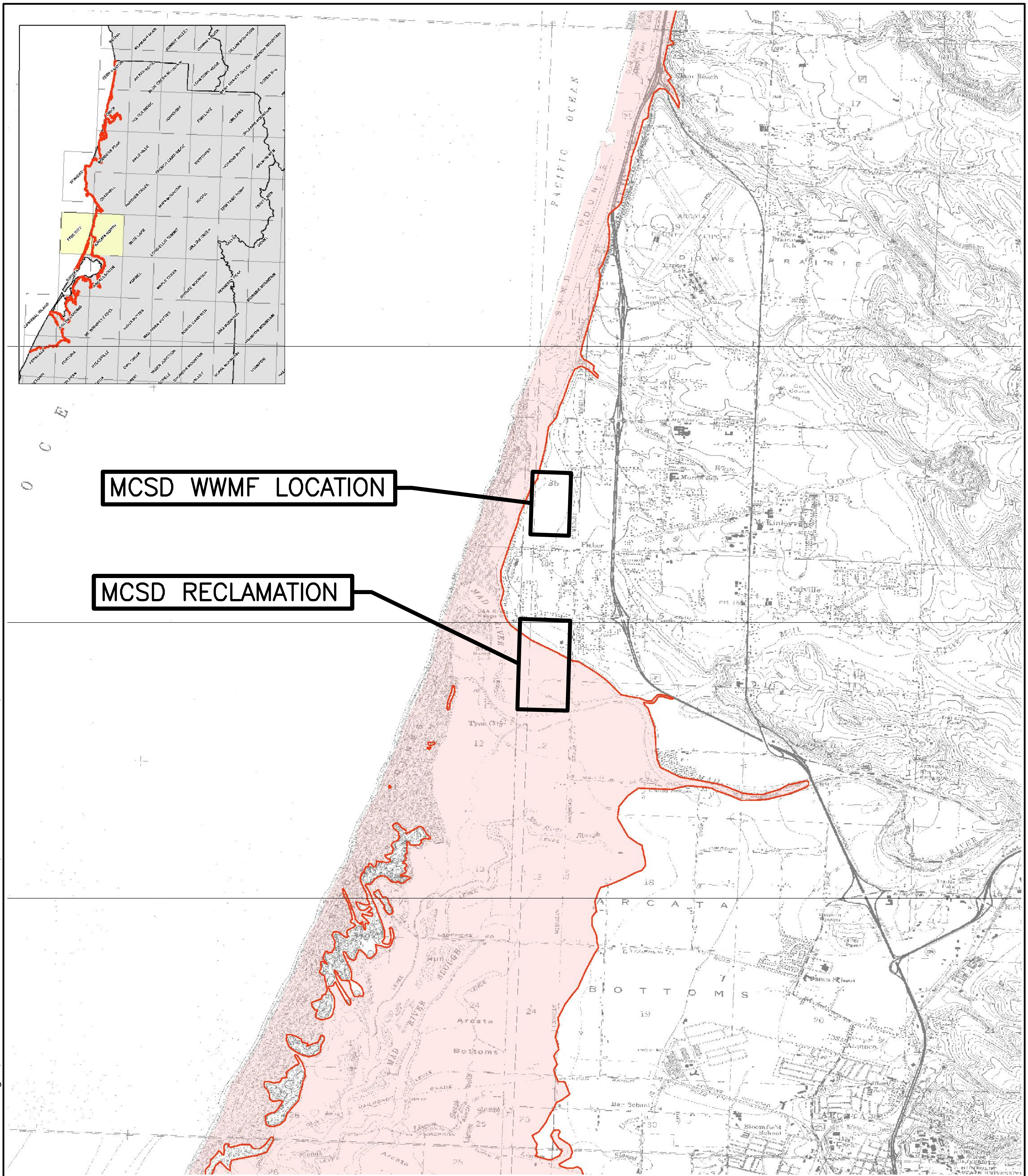


EXPLANATION

S SCARP
LD LINEAR DRAINAGE
WT WARPED TERRACE
DT DOWN THROWN

NTS

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Geologic and Geomorphic Map SHN 008189
August 2011	008189-GEOL-GEOM	Figure 1-7



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SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Tsunami Inundation Map SHN 008189
August 2011	008189-TSUNAMI	Figure 1-8

\\Eureka\Projects\2008\008189-MCSD\300-FacilitiesPlan\Dwgs , SAVED: 8/8/2011 8:21 AM CNEWELL, PLOTTED: 8/8/2011 8:43 AM, CHRIS D. NEWELL impoundment structure). Flood levels are defined by mapping produced by the Federal Emergency Management Authority (FEMA) and on a special map outlining the potential effects of a Matthews Dam failure. Figure 1-9 shows the locations of MCSD facilities relative to potential flood areas.

2.2.3 Public Health Hazards

There are several potential sources of hazardous conditions or material releases within McKinleyville in addition to the naturally-occurring hazards discussed in Section 2.2.2.

The MCSD WWMF contains more than the California-Occupational Health and Safety Administration (Cal-OSHA) threshold limit of extremely hazardous materials, in the form of chlorine gas. Chlorine is regulated under the California Accidental Release Prevention (CalARP) Program, as found in the California Code of Regulations (CCR), Title 19, Division 2, Chapter 4.5; and the Cal-OSHA Process Safety Management standards found in CCR Title 8, Section 5189, and Code of Federal Regulations (CFR) , Title 29, Section 1910.119.

The proximity of residential areas to Highway 101 increases the likelihood of impacts from releases of hazardous materials from truck shipments transported on Highway 101.

The Arcata-Eureka Airport is located in McKinleyville; therefore the MCSD service areas are located within the Airport Analysis and Safety Analysis Zones. Primarily, the airport is a commercial service airport providing airline and general aviation services to the community and the flying public. Additionally, the U.S. Coast Guard Search and Rescue Base is located on the airport grounds. Crashes and fires associated with aircraft landing, take-off, and fueling operations near the airport are a potential source of hazardous conditions and material releases.

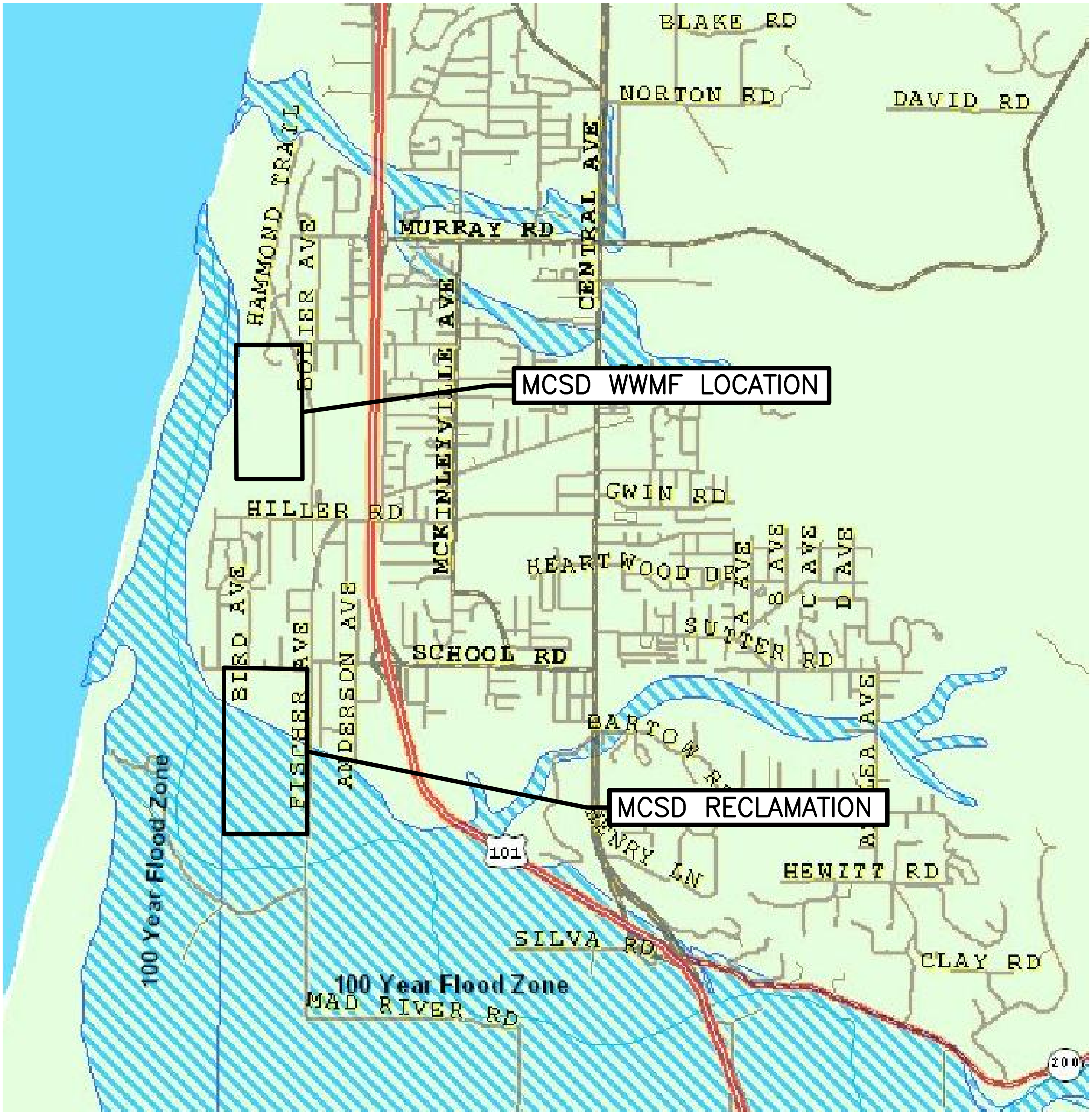
2.2.4 Energy Production and Consumption

There are no power generation facilities within the boundaries of McKinleyville. Natural gas and electric service is provided by Pacific Gas and Electric Company (PG&E). McKinleyville is served from a 60 killiVolt (kV) transformer line running from the Janes Creek substation in Arcata toward the City of Trinidad, between McKinleyville and Fieldbrook. The 8-inch natural gas main runs north to south along Central Avenue. Electric services provided by PG&E are provided in accordance with current rates and rules approved by the California Public Utilities Commission.

2.2.5 Water Resources

MCSD currently relies on the Mad River as a resource for domestic and fire supply water. Water is purchased under long-term contract from the Humboldt Bay Municipal Water District (HBMWD). Drinking water that is supplied to MCSD is withdrawn from the bed of the Mad River through four radial-arm "Ranney collectors."

Water is gravity-fed from HBMWD's facility on the Mad River to the Ramey Pump Station. Water is then pumped to MCSD's six storage tanks from which it is gravity-fed to MCSD's customers. The total combined system storage capacity is 5.25 million gallons. The delivery system, from storage tanks to individual users, consists of about 84 miles of water mains.



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SHN Consulting Engineers & Geologists, Inc.

McKinleyville Community Services District
Wastewater Management Facility
McKinleyville, California

100 Year Flood Zone Map

SHN 008189

August 2011 | 008189-100YR-FLOOD | Figure 1-9

Currently, the District has 5,315 lateral water connections, serving approximately 6,042 active water accounts. Two new 3-million gallon tanks are planned for construction. New tanks will increase the District's storage capacity, enhance fire flows during peak summer usage, and provide additional system capacity for new growth, especially in northern McKinleyville (MCSD, 2011).

The RWQCB's *Water Quality Control Plan for the North Coast Region* (Basin Plan) (RWQCB, 2007) designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for all waters addressed through the plan. Beneficial uses applicable to the Mad River and its tributaries include municipal and domestic water supply. Discharges of municipal wastewater to the Mad River from the WWMF are regulated under NPDES Permit No. CA0024490, Order No. WQ 2011-0008-DWQ. The NPDES permit implements the applicable regulations for protection of beneficial uses as specified in the basin plan for this region.

2.2.6 Biological Resources

2.2.6.1 Environmental Setting

The environmental setting within McKinleyville is characterized by the presence of the Mad River and Pacific Ocean in conjunction with the residential and commercial development. Natural resources are primarily confined to the Mad River and surrounding riparian corridor, along with the coastal areas to the west and timberlands to the east. The environmental setting within McKinleyville is predominantly affected by the mild maritime climate, and current and historical development. Influence from these factors is evident in the variety of habitat types found in the vicinity, which include freshwater and estuarine wetlands, coastal prairie, coastal strand, scrub-shrub, and North Coast coniferous forest. Habitat within McKinleyville has been altered by historical development and current land uses.

Streams and riparian corridors, wetlands, and forested areas containing habitat and/or nesting sites for rare, threatened, and endangered species and species of concern have been designated as environmentally sensitive habitat areas due to their importance for providing fish and wildlife value.

2.2.6.2 Vegetation Habitat

Natural vegetation within McKinleyville includes a diverse mixture of forested swamps, riparian woodlands and grasslands, and is dominated by the presence of Sitka spruce. Beach Pine Forest, Northern Coastal Coniferous Forest, Perennial Grassland, Redwood Forest, Northern Coastal Scrub, Coastal Dunes, and Red Alder Riparian Forest habitats can also be found within McKinleyville. The extent of these naturally occurring habitats has been actively altered over time by human manipulation, agriculture, and settlement. A large portion of the original coniferous forest that once occurred in McKinleyville has been cleared, leaving the community covered with grassy areas and fewer trees. Historically, blue-gum eucalyptus, Monterrey pine, and cypress, are non-natives and have been planted in rows as windbreaks. Other exotic plants have taken hold in McKinleyville with effects ranging from cumulative displacement of crucial habitat-providing native species, to weedy species presenting nuisances to agriculture, landscaping, and open space.

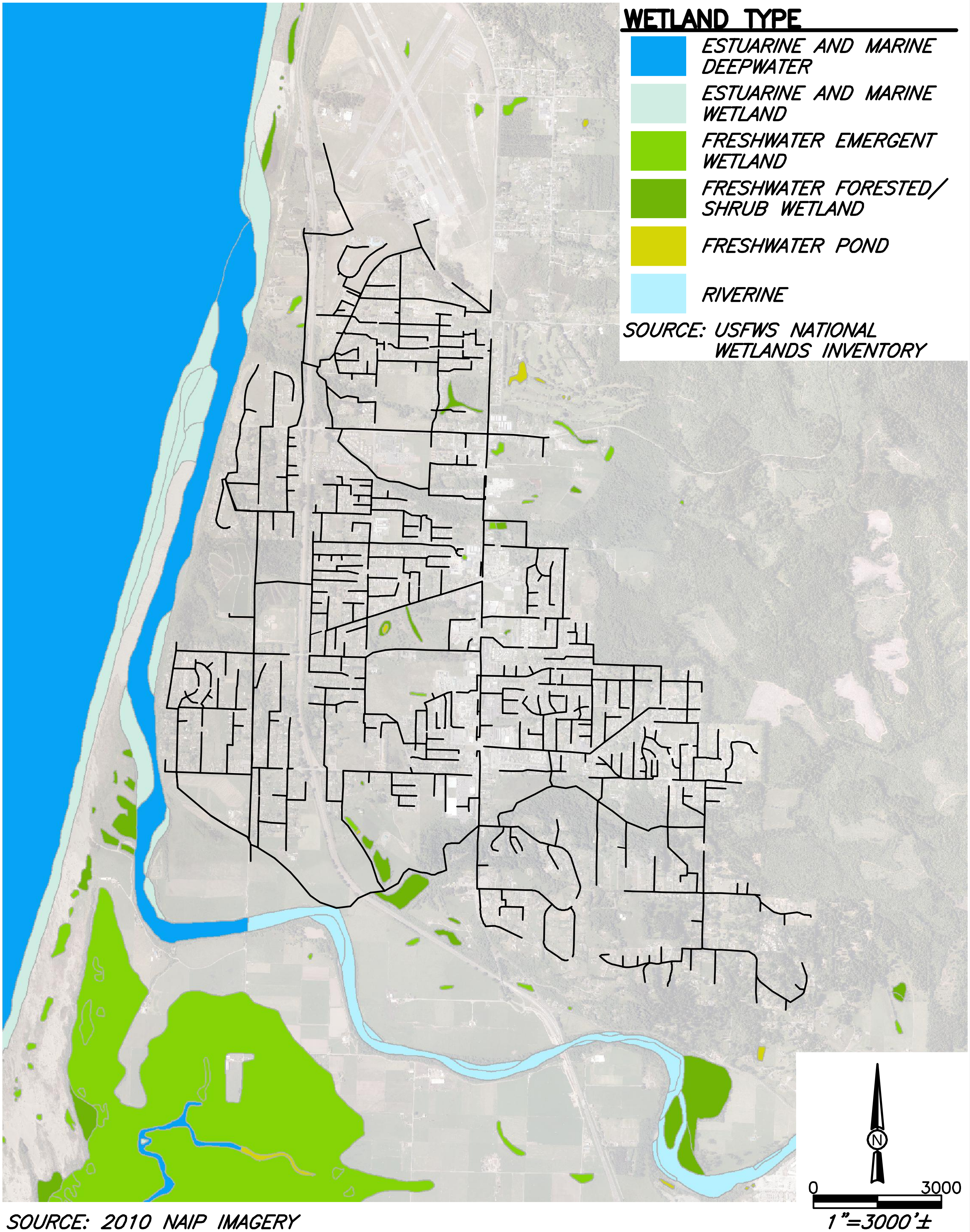
2.2.6.3 Special Status Species

Potentially occurring species identified as candidate or listed as rare, threatened, or endangered (herein referred to as Special Status) by local, state, and federal regulations, were reviewed by querying the California Natural Diversity Database (CNDDB) RareFind 3 program (CDFG, 2011) for historical and/or existing occurrences of sensitive species and habitats within McKinleyville and all immediately adjacent United States Geological Survey (USGS) quadrangles. All plant species included on Lists 1 and 2 of California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California (Tibor, 2001) were also reviewed to determine potential presence in McKinleyville. Tables D-1 and D-2, included in Appendix D, present a summary of the regionally occurring special status animal species and plant species, respectively for the McKinleyville area. Site-specific habitat evaluations are necessary to determine actual species composition within a proposed project area.

2.2.6.4 Wetlands

The U.S. Fish and Wildlife Service (USFWS) is the federal agency responsible for tracking wetland trends as well as maintaining a reliable inventory through its National Wetland Inventory (NWI) (USDI, 1987). The NWI can be queried for specific locations throughout the country to aid federal, state, and local agencies in making informed decisions concerning wetlands. Wetlands in McKinleyville occur in and adjacent to riparian corridors and water bodies, and as isolated "pocket" wetlands. Although NWI maps are excellent references for determining the presence or absence of wetlands, the resolution of the NWI tends to be on a macro scale, with no field verification. Site-specific wetland delineations are necessary to determine an accurate distribution of wetlands within a proposed project area. Based on the purpose of this plan, a global review of wetlands was performed and Figure 1-10 shows the MCSD facilities relative to the NWI mapped wetland features in the McKinleyville area. According to the NWI, wetland types found in McKinleyville include:

- **Estuarine Subtidal Unconsolidated Bottom Permanently Flooded (E1UBL):** The Estuarine system includes deepwater tidal habitats and adjacent tidal wetlands that are influenced by water runoff from and often semi-enclosed by land. They are located along low-energy coastlines and they have variable salinity. These habitats are continuously submerged with tidal water and include all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6 to 7 centimeters [cm]), and a vegetative cover less than 30% (Cowardin et al., 1979).
- **Palustrine Scrub-Shrub Broad Leaved Deciduous Seasonally Flooded (PSS1C):** This Palustrine system includes all nontidal wetlands dominated by woody vegetation less than 6 meters (m) (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions, with relatively wide, flat leaves that are shed during the cold or dry season. Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years (Cowardin et al., 1979).
- **Palustrine Unconsolidated Bottom Permanently Flooded (PUBHx)**: This Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, and mosses or lichens. It also includes all wetlands and deepwater habitats with at least



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SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	McKinleyville Area Wetlands SHN 008189
	August 2011 / 008189-300-MCKVLLE-WTLND	Figure 1-10

25% cover of particles smaller than stones less than 6 to 7 cm (2.3 to 2.4 inches), and a vegetative cover less than 30%. Water covers the land surface throughout the year in all years (Cowardin et al., 1979).

- **Riverine Upper Perennial Unconsolidated Bottom Permanently Flooded (R3UBH):** This Riverine system includes all wetlands and deepwater habitats contained in natural or artificial channels periodically or continuously containing flowing water or which forms a connecting link between the two bodies of standing water and is characterized by a high gradient and fast water velocity. There is no tidal influence, and some water flows throughout the year. This substrate consists of rock, cobbles, or gravel with occasional patches of sand. There is very little floodplain development. This habitat also includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6 to 7 cm), and a vegetative cover less than 30%. Water covers the land surface throughout the year in all years (Cowardin et al., 1979).
- **Estuarine Intertidal Unconsolidated Shore San Regularly Flooded (E2US2N):** This Estuarine system describes deepwater tidal habitats and adjacent tidal wetlands that are influenced by water runoff from and often semi-enclosed by land. They are located along low-energy coastlines, have variable salinity, and are areas from extreme low water to extreme high water and associated splash zone. The unconsolidated particles smaller than stones are predominantly sand, although finer or coarser sediments may be intermixed. This habitat also includes all wetland habitats having two characteristics: 1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock; and 2) less than 30% areal cover of vegetation. Landforms, such as beaches, bars, and flats, are included in the Unconsolidated Shore class. Tidal water alternately floods and exposes land surface at least once daily (Cowardin et al., 1979).
- **Palustrine Forested Broad Leaved Deciduous Seasonally Flooded (PFO1C):** This Palustrine system includes all nontidal wetlands dominated by woody vegetation that is 6 m (20 feet) tall or taller. Trees or shrubs have relatively wide, flat leaves that are shed during the cold or dry season. Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years (Cowardin et al., 1979).
- **Palustrine Emergent Persistent Seasonally Flooded (PEMIC):** This Palustrine system includes all nontidal wetlands characterized by erect, rooted, and herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants that normally remain standing at least until the beginning of the next growing season. Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years (Cowardin et al., 1979).

2.2.6.5 Fisheries Resources

The Mad River is known to contain and provide habitat for the following state and federally listed species (EPA, 2007):

- Southern Oregon/Northern California Coast Coho Salmon Evolutionary Significant Unit (ESU)
- California Coastal Chinook Salmon ESU
- Northern California Steelhead Distinct Population Segment (DPS)

Coastal cutthroat trout, another Special Status Species, has also been reported for the Mad River and is currently being considered for federal listing.

The Mad River is designated as critical habitat for the coho salmon and is considered Essential Fish Habitat pursuant to the Magnuson-Stevens Fisheries Conservation and Management Act, as amended (16 United States Code [USC] Section 1801 et seq.). In 1992, the U.S. Environmental Protection Agency (EPA) added the Mad River to California's 303(d) impaired water list due to elevated sedimentation/siltation and turbidity, as part of listing the entire Mad River basin. The North Coast Regional RWQCB has continued to identify the Mad River as impaired in subsequent listing cycles, the latest in 2006. The 2006 303(d) listing identifies temperature as an additional impairment to the watershed.

Sediment and turbidity Total Maximum Daily Loads (TMDLs) were approved for the Mad River watershed by the EPA in December 2007. The purpose of establishing the Mad River TMDLs was to identify the total amount of sediment and turbidity that can be delivered to the Mad River and its tributaries without exceeding water quality standards, and subsequently to allocate the total amount among the sources of sediment in the watershed (EPA, 2007). The primary purpose of the TMDL development process is to ensure that beneficial uses of water (such as salmonid habitat) are protected from detrimental increases in sediment and turbidity (EPA, 2007).

2.2.7 Air Quality

McKinleyville is located within the North Coast Air Basin, which covers Del Norte, Humboldt, Mendocino, and Trinity Counties in their entirety and part of Sonoma County. The North Coast Unified Air Quality Management District (NCUAQMD) regulates air pollutant point sources found within the air basin.

Currently, Humboldt County is a non-attainment area for state standards for particulate matter of less than 10 micrometers (µm) in diameter (PM-10). PM-10 emissions include smoke from wood stoves, airborne salts, diesel exhaust, and other particulate matter naturally generated by ocean surf. Due in part to the large number of wood stoves in Humboldt County and the generally heavy surf and high winds common to the area, Humboldt County has exceeded the state standard for PM-10 air emissions. For other point source pollutants, the air basin is an attainment area.

Air quality within McKinleyville meets or exceeds the established air quality standards. Potential sources of air pollution include emissions from vehicle using the local streets and the Redwood Highway (Highway 101), and recreational boat emissions in the river, residential wood burning stoves, open and permitted burning, and agricultural operations.

2.2.8 Noise

Sources of significant noise affecting the McKinleyville area include the following:

- Aircraft landings and take-offs at the Arcata-Eureka Airport
- Vehicular traffic on Highway 101 and major arterial and collector streets
- Construction sites
- Industrial processes

Noise levels for the airport have been measured, projected, and addressed in the Airport Land Use Compatibility Plan for the Arcata-Eureka Airport. Streets and highways within McKinleyville are important noise sources, with the primary source being Highway 101.

2.2.9 Land Use Issues

Existing land uses in McKinleyville include commercial, residential, industrial, recreational, and public use. Much of the land base within the urban development area has been developed. According to the McKinleyville Community Plan (Humboldt County, 2002), the majority of development within the community core will take the form of low- to medium–density residential and community commercial "in-fill" of relatively small (five acres or less) vacant parcels. Land uses for the McKinleyville area include:

- Commercial
- Residential
- Industrial
- Agricultural

2.2.9.1 Commercial

Commercial land uses in the planning area are centered on Central Avenue between School Road on the south and Railroad Avenue on the north. A smaller number of commercial establishments are located on Sutter Road, Central Avenue north of Railroad Avenue to Murray Road, and McKinleyville Avenue.

2.2.9.2 Residential

There are several residential low-density and medium density areas within McKinleyville. The majority of residential areas are located to the east and west of Central Avenue within the core urban development area for McKinleyville.

2.2.9.3 Industrial

A small portion of McKinleyville is designated for industrial land use. The Airport Business Park site is a 60-acre parcel located in the northern portion of McKinleyville and is designated as a mixed light industrial/commercial use area that allows: storage and warehousing, research and development, light industrial/manufacturing, administrative, professional/business office, and support commercial uses. The zoning for the property includes performance standards that restrict the development of uses on the site that would be incompatible with the adjacent residential area.

2.2.9.4 Agricultural

About 2,200 acres of prime agricultural soils are located within the McKinleyville urban development area and are provided with water and sewer facilities by the MCSD. An additional 280 acres are located near the site of the Arcata-Eureka Airport.

Agricultural uses occur upon lands adjacent to the Arcata-Eureka Airport and in Dow's Prairie, on bluffs between Highway 101 and the Pacific Ocean, on the flat lowlands and floodplains of the Mad and Little River Valleys, and in a number of other isolated locations throughout McKinleyville. Agricultural endeavors include, but are not limited to beef and dairy farming, bulb production, flower production, produce production, cut-flower production, berry production, nursery crops, and organic crops. Several areas are used for crop cultivation. Many residents own horses, cattle, sheep, and other livestock that graze on small plots of land, usually adjacent to their respective residences.

2.2.9.5 Public Facilities and Recreation

Public facilities within the District boundaries include parks, recreational sites, library, schools, streets, water, wastewater treatment, drainage, and airport facilities (which are operated by Humboldt County). The majority of public facilities, specifically schools and recreational facilities are located in or near residential areas, west and east of Central Avenue.

The County and MCSD share recreation authority within the community of McKinleyville. MCSD has several recreational projects, the majority of which can be characterized as recreational facilities primarily designed to accommodate organized or team sport activities.

2.3 Socio-Economic Environment

2.3.1 Economic Conditions and Trends

McKinleyville's land use is primarily residential, and most of McKinleyville's employed residents are employed in Arcata and Eureka. McKinleyville's employment opportunities involve commercial retail and service businesses. Commercial services are primarily located along Central Avenue between School Road and Murray Road.

During the 1990s, nearly all of McKinleyville's commercial growth was in the form of franchise/ chain commercial services located along Central Avenue. The placement of these new facilities has given Central Avenue the appearance of a commercial strip. These facilities include drive-through restaurants, dining restaurants, auto parts stores, a supermarket, and a department store. Other commercial ventures include a building supply yard and expanded car lots.

The McKinleyville Community Plan states that there is a need to diversify the economic base and encourage additional employment. Portions of McKinleyville may be appropriate for economic development proposals because of the availability of water and sewer service, access to Highway 101 and the availability of air service. Consequently, the plan continues to propose three sites for industrial/commercial development near the Arcata-Eureka Airport (Humboldt County, 2002).

2.3.2 Population

The McKinleyville Community Planning Area, including the Coastal Zone segment had an estimated population (1998) of 12,770 based on projections from the California Department of Finance extrapolated from the 1990 US Census of Population. This is approximately 10% of the County's total population at that time (127,700). The mean number of persons per household for this period was 2.67. Growth in the McKinleyville area alone accounted for almost 60% of the population increase for all unincorporated areas within the County between 1990 and 1998 (Humboldt County, 2002).

McKinleyville is the most populated unincorporated area in Humboldt County and is one of the fastest growing communities in the county. The current (2011) estimated residential population for McKinleyville is approximately 14,500 (MCSD, 2011). The current number of persons per household for McKinleyville is estimated to be 2.58 (MCSD, 2010).

2.3.3 Population Growth Projections

Population growth forecasts were presented in the McKinleyville Community Plan based on projections from the State Department of Finance. Two potential forecasts were presented, an "Alternative Growth" projection (1.8% annual increase), based on current trends for the McKinleyville planning area, and a "Ratio/Share" projection (1.05% annual increase), based on the County average growth rate. The alternative growth projection is considered to be the more probable projection (Humboldt County, 2002). For purposes of this facilities plan, the average growth rate used to develop 20-year flow projections was based on the alternative growth rate that projects a 1.8% annual increase in population.

2.4 Land Use Regulations

2.4.1 County Comprehensive Plan and Zoning Ordinance

The MCSD service area is located within the McKinleyville and Humboldt County planning area, subject to the *Humboldt County Volume I Framework Plan, and McKinleyville Community Plan* (Humboldt County, June 1999). Portions of the service area are located within the coastal zone and subject to the *Humboldt County General Plan Volume II, McKinleyville Area Plan of the Humboldt County Local Coastal Program* (Humboldt County, May 1995). The Humboldt County General Plan (Volume 1–Framework Plan) and Humboldt County Code-Zoning Regulations contain the applicable land use policies and zoning code relevant to the facilities plan.

2.4.2 Intergovernmental Agreements

MCSD is an independent, special district governed by a five member Board of Directors elected by McKinleyville's voters. Community Services Districts (CSDs) are granted powers by the State of California, pursuant to Section 61000-61009 of California Government Code, to carry out the function designated in the petition for formation and any additional services approves by the board of directors and CSD voters. The District has authority to serve water and treat sewer wastes, and holds street lighting, library, and recreational powers.

Part 2 Operations Evaluation

3.0 Wastewater Characterization

Municipal waste loadings were characterized using flow monitoring and sampling data collected from May 2003 through October 2010.

3.1 Influent Flow Analysis

Influent WWMF flow characteristics were evaluated based on influent flow data provided by MCSD and precipitation data for the period from November 2003 through May 2010. Table 3-1 summarizes the flow data.

Table 3-1
WWMF[1] Monthly Influent Flow Summary
MCSD Wastewater Management Facility

Month/Year	Influent Flow (MGD)[2]						
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
November	0.925	0.858	0.967	0.892	0.971	0.926	0.940
December	1.135	0.918	1.229	1.128	1.085	1.019	0.962
January	1.203	1.081	1.567	1.146	1.277	1.055	1.182
February	1.280	0.940	1.453	1.333	1.288	1.085	1.144
March	1.126	0.974	1.575	1.325	1.169	1.189	1.226
April	0.988	1.118	1.384	1.145	1.053	1.028	1.270
May 1-14	0.924	0.849	1.129	1.081	0.985	1.093	1.204
Average	1.083	0.962	1.329	1.150	1.118	1.056	1.133
AWWF[3]	**1.119 MGD**						
May 15-31	0.906	0.848	1.039	0.997	0.920	0.985	1.105
June	0.857	0.855	0.980	0.940	0.897	0.925	1.117
July	0.885	0.855	0.908	0.901	0.872	0.872	0.930
August	0.847	0.844	0.887	0.884	0.867	0.879	0.930
September	0.851	0.849	0.897	0.898	0.885	0.883	0.884
October	0.875	0.848	0.899	0.944	0.884	0.894	0.945
Average	0.870	0.850	0.935	0.927	0.888	0.906	0.985
ADWF[4]	**0.909 MGD**						

1. WWMF: Wastewater Management Facility
2. MGD: Million Gallons per Day
3. AWWF: Average Wet Weather Flow: The average influent flow during period from November 1 through May 14.
4. ADWF: Average Dry Weather Flow: The average influent flow during period from May 15 through October 31.

3.1.1 Average Dry and Wet Weather Flows

Average Dry Weather Flow (ADWF) is the average influent flow during the months of May through October. For the purposes of this analysis, the dry season flow has been defined to correspond with the period of prohibited discharge to the Mad River, May 15 through September 30. Due to low regional rainfall averages in October, this month has also been included in the average dry weather flow analysis. Based on analysis of the dry weather season data for May 15, 2003 through October 31, 2010, the ADWF is approximately 0.909 Million Gallons per Day (MGD).

The ADWF can be divided into two descriptive components: base sanitary flow and base infiltration. The portion of treatment plant flow that is entirely attributable to sanitary sewage is known as the base sanitary flow. The base sanitary flow was estimated at 0.830 MGD, based on minimum influent flows during periods of extended dry weather.

The difference between the ADWF and the base sanitary flow is the base infiltration rate. Base infiltration rates depend upon such factors as the quality of material, workmanship, age, and condition in the sewers and building connections; maintenance efforts; and groundwater elevations compared with the elevation of the sewer pipes. A base infiltration rate of 10 to 20 gallons per day (gpd) per Equivalent Dwelling Unit (gpd/EDU) is considered unavoidable infiltration. EDUs are defined as any single-family residential structure.

Based on an ADWF of 0.909 MGD, and an estimated base sanitary flow of 0.830 MGD, the base infiltration rate at the MCSD WWMF was estimated to equal 0.079 MGD. During this period, it was estimated that on average approximately 5,000 Equivalent Dwelling Units (EDUs) contributed wastewater to the collection system, resulting in a base infiltration rate of 16 gpd/EDU.

Average Wet Weather Flow (AWWF) is the average influent flow during the months of November through May. For the purposes of this analysis, the wet season flow has been defined to extend until the period of prohibited discharge to the Mad River begins on May 15. Based on analysis of the wet weather season data for November 2003 through May 14, 2010, the AWWF is approximately 1.119 MGD.

3.1.2 Maximum Monthly Dry and Wet Weather Flows

Calculation of maximum monthly flows is based on identifying the monthly rainfall and the monthly average wastewater flows during the months when Infiltration and Inflow (I/I) impacts the collection system. The linear relationship between monthly rainfall and average wastewater flow is presented graphically and used to predict the flow that corresponds to the cumulative monthly precipitation defined by the required recurrence interval. The methodology employed identifies the seasonal maximum monthly average flow, which has the probability of recurrence once every 5 years during the winter and once every 10 years during the summer.

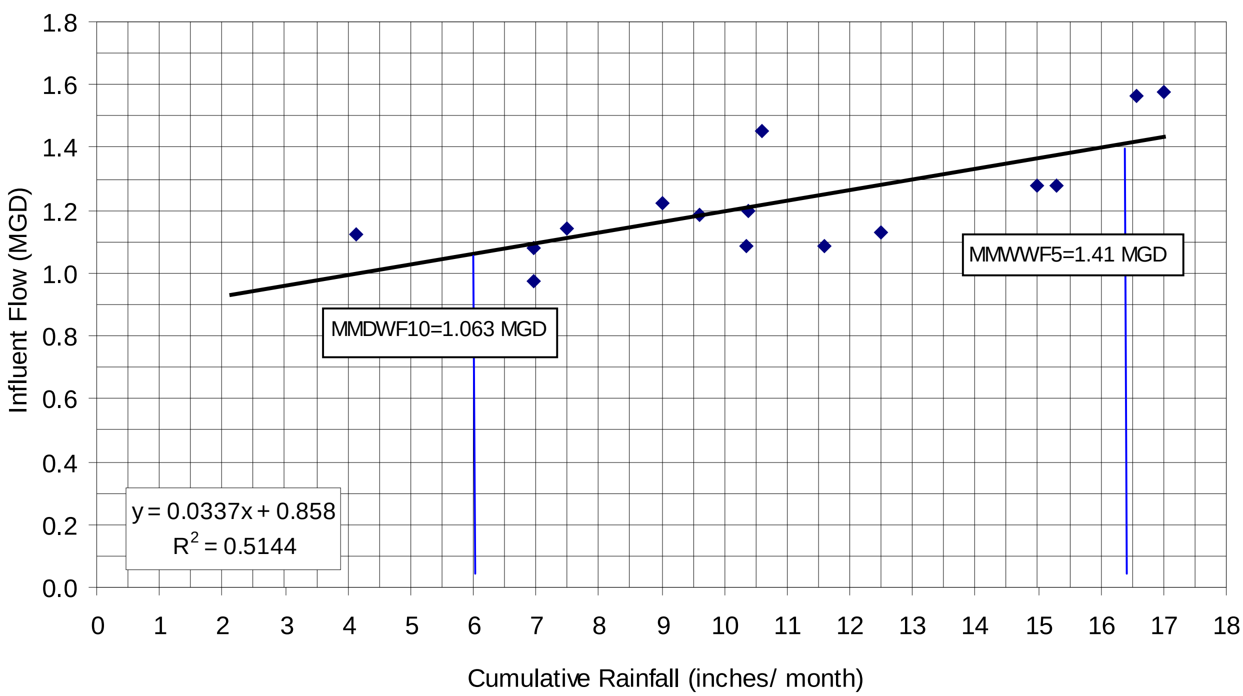
Table 3-2 lists the data points used for the maximum monthly flow analysis and Figure 3-1 presents the graphical representation of flow as a function of cumulative rainfall for the MCSD WWMF.

Table 3-2
Monthly Average Influent Flows and Precipitation
MCSD Wastewater Management Facility

Month	Year	Influent Flow (MGD)[1]	Total Monthly Precipitation (inches)
January	2004	1.200	10.38
February	2004	1.280	15.30
March	2004	1.126	4.13
January	2005	1.081	6.97
January	2006	1.567	16.57
February	2006	1.453	10.60
March	2006	1.575	17.00
December	2006	1.128	12.50
November	2007	0.971	6.96
December	2007	1.085	11.61
January	2008	1.277	15.00
February	2009	1.085	10.36
March	2009	1.189	9.62
February	2010	1.144	7.50
March	2010	1.226	9.00

1. MGD: Million Gallons per Day

Figure 3-1
Average Monthly Flow / Cumulative Rainfall



Monthly total precipitation data from the National Weather Service Eureka Woodley Island Station for the period of record (May 1906 - January 2009) was used as a basis for statistical estimation of return intervals. To derive an accurate estimate of rainfall in McKinleyville, the recorded precipitation from the Eureka gage was corrected by a factor relating it to measured data at the MCSD facility. Precipitation data measured at the MCSD facility from May 2003 through January 2009 indicated that the recorded monthly cumulative rainfall in May was an average of 1.3 times that measured at Eureka, and the cumulative monthly rainfall in January was an average of 1.7 times that measured at the weather station.

Maximum Month Dry Weather Flow-10 ($MMDWF_{10}$) is the maximum monthly average dry weather flow with a 10% probability of occurrence. This flow represents the dry weather season monthly average flow with a recurrence interval of 10 years. For the purposes of this analysis, the dry season flow has been defined to correspond with the period of prohibited discharge to the Mad River, May 15–September 30; and all of October is also included in the dry season period.

A statistical analysis determined the estimated monthly rainfall at the MCSD facility with a 1-in-10-year recurrence interval in May to be 6.08 inches. Based on the linear regression shown in Figure 3-1, this corresponds to a $MMDWF_{10}$ of 1.063 MGD.

Maximum Month Wet Weather Flow-5 ($MMWWF_5$) is the maximum monthly wet weather average flow with a 20% probability of occurrence. This flow represents the wet season monthly average flow that is anticipated to have a 5-year recurrence interval.

