



Pueblo POTW/FOTW Options Study

**Draft Final Report
(Revision 1)**

Report to:
Program Manager for Assembled
Chemical Weapons Alternatives
(PMACWA)
Aberdeen Proving Ground, MD
21010

12 June 2003

FOCIS Associates, Inc.
A GEO-CENTERS INC. Company
7 Wells Avenue
Newton, MA 02459

Contract No.: DAAD13-01-D-0006

FOCIS Reference No.: 32041.7.1.3

PCAPP POTW/FOTW Options Study

Table of Contents

Section	Page
Table of Contents	i
Executive Summary.....	ES-1
1.0 Introduction.....	1
1.1 Background	1
1.2 Objectives	1
1.3 Approach.....	2
1.3.1 Feasibility Study.....	2
1.3.2 Evaluation of Viable Options	3
1.3.3 Development of an Implementation Plan	3
2.0 Study Area.....	4
2.1 Defined Study Area	4
2.2 Description of the Study Area	4
2.3 Population.....	10
3.0 PCAPP Hydrolysate and Biotreatment Plant Effluent Information.....	12
3.1 Hydrolysate Characteristics Pertinent to Biotreatment and Discharge in General	12
3.2 Hydrolysate Characteristics Pertinent to Discharge to the Arkansas River	12
3.3 Pertinent Characteristics of the PCAPP Biotreatment Plant	13
3.4 Assessment Factors.....	14
4.0 Needs Assessment.....	16
4.1 City of Pueblo	16
4.2 Pueblo West	18
4.3 St. Charles Mesa	18
4.4 Avondale and North Avondale	18
4.5 Boone	19
4.6 PCAPP (sanitary wastewater), Pueblo Chemical Depot (PCD), and Pueblo Depot Industrial Park (PDIP)	19
4.7 Airport Industrial Park (AIP).....	19
4.8 Transportation Technology Center (TTC).....	20
4.9 Rocky Mountain Steel Mill (RMSM).....	20
4.10 Rio Grande Portland Cement	20
4.11 Needs Assessment Findings	20
5.0 Feasibility Assessment.....	21
5.1 Treatment of the PCAPP Hydrolysate at a Local POTW	21
5.1.1 Treatment of PCAPP Hydrolysate at the Pueblo WWTP	21
5.1.2 Treatment of PCAPP Hydrolysate at Multiple WWTPs	22
5.2 Construction of a FOTW at or Near PCAPP	23
5.3 Use of All or Part of the PCAPP Biotreatment Plant After PCAPP Closure	23
6.0 Assessment Conclusions.....	24
7.0 References.....	25

PCAPP POTW/FOTW Options Study

Appendices

Appendix A – Brief Overview of the Pretreatment Regulations [40CFR403]

Appendix B – Technologies for Sulfate Removal

Appendix C – Acceleration Options Working Group 21 January 2003 Meeting Minutes

List of Tables

Table 1: Historical and Projected Population Growth, 1970 to 2030 10

Table 2: Summary of PCAPP Wastewater Characteristics and Dilution Factors, Treatment Capacities, and Average Daily Flows Required for Treatment and Discharge 13

List of Figures

Figure 1: Study Area..... 5

Executive Summary

ES.1 Introduction

The Program Manager for Assembled Chemical Weapons Alternatives (PMACWA) is evaluating various implementation options for the Pueblo Chemical Agent Destruction Pilot Plant (PCAPP) in an on-going effort to identify opportunities to reduce cost and schedule and increase public involvement in the program. The Citizens' Advisory Commission (CAC), through its Accelerated Options Working Group (AOWG), requested PMACWA to assess the feasibility of several local options to the current plan for treating the PCAPP process wastewater, which will consist primarily of the agent/energetic hydrolysate.

The current plan for PCAPP includes on-site biotreatment of the hydrolysate followed by water recovery and reuse and thus no liquid discharge. Under the current plan the PCAPP biotreatment plant will treat only PCAPP process wastewater and most likely be decommissioned, dismantled, and removed as part of PCAPP closure. The options assessed in this study include the following:

- Treating the PCAPP hydrolysate at a local publicly or privately owned treatment works (POTW);
- Construction of a federally owned treatment works (FOTW) at or near PCAPP that would treat the PCAPP hydrolysate and wastewater from PCAPP, Pueblo Chemical Depot (PCD), or other off-site locations; and
- Use of all or part of the PCAPP on-site biotreatment plant by a local entity after PCAPP closure.

The major objectives of the POTW/FOTW Options study were as follows:

- Identify the following:
 - Local POTWs that could potentially accept and treat the PCAPP hydrolysate;
 - Potential users for a FOTW located at or near PCAPP; and
 - Local entities that could potentially use all or part of the PCAPP biotreatment plant after PCAPP closure.
- Evaluate potentially feasible POTW/FOTW options and compare them to the current PCAPP biotreatment plan.
- Conduct a more detailed assessment of any viable POTW/FOTW option and develop an implementation plan.

The approach developed to conduct the POTW/FOTW Options study can be summarized as follows:

- Feasibility Study (Phase IA)
 - Needs Assessments
 - Feasibility Assessment (preliminary screening)
- Evaluation of Viable Options (Phase IB)
- Development of an Implementation Plan (Phase II)

ES.2 Needs Assessment

The approach to the first task of the Feasibility Study was to:

- Identify the study area.
- Analyze current and future wastewater treatment practices (both municipal and industrial).
- Forecast future population growth and industrial development.
- Project future wastewater flows, loads, and characteristics.
- Assess the condition and performance of existing local wastewater treatment facilities.
- Review pertinent regulatory requirements and community development plans.

At the 10 October 2002 meeting of the AOWG, PMACWA and other AOWG members agreed to a study area and the public, commercial, and industrial entities within the study area that may potentially play a role in a POTW/FOTW option or benefit from future use of the PCAPP biotreatment plant. The study area was defined as follows:

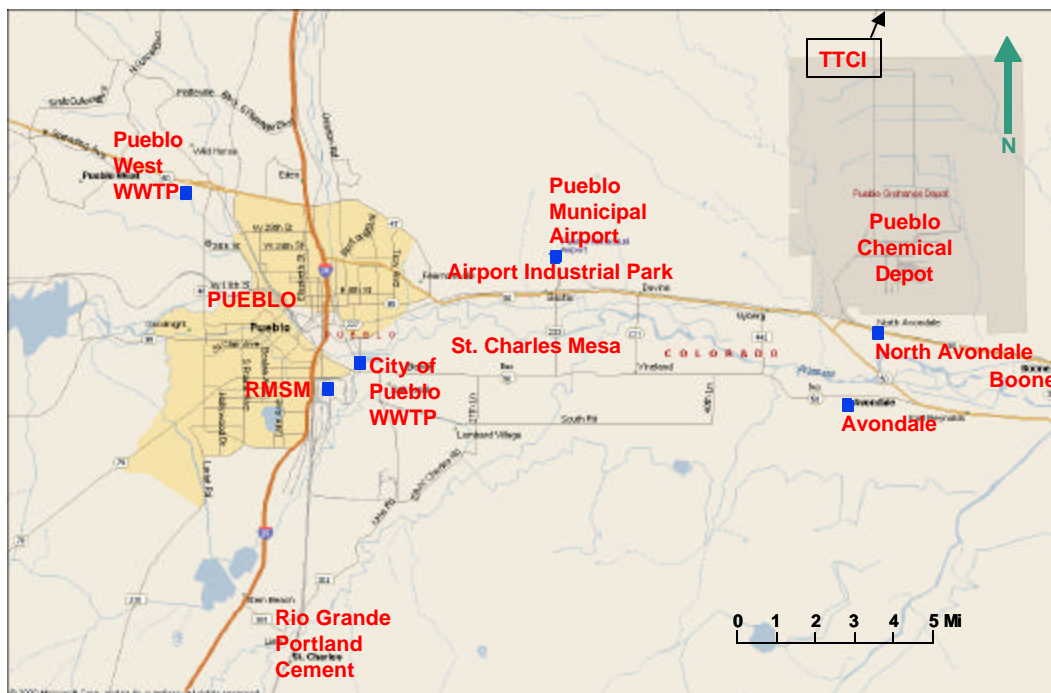
- City of Pueblo
- Area of Pueblo County in proximity to PCD
- Pueblo West

Within the study area, the following entities were identified as either having POTWs that could potentially accept and treat the PCAPP hydrolysate, being potential users for a FOTW located at or near PCAPP, or entities that could potentially use all or part of the PCAPP biotreatment plant after closure:

- Offsite public
 - City of Pueblo
 - Pueblo West
 - St. Charles Mesa
 - Avondale and North Avondale
 - Boone
- Onsite commercial/industrial (PCD)
 - PCAPP (sanitary wastewater)
 - PCD tenants
- Offsite commercial/industrial
 - Airport Industrial Park (AIP)
 - Transportation Technology Center (TTC)
 - Rocky Mountain Steel Mill (RMSM)
 - Rio Grande Portland Cement

Figure ES-1 shows the study area and the locations of the individual entities within the study area.

Figure ES-1: Study Area



Source: Microsoft Corporation, 2000

The needs assessment indicates that wastewater treatment needs within the City of Pueblo, Avondale, North Avondale, and Boone can most likely be met with existing facilities. Areas with higher growth rates, such as Pueblo West and St. Charles Mesa, may have a greater need for new or expanded wastewater treatment facilities, but both communities have already taken the necessary steps to address this need. Similarly, wastewater treatment needs at commercial/industrial entities, including PCD, are being met by existing facilities.

