# Wastewater Reuse Systems for Idaho Development Projects - A Case Study -

For:
2007 Idaho Wastewater Reuse Conference

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SUNCOR

# Purpose of Presentation

- Discuss experience with planning, design and construction of Class A and Class B wastewater reuse systems for Idaho development projects.

PE

# Idaho Developments

AVIMOR™

SOUTHFORK LANDING

HIDDEN SPRINGS
CHANGE YOUR VIEW

AVIMOR™

HIDDEN SPRINGS
CHANGE YOUR VIEW

SOUTHFORK
LANDING

# Top 10 Fastest Growing States (1)

| State | Percent Change |
|---|---|
| 1. Arizona | 3.6 |
| 2. Nevada | 3.5 |
| **3. Idaho** | **2.6** |
| 4. Georgia | 2.5 |
| 5. Texas | 2.5 |
| 6. Utah | 2.4 |
| 7. North Carolina | 2.1 |
| 8. Colorado | 1.9 |
| 9. Florida | 1.8 |
| 10. South Carolina | 1.7 |

(1) Per U.S. Census Bureau

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# Common Scenario

- Development of a new community outside of “metro” area of impact, intended to provide a “country” or “relaxed” lifestyle setting
- Treatment plant service size
  - Avimor - 3,300 Homes
  - SouthFork Landing - 630 Homes
  - Hidden Springs - 1,525 homes
- Development needs stand-alone utilities including water and wastewater systems to support project

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# Wastewater Issues Important to Developers

- Initial capital cost
- Schedule
- Proven technology
- System reliability
- Reuse potential
- Ease of implementation
- Ability to meet environmental requirements
- Ease of operation
- Odor and noise
- Footprint

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# Capital Costs

- Initial capital costs need to be kept in line with lot sales
  - Reduce upfront costs for system by providing an expansion plan for new treatment facilities as new development phases are built
  - Requires multiple treatment trains to be built in phases
    - Define minimum design flows per phase and how many treatment trains per phase
    - How trains connect together in future

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# Schedule Conflict

- Work on treatment system is often delayed until approvals are obtained by County

- But…Project needs to be planned, permitted and constructed in time to allow for sanitary restrictions to be lifted so that lots can be sold

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# Planning

- Studies Required
  - Facilities Plan
  - Preliminary Engineering Report
  - Reuse Permit
    - Preliminary technical report
    - Reuse permit application
    - If Class A – Class A engineering report
  - NPDES Permit Application

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# Planning
# Flows and loads

- Allocate 300 gpd per residential
  - Avimor – Phase I  333,000 gpd
  - SouthFork Landing -  Phase I  67,000 gpd
- If historical data supports a reduction in the unit flow rate reduced unit volumes may be approved
  - Hidden Springs  Phase II  -  275,000 gpd (Hidden Springs @ 180 gpd/residence)
- Ten States Standards unit loading values used for determination of wastewater loading

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# Planning

- Selected Treatment Process
  - Avimor - MBR
    - (Class B Reuse)
  - SouthFork Landing - MBR
    - (Class A Reuse)
  - Hidden Springs - Aerated Lagoon w/ Filtration
    - (Class B Reuse – First in State)

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# Planning

- Solids Handling
  - Can be a challenge for developers since few options are available to small systems
  - Developments typically have limited storage capability due to location within development
  - Trucking to landfill was best alternative
    - Liquid sludge – near-term
    - Dewatered sludge – long term

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# Planning

- WWTF Operations
  - Contract operations
    - Numerous “local” operations groups are forming to meet demand
- Options for effluent disposal:
  - NPDES Permit
  - Reuse/recharge

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# NPDES

- Receiving streams can provide long-term or winter time option for effluent disposal
  - Avimor – Spring Valley Creek – Dry Creek – Boise River
  - SouthFork Landing – South Fork of Payette River
- Timing for NPDES permitting typically does not meet requirements of project schedule
  - Requires dual reuse/disposal plan utilizing initial reuse and then phase into direct discharge at least during winter months
- Region X will take >24 month turn-around on NPDES permits
- Status of TMDL for watershed will be a critical issue for NPDES

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# Effluent Reuse

- Idaho Reuse Rules
  - Revised 02/27/07
  - Few Class A or Class B reuse permits have been issued under new reg's
- Provides five categories for effluent disposal
  - Class A and B are most common for municipal reuse
  - Class A carries a high price "tag" for additional facilities to satisfy redundancy requirements of the regulations
  - Class B provides very high quality reuse water and often meets reuse objectives

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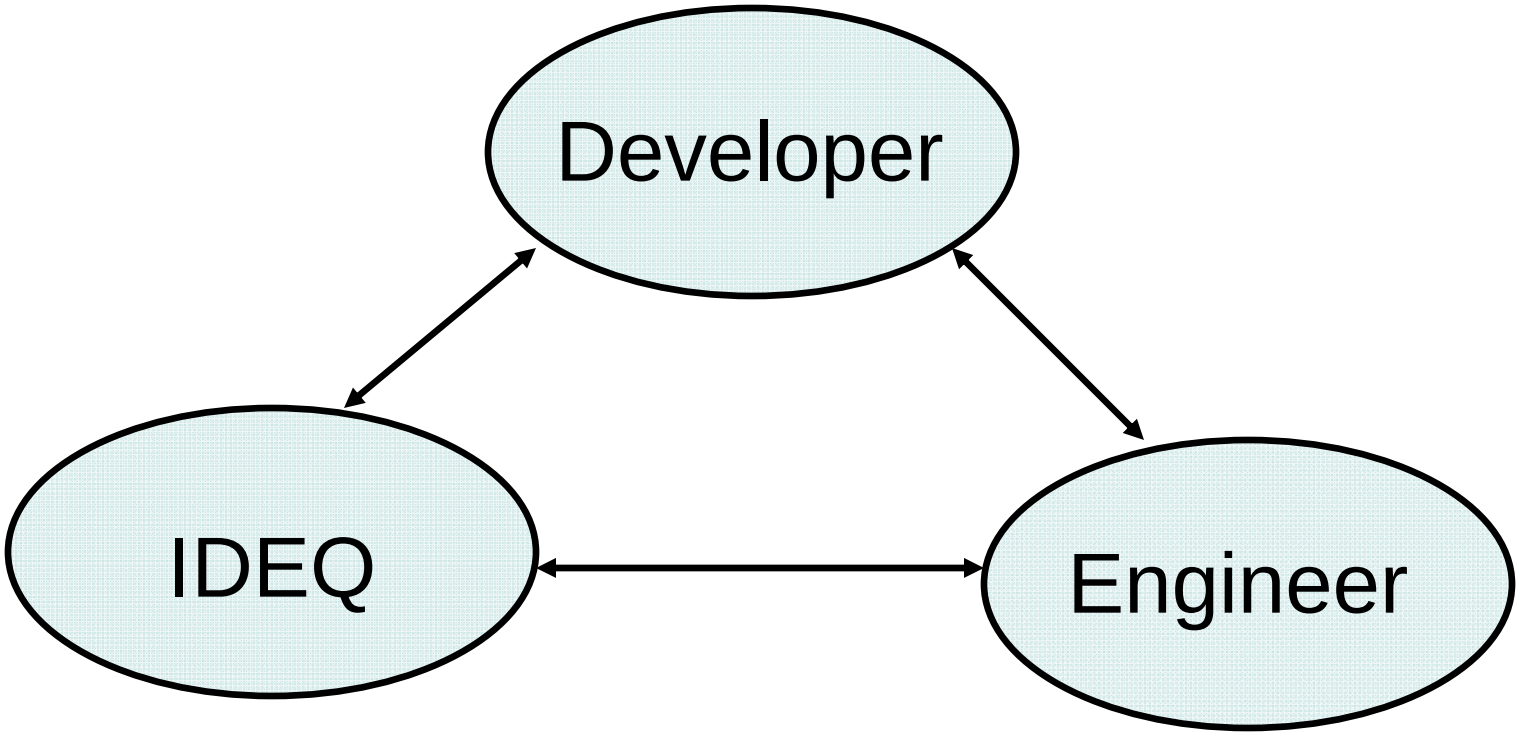
# Team Approach will Resolve Site Specific Reuse Issues



# Effluent Reuse

- Reuse rules will dictate the level of treatment required for BOD/TSS and disinfection
  - Class A adds redundancy to the system
    - For South Fork Landing has a redundant treatment train and 7-day holding pond was designed into system
- Nitrogen will be driven by impacts on groundwater < 10 mg/l TN for recharge systems
- Phosphorus will be set by TMDL depending on the connection between groundwater and surface waters

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# Wastewater Disposal Scenarios

- Summer (April 1 – Nov. 1)
  - Avimor, South Fork Landing and Hidden Springs
    - Landscape irrigation
      - Parks
      - Ball fields
      - Common areas
    - Buffer zone requirements need to be identified early in planning process
- Winter (Nov 1 - March 31)
  - Hidden Springs
    - Storage
  - Avimor and South Fork Landing
    - Groundwater recharge through rapid Infiltration
    - Future NDPES discharge