Based on the monthly total precipitation data, the monthly rainfall with a 1-in-5 year recurrence interval in January is 16.48 inches. Based on the linear regression shown in Figure 3-1, this corresponds to a $MMWWF_5$ of 1.41 MGD.

3.1.3 Peak Day Average Flow

Peak Day Average Flow-5 ($PDAF_5$) is the largest daily flow associated with a 5-year, 24-hour precipitation event. The peak day average flow has a 0.27% probability of occurrence or 1 day in 365 days of any given year. Estimation of peak day flow is based on a regression analysis of daily plant flows during or immediately following significant rainfall events during the wet season.

Because the increased influent flow to the WWMF during wet weather is highly correlated with rainfall, evaluation of this regression can be used to define peak day flow associated with a specific rainfall event. The $PDAF_5$ event is determined from a plot of the recorded daily flow that occurred during or 24 hours after a significant rainfall event. Table 3-3 lists the data points used for the peak day average flow analysis.

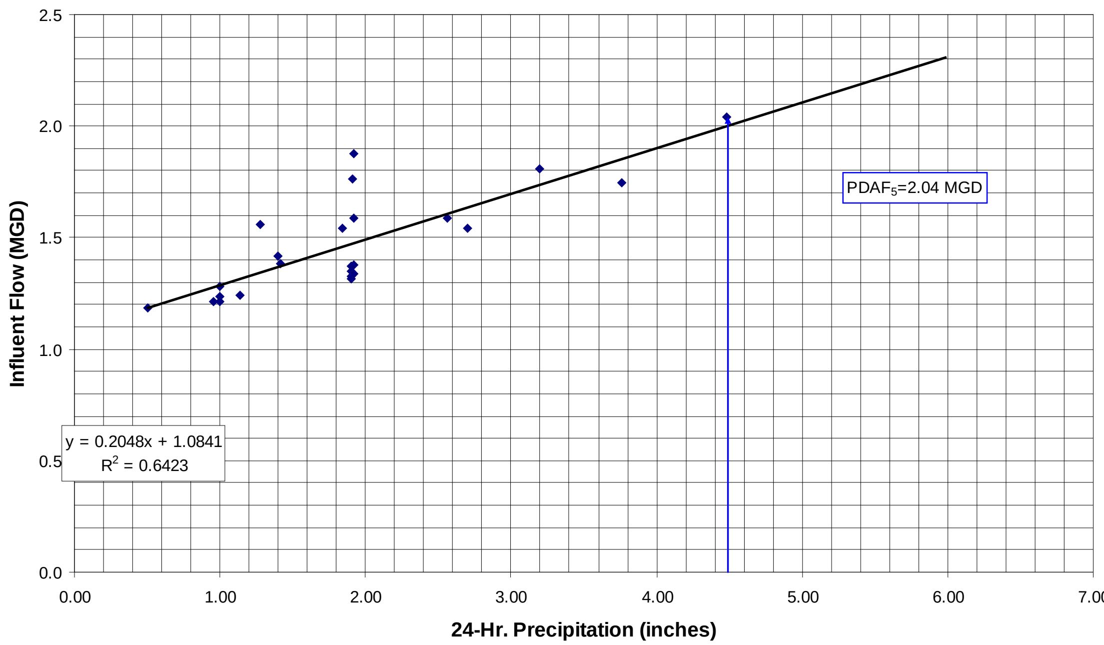
Table 3-3
Data Points for Peak Daily Average Flow Analysis
MCSD Wastewater Management Facility

Date	Daily Precipitation (inches)	Date	Influent Flow (MGD)[1]
2/17/2004	1.84	2/17/2004	1.540
2/26/2004	2.56	2/26/2004	1.590
12/31/2004	1.92	1/1/2005	1.339
12/1/2005	1.42	12/1/2005	1.383
12/28/2005	1.91	12/28/2005	1.765
1/7/2006	1.40	1/7/2006	1.419
1/20/2006	1.92	1/21/2006	1.879
2/27/2006	3.76	2/28/2006	1.747
4/15/2006	1.92	4/15/2006	1.586
2/21/2007	4.48	2/27/2007	2.042
1/5/2008	1.28	1/5/2008	1.559
1/27/2008	1.92	1/28/2008	1.380
1/31/2008	3.20	2/2/2008	1.811
12/28/2008	2.70	12/28/2008	1.544
2/16/2009	0.96	2/16/2009	1.214
2/22/2009	1.14	2/23/2009	1.243
1/19/2010	1.90	1/19/2010	1.313
1/30/2010	1.00	1/30/2010	1.281
2/2/2010	0.50	2/2/2010	1.182
2/14/2010	1.00	2/15/2010	1.215
2/26/2010	1.90	2/26/2010	1.326
3/2/2010	1.90	3/3/2010	1.349
3/12/2010	1.90	3/12/2010	1.374
3/24/2010	1.00	3/25/2010	1.238

1. MGD: Million Gallons per Day

By performing a regression analysis of this data, a linear relationship is established, as shown in Figure 3-2. The $PDAF_5$ is based on the intercept of this line with the 5-year, 24-hour precipitation event. Based on *Isopluvials of the 5-Yr Precipitation for Northern California* (NOAA, 1973) the 24-hour precipitation with a 5-year recurrence interval is 4.5 inches. Based on the regression analysis shown in Figure 3-2, the resulting $PDAF_5$ for a 4.5-inch event is equal to 2.045 MGD.

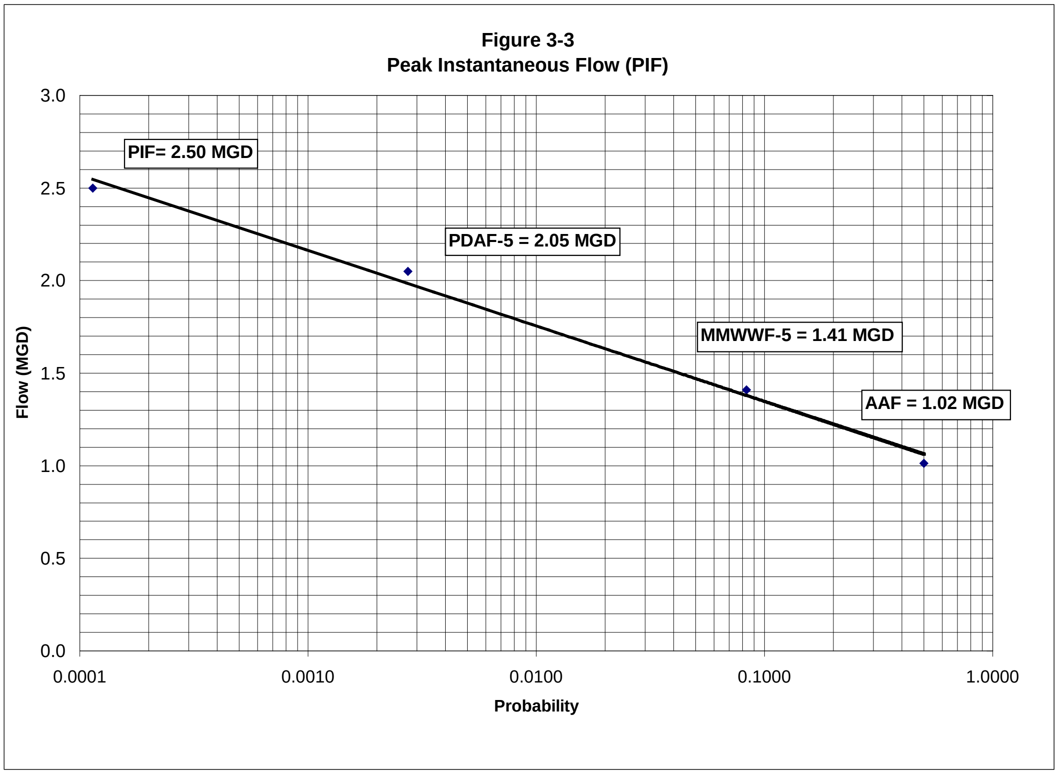
Figure 3-2
Peak Day Average Flow (PDAF-5)



3.1.4 Peak Instantaneous Flow

Peak Instantaneous Flow-5 (PIF_5) is the highest sustained hourly flow resulting from a 5-year storm during high groundwater periods. The PIF is used as the basis of design for the required hydraulic capacity of conveyance and treatment system components.

The PIF_5 has 0.011% probability of occurrence (1 hour in 8,760 hours of the year) and can be extrapolated from a probability plot of the flows derived in the previous section, using logarithmic probability paper. Figure 3-3 shows a graphical representation of a probability plot of Average Annual Flow (AAF), $MMWWF_5$, and $PDAF_5$. The PIF_5 for the MCSD WWMF is estimated to be 2.5 MGD.



3.1.5 Influent Flow Analysis Summary

Table 3-4 summarizes the results for the MCSD WWMF influent flow analysis based on data collected from November 2003 through October 2010.

Table 3-4
Influent Flow Analysis Summary of Results[1]
MCSD Wastewater Management Facility

	MGD[2]	gpd/EDU[3]	gpcd[4]
Base Sanitary Flow	0.830	166	64
Base Inflow and Infiltration	0.079	16	6
Average Dry Weather Flow (ADWF)	0.909	182	70
Average Wet Weather Flow (AWWF)	1.119	224	87
Average Annual Flow (AAF)	1.022	204	79
Maximum Month Dry Weather Flow (MMDWF-10)	1.063	213	82
Maximum Month Wet Weather Flow (MMWWF-5)	1.413	283	110
Peak Day Average Flow (PDAF-5)	2.045	409	159
Peak Instantaneous Flow (PIF-5)	2.500	500	194

1. Influent flow analysis based on flow data collected November 2003 through October 2010
2. MGD: Million Gallons per Day
3. gpd/EDU: gallons per day per Equivalent Dwelling Unit (EDU); based on an average of 5,000 EDUs served by MCSD during this period
4. gpcd: gallons per capita per day (2.58 persons per household, equivalent population 12,897)

The EPA has developed guidelines for assessing peak flow data and determining the acceptable amount of I/I in a sewer system (EPA, 1985). The EPA considers infiltration not to be excessive if during periods of high groundwater and dry weather the highest average daily flow recorded over a 7 to 14 day period does not significantly exceed 120 gallons per capita per day (gpcd); inflow is not considered excessive if during a storm event, the highest daily flow recorded is less than or equal to 275 gpcd (EPA, 1985). As shown in Table 3-4, the MMDWF-10 of 82 gpcd meets the guidelines for non-excessive infiltration and the PDAF-5 of 159 gpcd meets the criteria for non-excessive inflow.

3.2 Wastewater Characteristics

The MCSD WWMF serves residential and commercial customers in the unincorporated community of McKinleyville. The community is basically residential and the majority of commercial establishments are service oriented in nature. Commercial water users and wastewater contributors, including restaurants and bars, gas stations, automotive repair and detailing services, wholesale foods, a small brewery, a winery, and a variety of retail shops and offices, account for less than 10% of the wastewater influent that is conveyed to the MCSD WWMF.

3.2.1 Influent Loading

Table 3-5 summarizes influent loadings of Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), and Total Ammonia-Nitrogen (NH_3-N). The loadings presented in Table 3-5 are based on monitoring data collected at the MCSD WWMF from 2003 through 2010.

Table 3-5
WWMF[1] Influent BOD[2], TSS[3], and NH_3-N[4] Loading Summary
MCSD Wastewater Management Facility

	BOD				TSS				NH_3-N			
	Average		Max Mo. Ave.		Average		Max Mo. Ave.		Average		Max Mo. Ave.	
Year	mg/L[5]	ppd[6]	mg/L	ppd	mg/L	ppd	mg/L	ppd	mg/L	ppd	mg/L	ppd
2003	229	1,892	327	3,035	253	2,168	400	3,964	33	294	37	353
2004	228	1,795	327	2,572	219	1,737	350	2,752	33	263	37	292
2005	238	1,863	305	2,565	247	1,919	410	3,103	34	276	39	336
2006	266	2,379	358	2,729	262	2,383	520	2,315	33	303	40	364
2007	274	2,295	333	2,654	203	1,699	280	2,188	35	301	40	335
2008	291	2,370	340	2,675	204	1,648	245	1,986	35	294	39	352
2009	281	2,203	345	2,603	214	1,729	273	2,335	39	313	43	330
2010	248	2,166	360	2,894	218	1,899	350	2,814	42	375	50	440
Average	**257**	**2,120**	**---**	**---**	**227**	**1,898**	**---**	**---**	**36**	**302**	**---**	**---**
Max Mo.	**---**	**---**	**360**	**3,035**	**---**	**---**	**520**	**3,964**	**---**	**---**	**50**	**440**

1. WWMF: Wastewater Management Facility
2. BOD: Biochemical Oxygen Demand
3. TSS: Total Suspended Solids
4. NH_3-N: Ammonia-Nitrogen
5. mg/L: milligrams per Liter
6. ppd: pounds per day

From 2003 through 2010, BOD loadings averaged 2,120 pounds per day (ppd). Based on an average of 5,000 EDUs served during this period, 0.42 pounds per day are contributed per EDU, which based on 2.58 persons per household, equates to 0.16 pounds per capita per day (ppcd). TSS loadings averaged 1,898 ppd, or approximately 0.38 ppd/EDU (0.15 ppcd). Per capita loadings for BOD and TSS are within the range for typical domestic wastewater, but on the high end of this range (Metcalf and Eddy, 2003).

Ammonia loadings from 2003 through 2010 averaged 302 ppd or approximately 0.06 ppd/EDU (0.023 ppcd), a value that exceeds the published unit loading factors for NH_3-N developed for municipal domestic wastewater. High total nitrogen loadings were confirmed by sampling conducted on the WWMF influent in 2010 for Total Kjeldahl Nitrogen (TKN), combined organic and ammonia nitrogen. Those results indicated a per capita loading of 0.043 ppcd, which also exceeded the published ranges of values.

Table 3-6 summarizes per capita loadings and wastewater strengths for comparison to published values. Average wastewater concentration of BOD, TSS, and NH_3-N were in the medium to strong range as expected for a system with low rates of infiltration. Per capita loadings for NH_3-N are unusually strong.

Table 3-6
Wastewater Management Facility Influent Composition
MCSD Wastewater Management Facility

	Unit Loadings (ppcd)[1]		Concentration (mg/L)[2]				
	MCSD	Published	MCSD		Published		
	Average	Typical	Average	Maximum	Weak	Medium	High
BOD[3]	0.16	0.18	257	360	110	220	400
TSS[4]	0.15	0.20	227	520	100	220	350
NH_3-N[5]	0.023	0.007	36	50	12	25	50
TKN[6,7]	0.043	0.027	63	78	20	40	85

1. ppcd: pounds per capita per day
2. mg/L: milligrams per Liter
3. BOD: Biochemical Oxygen Demand, Influent sampling 2003-2010
4. TSS: Total Suspended Solids, Influent sampling 2003-2010
5. NH_3-N: Ammonia-Nitrogen, Influent sampling 2003-2010
6. TKN Total Kjeldahl Nitrogen (Free ammonia and organic nitrogen combined)
7. Bi-weekly sampling from 1/2010-12/2010

3.2.2 Constituents of Concern

The current constituents of concern include the following priority pollutants: 4,4'-Dichloro-diphenyltrichloroethane (DDT), bis(2-ethylhexyl)phthalate, and carbon tetrachloride. These constituents are monitored in compliance with the California Toxics Rule when the facility is discharging to the Mad River. Copper, lead, alpha-1,2,3,4,5,6-hexachlorocylohexane (alpha-BHC) and 2,3,7,8 Tetrachlorobenzeno-p-dioxin (TCDD) congeners were previous constituents of concern that are no longer subject to effluent limitations in the new permit. As discussed in more detail in

Section 5.1 new regulatory requirements for copper have been implemented based on adoption of a Water Effects Ratio (WER) for determining required discharge limitations, and MCSD is currently in compliance with those requirements.

Although it has been determined that copper concentrations in the WWMF effluent do not pose a risk to water quality, high influent concentrations of copper in the wastewater influent are a concern because of possible inhibitory effects on the nitrification process. A recent study recorded 50% inhibition of nitrification during batch tests with influent copper levels of 1 mg/L (WEF, 2002). Based on sampling conducted on the wastewater influent in 2009, influent concentrations of copper are below 0.14 mg/L, 90% of the time, and assuming a linear effect, possible nitrification inhibition would be approximately 10%.

A wide range of values is given in the literature for levels at which copper becomes inhibitory to nitrification, with threshold concentrations of 0.5 micrograms per Liter (µg/L) to 500 µg/L cited (Metcalf and Eddy, 1991). If it is determined during pre-design that reduction of copper is necessary to preserve effective nitrification of the influent, pre-treatment in the form of precipitation or chelating agents would be recommended. Based on annual monitoring results provided by HBMWD, the observed concentrations of copper in the WWMF influent can be attributed due to the municipal drinking water, which is drawn from the Mad River (MCSD, 2011).

3.3 Flow and Loading Projections

Table 3-7 summarizes influent flow data from the MCSD WWMF and Table 3-8 summarizes the influent loading data.

Table 3-7
Flow Projections
MCSD Wastewater Management Facility

Year	2003-2010			2010	2015	2020	2025	2030
EDUs[1]	**4,999**			**5,267**	**5,758**	**6,296**	**6,883**	**7,525**
eq. population[2]	**12,897**			**13,589**	**14,857**	**16,243**	**17,758**	**19,415**
Wastewater Flows	**MGD[3]**	**g/EDU/d[4]**	**gpcd[5]**	**MGD**	**MGD**	**MGD**	**MGD**	**MGD**
Base Sanitary	0.830	166	64	0.874	0.956	1.045	1.143	1.249
Base I/I[6]	0.079	16	6	0.083	0.091	0.099	0.109	0.119
ADWF[7]	0.909	182	70	0.958	1.047	1.145	1.252	1.368
AWWF[8]	1.119	224	87	1.179	1.289	1.409	1.541	1.684
AAF[9]	1.022	204	79	1.068	1.168	1.277	1.396	1.526
MMDWF[10]	1.063	213	82	1.120	1.224	1.339	1.464	1.600
MMWWF[11]	1.413	283	110	1.489	1.628	1.780	1.946	2.127
Peak Day	2.045	409	159	2.155	2.356	2.575	2.816	3.078
PIF[12]	2.500	500	194	2.634	2.880	3.148	3.442	3.763

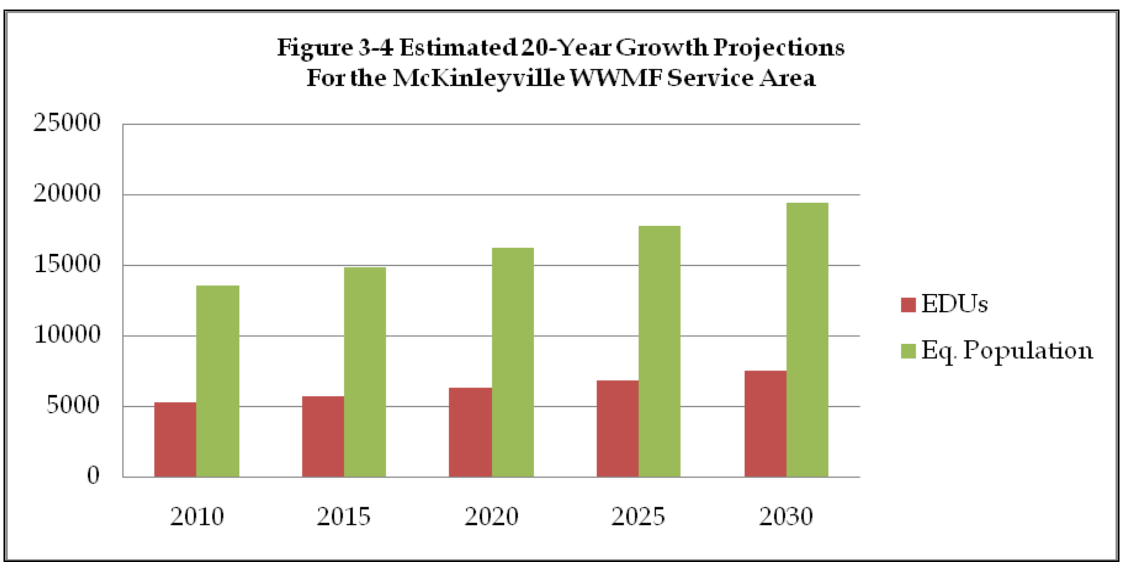
1. EDU: Equivalent Dwelling Units
2. eq population: Equivalent Population
3. MGD: Million Gallons per Day
4. g/EDU/d: gallons per Equivalent Dwelling Unit per day
5. gpcd: gallons per capita per day
6. I/I: Infiltration and Inflow
7. ADWF: Average Dry Weather Flow
8. AWWF: Average Wet Weather Flow
9. AAF: Average Annual Flow
10. MMDWF: Maximum Month Dry Weather Flow
11. MMWWF: Maximum Month Wet Weather Flow
12. PIF: Peak Instantaneous Flow

Table 3-8
Loading Projections
MCSD Wastewater Management Facility

Year	**2003-2010**			**2010**	**2015**	**2020**	**2025**	**2030**
EDUs[1]	**4,999**			**5,267**	**5,758**	**6,296**	**6,883**	**7,525**
eq. population[2]	**12,897**			**13,589**	**14,857**	**16,243**	**17,758**	**19,415**
Wastewater Loads	**ppd[3]**	**ppd/EDU[4]**	**ppcd[5]**	**ppd**	**ppd**	**ppd**	**ppd**	**ppd**
Average Day BOD[6]	2,120	0.42	0.16	2,234	2,442	2,670	2,919	3,191
Max Mo. BOD	3,035	0.61	0.24	3,198	3,496	3,822	4,179	4,569
Max Day BOD	4,111	0.82	0.32	4,331	4,736	5,177	5,660	6,188
Ave NFR[7]	1,898	0.38	0.15	2,000	2,186	2,390	2,613	2,857
Max Mo. NFR	3,964	0.75	0.29	3,964	4,334	4,738	5,180	5,664
Max Day NFR	5,305	1.01	0.39	5,305	5,800	6,341	6,933	7,580
Average Day TKN[8]	558	0.11	0.04	588	643	703	768	840
Max TKN	702	0.14	0.05	740	809	884	967	1,057
Max Day TKN	809	0.16	0.06	852	932	1,019	1,114	1,218
Average Day NH_4-N[9]	302	0.06	0.02	318	348	380	416	455
Max. Mo NH_4-N	440	0.09	0.03	464	507	554	606	662
Max Day NH_4-N	450	0.09	0.03	474	518	567	620	677

1. EDU: Equivalent Dwelling Units
2. eq population: Equivalent Population
3. ppd: pounds per day
4. ppd/EDU: pounds per day per Equivalent Dwelling Unit
5. ppcd: pounds per capita per day
6. BOD: Biochemical Oxygen Demand
7. NFR: Non-Filterable Residue
8. TKN: Total Kjeldahl Nitrogen
9. NH_4-N: Ammonium-Nitrogen

Projections are based on an alternative growth rate projection of 1.8% annual increase, cited as the probable growth rate projection in the McKinleyville Community Plan (Humboldt County, 2002). Figure 3-4 shows the estimated 20-year growth projections for the MCSD WWMF service area.



4.0 Existing Wastewater Facilities

4.1 Wastewater Collection System

This section of the facilities plan provides an overview of the sanitary sewer collection and conveyance systems serving MCSD. Information presented in this section is based on discussion with MCSD staff and our review of the following documents:

- Community Infrastructure and Services Technical Report (W&K, 2008)
- MCSD Sanitary Sewer Management Plan (FES, 2011)
- MCSD Municipal Services Review (LAFCo, 2009)
- MCSD Budget for the Fiscal Year Ending June 30, 2012 (MCSD, 2011)

4.1.1 System Description

MCSD maintains approximately 65 miles of sewer mains (MCSD, 2010). The collection system consists of approximately 63 miles of gravity sewer mains, 2 miles of pressure mains, 900 sanitary manholes, and five pump stations. Gravity sewer lines range in size from 6-inch lines to 24-inch lines, with the majority of the system (76%) comprised of 6-inch lines. An overview of the MCSD collection system was included as Figure 1-4. The community sewer collection and conveyance system is owned and operated by MCSD and services the sewer collection area shown in Figure 1-5.

MCSD maintains a radio telemetry system that allows all key facilities to be monitored constantly from the MCSD field office. The sewer facilities are connected to the computer system by radio telemetry. Upgrading of the system from land-based telephone lines to radio telemetry was started in 2003 and completed in 2009 (MCSD, 2011).

4.1.2 Lift Stations

Five lift stations have been constructed to convey wastewater from the collection system tributary areas to the MCSD WWMF. A summary evaluation of the lift stations is provided in Table 4-1. The maximum pump capacities reported in the analysis were determined by draw down testing performed in 2009 by SHN and additional testing completed by the District in 2011.

Average pumping rates and total pump capacity shown for each lift station were based on the data collected from the pump tests in 2009 and 2011. The process included calculating the incoming flow rate to the pump station using the time and height difference in water surface elevations noted during the pump tests. The average pumping rate was then determined by calculating the volume of effluent pumped out based on changes in the water surface elevation during the pump test and adding to that volume the amount of effluent that came into the wet well while the pump was running. The combined volume was divided by the pumping time to arrive at the average pump flow rates. Pump tests at each lift station were conducted individually for each pump and while running multiple pumps simultaneously.

Table 4-1
Lift Station Summary
MCSD Wastewater Management Facility

Description	PS #1	PS #2	PS #3	PS #4	PS #5
Name	B Street	Letz Lane	Kelly Street	Hiller Road	Fisher Road
System Type	Duplex, self-priming	Triplex, self-priming	Duplex, self-priming	Duplex, self-priming	Quad, flooded suction
Number of Pumps	2	3	2	2	4
Pump Type(s)	Centrifugal, non-clog	Centrifugal, non-clog	Centrifugal, non-clog	Centrifugal, non-clog	Centrifugal, non-clog
Pump Make(s)	Gorman Rupp	Gorman Rupp (All Pumps)	Gorman Rupp	Gorman Rupp	Worthington (All Pumps)
Pump Model(s)	2, T3A3B	1, T8A3B 2, T4A-5	2, T3A3B	2, T6A3B	2, 4MFV-11 2, 4MFV-15
Pump hp[1]	5	15 (P1 & P2) 50 (P3)	5	20	30 (P1 & P2) 100 (P3 & P4)
Pump Size(s)	3-inch	4-inch (P1 & P2) 8-inch (P3)	3-inch	6-inch	4-inch (P1 & P2) 8-inch (P3 & P4)
Motor Make(s)	Allis Chambers	Allis Chambers (P1) Baldor (P2) US Electric (P3)	Allis Chambers	General Electric	General Electric (All Pumps)
Motor Volts	240	480 (All Pumps)	240	240	480 (All Pumps)
Firm Capacity[2]	182 gpm[3]	673 gpm	125 gpm	836 gpm	1,614 gpm
Overflow point	Low spot @ wetwell	---	---	To Fisher @ 9.5	---
Auxiliary power type	35 kw Generator	125 kw Generator	Portable	Not Required (passive overflow)	170 kw Generator
Force main length	1,457 ft[(4)]	1,716 ft	30 ft	1,298 ft	5,960 ft
Force main size	10-inch	10-inch	6-inch	12-inch	12-inch
Discharge manhole	Manhole at Park and A	Manhole at Murray	Manhole at Eucalyptus	Headworks	Headworks

1. hp: Horsepower
2. Firm capacity was estimated based on pump tests conducted in 2009 and 2011, and assumes the largest pump at each lift station is offline.
3. gpm: gallons per minute
4. ft: feet

Improvements to the lift stations over the last 10 years have been focused mainly on the Fisher Road pump station. In 2001, the Fisher lift station flow meter was upgraded. In 2002, the grinder/communiter at the Fisher lift Station was replaced. In 2005 a restoration project at the Fisher lift station was completed to rehabilitate wet well valves, doors, light fixtures and exterior facilities (MCSD, 2010). The Hiller Road lift station was also upgraded in 2001 to increase capacity.

4.1.3 Age and Condition

MCSD's wastewater collection system was installed in the mid-1980s and has been well maintained. District staff has placed an operational priority on investigating and monitoring I/I of groundwater and storm runoff into the collection system. Smoke testing of the collection system is completed periodically to test for leaks and misconnections (MCSD, 2010). Each winter, the District also monitors wet weather flows at various manhole locations and expends the necessary resources to reduce I/I during wet weather. Overall, the MCSD collection system experiences some of the lowest I/I rates in the County (W&K, 2008).

4.1.4 Assessment

4.1.4.1 Collection System

Detailed review of the collection system was last completed in 2004. Pipe replacement has been on hold pending further engineering analysis. Projected growth in McKinleyville raises questions about the adequacy of the collection system capacity. MCSD is investigating the potential impacts to the collection system capacity based on various development projections provided by the County. Further discussion of the collection system analysis developed for this effort is presented in Section 6.

Based on staff observations, and as demonstrated by preliminary model results, no surcharging occurs within the collection system under existing dry weather conditions. However there were previous deficiencies identified in the system including the capacity of the main trunk lines, such as the Thiel Avenue line under Hiller Park, and the Widow White Creek line under the freeway (W&K, 2008). The District has considered adding additional capacity either by addition of parallel lines or pulling and replacing the existing lines (W&K, 2008).

4.1.4.2 Lift Stations

The pumps at each lift station are the original pumps installed when the system was constructed. The age of the pumps at each lift station is a known deficiency, but there has been no known failure to date (MCSD, 2011). MCSD staff provides semi-annual maintenance for each pump including adjustments and rehabilitation of the pump volute, as necessary. There have been no motor upgrades since the Hiller lift station sheaves and motors were upgraded in 2001.

4.2 Wastewater Treatment

The MCSD WWMF is a facultative pond system followed by wetlands treatment and chlorine disinfection. The overall site plan for the existing treatment system is depicted schematically in Figure 1-3.

4.2.1 System Description

4.2.1.1 Headworks

Wastewater from the Hiller and Fisher lift stations is pumped into a splitter box at the head of the facultative pond system where downward opening slide gates split the flow between the primary treatment ponds. Metering is provided by flow meters on the two force mains.

There is no functional pre-treatment of the influent, screening, or grit removal prior to discharge to primary treatment Ponds 1A and 1B. There are two grinders located in the existing system–one grinder is located at the Fisher lift station and the second grinder at the treatment plant. The grinders reduce large inorganic solids to small particles so that they may pass through the treatment system. Allowing the inorganic solids to remain in the flow stream increases the sludge volumes due to the inorganic solids not breaking down during treatment.

4.2.1.2 Facultative Pond System

Parallel primary treatment Ponds 1A and 1B are followed by secondary Ponds 2 and 3, generally operated in series. Supplemental aeration is supplied by 12, 5 horsepower (hp) turbine aerators: five each in Pond 1A and Pond 1B and two in Pond 2.

4.2.1.3 Wetlands Treatment

The secondary ponds are followed by two wetlands treatment cells operated in series. Wetlands 4 and 5 were constructed in 2005, to provide enhanced BOD and nutrient removal.

4.2.1.4 Disinfection

Secondary effluent from the wetlands treatment cells discharges to the chlorine contact basin. Following disinfection, effluent is gravity-fed to the Mad River for discharge, applied at one of four land reclamation sites, and/or discharged to the percolation ponds. During the period of discharge to the Mad River effluent is dechlorinated prior to discharge using sulfur dioxide injected in the effluent channel of the chlorine contact basin.

4.2.2 Secondary Treatment Capacity

The following analysis of secondary treatment capacity is based on the treatment system's capacity to treat organic loadings in the form of BOD. Generally, suspended solids or Non-Filterable Residue (NFR) can be assumed to track fairly closely with BOD in a pond system with the exception that excessive algae growth can lead to high levels of suspended solids in the pond effluent.

4.2.2.1 Facultative Ponds

Facultative ponds are designed using empirically derived surface loading rates coupled with a more detailed kinetic analysis, such as the equation developed by Wherner-Wilhelm to determine required detention times. Facultative lagoons with supplemental surface aeration (such as, the ones at MCSD) have a greater allowable surface or areal loading rate and the design may be controlled by the required detention time as calculated with the Wherner-Wilhelm equation.

Table 4-2 summarizes surface or areal loading on the MCSD facultative pond system. Typical loading rates for the facultative pond with supplemental aeration are 50-180 pounds/acre/day (Metcalf and Eddy, 1991). The pond loading on the MCSD ponds during the maximum month currently exceeds typical values and in 2030, average BOD loading will exceed the typical range of values.

Table 4-2
Areal BOD[1] Loading Rates
MCSD Wastewater Management Facility

Area	Acres	2010				2030			
		Average		Max Month		Average		Max Month	
		ppd[2]	ppd/ac[3]	ppd	ppd/ac	ppd	ppd/ac	ppd	ppd/ac
Ponds 1A & 1B	11.2	2,234	199	4,433	396	3,191	285	6,673	596
Combined[4]	16.1	2,234	139	4,433	275	3,191	198	6,673	414

1. BOD: Biochemical Oxygen Demand
2. ppd: pounds per day
3. ppd/ac: pounds per day per acre
4. Ponds 1A, 1B, 2, and 3

The first order removal rate equation developed by Wherner-Wilhelm is used to predict BOD removal rates based on available detention time and temperature assuming a flow through pattern between plug-flow and complete mix. Table 4-3 summarizes the results of an analysis showing detention times and expected removal rate.

Table 4-3
Theoretical BOD[1] Removal Rates (Wherner-Wilhelm)
MCSD Wastewater Facilities Plan

Ponds	2010						2030					
	MMDWF[2] = 1.1 MGD[3]			MMWWF[4] = 1.5 MGD			MMDWF = 1.6 MGD			MMWWF = 2.1 MGD		
	DT[5]	KT[6]	Re[7]	DT	KT	Re	DT	KT	Re	DT	KT	Re
	days		%	days		%	days		%	days		%
P1	20.1	4.02	87	15.2	2.13	73	14.10	2.82	80	10.6	1.48	65
P2	3.6	0.72	NC[8]	2.7	0.38	NC	2.50	0.50	NC	1.9	0.27	NC
P3	3.8	0.76	NC	2.8	0.39	NC	2.70	0.54	NC	2	0.28	NC
All	27.5	5.50	90	20.7	2.90	80	19.3	2.70	79	14.5	2.03	72

1. BOD: Biochemical Oxygen Demand
2. MMDWF: Maximum Month Dry Weather Flow
3. MGD: Million Gallons per Day
4. MMWWF: Maximum Month Wet Weather Flow
5. DT: Detention Time
6. KT: Removal Rate--First order rate constant for BOD removal 0.25 d-1 corrected for temperature. Winter k=0.14 d-1 Summer = 0.20 d-1
7. Re: Percent Removal
8. NC: Not Calculated

The analysis is presented for maximum month flows, which define the limiting conditions. Higher BOD removal rates are to be expected during low flows and higher temperatures. For example, theoretical rates at ADWF and 18.8 °C range from 80 to 90%.

Based on the analysis, the majority of the BOD removal is expected to occur in Ponds 1A and 1B. Theoretical predictions were comparable to BOD removal rates recorded in the MCSD WWMF capacity study (OLA, December 2000). During this study, conducted in the spring and summer of 2000, BOD removal in Ponds 1A and 1B ranged from 50 to 85%. Overall, BOD removal rates of 78 to 90% recorded during the capacity study were also comparable to the theoretical predictions.

Table 4-4 presents the results of theoretical BOD removal rates based on temperature and detention time applied to average influent BOD concentrations. The current NPDES permit requires that the facility meets an average monthly limit of 45 mg/L BOD year round. The loading analysis indicates that the secondary ponds are at the limits of their capacity to provide the required BOD removal reliably without additional BOD removal in the wetlands during the winter months.

Table 4-4
Theoretical BOD[1] Removal Rates Based on Temperature and Detention Time
MCSD Wastewater Management Facility

2010						2030					
MMDWF[2] = 1.1 MGD[3]			MMWWF[4] = 1.5 MGD			MMDWF = 1.6 MGD			MMWWF = 2.1 MGD		
Infl.[5]	Re.[6]	Effl.[7]	Infl	Re.	Effl.	Infl	Re.	Effl.	Infl	Re.	Effl.
mg/L[7]	%	mg/L	mg/L	%	mg/L	mg/L	%	mg/L	mg/L	%	mg/L
272	90%	27	244	80%	49	272	79%	57	244	72%	68

1. BOD: Biochemical Oxygen Demand
2. MMDWF: Maximum Month Dry Weather Flow
3. MGD: Million Gallons per Day
4. MMWWF: Maximum Month Wet Weather Flow
5. Infl.: Influent
6. Re.: Percent Removal
7. Effl.: Effluent

4.2.2.2 Wetlands

Wetland organic loading rates based on the expected effluent quality from the facultative pond system are presented in Table 4-5. Loading rates for the approximate 6 acres of existing wetlands range from 43 ppd/ac at current flows to 226 ppd/ac at future flows and loadings.

Table 4-5
Organic Loading Rate on Wetlands Cells
MCSD Wastewater Management Facility

2010						2030					
MMDWF[1] = 1.1 MGD[2]			MMWWF[3] = 1.5 MGD			MMDWF = 1.6 MGD			MMWWF = 2.1 MGD		
FS Re.[4]	Loading		FS Re.	Loading		FS Re.	Loading		FS Re.	Loading	
%	ppd[5]	ppd/ac[6]	%	ppd	ppd/ac	%	ppd	ppd/ac	%	ppd	ppd/ac
90	254	43	80	676	114	79	744	126	72	1335	226

1. MMDWF: Maximum Month Dry Weather Flow
2. MGD: million gallons per day
3. MMWWF: Maximum Month Wet Weather Flow
4. FS Re.: Removal in facultative system preceding wetlands
5. ppd: pounds per day
6. ppd/ac: pounds per day per acre

A range of loading rates is presented in the literature for areal loading on wetlands. There is general agreement that loading rates should not exceed 100 ppd/ac if aerobic conditions are to be maintained near the surface and odors minimized (Crites & Tchobanoglous, 1998). Typical BOD loading rates on wetlands are in the range of 50-70 ppd/ac (Tchobanoglous, 1987). The EPA design manual for constructed wetlands treatment (EPA, 2000,) is more conservative in its approach, stating that organic loading rates in the range of 10 to 25 pounds BOD/acre/day to free water surface wetlands have been shown to meet secondary effluent standards of 30 mg/L BOD and TSS effectively. Even though the current NPDES permit does not require that the MCSD WWMF meet secondary standards of 30 mg/L for both BOD and TSS, the organic loading rates on the wetlands are high enough to call into doubt the ability of the combined facultative ponds and wetlands system to meet the permit requirements of 45 mg/L BOD and TSS reliably, especially as loadings increase.

Enlarging the wetland cells to provide secondary treatment and enhanced treatment for nutrient removal is discussed as an alternative in the evaluation of treatment alternatives in Section 6. As part of that analysis, biological rate constants for wetlands treatment are discussed and used to provide specific criteria for how large treatment wetlands would need to be to meet the current permit and/or future secondary requirements.

4.2.2.3 Nutrient Removal

Currently, removal rates for ammonia in the facultative pond system range from 20 to 50%. The mechanisms of ammonia removal in pond systems and reasons for its wide range are discussed in more detail in subsequent sections. The values presented here are used to provide an estimate of nitrogen loading on the wetland cells as part of a discussion regarding the capacity of wetland cells to achieve required removal rates reliably.

According to the EPA design manual for wetlands, the maximum Total Nitrogen (TN) loadings on a free water surface wetland to sustain an effluent TN of less than 10, can conservatively be set to 5 kilograms per hectare (kg/ha) (4.5 ppd/ac) (EPA, 2000). At a removal rate of 25%, the lower end of the range for the facultative pond system, ammonia loading on wetlands Ponds 4 and 5 is approximately 231 ppd or 39 ppd/ac. Under these conditions, current loading on the wetlands is seven times the recommended loading on a free water surface wetland designed to achieve land application standards.

4.2.3 Disinfection System

Treated effluent is chlorinated prior to disposal using chlorine gas. When the WWMF is discharging to the Mad River, effluent is dechlorinated at the end of the chlorine contact basin using sulfur dioxide.

4.2.3.1 Chlorination

The WWMF is equipped with two chlorinators (one with a capacity to feed 200 ppd, and one with a capacity to feed 400 ppd) and one sulfonator, also with a 200 ppd capacity. Table 4-6 summarizes chlorine usage from 2010 data.