ES.3 Feasibility Assessment

As data and information were collected, an assessment of how the study area wastewater treatment needs relate to the needs and timeframe of biotreatment of the PCAPP hydrolysate was conducted. Pertinent data and information on the PCAPP hydrolysate and biotreatment plant were identified and used to assess the compatibility of the needs of public, commercial, and industrial entities with those of PCAPP biotreatment. The feasibility assessment examined wastewater treatment needs, treatment capacities, and water quality issues to screen out unfeasible options.

Based on the expected characterization of the 3.8-wt% hydrolysate, the standards for discharge to the Lower Arkansas River, and the timing of the PCAPP operation, the following assessment factors were used for evaluation of POTW/FOTW Options:

- In order to accept and treat the PCAPP hydrolysate:
 - Potential candidate POTWs will need excess hydraulic capacity of 0.068 mgd (million gallons per day) and excess organic treatment capacity of 12,700 lb/d of biological

PCAPP POTW/FOTW Options Study

oxygen demand (BOD). This assumes that only one facility will be used to treat the hydrolysate from PCAPP.

- All potential candidate POTWs in the study area discharge to the Lower Arkansas River Segment 1a or its tributaries. Therefore, candidate POTWs must have either an average daily flow of greater than 5 mgd (how much greater being a function of the sulfate levels at the POTW) or the capability of removing sulfate in order to meet the stream standard.
- In order to consider construction of an FOTW that treats PCAPP hydrolysate and other PCAPP, PCD, or off-site wastewaters:
 - The unmet needs of potential users will have to coincide with PCAPP pilot testing and operations, which will occur from about 2007 to 2010*.

Also, since a FOTW would discharge to the Lower Arkansas River Segment 1a via one or more of its tributaries, the average daily wastewater flows from other users (i.e., non-PCAPP) will have to be greater than 5 mgd (how much greater being a function of the sulfate levels in the other wastewaters) in order to provide the necessary dilution for the treated PCAPP hydrolysate to meet the stream standard for sulfate, or the FOTW will have to remove the excess sulfate from the effluent prior to discharge.

Treatment of the PCAPP Hydrolysate at a Local POTW

Treatment of the PCAPP hydrolysate does not appear to be a feasible option at a local POTW. Even the largest biological wastewater treatment plant in the study area, the Pueblo Wastewater Treatment Plant (WWTP) with a design hydraulic capacity of 19 mgd and a design organic capacity of 33,100 lb/d of BOD, does not have the excess organic treatment capacity needed to treat the PCAPP hydrolysate now or, based on their current expansion plans, within the PCAPP operating timeframe. The total organic treatment capacity of the Pueblo WWTP would have to be increased by approximately 20% in order to handle the PCAPP hydrolysate. Additionally, the selenium and sulfate concentrations expected in the PCAPP hydrolysate exceed the pretreatment standards of the Pueblo WWTP and, while removal of selenium from the hydrolysate may be affordable, sulfate removal, which is not possible until after biotreatment, poses significant technical and financial obstacles at such large flows.

Treatment of PCAPP Hydrolysate at Multiple WWTPs

Using more than one local POTW to treat the PCAPP hydrolysate was also found to be unfeasible. For example, the combined organic treatment capacities of the Pueblo, the Pueblo West, and proposed St Charles Mesa WWTPs at build-out might be sufficient to treat the PCAPP hydrolysate (if local needs do not consume excess capacity) but sulfate removal would still be an issue.

Construction of a FOTW at or Near PCAPP

Construction of a FOTW at or near PCAPP to treat PCAPP hydrolysate, PCAPP sanitary wastewater, other PCD wastewaters, and off-site wastewaters does not appear to be a feasible option. In order to be workable, the combined flows of PCAPP sanitary wastewater, PCD wastewaters, and off-site wastewaters would have to total over 5 mgd to meet discharge limits for sulfate. The local unmet wastewater treatment demand is well below 5 mgd. St Charles Mesa

* PMACWA, ACWA neut-bio schedule comparison, CAIG and PMACWA projections, attachment to email from Scott Susman to Armand Balasco, dated 12 June 2002.

PCAPP POTW/FOTW Options Study

is the only local entity with plans for new construction and their initial plant will only be 1.25 mgd with build-out possibly to 3.75 mgd beyond the PCAPP operating timeframe. The wastewater treatment needs of other local entities are being met by existing facilities. Even if the demand existed, sulfate removal would still be an issue.

Use of All or Part of the PCAPP Biotreatment Plant After PCAPP Closure

Any of the public and industrial entities in the study area may have use for parts of the PCAPP biotreatment plant after PCAPP closure. It is unlikely that any of them would use the entire plant or even a significant portion. Current projections do not show additional wastewater treatment needs in the area reaching the equivalent domestic capacity of the PCAPP biotreatment plant. Even at the Pueblo WWTP, expansion planning for organic treatment capacity over the next 20 years is geared more towards adding redundancy rather than capacity.

Use of all or part of the PCAPP biotreatment plant after PCAPP closure is an option that could be revisited as details of the PCAPP design are developed. For now, however, there is no definable option.

ES.4 Assessment Conclusions

The findings of the Needs and Feasibility Assessments were presented to the AOWG at a meeting held on 21 January 2003. Following the presentation, the group had the opportunity to ask questions and discuss the findings. The group concluded that there are no viable POTW/FOTW options. An exception may be the use of all or part of the PCAPP biotreatment plant after PCAPP closure, which could be revisited as details of the PCAPP design are developed. For now, however, since there is no definable option, the group recommended that FOCIS Associates conclude the POTW/FOTW options study and submit a final report.

PCAPP POTW/FOTW Options Study

1.0 Introduction

1.1 Background

The Program Manager for Assembled Chemical Weapons Alternatives (PMACWA) is evaluating various implementation options for the Pueblo Chemical Agent Destruction Pilot Plant (PCAPP) in an on-going effort to identify opportunities to reduce cost and schedule and increase public involvement in the program. The Citizens' Advisory Commission (CAC), through its Accelerated Options Working Group (AOWG), requested PMACWA to assess the feasibility of several local options to the current plan for treating the PCAPP process wastewater, which will consist primarily of the agent/energetic hydrolysate.

The current plan for PCAPP includes on-site biotreatment of the hydrolysate followed by water recovery and reuse and thus no liquid discharge. Under the current plan the PCAPP biotreatment plant will treat only PCAPP process wastewater and most likely be decommissioned, dismantled, and removed as part of PCAPP closure. The options assessed in this study include the following:

- Treating the PCAPP hydrolysate at a local publicly or privately owned treatment works (POTW);
- Construction of a federally owned treatment works (FOTW) at or near PCAPP that would treat the PCAPP hydrolysate and wastewater from PCAPP, Pueblo Chemical Depot (PCD), or other off-site locations; and
- Use of all or part of the PCAPP on-site biotreatment plant by a local entity after PCAPP closure.

While the POTW/FOTW Options study focused on local options to the current PCAPP hydrolysate biotreatment plan, PMACWA is also assessing options for the shipment of energetics and hydrolysate to more-distant off-site locations for treatment. The results of the Off-site Shipment Options studies will be presented in separate reports.

1.2 Objectives

The major objectives of the POTW/FOTW Options study were as follows:

- Identify the following:
 - Local POTWs that could potentially accept and treat the PCAPP hydrolysate;
 - Potential users for a FOTW located at or near PCAPP; and
 - Local entities that could potentially use all or part of the PCAPP biotreatment plant after PCAPP closure.
- Evaluate potentially feasible POTW/FOTW options and compare them to the current PCAPP biotreatment plan.
- Conduct a more detailed assessment of any viable POTW/FOTW option and develop an implementation plan.

1.3 Approach

The POTW/FOTW Options study was initially divided into two phases. The first phase was to consist of information and data collection and the evaluation of potentially feasible POTW/FOTW alternatives to the current plan of on-site biotreatment of PCAPP hydrolysate followed by water recovery and reuse and no liquid discharge. If viable alternatives were identified in the first phase, plans to implement the alternative would be developed in the second phase of the study. The two-phased approach can be summarized as follows:

- Feasibility Study (Phase I)
 - Needs Assessments
 - Evaluation of Options
- Development of an Implementation Plan (Phase II)

In the course of collecting information and data, it became apparent that a preliminary screening of options, based on wastewater treatment needs, treatment capacities, and water quality issues, should be made and presented to the AOWG prior to conducting any detailed evaluation of options. This approach affords the AOWG the opportunity to determine whether any option is worthy of detailed evaluation before expending the resources necessary for such an evaluation. The modified approach can be summarized as follows:

- Feasibility Study (Phase IA)
 - Needs Assessments
 - Feasibility Assessment (preliminary screening)
- Evaluation of Viable Options (Phase IB)
- Development of an Implementation Plan (Phase II)

This report presents the findings of the Feasibility Study (Phase IA).

1.3.1 Feasibility Study

Needs Assessment. The approach to the first task of the Feasibility Study was to:

- Identify the study area.
- Analyze current and future wastewater treatment practices (both municipal and industrial).
- Forecast future population growth and industrial development.
- Project future wastewater flows, loads, and characteristics.
- Assess the condition and performance of existing local wastewater treatment facilities.
- Review pertinent regulatory requirements and community development plans.

The information and data was collected from a number different sources including:

- Pueblo Depot Activity Redevelopment Authority.
- Colorado Department of Public Health and Environment.
- Colorado Department of Natural Resources.
- Pueblo County Department of Planning and Development.