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# Project Implementation

- Approach similar to industrial rather than municipal work
  - No public work's bidding requirements
  - Direct negotiated purchase of equipment
  - Selection of contractors is often negotiated with pricing being based on:
    - Not-to-exceed price
    - Cost plus fixed fee
    - Time and expense basis

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# Design/Build

- Avimor and SFL – Design Build Projects
  - Attractive to developers
    - Contractor takes lead role in project with support from engineers
    - Developers are familiar dealing with contractors
    - Single point of responsibility
    - Often combines wastewater, water systems and other site utilities under one contract

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# Case Study No. 1
# Avimor

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# Avimor Planned Community

- Kevin Wentland, P.E.
- Project Introduction
  - What is Avimor
  - Wastewater & Reuse at Avimor
    - Long term & short term
  - Experiences
  - Status

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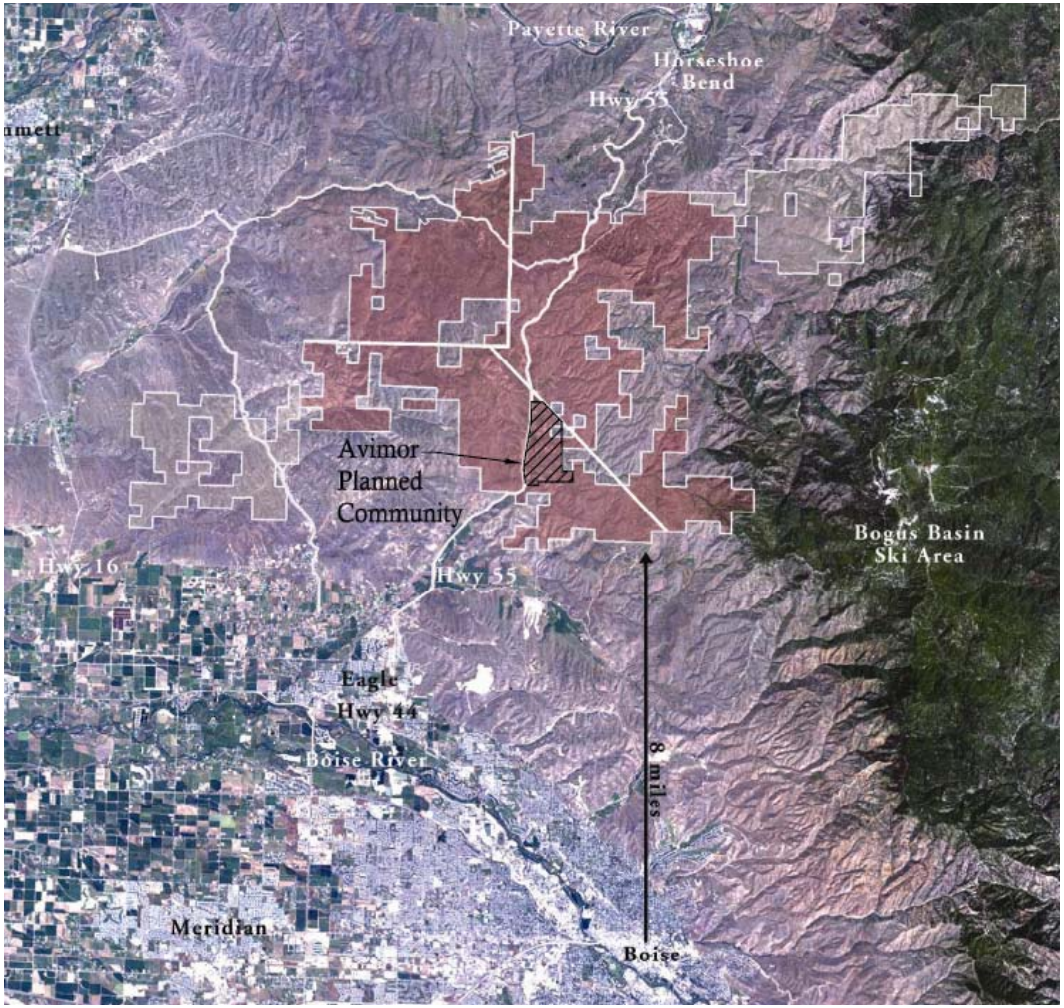
# Avimor Planned Community

- Spring Valley Ranch 32,000 acres
- 10 miles north of Eagle, Idaho
- Ada, Boise, and Gem counties
- Elevation ranges between 3150 and 3520
- Residential, commercial, and institutional property will cover 9,200 acres of the development.

# Avimor Location

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# Avimor Water Conservation

- Low-flush toilets
- Low-flow fixtures
- Insulation of hot-water pipes and heaters
- Low-flow dishwashers and washing machines
- 200 gpd/lot expected
- For planning purposes, 300 gpd per lot is used.

# AWRF Overview

- Class B Facility
- 0.33 mgd facility expandable to 1.0 mgd in three equal phases
- Draft Reuse Permit open for comment
- Treatment system is activated sludge with membranes
- Designed for removal of BOD, TSS, TN, TP (chemical precip)
- Solids handling

# AWRF Requirements

- Master Plan
- Preliminary Engineering Report
- Design Plans and Specs
- Reuse Permit
- NPDES Permit

# AWRF Schedule

- Master Planning, PER -  6 months
- Plans & Specs – 4 ½ months
- Review & Revisions – 3 months
- Reuse Permit – year to draft permit
- Construction – 1 year

# AWRF Design Loading & Flows

| Parameter | Loading (lbs/person) |
|---|---|
| Biochemical oxygen demand, 5-day (BOD5) | 0.1700 |
| Total suspended solids (TSS) | 0.1900 |
| Total phosphorus (TP) | 0.0059 |
| Total nitrogen (TN) | 0.0294 |

## Flows

| | Flow (mgd) |
|---|---|
| Average daily | 0.33 |
| Peak daily | 0.66 |
| Peak hour | 1.16 |

# Flow and Loading

| Parameter | Flow | Loading (lbs/day) | | | |
|---|---|---|---|---|---|
| | (mgd) | $BOD_5$ | TSS | TN | TP |
| Average daily | 0.33 | 701.3 | 783.8 | 121.3 | 24.3 |
| Peak daily | 0.66 | 1,402.50 | 1,567.50 | 242.6 | 48.7 |
| Peak hour | 1.16 | | | | |

# Phase 2 Flow and Load

| Parameter | Flow | Loading (lbs/day) | | | |
|---|---|---|---|---|---|
| | (mgd) | $BOD_5$ | TSS | TN | TP |
| Average daily | 0.66 | 1,402.50 | 1,567.50 | 243 | 49 |
| Peak daily | 1.32 | 2,805.00 | 3,135.00 | 485 | 97 |
| Peak hour | 2.31 | | | | |

# Phase 3 Flow and Load

| Parameter | Flow | Loading (lbs/day) | | | |
|---|---|---|---|---|---|
| | (mgd) | $BOD_5$ | TSS | TN | TP |
| Average daily | 1.00 | 2,805.00 | 3,135.00 | 485 | 97 |
| Peak daily | 2.00 | 5,610.00 | 6,270.00 | 970 | 195 |
| Peak hour | 3.00 | | | | |

# Effluent Design Criteria

- BOD & TSS < 5.0 mg/l
- TP < 0.1 mg/l
- TN < 8.0 mg/l
- Turbidity < 2.0 NTU

# AWRF Components

- Lift Station
  - 1.0 mgd – ultimate capacity
- Headworks
  - Fine screening
    - Structural for ultimate capacity
    - Mechanical equipment for 1st Phase
    - Screenings to landfill

# AWRF Components

- Equalization Basin
  - Ultimate capacity
- Anoxic Basin
  - 1st Phase
- Aeration Basins
  - 1st Phase
  - 3 trains

# AWRF Components

- MBR Basins
  - 1st Phase
  - 3 basins
- Control Building
  - Ultimate capacity
- Permeate Pumps
  - 1st Phase
- Blowers
  - 1st Phase