Table 4-6
Chlorine and Sulfur Dioxide Usage
MCSD Wastewater Management Facility

	Chlorine Usage								Sulfur Dioxide Usage			
	Dosage				Residual		Demand		Dosage			
	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max
	ppd[1]	ppd	mg/L[2]	mg/L	mg/L	mg/L	mg/L	mg/L	ppd	ppd	mg/L	mg/L
January	95	194	11	59	3	6	9	58	95	194	11	59
February	156	200	17	29	2	5	15	28	35	61	4	6
March	174	203	17	20	1	4	15	19	34	46	4	33
April	156	193	15	19	2	5	13	19	35	56	3	5
May	140	200	14	21	2	11	13	20	17	56	2	5
June	105	197	11	22	3	8	9	20	NA[3]	NA	NA	NA
July	93	144	12	3	3	8	10	17	NA	NA	NA	NA
August	68	119	9	3	3	6	7	14	NA	NA	NA	NA
September	108	156	15	3	3	9	12	21	NA	NA	NA	NA
October	69	108	9	4	4	6	6	11	NA	NA	NA	NA
November	99	168	11	3	3	5	9	19	29	NA	4	NA
December	144	209	14	2	2	4	12	18	35	3	3	6
Average	117	---	13	---	3	---	11	---	40	---	4	---
Maximum	---	209	---	59	---	11	---	58	---	194	---	59

1. ppd: pounds per day
2. mg/L: milligrams per Liter
3. NA: Not Applicable

In 2010, daily usage averaged 117 ppd but exceeded 200 ppd several times.

Chlorine demand is the amount of chlorine required to maintain the required disinfection residual in the wastewater effluent. Chlorine demand at the MCSD facility ranges from 6 to 60 mg/L. Periods of high chlorine demand can be attributed to high levels of suspended solids and algae and build-up of hydrogen sulfide in the treatment wetlands. These periods of high demand result in an average demand that is more than twice that expected for secondary treatment using activated sludge (White, 1992).

4.2.3.2 Contact Basin

The serpentine plug flow configuration of the contact basin consists of 13 channels with an average length of 42 feet and a maximum depth of 9.9 feet providing a volume of approximately 197,000 gallons. Because some degree of short-circuiting is inherent in any plug flow regime, actual detention time will be less than the theoretical detention time based on total volume.

To measure actual detention time at the MCSD facility, a dye test was conducted in June 2000 (OLA, December 2000). The results of this test indicated that at high flows, the contact basin has an active volume of 106,500 gallons and could provide the required detention time of 30 minutes at a flow of 5.11 MGD (3,550 gallons per minute [gpm]).

4.2.3.3 Uniform Fire Code

At a minimum, Article 80 of the Uniform Fire Code requires facilities using chlorine gas and not equipped with scrubber systems to have the following controls:

- Approved containment vessels or containment systems
- Protected valve outlets
- Gas detection system
- Approved automatic-closing fail-safe valve

The gas chlorination at MCSD has been inspected by the Fire Marshal and determined to be compliance with the Uniform Fire Code. The gas cylinders are contained in a chlorine room equipped with gas monitors and the installation of automatic closing fail-safe valves has been budgeted for 2011.

4.2.4 Treatment System Performance

The facultative ponds are followed by treatment wetlands that were designed to treat secondary effluent. This section provides a detailed analysis of system performance in terms of the theoretical capacity, and a discussion of whether there are improvements and or operational changes that can improve system compliance and reliability.

4.2.4.1 BOD and NFR Removal

Figures 4-1 and 4-2 provide an overview of the monthly BOD and NFR removal achieved in the treatment system; respectively. Figures 4-3 and 4-4 show the 2010 monthly seasonal variation and annual average variation in BOD concentrations by system component, respectively. The seasonal variation in pond performance indicates declining performance in summer months. This deterioration in performance may be related to increased algae growth. Although algae are part of the treatment in any facultative system, large blooms can cause large variations in pH, and Dissolved Oxygen (DO), which can be detrimental to the process. The algae uses up carbon dioxide during the day and can cause increased pH. The result is usually an increase in NFR, and BOD may increase when algae sinks, contributing to eutrophic conditions at depth in the ponds.

Figure 4-1
BOD Removal

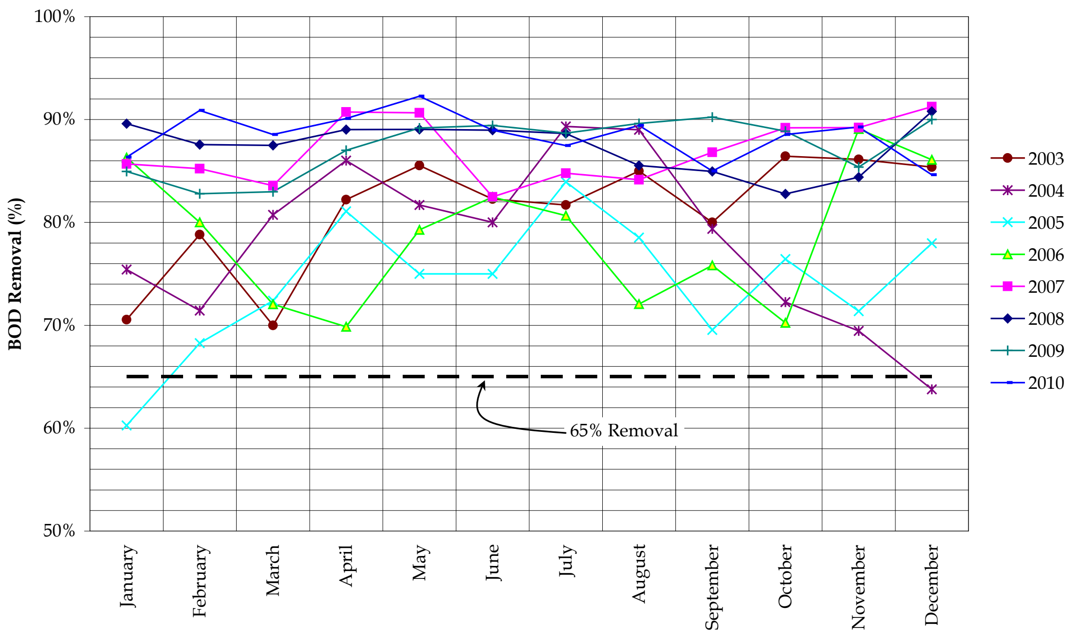


Figure 4-2
NFR Removal

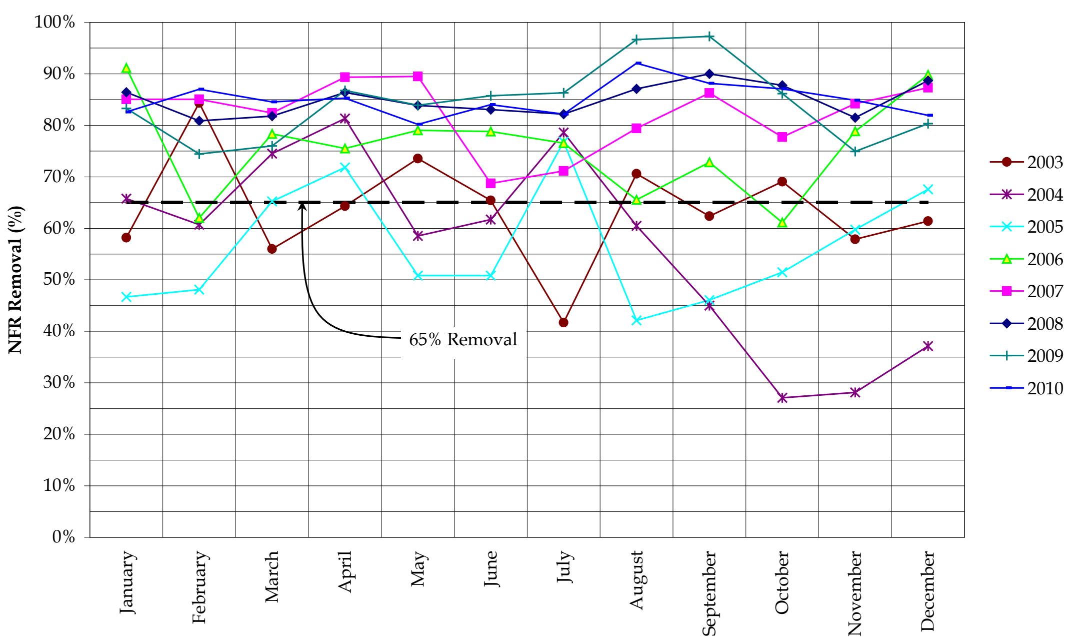


Figure 4-3
Facultative Pond Monthly Average BOD (2010)

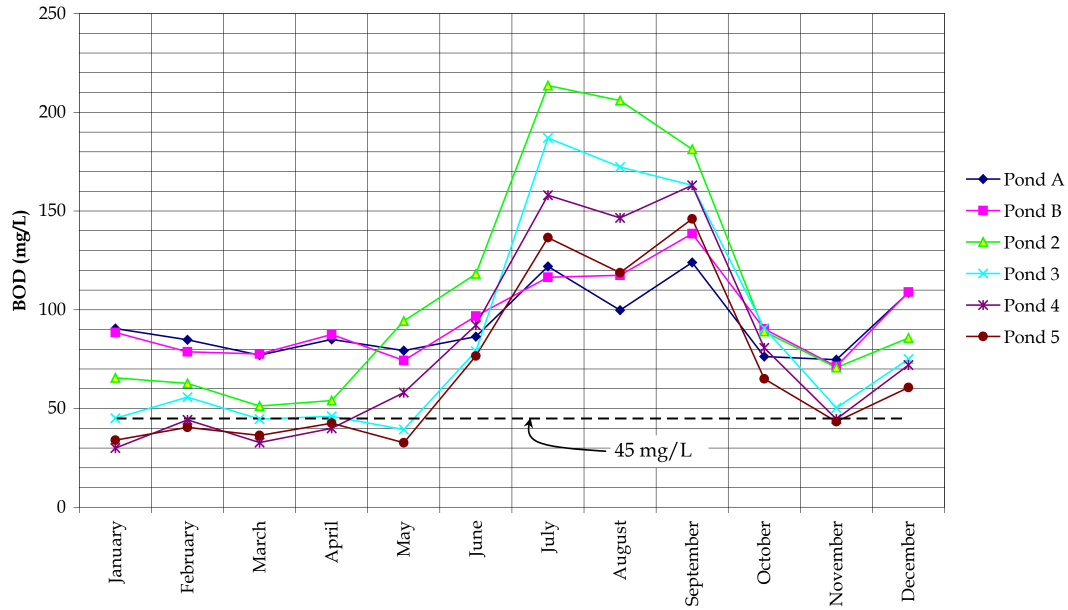
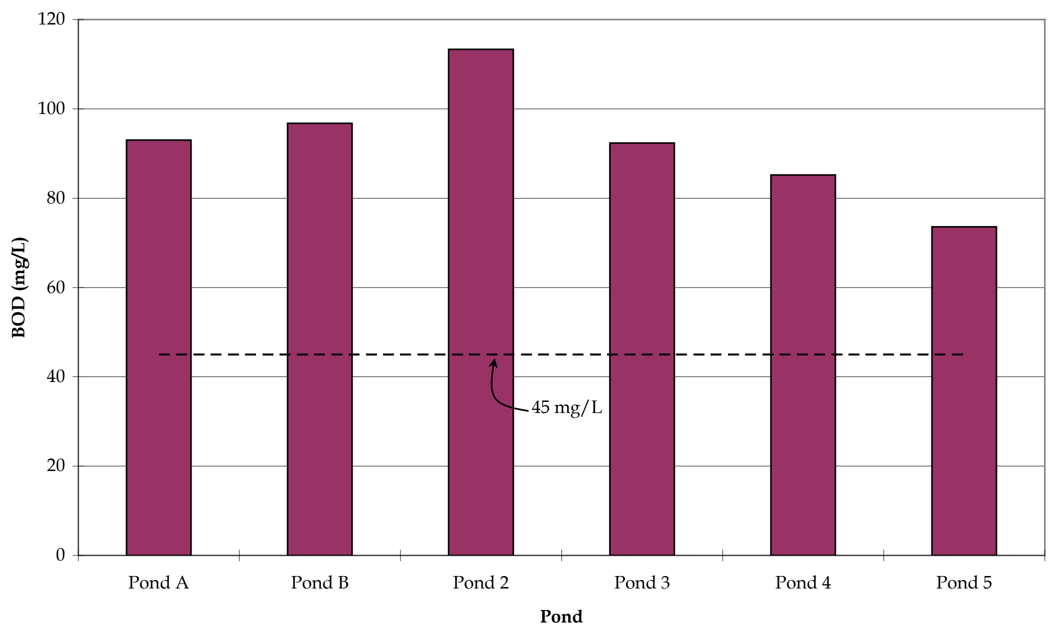


Figure 4-4
Facultative Pond Annual Average BOD (2010)

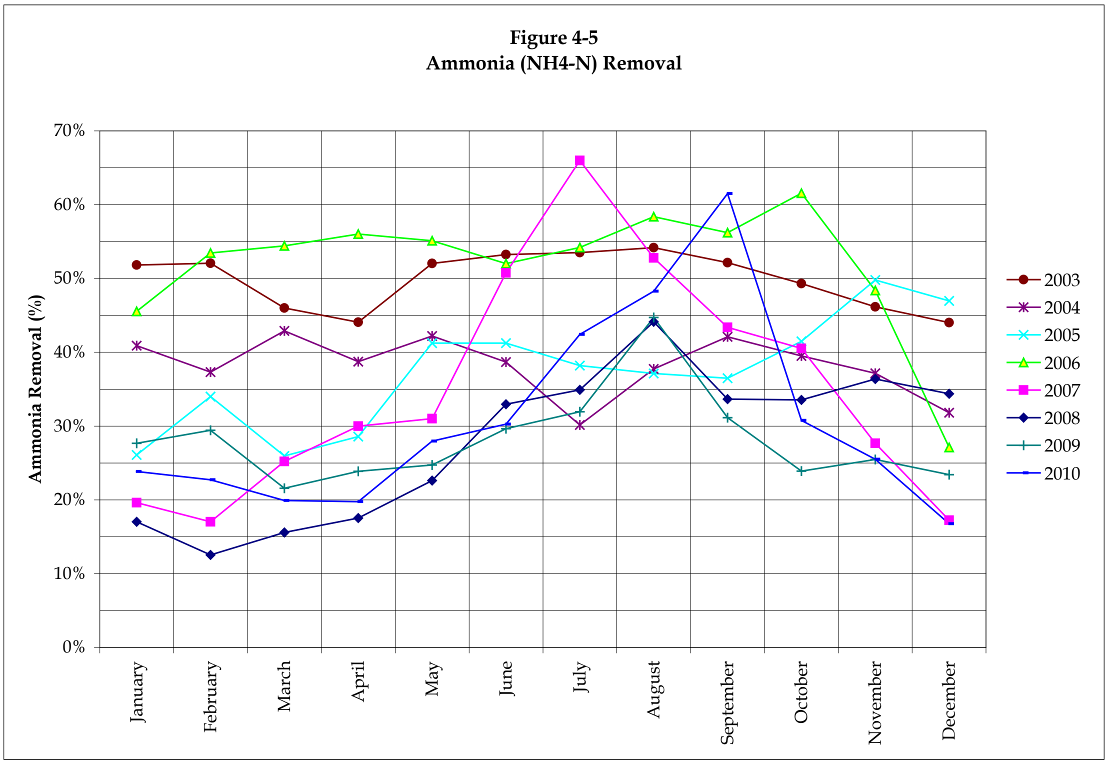


4.2.4.2 Ammonia Removal

Nitrogen removal in facultative ponds is positively correlated with increased temperature, pH, and detention time. It occurs principally through the following processes:

- Gaseous ammonia stripping to atmosphere
- Ammonia assimilation in algal biomass
- Nitrate assimilation in algae
- Biological nitrification-denitrification

Figure 4-5 provides an overview of the monthly ammonia removal achieved in the treatment system from 2003 through 2010. Figure 4-6 shows the monthly range in TKN removal for 2010.



4.2.4.3 Nitrogen Removal in Facultative Ponds

During the winter and spring, ammonium-nitrogen (NH_4-N) removal in the facultative pond system is reduced by colder temperatures and shorter detention times. Effluent NH_4-N levels have been a concern because of the potential toxicity of unionized ammonia when the MCSD WWMF is discharging to the Mad River. SHN analyzed ammonia and total nitrogen removal in the secondary pond system during the 2010 wet weather discharge period, to determine if the ammonia removal process was meeting theoretical expectations based on temperature, pH, and detention time. Table 4-7 summarizes the results.

Figure 4-6
Total Kjehldahl Nitrogen (TKN)

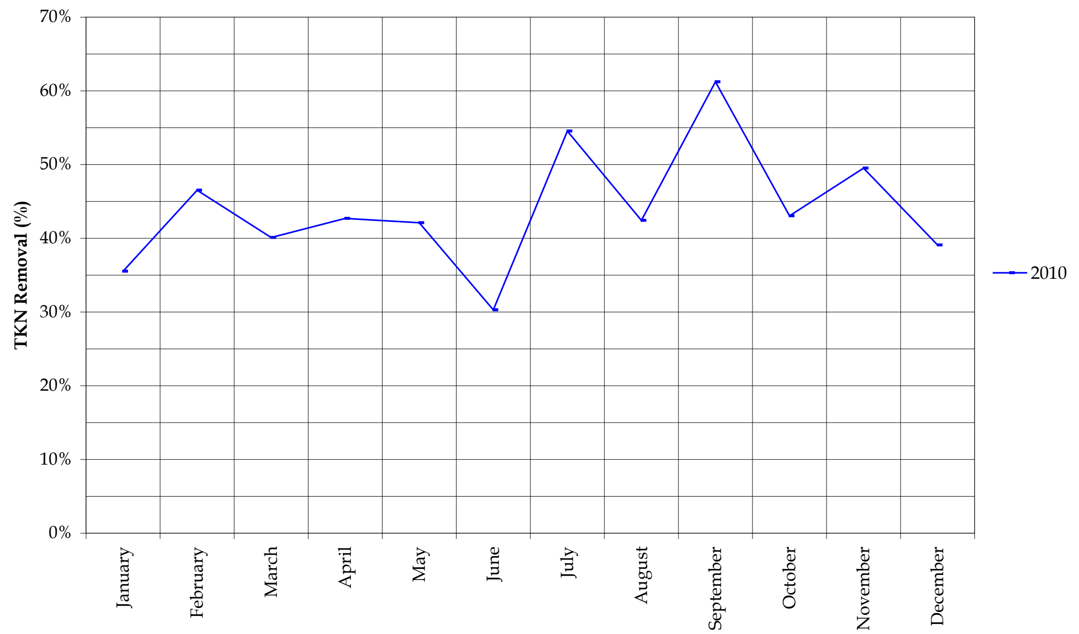


Table 4-7
Nitrogen Removal, 2010
MCSD Wastewater Management Facility

	NH_4-N(1)				TKN[2]				
	Influent	Effluent	Removal		Influent	Effluent	Removal		
	mg/L[3]	mg/L	Observed	Predicted[1]	mg/L	mg/L	Observed	Predicted	Predicted
January	36	28	25%	39%	64	41	47%	30%	25%
February	40	30	23%	40%	72	39	40%	32%	28%
March	36	29	19%	33%	53	32	43%	28%	25%
April	34	27	19%	32%	58	33	42%	28%	24%

1. NH_4-N: Ammonium-Nitrogen
2. TKN: Total Kjeldahl Nitrogen
3. mg/L: milligrams per Liter

It is important to note that the observed ammonia removal rates noted in Table 4-7 underestimate total ammonia removal in the ponds because the contribution from influent organic nitrogen is not included in the calculation. An annual average of 20 mg/L of organic nitrogen is removed in the facultative pond system; this organic nitrogen is first converted to NH_4-N. If the ammonia removal rates in Table 4-7 are recalculated to include the contribution from influent organic nitrogen, ammonia removal averages 47%. In general, total nitrogen removal in the ponds exceeds theoretical expectations as indicted by the values for TKN removal.

4.2.4.4 Nitrogen Removal in Wetlands

The treatment wetlands came on-line in 2006. Although some increase in overall performance has been noted, the expected increase in nutrient removal has not been achieved and effluent ammonia levels remain high.

The treatment wetlands, which receive secondary effluent from Ponds 2 and 3, are shallow and planted with emergent vegetation, which is best at removing nitrogen in the form of nitrates either by denitrification (which converts nitrates to nitrogen gas [N_2] thereby removing it from the system) or plant uptake. However, the nitrogen from the secondary ponds is almost entirely in the form of ammonia.

The wetlands system lacks a method of reliable nitrification. Wetland Pond 4 was designed with deeper cells for nitrification, but the facility has not been successful in growing the submerged plants best suited for conversion of ammonia. The District is conducting a pilot test in Pond 3 using Submerged Aquatic Vegetation (SAV) species to treat effluent from Ponds 1 and 2.

4.2.5 Permit Compliance

According to the 2010 annual report for the MCSD WWMF (MCSD, 2011) the treatment system was in compliance with BOD, NFR, settleable solids, chlorine residual, and nitrate as nitrogen limitations during 2010. Coliform monthly median and daily maximum concentrations were also in compliance with the exception of the values recorded in May 2010.

Priority pollutant testing results for copper, lead, alpha-BHC, 4,4′-DDT, bis(2-ethylhexyl)phthalate and 2,3,7,8-TCDD equivalents were in compliance with applicable limitations with the exception of the 4,4′-DDT concentrations recorded in February and March 2010. With regard to the 4,4′-DDT excursions, the District noted that the February and March results for 4,4′-DDT indicated an intermittent appearance of that constituent in treated effluent. During the sanitary survey conducted in 2009, no generator of that constituent was identified (FES, 2009). All forms of DDT are currently illegal to purchase or sell and it has been difficult to identify the source of the pollutant given that the appearance of the pollutant is intermittent. The District is continuing to investigate and will (hopefully) eliminate the source as the solution to the intermittent excursions.

Acute and chronic toxicity monitoring was conducted in 2010 and acute toxicity testing results were in compliance with designated limitations during 2010. The chronic toxicity monitoring indicated that the test results for 2010 exceeded the chronic toxicity trigger of 1 toxicity unit (TUc). Similar results were recorded during the chronic toxicity testing completed in 2009. In response to the 2009 chronic toxicity monitoring results, the District completed a Toxicity Reduction Evaluation (TRE) that concluded that the TUc exceedances were due to ammonia toxicity in the effluent (SHN, 2010).

The main area of concern noted in the 2010 annual report was the presence of high ammonia concentrations in the effluent. Although the current permit does not directly limit ammonia in effluent discharges, the District anticipates limits will be established in the next permit cycle.

4.3 Disposal System

4.3.1 Mad River Discharge

During the discharge period, October 1 through May 14, and when the flow in the river is greater than 200 cubic feet per second (cfs), treated wastewater effluent is discharged to the Mad River. The existing outfall pipe for the Mad River Discharge is located at the Hammond Trail Bridge crossing on the Mad River.

4.3.2 Percolation Ponds

During the discharge prohibition period, May 15 through September 30, effluent is discharged to the percolation ponds and/or to land for reclamation. The percolation ponds include two separate basins that are alternated in use. The use of the percolation ponds for effluent disposal is allowed under the current permit; however, the RWQCB has indicated that future discharge permits may limit this use. The District is currently in the process of studying other disposal alternatives to the percolation pond discharge to comply with the Bay and Estuaries Policies and the Basin Plan discharge prohibitions for summer discharge of treated wastewater effluent.

4.4 Land Reclamation System

4.4.1 Existing Reclamation System

MCSD reclaims wastewater effluent at the Lower Fisher Ranch, Upper Fisher Ranch, the Hiller Parcel, and the Pialorsi Ranch. Land reclamation locations are shown on Figure 1-2. A reserve reclamation area is also shown Figure 1-2 for the Pialorsi Ranch property located east of Fisher Road. Although this area is not currently used for reclamation, recent discussions (2011) with the owner have indicated future use of this area for reclamation may be considered.

The Fisher and Pialorsi Ranches are located south of School Road and west of Fisher Road in McKinleyville. Wastewater effluent is also reclaimed for irrigation of storm water wetlands and a forested area at Hiller Park in McKinleyville during the dry months of the year. For the purpose of this facilities plan, the analysis of wastewater loading on the MCSD wastewater effluent reclamation areas was limited to the Fisher Ranch and Pialorsi Ranch irrigation areas, where the majority of reclamation occurs. Reference to the "Upper" and "Lower" Fisher Ranch is used to differentiate the upper terrace, where both flood irrigation and spray irrigation operations occur, from the lower floodplain at the toe of the hill slope, where spray irrigation is applied. The Upper Fisher Ranch consists of approximately 33 acres, 28 of which are used for reclamation. Wastewater effluent is applied to approximately 19 acres through flood irrigation and to 9 acres by spray irrigation. The Lower Fisher Ranch consists of approximately 45 acres and the Pialorsi Ranch has approximately 35 acres available for irrigation.

Based on data collected from 2008 through 2010, the Upper Fisher Ranch received 25 to 29% of the annual effluent discharge, whereas the Lower Fisher and Pialorsi Ranches received zero to 2% and 4 to 7% of the annual discharge, respectively.

4.4.2 Capacity

To evaluate the capacity of the reclamation area based on the irrigation pattern currently used by MCSD to reclaim wastewater effluent, the following were addressed:

- Hydrologic Properties of Soil
- Climate Data
- Irrigation Season
- Water Balance

4.4.2.1 Hydrologic Soil Properties

The Upper Fisher Ranch soils have been defined as coarse loam with an observed rooting depth of 36 to 45 inches (NRCS, 2010). The Lower Fisher Ranch soils have been defined as the fine silt Arlynda soil series, which was observed with rooting depths of 22 to 41 inches (NRCS, 2010). These soil qualities are used to estimate soil porosity, field capacity, and the Available Water Holding Capacity (AWHC), which are summarized in Table 4-8. AWHC is a measure of the total amount of water stored in the soil that is available to the plant, or the capacity of the soil. Field capacity is the upper limit of stored water in the soil once free drainage has occurred. When a soil is at field capacity, the soil reservoir is completely full. Hydrologic soil properties are used to develop irrigation schedules to maximize crop production by providing sufficient water supply and to reduce surplus runoff.

Table 4-8
Hydrologic Soil Properties for MCSD Reclamation Areas
MCSD Wastewater Management Facility

Soil Properties	Upper Fisher Ranch	Lower Fisher Ranch
Soil Class	Coarse Loam[1]	Fine Silt[1]
Porosity	46%[2]	47%[2]
Field Capacity	24%[2]	28%[2]
Wilting Point	10%[2]	15%[2]
Rooting Depth	36–45 inches[1]	22–41 inches[1]
AWHC[3] within the Root Zone	5–7 inches	4–8 inches

1. Source: NRCS soil series descriptions for Arcata and Arlynda soils
2. Source: Dunne and Leopold, 1978
3. AWHC: Available Water Holding Capacity

4.4.2.2 Climate Data

Monthly average precipitation at the Eureka Woodley Island weather station for the period of record (1948 through 2010) has been summarized by the Western Regional Climate Center (WRCC, 2011). Over 90% of total rainfall occurs from October through April, which is considered the wet season.

Evapotranspiration (ET) is the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). Reference ET (ET_0) is the ET rate of a reference crop, typically a standardized grass surface. Using the California

Irrigation Management Information System reference map of ET_0 zones in California, McKinleyville is within Zone 1 (coastal plains) characterized by dense fog (CIMIS, 1999). Crop evapotranspiration (ET_C) is a measure of the plant transpiration plus the soil surface evaporation. The ET_C rate is estimated as the product of a crop coefficient and ET_0. The crop coefficient for hay grass ranges from 0.6 near dormancy to 0.95 during the period of maximum growth, with an average of 0.82 during the growing season. The climate data used for the water balance is shown in Table 4-9.

Table 4-9
Climate Data for MCSD Reclamation Areas
MCSD Wastewater Management Facility

Parameter	Wet Season				Dry Season					Wet Season		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation (inches)[1]	6.78	5.38	5.24	3.05	1.69	0.65	0.14	0.33	0.75	2.65	5.63	7.11
ET_0 (inches)[2]	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62
K_C[3]	0.60	0.60	0.73	0.91	0.95	0.95	0.87	0.80	0.80	0.73	0.65	0.60
ET_C (inches)[4]	0.56	0.84	1.81	3.01	3.83	4.28	4.05	3.22	2.64	1.81	0.78	0.37
Potential storage	---	---	---	---	2.22	3.59	3.86	2.86	1.77	---	---	---

1. Eureka at Woodley Island for period of record 1949-2009 (WRCC, 2010)
2. ET_0: Reference evapotranspiration (CIMIS, 2010)
3. K_C: Crop coefficient (BLM, 2010)
4. ET_C: Crop evapotranspiration

4.4.2.3 Irrigation Season

The irrigation season (dry season) is defined as the months where the monthly ET_C rate is greater than the monthly precipitation rate. As shown in Table 4-9, the irrigation season is from May through September. The difference between the precipitation rate and the ET_C rate during the irrigation season is a measure of the potential water loss or conversely, the potential storage available in the soil. The accumulated potential available storage in the soil during the irrigation season is 14.3 inches.

4.4.2.4 Irrigation Water Balance

The goal of a water balance calculation is to determine if the wastewater effluent irrigation is applied at reclamation rates to the application areas. The following assumptions were made:

1. Irrigation rates are based on average effluent distribution data from 2008 through 2010.
2. There are 165 week days (available irrigation days) from May 15–December 31.
3. Monthly effluent discharge volumes applied to irrigation areas were distributed equally to available irrigation days per month.
4. Daily effluent discharge volumes applied to irrigation areas were distributed equally over 18 hours per day.
5. The irrigation season begins with the top 24 inches of the root zone at field capacity.
6. The irrigation efficiency is 75%.
7. Permeability is controlled by the most restrictive soil horizons within the soil layer.

Management Allowable Depletion (MAD) is the percent of the AWHC that an irrigator will allow the crop to deplete before irrigating. Typically, depending on the crop and soil type, a MAD above 50% results in stress to the crop and yield reduction. The results of the water balance for each reclamation area are summarized in Table 4-10. Negative MAD values are representative of surplus water conditions (no soil moisture deficit) and may indicate periods when water ponds or drains from the soil layer toward the groundwater.

4.1.2.5 Agronomic Loading Rates

The agronomic rate is the amount of nutrients that can be applied to a specific crop within an appropriate period. Applying wastewater at an agronomic rate will supply a plant with the amount of nitrogen it demands while minimizing the amount of nitrogen that is released below the root zone and/or provide the appropriate amount of other plant nutrients to promote plant growth. Annual nitrogen loading per acre was estimated, assuming that average monthly wastewater effluent TKN concentrations will be used to grow hay grass on the Upper Fisher, Lower Fisher, and Pialorsi Ranches, which provide 28, 45, and 35 acres of land for reclamation, respectively. Data worksheets showing the nutrient loading calculations are included in Appendix E.

A comparison of the recommended nitrogen loading rates (approximately 170 pounds per acre, based on current crop cover) with the reported TKN loading rates from 2010 indicates that the Upper Fisher, Lower Fisher, and Pialorsi Ranches received nitrogen at approximately 683%, 0%, and 82% of agronomic rates, respectively. Based on nitrogen loading estimates from 2010, approximately 217 acres are required to balance effluent nitrogen loading with crop agronomic rates of uptake equally; the existing reclamation area supplies 50% of that target if the effluent distribution among irrigation areas were in proportion with available reclamation areas.

Plant Available Nitrogen (PAN) is the sum of available inorganic nitrogen and the percentage of organic nitrogen that mineralizes into ammonia. The mineralization of organic nitrogen typically is not a major concern for municipal wastewater land treatment systems, with the exception of systems receiving effluent containing significant concentrations of algae (EPA, 2006). Organic nitrogen concentrations calculated from the 2010 MCSD effluent data accounted for 21% of the total TKN annual loading; therefore, it is included in the nitrogen loading budget. Realistically, PAN would be sourced from the proportion of ammonia that was not volatized, the proportion of organic nitrogen that was mineralized, and nitrate.

Treated wastewater contains many essential nutrients; however, if ratios are inadequate, nutrient management should be employed. Optimum nutrient ratios to ensure proper nutrient use are generally 4 parts Nitrogen to 1 part Phosphorous to 2 parts Potassium (4N:1P:2K). The WWMF effluent is sampled for nitrogen; however, the phosphorus and potassium concentrations are not characterized as part of their monitoring program. To ensure that optimum nutrient uptake is occurring, effluent phosphorus and potassium are recommended to be included as part of the on-going monitoring program for WWMF effluent discharges.

Table 4-10
Water Balance for Existing Irrigation Practices at Reclamation Areas[1]
MCSD Wastewater Management Facility

Month	Monthly Average Precipitation (in/day)	Monthly Average ET_C[2] (in/day)	Assumed Irrigation Days per Month (days)	Assumed Irrigation Duration (hours/day)	Upper Fisher Ranch		Lower Fisher Ranch		Pialorsi Ranch	
					Monthly Average Application Rate (in/day)	Monthly Average MAD[2] (%)	Monthly Average Application Rate (in/day)	Monthly Average MAD (%)	Monthly Average Application Rate (in/day)	Monthly Average MAD (%)
May	0.05	0.12	12	18	0.18	-9%	0.00	16%	0.02	14%
June	0.02	0.14	22	18	0.46	-150%	0.00	57%	0.09	31%
July	0.00	0.13	21	18	0.38	-307%	0.01	110%	0.10	43%
August	0.01	0.10	23	18	0.40	-458%	0.02	154%	0.10	47%
September	0.03	0.09	22	18	0.40	-622%	0.02	184%	0.11	40%
October	0.09	0.06	21	18	0.51	-858%	0.03	181%	0.06	13%
November	0.19	0.03	22	18	0.68	-1231%	0.02	127%	0.05	-55%
December	0.23	0.01	22	18	0.27	-1573%	0.00	37%	0.01	-154%

1. Based on average effluent distribution data from 2008 through 2010
2. ET_C: Crop evapotranspiration
3. MAD: Management Allowable Depletion

Part 3 Project Feasibility

5.0 Basis of Planning

5.1 Regulatory Requirements

5.1.1 Permit Constraints

This section summarizes the NPDES waste discharge requirements for the MCSD WWMF. MCSD currently discharges under NPDES Permit No. CA0024490, Waste Discharge Order No. WQ 2011-0008-DWQ. This permit was adopted by the State Water Resources Control Board (SWRCB) on April 19, 2011, and went into effect on the same day. The permit will expire on April 18, 2016.

5.1.1.1 Discharge Prohibitions

Pursuant to SWRCB Order No. WQ 2011-0008-DWQ, the discharge of treated effluent from the WWMF to the Mad River or its tributaries is prohibited from May 15 through September 30 of each year. This discharge prohibition does not prohibit discharge to the Hiller Storm Water Treatment Wetlands (Discharge Point 005) or the percolation ponds (Discharge Point 002). From October 1 through May 14 of any given year, treated wastewater effluent from the WWMF can be discharged directly to the Mad River when river flows are both greater than 200 cfs and greater than 100 times the wastewater discharge rate, based on the most recent daily flow measurement, as measured at the Highway 299 overpass (USGS Gage No. 11-4810.00).

5.1.1.2 Effluent Limitations

With the adoption of the 2011 NPDES permit, monitoring locations were revised for the facility discharges. Table 5-1 summarizes the monitoring locations for compliance with the effluent limitations. Discharge points are shown on Figure 5-1. Monitoring locations, including surface water, land reclamation, receiving water and monitoring well locations, are shown on Figure 5-2.

Table 5-1
Discharge Monitoring Locations[1]
MCSD Wastewater Management Facility

Discharge Point	Monitoring Location	Monitoring Location Description
--	M-INF	Treatment facility headworks
All	M-001	Chlorine contact chamber following dechlorination
001	M-002	Outfall to the Mad River under the Hammond Trail railroad bridge
002	M-003	Outfall to Mad River percolation ponds
003	M-004	Recycled wastewater irrigation of Lower Fisher Ranch
004	M-005	Discharge to land on Upper Fisher Ranch
005	M-006	Recycled wastewater irrigation of Hiller Storm Water Treatment Wetland
006	M-007	Recycled wastewater irrigation of Pialorsi Ranch
--	M-008	Overflow from the Hiller Storm Water Treatment Wetland
--	R-001	Mad River at Highway 101 Bridge

SOURCE: 2010 NAIP IMAGERY

\\Eureka\Projects\2008\008189-MCSD\300-FacilitiesPlan\Dwgs , SAVED: 8/5/2011 2:22 PM CNEWELL, PLOTTED: 8/8/2011 8:45 AM , CHRIS D. NEWELL

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Dishcharge Location Map SHN 008189
	August 2011 / 008189-DISCHRG-LOC	Figure 5-1

SOURCE: 2010 NAIP IMAGERY

\\Eureka\Projects\2008\008189-MCSD\300-FacilitiesPlan\Dwgs , SAVED: 8/5/2011 2:23 PM CNEWELL, PLOTTED: 8/8/2011 8:46 AM , CHRIS D. NEWELL

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Monitoring Location Map SHN 008189
	August 2011 / 008189-MWELL-LOC	Figure 5-2

Table 5-1
Discharge Monitoring Locations[1]
MCSD Wastewater Management Facility

Discharge Point	Monitoring Location	Monitoring Location Description
--	R-002	North bank of Mad River as close as possible to the discharge point under the Hammond Trail Bridge
--	W-001	Well M-1 adjacent to Fisher Road
--	W-002	Well M-2 on the SW corner of the intersection of School and Fisher Roads
--	W-006	Well M-6 south of W-9 and west of W-7
--	W-007	Well M-7 in the upper portion of the Fisher parcel
--	W-008	Well M-8 400 feet west of the intersection of School and Fisher Roads
--	W-009	Well M-9 adjacent to School Road
--	W-014	Well downgradient of the Hiller Storm Water Treatment Wetland irrigation area
--	W-015	Well within the Lower Fisher Ranch irrigation area
--	W-016	Well within the Pialorsi Ranch irrigation area

1. Reproduced from NPDES No. CA0024490, Attachment E: Monitoring and Reporting Program

Table 5-2 summarizes the effluent limitations for discharges from the WWMF to the Mad River.

Table 5-2
Wastewater Effluent Limitations for Discharge Point 001(Mad River Outfall)[1]
MCSD Wastewater Management Facility

Parameter	Units	Monthly Average[2]	Weekly Average[3]	Daily Max.	Instantaneous		Sampling	
					Min.	Max.	Type	Frequency
BOD[4]	mg/L[5]	45	65	--	--	--	24-hr Composite	Weekly
	ppd[6,7]	604	873	--	--	--		
TSS[8]	mg/L	83	--	--	--	--	24-hr Composite	Weekly
	ppd[7]	1,108	--	--	--	--		
pH	unitless	--	--	--	6.5	8.5	Grab	Daily
Settleable Matter	ml/L[8]	0.1	--	0.2	--	--	Grab	Weekly
Chlorine Residual	mg/L	0.01	--	0.02	--	--	Grab	Daily
Nitrate as Nitrogen	mg/L	10	--	--	--	--	Grab	Monthly
4,4′-DDT[9]	µg/L[10]	0.00059	--	0.0027	--	--	Grab	Semi-Annually
Bis(2-ethylhexyl) phthalate	µg/L	1.8	--	3.0	--	--	Grab	Semi-Annually
Total Coliform	MPN/100 ml[11]	23 (median)	--	230	--	--	Grab	Weekly

1. Reproduced from NPDES No. CA0024490
2. The arithmetic mean of all daily results during a calendar month
3. The arithmetic mean of all daily results made during a calendar week
4. BOD: Biochemical Oxygen Demand
5. mg/L: milligrams per liter
6. ppd: pounds per day
7. Based on a design flow rate of 1.61 Million Gallons per Day (MGD).
8. ml/L: milliliters per Liter
9. 4,4′-DDT: Dichlorodiphenyltrichloroethane
10. µg/L: micrograms per Liter
11. MPN/100 ml: Most Probable Number per 100 milliliters

In addition to the effluent limitations listed in Table 5-2, the permit requires that the average monthly percent removal of BOD and TSS shall not be less than 65% as measured at Monitoring Location M-001. The percent removal shall be determined from the monthly average influent concentrations and monthly average effluent concentrations for each constituent over the same period.

The permit also sets forth acute toxicity effluent limitations when discharging to the Mad River. The limitations state that no acute toxicity shall be present in the effluent. Discharges are considered in compliance with this requirement when the survival of aquatic organisms in a 96-hour bioassay meets a minimum 70% survival for any one bioassay and a median of at least 90% survival for all bioassays conducted in a calendar month.