PCAPP POTW/FOTW Options Study

- Wastewater departments and facilities
 - City of Pueblo Department of Wastewater
 - City of Pueblo Wastewater Treatment Plant
 - Pueblo West Metropolitan District
 - St. Charles Mesa Sanitation District and Northstar Engineering and Surveying
- Program Manager for Chemical Demilitarization (PMCD) Site Specific Environmental Impact Statement (EIS).

Feasibility Assessment. As data and information were collected, an assessment of how the study area wastewater treatment needs relate to the needs and timeframe of biotreatment of the PCAPP hydrolysate was conducted. Pertinent data and information on the PCAPP hydrolysate and biotreatment plant were identified and used to assess the compatibility of the needs of public, commercial, and industrial entities with those of PCAPP biotreatment. The feasibility assessment examined wastewater treatment needs, treatment capacities, and water quality issues to screen out unfeasible options.

1.3.2 Evaluation of Viable Options

In the Evaluation of Viable Options, any potentially viable POTW/FOTW options identified in this Feasibility Study will be further explored and evaluated. The approach of the Evaluation of Viable Options will be to:

- Further assess potentially viable POTW/FOTW options;
- Identify issues associated with each option that could impact implementation, including technical, cost, schedule, logistical, legal, and/or permitting issues; and
- Evaluate the options relative to each other and to the current PCAPP biotreatment plan, weighing the advantages and disadvantages based on related issues.

1.3.3 Development of an Implementation Plan

Based on the results of the Evaluation of Viable Options, PMACWA will work with the community and local government to select an appropriate, technically viable option, if any, to the current PCAPP biotreatment plan and develop an Implementation Plan that addresses pertinent issues such as:

- NEPA requirements
- Water rights
- Financing and user rate structures
- Institutional structures and management systems
- Permitting and compliance
- Legal issues
- Liability issues
- Schedule

2.0 Study Area

2.1 Defined Study Area

At the 10 October 2002 meeting of the AOWG, PMACWA and other AOWG members agreed to a study area and the public, commercial, and industrial entities within the study area that may potentially play a role in a POTW/FOTW option or benefit from future use of the PCAPP biotreatment plant. The study area was defined as follows:

- City of Pueblo
- Area of Pueblo County in proximity to PCD
- Pueblo West

Within the study area, the following entities were identified as either having POTWs that could potentially accept and treat the PCAPP hydrolysate, being potential users for a FOTW located at or near PCAPP, or entities that could potentially use all or part of the PCAPP biotreatment plant after closure:

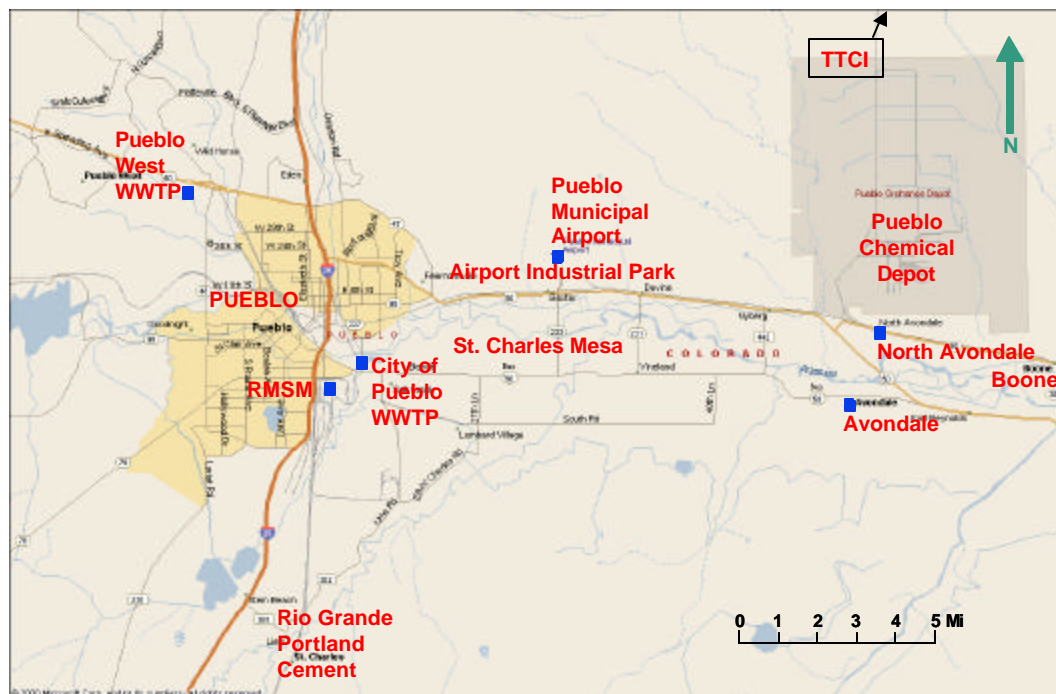
- Offsite public
 - City of Pueblo
 - Pueblo West
 - St. Charles Mesa
 - Avondale and North Avondale
 - Boone
- Onsite commercial/industrial (PCD)
 - PCAPP (sanitary wastewater)
 - PCD tenants
- Offsite commercial/industrial
 - Airport Industrial Park (AIP)
 - Transportation Technology Center (TTC)
 - Rocky Mountain Steel Mill (RMSM)
 - Rio Grande Portland Cement

Figure 1 shows the study area and the locations of the individual entities within the study area.

2.2 Description of the Study Area

Pueblo County. Pueblo County is located in south central Colorado approximately 112 miles south of Denver along the southernmost edge of an area known as the Front Range of the Rocky Mountains. The county covers approximately 2,400 square miles and has a population of 141,472¹. The county seat is the City of Pueblo, which sits on Colorado's high plain. The Arkansas River, originating in the mountains to the west, passes through Pueblo where it meets Fountain Creek. The Colorado Rockies West Mountain Range begins in western Pueblo County,

Figure 1: Study Area



Source: Microsoft Corporation, 2000

reaching an elevation of 12,349 feet at Greenhorn Peak. With average annual precipitation of only about 12 inches and average daily high and low temperatures of 68°F and 37°F, respectively, Pueblo’s climate is characterized as semi-arid and mild.

In Pueblo County, public services are provided by a combination of local governments and private entities. Five rural water districts and two metropolitan districts, which are defined as areas in which three or more public services are available², supply water to residents of Pueblo County. The five rural water districts include Saint Charles Mesa, Avondale, Boone, Beulah, and Rye. The two metro districts are Pueblo West and Colorado City. The Arkansas River is the main source of drinking water for the city of Pueblo and surrounding communities. The Pueblo Board of Water Works, which oversees water rights, has sufficient water rights to serve approximately 360,000 people with associated industrial and commercial growth². Current pumping capacity is 80 million gallons per day (mgd), while average and peak demands are 23 mgd and 60 mgd, respectively³.

Wastewater management jurisdictions within the county are set-forth in the county’s Section 208 Water Quality Management Plan⁴. The city of Pueblo is the water quality management agency for land, systems, and projects within the boundaries of the following political subdivisions:

- City of Pueblo
- Salt Creek Sanitation District
- Blende Sanitation District

PCAPP POTW/FOTW Options Study

- A portion of the St. Charles Mesa Sanitation District
- Pueblo Memorial Airport and Pueblo Airport Industrial Park

The City of Pueblo is the management agency for Salt Creek, Blende, the Pueblo Memorial Airport and Industrial Park, and the far western portion of the St. Charles Mesa Sanitation District primarily because their wastewater is treated in the City treatment plant. The management jurisdiction may change as new boundaries are drawn as a result of new development or annexation.

The County of Pueblo is the water quality management agency for the remaining land, systems, and projects within the geographic limits of Pueblo County that are not otherwise under City jurisdiction. These include:

- Pueblo West Metropolitan District
- Pueblo Reservoir State Recreation Area
- St. Charles Mesa District (that portion not served by the City of Pueblo)
- Rocky Mountain Steel Mill [formerly Colorado Fuel & Iron (CF&I) Co.]
- Avondale Water and Sanitation District
- Town of Boone
- Town of Rye
- Colorado City Metropolitan District

Generally, these entities are responsible for operating and maintaining wastewater treatment facilities that are located within their respective areas.

City of Pueblo. The City of Pueblo (elevation 4,700 feet) is located at the confluence of the Arkansas River and Fountain Creek in the middle of Pueblo County. The area has been an important transportation crossroads and trading center for over 150 years. A small fort was established at the present site of Pueblo in the early 1840s, although Spanish and French explorers had visited the area as early as 1540. The City of Pueblo was formally incorporated in 1872 during a time of rapid growth when the railroads came to the area. In 1886, two other towns, namely South Pueblo and Central Pueblo joined the city. A third town, Bessemer, which grew from the steel industry, was annexed in 1894. These four towns together make up the present City of Pueblo.

Today, the City of Pueblo occupies over 44 square miles and lies at the crossroads of two major highways, Interstate 25 (north/south) and U.S. 50 (east/west). Areas within the existing city limits and developed urban areas in close proximity to the city are fully developed with water, sewer, and roads. These areas cover about three-fourths of the existing development within the region². The City of Pueblo has one wastewater treatment plant that services the entire city, as well as the airport industrial park and portions of St. Charles Mesa, Salt Creek, and Blende Sanitation Districts. Details on this facility are provided in subsequent sections of this report.

Pueblo West. The Pueblo West Metropolitan District (PWMD) is located approximately 7 miles northwest of the City of Pueblo along US Highway 50, immediately north of the Pueblo Dam and Reservoir, which is part of the Fryingpan-Arkansas Water project. The United States Bureau of Reclamation constructed the dam in 1975.