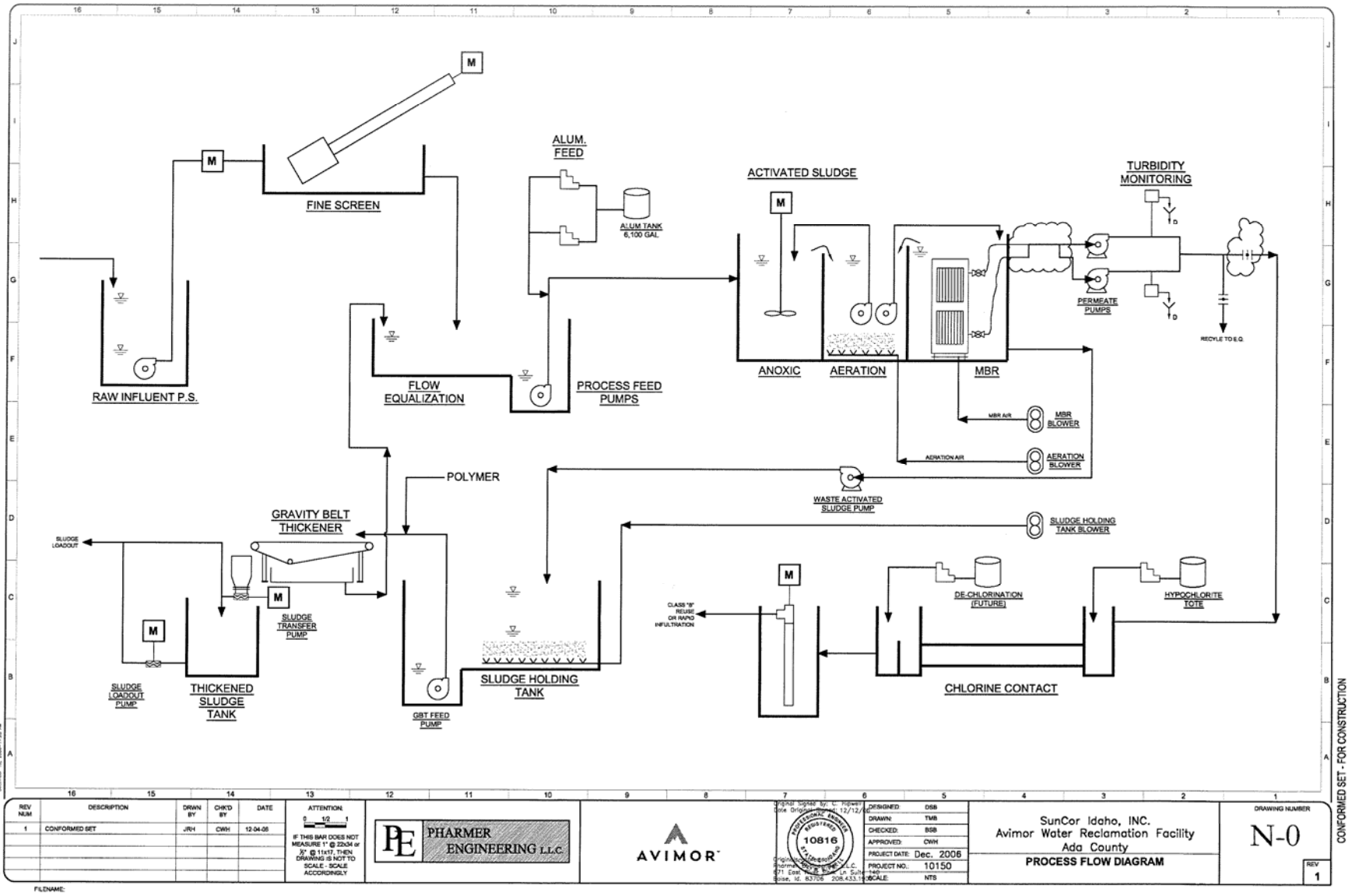
# AWRF Components

- WAS Pumps
  - Ultimate capacity
- Sludge Storage
  - Ultimate capacity
- Solids handling
  - GBT
  - Press added at future phase

# AWRF Components

- Disinfection with Chlorine
  - Ultimate capacity
- Reuse Pumping
  - Ultimate capacity
- Electrical
  - 1st Phase
  - Room for expansion

# AWRF P&ID




| REV NUM | DESCRIPTION | DRAWN BY | CHK'D BY | DATE |
|---|---|---|---|---|
| 1 | CONFORMED SET | JRH | CWH | 12-04-06 |

ATTENTION: IF THIS BAR DOES NOT MEASURE 1" @ 22x34 or ½" @ 11x17, THEN DRAWING IS NOT TO SCALE - SCALE ACCORDINGLY

PHARMER ENGINEERING L.L.C.

AVIMOR

| | |
|---|---|
| DESIGNED: | DSB |
| DRAWN: | TMB |
| CHECKED: | BSB |
| APPROVED: | CWH |
| PROJECT DATE: | Dec. 2006 |
| PROJECT NO.: | 10150 |
| SCALE: | NTS |

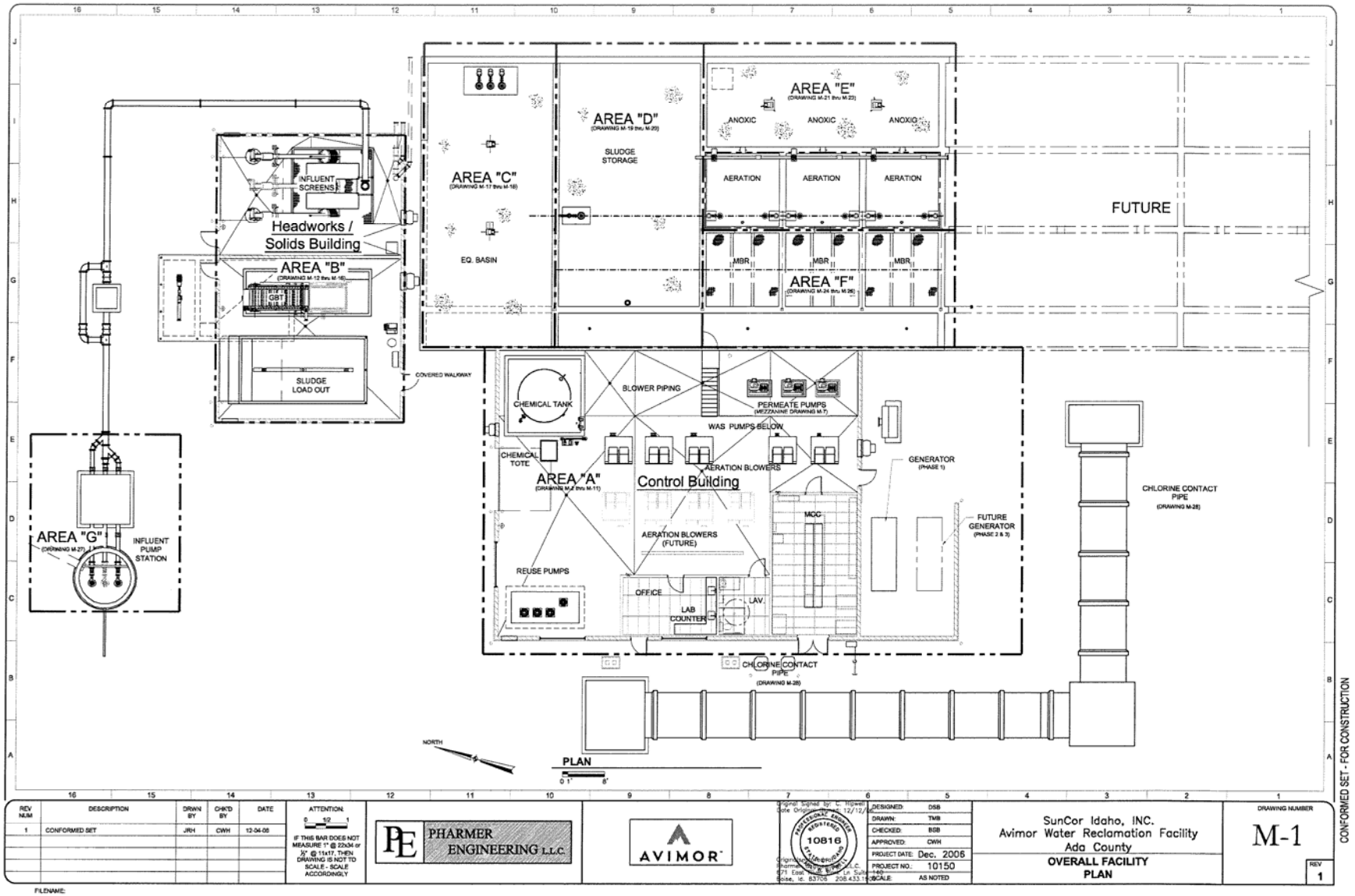
SunCor Idaho, INC.
Avimor Water Reclamation Facility
Ada County
PROCESS FLOW DIAGRAM

DRAWING NUMBER N-0

REV 1

CONFORMED SET - FOR CONSTRUCTION

# AWRF Overall Facility



# Reuse Effluent

- Irrigation of landscaping with overflow to RI (March – November)
- Winter effluent will all go to RI
- Ag areas as backup

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# IDEQ Draft Reuse Permit

- May 30th, 2007 Draft Permit
  - RI Site
  - Ag Areas
- Adding details as requested for use for irrigation

# Reuse Permit Limits

- Class B Water Quality Requirements
- Nitrogen
  - Minimal Impacts to GW
- Phosphorus
  - TMDL based
  - NPDES permit – as required to discharge to Spring Valley Creek

# Draft Permit Limits

- **Biochemical Oxygen Demand** <5.0 mg/L GS, <5.0 mg/L NGS
- **Total Suspended Solids** <5.0 mg/L GS, <5.0 mg/L NGS
- **Total Nitrogen** <8.0 mg/L GS, <8.0 mg/L NGS
- **Total Phosphorous** <8.0 mg/L (<0.1 mg/L for RI basin a, b) <0.1 mg/L b
- **Turbidity** 24 hour average of: <2.0 NTU , <2.0 NTU. With no instantaneous more than 5.0.
- **Total Coliform** <2.2 CFU/100mL of effluent <2.2 CFU/100mL of effluent
- **Chlorine Residual** of 1.0 mg/l

a Treated effluent discharged to the RI basin during the growing season must be treated to 0.2 mg/L to ensure surface water protection, due to potential interconnectivity issues associated with the basin, ground water, and surface water.

b The phosphorous concentration presented in this table (i.e., <0.1 mg/L) represents the effluent reduction level designed for the wastewater treatment facility. Phosphorous limits for effluent discharged from AWRF to the RI basin will ultimately be required to conform to the final version of the Lower Boise River Phosphorous TMDL.