Effluent limitations for discharges to the percolation ponds are shown in Table 5-3 and the effluent limitations for the land reclamation sites are shown in Table 5-4.

5.1.1.3 Receiving Water Limitations

Receiving waters are monitored in the Mad River at the Highway 101 bridge upstream of the influence of the discharge (R-001) and on the north bank of the Mad River as close as possible to the discharge point under the Hammond Trail Bridge (R-002). Receiving water samples collected at these locations are compared to receiving water limitations based on the water quality objectives contained in the basin plan for the Mad River. The receiving water limitations address water quality objectives for dissolved oxygen, specific conductance, pH, turbidity, floatables, taste- and odor-producing substances, coloration, bottom deposits (total dissolved solids), biostimulants, toxic substances, temperature, pesticides, oils/grease, and other chemical constituents as specified in the basin plan.

Table 5-3
Wastewater Effluent Limitations for Discharge Point 002 (Percolation Ponds)[1]
MCSD Wastewater Management Facility

Parameter	Units	Monthly Average[2]	Weekly Average[3]	Daily Max.	Instantaneous		Sampling	
					Min.	Max.	Type	Frequency
BOD[4]	mg/L[5]	45	65	--	--	--	24-hr Composite	Weekly
TSS[6]	mg/L	83	--	--	--	--	24-hr Composite	Weekly
Nitrate as Nitrogen	mg/L	10	--	--	--	--	Grab	Monthly
Total Coliform	MPN/100 ml[7]	23 (median)	--	230	--	--	Grab	Weekly

1. Reproduced from NPDES No. CA0024490
2. The arithmetic mean of all daily results during a calendar month
3. The arithmetic mean of all daily results made during a calendar week
4. BOD: Biochemical Oxygen Demand
5. mg/L: milligrams per liter
6. TSS: Total Suspended Solids
7. MPN/100 ml: Most Probable Number per 100 milliliters

Table 5-4
Wastewater Effluent Limitations for Discharge Points 003, 004, 005, and 006 (Land Reclamation)[1]
MCSD Wastewater Management Facility

Parameter	Units	Monthly Average[2]	Weekly Average[3]	Daily Max.	Instantaneous		Sampling	
					Min.	Max.	Type	Frequency
BOD[4]	mg/L[5]	45	65	--	--	--	24-hr Composite	Weekly
TSS[6]	mg/L	83	--	--	--	--	24-hr Composite	Weekly
Total Coliform	MPN/100 ml[7]	23 (median)	--	230	--	--	Grab	Weekly

1. Reproduced from NPDES No. CA0024490
2. The arithmetic mean of all daily results during a calendar month
3. The arithmetic mean of all daily results made during a calendar week
4. BOD: Biochemical Oxygen Demand
5. mg/L: milligrams per liter
6. TSS: Total Suspended Solids
7. MPN/100 ml: Most Probable Number per 100 milliliters

5.1.1.4 New Provisions

Order No. WQ 2011-0008-DWQ rescinded the previous NPDES permit (Order No. R1-2008-0039) and contains the following significant changes:

1. Effluent limitations for copper, lead, alpha-BHC and dioxin congeners were removed from the permit.
2. Effluent limitations for 4,4′ DDT have been revised.
3. Mass-based limits for the BOD and TSS have been revised.
4. Receiving water classifications have been removed from the permit for discharges to the Hiller Stormwater Wetlands and the Lower Fisher Ranch Stormwater Ditch.

5.1.2 Pre-treatment Regulations

5.1.2.1 Source Control Program

The District is required to perform source control functions, including the following:

- Implement the necessary legal authorities to monitor and enforce source control standards, restrict discharges of toxic materials to the collection system and inspect facilities connected to the system.
- If waste haulers are allowed to discharge to the Facility, establish a waste hauler permit system, to be reviewed by the Executive Officer, to regulate waste haulers discharging to the collection system of Facility.

- Conduct a waste survey once every five years, or more frequently if required by the Regional Water Board Executive Officer, to identify all industrial dischargers that might discharge pollutants that could pass through or interfere with the operation or performance of the Facility.
- Perform ongoing industrial inspections and monitoring, as necessary, to ensure adequate source control.

5.1.2.2 Summary of Recent Source Control Studies

During a pretreatment compliance audit conducted by Tetra Tech in 2009 it was determined the District local limits were not adequate (Tetra Tech, 2009). As part of the process to update the local limits, it was also determined that the District Sewer Use Ordinance would need to be updated to give the District better authority to enforce new local limits and to establish individual discharge permits for commercial customers that have the potential to discharge wastes other than domestic sewerage. A copy of the RWQCB Correspondence and the pretreatment compliance inspection summary report prepared by Tetra Tech in April 2009 is included in Appendix F.

The District enlisted the services of Freshwater Environmental Services (FES) to complete a Sanitary Sewer Monitoring Program Report in June 2009 (FES, 2009). FES was also contracted to draft a sewer use ordinance and to complete a local limits work plan for RWQCB for concurrence. A draft local limits development work plan was prepared by FES in January 2011 (FES, 2011a). Copies of the additional source control studies completed by FES are included in Appendix F.

5.1.3 Collection System Standards

5.1.3.1 Statewide General WDRs for Sanitary Sewer Systems

On May 2, 2006, the State Water Board adopted State Water Board Order 2006-0003-DWQ, Statewide General WDRs for Sanitary Sewer Systems. Order No. 2006-0003-DWQ requires that all public agencies that currently own or operate sanitary sewer systems apply for coverage under the General WDRs. The deadline for dischargers to apply for coverage under State Water Boards Order 2006-0003-DWQ was November 2, 2006. The District has applied for coverage under, and is subject to the requirements of Order 2006-0003-DWQ and any future revisions thereto for operation of its wastewater collection system.

In addition to the coverage obtained under Order 2006-0003, the Discharger's collection system is also part of the treatment system that is subject to this Order. As such, pursuant to federal regulations, the discharger must properly operate and maintain its collection system (40 CFR § 122.41(e)), report any non-compliance (40 CFR § 122.41(l)(6) and (7)), and mitigate any discharge from the collection system in violation of this Order (40 CFR § 122.41(d)).

5.1.3.2 Sanitary Sewer Overflows

The District is required to continue electronic and/or telefax reporting of Sanitary Sewer Overflows (SSOs) pursuant to Provision D.15 and General Monitoring and Reporting

Requirement G.2 of Order No. 2006-0003-DWQ and Monitoring and Reporting Program No. 2006-0003-DWQ. Oral reporting of SSOs as specified in the NPDES permit is required through the term of the Order.

FES recently completed a Sanitary Sewer Management Plan for MCSD in May 2011 (FES, 2011b) in compliance with the general requirements of Order No. 2006-003. A copy of the plan is included in Appendix G.

5.1.4 Reclaimed Water Use Regulations

The District is required to comply with applicable state and local requirements regarding the production and use of reclaimed wastewater, including requirements of Water Code sections 13500–13577 (Water Reclamation) and Department of Health Services regulations at CCR Title 22, Sections 60301–60357 (Water Recycling Criteria).

The District is also required to maintain compliance with the effluent limitations listed in Table 5-4 when applying effluent at Discharge Points 003, 004, 005, and 006. Compliance is measured at Monitoring Location M-001.

In addition to the effluent limitations listed the following reclamation specifications also apply in the permit:

- Disinfection: The disinfected effluent shall not contain concentrations of total coliform bacteria exceeding the following concentrations:
  - The median concentration shall not exceed 23 MPN/100 ml, for samples collected during any calendar month.
  - No sample shall exceed a coliform count of 230 MPN/100 ml.
- The use of recycled water shall not create a condition of pollution or nuisance as defined in Water Code section 13050(m).
- Recycled water and airborne spray shall not be allowed to escape from the authorized recycled water use area(s). [CCR Title 22, Section 60310(e)]
- Direct or windblown spray, mist, or runoff from irrigation areas shall not enter dwellings, designated outdoor eating areas, or food handling facilities. [CCR title 22, section 60310(e)(2)]
- Disinfected secondary treated recycled water shall not be irrigated within 100 feet of any domestic water supply well or domestic water supply surface intake, unless the technical requirements specified in CCR Title 22, Section 60310(a) have been met and approved by the Department of Health Services (DHS).
- Disinfected secondary treated recycled water shall not be irrigated with 100 feet of the change in grade between the upper and lower Fisher Ranch irrigation areas. Best management practices shall also be developed and implemented to prevent the creation of runoff that leads to the discharge of recycled water to the County drainage swale located on the Lower Fisher Ranch.

- All areas where recycled water is used that are accessible to the public shall be posted with signs that are visible to the public, in a size no less than 4 inches high by 8 inches wide, that include the following wording: "RECYCLED WATER–DO NOT DRINK"(CCR Title 22, Section 60310(g)). Each sign shall display an international symbol similar to that shown in Title 22, Figure 60310-A. These warning signs shall be posted at least every 500 feet with a minimum of a sign at each corner and access road.

5.1.5 Biosolids Regulations

5.1.5.1 List of Regulations

MCSD's disposal of biosolids is currently regulated under NPDES Permit No. CA0024490 Order No. WQ 2011-0008-DWQ. Order No. 2011-0008-DWQ states that biosolids shall be disposed of in accordance with applicable federal and state regulations.

As set forth in the permit, the disposal of biosolids is regulated through the following requirements:

- 40 CFR Parts 257, 258, 501, and 503; EPA's Biosolids Rule
- SWRCB Order No. 2004-0012-DWQ (General Waste Discharge Requirements for the Discharge of Biosolids to Land as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities (General Order)
- CCR Title 27, Division 2

Sludge or biosolids that are disposed of in a municipal solid waste landfill or used as landfill cover are required to meet the applicable requirements of 40 CFR 258.

The 40 CFR Part 503 regulations for land application fall into two broad categories: Processes to Reduce Pathogens and Vector Attraction Reduction. The application of Processes to Significantly Reduce Pathogens (PSRP) and Processes to Further Reduce Pathogens (PFRP) involves the deactivation of pathogens and results in two categories of biosolids.

- Class A biosolids are high quality sludges, low in pathogens (less than 1,000 Fecal Coliform (FC)/100 ml), suitable to be sold or given away for a variety of purposes including home gardens and lawns, silviculture, and land not meeting site restrictions for Class B biosolids.
- Class B biosolids are suitable for pasture and woodland applications, non-contact use only (less than 2,000,000 FC/100 ml).

The SWRCB General Order sets forth WDRs for use of Class B biosolids as soil amendment for agricultural, silvicultural, horticultural, and land reclamation applications. The General Order is intended to streamline the regulatory process for application of biosolids; however, it does not supersede 40 CFR Part 503 Regulations. Class A biosolids complying with the 40 CFR Part 503 are not regulated by the General Order except under special circumstances.

5.1.5.2 Summary of 40 CFR Part 503 Regulations

All land-applied biosolids must comply with one of the pathogen reduction standards listed in 40 CFR Part 503.32. Table 5-5 summarizes the pathogen reduction standards.

Table 5-5
Summary of Pathogen Reduction Requirements[1]
MCSD Wastewater Management Facility

Class A Biosolids[2]	Class B Biosolids[3]
Alternative 1: Thermally Treated Biosolids. Use one of four time-temperature regiments.	Alternative 1: Monitoring of Indicator Organisms. Test for fecal coliform density as an indicator for all pathogens at the time of biosolids use or disposal.
Alternative 2: Biosolids Treated in a High pH-High Temperature Process. Specifies pH, temperature, and air-drying requirements.	Alternative 2: Use of Processes to Significantly Reduce Pathogens (PSRP). Biosolids are treated in one of the PSRP identified in CFR[4] 40 Part 503.
Alternative 3: For Biosolids Treated in Other Processes. Demonstrate that the process can reduce enteric viruses and viable helminth egg ova. Maintain operating conditions used in the demonstration.	Alternative 3: Use of Processes Equivalent to PSRP. Biosolids are treated in a process equivalent to one of the PSRPs, as determined by the permitting authority.
Alternative 4: Biosolids Treated in Unknown Processes. Demonstration of the process is unnecessary. Instead, test for pathogens Salmonella sp. or fecal coliform bacteria, enteric viruses, and viable helminth ova--at the time the biosolids are used or disposed of, or are prepared for sale or giveaway.	--
Alternative 5: Use of Further Reduce Pathogens (PFRP). Biosolids are treated in one of the PFRP identified in 40 CFR Part 503.	--
Alternative 6: Use of a Process Equivalent to PFRP. Biosolids are treated in a process equivalent to one of the PFRPs, as determined by the permitting authority.	--

1. Source: EPA, September 1995
2. Class A Biosolids are biosolids that contain no detectable level of pathogens.
3. Class B Biosolids are biosolids that are treated but still contain a detectable level of pathogens.
4. CFR: Code of Federal Regulations

All land-applied biosolids must also comply with one of the applicable vector attraction reduction requirements specified in 40 CFR 503.33. Table 5-6 summarizes the vector attraction reduction options identified in 40 CFR Part 503.

Table 5-6 Vector Attraction Reduction Options[1] MCSD Wastewater Management Facility	
Option Number	**Description of Option**
1	Reduce the mass of volatile solids by a minimum of 38%.
2	Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit.
3	Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit.
4	Meet a specific oxygen demand uptake rate for aerobically treated biosolids.
5	Use aerobic processes at an average temperature of 40°C for 14 days or longer.
6	Add alkaline materials to raise the pH under specified conditions.
7	Reduce moisture content of biosolids that do not contain unstabilized solids from other than primary treatment to at least 75% solids.
8	Reduce moisture content of biosolids with unstabilized solids to at least 90%.
9	Inject biosolids beneath the soil surface within a specified time, depending on the level of pathogen treatment.
10	Incorporate biosolids applied to or placed on the land surface within specified periods after application to or placement on the land surface.
1. Source: EPA 40 CFR Part 503: Biosolids Rule, Land Application	

In addition to the pathogen reduction and vector attraction reduction requirements, the following standards also apply for land application of biosolids:

- Biosolids application rates must not exceed the nitrogen agronomic rates of the crop being planted.
- A biosolid with a moisture content of less than 75% shall not be applied during periods when wind speeds exceed 25 miles per hour.
- Biosolids are not to be applied in amounts exceeding the Risk Assessment Acceptable Soil Concentration as described by the following equation:

$$BC = RP - 1.8\,(BS)$$

where:

BC = Background Cumulative Adjusted Loading Rate (pounds per acre [lbs/acre])
RP = 40 CFR Part 503 Cumulative Pollutant Loading Rate (lbs/acre)
BS = Actual Site Background Site Soil Concentration (milligrams per kilogram [mg/kg])

Table 5-7 summarizes 40 CFR Part 503 pollutant limits.

Table 5-7
Pollutant Limits for Land Applied Biosolids[1]
MCSD Wastewater Management Facility

Constituent	Maximum Value in all Biosolids (mg/kg)[2]	Maximum Value in EQ[3] and PC[4] Biosolids (mg/kg)	Annual Loading Rate (kg/ha)[3]	Lifetime Loading Rate (kg/ha)
Arsenic	75	41	2.0	41
Cadmium	85	39	1.9	39
Chromium	3,000	1,200	150	3,000
Copper	4,300	1,500	75	1,500
Lead	840	300	15	300
Mercury	57	17	0.85	17
Molybdenum	75	18	0.90	18
Nickel	40	420	21	420
Selenium	100	36	5.0	100
Zinc	7,500	2,800	140	2,800

1. Source: EPA, September 1995
2. mg/kg: milligram per kilogram
3. EQ: Excellent Quality biosolids, as defined in 40 CFR Part 503
4. PC: Pollutant Concentration biosolids, as defined in 40 CFR Part 503
5. kg/ha: kilogram per hectare

In addition to the pollutant limits, land-applied biosolids must also meet the following requirements:

- Biosolids to be tilled into the soil must be incorporated into the soil within 48 hours in non-arid areas during the period from May 1 through September 30.
- Grazing of domesticated animals in areas where biosolids have been applied is restricted until the necessary waiting period has elapsed.
- Application of biosolids to slopes of greater than 10% requires an erosion control plan.
- Tail water (water located immediately downstream) from conveying structures shall be designed and maintained to minimize field erosion.
- Staging and biosolids application areas must be at least:
  - 10 feet from property lines;
  - 500 feet from domestic water supply wells;
  - 100 feet from non-domestic water supply wells;
  - 50 feet from public roads and occupied on-site residences;
  - 100 feet from surface waters, including wetlands, creeks, ponds, lakes, underground aqueducts, and marshes;
  - 33 feet from primary agricultural drainages;
  - 500 feet from occupied non-agricultural buildings and off-site residences;
  - 400 feet from a domestic water supply reservoir;

- o 200 feet from primary tributary to a domestic water supply;
- o 2,500 feet from any domestic surface water supply intake; and
- o 500 feet from enclosed water bodies that could be occupied by pupfish.

5.2 Basis of Design

The evaluation of alternatives presented in Section 7 includes the design criteria evaluation for each WWMF treatment system component. Projected wastewater flows used for the capacity analysis and preliminary design were described in Section 3.

5.3 Basis for Cost Estimates

The estimated construction costs included in the evaluation of alternatives as presented in Section 7 are based on actual construction bidding results from similar work, published cost guides, and other construction cost experience. Reference was made to the available drawings of the existing facilities to determine construction quantities. Where required, estimates were based on preliminary layouts of the proposed improvements.

5.3.1 Contingencies

A contingency factor equal to 20% of the estimated construction cost has been added. Recognizing that the cost estimates are based on concept design, allowances must be made for variations in final quantities, bidding market conditions, adverse construction conditions, unanticipated specialized investigations, and other difficulties that cannot be foreseen at this time, but that may tend to increase final costs.

5.3.2 Engineering

The cost of engineering services for major projects typically include special investigations, a pre-design report, surveying, foundation exploration, preparation of contract drawings and specifications, bidding services, construction management, inspection, construction staking, start-up services, and the preparation of operation and maintenance manuals. Depending on the size and type of the project, engineering costs may range from 15 to 25% of the contract cost when all of the above services are provided. The lower percentage applies to large projects without complicated mechanical systems. The higher percentage applies to small, complicated projects. The engineering costs for design and construction of the proposed project will average about 20% of the construction cost. An additional 5% was added to the average engineering costs to account for anticipated project planning and permitting needs, resulting in the 25% engineering cost used for the cost estimates presented in this study.

5.3.3 Legal and Administrative

An allowance of 4% of construction cost has been added for legal and administrative services. This allowance is intended to include internal project planning and budgeting, project administration, liaison, interest on interim financing, legal services, review fees, legal advertising, and other related expenses associated with the project.

5.4 Basis for Alternatives Considered

In February 2010, the District and SHN initiated efforts to develop a feasibility study that identified the most feasible options for future upgrades to the MCSD wastewater treatment, reclamation, and disposal facilities. The goal of the feasibility study process was to identify the final alternatives to be considered in the 20-year facilities plan.

A series of public workshops, presentations, and technical review sessions were held in 2010 as part of the feasibility study process. A public scoping workshop was held in April 2010 to engage interested community members. The workshop presented an opportunity for rate payers and stakeholders to provide input on alternatives to be considered. The outcome of the workshop included a list of ideas and treatment system goals from the public to be considered. A technical review session was then held in June 2010. During this workshop, SHN and District staff selected the final evaluation criteria, weighting factors, and scoring system for the process evaluation. The group then developed a process option evaluation matrix, which involved applying criteria and ranking ideas for all process options identified. The outcome of the technical review session included a final ranking of alternatives to be considered in the 20-year facilities plan.

An update on the feasibility study was presented to the MCSD Board in July 2010 and included a request for the Board to approve the top four alternatives from the feasibility study for further review in the 20-year facilities plan. Board approval was granted with slight modifications to the alternatives to be considered. The top four treatment alternatives approved for review included an expanded lagoon/wetland system, suspended aeration system, oxidation ditch, and membrane treatment system. The Board also approved further review of the ocean outfall disposal alternative as part of the 20-year facilities planning process. Following Board approval in July 2010, the facilities plan was completed using the top four treatment alternatives as identified during the feasibility study process. Additional scoping efforts were also initiated regarding the ocean outfall disposal alternative; further discussion regarding this process is included in Section 8.4.

Based on the peer review comments provided by Kennedy-Jenks in August 2011, the District requested that one additional treatment alternative be added to the facilities plan. Based on this request, a conventional activated sludge system was added to the treatment alternatives reviewed in the facilities plan.

6.0 Collection System Analysis

6.1 Model Description

6.1.1 Model Development

The MCSD collection system model was initially developed using the program StormNet, a proprietary software package distributed by Boss International. Over the course of the model development, the program was transferred from Boss to Autodesk and renamed the Storm and Sanitary Analysis program. The 2011 version of the Autodesk Storm and Sanitary Analysis software was used for the analysis presented in this report.

The purpose of the collection system model was to create a tool that can be used to evaluate the MCSD collection system under existing and projected flow conditions. The model is still under development as of the publish date for this facilities plan and will continue to be calibrated with new data as it becomes available during the next wet weather season. The model is currently being used as preliminary analysis tool to determine if there are areas in the collection system that may be limited in capacity under existing and/or varying growth conditions. The majority of the residential and commercial establishments in McKinleyville are located east of Highway 101 and the treatment facility is located west of Highway 101. Figure 1-5, presented in Section 1, shows the extent of the collection system for the MCSD service area.

6.1.2 Collection System Data

MCSD maintains a GIS database of its collection system. The GIS database provided the base layer of information for the collection system model. The pipes in the database were converted to links in the model and the manholes and cleanouts were converted to junctions. Each link had invert elevations assigned and a sanitary time pattern was applied at each junction. Main line pipes 6-inches and larger were included in the model. The distribution of pipe size as modeled for the MCSD collection system is shown in Table 6-1.

Table 6-1
Pipe Size Distribution[1]
MCSD Wastewater Management Facility

Pipe Diameter	Total Number of Pipe Segments	Total Length (feet)
6 inch	957	255,707
8 inch	92	28,327
10 inch	44	15,634
12 inch	36	10,371
15 inch	40	11,296
16 inch	1	106
18 inch	11	2,802
21 inch	4	1,702
24 inch	23	8,700

1. 4-inch and 2-inch pipes were not evaluated in the collection system model.

6.1.3 Pump Station Data

The pump data for each lift station was based on information provided by the District and pump drawdown tests conducted in 2009 and 2011. Table 6-2 summarizes the pumping capacity used in the model for each lift station.

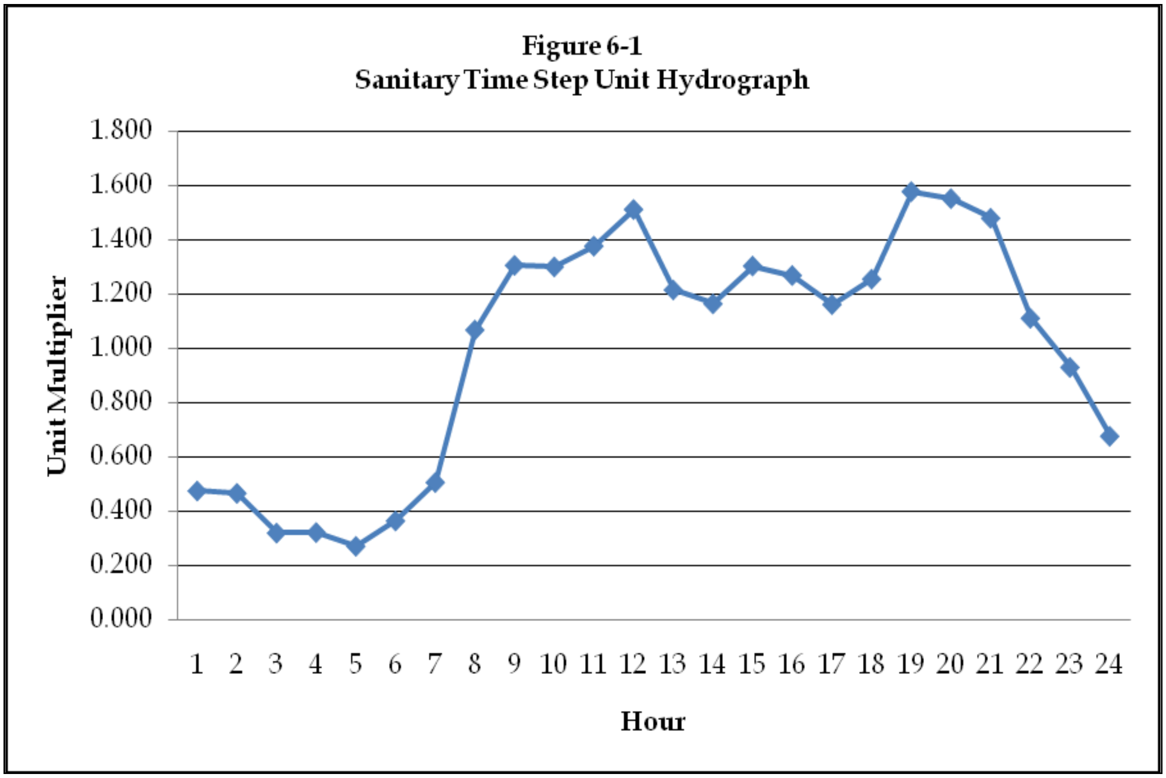
Table 6-2
Lift Station Pump Capacity Summary
MCSD Wastewater Management Facility

Name	Pump #	Description	Design Capacity[1] (GPM)[2]	Test Flow[3] (GPM)	Firm Capacity[4] (GPM)
B Street (PS #1)[5]	1	Pump 1 only	225	192	182
	2	Pump 2 only	225	182	
	1, 2	Pump 1 and 2	---	242	
Letz (PS #2)	1	Pump 1 only	500	316	673
	2	Pump 2 only	500	219	
	1, 2	Pump 1 and 2	---	673	
	3	Pump 3 only	1,100	782	
Kelly (PS #3)	1	Pump 1 only	225	125	125
	2	Pump 2 only	225	131	
	1, 2	Pump 1 and 2	---	---	
Hiller (PS #4)	1	Pump 1 only	550	836	836
	2	Pump 2 only	550	836	
	2	Pump 1 and 2	---	1,338	
Fisher (PS #5)	1	Pump 1 only	900	575	1,614
	2	Pump 2 only	900	613	
	1, 2	Pump 1 and 2	---	924	
	3	Pump 3 only	1,500	1,614	
	4	Pump 4 only	1,500	1,643	

1. Operating point indicated on pump curves
2. GPM: gallons per minute
3. As determined during drawdown tests conducted in 2009 and 2011
4. Firm capacity assumes largest pump is offline
5. PS: pump station

6.1.4 Sanitary Time Pattern Development

A sanitary time pattern was developed for the collection system based on dry weather flow monitoring conducted in July 2011. Flows were recorded daily in 15 minute intervals and then averaged over an hour. The location for the flow monitoring was chosen to avoid influence from tributary pump stations. The sanitary time step unit hydrograph developed from the flow metering data is shown in Figure 6-1.



6.1.5 RDII Input Parameters

The storm and sanitary sewer analysis model allows users to integrate Rainfall Derived Infiltration and Inflow (RDII) into the sanitary sewer analysis. The model uses a RDII unit hydrograph (UH) to estimate the amount of rainfall that enters the collection system. The RDII unit hydrograph is defined by three parameters:

- R, the percentage of rainfall that enters the sanitary sewer analysis system as RDII
- T, the time from the onset of rainfall to the peak of the UH in hours
- K, the ration of time to recession of the UH to the time to peak

For the MCSD collection system analysis, RDII input parameters were estimated based on recorded flows during representative 2 and 5-year 24-hour rainfall events. For purposes of the RDII analysis the default hydrologic parameters associated with the time series data for Humboldt County (Arcata) was used. The 2-year intensity storm shown for Arcata had a total rainfall amount of 3.5 inches and the 5-year intensity storm had a total rainfall amount of 4.5 inches.

Table 3-3 (in Section 3) provides a summary of the anticipated total influent flow associated with varying rainfall depths. Table 6-3 shows a summary of the wet weather flow allocation for existing conditions based on the RDII analysis.

Table 6-3
Summary of Collection System Model Wet Weather Flow Allocation
MCSD Wastewater Management Facility

Return Interval	Rainfall (inches)	Rainfall Derived Infiltration and Inflow[1] (MGD)[2]	Total Flow (MGD)
None	0	0.00	0.95
2-Year	3.5	0.84	1.79
5-Year	4.5	1.10	2.05[1]
100-Year	6.9	1.72	2.67

1. Corresponds to the peak day average flow shown in Table 3-4
2. MGD: million gallons per day

6.2 Model Simulations

6.2.1 Existing Flows

Existing dry-weather flows were allocated in the collection system model based on the distribution of single family, multi-family and commercial developments in McKinleyville. Each development type was assigned an EDU allocation as shown in Table 6-4. As of December 2010, the District had approximately 4,048 single-family sewer connections. EDU allocations for the remaining multi-family and commercial developments were based on review of water use records for 2009 and 2010. An additional 93 single-family connections were included in the model analysis to account for high water use multi-family units (for example, mobile home parks). For a base flow equal to 180 gpd/EDU, the total dry-weather flow allocation included in the model is approximately 0.95 MGD.

Table 6-4
Summary of Dry Weather Flow Allocation
MCSD Wastewater Management Facility

Development Type	EDU[1] Allocation	EDUs	Total Flow[2] (gpd)[3]
Single Family Residential	Direct (1:1)[2]	4,141	745,380
Multi-Family Residential	0.56 x Number of Units[4]	746	134,280
Commercial	Based on 90% of water usage[5]	380	68,400
Total	---	5,267	948,060

1. EDU: Equivalent Dwelling Unit
2. Commercial EDUs will vary based on water use data.
3. gpd: gallons per day
4. Based on 180 gpd/EDU.
5. Based on 4,048 single-family sewer connections at year end 2010. Includes additional allocation of approximately 93 EDUs for high water use multi-family units.

6.2.2 Future Development Scenarios

The District has been taking steps to identify and project the affects of growth in central McKinleyville; however, it is largely dependent on the full extent of the County's development plan for McKinleyville. As part of the Humboldt County general plan update, the County has provided the District with a variety of new development projections. The County is also currently addressing multi-family rezoning efforts in McKinleyville, and how these efforts may change the general plan projected growth scenarios.

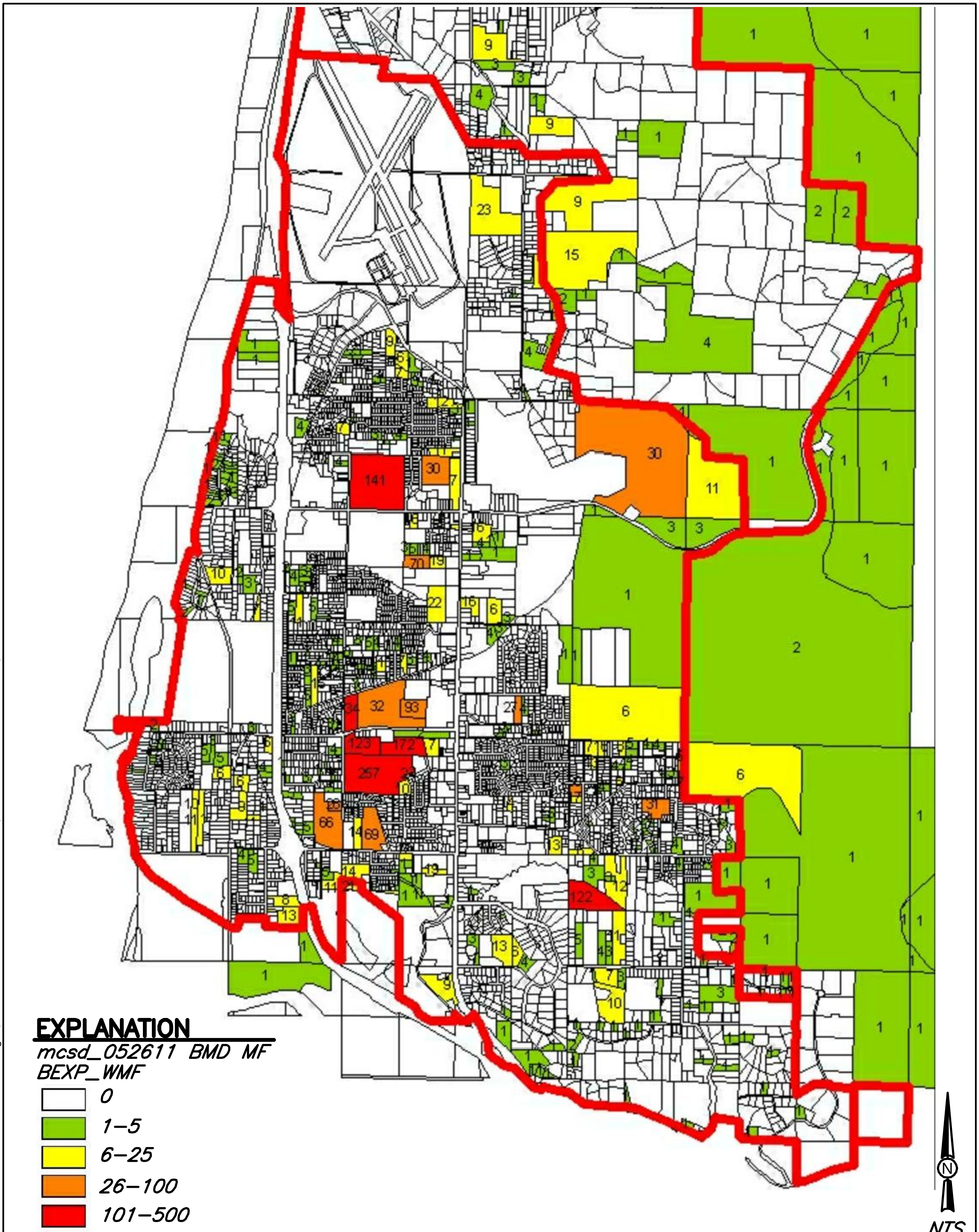
On May 26, 2011, the County provided the District with the latest combined development projection data set for the MCSD service area. The data set provided the estimated number of development units that would be developed in McKinleyville for varying general plan and multi – family rezone planning conditions. Table 6-5 summarizes the development unit projections provided by the County for the various growth scenarios.

Table 6-5
General Plan and Multi-Family Rezone Development Projections[1]
MCSD Wastewater Management Facility

Name	Description	Total Units Proposed[1]	Units Within Service Area[2]	Anticipated Flow Increase[3] (gpd)[4]
BMID-MF[4]	GP Update/MF Mid	2,760	2,562	461,160
BMAX-MF[5]	GP Update/MF Max	7,222	6,898	1,241,640
DMID-MF[6]	GP/MF Mid	2,057	1,850	333,000
DMAX-MF[7]	GP/MF Max	6,291	5,965	1,073,700

1. As provided by Humboldt County on May 26, 2011.
2. Based on service area as presented in the collection system model.
3. Anticipated flow increase based on estimated contribution of 180 gpd/unit.
4. gpd: gallons per day
5. Development potential at expected density for General Plan Update Alternative B with Multi-Family (MF) rezone parcels at expected density substituted.
6. Development potential at maximum density for General Plan Update Alternative B with MF rezone parcels at maximum density substituted.
7. Development potential at expected density for General Plan Alternative D with MF rezone parcels at expected density substituted.
8. Development potential at maximum density for General Plan Alternative D with MF rezone parcels at maximum density substituted.

As shown in Table 3-7, the projected number of EDUs for year 2030 is 7,525, which is approximately 2,260 more EDUs than the number of EDUs for 2010 (5,267). Because the growth projection for Alternative B with Multi-Family (BMID-MF) scenario includes the development of approximately 2,500 new EDUs in the District's service area, this scenario was used for evaluation of the collection system under projected flow conditions. The County-provided GIS data set included a direct allocation of development allocation by parcel. Figure 6-2 shows the representative distribution of development for the BMID-MF scenario. Table 6-6 shows the flow allocation for the BMID-MF scenario for each wet weather flow condition.



Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Projected Development Conditions- BMID-MF SHN 008189.300
October 2011	008189-300-6-2-PROJ-GROWTH	Figure 6-2

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Table 6-6
Summary of Flow Allocations for Existing and Projected Conditions
MCSD Wastewater Management Facility

Return Interval	RDII[1] (MGD)[2]	Average Dry Weather Flow (MGD)	RDII[2] Wet Weather Flow (MGD)	BMID-MF[3] Flow Increase (MGD)	BMID-MF Total Flow (MGD)
None	0.00	0.95	0.95	0.46	1.41
2-Year	0.84	0.95	1.79	0.46	2.25
5-Year	1.10	0.95	2.05	0.46	2.51
100-Year	1.72	0.95	2.67	0.46	3.13

1. RDII: Rainfall Derived Infiltration and Inflow
2. MGD: million gallons per day
3. BMID-MF: Alternative B with Multi-Family

6.3 Results

6.3.1 Pipe Capacity Assessment

The capacity of the collection system was evaluated by comparing the ratio between the predicted depth of flow and the diameter of each pipe segment investigated. Pipe segments that were at capacity and/or with flow ratios in excess of 0.75, indicating pipes are flowing at greater than 75% capacity, were identified as segments requiring further investigation.

Figure 6-3 shows the flow ratio distribution in the pipe network under existing conditions. Figures 6-4 and 6-5 show the flow ratio distribution in the pipe network for existing conditions including the 5-year and 100-year wet-weather RDII allocations, respectively.

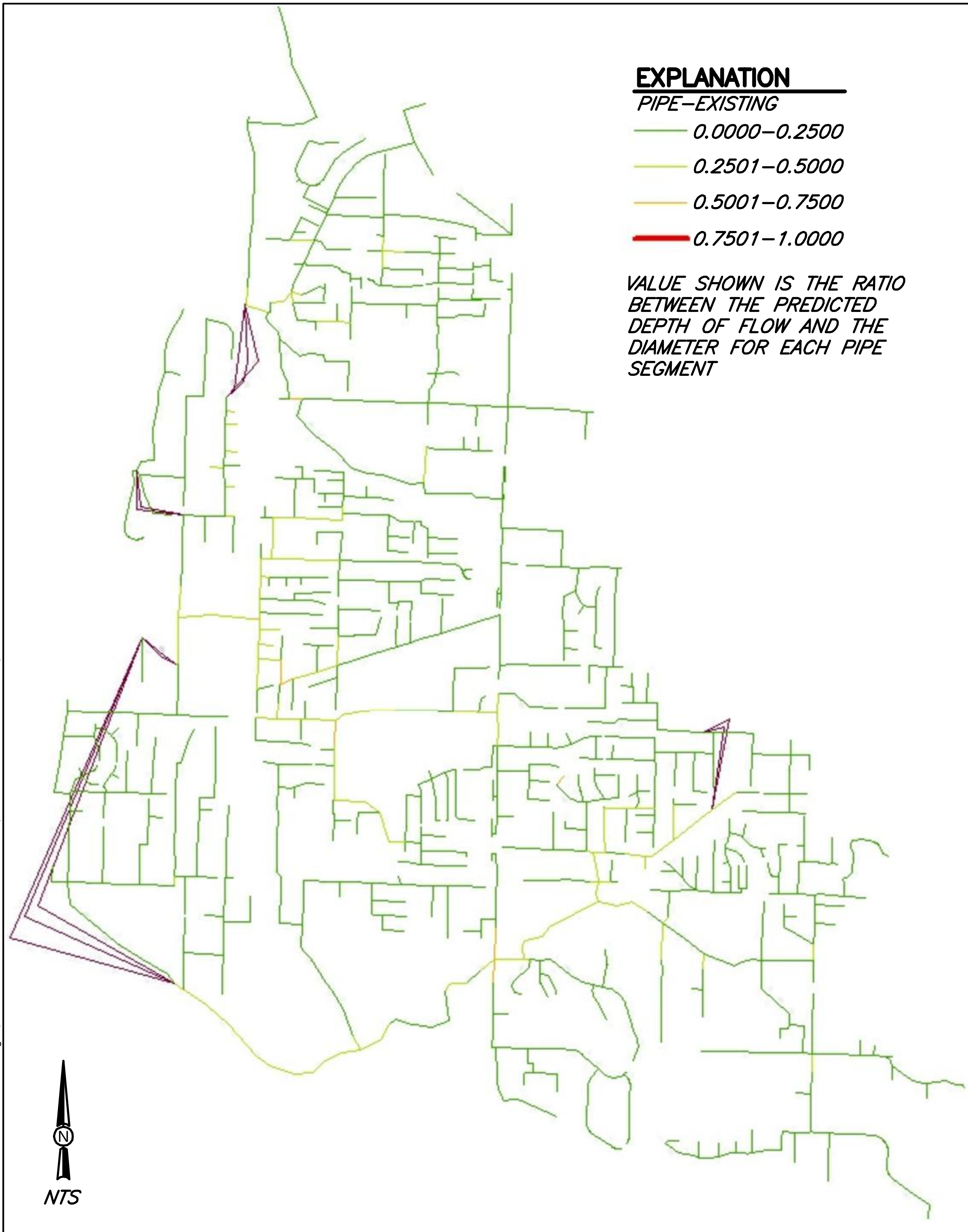
Figure 6-6 shows the flow ratio distribution in the pipe network for the BMID-MF projected flow condition. Figures 6-7 and 6-8 show the flow ratio distribution in the pipe network for the BMID-MF flow projection including the 5-year and 100-year wet-weather RDII allocations, respectively.