The PWMD was created in 1969 and is one of two metro districts in the county. (The other metro district is the Colorado City Metro District located 20 miles south of the City of Pueblo along Interstate 25). Governed by a Board of Directors, the PWMD is a political subdivision formed in accordance with the Special District Act of the State of Colorado. The district provides municipal services, such as street improvements, sanitation, fire protection, recreation, and water and sewer services to its residents, but like other metro districts, it does not have the power to provide police services or zoning and subdivision. These services are provided to residents of the district by Pueblo County. According to the 2000 census, the district has a population of 17,178.

The area of the district, including annexations, contains about 31,000 acres or 49 square miles with about 19,729 lots of various sizes⁵. According to the 1995 Wastewater Master Plan for the District, of the total number of lots planned at build-out, only about 32% (or 6,265) will be sewer residential lots and less than 5% (or 858) will be for commercial and industrial use. The remaining lots (12,606) will be unsewered residential lots served by septic tanks. The average areas of sewer residential and unsewered residential lots are 0.56 and 2.08 acres, respectively. Wastewater from the district is treated in the Pueblo West wastewater treatment plant (WWTP). Details on this facility are provided in subsequent sections of this report.

St Charles Mesa. St Charles Mesa is an upland terrace area located southeast of the City of Pueblo. The Mesa is bounded by the Salt Creek Valley below its northwestern slope, the Arkansas River Valley below its northern slope, the St. Charles River Valley below its southeastern slope, and shale-dominated hillocks to the southwest⁶. The Bessmer Ditch, which delivers irrigation water to farms on the mesa and other areas of the lower Arkansas River Valley, traverses St. Charles Mesa along its southern side. U.S. Highway 50 (business) runs east to west through the northern half of the district.

The Saint Charles Mesa district, which covers approximately 10 square miles, was originally developed during the late 1800s for use as an agricultural area⁶. During the last 35 years, the Mesa has become increasingly urbanized as cultivated fields have been subdivided and converted to residential areas. Currently, crops are grown on only about 4 square miles of the Mesa.

The District has completed plans for a centralized wastewater treatment facility to replace individual sewage disposal systems (ISDSs, i.e., septic tanks and leach fields) in higher density areas. Details on this facility are provided in subsequent sections of this report.

Avondale and North Avondale. The Town of Avondale (population 754) is located in an agricultural area approximately 14 miles east of the City of Pueblo, directly south of PCD near U.S. Highway 50. The total population of the Avondale sub-division, which includes North Avondale, is 2,574¹. The Pueblo Regional Development Plan categorizes the Avondale area as a Country Village because it is situated in more remote areas of the Region, providing both

PCAPP POTW/FOTW Options Study

neighborhood developments and commercial retail services to serve the day-to-day needs of residents². Development within these areas is encouraged to follow traditional patterns typical of the areas history and past growth while protecting the surrounding agricultural lands and forest. Local zoning ordinances maintain lot sizes of 1 acre or larger in areas without public sewer and allow densities of up to 3 or 4 units per acre where both public sewer and water are available. The Avondale Water and Sanitation District has two wastewater treatment facilities. Details are provided in subsequent sections of this report.

Boone. The town of Boone (population 323) is located approximately 19 miles east of the City of Pueblo (5 miles east of PCD) along U.S. Highway 50. Like Avondale, the Town of Boone is surrounded by agricultural lands and is classified as a Country Village². Future development in the area is not expected to be rapid, but rather at a pace and level that preserves the rural character of the community. Boone has one wastewater treatment facility. Details are provided in subsequent sections of this report.

Pueblo Chemical Depot and Pueblo Depot Industrial Park. The Pueblo Chemical Depot (PCD) is located approximately 14 miles east of the center of the City of Pueblo in Pueblo County and about 2 miles north of the Arkansas River). The installation encompasses approximately 23,000 acres and includes a variety of buildings, structures, and developed areas.

Existing facilities at PCD include approximately 270 buildings used for administration, housing, maintenance, and storage. Most of these structures are located in the southern portion of the installation. In addition, PCD has earth-covered concrete igloos initially constructed for storage of conventional and chemical munitions. While most of the igloos that do not contain chemical weapons are empty, a small number (about 70) are leased to other organizations for storage. PCD also contains inactive demolition grounds and undeveloped perimeter zones. The PCAPP will be constructed on approximately 25 acres of land near where chemical weapons are stored.

Located within a portion of PCD is the Pueblo Depot Industrial Park (PDIP), which is managed by the Pueblo Depot Activity Development Authority (PDADA). Since 1996, the Authority has leased 857 buildings containing 3,910,800 square feet from the Army. Buildings are available for warehousing, distribution, manufacturing and specialty uses. Current major occupants include Boeing, Lockheed Martin, and the Trane Company. These companies, together with the Authority employ approximately 22 people.

According to the latest update of the Authority's Reuse Development Plan⁷, future uses of Depot land will be divided as follows:

- Industrial - 37% (8,455 acres)
- Wildlife Management – 62% (14,154 acres)
- Residential - 0.9 % (210 acres) for residential
- Recreation – 0.025% (5.7 acres).

Industrial uses include storage, distribution, manufacturing, office, and operations support. Currently, the Depot has 19 residential structures containing a total of 23 dwelling units (16

single family structures, 2 duplex structures, and 1 triplex structure) and two barracks-type structures. The Development Plan estimates that the allocated area for residential use can absorb an additional 80 to 150 dwelling units. The barracks are not considered for future residential use because of the anticipated lack of demand for these types of units.

Airport Industrial Park. Pueblo's Airport Industrial Park (AIP), consisting of 2,900 acres adjacent to the Pueblo Memorial Airport, is located six miles east of downtown Pueblo on U.S. Highway 50. The Pueblo Economic Development Corporation (PEDCO) is coordinating the Industrial Park Development. Water and sewer services are provided by the City of Pueblo. Major occupants include: U.S. Government Documents Distribution Center, U.S. Weather Bureau, Target Distribution Center, The Glenn Company, Boeing, Atlas Pacific, PCL Packaging, Kurt Manufacturing, Trane, Goodrich Corporation, Doane Products, Swift Trucking, Jones Tones, Haddonstone, Ashland Chemical, Timberline Steel, Universal Boiler Works, Inc., Absolute Manufacturing, Agalite Bath Enclosures, INNOTRAC, TR Toppers, and Stonecraft Industries, among others⁸. Together, these occupants employ over 3,500 people.

Transportation Technology Center. The U.S. Department of Transportation (DOT) Transportation Technology Center (TTC) is a railroad and transit research facility located approximately 15 miles northwest of the City of Pueblo, directly north of the PCD. A private for-profit entity, TTC Inc., operates the Center for the DOT. The TTC employs approximately 240 people and has 52 square miles of property, 48 miles of track, and numerous office, maintenance shop, and laboratory buildings. Wastewater is treated in septic tanks and leach fields. Details are provided in subsequent sections of this report.

Rocky Mountain Steel Mill. The Rocky Mountain Steel Mill (RMSM) is located in the City of Pueblo's south side, along Interstate 25. Formerly known as Colorado Fuel & Iron Company (CF&I), the Mill was purchased by Oregon Steel in 1993. At one time CF&I was Pueblo's largest employer and an integral part of one of the state's biggest industries. The recession in the early 1980's, combined with cheaper steel imports from foreign competitors, caused significant downsizing and layoffs at the plant. Today, RMSM has narrowed its product focus and become a Specialty Product Mini Mill that employs some 780 workers. RMSM has both sanitary and industrial wastewater treatment facilities. Details are provided in subsequent sections of this report.

Rio Grande Portland Cement. The Rio Grande Portland Cement Corp., a U.S. subsidiary of Grupo Cementos de Chihuahua, a Mexican company, is building a 1.0 million ton per year cement plant approximately six miles southeast of downtown Pueblo. The plant received a construction permit from the Colorado Department of Public Health and Environment (CDPHE) on 25 September 2000 following considerable controversy about the plant's possible effects on air quality⁹. However, local opponents have continued to press lawsuits against Pueblo County and the CDPHE, challenging their decisions to grant GCC other required permits, such as special-use, air emissions, and mined land reclamation permits¹⁰. As of late 2002 construction had not begun. When completed, the new facility will include both a limestone quarry, which will provide most of the raw materials needed to make cement, and the equipment for the

PCAPP POTW/FOTW Options Study

manufacturing process itself. Rio Grande will be able to produce approximately 1 million tons of cement annually. Total investment is expected to be approximately \$155 million.

2.3 Population

Population growth is a major factor in assessing future infrastructure needs of a community. Population data for the study area are shown in Table 1. Population growth within both the City of Pueblo and Pueblo County has not followed a consistent growth pattern. Recent figures from the 2000 Census show that the City of Pueblo experienced a 3.5% increase over the past decade. However, between 1980 and 2000 the population actually declined in both the county and city due to an economic recession and the loss of jobs primarily in the steel industry. In 2000, the city had a population of 141,472, making it the 7th largest city the State of Colorado. Over the next 30 years the population is expected to increase steadily at a projected average annual rate of 0.67%, or nearly double the annual growth rate experienced over the last decade. The percentage of the county's population living within the City of Pueblo is expected to continue to decline sharply as more growth takes place in the surrounding areas, such as Pueblo West and Saint Charles Mesa. Overall population within the county is expected to increase over the next 30 years at an average annual rate of 1.2%.