# Reuse Irrigation Areas

- Bike Path
- Parks
- Ball field
- Along streets
- Common areas

# Reuse Requirements

- Nightime irrigation
- Signs at RI site and irrigation areas
  - “irrigated with reclaimed wastewater – do not drink”
- Buffer distances

# RI Site

- Pierce Park Sand
- 2-3 acres of 3-4 basins
  - 0.3 acres needed based on soil classification
- Currently performing field testing for infiltration
- Fenced & Signs

# Monitoring Requirements for AWRF and RI

- Flow into AWRF and to RI - daily
- Influent BOD5 - monthly
- Turbidity of MBR effluent prior to chlorination - continuous
- Total coliform of disinfected effluent - Daily
- Effluent COD, BOD5, TKN, Nitrate, Ammonia, TP, free chlorine residual – Monthly
- GW and Suface Water Monitoring – April & November
- Basin Usage
- Flow Meter Calibrations

# Compliance Activities

- O&M Plan
- Plans & Specs for RI Site
  - Engineering report for basis of design
- Plans for GW and Surface Water Monitoring System
- Runoff management plan
- Scaled site map
- Waste solids management plan

# Start-up and Operation

- OMCS
  - Assist with Start-up
  - Operation of AWRF
    - Includes collection system
    - RI system
    - Irrigation system
    - Ag areas

# Avimor NPDES

| Parameter | Winter |
|---|---|
| BOD | < 10.0 mg/L |
| TSS | < 10.0 mg/L |
| Total residual chlorine | 0.0 mg/L |
| Total Kjeldahl nitrogen (TKN) | < 3.0 mg/L |
| Fecal coliform | < 200 MPN[A]/100 ml |
| Ammonia | < 1.0 mg/L |
| Nitrite + nitrate | < 5.0 mg/L |
| TP[B] | < 0.15 mg/L |

[A] most probable number

[B] Applicable November 1 through March 31

Note: pH values shall be between 6.5 and 8. Winter temperature shall be 10 degrees C maximum.

# Case Study No. 2
# South Fork Landing

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# SFL Planned Community

- Southfork Landing, LLC
- Boise County near Garden Valley, Idaho
- 878 acres with 280 acres developed
- 616 lot development along South Fork of Payette River
- Cabins, Hotel, Light Commercial
- Large open space

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# Southfork Landing

# SFL Overview

- Class A Facility
- 0.067 mgd facility expandable to 0.2 mgd in three equal phases with alternative fourth phase
- Reuse Permit in Progress
- Treatment system is activated sludge with membranes
- Designed for removal of BOD, TSS, TN, TP (chemical precip)

# Class A & B Differences

- Mechanical Redundancy
  - Additional Train
- 7-Day Pond
  - Or alternative discharge
- Buffer distances

# Why Class A

- Ground Water Recharge in Open Basins
- Proximity to Southfork of Payette River

# SFL Requirements

- Master Plan
- Preliminary Engineering Report
- Design Plans and Specs
- Reuse Permit
- NPDES Permit

# SFL Schedule

- Master Planning, PER -  6 months
- Plans & Specs – 4 ½ months
- Review & Revisions – 3 months
- Reuse Permit – year to draft permit
- Construction – 1 year

# SFL Design Layout

- Ultimate capacity considerations
- Three initial trains
  - More trains as needed during each expansion
  - Trains set up for Class A mechanical redundancy requirements
- 7-day pond

# Effluent Design Criteria

- BOD & TSS < 5.0 mg/l
- TP < 0.1 mg/l – with possible further reduction
- TN < 10.0 mg/l
- Turbidity < 0.2 NTU

# SFL Components

- Lift Station
  - 0.2 mgd – ultimate capacity
- Headworks
  - Fine screening
    - Structural for ultimate capacity
    - Mechanical equipment for 1st Phase
    - Screenings to landfill

# SFL Components

- Equalization Basin
  - Ultimate capacity
- Anoxic Basin
  - 1st Phase
  - 3 basins
- Aeration Basins
  - 1st Phase
  - 3 trains

# SFL Components

- MBR Basins
  - 1st Phase
  - 3 basins
- Control Building
  - 1st Phase
  - Expandable
- Permeate Pumps
  - 1st Phase
- Blowers
  - 1st Phase

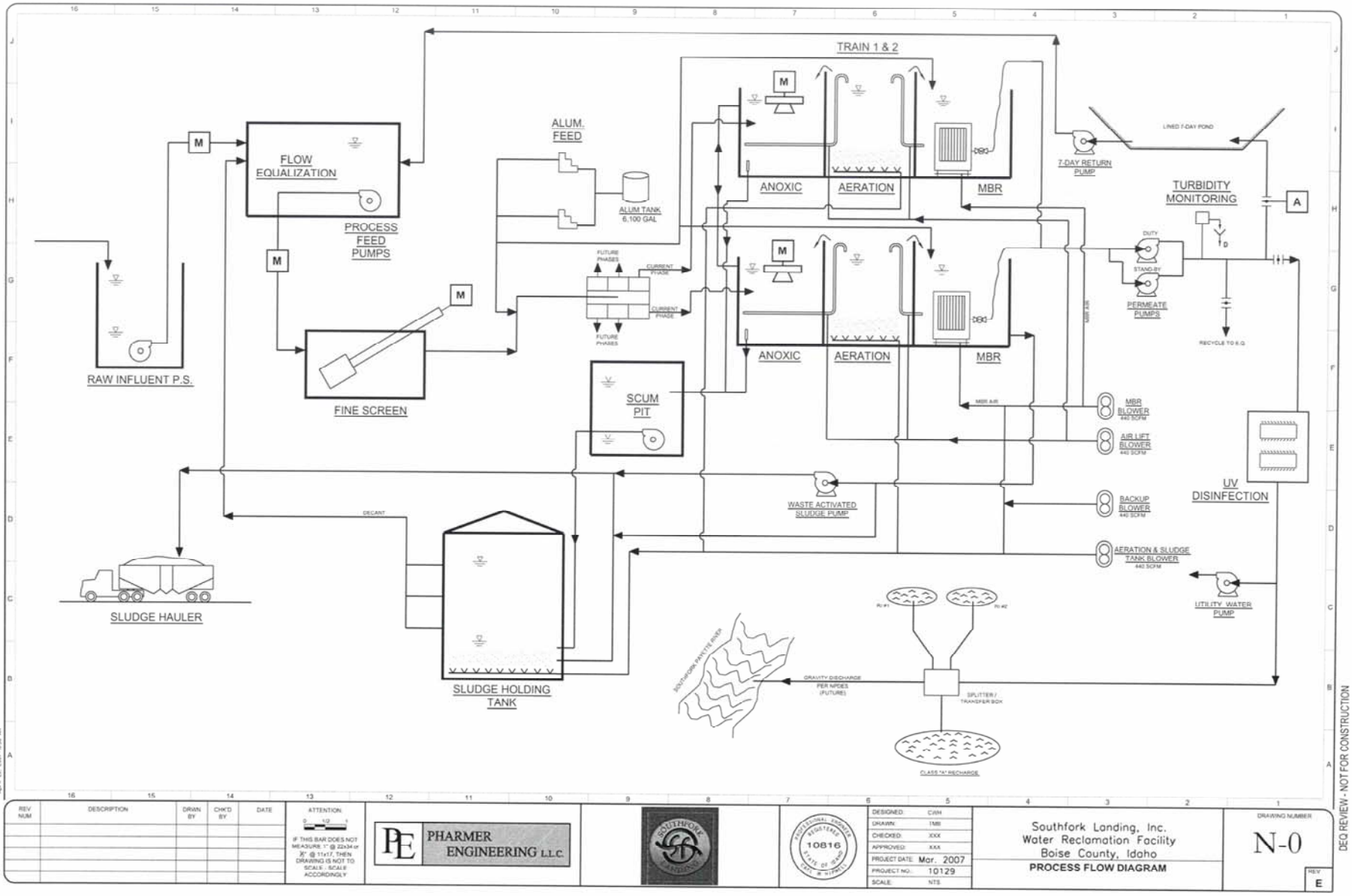
# SFL Components

- WAS Pumps
  - Ultimate capacity
- Sludge Storage
  - Ultimate capacity
- Solids handling
  - Later phase