6.3.2 Pump Capacity Assessment

The pump capacity at each lift station was evaluated by comparing the peak inflow under existing and projected conditions, with the firm capacity identified for each lift station. Table 6-7 shows the results of the lift station assessment for existing and projected peak flows.

6.3.3 Identified Deficiencies

As shown on Figures 6-3 through 6-8, there are three gravity collection trunk lines that extend under Highway 101 conveying the majority of the wastewater flows from the east side to the west side of McKinleyville where the treatment and disposal facilities are located. For the existing dry-weather conditions (Figure 6-3), and up to the existing 5-year RDII condition (Figure 6-4), the collection system is able to collect and convey wastewater flows through the pipe network without surcharging. Under the existing 100-year RDII scenario (Figure 6-5), the system shows some surcharging in the main trunk lines (Lines 3 and 5). For the BMID-MF projected dry-weather flow



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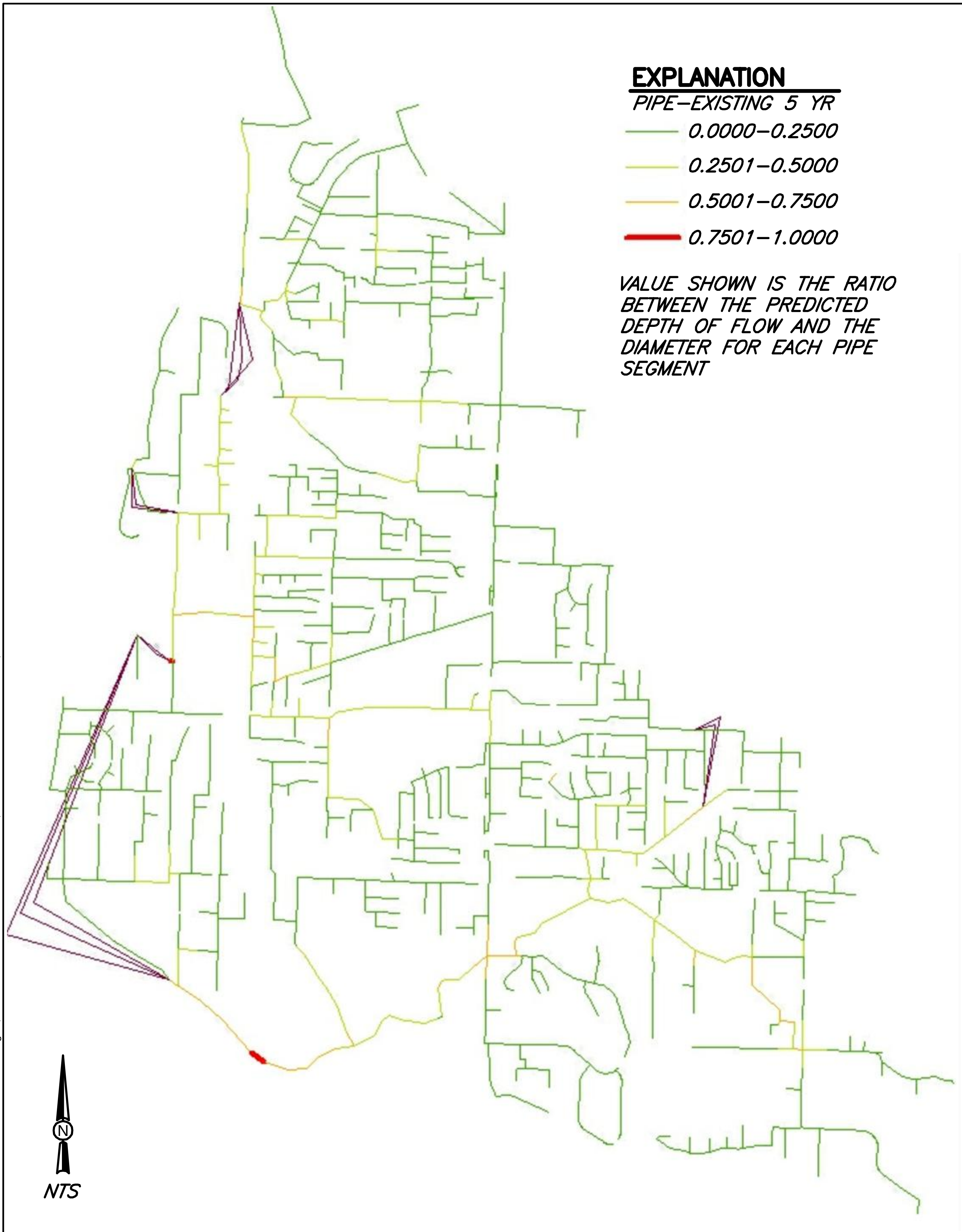
SHN Consulting Engineers & Geologists, Inc.

McKinleyville Community Services District
Wastewater Management Facility
McKinleyville, California

Pipe Capacity Assessment-
Existing Conditions
SHN 008189.300

October 2011 | 008189-300-PIPE-CAPC | Figure 6-3



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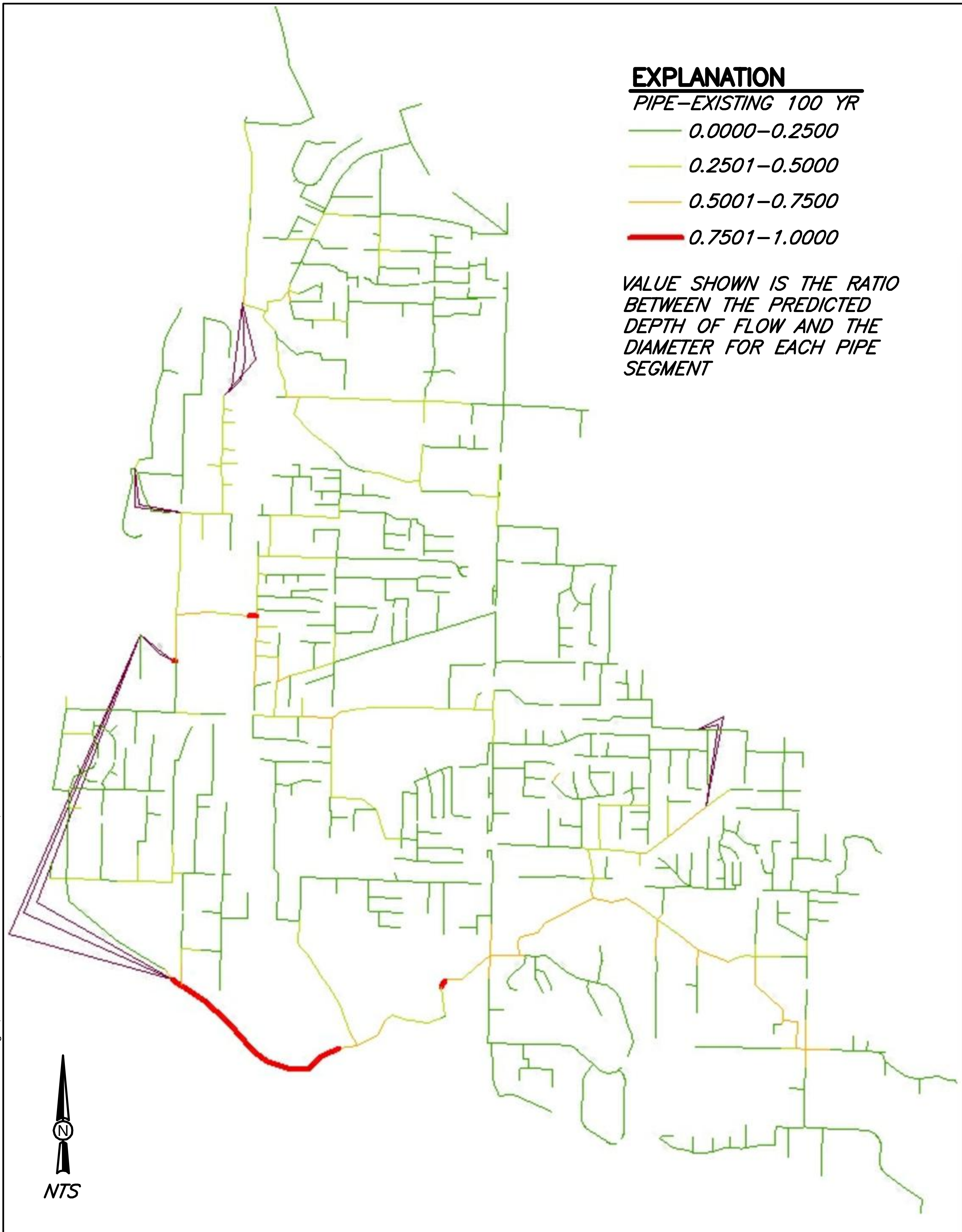
	October 2011	008189-300-PIPE-CAPC	Figure 6-4



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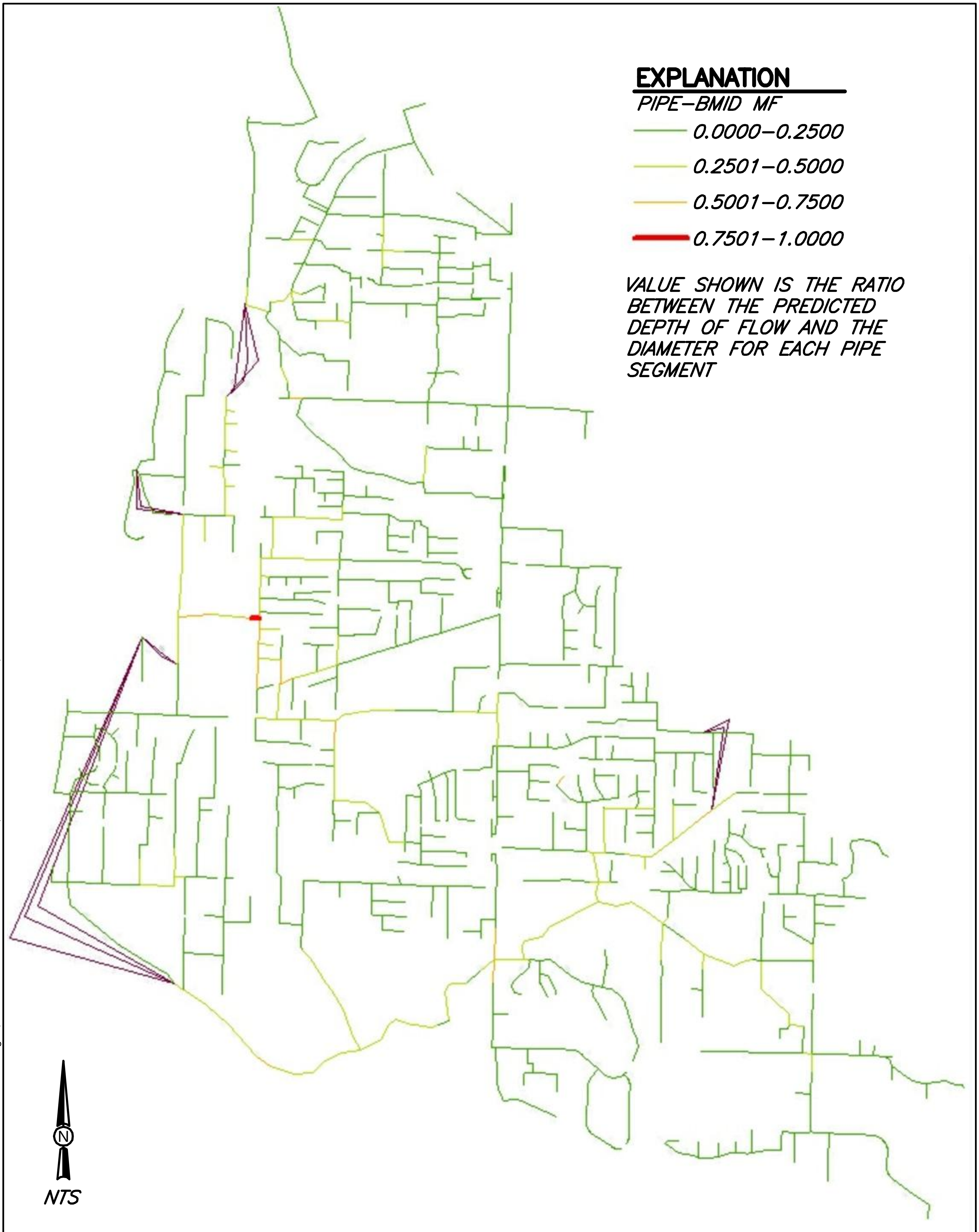
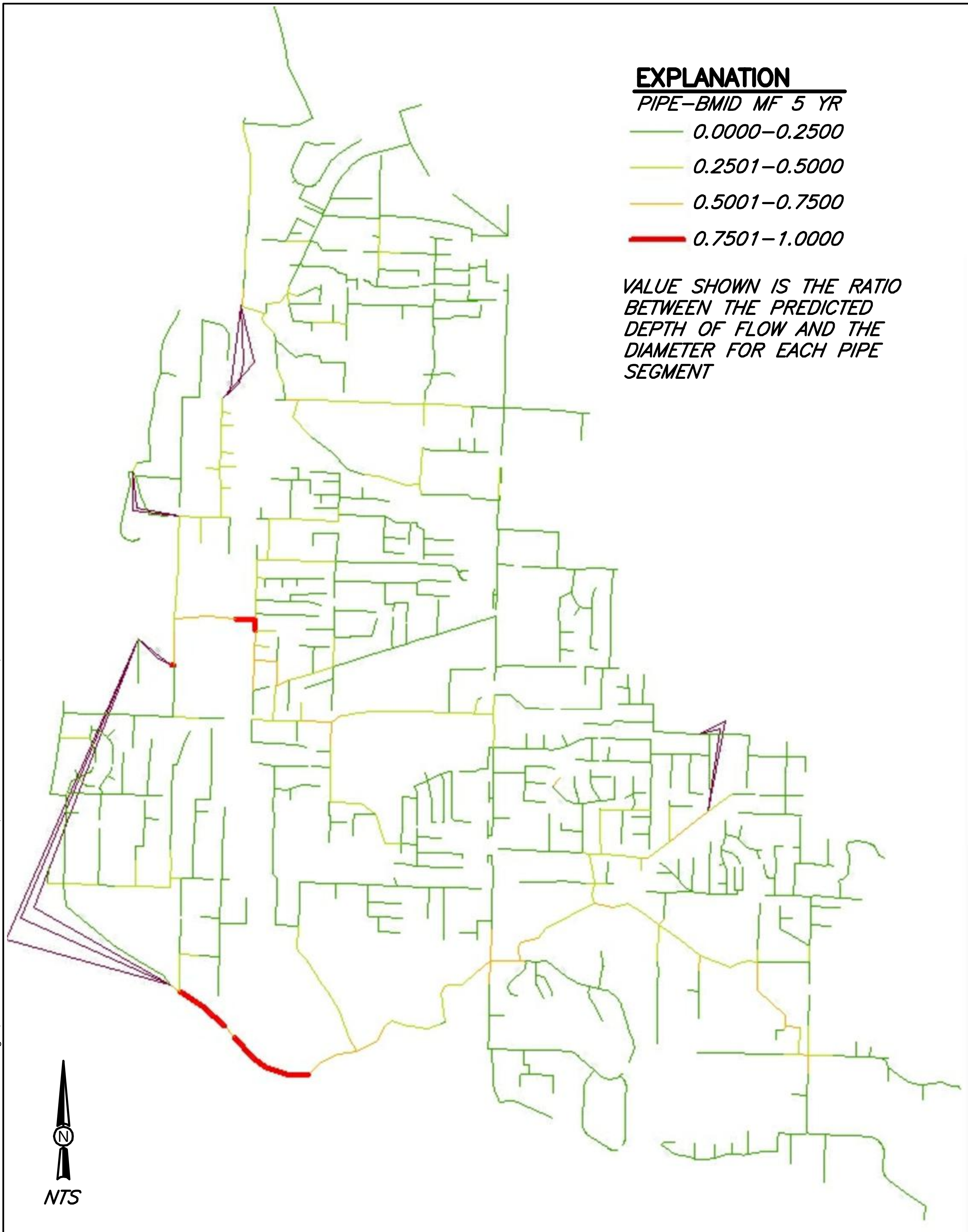
Wastewater Management Facility
McKinleyville, California

Pipe Capacity Assessment-
Existing Conditions, 100 Yr RDII
SHN 008189.300

October 2011 | 008189-300-PIPE-CAPC | Figure 6-5



SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Pipe Capacity Assessment- BMID-MF Projected Conditions SHN 008189.300
October 2011	008189-300-PIPC-CAPC-BMID	Figure 6-6



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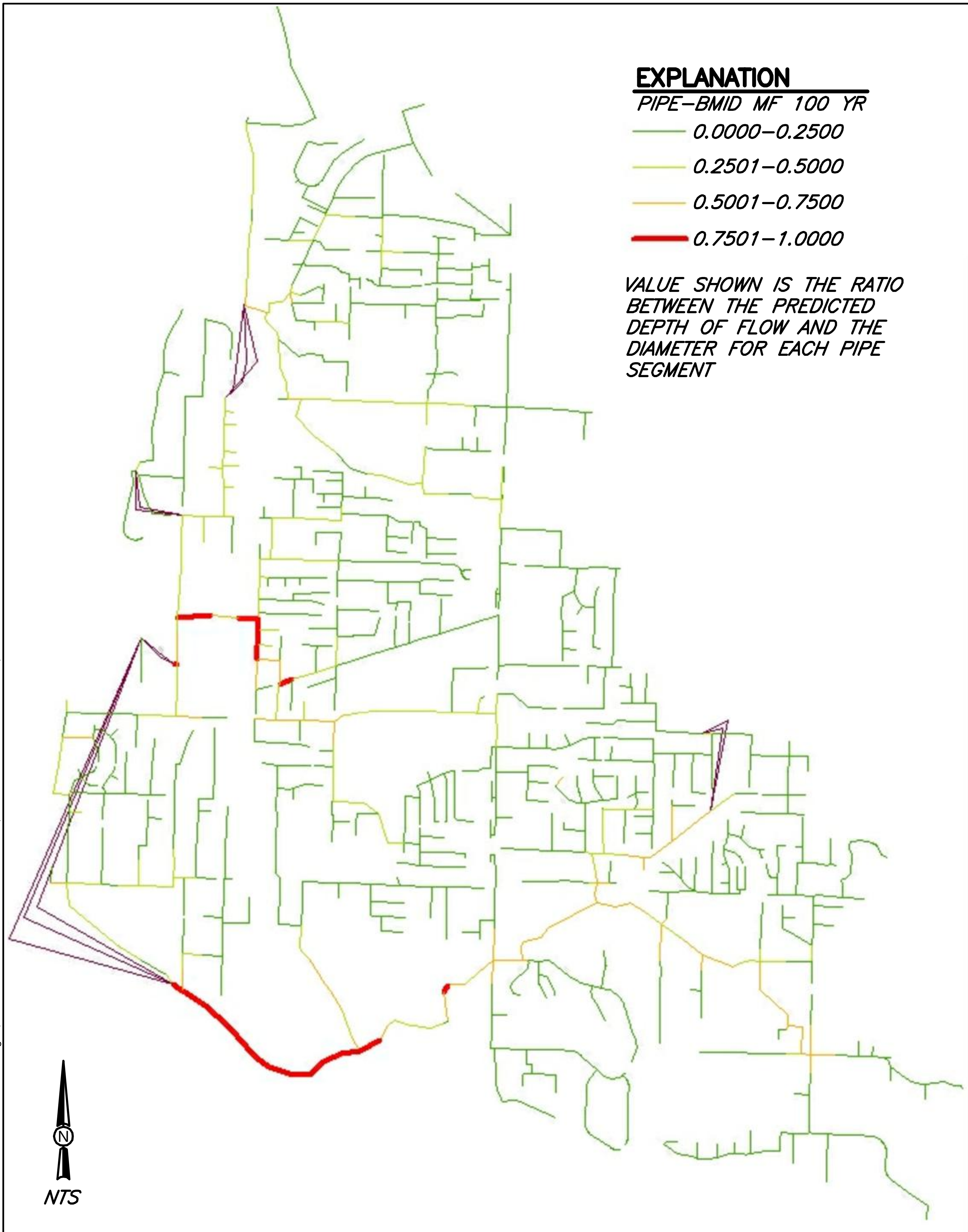
McKinleyville, California

Pipe Capacity Assessment-
BMID-MF Projected Conditions, 5 Yr RDII
SHN 008189.300

October 2011	008189-300-PIPC-CAPC-BMID	Figure 6-7



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McKinleyville, California

Pipe Capacity Assessment-
BMID-MF Projected Conditions, 100 Yr RDII
SHN 008189.300

October 2011 | 008189-300-PIPC-CAPC-BMID | Figure 6-8

\\Zing\projects\2008\008189-MCSD\300-FacilitiesPlan\Dwgs , SAVED: 10/5/2011 2:07 PM NDOWNEY, PLOTTED: 10/6/2011 12:33 PM, NATHAN DOWNEY conditions (Figure 6-6), the system shows some surcharging, and under the 5-year and 100-year RDII conditions (Figures 6-7 and 6-8, respectively) the system shows extensive surcharging in the main trunk lines.

Table 6-7
Lift Station Assessment at Peak Flows
MCSD Wastewater Management Facility

Lift Station	Firm Capacity (gpm)[1]	Existing Peak Instantaneous Flow[2] (gpm)	Projected Peak Instantaneous Flow[3] (gpm)	Exceed Firm Capacity (Y/N)
B Street (PS #1)	182	120	146	N
Letz Lane (PS #2)	673	814	974	Y
Kelly (PS #3)	125	86	93	N
Hiller (PS #4)	836	954	1,000	Y
Fisher (PS #5)	1,614	1,895	2,506	Y

1. gpm: gallons per minute
2. Based on total existing peak instantaneous flow of 2.67 MGD
3. Based on total projected peak instantaneous flow of 3.13 MGD

The results of the lift station pump assessment show that the Letz, Hiller, and Fisher lift stations are limited in their capacity to handle existing and projected peak flows based on firm capacity alone.

7.0 Treatment Alternatives

Current organic and suspended solids loadings on the MCSD facultative pond system with supplemental aeration are at the high range of the system's capacity to provide adequate secondary treatment. Secondary treatment alternatives are presented for providing improved performance, reliability, and the additional treatment capacity to meet future loadings. The secondary treatment alternatives included for review in this section were selected based on the WWMF feasibility study planning efforts undertaken in 2010 by the District and SHN.

Treatment alternatives must also address nitrogen removal. In addition to concerns about ammonia toxicity violations, compliance with surface water discharge limitations requires effluent nitrate-nitrogen concentrations to be less than 10 mg/L. Because land reclamation is based on agronomic application rates, effluent nitrogen concentrations are also limited by the land available for irrigation of effluent during the non-discharge period. This section includes an evaluation of treatment systems for the ability to reduce total nitrogen to less than 10 mg/L. This is a common land application standard—one that will increase the facility's disposal options.

Options for addressing system deficiencies not directly related to secondary performance are also evaluated in this section. The lack of any pre-treatment facilities for screening and grit removal is one such deficiency. An evaluation of pre-screening and grit removal alternatives precedes the discussion of secondary treatment alternatives. Discussion of auxiliary systems, such as biosolids management, is included in the discussion of secondary treatment options. We have also included a detailed evaluation of options for biosolids stabilization, storage, and disposal for the preferred secondary treatment option.

7.1 New Headworks

Wastewater contains large solids that can interfere with treatment processes or cause undue mechanical wear and increased maintenance on wastewater treatment equipment. To minimize potential problems, these materials are removed from the influent wastewater. Preliminary treatment at the MCSD facility includes pre-screening, and grit removal.

7.1.1 Pre-Screening

Screening is especially important in treatment systems without primary clarifiers. Fine screens have openings from $^{1}/_{16}$ to ¼ -inch in diameter and are used to remove material that may significantly impair downstream solid and liquid processes. It is important to remove inorganic solid material because it will contribute to the formation of a scum layer in downstream basins, clarifiers, tertiary wetlands, or contact basins. Unscreened wastewater also damages pumping equipment, and can contribute to plugging of diffusers in aeration basin(s). Plastics and other solids that make it through the treatment process cause problems for biosolids and effluent disposal. Types of fine screen equipment include:

- Inclined drum or cylindrical screen
- Belt screen–continuous self cleaning
- Band screen with center feed

7.1.1.1 Inclined Spiral Screen

Drum or cylindrical screens are placed in a channel at an incline in the direction of flow. Wastewater flows into the interior of the drum and through the screen. Solids are scraped off of the interior of the screen mechanically with either brushes or a small rake depending on the manufacturer. From the interior of the cylindrical screen an auger conveys solids up an incline of approximately 35 degrees. The solids material is compressed and dewatered as it moves up the conveyor and is then dropped into a dumpster.

Advantages:

- Less expensive than continuous self-cleaning screens
- Provides dewatering and compaction in the screw conveyor
- Designed for lower flows
- Low head loss

Disadvantages:

- Longer channel (inclined at angle of 35 degrees)

7.1.1.2 Belt Screens

Continuous self-cleaning screens consist of a continuous "belt" of plastic or stainless steel elements installed at a 70 degree angle in the channel and pulled through wastewater to provide screening. Screen openings range from ⅛ to ¼ inch in diameter. The continuous screening action of these screens allows efficient removal of large quantities of solids and because of the greater solids handling capacity, smaller openings may be used.

Advantages:

- Very efficient
- Shorter channel length (inclined at 70 degrees to horizontal)

Disadvantages:

- Lower range of flows than drum screen
- More expensive
- Greater head loss
- Screenings compactor required downstream of unit

7.1.1.3 Band Screens

Band screens are similar to belt screens but have a vertical configuration parallel to the channel walls. With a center feed type screen, wastewater flows out through both sides of the screen, doubling the screening area. The wastewater enters through the center of the screen, passes through the stainless steel sieve elements and exits through the sides of the unit. Screenings are captured by the elements and are carried up to the discharge point where they are removed by a pressurized spray header system. The material is discharged into a sluice trough and conveyed for collection and disposal, typically to a screenings washing and dewatering system.

7.1.1.4 Design Criteria

Because of the lack of primary treatment at the WWMF it is recommended that some degree of fine screening, with a maximum screen opening of 0.25 inches, be provided. All of the fine screening units discussed in the previous section normally are placed following the pump station because screens with openings less than 0.50 inches in diameter will collect too much fecal material when placed prior to a pump station in a gravity collection system.

Some wastewater treatment systems use both coarse screening (greater than ½-inch) in the form of bar screen placed prior to the pumps and fine screening placed after the pumps. This is not considered the best option for the MCSD wastewater treatment system where solids loading does not warrant installation of both types of screens.

Pre-screening could be accomplished by one screening unit designed to handle the projected (2030) PIF of 3.8 MGD. Flows greater than this would be diverted to a bypass channel equipped with coarse screening in the form of a bar screen. However for most screens, the design of the approach channel is limiting at low flows because minimum velocities cannot be maintained in a channel sized for screens rated for the larger flow. Generally the screening channel should be designed to maintain a 1.25 feet per second (ft/s) minimum velocity at peak hourly flows during dry weather conditions to prevent solid material from settling out ahead of the screen. To maintain this velocity at the current ADWF of 1.0 MGD, the channel should not be greater than 2 feet in width.

7.1.1.5 Summary of Options

Screening options for the WWMF include ether a single screen designed for a projected PIF of 3.8 MGD or two channels, each provided with a 2-MGD screen. Equipment costs for two spiral screens are approximately $130,000. Equipment costs for two belt or band screens with redundant compactors are estimated to be $275,000. Generally installation of belt or band screens is also more expensive because of the increased channel depth required and the need to provide for more conveyance and compaction of screened material. The least expensive equipment option would be to install two inclined 2 MGD spiral screens.

7.1.2 Grit Removal

Grit includes sand, gravel, cinder, or other heavy solid materials that are "heavier" (higher specific gravity) than the organic biodegradable solids in the wastewater. Grit also includes eggshells, bone chips, seeds, coffee grounds, and large organic particles, such as food waste. Removal of grit prevents unnecessary abrasion and wear of mechanical equipment, grit deposition in pipelines and channels, and accumulation of grit in ponds and/or aeration basins. Grit removal facilities typically follow screening to prevent large solids from interfering with grit handling equipment. In secondary treatment plants without primary clarification, grit removal should precede aeration (Metcalf & Eddy, 2003).

Grit is traditionally defined as particles larger than 0.008 inch in diameter (65 mesh) and with a specific gravity of greater than 2.65 (EPA, 1987). Equipment design was traditionally based on removal of 95% of these particles. However, with the recent recognition that smaller particles must be removed to avoid damaging downstream processes, many modern grit removal designs are capable of removing up to 75% or more of 0.006 inch (100 mesh) material.

The following types of grit removal systems were evaluated as options for the proposed new headworks at the MCSD WWMF:

- Aerated grit chamber
- Vortex type grit chamber
- Head cell

7.1.2.1 Aerated Grit Chamber

In aerated grit chambers, grit is removed by causing the wastewater to flow in a spiral pattern. Air is introduced in the grit chamber along one side, causing a perpendicular spiral velocity pattern to flow through the tank. Heavier particles are accelerated and diverge from the streamlines, dropping to the bottom of the tank, while lighter organic particles are suspended and eventually carried out of the tank.

Aerated grit chambers use a sloped tank bottom in which the air roll pattern sweeps grit along the bottom to the low side of the chamber. A horizontal screw conveyor typically is used to convey settled grit to a hopper at the head of the tank. Once removed from the chamber, grit is usually washed with a hydrocyclone and dewatered in a grit classifier to ease handling and remove organic material. The grit is then conveyed directly to a truck, dumpster, or storage hopper. From there, the grit is taken to a landfill or other disposal facility.
Aerated grit chambers typically are designed to remove particles of 70 mesh (0.008-in) or larger, with a detention period of two to five minutes at peak hourly flow. When wastewater flows into the grit chamber, particles settle to the bottom according to their size, specific gravity, and the velocity of roll in the tank. A velocity that is too high will result in lower grit removal efficiencies, while a velocity that it too low will result in increased removal of organic materials. Proper adjustment of air velocity will result in nearly 100% removal of the desired particle size and well-washed grit.

Advantages:

- Consistent removal efficiency over a wide flow range.
- A relatively low putrescible organic content may be removed with a well-controlled rate of aeration.
- Performance of downstream units may be improved by using pre-aeration to reduce septic conditions in incoming wastewater.
- Aerated grit chambers are versatile, allowing for chemical addition, mixing, pre-aeration, and flocculation.

Disadvantages:

- Potentially harmful volatile organics and odors may be released from the aerated grit chamber, requiring odor control.

- Aerated grit chambers require more power than other grit removal processes.
- Maintenance and control of the aeration system requires additional labor.
- Size of the tank to provide adequate detention times may be prohibitive at peak flows.

Some manufacturers provide aerated grit channels as part of a combination unit manufactured in conjunction with a screenings unit. A grit conveyor in the bottom of the channel moves grit to a lateral sump from which it is transported by an inclined grit transport screw undergoing dewatering in the process. To provide a minimum of two minutes of detention time at the projected PIF of 3.8 MGD, would require two channels each 10 feet deep, 4 feet wide, and 9 feet long.

7.1.2.2 Vortex-Type Grit System

The vortex-type or grit removal system relies on a mechanically induced vortex to capture grit solids in the center hopper of a circular tank. The vortex is produced by a combination of an inlet flume, sloped baffle, and adjustable rotating paddles at the center of the flume. In some systems, the vortex circulation pattern is maintained by pumps instead of paddles.

Grit settles by gravity into the bottom of the tank (in a grit hopper) while effluent exits at the top of the tank. The grit that settles into the grit hopper may be removed by a centrifugal grit pump or an airlift pump, and is usually washed and dewatered with a cyclone/classifier degritting system prior to disposal.
Flow into a vortex-type grit system should be straight, smooth, and streamlined. The straight inlet channel length typically is seven times the width of the inlet channel, or 15 feet, whichever is greater. The ideal velocity range in the influent typically is 2 to 3 ft/s at 40 to 80% of peak flow. A minimum velocity of 0.5 ft/s should be maintained at all times because lower velocities will not carry grit into the grit chamber (WEF, 1998).

Advantages:

- These systems remove a high percentage of fine grit, up to 73% of 140-mesh (0.004 in diameter) size.
- Vortex grit removal systems are consistently efficient over a wide flow range.
- There are no submerged bearings or parts that require maintenance.
- The footprint (horizontal dimension) of a vortex grit removal system is small relative to other grit removal systems, making it advantageous when space is an issue.
- Head loss through a vortex system is minimal, typically 6 millimeters (mm) (0.25 in). These systems are also energy efficient.

Disadvantages:

- Vortex grit removal systems usually are of a proprietary design, which makes modifications difficult.
- Paddles may collect material not removed by the screening equipment.

- Vortex units usually require deep excavation due to their depth, which increases construction costs, especially if unrippable rock is present.
- The grit sump tends to clog and requires high-pressure agitation using water or air to loosen grit compacted in the sump.

The vortex grit removal system and the head cell provide more efficient grit removal than the aerated grit chamber and remove smaller material. A vortex grit chamber rated for 3.8 MGD would be approximately 12 feet deep, 12 feet in diameter at the top and 4 feet in diameter at the bottom.

7.1.2.3 HeadCell®

A HeadCell® is a modular, multi-tray solids concentrator that removes grit down to 50 micron in size (200 mesh). Grit removal in the system is based on creating a vortex action across multiple tray layers that serve as settling basins (similar to settling tubes in clarifiers). Solids caught in the vortex flow are swept down each tray to a central core where they are collected and pumped to a grit washing device. The use of stacked multiple trays creates a large surface area that effectively captures grit in a relatively small footprint.

A HeadCell® unit capable of a 95% grit removal efficiency at the PIF of 3.8 MGD process design flow would be 6 feet in diameter, and would be placed in the center of a surrounding concrete vessel. The vessel would have a 2-foot wide circular channel extending around the exterior circumference of the head cell unit. The bottom and sidewalls of the tank would be sloped down with an overflow weir installed across the concrete containment vessel.

Advantages:

- High removal efficiency
- Low head loss
- Relatively small footprint
- Relatively low equipment and construction costs
- Passive operation, no moving parts

Disadvantages:

- Proprietary system
- Open tank may collect floatables

The HeadCell® has the advantage of not having any moving parts and not requiring construction of the deep circular tank required for the vortex system A HeadCell® sized for the PIF would be 6 feet in diameter and have a total of 4 trays (10 feet deep overall).

7.1.2.4 Cost Comparison

Table 7-1 summarizes estimates of equipment cost for the three types of grit removal systems. In general, equipment and installations costs for the three systems are very comparable.

Table 7-1
Comparison of Probable Cost for Grit Removal Technologies
MCSD Wastewater Management Facility

	Equipment	Grit Pumps	Classifier/ Cyclone	Concrete Tank	Electrical	Total
Aerated Grit Chamber	$174,000	Supplied	Supplied	$35,000	$52,200	$261,200
Vortex- type Grit System	$75,000	$40,000	$78,000	$30,000	$57,900	$280,900
HeadCell®	$90,000	$40,000	$78,000	$25,000	$42,900	$275,900

7.2 Upgrade or Expand Existing Facultative System

The existing WWMF, a facultative lagoon system with supplemental aeration followed by treatment wetlands, is at capacity for organic loading and detention times are insufficient to provide required ammonia removal. Several alternatives for improving secondary treatment and nitrogen removal through an upgrade or expansion of the existing system were evaluated. These alternatives included:

- Increased Wetland Treatment
- Upgraded Aeration System (partial mix/complete mix)
- Use of a Nitrifying Filter

7.2.1 Increased Wetland Treatment

Wetland treatment has been shown to be an effective method of BOD removal when systems are loaded at rates less than 100 ppd/ac. The degree to which the systems are effective at removing nitrogen depends upon nitrification and denitrification reactions that are a function of detention time and temperature and upon the numbers of nitrifying organisms. Nitrifying organisms require oxygen and an adequate surface area on which to grow.

7.2.1.1 Conversion of Ponds 2 and 3

It was noted in the performance review that most of the BOD and ammonia removal takes place in Ponds 1A and 1B, and Ponds 2 and 3 are do not contribute significantly to BOD removal, especially in the summer. Conversion of Ponds 2 and 3 to treatment wetlands was considered as an alternative for improving secondary treatment capacity.

Based on earlier discussions of wetland capacity, it was determined that loading on treatment wetlands should not exceed 100 ppd/ac and optimally should be around 50 ppd/ac. The loadings presented in Table 7-2 indicate that if Ponds 2 and 3 were converted to wetlands and all four wetland cells are fed in series as wetland treatment cells, the loading would still exceed the recommended maximum of 100 ppd/ac at the design condition. If wetlands are to be used to improve secondary treatment, additional wetland area(s) will need to be constructed.

Table 7-2
Organic Loading on Wetlands Following Conversion of Ponds 2 and 3
MCSD Wastewater Management Facility

	Projected Flow 2030 (MGD)[1]	Influent BOD[2] (mg/L)[3]	Removal	Pond 1A and 1B Effluent BOD		Area (acres)	Loading (ppd/ac)[5]
			(%)	(mg/L)	(ppd)[4]		
MMWWF[6]	2.13	244	65%	85	1,517	10.81	140
MMDWF[7]	1.60	272	80%	54	726	10.81	67

1. MGD: million gallons per day
2. BOD: Biochemical Oxygen Demand
3. mg/L: milligrams per Liter
4. ppd: pounds per day
5. ppd/ac: pounds per day per acre
6. MMWWF: Maximum Monthly Wet Weather Flow
7. MMDWF: Maximum Daily Wet Weather Flow

7.2.1.2 Area Requirements

To determine the area of wetland treatment cells required for provision of required secondary treatment, kinetic coefficients developed from studies of existing Free Water Surface (FWS) wetlands were applied to design loadings from Stabilization Ponds 1A and 1B (Crites and Tchobanoglous, 1998).

A. Secondary Treatment (BOD Removal)

Secondary permit requirements of 30 mg/L BOD were assumed. The target effluent concentration was derived by subtracting 5 mg/L from the required effluent concentration, to account for BOD contributed by plant decay in the wetland cells, and then multiplying by a Coefficient of Reliability (COR) to account for variability in the wetlands effluent. A COR of 60% was used based on typical coefficients of variation for wetland treatment and assuming a statistical probability of 95% for meeting the criteria (Crites and Tchobanoglous, 1998).

Detention time for BOD removal:

$$t \text{ (days)} = -(\ln C/C_0)/k_W = 4.6 \text{ days}$$

Where:

C_0= Influent = 87 mg/L BOD
Ce= Target Effluent Quality = 30 mg/L BOD
Cd = Added by Decay = 5 mg/L BOD
COR = Coefficient of Reliability (@ 95 % Reliability) = 0.60
$C = COR(C_e - C_d) = 15$
t = detention time, days
k_w= overall BOD removal-rate constant corrected for temperature, = $0.38\ d^{-1}$

Area requirements can be calculated from the required detention time using the following formula:

$$\text{Area (acres)} = (Q*t*3.07)/(dw*n) = 19 \text{ Acres}$$

Where:

Q_{INF} = Influent, MGD = 2.1 MGD (Projected MMWWF 2030)
n = plant based void ratio = 0.65
dw = depth of flow, ft=2.3 ft
Conversion 3.07 ac.ft/MGD

Table 7-3 summarizes the design criteria for wetland treatment cells. Based on the preceding calculations, we estimated a total detention time of 4.6 days and an estimated area of 19 acres of wetland treatment would be required for BOD removal at projected design loadings.