Previously, growth and development within the St. Charles Mesa area was constrained by the lack of sanitary sewer and high groundwater table². These constraints limited the development of new residential subdivisions with much greater densities (half acre to one acre lots) than the large acreage plots (10 to 40 acres) characteristic of this area when it was predominantly a

Table 1: Historical and Projected Population Growth, 1970 to 2030

	1970	1980	1990	2000	2010	2020	2030
Pueblo County							
Population	118,238	125,972	123,051	141,472	159,257	179,886	199,782
Change	-0.4% [§]	6.5%	-2.3%	15%	12.6%	13%	11.1%
City of Pueblo							
Population	97,774	101,686	98,640	102,121	110,063	117,282	124,246
Change	7.2% ^{§§}	4%	-3%	3.5%	7.7%	6.6%	5.9%
City/County	83%	81%	80%	72%	69%	65%	62%
Pueblo West							
Population	---	---	4,613	17,178	---	---	---
Change	---	---	---	73%	---	---	---
St. Charles Mesa							
Population	---	---	8,441	8,891	---	---	---
Change	---	---	---	5%	---	---	---
Avondale (sub-division)							
Population	---	---	2,382	2,574	---	---	---
Change	---	---	---	7%	---	---	---
Boone							
Population	---	---	341	323	---	---	---
Change	---	---	---	-7.5%	---	---	---

§ Based on 1960 population of 118,707

§§ Based in 1960 population of 91,181

Sources: U.S. Census Bureau, City of Pueblo 2002 Data Book

PCAPP POTW/FOTW Options Study

farming community. Now that these barriers to growth are being addressed, the area will likely experience a much higher population growth over the next decade than it experienced in previous decade.

The implication of the population data is that wastewater treatment needs within the City of Pueblo, where growth is relatively low, can most likely be met with existing facilities. Areas with higher growth rates, such as Pueblo West and St. Charles Mesa, may have a greater need for new or expanded wastewater treatment facilities. As will be discussed in the next section of this report, both communities have already taken the necessary steps to address this need.

3.0 PCAPP Hydrolysate and Biotreatment Plant Effluent Information

Pertinent information on the PCAPP hydrolysate and PCAPP biotreatment plant effluent was compiled to use as the basis for assessing the compatibility of community needs with the needs of PCAPP hydrolysate biotreatment. The factors addressed in the preliminary screening presented in Section 5 include treatment capacities (hydraulic and organic), water quality issues related to sulfate levels in the Arkansas River, and timing. This section presents the information on the PCAPP hydrolysate and PCAPP biotreatment plant effluent pertinent to the assessment and defines the assessment factors.

3.1 Hydrolysate Characteristics Pertinent to Biotreatment and Discharge in General

In order to perform the Feasibility Assessment of the potential POTW/FOTW Options, a characterization of the mustard hydrolysate from the PCAPP needed to be developed. This characterization is based on the PMACWA Demonstration and Engineering Design Study Programs and the Engineering Design Packages prepared for Pueblo. From this information, the key considerations are as follows:

- At a 3.8-wt% agent loading, the PCAPP neutralization process will generate on the order of 68,000 gal/d of hydrolysate¹¹.
- The organic concentration of the hydrolysate will be approximately 45,000 mg/L as measured by chemical oxygen demand (COD). This is roughly equivalent to the organic loading of a 7.5-mgd (million gallon per day) domestic wastewater treatment plant (assuming a domestic wastewater biochemical oxygen demand [BOD] of 200 mg/L and a COD/BOD ratio of 2) with approximately 12,500 lb/d of BOD.
- The total dissolved solids (TDS) concentration will be approximately 3%.
- Treatment in the PCAPP biotreatment plant (with water recycle and no liquid discharge to the environment) calls for approximately 3 fold dilution of the 3.8-wt% hydrolysate to reduce the TDS concentration of the biofeed to approximately 1% in order to minimize inhibition of the biological activity.
- Based on prior experience at Aberdeen Proving Ground treatment of the hydrolysate in a biotreatment plant that discharges to a body of water requires either a 30 fold dilution of the 3.8-wt% hydrolysate or additional treatment to reduce the TDS concentration of the bio-effluent to approximately 0.2% in order to pass whole effluent toxicity (WET) testing.
- Because of the relatively high TDS of the hydrolysate, greater than 30-fold dilution or demineralization capability will have to be provided by any POTW that accepts and treats the 3.8-wt% hydrolysate.

3.2 Hydrolysate Characteristics Pertinent to Discharge to the Arkansas River

Indigenous minerals and rock (Pierre Shale) and non-point sources contribute significant concentrations of selenium and sulfate to the Arkansas River. The in-stream background concentrations of these compounds are near or exceed the maximum allowable in-stream

concentrations of 310 mg/L for sulfate and 17 ug/L for selenium¹². Both of these compounds are found in the hydrolysate and would impact discharge of the effluent to the Arkansas River.

- The sulfur content of the 3.8-wt% hydrolysate will be approximately 7,500 mg/L. Biotreatment of the hydrolysate has the potential to convert this sulfur to approximately 23,400 mg/L of sulfate. In order to reduce the sulfate concentration to meet the stream standard of 310 mg/L, the 3.8-wt% hydrolysate would require a 75-fold dilution if the diluent wastewater does not contain sulfate. Higher dilution factors would be required if the diluent wastewater does contain sulfate.
- The selenium concentration in the hydrolysate will vary. Analytical results indicate that concentrations of at least 90 ug/L should be expected¹³. In that case, a greater than 6-fold dilution of the 3.8-wt% hydrolysate would be required to meet the stream standard of 17 ug/L.
- Therefore, greater than 75-fold dilution or demineralization capability would have to be provided by any POTW that accepts and treats 3.8-wt% hydrolysate and discharges to the Lower Arkansas River.

3.3 Pertinent Characteristics of the PCAPP Biotreatment Plant

Pertinent characteristics of the PCAPP biotreatment plant include the following:

- The PCAPP biotreatment plant will have a capacity on the order of 0.2 mgd¹¹ at an organic concentration of 15,000 mg/L as COD¹³.
- The average concentration of sulfate in the PCAPP biotreatment plant effluent is expected to be approximately 7,800 mg/L or 13,200 lb/d at 0.2 mgd.
- Operation of the PCAPP Facility is estimated to begin in December 2007 with the initiation of the Pilot Test and end in April 2010¹³.

Table 2 summarizes the relevant wastewater characteristics and dilution requirements for discharge by a facility that lacks the capability of removing sulfate, selenium, and TDS.

Table 2: Summary of PCAPP Wastewater Characteristics and Dilution Factors, Treatment Capacities, and Average Daily Flows Required for Treatment and Discharge

	Wastewater Stream	
	3.8-wt% hydrolysate	PCAPP biotreatment effluent
Wastewater characteristics		
Quantity	0.068 mgd	0.2 mgd
Organic loading as BOD ¹	22,500 mg/L 12,700 lb/d	750 mg/L 1,270 lb/d
TDS	3 %	2 %
Sulfate ²	23,400 mg/L ³ 13,200 lb/d ³	7,800 mg/L 13,200 lb/d
Selenium	90 mg/L	30 mg/L

Table 2: Summary of PCAPP Wastewater Characteristics and Dilution Factors, Treatment Capacities, and Average Daily Flows Required for Treatment and Discharge (continued)

	Wastewater Stream	
	3.8-wt% hydrolysate	PCAPP biotreatment effluent
Dilution factor needed for:		
Treatment in PCAPP biotreatment plant (no discharge) <ul style="list-style-type: none"> to maintain ~1% TDS concentration in biofeed 	~3	---
Treatment of 3.8-wt% hydrolysate at WWTP that discharges to any stream or direct discharge of the PCAPP biotreatment plant effluent to any stream: <ul style="list-style-type: none"> to pass WET testing (TDS concentration ~0.2% or less) 	≥ 30	≥ 10
Treatment of 3.8-wt% hydrolysate at a WWTP that discharges to the Lower Arkansas River Segment 1a or direct discharge of the PCAPP biotreatment effluent to the Lower Arkansas River Segment 1a: <ul style="list-style-type: none"> to meet water quality standard for sulfate (310 mg/L) to meet water quality standard for selenium (17 ug/L) 	> 75 ⁴ > 5.7 ⁴	> 25 ⁴ > 1.9 ⁴
Flow and capacity required at receiving WWTP		
Excess hydraulic capacity	≥ 0.068 mgd	---
Excess organic capacity, as BOD	≥ 12,700 lb/d	---
Average daily flow	> 5 mgd ⁵	---

Values are approximate.

- 1 Assumes COD/BOD ratio of 2.
- 2 Assumes all sulfur in agent is eventually converted to sulfate and not lost from the system.
- 3 This is the potential sulfate concentration. Actual sulfate concentration in hydrolysate will be low; most of the sulfur will still be in thiodiglycol.
- 4 These are the minimum dilution factors, those required if the receiving WWTP effluent currently contains no sulfur. Since most wastewaters contain sulfate, higher dilution factors will be required.
- 5 Based on the dilution factor required to meet the stream standard for sulfate. Again, this represents the absolute minimum because it assumes that the receiving WWTP effluent contains no sulfate.

3.4 Assessment Factors

Based on the expected characterization of the 3.8-wt% hydrolysate, the discharge requirement to the Lower Arkansas River, and the timing of the PCAPP operation, the following assessment factors were used for evaluation of POTW/FOTW Options:

- In order to accept and treat the PCAPP hydrolysate:
 - Potential candidate POTWs will need excess hydraulic capacity of 0.068 mgd and excess organic treatment capacity of 12,700 lb/d of BOD. This assumes that only one facility will be used to treat the hydrolysate from PCAPP.
 - All potential candidate POTWs in the study area discharge to the Lower Arkansas River Segment 1a or its tributaries. Therefore, candidate POTWs must have either an average

PCAPP POTW/FOTW Options Study

daily flow of greater than 5 mgd (how much greater being a function of the sulfate levels at the POTW) or the capability of removing sulfate in order to meet the stream standard.