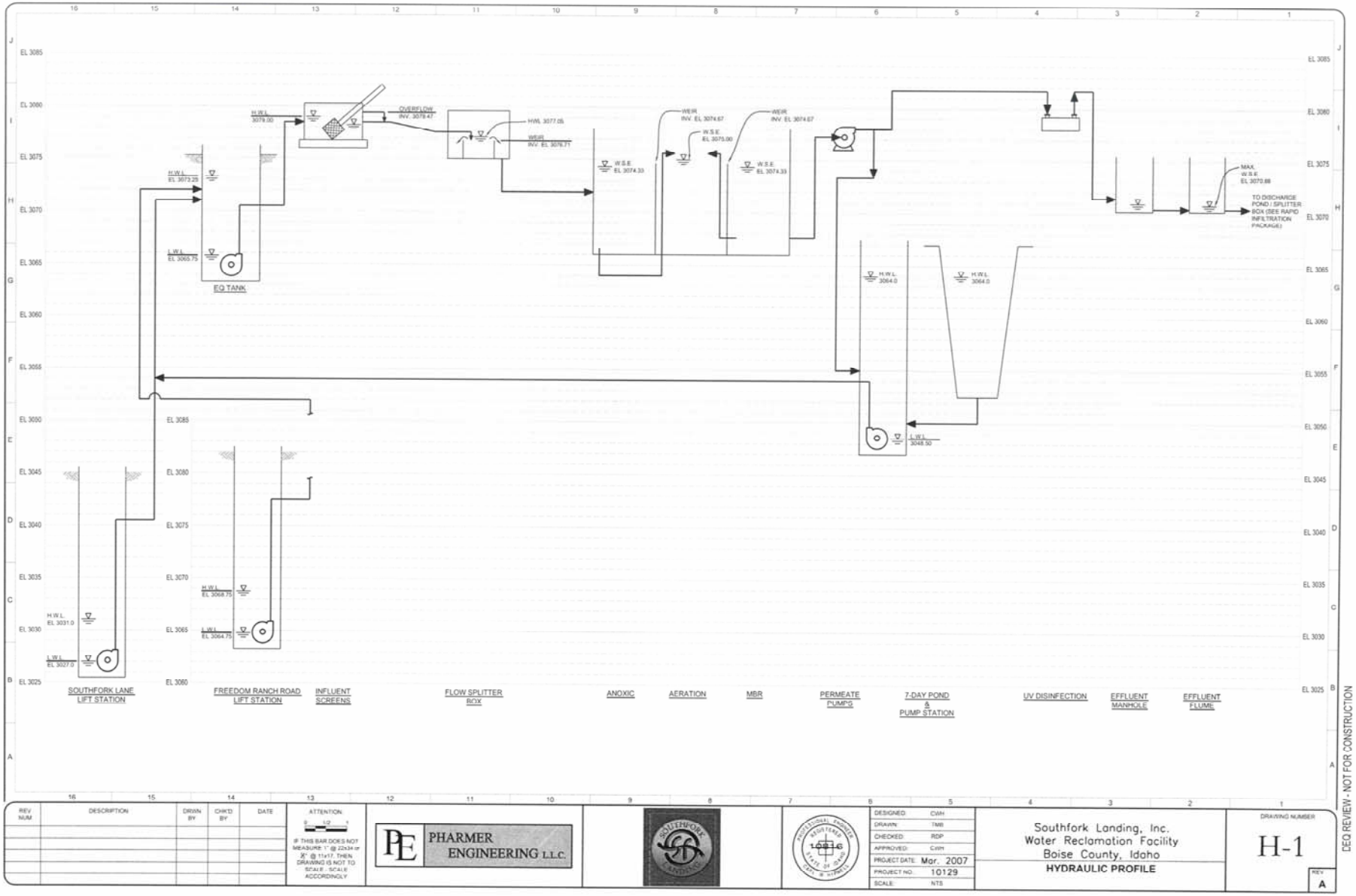
# SFL Components

- Disinfection with UV
  - Ultimate capacity
- Electrical
  - 1st Phase
  - Room for expansion

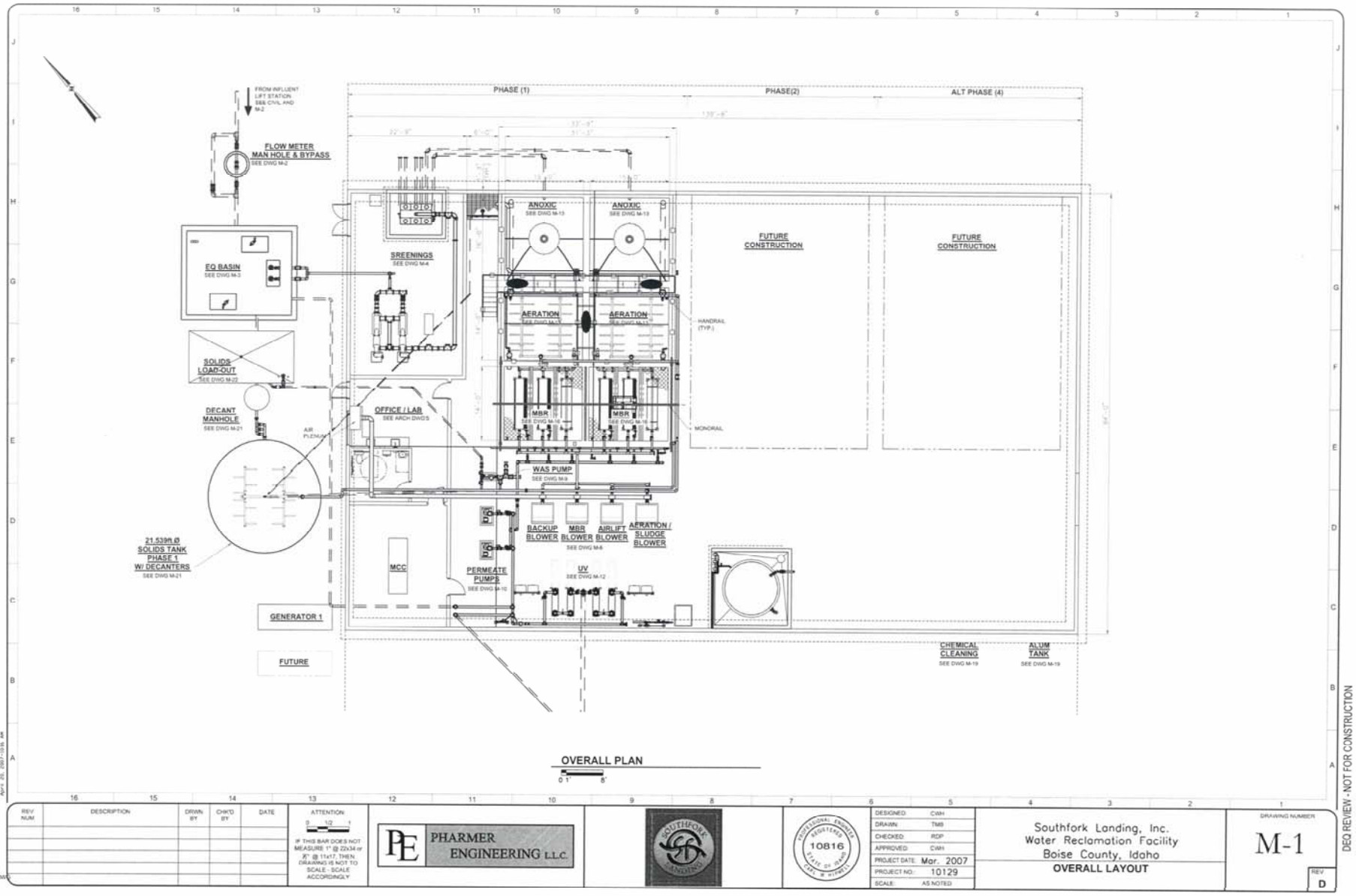
# SFL P&ID


TRAIN 1 & 2
FLOW EQUALIZATION
PROCESS FEED PUMPS
RAW INFLUENT P.S.
FINE SCREEN
ALUM. FEED
ALUM TANK 6,100 GAL
ANOXIC
AERATION
MBR
7-DAY RETURN PUMP
LINED 7-DAY POND
TURBIDITY MONITORING
PERMEATE PUMPS
RECYCLE TO E.Q.
SCUM PIT
MBR BLOWER
AIR LIFT BLOWER
BACKUP BLOWER
AERATION & SLUDGE TANK BLOWER
UTILITY WATER PUMP
UV DISINFECTION
WASTE ACTIVATED SLUDGE PUMP
SLUDGE HAULER
SLUDGE HOLDING TANK
DECANT
GRAVITY DISCHARGE PER NPDES (FUTURE)
SPLITTER / TRANSFER BOX
CLASS "A" RECHARGE
PHARMER ENGINEERING L.L.C.
Southfork Landing, Inc.
Water Reclamation Facility
Boise County, Idaho
PROCESS FLOW DIAGRAM
N-0
DEQ REVIEW - NOT FOR CONSTRUCTION