Table 7-3
Design Criteria Free Water Surface Constructed Wetlands
MCSD Wastewater Management Facility

Secondary Treatment Wetlands	
Maximum Areal Loading Rate (ARL)	<100 ppd[1]/acre
Design Areal Loading Rate (ARL)	50 ppd/ac
Hydraulic Retention Time (HRT)	3-5 days
Water Depth (Shallow)	0.2-1.5 feet
Water Depth (Deep)	>4 feet[2]
Enhanced Treatment Wetlands	
Hydraulic Retention Time (HRT)	10 days
BOD[3] Removal Rate[4]	
K_{BOD} (20 °C)[5]	0.68/day
Kw (10.2 °C)[6]	0.38/day
Ks (16.5 °C)[7]	0.55/day
Ammonia Removal Rate[8]	
$K_{NH3\text{-}N}$ (20 °C)	0.22/day
Kw (10.2 °C)	0.14/day
Ks (16.5 °C)	0.19/day

1. ppd: pounds per day
2. >: greater than
3. BOD: Biochemical Oxygen Demand
4. Temperature Correction for BOD removal theta = 1.06
5. K_{BOD}: Removal rate for BOD
6. Kw: Removal rate for winter
7. Ks: Removal rate for summer
8. Temperature Correction for NH_4-N removal theta = 1.048

B. Nutrient Removal

The rates of nitrification, the conversion of ammonia-nitrogen (NH_3-N) to nitrate-nitrogen (NO_3-N), and denitrification the subsequent conversion of NO_3-N to nitrogen (N_2) are much slower than those for BOD conversion, therefore the area of wetlands required for nitrogen removal will far exceed the area required for BOD and TSS removal. The expected effluent quality can be calculated based on published rates for nitrification and the actual NH_3-N concentrations of Ponds 1A and 1B effluent.

In 2009, the average wet-weather concentration of the NH_3-N leaving Ponds 1A and 1B was 29.5 mg/L and it is assumed an additional 9 mg/L of ammonia will be contributed by the organic nitrogen in Pond 1A and 1B effluent. At a detention time of 4.6 days in the treatment wetlands, the removal rate for nitrogen is 48% and the effluent concentration of ammonia is 20 mg/L.

The area required to provide an effluent with TKN concentration of 10 mg/L was calculated as follows:

$$t \text{ (days)} = -(\ln C/C_0)/k_W = 12 \text{ days}$$

Where:

C_0= Influent = 38.5 mg/L NH_3-N
Ce= Target Effluent Quality = 7 mg/L NH_3-N (TKN=10 mg/L)
t = detention time, days
k_w= overall NH_3-N removal-rate constant corrected for temperature, = 0.14 d^{-1}

Area requirements can be calculated from the required detention time as follows:

$$\text{Area (acres)} = (Q^*t^*3.07)/(dw^*n) = 52 \text{ Acres}$$

Where:

Q_{INF} = Influent , MGD = 2.1 MGD (Projected MMWWF 2030)
n = plant based void ratio = 0.65
dw= depth of flow, ft =2.3 ft
Conversion 3.07 ac.ft/MGD

C. Reliability

The existing wetland treatment cells do not achieve expected rates of ammonia removal, and BOD removal is not reliable. Nitrification is limited by:

- Wetland cells are subject to high organic loads, which deplete oxygen and select heterotrophs (an organism that cannot fix carbon and uses organic carbon for growth) over nitrifiers (bacteria that grow by consuming inorganic nitrogen compounds).
- Wetland cells are not configured for optimal nitrogen removal. Deeper free water surface areas designed to optimize nitrification should precede the shallow cells planted with emergent vegetation, which is best at denitrification. It is difficult to maintain plants in open water surface areas due to plant predation. (The WWMF has experienced problems maintaining plants in the free water surface areas of the existing cells due to plant predation. A pilot test is being conducted using SAV in Ponds 3 and 4. The purpose of the pilot test is to improve performance of the enhancement wetlands. However, even if plants can be maintained in the open water areas due to improved plant selection, large areas are needed to reliably provide required rates of nitrification.)

D. Feasibility and Cost

Within the existing plant site boundaries there are an estimated 24 acres that could be converted to wetlands. Land available for additional wetland treatment cells to the south and west of the existing plant could provide the additional 8 acres required for secondary treatment; however, there is not enough area to provide the 52 acres required for reduction of total nitrogen levels to 10 mg/L. Prior to determining the availability of additional land, a preliminary opinion of probable cost (Table 7-4) was developed to determine feasibility using the following assumptions:

- Cells would be configured for plug flow with the ability to be bypassed.
- Gravity flow from one cell to the next would not be feasible therefore pump stations would be required to pump the discharge from each wetland treatment cell.
- It is assumed that all the wetlands treatment cells would need to be lined. Unless exempted, wastewater surface impoundments must be designed in accordance with Title 27 requirements for a Class II waste management units. The requirements include provisions for liners that meet a prescriptive standard or for an engineered alternative that provides equivalent protection. Engineered alternatives and/or exemptions to this requirement require further detailed analyses.

Table 7-4
Engineer's Opinion of Probable Cost for Wetland Treatment
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$1,845,235
Convert Ponds 2 and 3 (5 Acres)				
Lining	SF[1]	$2.50	217,800	$544,500
New Planting	SF	$1.50	217,800	$326,700
Modify Ponds 4 and 5 (6 Acres)				
Planting	SF	$1.50	261,360	$392,040
Lining	SF	$2.50	261,360	$653,400
Additional Treatment Wetlands (8 Acres)				
Excavation	CY[2]	$20	38,720	$774,400
Berm	CY	$30	20,000	$600,000
New Planting	SF	$1.50	348,480	$522,720
Lining	SF	$2.50	348,480	$871,200
Outlet structures	EA[3]	$5,500	4	$22,000
Pump Stations	EA	$7,500	4	$30,000
Collection Piping	LF[4]	$100	800	$80,000
Enhancement Wetlands (32 acres)				
Construction[5]	LS[6]	$10,560,000	ALL	$10,560,000
Construction Subtotal				$17,222,195
Contingency 20%				$3,444,439
Engineering 25%				$4,305,548
Admin 4%				$688,887
Project Subtotal				**$25,661,070**

1. SF: Square Feet
2. CY: Cubic Yards
3. EA: Each
4. LF: Linear Feet
5. Cost of additional wetlands estimated at $330,000/acre
6. LS: Lump Sum

Advantages:

- Maintains use of existing stabilization ponds and natural treatment system

Disadvantages:

- The large areas required (coupled with pumping and lining costs) limit the feasibility of this alternative for secondary treatment and enhanced nutrient removal
- Preliminary estimates of project costs are more than four times the cost of alternatives providing equivalent treatment (as presented in subsequent sections)
- Has a lower reliability than mechanical systems

7.2.2 Aerated System/Nitrifying Filters

The existing facultative pond system with supplemental aeration does not have the capacity to treat projected organic loadings. However, higher loadings can be sustained if air is added in sufficient quantities to suspend the microbial population in the aerated basins. In aerated basins that are either partially or completely mixed, the kinetic constants governing BOD removal and nitrification are higher than those in a facultative system where the microbial population is not suspended.

In this section, increasing secondary treatment capacity by changing the existing facultative pond system to an aerated pond system was evaluated as a feasible alternative. The aerated pond system would be combined with a nitrifying filter bed to provide reliable nitrification of ammonia.

7.2.2.1 Partially Mixed System

In a partially mixed system, the oxygen requirements generally control the power input required. Air requirements based on projected BOD and TKN and NH_3-N loadings and assuming a transfer efficiency of 2.0 pounds of Oxygen (O_2) per horsepower-hour (hp-hr) were estimated to be 360 hp.

The reduction of BOD in a partial mix system was calculated based upon available detention time in the existing three pond system minus an allowance for construction of a nitrifying filter as follows:

$$C_n = 1/[1+kt/n]^n\ C_0$$
$$= (0.17)(C_0)$$
$$= 42 \text{ mg/L BOD}$$

Where:

$k = 0.19\ d^{-1}$ (@ 10 °C)
Detention time = 13 days (At Projected MMWWF 2030)
C_n = Effluent BOD concentration in cell n
C_0 = Influent BOD concentration =244 mg/L
n = number of cells in series = 3

7.2.2.2 High Performance Aerated Pond System

The High Performance Aerated Pond System (HPAS) also called the Dual Power Multicellular (DPMC) treatment process was developed as a modification to the conventional aerated lagoon system and has been used with success in numerous installations in the U.S. The system is comprised of multiple cells aerated at different levels. The first cell consists of a reactor with a retention time of 1.5 to 2.5 days aerated to maintain complete mix conditions at a minimum of 30 horsepower per million gallons (hp/MG). The partially mixed cells following the suspended cell are aerated at 5 to 8 hp/MG–a level that permits the settleable solids to settle, but is sufficient to maintain aerobic conditions.

The deep sections of Ponds 1A and 1B are suitable for creation of complete mix cells using suspended baffles. The primary sections of these two ponds are as much as 13.5 feet deep–enough to use large aspirating aerators with integral blowers supplying fine bubble aeration and a high oxygen transfer efficiency.

The reduction of BOD in the combined system was calculated as follows

$$C_n = 1/[1+kt/n]^n C_0$$
$$= (0.26)(C_0)$$
$$= 63 \text{ mg/L BOD}$$

Where:

Complete Mix:

$k = 1.7\ d^{-1}$ (@ 10 °C)
detention time = 2.25 days (At Projected MMWWF 2030)
C_n = Effluent BOD concentration in cell n
C_0 = Influent BOD concentration = 244 mg/L
n =1

$$C_n = 1/[1+kt/n]^n C_0$$
$$= (0.31)(C_0)$$
$$= 20 \text{ mg/L BOD}$$

Where:

Partial Mix:

$k = 0.19\ d^{-1}$ (@ 10 °C)
detention time = 8.35 days (@ MMWWF)
C_n = Effluent BOD concentration in cell n
C_0 = Influent BOD concentration = 63 mg/L
n=2

7.2.2.3 Nitrifying Filter

Nitrifying filter beds are an innovative concept developed as a retrofit for constructed wetlands systems to meet ammonium-nitrogen (NH_4-N) discharge requirements reliably (Reed et al., 2006). The rock media provide the substrate for a biofilm in much the same way as rocks would in a trickling filter or Recirculating Gravel Filter (RGF). However, filter beds are specifically designed to remove NH_4-N following a secondary process to remove BOD and are subjected to much higher hydraulic loading rates than RGFs.

Design criteria for a filter bed area are based on attached growth processes and are related to the specific surface area of the media. Additional requirements include:

- Low BOD (BOD/TKN <1)
- Aerobic conditions
- Surface moist at all times
- Sufficient alkalinity (8.6 mg alkalinity (CO_3^-)/mg NH_3-N oxidized)

An equation relating ammonia loading to required surface area was developed based on curve fitting of performance data from other nitrification reactors. The equation for determining surface area was verified in a full scale application at Mandeville, Louisiana (Reed et al., 2006). In Mandeville, the filter bed followed a high performance aerated lagoon system similar in design to the combined aeration system described above.

Based on the equation cited above and assuming an effluent NH_3-N concentration of 5 mg/L, the required surface area is 5,744 square feet per pound of NH_3-N oxidized. If the filter is constructed using gravel with a surface area of 57.8 square feet per cubic foot (SF/CF) and the maximum projected loading is 525 ppd NH_3-N, then approximately 1,930 cubic yards (CY) of media will be required.

Nitrifying filters generally are 1 to 2 feet deep. Continuous feed is possible if aerobic conditions are maintained in the filter, for example through the use of recirculating pumps and a spray distribution system.

7.2.2.4 Denitrification

The nitrifying filter is designed to convert ammonia-nitrogen (NH_3-N) to nitrate-nitrogen (NO_3-N) because nitrification is generally the rate limiting step in a free water surface wetland. Removal of the nitrate is accomplished through a combination of plant uptake and biological conversion or denitrification with bacterial conversion accounting for 90% of the removal.

The low DO environment in an established free water surface wetland is conducive to denitrification which generally can be accomplished at detention times of 2 to 4 days. As with other bacteriologically mediated processes, denitrification is affected by temperature and detention time and limiting conditions in the wetlands that occur during winter. Using a rate constant of 0.247/day (1.0/day at 20 °C corrected for a temperature of 10 °C), the required detention time to denitrify the effluent from the nitrifying filter is estimated to be 5 days.

Based on the projected MMWWF of 2.1 MGD and assuming a maximum depth of 3 feet in the wetlands, a detention time of 5 days equates to a required area of approximately 11 acres, which is the entire area of Ponds 2 and 3, and Wetland Cells 4 and 5. However, if the nitrifying filter is built so that flow can be recycled from the wetlands, the area required for denitrification can be reduced. Recycling also has the advantage of decreasing the soluble BOD concentration going into the filter.

7.2.2.5 Feasibility and Cost

Of the two aeration systems investigated, only the high performance aeration system could reliably achieve the BOD removal required to provide a BOD/TKN ratio of less than one prior to the nitrifying filter. In addition, the HPAS has a lower total power requirement and frees up area for additional wetlands to denitrify the filter bed effluent.

A preliminary layout for the combined aerated pond system and nitrifying filter bed is shown in Figure 7-1. An estimate of probable cost is presented in Table 7-5.

Advantages:

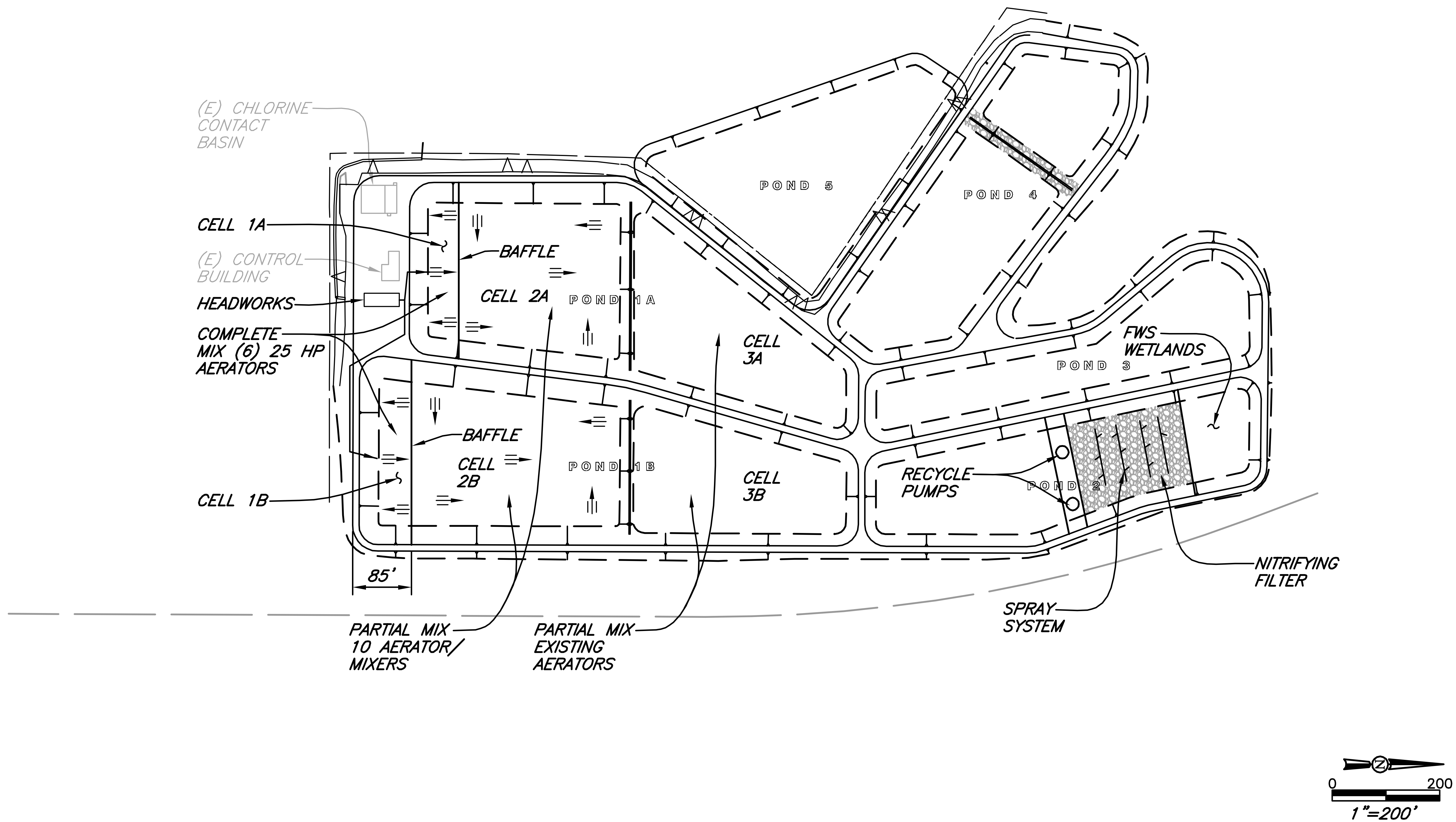
- Can reliably achieve BOD removal required
- Construction costs comparable to extended aeration, lower than other alternatives
- Maintains natural wetland treatment system
- Low biosolids production

Disadvantages:

- Cannot reliably provide effluent ammonia levels of less than 5 mg/L
- Large construction footprint
- More difficult to expand system; may require area outside existing footprint
- Higher power costs as compared to other alternatives
- When O&M costs including power are considered present value is higher than extended aeration
- Plugging of rock filter may require maintenance

Table 7-5
Engineer's Opinion of Probable Cost for High Performance Aeration System/Nitrifying Filter
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$522,757
Sludge Removal/Dewatering	LS[1]		ALL	$200,000
Aerators 25 hp[2]	EA[3]	$36,000	6	$216,000
Aerators 5-7.5 hp	EA	$15,000	10	$150,000
Lining Aerated Basins	SF[4]	$2.50	487,872	$1,219,680
Lining Pond 2	SF	$2.50	104,544	$261,360
Lining Pond 3	SF	$2.50	108,900	$272,250
Plantings	SF	$1.50	130,680	$196,020
Baffles	LF[5]	$75	1,500	$112,500
Nitrifying Filter				
Filter Recycle Pumps	EA	$15,000	2	$30,000
Filter Structure	CY[6]	$1,100	1,135	$1,248,500
Filter Media	CY	$35	2,000	$70,000
Spray Distribution System	LS	$30,000	ALL	$30,000
Electrical	LS	$175,000	ALL	$175,000



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SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, CA	High Performance Aeration System (HPAS)/ Nitrifying Filter (NF) Alternative 1 SHN 008189	
	August 2011	008189-POND-ALT1	Figure 7-1

Table 7-5
Engineer's Opinion of Probable Cost for High Performance Aeration System/Nitrifying Filter
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Generator	EA	$175,000	1	$175,000
Construction Subtotal				$4,879,067
Contingency 20%				$975,813
Engineering 25%				$1,219,767
Admin 4%				$195,163
Project Subtotal				**$7,269,810**

1. LS: Lump Sum
2. hp: horsepower
3. EA: Each
4. SF: square Feet
5. LF: Linear Feet
6. CY: cubic Yards

7.3 Extended Aeration System Processes

In the performance analysis for natural treatment systems, the slow growth rate of nitrifiers leads to a requirement for long detention times in aerated pond systems and wetlands. To create a reliable process for nitrification, the lagoon process must be modified so that the solids age can be uncoupled from the Hydraulic Retention Time (HRT). This is accomplished through sedimentation in clarifiers with solids recycling which is the definition of an activated sludge or suspended growth process.

In the suspended growth process, the age or Solids Retention Time (SRT) of the bacterial population is managed and nitrifiers are selected for the maintenance of a high SRT. Two extended aeration processes were evaluated as appropriate for the WWMF:

- Suspended aeration chains and internal clarifiers installed in existing facultative ponds
- An oxidation ditch: an aeration basin constructed in an elliptically shaped channel followed by circular clarifiers

7.3.1 Earthen Basin System

The in-basin extended aeration system uses suspended aerators and integral clarifiers sharing a common wall with the aeration basin, to convert facultative pond systems to extended aeration systems. In addition to providing fine bubble diffused air with high transfer efficiency, the suspended aerators mix large basin volumes efficiently. This has led to the development of systems that are designed with SRTs that are longer than most extended aeration systems.

As an alternative to the use of integral clarifiers, conventional stand-alone clarifiers can also be used with the in-basin extended aeration system.

7.3.1.1 Effluent Quality

The in-basin extended aeration process results in reliable BOD removal, nitrification, and denitrification. The extended aeration system with solids recycle would provide the ability to reliably nitrify and provide effluent NH_4 (ammonium) at a concentration of less than 1 mg/L. In addition, the suspended aerators can be controlled to provide anoxic zones for denitrification reducing effluent nitrate concentrations to 3 to 4 mg/L. The system can reliably achieve TN concentrations, including an allowance for unmetabolized organic nitrogen, of 8 to 10 mg/L.

The long SRTs of 30 to 70 days provide process stability. Due to the large quantity of biological solids present, wide swings in organic and hydraulic loads can easily be handled without equipment or process adjustments. The excess biomass produced is well digested and stabilized.

7.3.1.2 General Configuration/Cost

Based on the projected loadings and flows developed in Section 3, several feasible configurations for an in-basin extended aeration system were developed. A configuration employing two basins placed end to end within a single earthen berm provided the most cost-effective use of the existing facultative pond. This configuration is shown in Figure 7-2. Aeration basin and clarifier dimensions were based on design criteria provided by two manufacturers of this type of system. Conventional stand-alone clarifiers would add an additional cost.

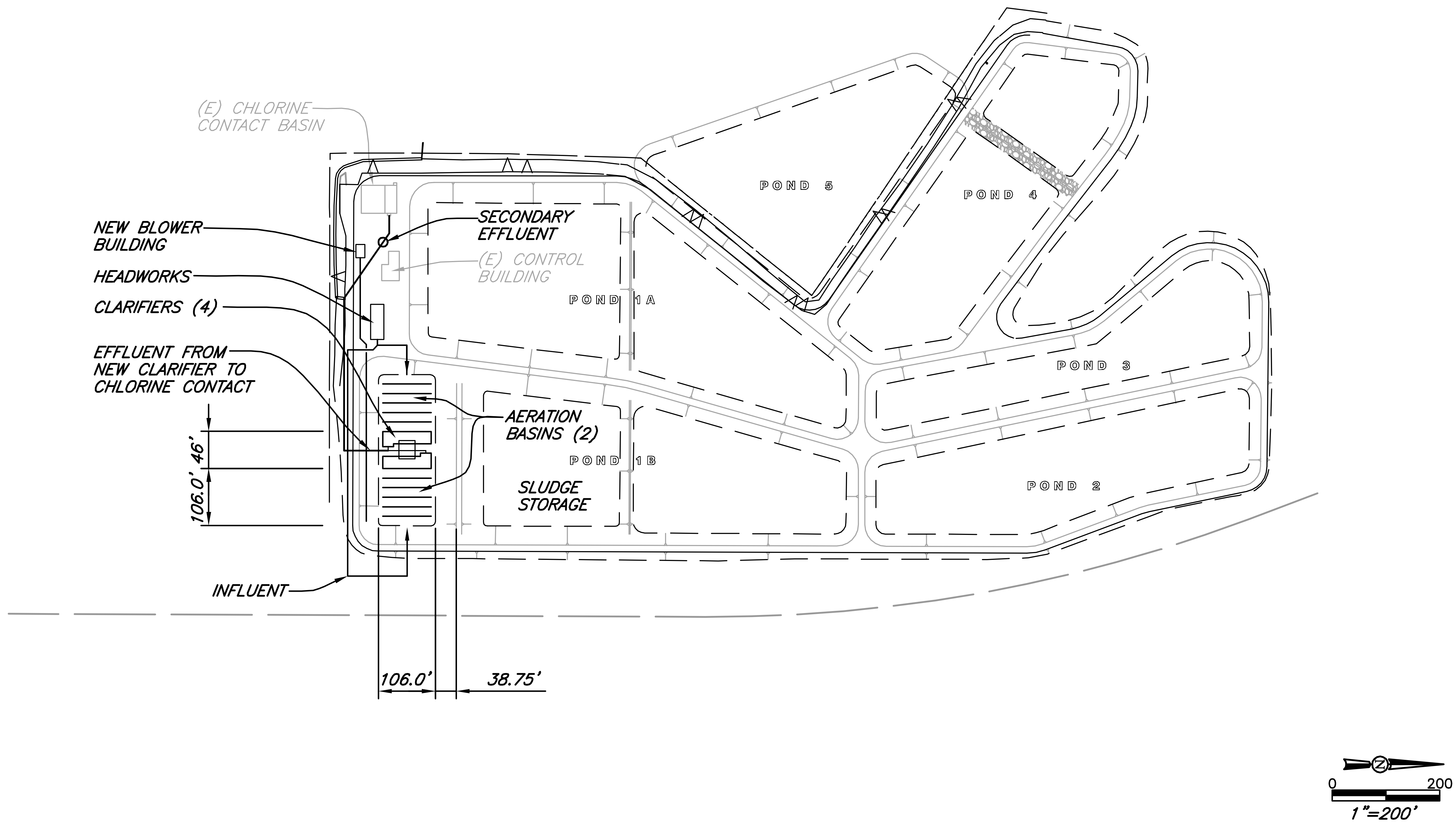
Table 7-6 presents a preliminary estimate of probable cost for an extended aeration system constructed within MCSD WWMF Pond 1B.

Advantages:

- High effluent quality with reliably low ammonia, nitrate and total nitrogen
- Efficient mixing resulting in reduced aeration requirements and power cost
- Long sludge age (greater than 60 days) provides very stable process tolerant to shock loads
- Low volume highly stabilized solids
- In-basin construction results in lower cost than other extended aeration systems (such as oxidation ditch)

Disadvantages:

- Aeration basin difficult to take off line (although not usually necessary for the range of flows at MCSD WWMF)
- Integral clarifiers may have issues with RAS control which can be addressed through modifications to the RAS pumps or through the use of conventional clarifiers



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SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, CA	In -Basin Extended Aeration System Alternative 2 SHN 008189
	August 2011	008189-POND-ALT2 — Figure 7-2

Table 7-6
Engineer's Opinion of Probable Cost for Suspended Aerators and Integral Clarifiers
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$534,004
Earthwork				
Sludge Removal	LS[1]	$300,000	ALL	$300,000
Excavation	CY[2]	$30	300	$9,000
Foundation stabilization	CY	$35	150	$5,250
Fill (berm)	CY	$32	12,500	$400,000
Aeration Basin Lining	SF[3]	$2.50	52,000	$130,000
Sludge Pond Lining	SF	$2.50	140,000	$350,000
Structural				
Concrete Walls	CY	$1,200	200	$240,000
Inclined Base	CY	$1,400	160	$224,000
Blower Building	SF	$250	600	$150,000
Equipment				
Equipment	LS	$1,368,000	ALL	$1,368,000
Biolac Installation	LS	$410,400	ALL	$410,400
RAS Pumps [4]	EA[5]	$6,000	4	$24,000
Electrical	LS	$356,880	ALL	$356,880
Generator	EA	$175,000	1	$175,000
Mechanical				
Grating	SF	$50	600	$30,000
Railing	LF[6]	$75	350	$26,250
Influent 12-inch	LF	$160	550	$88,000
Effluent 14-inch	LF	$200	450	$90,000
RAS 10-inch	LF	$100	300	$30,000
WAS[7] 4-inch	LF	$65	50	$3,250
Air manifold 10-inch	LF	$100	200	$20,000
Additional Yard Piping	LS	$20,000	ALL	$20,000
Construction Subtotal				$4,984,034
Contingency 20%				$996,807
Engineering 25%				$1,246,008
Admin 4%				$199,361
Project Subtotal				**$7,426,210**

1. LS: Lump Sum
2. CY: Cubic Yards
3. SF: Square Feet
4. RAS: Return Activated Sludge; assume installation of modified air lift or Geyser Pumps
5. EA: Each
6. LF: Linear Feet
7. WAS: Waste Activated Sludge

7.3.2 Oxidation Ditch

An oxidation ditch is another extended aeration system that uses long SRTs for biological oxidation and nitrification. Typical oxidation ditch treatment systems consist of a single or multi-channels within a ring, oval or horse-shoe configuration. Horizontally or vertically mounted aerators provide circulation, oxygen transfer, and aeration in the ditch.

Oxidation ditches are applicable wherever activated sludge extended aeration systems are appropriate. Oxidation ditch systems have a larger footprint than conventional treatment systems, but can be less expensive to construct and operate due to the efficiency of the aeration and mixing. The oxidation ditch systems are generally followed by stand-alone clarifiers.

7.3.2.1 Effluent Quality

The effluent quality produced by oxidation ditch systems is similar to other extended aeration systems with concentrations: BOD 10 mg/L, TSS 15 mg/L, and NH_3 (ammonia) 1 mg/L. The systems can be configured to denitrify either by addition of a stand-alone anoxic basin with recycling or with an anoxic internal ring.

7.3.2.2 General Configuration/Cost

The two-train oxidation ditch system presented in Figure 7-3 was sized based on projected flows and loadings. The aeration basins shown provide an HRT of 20 hours at the projected MMWWF.

A budgetary estimate of aeration equipment costs was obtained from a manufacturer of oxidation ditch systems. The aeration system design was based on oxygen requirements to treat projected maximum month BOD and NH_3 loading. Based on a transfer efficiency of 3 pounds of Oxygen per Brake Horsepower (O_2/BHP) the total power requirement for oxidation of BOD and NH_4-N was 98 hp. Aeration is provided by four, 25-hp combination aerator/mixers, each with a 5-hp regenerative blower. The system is completely mixed with a mixing intensity of 113 hp/MG.

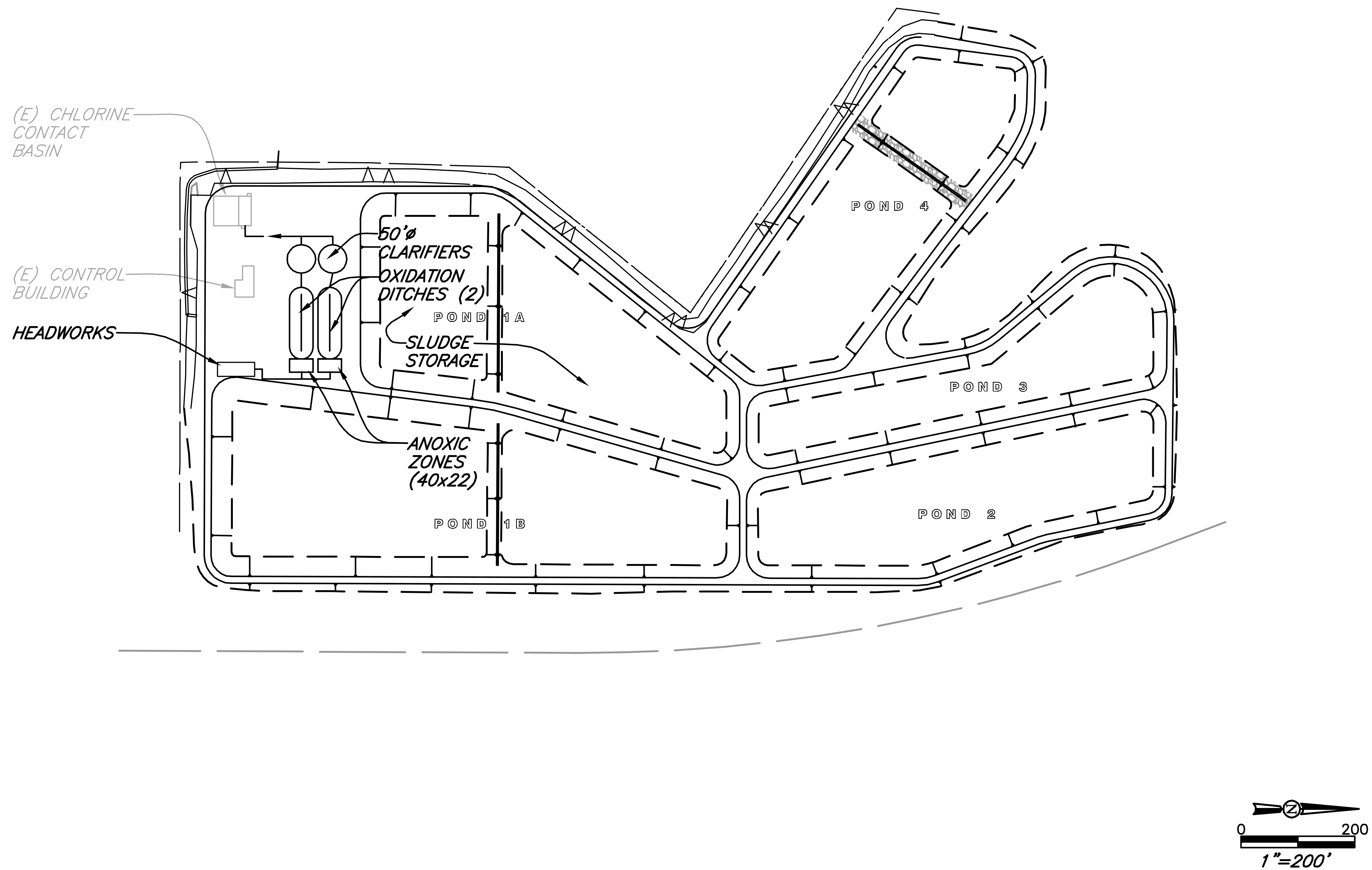
At a design SRT of 18 days, the oxidation ditch system is designed to nitrify completely. Two anoxic denitrification basins were included in the layout for the proposed alternative and in the opinion of probable cost (Table 7-7). Also included are two, 50-foot diameter circular clarifiers designed to provide a surface overflow rate of 800 gallons per day per square foot (gpd/SF) at the projected peak day flow of 3.08 MGD.

Advantages:

- Long sludge age (greater than 30 days) provides stable process tolerant to shock loads
- Stabilized solids intermediate in volume (between in-basin extended aeration and MBR)
- Can use aerators/mixers combination so aerators can be turned off for denitrification
- Intermediate in energy efficiency, power use

Disadvantages:

- Large footprint and concrete construction results in high costs
- Need for concrete clarifiers adds to cost and footprint



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McKinleyville Community Services District
Wastewater Management Facility
McKinleyville, CA

Extended Aeration Oxidation Ditch
Alternative 3
SHN 008189

October 2011 | 008189-POND-ALT3 | Figure 7-3

Table 7-7
Engineer's Opinion of Probable Cost for Oxidation Ditch/Circular Clarifiers
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$641,808
Earthwork				
Sludge Removal/Dewatering	LS[1]	$300,000	ALL	$300,000
Fill (berm)	CY[2]	$32	12,000	$384,000
Additional Fill	CY	$30	22,500	$675,000
Line Sludge Pond	SF[3]	$2.50	130000	$325,000,
Structural				
Concrete Wall	CY	$1,400	400	$560,000
Oxidation Ditch Floor	CY	$1,200	400	$480,000
Anoxic Basins FS	CY	$1,200	65	$78,000
Anoxic Basins Wall	CY	$1,200	100	$120,000
Clarifiers Suspended	CY	$1,400	200	$280,000
Clarifiers Slab	CY	$1,200	145	$174,000
Clarifier Distribution Box	LS	$60,000	ALL	$60,000
Equipment				
Aeration Equipment	LS	$504,000		$504,000
Mixer	EA[4]	$9,000	2	$18,000
Clarifier Drives	LS	$200,000	ALL	$200,000
Launderer Weirs	LS	$15,000	ALL	$15,000
WAS[5] Pumps	EA	$7,500	3	$22,500
RAS[6] Pumps	EA	$22,000	3	$66,000
Scum Pumps	EA	$4,500	2	$9,000
Electrical	LS	$300,000	ALL	$300,000
Generator	EA	$175,000	1	$175,000
Installation	LS	$228,600	ALL	$228,600
Mechanical				
Catwalks	SF	$100	350	$35,000
Grating	SF	$50	1,000	$50,000
Railing	LF[7]	$75	900	$67,500
Influent 12-inch	LF	$160	550	$88,000
Effluent 14-inch	LF	$200	450	$90,000
RAS Piping 6-inch	LF	$85	280	$23,800
Additional Yard Piping	LS	$20,000	ALL	$20,000
Construction Subtotal				$5,990,208
Contingency 20%				$1,198,042
Engineering 25%				$1,497,552
Admin 4%				$239,608
Project Subtotal				**$8,685,802**

1. LS: Lump Sum
2. CY: Cubic Yards
3. SF: Square Feet
4. EA: Each
5. WAS: Waste Activated Sludge
6. RAS: Return Activated Sludge
7. LF: Linear Feet

7.4 Conventional Activated Sludge with Biological Nutrient Removal

Conventional activated sludge systems can be modified to provide reliable biological nutrient removal. Biological Nutrient Removal (BNR) is defined as the process by which concentrations of nitrogen and/or phosphorous in plant effluent are reduced to levels below that which would be attainable through secondary treatment only. All of the treatment alternatives evaluated include BNR for nitrogen removal, the removal of nitrogen though nitrification of ammonia and subsequent denitrification of nitrate and nitrate. Alternatives have been evaluated in order of increasing complexity. Conventional activated sludge systems configured for nitrification and denitrification are more mechanically complex than Alternatives 1 through 3.

Activated sludge systems are the most extensively used secondary treatment systems nationally; and numerous configurations have been developed for BNR. The Modified Ludzack-Ettinger (MLE) Process, an activated sludge system with an initial anoxic stage followed by an aerobic stage has a proven track record for total nitrogen (TN) removal and will be used as the basis of treatment for Alternative Number 4.

7.4.1 Process Description

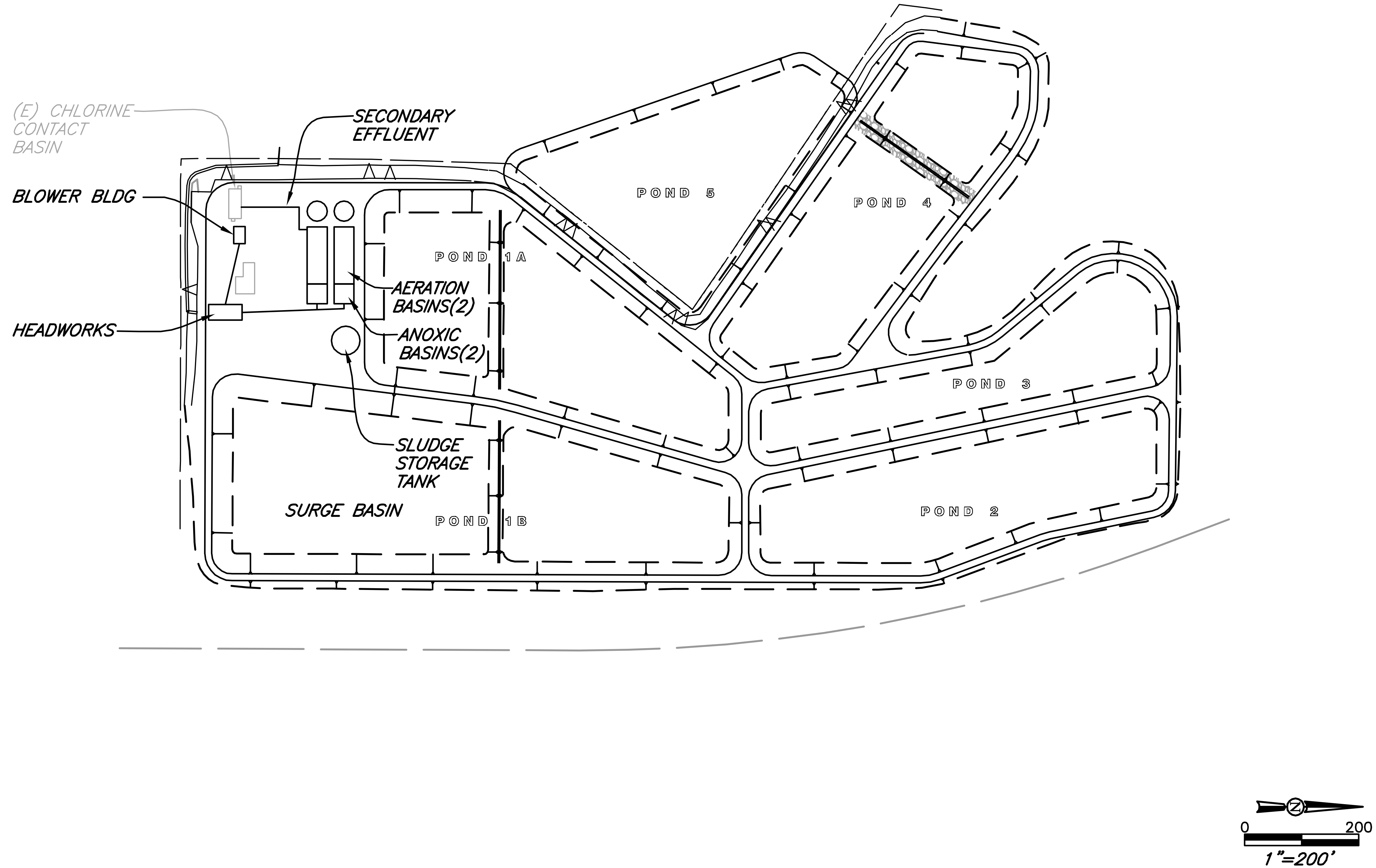
Nitrification occurs in the aeration basin usually in the second half of a plug flow configuration where BOD/TKN ratio is reduced because of oxidation of BOD. To promote denitrification of nitrates and the subsequent removal of nitrogen from the system as gas, the effluent from the aeration basin is returned to an anoxic zone. The process of denitrification adds alkalinity and oxygen back to the system, replenishing some of what has been removed by nitrification in the aeration basin.