- In order to consider construction of an FOTW that treats PCAPP hydrolysate and other PCAPP, PCD, or off-site wastewaters:
 - The unmet needs of potential users will have to coincide with PCAPP pilot testing and operations, which will occur from about 2007 to 2010¹⁴.
 - Also, since a FOTW would discharge to the Lower Arkansas River Segment 1a via one or more of its tributaries, the average daily wastewater flows from other users (i.e., non-PCAPP) will have to be greater than 5 mgd (how much greater being a function of the sulfate levels in the other wastewaters) in order to provide the necessary dilution for the treated PCAPP hydrolysate to meet the stream standard for sulfate, or the FOTW will have to remove the excess sulfate from the effluent prior to discharge.

4.0 Needs Assessment

This section presents a discussion of the wastewater treatment facilities and needs of each public and industrial entity in the defined study area. Information needed to assess the areas the wastewater treatment needs and the compatibility existing and planned wastewater treatment facilities with those of PCAPP is identified, including treatment capacities, water quality issues, and timing.

4.1 City of Pueblo

The City of Pueblo Wastewater Treatment Plant (WWTP) services the entire city, as well as the Airport Industrial Park and portions of the St. Charles Mesa, Salt Creek, and Blende Sanitation Districts. The Pueblo WWTP, also known as the James R. Dilorio Water Reclamation Facility, discharges to the Arkansas River in accordance with its NPDES permit (Permit No. CO-0026646)¹⁵. The plant has a design capacity of 19 mgd for hydraulic flow and 33,100 lbs of BOD₅ per day for organic loading (both 30-day averages). Current daily flows typically average approximately 12 mgd. The 95th percentile maximum monthly flow is 16 mgd (based on reported operating data from January 1995 through August 2002) or 84% of the design capacity^{16,17}. The 95th percentile maximum monthly organic loading for the same period is 23,540 lb/d BOD or 71% of the design capacity.

The Pueblo WWTP facility consists of headworks (i.e., screens, grit removal, screw pumps), primary treatment (two primary clarifiers), secondary treatment (one trickling filter [TF] followed by four solids contact [SC] basins), chlorination/dechlorination, and biosolids handling (gravity thickener, dissolved air floatation, four anaerobic digesters, and sludge drying beds)¹⁷. Most of the unit processes and facilities currently in use were brought on-line in 1989 when the plant underwent a major expansion and renovation. Much of the original WWTP, which was built in 1939, still exists on the site but is no longer in use. Additional improvements to the headworks are now underway and should be completed by the end of 2003.

The Pueblo WWTP NPDES permit requires the city to begin planning for facility expansion when the WWTP reaches 80% of its design capacity (based on maximum monthly average organic load) and to commence construction on or before the point when the WWTP reaches 95% of its design capacity. Based on projected flows and loads, the facility is expected to reach these respective milestones in approximately 2008 and 2025¹⁷ (Black and Veatch, 2000). The projection assumes an annual population growth of 1%, which is slightly higher than the 0.7 to 0.8 % annual growth forecasted by the Pueblo Regional Development Plan (Pueblo Area Council of Governments, 2001). Projections were also made based on 2% and 0.58% annual population growth rates, but the City selected 1% as its basis for facility planning.

Based on the current maximum monthly organic loading, the Pueblo WWTP currently has excess organic treatment capacity of approximately 9,560 lb/d of BOD (33,100 lb/d design capacity minus 23,540 lb/d current maximum monthly loading). Based on facility planning projections, excess organic treatment capacity, which is already less than the estimated organic loading of

PCAPP POTW/FOTW Options Study

12,700 lb/d of BOD from the PCAPP hydrolysate, will decrease to approximately 6,000 lb/d within the PCAPP operating timeframe. Therefore, in order to accept all of the PCAPP hydrolysate, the city would have to increase its total organic treatment capacity by approximately 20% (6,700 lb/d / 33,100 lb/d) before PCAPP operations begin. This would require expansion (and/or improvements) of the trickling filter system and solids contact basins and, quite likely, to the secondary clarifiers and sludge handling facilities. The 2000 Pueblo WWTP Master Plan, which of course did not consider treatment of the PCAPP hydrolysate, shows capital cost estimates for expansion of these unit processes to meet their needs through 2020 to be \$6.4 million (2000 dollars)¹⁷. Other unit processes are slated for expansion that may not be related to increased organic loading. In order to develop a design basis for expansion plans that do include treatment of PCAPP hydrolysate, a detailed study, including pilot testing using real or simulated hydrolysate, would be required. Study results may indicate that additional and accelerated expansion is required to treat the hydrolysate. A study of this kind could cost on the order of \$3 million or more and take a year or longer to execute based on past experience with biotreatment testing conducted during the PMACWA Demonstration and Engineering Design Study Programs.

Due to elevated levels of selenium and sulfate in the WWTP effluent, the Pueblo WWTP National Pollutant Discharge Elimination System (NPDES) permit requires the city to monitor selenium and sulfate concentrations and maintain existing water quality standards. They are not required to provide treatment to reduce current effluent concentrations of these constituents because much of the selenium and sulfate come from natural sources and the existing treatment processes appear to remove some of the selenium that would otherwise reach the Arkansas River. Additionally, treatment processes to remove selenium would increase selenium concentrations in the biosolids and cost-effective sulfate removal processes are not available for the magnitude of flow and concentrations seen at the Pueblo WWTP (see Appendix A). In order to maintain existing water quality standards, however, the Pueblo WWTP industrial pretreatment program requires that they do not accept for treatment any new sources of industrial wastewater with selenium concentrations that are expected to exceed a 30-day average of 17 ug/L or sulfate concentrations that are expected to exceed a 30-day average of 310 mg/L. (See Appendix A for a Brief Overview of Pretreatment Regulations.)

The expected concentration of selenium in the PCAPP hydrolysate is approximately 90 ug/L, which exceeds the pretreatment standards for discharge to the Pueblo WWTP. The hydrolysate selenium concentrations could be reduced through precipitation but sulfate issues would still remain. As the thiodiglycol contained in the hydrolysate is biodegraded, the sulfur in the thiodiglycol would be converted to sulfate and increase the current Pueblo WWTP sulfate concentrations by more than 20%, which would not be in keeping with the goal to maintain existing water quality standards. Alternatives for removing the sulfate contributed by the PCAPP hydrolysate from the WWTP effluent are discussed in Appendix B (Technologies for Sulfate Removal). Alternatives include precipitation, biological treatment, ion exchange, and membrane processes. These technologies have been proven effective at removing sulfate from water and wastewater but their application in this case poses some significant technical and financial obstacles that arise largely from the relatively high flow of the Pueblo WWTP. Existing sulfate removal facilities treat only 1 to 2 mgd or less, and each technology produces residuals that that

PCAPP POTW/FOTW Options Study

must be managed responsibly. Estimated capital costs for these technologies range from \$18 million to \$47 million with operating and maintenance (O&M) costs ranging from \$6.7 million/year to \$352 million/year. The estimates are extrapolated from cost data found in References 3 and 4 of Appendix B and should be considered order-of-magnitude type estimates.

4.2 Pueblo West

Wastewater from the district is treated in the Pueblo West WWTP. The facility, which was recently modified and expanded in 1999, provides secondary treatment and nitrogen removal. The cost of the expansion was approximately \$3.6M. The design capacity of the plant is: average daily of 1.3 mgd, peak daily of 1.8 mgd, and maximum monthly of 2.9 mgd⁵. System headworks include screens and grit removal. Secondary treatment and nitrogen removal are accomplished in two lined, earthen basins (with aerobic and anoxic zones) followed by two secondary clarifiers and an ultraviolet disinfection unit. Waste activated sludge is aerobically digested and stored in one of two converted lagoon cells before being hauled off-site for land application. Currently, the plant is operating at about 56% of its peak daily design capacity of 1.8 mgd. The plant is laid out to readily allow expansion to 3.6 mgd. Pueblo West is conducting a study to determine when an expansion will be needed. The facility discharges to Pesthouse Gulch, which flows approximately two miles to Wild Horse Creek and then flows another seven miles to the Arkansas River.

4.3 St. Charles Mesa

The District has completed plans for a 1.25 mgd deep-shaft type wastewater treatment system to replace Individual Sewage Disposal Systems (ISDS) in higher density areas^{18,19}. The first phase of the project, installation of 6,000 feet of sewer line from the community to the WWTP site, is currently underway. Funds are now being raised for the next phase of the project, construction of the treatment system, which is expected to begin in the spring of 2003 and last 8 to 10 months. When completed, the \$3 million dollar WWTP is expected to have initial flows of 0.44 to 0.45 mgd and provide adequate capacity for 10 or more years. The site can accommodate two additional 1.25 mgd deep shaft-type treatment systems for future expansion.

4.4 Avondale and North Avondale

The Avondale Water and Sanitation District has two wastewater treatment facilities^{4,20}. The District's Avondale facility has a capacity of 0.15 mgd and consists of one, 10 acre (three cell) lagoon, a 3.9 acre land application area, and chlorine disinfection system. Due to low flows, there is no discharge for 5 to 7 months each year. When the system discharges, the effluent goes to the Green Arroyo. The average effluent flow during months of discharge is about 0.08 mgd. The lagoon was upgraded in 1994 from a single cell system to a three-stage stabilization pond to improve performance. The town of Avondale is now considering installing a small package plant in-line to maintain year-round discharge.