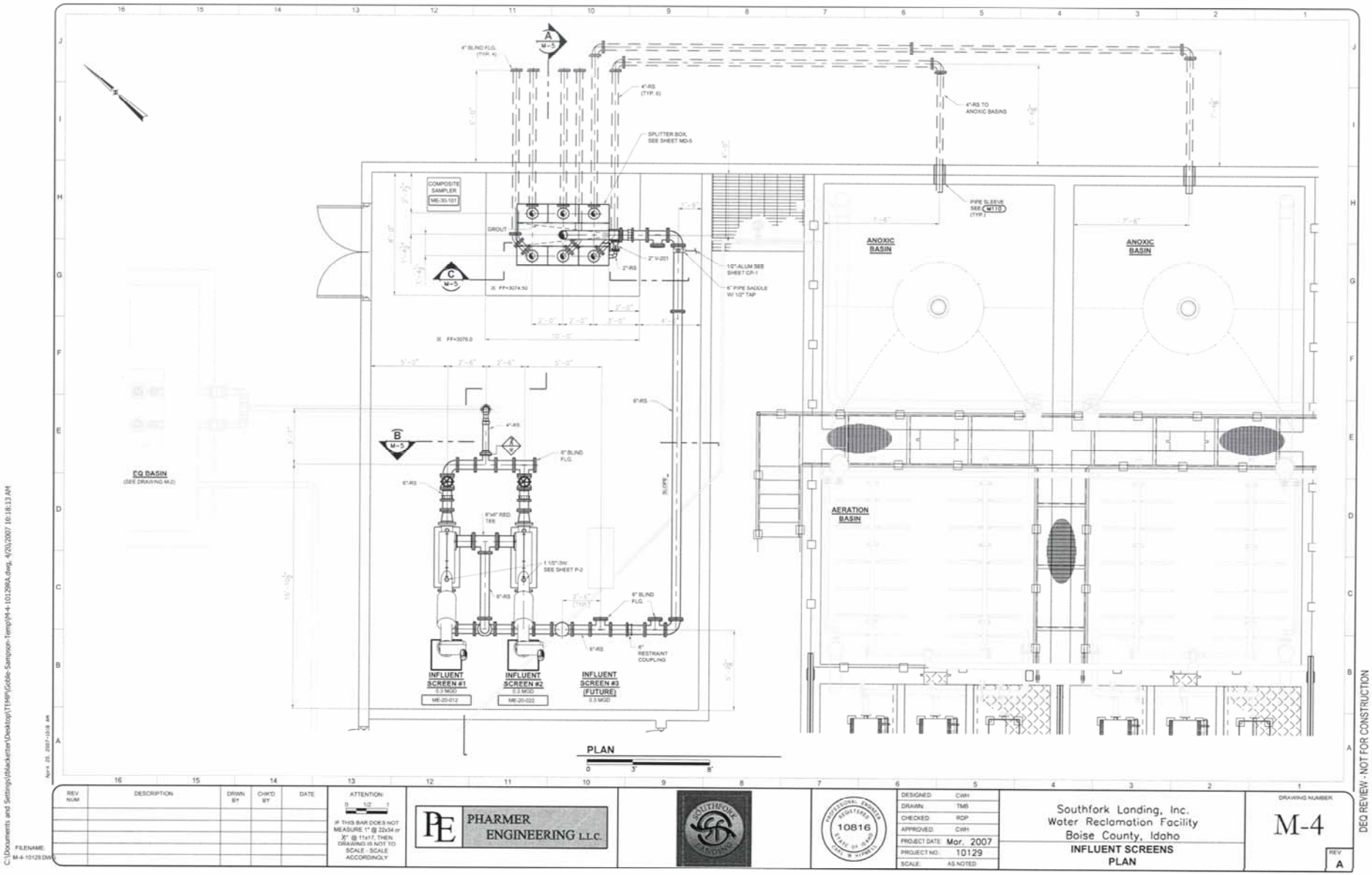
# SFL Hydraulic Profile



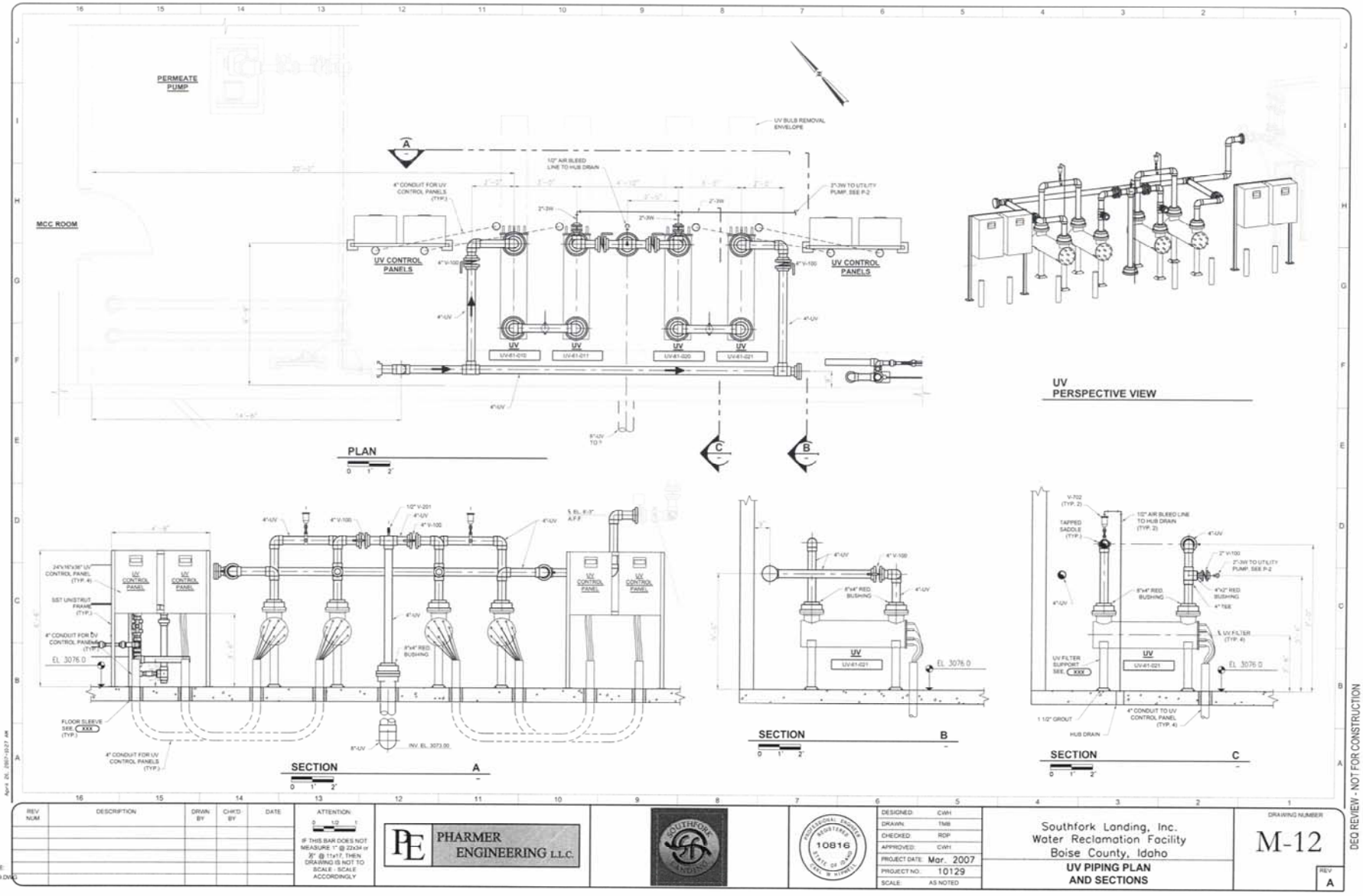
# SFL Overall Facility



# SFL Headworks and Split



# SFL Disinfection



# Reuse Effluent

- Irrigation of landscaping in equestrian area and around treatment plant with overflow to aquifer recharge and/or RI (March – November)
- Winter effluent will all go to aquifer recharge and/or RI

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# Proposed Reuse Permit Limits