The pumps that recycle mixed liquor from the aeration basin back to the anoxic zone are called Mixed Liquor Recycle (MLRS) pumps. These are large solids handling pumps with the capability of pumping two to four times the influent flow. The anoxic basin, which must be provided with mixing, typically is equipped with submersible mixers.

7.4.2 Configuration and Cost

A layout for an activated sludge system designed to remove nitrogen is presented in Figure 7-4. Costs are presented in Table 7-8. The layout is based on the assumption that the system will need to treat the projected MMWWF of 2.137 MGD and that flows greater than this will be stored in the surge basin (approximately 19 MG). The aeration basins shown provide retention times of 6-12 hours at MMWWF; the anoxic zones approximately 2 hours. Two, 50-foot diameter clarifiers are similar to those required for Alternative 3, based on parallel oxidation ditches.

Cost does not include sludge dewatering or long-term storage. Sludge production exceeds that which could feasibly be stored in a sludge lagoon for periodic removal especially if Pond 1B is lined to provide flow equalization. Biosolids management costs are included in the evaluation of Operations and Maintenance (O&M) costs for the various treatment options in Section 7.5, based on the assumption that solids will be hauled to another facility for dewatering and disposal. A storage tank has been provided in the construction cost.



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	October 2011	008189-POND-ALT4 — Figure 7-4

Table 7- 8
Engineer's Opinion of Probable Cost for Activated Sludge With BNR
MCSD Wastewater Management Facility

Mobilization	LS[1]	$810,936	ALL	$810,936
Earthwork				
Sludge Removal /Dewatering	LS	$300,000	ALL	$300,000
Fill (berm)	CY[2]	$32	12,000	$378,000
Additional Fill	LS	$30	22,500	$675,000
Surge basin	SF[3]	$3	240,000	$600,000
Structural				
Sludge Storage Tank	LS	$175,000	ALL	$175,000
Bower Bld.	LS	$150,000	ALL	$150,000
Tank Walls	CY	$1,400	550	$770,000
Slab	CY	$1,200	800	$960,000
PS (Dry Pit)	LS	$150,000	ALL	$150,000
Clarifiers	CY	$1,400	200	$280,000
Clarifiers	CY	$1,200	145	$174,000
Clarifier Distribution Box	LS	$60,000	ALL	$60,000
Equipment				
Aeration Equipment	LS	$300,000	ALL	$300,000
Diffusers	LS	$240,000	ALL	$240,000
Mixers	EA[4]	$12,000	2	$24,000
Clarifier Drives	LS	$200,000	ALL	$200,000
Launderer Weirs	LS	$15,000	ALL	$15,000
WAS[5] Pumps	EA	$7,500	3	$22,500
RAS[6] Pumps	EA	$22,000	3	$66,000
MLRS[7]	EA	$30,000	3	$90,000
Scum Pumps	EA	$4,500	2	$9,000
Generator	LS	$175,000	ALL	$175,000
Installation	LS	$301,800	ALL	$301,800
Electrical	LS	$350,000	ALL	$350,000
Mechanical				
Catwalks	SF	$100	200	$20,000
Railing	LF[8]	$75	260	$19,500
Recirculation	LF	$120	260	$31,200
Influent 12-	LF	$160	550	$88,000
Effluent 14-inch	LF	$200	450	$90,000
RAS Piping 6-inch	LF	$85	280	$23,800
Additional Yard Piping	LS	$20,000	ALL	$20,000
Construction Subtotal				$7,568,736
Contingency 20%				$1,513,747
Engineering 25 %				$1,892,184
Admin 4%				$302,749
Project Subtotal				**$10,974,667**

1. LS: Lump Sum
2. CY: Cubic yards
3. SF: Square Foot
4. WAS: Waste Activated Sludge
5. RAS: Return Activated Sludge
6. MLRS: Mixed Liquor Recycle (pumps)
7. LF: Linear Foot

Advantage:

- Reliability and proven track record

Disadvantages:

- High capital cost
- Higher annual power costs than suspended aeration due to MLRS pumps and mixers
- Higher sludge production than extended aeration systems
- Increased mechanical complexity
- Not as forgiving of shock loads as in-basin extended aeration with large sludge ages

7.5 Membrane Bioreactors

Membrane Bioreactors (MBRs) combine membrane technology with the activated sludge process to provide secondary and tertiary treatment in the same reactor vessel. With this treatment technology, microfiltration modules replace the clarification step with a membrane sheet providing liquid-solid separation. Suspended solids can be removed completely producing very high quality (almost bacteria-free) treated water.

7.5.1 Process Description

Membrane bioreactors use a hollow fiber, ultra filtration membrane immersed within an activated sludge tank with very high mixed liquor. With a pore size less than 0.1 µm, the membrane is a complete physical barrier to the mixed liquor solids, bacteria, and most viruses. A vacuum varying between 2 and 9 pounds per square inch (psi) is applied to a head connecting the membrane modules through the use of a centrifugal pump. The treated water is drawn through the hollow fibers and pumped out as high quality effluent. Air in the aeration basin scours the membrane and keeps it from fouling.

Liquid is periodically pumped back through the membrane in a pulse, which coupled with a membrane air scour system, cleans the membrane by forcing solids away from it. Other components of the treatment system include pumps for inducing the vacuum, mixed liquor recycle pumps, membrane air scour blowers, chemical feed system for membrane cleaning, and an aeration system. Many of the treatment components are similar to those contained in an activated sludge system, although there is no need for a return activated sludge pumping system because there is no clarifier. MLRS pumps keep the reactor solids mixed, and solids are wasted from the recycle stream.

The MBR systems investigated employ ultra fiber hollow tube membranes, following biological treatment in high mixed liquor aeration systems. The filtered wastewater, or permeate, is pulled through the membrane by a vacuum pumping system. The biological treatment preceding the membranes generally have an SRT of 10 to 15 days, sufficient for nitrification but not as long as the extended aeration systems discussed in the previous sections. The aeration basin(s) are designed to provide a hydraulic retention time of 6 to 8 days.

With a membrane bioreactor the need for a secondary clarifier is eliminated because aeration and clarification can be carried out in a single reactor with the membranes immersed in the aeration basin or alternatively in a separate module following aeration. Performance is considered highly reliable because of the physical barrier provided by the membrane, which in the case of membrane bioreactors is an "ultra-filtration" membrane.

7.5.2 Configuration and Cost

MBRs are essentially a clarifier and filter in an activated sludge process containing very high mixed liquor concentrations. Because of the high sludge concentration and reactor capacity, the aeration volume is significantly reduced, allowing the entire process to have a small footprint.

Two budgetary proposals for membrane equipment were obtained for the purpose of providing an Engineer's opinion of probable cost. The MemPulse™ system manufactured by Siemans Inc. was paired with an oxidation ditch configuration with mechanical aerators, and the Zenon™ system manufactured by General Electric followed conventional activated sludge basins provided with anoxic cells for denitrification. The proposed layout of the membrane system is presented in Figure 7-5. The costs presented in Table 7-9 are based on the Zenon™ system, but both estimates were similar, resulting in estimates of project cost close to $13 million.

The proposals and layout are based on treating the projected MMWWF of 2.137 MGD and storing approximately 19 MGD in a surge basin. The amount stored is equal to the sum of the projected peak week for six days, PDAF for 20 hours, and PIF for four hours.

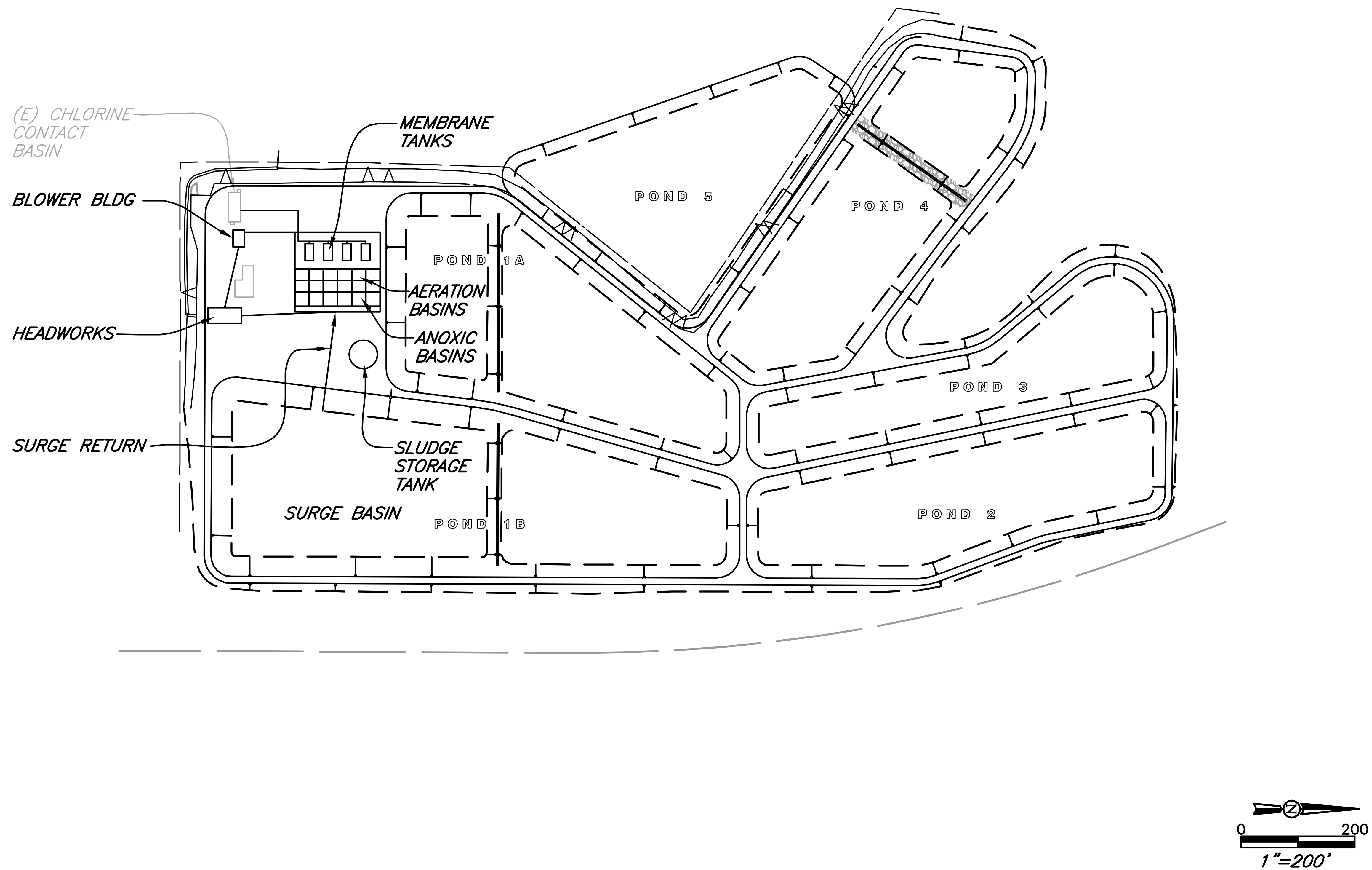
Membrane treatment systems provide very high quality effluent but are expensive systems to construct and operate with equipment cost and construction cost more than double the cost of other secondary systems evaluated. One advantage that a membrane treatment system provides includes a small footprint, which is not a significant benefit for MCSD given the amount of land available near the existing facility. Another advantage is the high quality effluent. In comparison to suspended air systems, the membrane treatment system will provide greater reliability for suspended solids removal and slightly greater BOD removal. The high effluent quality also allows disinfection requirements to be more reliably met by reducing interference with the chlorine system.

Advantages:

- Consistently high effluent quality
- Small footprint
- Reduced disinfection costs
- Can provide effluent suitable for municipal reuse without additional treatment
- Ability to meet more stringent discharge requirements than currently permitted

Disadvantages:

- Higher operational complexity than extended air process
- High capital cost
- Additional mechanical and instrumentation maintenance required
- Higher sludge production than extended air processes



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SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, CA	Membrane Bioreactor (MBR) Alternative 5 SHN 008189
	October 2011	008189-POND-ALT5 — Figure 7-5

Table 7-9
Engineer's Opinion of Probable Cost for Membrane Treatment System
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$1,017,876
Earthwork				
Sludge Removal/Dewatering	LS[1]	$300,000	ALL	$300,000
Fill (Berm)	CY[2]	$32	12,000	$384,000
Surge Basin	SF[3]	$2.50	240,000	$600,000
Structural				
Slab	CY	$1,200	800	$960,000
Aeration Basin	CY	$1,400	800	$1,120,000
Sludge Storage Tank	LS	$175,000	All	$175,000
Blower Building	SF	$250	600	$150,000
Equipment				
Blower Equipment	LS	$432,000	ALL	$432,000
Membranes	LS	$2,400,000	ALL	$2,400,000
WAS[4] Pumps	EA[5]	$7,500	3	$22,500
RAS[6] Pumps	EA	$22,000	3	$66,000
Scum Pumps	EA	$4,500	2	$9,000
Installation	LS	$859,800	ALL	$859,800
Electrical	LS	$550,000	ALL	$550,000
Generator	EA	$175,000	1	$175,000
Mechanical				
Sidewalks	SF	$50	1750	$87,500
Railing	LF[7]	$75	1,200	$90,000
Influent 12-inch	LF	$160	100	$16,000
Effluent 14-inch	LF	$200	200	$40,000
RAS Piping 6-inch	LF	$85	300	$25,500
Additional Yard Piping	LS	$20,000	ALL	$20,000
Construction Subtotal				$9,500,176
Contingency 20%				$1,900,035
Engineering 25%				$2,375,044
Admin 4%				$380,007
Project Subtotal				**$14,155,262**

1. LS: Lump Sum
2. CY: Cubic Yards
3. SF: Square Feet
4. WAS: Waste Activated Sludge
5. EA: Each
6. RAS: Return Activated Sludge
7. LF: Linear Feet

7.6 Comparison of Secondary Treatment Options

This section provides a detailed comparison of secondary treatment alternatives and a recommendation regarding the preferred alternative as the project moves forward. Of the secondary treatment alternatives that were evaluated, there are five alternatives that would provide the required treatment for projected flows and loadings at a feasible cost:

- HPAS followed by nitrifying filter and wetlands
- In-basin extended aeration system with suspended aerators and integral clarifiers
- Oxidation ditch
- Activated Sludge with BNR (MLE process)
- Membrane Bioreactor (MBR)

Alternatives that were considered, but were determined to be infeasible due to high capital cost, land requirements, or other physical constraints, include expanded treatment and enhancement wetlands. Treatment and enhancement wetlands were discussed in the previous section and the probable cost of the wetlands construction ($24 M) was determined a limiting factor.

The five alternatives considered viable were evaluated based on the following evaluation criteria:

- Effectiveness
- Cost
- Implementability
- Public Acceptance
- Regulatory Issues

7.6.1 Effluent Quality

Secondary treatment alternatives were evaluated based on the ability to provide an effluent that complies with current NPDES permit requirements for BOD, TSS, and NO_3-N concentrations, and to provide NH_3-N removal to levels that ensure compliance with whole effluent toxicity requirements when the facility is discharging to the Mad River. Nitrogen removal is an important indicator of current and anticipated effectiveness because in addition to anticipated permit requirements for NH_3-N, the concentration of TN is an important component of the area required for land application.

As Table 7-10 shows, all of the alternatives investigated provide significant nitrogen removal and ammonia reduction, but Alternative 1 cannot reliably provide effluent ammonia levels of less than 5 mg/L and, therefore, may not meet anticipated permit limits. Based on *EPA National Recommended Water Quality Criteria to Protect Freshwater Aquatic Life* (EPA, 2003), it is expected that new ammonia limits for discharge to the Mad River will be less than 5 mg/L and may be as low as 1 mg/L.

Table 7-10
Anticipated Average Monthly Effluent Quality
MCSD Wastewater Management Facility
(mg/L)[1]

	BOD[2]	TSS[3]	NH_3-N[4]	NO_3-N[5]	TN[6]
Aerated Pond System/Nitrifying Filter	20	20	5	5-10	10-15
In-basin Extended Aeration	10	10	<1[7]	4	8
Oxidation Ditch	10	15	1	4	10
Activated Sludge with BNR (MLE Process)	10	10	1	4	8
Membrane Treatment	3	1	1	4	5[8]
Current Mad River Discharge Limits	45	83	NA[9]	10	NA
Current Land Reclamation Limits	45	83	NA	10	NA
Anticipated Mad River Discharge Limits	30	30	1-5	10	10
Anticipated Land Reclamation Limits	30	30	NA	10	10
Anticipated Land Disposal Limits	30	30	NA	10	10

1. mg/L: milligrams per Liter
2. BOD: Biochemical Oxygen Demand
3. TSS: Total Suspended Solids
4. NH_3-N: Ammonia-Nitrogen
5. NO_3-N: Nitrate-Nitrogen
6. TN: Total Nitrogen
7. <: less than
8. Tertiary treatment and or chemical addition required to get below 5 mg/L
9. NA: Not Applicable

The extended aeration systems provide a higher quality effluent, and are more reliable than the improved lagoon system. The extended aeration systems have proved successful for removal of BOD and nutrients and performance guaranties can be obtained from system manufacturers. MBRs also produce high quality effluent, but at substantial additional cost.

Extended aeration systems, MBRs and MLE systems will reliably meet anticipated discharge standards for NH_4-N. MBR effluent is very low in TSS and can meet Class 2A reuse standards for municipal reuse without additional treatment. This gives them an advantage over extended aeration and MLE systems that would require a tertiary sand filter to provide the low turbidity water required to meet this purple pipe standard.

The ability of membrane bioreactors to provide higher quality water is reflected in a higher score for reliability and effectiveness in Table 7-16. Because both MBRs and in-basin extended aeration systems meet current and anticipated standards without tertiary treatment, the additional cost to treat effluent from the extended aeration systems to meet municipal reuse standards have not been included in the estimate of project cost in Table 7-15. However a brief discussion of tertiary treatment including expected effluent quality and costs is included for completeness in the following section.

7.6.1.1 Tertiary Treatment

Effluent complying with requirements for municipal reuse could be provided by installing a deep bed, granular media filter with continuous backwash following the in-basin extended aeration system. This type of filter, with coagulation, flocculation, and separation within the sand bed, has been used for tertiary filtration for more than 10 years and several manufacturers have obtained validation for Title 22 Class A compliance.

Recently, advanced filtration system have been developed incorporating two stages of continuous up-flow sand filters. These systems remove contaminants to levels beyond the Class 2A requirements for municipal reuse to levels previously thought achievable only by membrane filtration. Advanced filtration systems are a low cost alternative to low pressure tertiary membrane systems or MBR treatment systems that incorporate enhanced biological and chemical treatment systems and can achieve the following effluent quality:

- Turbidity 0.05 -0.10 NTU (Nephelometric Turbidity Units)
- Phosphorous 0.01 - 0.05 mg/L
- Total Nitrogen < 1 mg/L
- Biological BOD < 3.0 mg/L

Estimated project costs for additional tertiary treatment:

- Sand filter module following in-basin extended aeration system to provide Class 2A Municipal Reuse: $125,000 (each) providing 200 gpm (0.30 MGD)
- Two stage advanced filtration system following in-basin extended aeration system to provide the tertiary level of treatment cited above $480,000 per MGD

7.6.2 Implementability

The constructability, adaptability, and future expandability of each of the alternatives were scored on a scale of 1 to 5, with 5 being the most favorable. Overall implementability was scored based on the weighted sum of each factor and is presented in Table 7-11.

Table 7-11
MCSD Secondary Treatment Alternatives Implementability
MCSD Wastewater Management Facility

		Constructible Score	Adaptable Score	Expandable Score	Implementable Weighted Score
1	HPAS[1]/Nitrifying Filter	3.0	2.0	1.0	2.0
2	In-Basin Extended Aeration	5.0	3.0	3.0	3.6
3	Oxidation Ditch	2.0	4.0	2.0	2.6
4	Activated Sludge with BNR[2] (MLE)[3]	2.0	4.0	4.0	3.3
5	MBR[4]	2.0	4.0	5.0	3.6
Weight		0.33	0.33	0.33	0.33

1. HPAS: High Performance Aeration System
2. BNR: Biological Nutrient Removal
3. MLE: Modified Ludzack-Ettinger (process)
4. MBR: Membrane Bioreactor

All of the alternatives presented are constructed within the footprint of the existing basins, but Alternative 1, a high performance aeration system followed by a nitrifying filter and wetlands, has by far the largest construction footprint. Alternative 1 requires installation of baffles and new aerators, lining of the pond system and wetlands, construction of the nitrifying filter, and planting of new wetlands. It is scored as less constructible than the in-basin extended aeration system (Alternative 2), but easier to construct than the oxidation ditch (Alternative 3), the MLE process, (Alternative 4), and the MBR (Alternative 5) because of the requirement for concrete construction of multiple components for these systems. Alternative 1 would be difficult to expand because incorporation of area outside the existing plant site would be required.

Scoring adaptability or operational flexibility is somewhat subjective, but included was the ability to take basins off line, add chemicals if required, bypass, and handle shock loading. All of the systems handle variable loadings and chemical addition would be possible for the extended aeration systems and membrane treatment. The oxidation ditch and MBR are more adaptable in terms of taking individual aerators, aeration basins, or clarifiers off line.

The in-basin extended aeration system and the MBR received identical scores for implementability. The in-basin system would be easier to construct and the membrane system (because of its modular construction) is more expandable. The membrane system was scored marginally higher on adaptability but this scoring did not take into account the increased complexity of MBR operation required to provide the operational flexibility.

7.6.3 Costs

Construction costs for the five secondary treatment systems being evaluated were presented in the previous sections. To provide a basis for comparing total costs it was necessary to evaluate how annual operating cost would be affected by each alternative. The following factors will have an impact on operating costs:

- Aeration: annual power cost
- Operation and maintenance as reflected by increased staff
- Biosolids management

7.6.3.1 Annual Power Cost

Annual power requirements for the proposed alternatives are presented in Table 7-12.

Table 7-12
Annual Power Cost
MCSD Wastewater Management Facility

				Annual Usage	
		Horsepower	Operation	kWhr[1]	Cost[2]
Aeration					
	Existing	60	60%	235,164	$31,000
1	HPAS[3]/Nitrifying Filter	265	100%	1,731,068	$226,000
2	In-basin Extended Aeration	150	70%	685,895	$90,000
3	Oxidation Ditch	200	90%	1,175,820	$153,000
4	Activated Sludge with BNR[4] (MLE)[5]	150	70%	685,895	$90,000
5	Membrane Bioreactor	100	100%	653,233	$85,000
Pumping[6]					
	Existing			117,716	$16,000
1	HPAS/Nitrifying Filter			183,039	$25,000
2	In-basin Extended Aeration			248,363	$34,000
3	Oxidation Ditch			215,701	$29,000
4	Activated Sludge with BNR (MLE)			372,477	$50,000
5	Membrane Bioreactor			529,253	$71,000
Aeration and Pumping					
	Existing			418,203	$47,000
1	HPAS/Nitrifying Filter			1,914,107	$251,000
2	In-basin Extended Aeration			934,258	$124,000
3	Oxidation Ditch			1,391,521	$182,000
4	Activated Sludge with BNR (MLE)			1,058,372	$140,000
5	Membrane Bioreactor			1,182,486	$156,000

1. kWhr: Kilowatt hour
2. Power costs based on average of 0.13/kWh
3. HPAS: High Performance Aerated Pond System
4. BNR: Biological Nutrient Removal
5. MLE: Modified Ludzack-Ettinger (process)
6. Pumping costs for all alternatives include estimated $16,000 per year for irrigation pumping

The in-basin extended aeration system has the lowest annual power cost due to the following factors:

- Aeration system design is not mixing limited because of the configuration of the suspended aerators.
- Alternate aeration chains are operated on a timer to provide an anoxic zone for denitrification.
- Power requirements for auxiliary equipment are limited.

Power costs for the MBR system were based upon input from the manufacturer, and an assumption of complete mixing in the aeration basin preceding the membrane tank. Aeration costs for the MBR system are comparable to those of the in-basin extended aeration system, but overall, power costs are greater because of the cost of operating the permeate, or vacuum pumps, and other auxiliary equipment.

7.6.3.2 Biosolids Management Costs

Biosolids production for each of the secondary treatment alternatives is presented in Table 7-13. Yield estimates were based on the following values for volatile solids produced per pound of BOD:

- Existing = 0.20 lbs Volatile Suspended Solids (VSS)/lb BOD
- HPAS = 0.35 lbs VSS/lb BOD
- In-basin Extended Aeration = 0.45 lbs VSS/lb BOD- 4% further reduction in sludge storage
- Oxidation Ditch = 0.60 lbs VSS/lb BOD 4% further reduction in sludge storage
- Activated Sludge with BNR (MLE Process) = 0.70 lbs VSS/lb BOD
- Membrane Bioreactor = 0.70 lbs VSS/lb BOD

Table 7-13
Biosolids Management
MCSD Wastewater Management Facility

Year	BOD[1] (ppd)[2]	Existing		HPAS/NF[4]		Extended Aeration		Ox Ditch		MBR[5]/ MLE[6]	
		ton yr.	Annual Cost[3]	ton yr.	Annual Cost[3]	ton yr.	Annual Cost[3]	ton yr.	Annual Cost[3]	ppd	Annual Cost[7]
2010	2,234	82	$81,541	103	$102,742	178	$177,938	252	$251,612	1,944	$439,832
2020	2,670	97	$97,455	123	$122,793	213	$212,666	301	$300,718	2,323	$525,672
2030	3,191	116	$116,472	147	$146,754	254	$254,163	359	$359,398	2,776	$628,247

1. BOD: Biochemical Oxygen Demand
2. ppd: pounds per day
3. Estimate based on $1,000 per ton for private contractor
4. HPAS/NF: High Performance Aeration System/Nitrifying Filter
5. MBR: Membrane Bioreactors
6. MLE: Modified Ludzack-Ettinger
7. Estimate based on estimated cost of $0.62/lb for hauling to Fortuna

The aerated pond system is followed by partially mixed cells in which solids settle and undergo further digestion. For the purposes of this analysis, it has been assumed that the biosolids from the in-basin suspended aeration system and oxidation ditch system will be stored in a stabilization lagoon for approximately 10 years where they will undergo a similar process of digestion and a volatile solids reduction. Management costs for these three alternatives were based on a cost of $1,000/dry ton to have biosolids removed from the storage lagoon dewatered and hauled to private disposal or land application sites.

The MLE process and MBR system produces a larger volume of less stabilized biosolids than the other secondary treatment alternatives, and long-term storage in a stabilization lagoon would not be feasible. It is assumed that the biosolids could be hauled to the wastewater treatment facility in Fortuna, which has a biosolids handling facility that will accept liquid biosolids. According to the superintendent of that facility, the charge per pound of biosolids would be approximately 60 cents and it is estimated that hauling would contribute an additional 2 cents.

7.6.3.3. Disinfection Cost

No significant deficiencies in the existing disinfection system were identified. The existing gas chlorination system is in good condition and in compliance with the Uniform Fire Code (fail safe valves are to be installed this year). The contact basin is of relatively new construction and has adequate volume to provide required contact times for projected peak day flows.

To determine whether an alternative disinfections system such as ultraviolet (UV) or on-site generation of hypochlorite could provide sufficient savings in annual operating costs to warrant consideration a present value analysis was performed. At the current average chlorine demand, annual costs for chlorine gas were greater than the estimated annual cost for on-site generation of hypochlorite but less than that for UV disinfection. The potential savings in annual cost did not provide enough of a return over the 20-year period calculated to pay for a new UV system at an estimated cost of approximately $500,000.

The current average chlorine demand of greater than 10 mg/L is high due to interference from seasonally high levels of suspended solids and algae in the lagoon/wetlands effluent. Demand is expected to decrease with improved secondary treatment. At an average demand less than 7 mg/L annual operating costs are approximately equal to annual power and bulb replacement cost for UV and at the demands estimated for improved secondary treatment annual costs for chlorine are less than for either alternative evaluated.

Based on the lack of existing system deficiencies and the low cost of chlorine gas in comparison to other alternatives, annual costs for disinfection were estimated based on the existing system. Costs are presented in Table 7-14.

Table 7-14
Disinfection Annual Chemical Usage
MCSD Wastewater Management Facility

	Chloride (Cl_2) Usage						Sulfide (SO_2) Usage				Chemical
	Demand	Residual	Dosage			Annual	Dosage			Annual	Annual
	mg/L[2]	mg/L	mg/L	ppd[3]	t/yr.[4]	Cost	mg/L	ppd	t/yr	Cost	Cost
Current	10.8	2.6	13.4	117	21	$12,615	4	40	7	$4,551	$17,167
Alt 1	7	2	9	90	16	$9,699	3	35	6	$3,952	$13,650
Alt 2	6	1	7	70	13	$7,543	2	17	3	$1,976	$9,519
Alt 3	5	1	6	60	11	$6,466	2	17	3	$1,976	$8,441
Alt 4	4	1	5	50	9	$5,388	2	17	3	$1,976	$7,364
Alt 5	3	1	4	40	7	$4,310	2	17	3	$1,976	$6,286

1. mg/L: milligrams per Liter
2. ppd: pounds per day
3. t/yr.: tons per year

7.6.3.4 Project Cost/Present Value

Annual operating costs are summarized in Table 7-15. The 20-year present value of these costs was then added to the Engineer's estimate of probable project cost to obtain a present value estimate for comparison of secondary treatment alternatives.

In addition to the annual operating costs shown in Table 7-15, there may be costs associated with the occasional addition of caustic soda or lime to increase alkalinity in the system. The potential cost for this application would be minimal and would apply to all alternatives; therefore this cost has not been included for comparison purposes.

Table 7-15
Comparison of Annual Costs by Alternative and Project Present Value
MCSD Wastewater Management Facility

Alternative	Current	HPAS/NF[1]	Extended Aeration	Oxidation Ditch	MLE[2]	MBR[3]
Power Costs[4]	$47,000	$251,000	$124,000	$182,000	$140,000	$156,000
Biosolids Management	$97,455	$122,793	$212,666	$300,718	$525,672	$525,672
Chlorine/Sulfide	$17,167	$13,650	$9,519	$8,441	$7,364	$6,286
Personnel	$50,000	$50,000	$100,000	$100,000	$100,000	$100,000
Annual Training	-	-	$3,000	$3,000	$3,000	$6,000
Annual Ops Costs	$211,622	$437,443	$449,185	$594,160	$776,036	$793,958
Ops Present Va.[5]	$2,877,000	$5,945,000	$6,105,000	$8,075,000	$10,547,000	$10,791,000
Project Cost	---	$7,270,000	$7,427,000	$8,686,000	$10,975,000	$14,156,000
Project Present Value	---	$13,215,000	$13,532,000	$16,761,000	$21,522,000	$24,947,000

1. HPAS/NF: High Performance Aerated Pond System/Nitrifying Filter
2. MLE: Modified Ludzack-Ettinger
3. MBR: Membrane Bioreactors
4. Power cost based on an average of $0.13/kWh
5. 20-Year present value, discount rate of 4%

7.6.4 Preferred Project

Secondary treatment alternatives with the capacity to treat projected loadings and produce a high quality effluent complying with requirement for discharge to the Mad River in wet weather and land reclamation or disposal during the summer have been evaluated with regard to treatment, cost, and implementability. As shown in Table 7-16, the in-basin extended aeration system can meet anticipated permit requirements at the lowest cost.

Table 7-16
Summary Evaluation Matrix
MCSD Wastewater Management Facility

	Alternative	Total[1]	Reliability/ Effect.	Implement -ability	Cost	Public Acc.	Reg. Issues
1	HPAS/NF[2]	4.0	1	2	5	3	4
2	Extended Aeration	4.9	3	3.6	5	3	5
3	Oxidation Ditch	3.7	3	2.6	3	2	5
4	Activated Sludge (MLE Process)[3]	3.7	4	3.3	2	2	5
5	MBR[4]	3.7	5	3.6	1	3	5
Weight[5]			0.2	0.2	0.4	0.2	0.2

1. High score considered to be most favorable.
2. HPAS/NF: High Performance Aerated Pond System/Nitrifying Filter
3. MLE: Modified Ludzack-Ettinger
4. MBR: Membrane Bioreactors
5. Higher cost weight includes project cost and operations & maintenance as a measure of operational complexity

There are no regulatory or public acceptance issues anticipated regarding construction because the facility upgrades will be constructed within the footprint of the existing plant.

7.7 Biosolids Management

The extended aeration system recommended as the preferred alternative for improvements to secondary treatment at the McKinleyville facility produces a much stabilized sludge. The volume of sludge is also lower than other activated sludge processes making it feasible to store the biosolids for periodic removal.

Biosolids management alternatives appropriate for the WWMF include the following:

- Long-term storage in sludge stabilization pond (assumes contracting of solids removal on 10-year basis)
- Land application of liquid biosolids on MCSD land
- Contract with City of Fortuna for disposal

7.7.1 Long-Term Storage

Average annual biosolids production was calculated based upon projected BOD loadings. Sludge yield for the extended aeration process without primary clarification was estimated to be approximately 0.45 lbs total solids/lb BOD removed (Metcalf and Eddy, 1991 Table 12-7). If the sludge is stored for longer than several months, the volatile fraction is reduced by an estimated 40%. The results of these calculations are presented in Table 7-17.

Table 7-17
Biosolids Storage
MCSD Wastewater Management Facility

Year	BOD[1]	Sludge Yield[3]		Stored[5]	Annual Production		Sludge Storage[7]		
		VSS[3]	TSS[4]	TSS	TSS	TSS	Volume		Area
	ppd[2]	ppd	ppd	ppd	ton	MG[6]	MG	ac.ft.[8]	Acres[9]
2010	2,234	1,005	1,377	975	178	0.70	7	22	2.0
2020	2,670	1,202	1,646	1,165	213	0.86	9	27	2.4
2030	3,191	1,436	1,967	1,393	254	1.03	10	32	2.9

1. BOD: Biochemical Oxygen Demand
2. ppd: pounds per day
3. Sludge yield 0.45 lb, Volatile Suspended Solids (VSS)/lb BOD, Volatility 70%
4. TSS: Total Suspended Solids
5. Volatile fraction of sludge reduced by 40%
6. MG Million gallons at 6%
7. Required storage 10-years
8. ac.ft.: acre feet
9. Assumes 11 feet of depth

The sludge storage area shown in Figure 7-2 is approximately 2 acres and can hold approximately 6 MG of sludge assuming an 11-foot depth and 2-foot water cap. This volume will provide approximately 9 years of storage at current loading rates and 8 years at projected 2030 loading rates. Estimated costs to employ an independent contractor for biosolids removal and disposal are approximately $1,000 per dry ton. The estimate is based upon recent biosolids removal cost for similarly sized municipalities in the area.

7.7.2 Land Application

Biosolids management cost could be significantly reduced if liquid biosolids could be land applied, especially if land used by the MCSD for disposal of treated effluent could also be employed for biosolids disposal. To determine the feasibility of this approach, the nitrogen contributed by the biosolids was evaluated and the area required for land application based on an assumed loading rate for nitrogen of 120 lbs/acre/year. The results are summarized in Table 7-18.

Table 7-18
Land Application of Biosolids
MCSD Wastewater Management Facility

Year	TSS[1] ton/year	NH_4-N[2] lbs/year[3]	NO_3-N[4] lbs/year	Org-N[5] lbs/year	PAN[6] lbs/year	Acres
2010	178	1,763	35	2,115	3,913	33
2020	213	2,163	43	2,596	4,803	40
2030	254	2,586	52	3,103	5,741	48

1. TSS: Total Suspended Solids
2. NH_4-N: Ammonium-Nitrogen (assumed to be 1% of total solids availability 50%)
3. lbs/year: pounds per year
4. NO_3-N: Nitrate-Nitrogen (assumed to be 0.1% of total solids availability 100%)
5. Org-N: Organic Nitrogen (assumed to be 2% of total solids availability 30%)
6. PAN: Plant-Available Nitrogen (based on agronomic loading rate for nitrogen of 120 lbs/acre/year)

7.7.3 Hauling

The City of Fortuna wastewater treatment plant is accepting liquid biosolids for treatment and composting. The biosolids handling facility is currently making a Class A composted biosolid used for landscaping by local residences, businesses, and nurseries. Currently, charges range from $0.60/dry lb for highly volatile biosolids to $0.80/lb for more stabilized biosolids.

The liquid biosolids could be hauled by truck and discharged into the digester at Fortuna on a biweekly basis, eliminating the need for the large sludge storage lagoon. There would be an increase in the volume of biosolids handled because digestion in the sludge lagoon and the resulting reduction in volume would be eliminated. However, the increased volume at current rates charged by Fortuna for handling and composting would not be cost effective for MCSD.

Because of a lack of biosolids disposal options within Humboldt County, Fortuna is being encouraged by the RWQCB to handle biosolids on a regional basis. If other communities take advantage of this service, the rates may be reduced, making this a more cost-effective solution for MCSD.

8.0 Disposal and Reclamation Alternatives

MCSD is currently permitted to discharge treated wastewater effluent to the Mad River (Discharge Point 001) from October 1 through May 14 (the discharge period), if river flows are greater than 100 times the wastewater flow and the flow in the river is greater than 200 cubic feet per second. If the flow conditions are not met, effluent is discharged to the percolation ponds adjacent to the river (Discharge Point 002) and/or to land for reclamation (use as irrigation water). From May 15 through September 30 (the discharge prohibition period), effluent is discharged to the percolation ponds (Discharge Point 002) and/or to land for reclamation. Discharge to land occurs at the Lower Fisher Ranch (Discharge Point 003), Upper Fisher Ranch (Discharge Point 004), the Hiller Parcel (Discharge Point 005), and the Pialorsi Ranch (Discharge Point 006). The existing discharge points are shown on Figure 5-1.

A series of disposal and reclamation alternatives have been evaluated that will allow MCSD to comply with discharge regulations under existing and projected flow conditions, including:

- New reclamation practices
- Continued use of the existing outfall to the Mad River
- Municipal Reuse
- Use of an Ocean Outfall

8.1 New Reclamation Practices

Under current conditions wastewater reuse on the existing wastewater reclamation areas does not conform to the current waste discharge requirements for reclamation activities. The Upper Fisher Ranch is not currently operated for reclamation; wastewater effluent is applied by overland flow irrigation methods in quantities that exceed agronomic rates for hay grass. Opportunities to increase irrigation on the lower pastures may balance these effects; however, based on current nitrogen loading rates, the existing available reclamation area is not sufficient to reclaim wastewater. The existing percolation ponds are also proposed to be removed from service. In order to accommodate the land application of effluent, modifications to the existing disposal management practices will need to include a reduction in total nitrogen in the plant effluent and an increase of the crop cover's ability to use the available nitrogen being applied through land application.