PCAPP POTW/FOTW Options Study

The District's Fort Reynolds wastewater treatment lagoons are non-discharging and consist of one stabilization pond (2.5 acres) and two rapid infiltration beds (absorption ponds, one acre each).

The Pueblo Regional Development Plan² shows North Avondale in an area with a recommended land use intensity of 1 unit per 35 acres. Thus, North Avondale has no centralized wastewater treatment (nor any need for one), but relies on ISDSs for wastewater treatment.

4.5 Boone

The Boone wastewater facility consists of two 3.5-acre evaporative lagoons (no discharge) with a total capacity of 0.065 mgd^{4,21}. Current wastewater flows are such that the town needs and uses only one lagoon. The town does not anticipate any need for expansion within the next 20 years.

4.6 PCAPP (sanitary wastewater), Pueblo Chemical Depot (PCD), and Pueblo Depot Industrial Park (PDIP)

Sanitary wastewater will be generated at PCAPP through all phases of the program (i.e., construction, pilot testing, systemization, operations, and closure). In the early stages of construction, two existing 10,000 gpd evaporative lagoons located at PCD near the PCAPP construction site will be used to treat sanitary wastewater from PCAPP. PMACWA is assessing the ability of these lagoons to meet the sanitary wastewater treatment needs during peak construction periods. The expected quantity of sanitary wastewater during operations is 18,000 gal/d.

Sanitary wastewater from current PDIP tenants is pumped to the same PCD lagoons that will be used to treat PCAPP sanitary wastewater during at least the initial stages of construction. If this treatment capacity were increased (e.g., by adding additional lagoons) to support PCAPP construction and operation, the additional lagoon capacity would be available to PDIP tenants. Wastewater treatment capacity requirements of future PDIP tenants need to be determined based on re-use plans. Current tenants, mostly storage warehouses, generate little wastewater with only 22 employees.

4.7 Airport Industrial Park (AIP)

Prior to 1992, the City of Pueblo owned and operated a wastewater treatment plant at the AIP^{4,22}. In 1992, pump stations and piping were installed to convey wastewater from the AIP to the Pueblo WWTP and the AIP WWTP was closed. The decision to close the AIP WWTP and pump wastewater to the Pueblo WWTP was based on the results of two studies conducted by CH2MHILL in 1988 and 1989. A contributing factor to the decision was the elimination of the labor associated with the operation, maintenance, and permitting of a second WWTP. The WWTP has not been removed from the AIP, but it has not been maintained and would require extensive work to start it up.

4.8 Transportation Technology Center (TTC)

The TTC uses five septic tanks with a total capacity of 10,000 gal/day to treat sanitary wastewater²³. The septic tanks discharge to permitted leach fields. They do not foresee any additional wastewater treatment capacity requirements in their long-range (20-year) planning.

4.9 Rocky Mountain Steel Mill (RMSM)

The RMSM WWTP has a permitted capacity of 57 mgd but little of that capacity involves biological treatment^{4,15}. Discharge is to the Arkansas River, approximately 1 mile downstream of the Pueblo WWTP outfall. The RMSM wastewater treatment facilities include a domestic sewage treatment plant and an industrial wastewater treatment plant. The domestic sewage biotreatment system consists of a small activated sludge plant (aerobic basins, final clarifier, chlorine contact chamber) with a capacity of 0.25 mgd. The system discharges to the industrial wastewater treatment system, which includes scale pits and clarifiers for solids and oil removal, and two final lagoons for additional solids removal and biological treatment. Mechanical aerators are available at the final lagoons, but normally are not used because sufficient dissolved oxygen is present in the water.

An old biotreatment plant that was once used to treat coke plant waste still exists on the site^{24,25}. The system was shut down some 20 years ago when the coke plant was abandoned. According to plant personnel, the biotreatment system, which has a hydraulic capacity of 0.3 to 0.4 mgd and organic treatment capacity of 3,300 lb/d of BOD, would require significant renovation just to be functional.

4.10 Rio Grande Portland Cement

Attempts to obtain additional information about the Rio Grande Portland Cement facility and its wastewater treatment needs have been unsuccessful. It is likely, however, that there will be little or no need for biological treatment.

4.11 Needs Assessment Findings

The needs assessment indicates that wastewater treatment needs within the City of Pueblo, Avondale, North Avondale, and Boone can most likely be met with existing facilities within the timeframe of PCAPP. Areas with higher growth rates, such as Pueblo West and St. Charles Mesa, may have a greater need for new or expanded wastewater treatment facilities, but both communities have already taken the necessary steps to address this need. Similarly, wastewater treatment needs at commercial/industrial entities, including PCD, are being met by existing facilities.

5.0 Feasibility Assessment

The objective of this feasibility study was to identify potentially feasible POTW/FOTW options. These options include:

- Treatment of the PCAPP hydrolysate at a local POTW
- Construction of a FOTW at or near PCAPP that treats PCAPP hydrolysate, other PCD wastewaters, and offsite wastewaters
- Use of all or part of the PCAPP biotreatment plant after PCAPP closure by local entities

Previous sections of this report presented information on local wastewater treatment facilities and community needs and the major requirements for treatment of PCAPP hydrolysate in a POTW or FOTW. The following paragraphs present a discussion on the feasibility of local POTW/FOTW options.

5.1 Treatment of the PCAPP Hydrolysate at a Local POTW

Treatment of the PCAPP hydrolysate does not appear to be a feasible option at a local POTW. Even the largest biological wastewater treatment plant in the study area, the Pueblo WWTP with a design hydraulic capacity of 19 mgd and a design organic capacity of 33,100 lb/d of BOD, does not have the excess organic treatment capacity needed to treat the PCAPP hydrolysate now or, based on their current expansion plans, within the PCAPP operating timeframe. The total organic treatment capacity of the Pueblo WWTP would have to be increased by approximately 20% in order to handle the PCAPP hydrolysate. Additionally, the selenium and sulfate concentrations expected in the PCAPP hydrolysate exceed the pretreatment standards of the Pueblo WWTP and, while removal of selenium from the hydrolysate may be affordable, sulfate removal, which is not possible until after biotreatment, poses significant technical and financial obstacles at such large flows.

5.1.1 Treatment of PCAPP Hydrolysate at the Pueblo WWTP

The design and current operating conditions at the Pueblo WWTP (discussed in detail in Section 4.1, City of Pueblo) were compared against the estimated characterization of the PCAPP hydrolysate. In evaluating the option of sending the PCAPP hydrolysate to the Pueblo WWTP, we considered the excess hydraulic and organic capacities that currently exist there and how those capacities are expected to change during the life cycle of PCAPP.

Based on the current maximum monthly organic loading, the Pueblo WWTP currently has excess organic treatment capacity of approximately 9,560 lb/d of BOD (33,100 lb/d design capacity minus 23,540 lb/d current maximum monthly loading). Based on facility planning projections, excess organic treatment capacity, which is already less than the estimated organic loading of 12,700 lb/d of BOD from the PCAPP hydrolysate, will decrease to approximately 6,000 lb/d within the PCAPP operating timeframe. Therefore, in order to accept all of the PCAPP hydrolysate, the city would have to increase its total organic treatment capacity by approximately 20% (6,700 lb/d / 33,100 lb/d) before PCAPP operations begin. This would require expansion (and/or improvements) of the trickling filter system and solids contact basins and, quite likely, to

the secondary clarifiers and sludge handling facilities. The 2000 Pueblo WWTP Master Plan, which of course did not consider treatment of the PCAPP hydrolysate, shows capital cost estimates for expansion of these unit processes to meet their needs through 2020 to be \$6.4 million (2000 dollars)¹⁷. Other unit processes are slated for expansion that may not be related to increased organic loading. In order to develop a design basis for expansion plans that do include treatment of PCAPP hydrolysate, a detailed study, including pilot testing using real or simulated hydrolysate, would be required. Study results may indicate that additional and accelerated expansion is required to treat the hydrolysate. A study of this kind could cost on the order of \$3 million or more and take a year or longer to execute based on past experience with biotreatment testing conducted during the PMACWA Demonstration Testing and Engineering Design Study Programs.

The expected concentration of selenium in the PCAPP hydrolysate is approximately 90 ug/L, and exceeds the pretreatment standards for discharge to the Pueblo WWTP. The hydrolysate selenium concentrations could be reduced through precipitation but sulfate issues would still remain. As the thiodiglycol contained in the hydrolysate is biodegraded, the sulfur in the thiodiglycol would be converted to sulfate and increase the current Pueblo WWTP sulfate concentrations by more than 20%, which would not be in keeping with the goal to maintain existing water quality standards. Alternatives for removing the sulfate contributed by the PCAPP hydrolysate from the WWTP effluent are discussed in Appendix B. Alternatives include precipitation, biological treatment, ion exchange, and membrane processes. These technologies have been proven effective at removing sulfate from water and wastewater but their application in this case poses some significant technical and financial obstacles that arise largely from the relatively high flow of the Pueblo WWTP. Existing sulfate removal facilities treat only 1 to 2 mgd or less, and each technology produces residuals that that must be managed responsibly. Estimated capital costs for these technologies range from \$18 million to \$47 million with operating and maintenance (O&M) costs ranging from \$6.7 million/year to \$352 million/year. The estimates are extrapolated from cost data found in References 3 and 4 of Appendix B and should be considered order-of-magnitude type estimates.