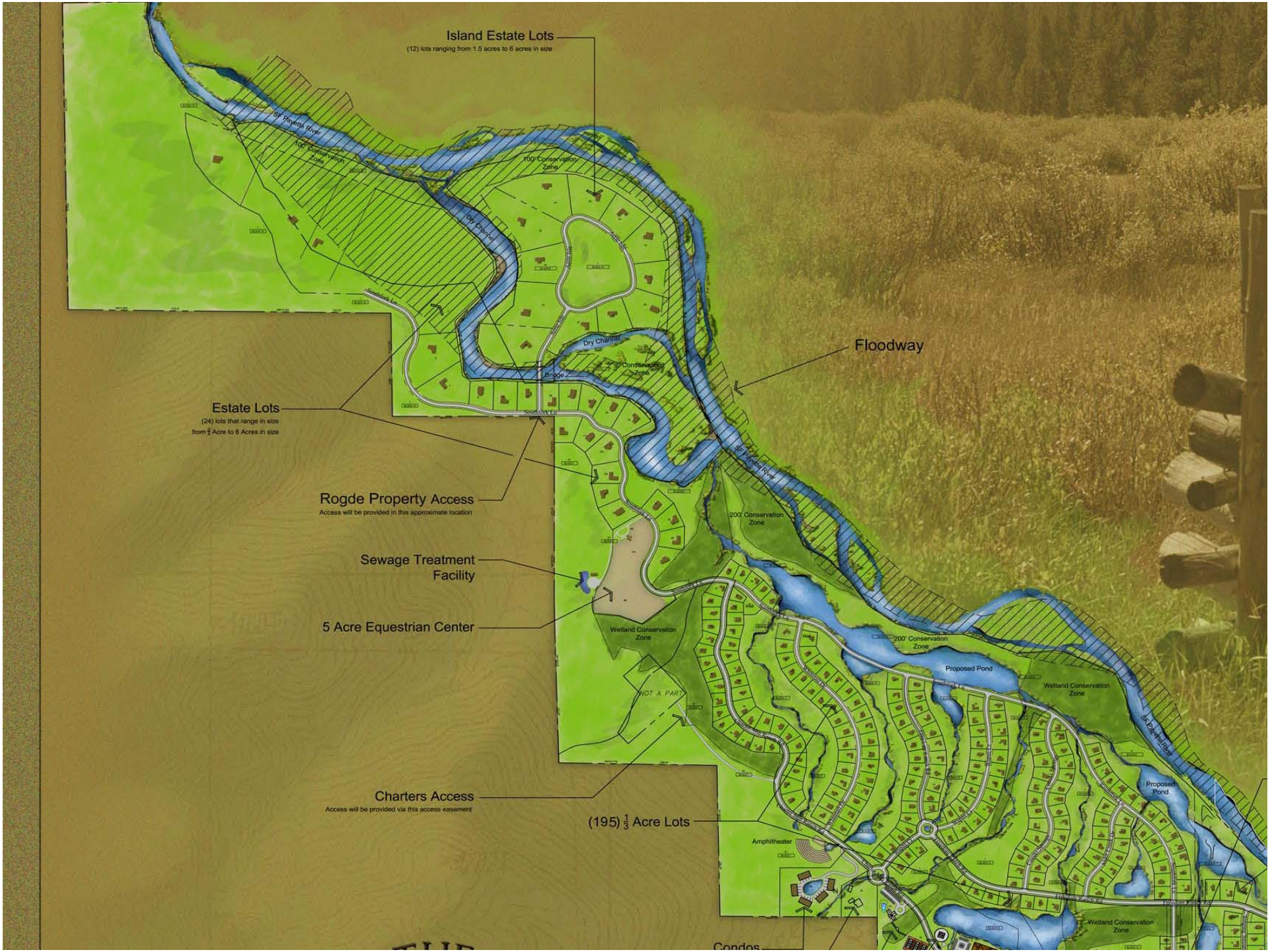
- Class A Water Quality Requirements
- Nitrogen
  - Minimal Impacts to GW
- Phosphorus
  - Protection of Special Resource Water
  - NPDES permit – as required to discharge to South Fork of the Payette River

# RI Site

- Silty Sand
- ½ acre of 2-3 basins
- Currently performing field testing for infiltration
- Fenced & Signs

# Aquifer Recharge

- Open basins
- Trout ponds


Island Estate Lots
(12) lots ranging from 1.5 acres to 6 acres in size
St. Francis River
100' Conservation Zone
Dry Channel
Bridge
Floodway
Estate Lots
(24) lots that range in size from ½ Acre to 6 Acres in size
Rogde Property Access
Access will be provided in this approximate location
Sewage Treatment Facility
5 Acre Equestrian Center
200' Conservation Zone
Wetland Conservation Zone
NOT A PART
Proposed Pond
Charters Access
Access will be provided via this access easement
(195) ⅓ Acre Lots
Amphitheater
Condos

# Case Study No. 3
# Hidden Springs

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# Hidden Springs - Overview

- 1,844 acre planned rural community
  - Three miles north of Boise in Ada County
- Community was designed and built to function as a “green” system
- First homes on-line in 1999
- Currently 500 homes discharge to the WWTF
- First Class B approved system in State
- Won the 2006 PNCWA Water Reuse Award
- System is currently being expanded to serve 1,525 connections

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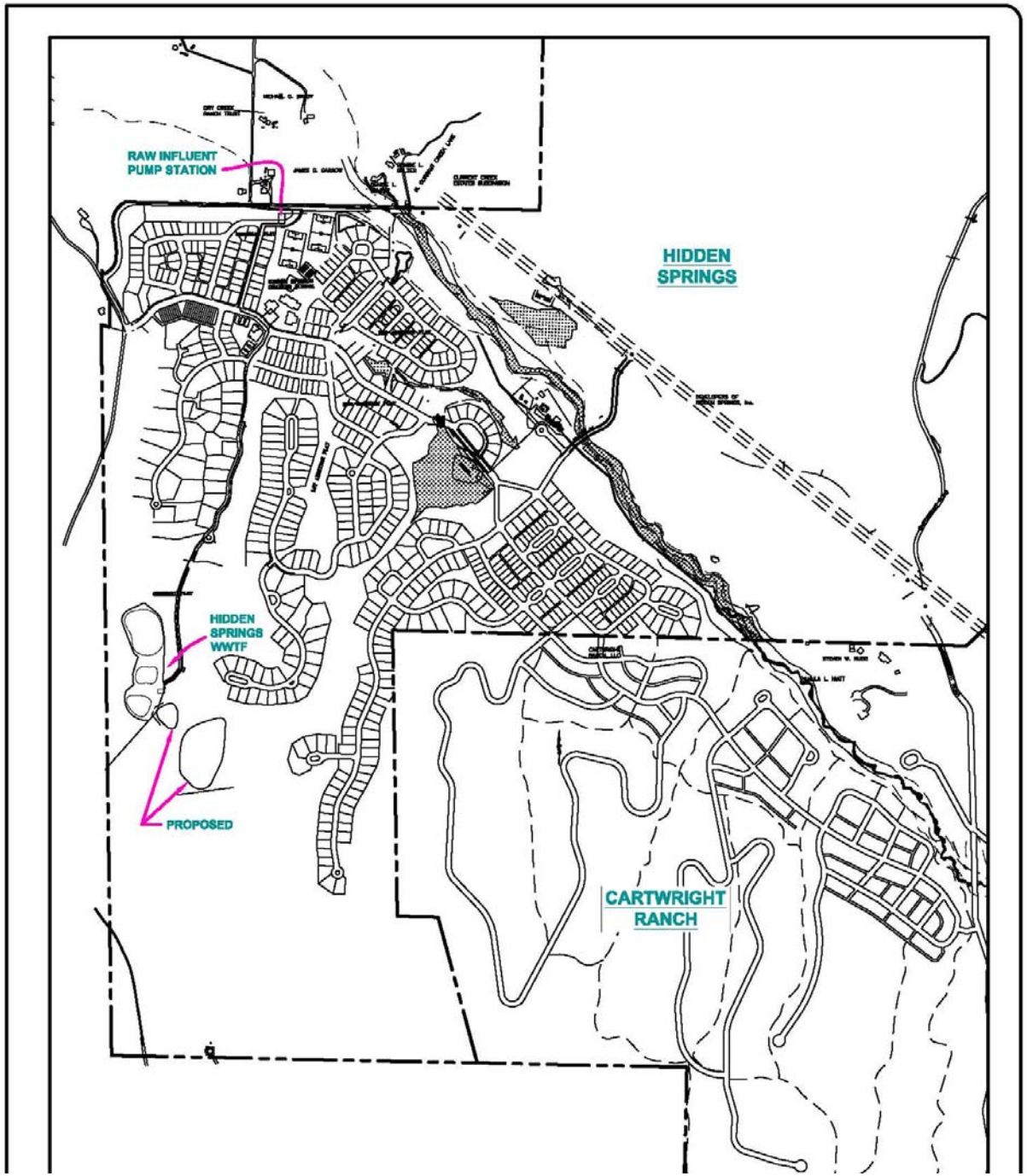