To increase reclamation capabilities at the land reclamation sites, installation of a poplar forest is proposed. The agronomic rate for the existing crop cover allows for the application of a total nitrogen loading of 120 to 170 pounds of nitrogen per acre per year. Poplars (*Populus* spp.) have proven to be effective biofilters and their forests provide a cost-effective method to recycle nutrients from wastewater discharge (EPA 2006). Literature suggests that poplars have a high transpiration rate and can have an average nitrogen uptake of 270 pounds of per acre per year, for a whole tree harvesting cycle of 6 to 15 years. By replacing the existing crop with a poplar tree forest, the total nitrogen loading can be increased from the current 170 pounds per acre per year to 220 -250 pounds per acre per year, reducing the total acreage required for land application.

Poplars are deciduous hardwood trees that grow in a wide variety of climates and soil conditions. There are four primary species of poplars that are used to create fast growing hybrids. Those include *Populus deltoids* (Eastern Cottonwood), *Populus nigra* (European Black Poplar), *Populus trichocarpa* (Western Black Cottonwood) and *Populus maximowiczii* (Asian Poplar).

Poplar trees are becoming a preferred treatment for the reuse of municipal and industrial wastewater. The trees have been proven to clean the water effectively and often provide a cheaper alternative than building additional treatment facilities. Poplar trees used for wastewater reuse in many instances will pay for themselves at harvest when the wood fiber is used for lumber, paper, or fuel for bio-energy.

The increased interest in using poplar trees in the treatment of wastewater is in part due because they are easy to manage and can provide a variety of secondary beneficial uses and products. A few of these products include fiber for pulp and paper, high quality lumber, poplar wood chips, biomass for renewable energy, shade, and windbreaks. In addition, poplar trees are one of the fastest growing trees. Poplars take less than 15 years to mature, whereas most other trees take 15 to 50 years to reach full maturity. This is an important factor for the following reasons: first, mature trees require more water for survival and growth; therefore, more wastewater can be applied as the trees mature. Secondly, older trees generally provide better quality lumber than do younger trees. Poplar trees also have a relatively high water uptake rate. Average poplar trees, aged at 3 years can absorb up to 10,000 gallons of water per acre per day in summer months.

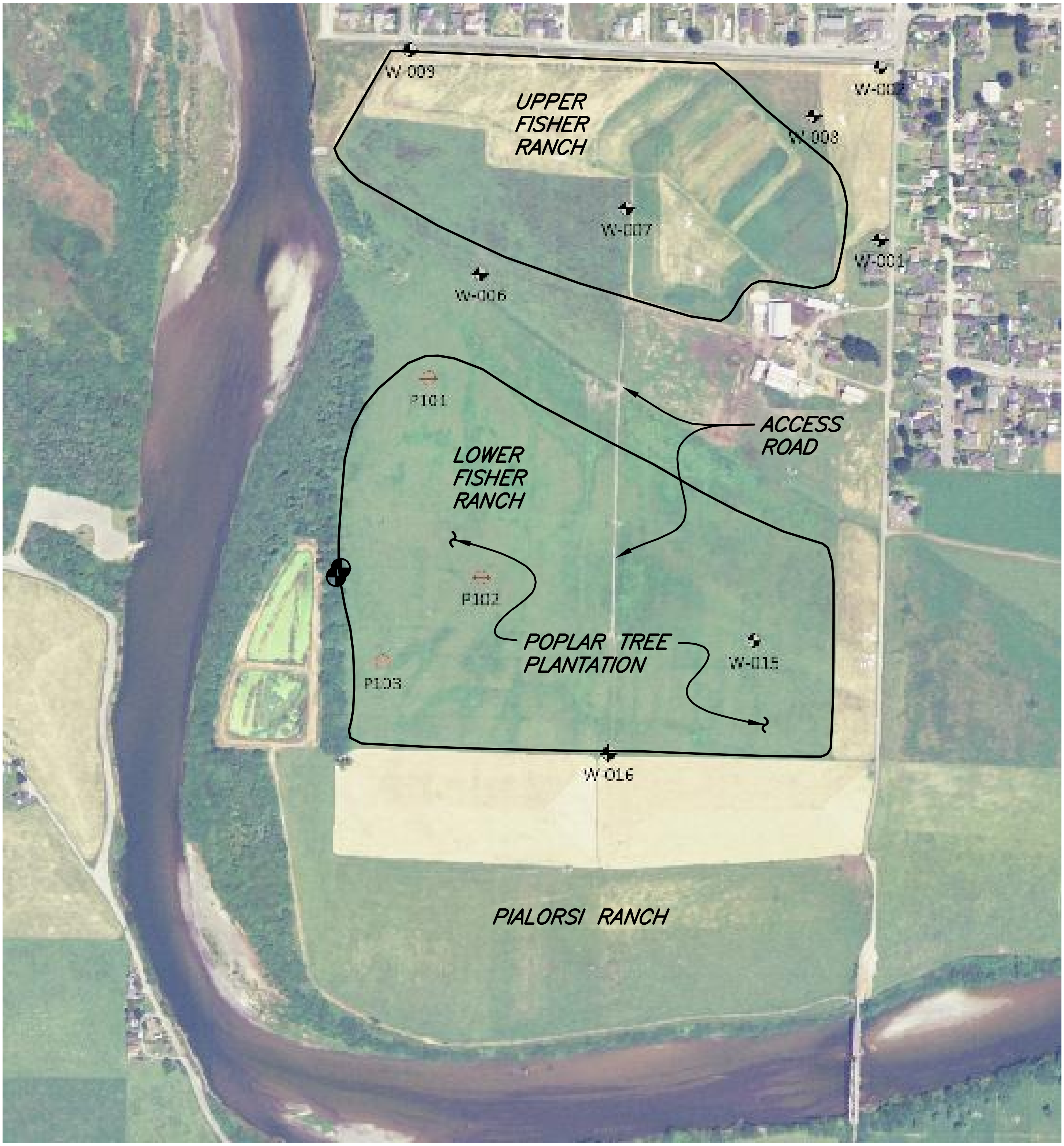
By using plant systems for reclamation of treated effluent, additional benefits of improved air quality are provided. Trees and shrubs have the potential to be an effective and inexpensive odor control mechanism. Trees can induce deposition of particulate matter by reducing wind speeds, and tree leaves can remove gaseous pollutants from the atmosphere. Trees also remove carbon dioxide (CO_2), one of the primary greenhouse gases that cause global warming.

8.1.1 Description of Disposal Strategy

8.1.1.1 Poplar Forest

The proposed poplar forest disposal plan includes the planting of a minimum of 45 acres of the lower Fisher Ranch property with poplars in 4 to 5 acre plots (Figure 8-1). The trees will receive wastewater through the irrigation system at a flow rate based on the age of the trees in the individual plot. Each plot of trees will be allowed to mature to the age of 10 to 15 years. The total acreage of the poplar forest is to be determined based on the results of the on-going pilot study. Additional acreage of trees will provide for the potential application of biosolids as part of a diverse biosolids disposal plan.

As the trees reach maturity, individual plots will be harvested in a crop rotation, harvesting no more than 10% of the forest in any single year. The rotation of the plots is designed to provide the maximum amount of mature trees while the younger trees have the opportunity to develop. The age of the trees at harvest can be varied depending on the end use of the harvested trees–the use of the trees for biomass generation requires a much shorter life cycle than trees being harvested for commercial milling.



EXPLANATION

MONITORING WELL

N

0 500'

1"=500'

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Land Disposal Site Plan SHN 008189.300
August 2011	008189-300-LAND-DISP-SITE	Figure 8-1

Each plot of trees will be irrigated with wastewater at agronomic rates adjusted for the age of the trees in each plot. A variety of irrigation systems will be evaluated with the evaluation criteria to include cost of installation, reliability, flow characteristics, and operation and maintenance considerations. The implementation of the preferred treatment plant modifications will reduce the total nitrogen from the current levels of 18 to 28 mg/L to total nitrogen of less than 8 mg/L. This reduction in total nitrogen will produce an effluent with an available nitrogen level of less than 6 mg/L.

Maintaining the existing crops and the current average annual flow of 1.12 MGD (2010) a total of 217 acres are required for land reclamation, assuming available nitrogen is equal to the current average annual TKN loading rate of 35 mg/L (2010). If poplars replaced the current grass crop mixture on the lower Fisher Ranch property, total acreage efficiency could be increased by 130%. Correspondingly, after future upgrades to the facility reduce available nitrogen concentrations to 6 mg/L and assuming an annual ADWF of 1.4 MGD, the total acreage required will be reduced from 90 acres (based on the current crop), to 75 acres, using poplars on approximately 45 acres of the available land reclamation sites.

Advantages:

- Ability to land apply entire dry weather flows without the use of the percolation ponds additional storage.
- Incorporation of biosolids disposal in the early years and potential for future use
- Low cost for development of alternative crops
- Biomass or merchantable timber from the harvesting of mature trees
- Flexibility to manage disposal based on variable weather conditions

Disadvantages:

- Additional operations and maintenance requirements over existing practices
- Increased nutrient management and recording required
- Groundwater monitoring requirements

8.1.1.2 Cost

The implementation of a polar forest disposal system will be spread over a 10-year period in order to build in the required rotation of the plants for harvesting. The initial planting would consist of 20 to 25 acres with the remaining acres being installed 5 acres per year for the following 4 to 5 years. The budgetary cost estimates presented in Table 8-1 are based on the construction of 45 acres of poplar forest, which is the minimum required acreage. The cost for the development of the poplar forest would be spread over a five to six year period.

Table 8-1
Engineer's Opinion of Probable Cost for Poplar Forest
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$121,500
Site Preparation	ac[1]	$500	45	$22,500
Planting of Trees	ac	$2,000	45	$90,000
Irrigation System	ac	$20,000	45	$900,000
Construction Subtotal				$1,134,000
Contingency 20%				$226,800
Engineering 25%				$283,500
Admin 4%				$45,360
Project Subtotal				**$1,689,660**

1. ac: acre

Harvesting activities will begin around year 12 after the initial planting. Costs associated with harvesting are not available at this time, but it is generally acknowledged that the cost of harvesting and replanting can be offset with the sale of the harvested trees as a bio-fuel or potentially for commercial milling. Operations and maintenance costs are projected to be approximately $25,000 per year to maintain the irrigation system.

8.1.2 Poplar Tree Pilot Study

A pilot study area has been established to evaluate the efficiency of poplar tree nutrient uptake in the southwest corner of the Lower Fisher Ranch reclamation area. The 1-acre site uses the existing irrigation main line that distributes wastewater effluent to the percolation ponds. Access to the pilot forest is from Fisher Avenue and the ranch roads that traverse the pastures. The pilot forest site is situated on the landscape to allow for expansion to the north and east.

A variety of trees, including hybrid poplars (black cottonwood and eastern cottonwood cross-fertilized), as well as trees native to the north coast of California were evaluated for consideration for the pilot study. The Black cottonwood (*Populus trichocarpa*) is a native cottonwood that was locally available and was selected for use based on its ability to uptake large quantities of water and its high nutrient assimilation capacity. Additional selection criteria included tree growth characteristics, viability, potential for beneficial use of harvested material, and local availability.

8.2 Existing Outfall to Mad River

During the discharge season, which extends from October 1 through May 14, wastewater is discharged from Discharge Point 001 to the Mad River. Discharge to the river is contingent on the flow in the river being above 200 cfs. During dry years, land application continues into the late summer and early fall months due to low river levels.

The existing discharge consists of a 16-inch pipe that extends from the treatment plant to the outfall located at the Hammond Trail Bridge crossing on the Mad River. The 16-inch plant effluent piping is reduced to an 8-inch pipe with a 16-foot length of flexible rubber pipe at the outfall. As the plant flows increase, the 8-inch piping and flexible hose may require upsizing; the capacity will need to be verified during additional pre-design efforts.

8.3 Municipal Reuse

It is recommended that the MCSD solicit public input regarding implementation of a municipal reuse program. Disinfected tertiary recycled water can be used for local schools, parks, golf courses, and so on. The main advantage of using recycled water is that it reduces peak demands on the municipal water system and storage tanks maintained by MCSD.

8.3.1 Requirements

Disinfected tertiary recycled water requires that secondarily treated wastewater is filtered prior to disinfection and that disinfection meets either of the following criteria:

- A CT (the product of chlorine residual and contact time) value greater than 90 minutes
- A median concentration of total coliform less than 2.2 MPN/100 ml and a maximum concentration of 23 MPN/100 ml

8.3.2 Implementation

The in-basin extended aeration system recommended in Section 7 as an upgrade to secondary treatment at the WWMF will provide disinfected secondary, 23 MPN recycled water suitable for irrigation and reclamation. A portion of the secondary effluent would be filtered using a granular media filters and the filtered water would be disinfected as separate side stream to provide disinfected tertiary recycled water.

The least expensive granular media filters are continuous backwash filters with an upflow configuration. Budgetary costs are estimated to be $480,000 per MGD. In addition to chemical addition and filtration systems, total project cost would include a separate purple pipe pumping and distribution system and would depend upon the demand for recycled water.

8.4 Ocean Outfall

The feasibility of year-round disposal of McKinleyville wastewater effluent using an ocean outfall was investigated because if it could be permitted, an ocean outfall could have significant advantages:

- It would eliminate the need for land reclamation, resulting in significant operations and maintenance savings
- If the mixing zone is approved, permit requirements for ammonia would be less stringent than they are for Mad River discharge, resulting in reduction in treatment costs.

- Concerns regarding the variable location of the river mouth and the associated extent of the adjacent estuary in the vicinity of the existing discharge location would be eliminated.

8.4.1 Regulatory Issues

A summary of issues regarding the proposed ocean outfall investigation was prepared by SHN in September 2010 (SHN, 2010). A copy of the summary of issues is included in Appendix H.

Two pre-application meetings were conducted in October and November 2010 to initiate the permitting process for construction of an ocean outfall for the WWMF. Representatives from the RWQCB, California Coastal Commission (CCC), California Department of Fish and Game (CDFG), National Marine Fisheries Service, US Army Corps of Engineers, and California State Lands Commission (CSLC) attended the meetings. A copy of the meeting summary from each workshop is also included in Appendix H.

Follow up discussion with CCC representatives was conducted in March 2011 to determine the level of effort needed for further permitting review of the ocean outfall alternative. The CCC indicated that the permitting of a new ocean outfall would require completion of an alternatives analysis that looked at other feasible alternatives for disposal that are not coastal dependant. If the analysis determines that other feasible options do not exist for disposal, then the CCC would consider pursuing permitting of the project. However if other onshore alternatives are available for disposal, the District would be directed to pursue the onshore alternatives over construction of a new ocean outfall.

Ocean outfalls in California are only permitted on a case-by-case basis. Regulatory agencies have indicated that a new ocean outfall would most likely not be permittable if other disposal alternatives exist. When coupled with improved secondary treatment and significant nitrogen reduction, continued surface water discharge to the Mad River and land reclamation at agronomic rates will comply with current and anticipated regulatory constraints.

The following information is presented herein to give the MCSD a basis for comparison to the current disposal strategy and to provide an alternative for disposal if regulations regarding discharge to the Mad River outfall change.

8.4.1.1 Mixing Zones

The EPA defines a mixing zone as an allocated impact zone where water quality standards may be exceeded as long as acutely toxic conditions are prevented and the State's beneficial uses are protected. Use of regulatory mixing zones as defined by the EPA is allowed at the discretion of the State. Historically, the RWQCB has decided whether to allow mixing zones in ocean on a case-by-case basis.

If a Regulatory Mixing Zone (RMZ) is permitted, water quality criteria must be met at the edge of the mixing zone. Water quality objectives for protection of marine life are defined in Table B of the California Ocean Plan. Constituents of particular concern in the McKinleyville effluent would include copper, lead, ammonia, diethyl phthalate, 4,4'-DDT, and dioxin equivalents.

Within RMZ A, a Toxic Dilution Zone (TDZ) may be provided to allow for dilution of toxic constituents below acute criteria or Criteria Maximum Concentration (CMC). The EPA provides guidance for setting stringent criteria that can be used to limit the TDZ based on probable exposure with no impact from short-term contact with toxic constituents. Three criteria are provided below, the more stringent of which should govern the limit of the TDZ.

1. The CMC should be met at a location that is 10% of the distance from the edge of the outfall structure to the edge of the RMZ.
2. The CMC should be met within a distance of 50 times the discharge length scale in any special direction. (The discharge length scale is calculated as the square root of the discharge port area.)
3. The CMC should be met within a distance of five times the local water depth in any horizontal direction from any discharge outlet.

8.4.1.2 Secondary Treatment

A new NPDES permit will need to be issued for an ocean outfall. Under the Clean Water Act (CWA), wastewater discharges from Publicly Owned Treatment Works (POTWs) are required to receive at least secondary treatment, unless an "ocean waiver" is obtained. Given anti-degradation requirements, treatment equivalent to current waste discharge requirements would be the minimum granted even under such a waiver.

It is assumed that secondary treatment limits for BOD and TSS of 30 mg/L will apply. Improvements to secondary treatment will be required because the existing facultative treatment system is at capacity for BOD removal. Secondary treatment could be provided by any of the secondary treatment alternatives discussed in Section 7.

8.4.1.3 Ammonia

The need to implement advanced treatment for nitrogen removal to provide effluent that complies with water quality limits for NH_4-N protective of aquatic life in the marine environment, and will depend upon whether the RWQCB permits a TDZ. Acute toxicity limits or CMC must be met within the TDZ, and Chronic or Continuous Concentration (CoCC) within the RMZ.

The CoCC and CMC vary with pH, temperature, and salinity, and can be calculated based on some assumptions regarding those parameters (Marshack, 2011). Estimates of these criteria and the required dilutions assuming secondary treatment without advanced levels of nitrogen removal are presented in Table 8-2.

Table 8-2
Ocean Outfall Ammonia Limits
MCSD Wastewater Management Facility

	Criteria	Marine Environment[3]			Effluent	Dilution Required
	NH_4-N[1]	pH	Temp	Salinity	NH_4-N	
	mg/L[2]	(pH units)	°C	g/kg[4]	mg/L	
CMC[5]	6.0	8.1	15	20	20	3.3
CCC[6]	1.0	8.1	15	20	20	20

1. NH_4-N: Ammonium-Nitrogen
2. mg/L: milligrams per Liter
3. Limiting values for ambient parameters
4. g/kg: grams per kilogram
5. CMC: Criteria Maximum Concentration (1-hr. average)
6. CoCC; Criteria Continuous Concentration (4 day average)

8.4.1.4 Required Treatment

If a toxic mixing zone is allowed for ammonia, enhanced treatment for nitrogen removal may not be required. Secondary treatment could be provided by an HPAS without a nitrifying filter at an estimated project cost of $4,700,000, or by treatment wetlands at an estimated project cost of $6,000,000.

8.4.2 New Outfall

The feasibility of constructing a new ocean outfall was discussed with the District and pertinent regulatory agency representatives in October and November 2010, with subsequent discussions with CCC staff in March 2011. A summary of the information reviewed is included in Appendix H.

8.4.2.1 Alignment

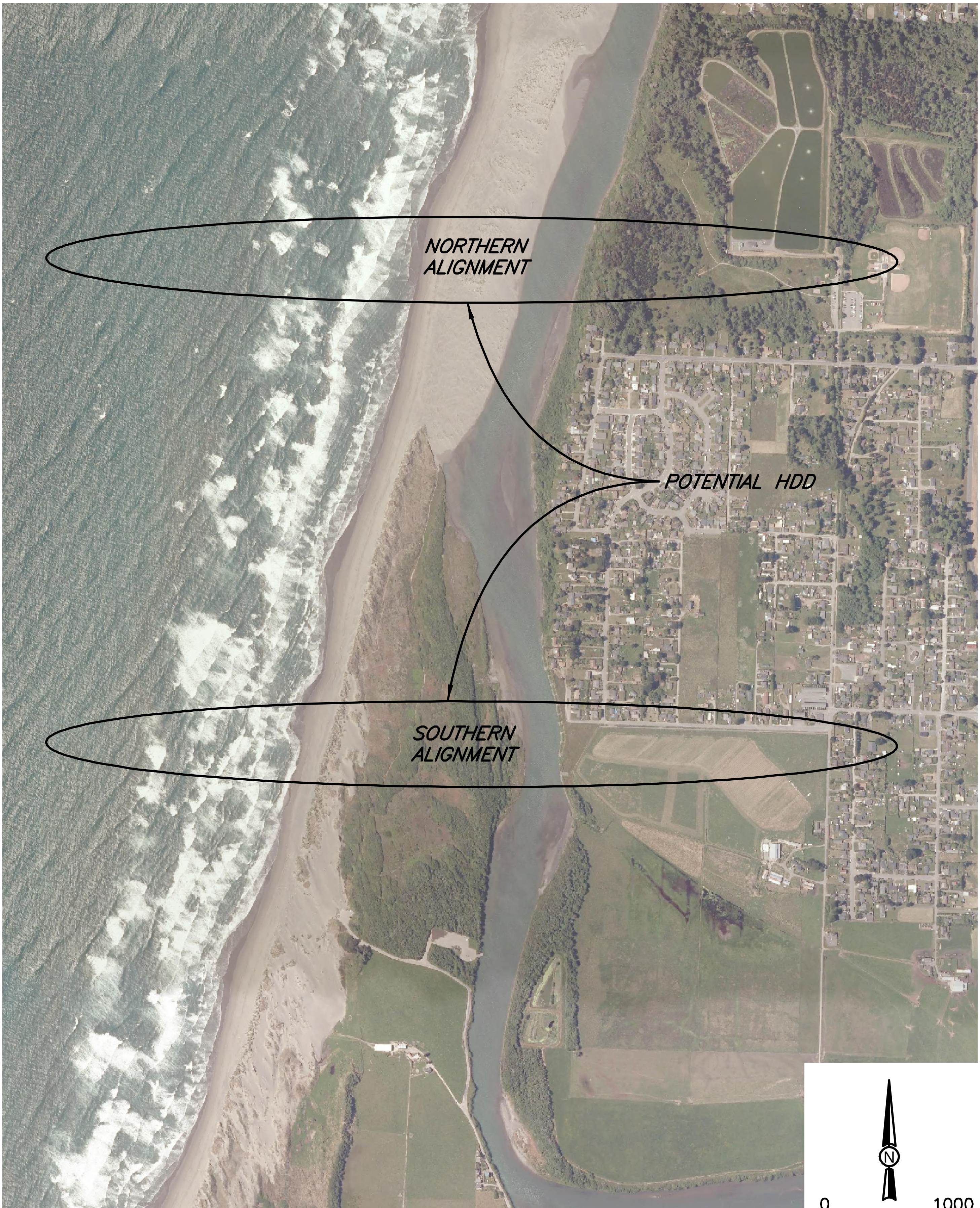
Locating a new outfall would depend upon many parameters, including:

- suitability for Horizontal Directional Drilling (HDD),
- offshore bathymetry, and
- subsurface conditions near the outfall diffusers.

It is assumed that the outfall would be constructed 2,000 to 4,000 feet offshore. This would put it outside of the zone of "immediate contact," which is defined in the ocean plan as the zone bound by the shoreline and a distance of 1,000 feet, or the 30-foot depth contour, whichever is less. In preliminary discussions two alignments were considered and are presented in Figure 8-2.

8.4.2.2 Budgetary Cost

Estimates of probable cost for the two alignments are presented in Table 8-3. This is a budgetary estimate and because of the uncertainty involved, a contingency of 30% is included in the estimate of project cost.



SOURCE: 2010 NAIP IMAGERY

SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, California	Conceptual Ocean Outfall Pipeline Location SHN 008189
	August 2011 008189-CONCEPT-OUTFALL	Figure 8-2

Table 8-3
Ocean Outfall Estimate of Probable Cost
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Northern Alignment				
Mobilization 12%				$541,800
HDD[1]	LF[2]	$1,000	4,000	$4,000,000
Diffusers	LS[3]	$75,000	ALL	$75,000
18-inch gravity discharge	LF	$220	2,000	$440,000
Construction Subtotal				$5,056,800
Contingency 30%				$1,517,040
Engineering 25%				$1,264,200
Admin 4%				$202,272
Project Subtotal				**$8,040,312**
Southern Alignment				
Mobilization 12%				$580,200
HDD	LF	$1,000	3,000	$3,000,000
Diffusers	LS	$75,000	ALL	$75,000
18-inch gravity discharge	LF	$220	8,000	$1,760,000
Construction Subtotal				$5,415,200
Contingency 30%				$1,624,560
Engineering 25%				$1,353,800
Admin 4%				$216,608
Project Subtotal				**$8,610,168**

1. HDD: Horizontal Directional Drilling
2. LF: Linear Foot
3. LS: Lump Sum

Part 4 Recommendations

9.0 Recommended Plan

This section presents the plan to correct deficiencies in the MCSD wastewater collection, treatment, and disposal systems and defines the upgrades required to enable the WWMF to meet secondary permit limits for the 20-year planning period. A site layout showing the recommended plan is included as Figure 9-1.

9.1 Collection System

The results of the preliminary collection system evaluation were presented in Section 6.0. The following sections describe the recommended collection system pipe network and pump station improvements.

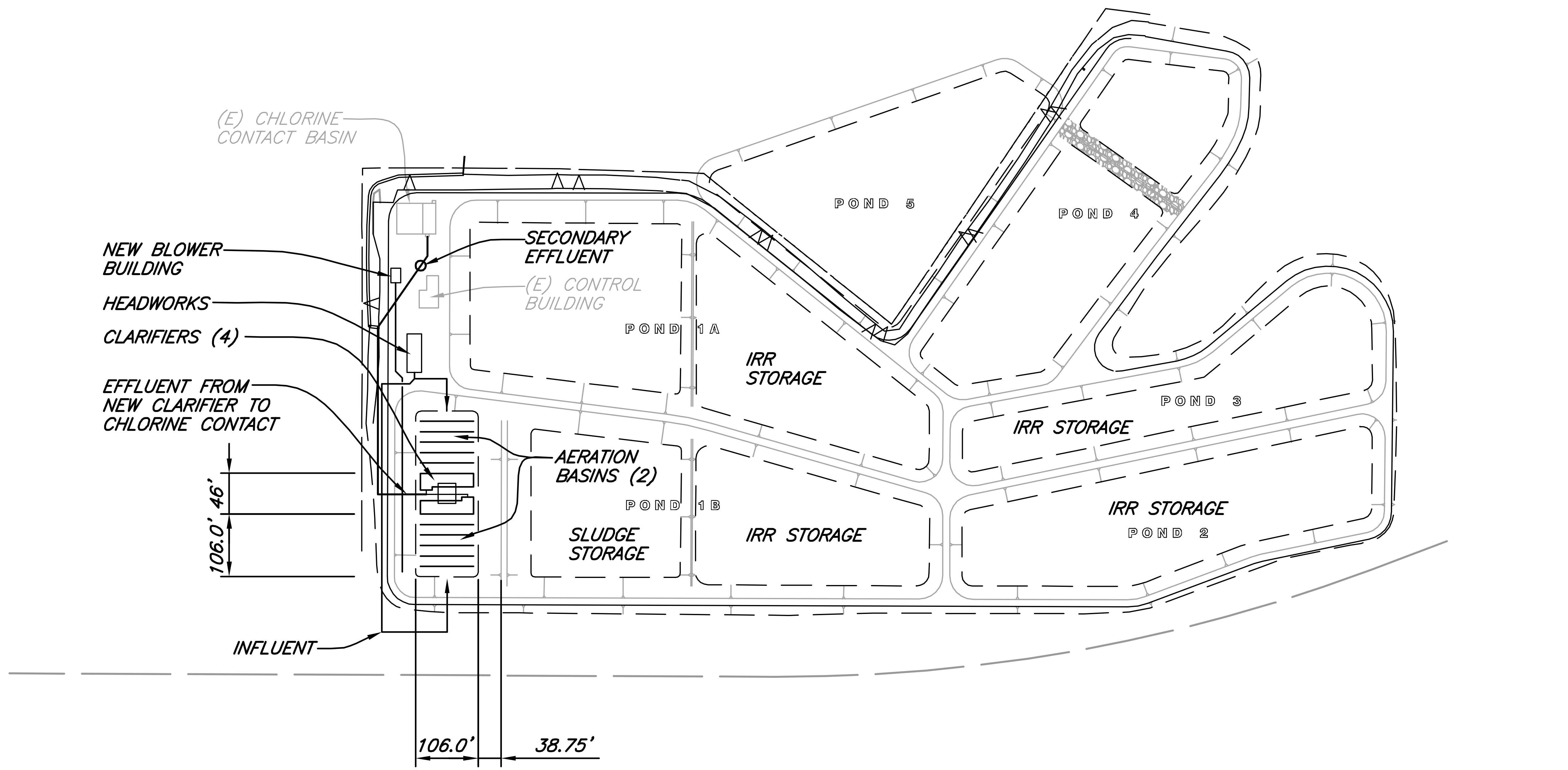
9.1.1 Pipe Network Improvements

The central trunk line under Highway 101 (Line 5) and the southern trunk line west of Highway 101 (Line 3) have been identified as the critical areas in the collection system that will require upgrades under projected flow conditions. Recommended improvements to the collection system network include lining the existing 10-inch AC pipes that comprise the central trunk line (Line 5) with Cured In Place Pipe (CIPP) and installing a 12-inch pipe parallel to the 10-inch line to increase capacity. For the pipes that comprise the southern trunk line (Line 3), recommendations include lining the existing 15-inch pipe with CIPP and installing a 15-inch pipe parallel to the existing 15-inch line.

Alternatives to the recommended improvements include direct pipe replacement rather than parallel pipe installation for each pipe network. These alternatives will be investigated for costs savings during design. Direct pipe replacement will require re-routing of flows during construction on each pipe segment, which may prove problematic for the larger trunk lines.

9.1.2 Lift Station Improvements

Recommendations for lift station improvements include mechanical and electrical system upgrades to the Letz, Hiller, and Fisher lift stations. Mechanical system upgrades will include replacing the pumps, motors, and any necessary but minor equipment (i.e., heating and ventilation systems) at the Letz, Hiller, and Fisher lift stations. Electrical system upgrades would include installing new motor control centers, adding variable frequency drives, installing a programmable logic controller (PLC), installing more modern level sensing equipment, and making any changes to the electrical system to comply with current electrical code requirements. At the Hiller Station, a new generator and automatic transfer switch will be added with the lift station upgrade project.



BASE MAP PROVIDED BY :
WINZLER & KELLY, DATED JUNE 2005

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SHN Consulting Engineers & Geologists, Inc.	McKinleyville Community Services District Wastewater Management Facility McKinleyville, CA	In -Basin Extended Aeration System Recommended Project SHN 008189
	August 2011	008189-POND-REC — Figure 9-1

The improvements will benefit MCSD by increasing the pump station efficiency, lowering electrical demands, increasing the station reliability, increasing worker safety, and reducing wear on the pumps. Upgrades to the pumps will include the capacity to discharge to an elevated headworks, adding approximately 10-feet of elevation to the existing hydraulic profile.

9.1.3 Detailed Cost Estimate

Preliminary cost estimates for the recommended pipe network and lift station improvements are presented in Table 9-1.

Table 9-1
Engineer's Opinion of Probable Cost for Collection System Improvements
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$241,800
Install 12-inch PVC parallel to Line 5 (trenchless installation)	LF[1]	$750	400	$300,000
Install 12-inch PVC parallel to Line 5 (trenching)	LF	$200	1,000	$200,000
Line Existing 10-inch Pipe	LF	$50	1,400	$70,000
Install 15-inch PVC parallel to Line 3	LF	$200	2,900	$580,000
Line Existing 15-inch Pipe	LF	$75	3,000	$225,000
Letz Lane Station Upgrades	LS	$175,000	1	$175,000
Hiller Lift Station Upgrades	LS	$175,000	1	$175,000
Fisher Lift Station Upgrades	LS	$290,000	1	$290,000
Construction Subtotal				$2,256,800
Contingency 20%				$451,360
Engineering 25%				$564,200
Admin 4%				$90,272
Project Subtotal				**$3,362,632**

1. LF: Lineal Foot
2. LS: Lump Sum

9.2 Treatment System

Alternatives for providing secondary treatment and biosolids management were evaluated in Section 7.0. The following sections describe the preferred secondary treatment and biosolids management systems in more detail, and summarize the recommended project.

9.2.1 Pre-treatment

Proposed preliminary treatment at the MCSD facility will include pre-screening, and grit removal. The recommended screening option is to install two inclined, 2-MGD spiral screens. The three grit removal options evaluated in Section 7 were comparable in cost. The HeadCell® is recommended as more effective than the aerated channel and easier to maintain than the vortex system.

Preliminary cost estimates for an elevated headworks are presented in Table 9-2. The screenings channel would be located on the second floor with drive through access for collecting screenings and grit from a dumpster on ground level.

Table 9-2
Engineer's Opinion of Probable Cost for New Headworks
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$81,960
Vertical Screens and Compactor	EA[1]	$65,000	2	$130,000
HeadCell®	EA	$90,000	1	$90,000
Grit Classifier	EA	$78,000	1	$78,000
Grit pumps	EA	$20,000	2	$40,000
Electrical	LS[2]	$75,000	ALL	$75,000
Headworks Construction	LS	$250,000	ALL	$250,000
Yard piping	LS	$20,000	ALL	$20,000
Construction Subtotal				$764,960
Contingency 20%				$152,992
Engineering 25%				$191,240
Admin 4%				$30,598
Project Subtotal				**$1,139,790**

1. EA: Each
2. LS: Lump Sum

9.2.2 Secondary Treatment System

Secondary treatment alternatives with the capacity to treat projected loadings and produce a high quality effluent complying with requirements for discharge to the Mad River in wet weather, and land reclamation or land disposal during the summer, were evaluated with regard to treatment, cost, implementability, public acceptance, and regulatory issues. Nitrogen removal, in addition to secondary treatment, was considered a priority.

The in-basin extended aeration system provides a high quality effluent that would be reliable in meeting anticipated permit requirements for land application and discharge to Mad River with effluent ammonia concentration less than 1 mg/L, and total nitrogen concentrations of 8 mg/L. Of the alternatives considered the in-basin extended aeration system had the lowest capital and operational costs. Project costs for the in-basin extended aeration system were estimated to be $7,426,000 as itemized in Table 7-6 and as summarized in Table 9-3.

Table 9-3
Engineer's Opinion of Probable Cost for Recommended Secondary Treatment Alternative[1]
MCSD Wastewater Management Facility

Description	Total Cost
Mobilization 12%	$534,004
Earthwork	$1,194,250
Structural	$614,000
Equipment	$2,334,280
Mechanical	$307,500
Construction Subtotal	$4,984,034
Contingency 20%	$996,807
Engineering 25%	$1,246,008
Admin 4%	$199,361
Project Subtotal	**$7,426,210**

1. The recommended secondary treatment alternative is the in-basin extended aeration system consisting of suspended aerators and integral clarifiers, itemized costs as presented in Table 7-6.

9.2.3 Biosolids Management

Three options for biosolids management were presented in Section 7.7. One option presented included the land application of liquid biosolids at the reclamation sites not used for the poplar forest plantation. Although disposal of both effluent and biosolids on the land reclamation sites may be feasible following plant modifications at current flows, crop uptake rates of nitrogen would probably be exceeded at future loadings without additional area for disposal and/or modification of crop cover. Planting additional acres of trees at the reclamation sites will provide for the potential application of biosolids as part of a diverse biosolids disposal plan. Development of the reclamation reserve area may also provide the additional area necessary for biosolids disposal.

The other options considered were hauling to a regional facility in Fortuna or contracting to have the biosolids dewatered and hauled away approximately every 10 years. Currently, disposal at the regional facility exceeds $1,000 per dry ton, but if the facility is expanded during the next five years, costs are expected to decrease.

9.3 Disposal and Reclamation

MCSD is applying wastewater effluent to the reclamation areas at irrigation rates that exceed the soil moisture deficit of the pastures (SHN, 2011). Without improvements to the disposal system, an increase in effluent flows distributed to the pastures, due to either the necessity to remove percolation ponds from the disposal system or from future urban growth, would further exceed the agronomic water demand of the existing reclamation sites. Improvements to the existing disposal and reclamation system are necessary to achieve compliance with effluent disposal and land reclamation requirements.

9.3.1 Storage

Discharge to the Mad River ceases on May 14. During a wet spring, it may be necessary to store effluent when land application rates are limited by precipitation, low rates of evapotranspiration, and high groundwater on the lower portions of the reclamation sites. The existing basins and wetlands that will not be converted for use in the extended aeration process, or used for sludge storage, will have approximately 23 MG of storage capacity. This additional basin and wetland storage area will be available for storage following completion of the secondary treatment system improvements.

9.3.2 Disposal

The District is in the process of studying alternatives to the continued use of the existing percolation ponds for effluent disposal. This facilities plan provides the basis for a proposed alternative that will allow for the percolation ponds to be abandoned in place and removed from use. The volume of water discharged annually to the percolation ponds will be discharged instead through increased land reclamation and/or land disposal following upgrades to the secondary treatment system. The estimated cost for percolation pond decommissioning is shown in Table 9-4. As an alternative to the decommissioning of the percolation ponds, the CDFG has expressed an interest in use of the percolation ponds for fish rearing facilities. This alternative use for the percolation ponds should be considered and investigated as part of the pre-design process.

Table 9-4
Engineer's Opinion of Probable Cost for Percolation Pond Decommissioning
MCSD Wastewater Management Facility

Description	Unit	Unit Cost	Quantity	Total Cost
Mobilization 12%				$11,700
Clearing and Grubbing	ac[1]	$3,500	3	$10,500
Earthwork	CY[2]	$8	10,500	$84,000
Replanting	ac	$1,000	3	$3,000
Construction Subtotal				$109,200
Contingency 20%				$21,840
Engineering 25%				$27,300
Admin 4%				$4,368
Project Subtotal				**$162,708**

1. ac: acre
2. CY: cubic yard

The in-basin extended aeration will reduce total nitrogen levels to less than 8 mg/L; however, effluent flows will gradually increase over time as the population of McKinleyville continues to grow. Because of the reduced nitrogen loading, land application of effluent at rates that exceed agronomic application rates should not negatively impacting soil or groundwater with regard to nitrate, which is generally the contaminant of concern. However, if application rates are higher than agronomic rates for a given land application area, the District will need to apply for a land disposal permit, rather than a land reclamation permit, for those specific areas.

The RWQCB grants land disposal permits if protection of groundwater beneficial uses can be demonstrated. The in-basin extended aeration system will provide the necessary effluent quality to ensure protection of groundwater for land disposal.

9.3.3 Reclamation

It is recommended that the reclamation efficiency of the land reclamation sites be increased by substituting poplar trees for the existing perennial grasses. Given the improved quality and low nitrate levels expected in the treated effluent, reclamation of effluent using poplar trees is a viable land reclamation improvement that will allow for increased hydraulic loading on the land reclamation sites. The cost to convert the land reclamation sites to a 45-acre poplar forest was estimated to be approximately $1,690,000.

9.4 Project Cost Summary

9.4.1 Project Cost

Table 9-5 presents the engineer's opinion of probable cost for the complete WWMF collection, treatment, and disposal system improvements.

Table 9-5
Engineer's Opinion of Probable Cost for Complete WWMF System Improvement
MCSD Wastewater Management Facility

Component	Description	Total Cost
Collection System	Gravity Mains/Lift Stations	$3,363,000
Pre-treatment	Headworks	$1,139,800
Secondary Treatment[1]	In-Basin Extended Aeration	$7,426,300
Land Reclamation	Poplar Forest	$1,689,700
Effluent Disposal	Percolation Pond Removal	$162,700
Total Project Cost	---	**$13,781,500**

1. Includes long-term Biosolids Storage

9.4.2 Operation and Maintenance

The proposed in-basin extended aeration system is more operationally complex than the current facultative pond system, but operation is very straight forward compared to other activated sludge systems. The fact that this system is operated at very long detention times not only produces a high quality effluent, but also makes it very forgiving in terms of operation.

Operational costs developed in Section 7 are presented in Table 9-6. Implementation of an extended aeration system will approximately double the amount of biosolids produced when compared to the facultative lagoons and add to operations and maintenance significantly. Based on a contract cost of $1,000 per dry ton produced annual cost for biosolids management would be approximately $216,000 per year. However, because the District could significantly reduce costs by land applying a significant portion of the biosolids produced, and/or costs for hauling to a regional facility may decrease, annual costs for biosolids management are estimated to be $150,000.

Table 9-6
Estimated Annual Operating Costs
MCSD Wastewater Management Facility

Description	Cost
Power Costs	$124,000
Biosolids Management[1]	$150,000
Chlorine Disinfection/Sulfide	$9,500
Operation Personnel	$100,000
Annual Training	$3,000
Annual Operating Costs	**$386,500**

1. Estimated cost for liquid hauling and land application

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