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# Hidden Springs - Overview Current System

- Provides Class B Reuse Water
- Operates under IDEQ Reuse Permit
  - LA-0000174-02
- Treatment facilities include:
  - Pump Station
  - Two aerated lagoons (operated in series)
  - Designed for removal of BOD / TSS / NH4
  - Also designed for partial Denitrification through oxygen deficient zones in lagoons

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# Hidden Springs - Overview Current System

- Treatment facilities (cont.):
  - 19.6 mil gal treated storage lagoon
  - Storage of treated water from November – March
  - Effluent Reuse Application Season
    - March - November
    - Filtration
    - Sodium Hypochlorite disinfection

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Blower / Filtration Bldg
Cell 1
Cell 2
Storage
Cell

# Hidden Springs - Overview Current Permit

- WWTF operated by Operation Management Consulting Services (OMCS)
- Application Site Area
  - Agricultural: 81.33 acres
  - Landscape Irrigation: 12.97 acres
  - Public gathering Areas: 30.8 acres
  - Total area: 125.1 acres
- Maximum Application Volume
  - 52.7 mil gal / year (145,000 gpd average)

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# Hidden Springs - Overview Current Permit

- Treatment Cell Effluent
  - BOD: 30 mg/l average max
    or 85% removal when influent BOD> 150 mg/l
  - TSS: 30 mg/l average max
    or 85% removal when influent TSS > 100 mg/l
- Filtration Effluent
  - Turbidity: 5 NTU instantaneous max
  - TSS: 5 mg/l average max
    7.5 mg/l weekly max
- Disinfection
  - 2.2 per 100 ml total coliform
- Free Chlorine Residual
  - 0.5 mg/l

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# Hidden Springs - Overview Current Permit Compliance

- Average Operating Performance (2004 – 2005)
  - Total Coliform (MPN): < 1.8 per 100 ml
  - Turbidity: < 1.1 NTU
  - TSS: < 4.7 mg/l
  - Total Nitrogen: < 4.2 mg/l

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# Hidden Springs Expansion

- Design Conditions:
  - 1,525 connections
  - 180 gpd/connection
    - Lower flow per residential unit is based on six years of operating data from Hidden Springs
  - Average Daily Flow: 274,500 gpd
  - Peaking factor: 3.35
  - Peak Flow: 640 gpm

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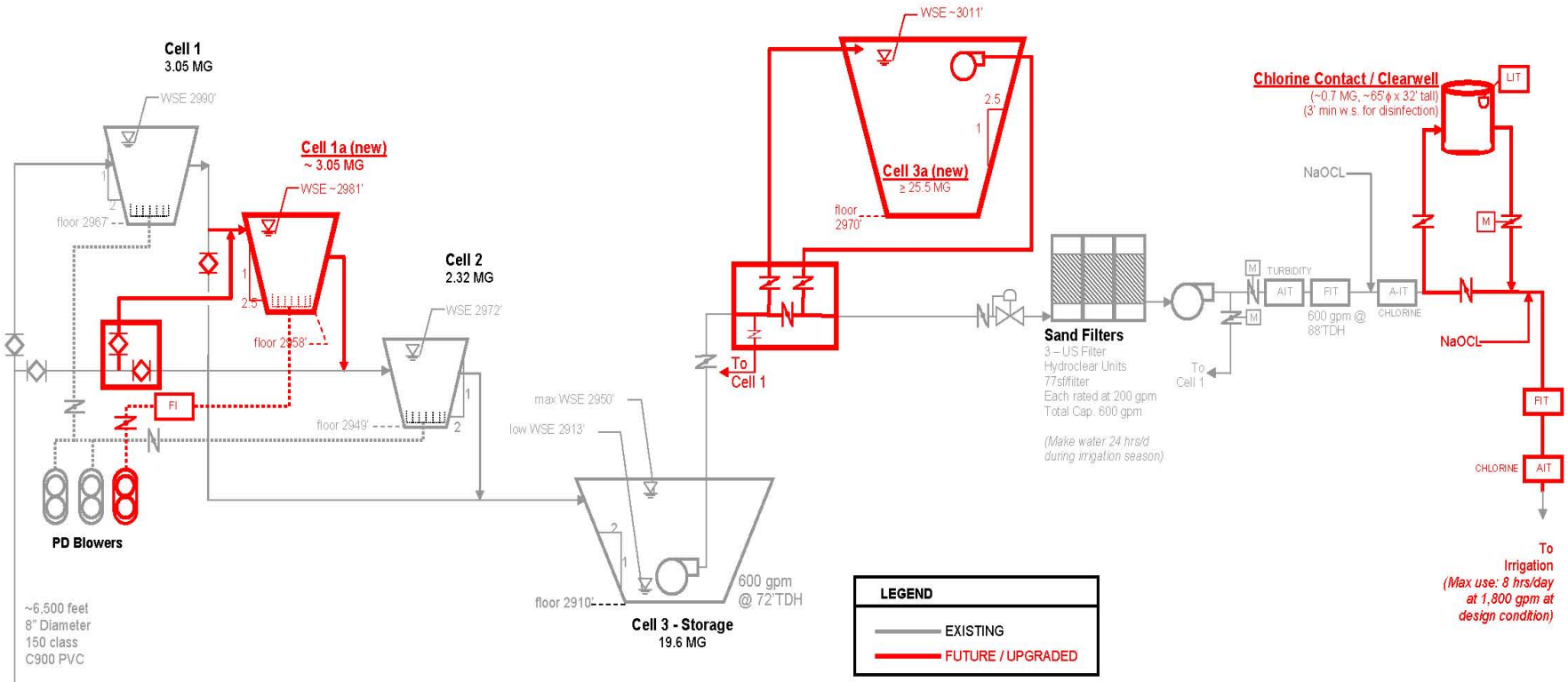
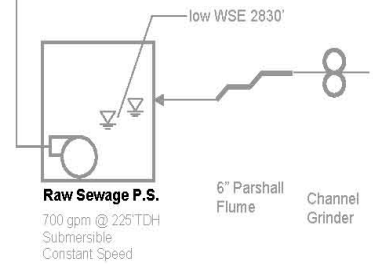
# Hidden Springs Expansion

- New Facilities Added
  - 1 - Aerated lagoon volume: 3.0 mg
    - (to be operated in series with existing two lagoons)
  - 1 - Winter storage cell volume: 26.0 mg
  - 1 - Chlorine contact / filtered effluent storage volume: 0.7 mg

PE




## FUTURE / UPGRADED DESIGN CRITERIA

**SYSTEM FLOWS**

| | | |
|---|---|---|
| Connections: | 1525 | Homes |
| Unit Flow: | 180 | gpd/home |
| Peaking Factor | *3.35* | |
| Peak Flow to P.S. | *640* | gpm |
| Average Daily Flow | *274,500* | gpd |

**TREATMENT**

| | | |
|---|---|---|
| Cell 1 Volume | 3.05 | MG |
| Cell 1 HRT | 11.1 | days |
| Cell 1a (new) Volume | ~3.05 | MG |
| Cell 1a (new) HRT | ~11.1 | days |
| Cell 2 Volume | 2.32 | MG |
| Cell 2 HRT | 8.5 | days |
| *HRT Req – 4°C* | *27* | *days (10 St. Stnds)* |
| *HRT Req – 10°C* | *21* | *days (10 St. Stnds)* |
| *HRT Req – 20°C* | *16* | *days (10 St. Stnds)* |
| $K_{20}$ (1st order rxn rate) | 0.16 | $day^{-1}$ (demonstrated) |

**STORAGE**

| | | |
|---|---|---|
| Cell 3 Volume | 19.6 | MG |
| Cell 1 HRT | 71.4 | days |
| Cell 3a (new) Volume | ≥ 25.5 | MG |
| New Storage Cell HRT | ≥ 93 | days |

**FILTRATION**

| | | |
|---|---|---|
| Filter Capacity | 600 | gpm |
| Daily Output | 0.874 | MGD |

| REV NUM | DESCRIPTION | DRWN BY | CHK'D BY | DATE |
|---|---|---|---|---|
| X | WORKING DRAFT | | | 11/20/06 |

ATTENTION
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" @ 22X34 OR 10" @ 11X17, THEN DRAWING IS NOT TO SCALE – SCALE ACCORDINGLY

PHARMER ENGINEERING LLC
PHARMER ENGINEERING LLC
671 E. RIVERPARK LN; STE 140
BOISE, ID 83706

HIDDEN SPRINGS SEWER CO., LLC
5890 WEST HIDDEN SPRINGS DRIVE
HIDDEN SPRINGS, IDAHO 83714

HIDDEN SPRINGS SEWER COMPANY, LLC
CAPACITY EXPANSION

PROCESS FLOW DIAGRAM / DESIGN CRITERIA

G-2

# Questions

$P_E$