Based on the available hydraulic and organic treatment capacities at the Pueblo WWTP and the selenium and sulfate discharge limitations to the Arkansas River, the PCAPP hydrolysate could not be treated at the Pueblo WWTP without significant changes to the plant. In addition, the excess capacity at the Pueblo WWTP is significantly greater than the excess capacities that exist at the other local WWTPs; therefore, they would not be viable treatment systems either.

5.1.2 Treatment of PCAPP Hydrolysate at Multiple WWTPs

Using more than one local POTW to treat the PCAPP hydrolysate was also found to be unfeasible. For example, the combined organic treatment capacities of the Pueblo, the Pueblo West, and proposed St Charles Mesa WWTPs at build-out might be sufficient to treat the PCAPP hydrolysate (if local needs do not consume excess capacity) but sulfate removal would still be an issue.

5.2 Construction of a FOTW at or Near PCAPP

Construction of a FOTW at or near PCAPP to treat PCAPP hydrolysate, PCAPP sanitary wastewater, other PCD wastewaters, and off-site wastewaters does not appear to be a feasible option. In order to be workable the combined flows of PCAPP sanitary wastewater, PCD wastewaters, and off-site wastewaters would have to total over 5 mgd to meet discharge limits for sulfate. The local unmet wastewater treatment demand is well below 5 mgd. St Charles Mesa is the only local entity with plans for new construction and their initial plant will only be 1.25 mgd with build-out possibly to 3.75 mgd beyond the PCAPP operating timeframe. The wastewater treatment needs of other local entities are being met by existing facilities. Even if the demand existed, sulfate removal would still be an issue.

5.3 Use of All or Part of the PCAPP Biotreatment Plant After PCAPP Closure

Any of the public and industrial entities in the study area may have use for parts of the PCAPP biotreatment plant after PCAPP closure. It is unlikely that any of them would use the entire plant or even a significant portion. Current projections do not show additional wastewater treatment needs in the area reaching the equivalent domestic capacity of the PCAPP biotreatment plant. Even at the Pueblo WWTP, expansion planning for organic treatment capacity over the next 20 years is geared more towards adding redundancy rather than capacity.

This is an option that could be revisited as details of the PCAPP design are developed,. For now, however, there is no definable option. PMACWA should discuss the potential for using the PCAPP with the local community. If there is a chance that the community would want to use all or part of the PCAPP on-site biotreatment plant after PCAPP closure then that end use should be considered in the design of the biotreatment plant. Not considering the future use of the PCAPP on-site biotreatment plant now could lead to the selection of a biotreatment system design that is not compatible with the community's future use plan. In addition, incorporation of a future use option in the PCAPP design at this time would most likely result in only a minimal cost impact on the ongoing design and subsequent construction efforts.

6.0 Assessment Conclusions

The findings of the Needs and Feasibility Assessments were presented to the AOWG at a meeting held on 21 January 2003 (See Appendix C, Acceleration Options Working Group 21 January 2003 Meeting Minutes). Following the presentation, the group had the opportunity to ask questions and discuss the findings:

- None of the potential candidate POTWs for accepting and treating PCAPP hydrolysate have excess hydraulic capacity of 0.068 mgd and excess organic treatment capacity of 12,700 lb/d of BOD.
- None of the potential candidate POTWs for accepting and treating PCAPP hydrolysate have either an average daily flow of greater than 5 mgd or the capability of removing sulfate in order to meet the stream standard.
- The unmet needs of potential users of an FOTW that treats PCAPP hydrolysate do not coincide with PCAPP pilot testing and operations nor do the unmet.
- The unmet needs of potential users of an FOTW that treats PCAPP hydrolysate do not exceed 5 mgd.

Based on the assessment findings, the AOWG concluded that there are no viable POTW/FOTW options. An exception may be the use of all or part of the PCAPP biotreatment plant after PCAPP closure, which could be revisited as details of the PCAPP design are developed. For now, however, since there is no definable option, the group recommended that FOCIS conclude the POTW/FOTW options study and submit a final report.

7.0 References

- ¹ U.S. Census Bureau, 2000 Census.
- ² Pueblo Area Council of Governments, “Pueblo Regional Development Plan,” September 2001.
- ³ Destruction of Chemical Munitions at Pueblo Chemical Depot, Colorado, “Draft Environmental Impact Statement,” PMCD, May 2001.
- ⁴ Pueblo County and Pueblo Area Council of Governments, “Section 208 Water Quality Management Plan, Volume VII, 1993 Update,” September 1994.
- ⁵ Rothberg, Tambarini, Winsor, Inc. (RTW), “Site Application for the Wastewater Treatment Plant,” prepared for the Pueblo West Metropolitan District, March 1998.
- ⁶ Brendle, D.L., “Evaluation of possible alternatives to lower the high water table of the St Charles Mesa, Pueblo County, Colorado, U.S. Geological Survey,” 2002.
- ⁷ Pueblo Depot Activity Development Authority, “Pueblo Chemical Depot Reuse Development Plan Update,” June 2000.
- ⁸ Pueblo Economic Development Corporation, “Pueblo 2002 Data Book,” 2002.
- ⁹ Budgar, L., “Cement plant awarded construction permit,” *The Pueblo Business Journal*, 29 September 2000.
- ¹⁰ Roper, P., Cement plant foes demand hearing, *The Pueblo Chieftain*, 22 November 2002.
- ¹¹ PCAPP design data provided by PMACWA.
- ¹² CDPHE Water Quality Control Commission, “Regulation No. 32, Classifications and numeric standards for Arkansas River Basin,” 24 April 2002.
- ¹³ Arthur D. Little, Inc., “Test Plan for Laboratory-Scale Biotreatability Testing of HD Hydrolysate generated from Projectile Washout System (PWS) Testing,” 25 January 2002.
- ¹⁴ PMACWA, ACWA neut-bio schedule comparison, CAIG and PMACWA projections, attachment to email from Scott Susman to Armand Balasco, dated 12 June 2002
- ¹⁵ CDPHE Water Quality Control Division, Permit Number CO-00226646, effective 1 August 2002.
- ¹⁶ Pueblo WWTP plant data, January 1989 through August 2002.
- ¹⁷ Black & Veatch Corp., “WWTP Master Plan,” prepared for the City of Pueblo, Colorado Department of Wastewater, May 2000.
- ¹⁸ Northstar Engineering and Surveying, Inc., “Site Application Report for Affordable Residential Communities,” prepared for the St Charles Mesa Sanitation District, April 2000.
- ¹⁹ Northstar Engineering and Surveying, Inc., “Sanitary Sewer Master Plan for St Charles Mesa Sanitation District,” July 1998, updated January 2000.
- ²⁰ Telecon with Michelle Childs, Avondale Water and Sanitation District. November 2002.
- ²¹ Telecon with Ray Terry, Town of Boone, November 2002.
- ²² Conversations with Don Andrews, Nancy Keller, and Don Fouts, Pueblo WWTP, October 2002.
- ²³ Telecons with Gunar Spons, DOT ARA, and Mark White, TTCI, October 2002.
- ²⁴ Dart Environment and Services Company, “Operation and maintenance of biological treatment system for coke plant wastewater at CF&I Steel Corporation,” Pueblo, Colorado, April 1980.
- ²⁵ Telecon with Carl Hund, RMSM, November 2002.

Appendix A – Brief Overview of the Pretreatment Regulations [40CFR403]

Appendix A – Brief Overview of the Pretreatment Regulations [40CFR403]

General Pretreatment Regulations

The objectives of general pretreatment regulations are as follows:

- To prevent the introduction of pollutants into POTWs which will interfere with the operation of a POTW, including interference with its use or disposal of municipal sludge;
- To prevent the introduction of pollutants into POTWs which will pass through the treatment works or otherwise be incompatible with such works; and
- To improve opportunities to recycle and reclaim municipal and industrial wastewaters and sludges.

These objectives are achieved by imposing general and specific prohibitions, specific effluent limits, and categorical standards on users of the POTW.

General prohibitions. A user may not introduce into a POTW any pollutants that cause pass through or interference. These general prohibitions and the specific prohibitions described below apply to each user introducing pollutants into a POTW whether or not the user is subject to other National pretreatment standards or any national, State, or local pretreatment requirements.

Specific prohibitions. The following pollutants are not be introduced into a POTW:

- Pollutants which create a fire or explosion hazard in the POTW, including, but not limited to, wastestreams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21.
- Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the works is specifically designed to accommodate such discharges
- Solid or viscous pollutants in amounts which will cause obstruction to the flow in the POTW resulting in interference
- Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW
- Heat in amounts which will inhibit biological activity in the POTW resulting in interference, but in no case heat in such quantities that the temperature at the POTW exceeds 40°C (104 °F) unless the approval authority, upon request of the POTW, approves alternate temperature limits
- Petroleum oil, nonbiodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through
- Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems
- Any trucked or hauled pollutants, except at discharge points designated by the POTW

Specific effluent limits. Specific effluent limits must be developed by POTWs in the following cases:

- Each POTW developing a POTW pretreatment program must develop and enforce specific effluent limits to implement the prohibitions listed above. Each POTW with an approved pretreatment program continues to develop these limits as necessary and effectively enforce such limits.
- All other POTWs, in cases where pollutants contributed by users result in interference or pass-through and such a violation is likely to recur, develop and enforce specific limits for industrial users, and all other users, as appropriate, which, together with appropriate changes in the POTW or its operation, are necessary to ensure renewed and continued compliance with the POTW NPDES discharge permit or sludge use or disposal practices.
- Where specific prohibitions or limits on pollutants or pollutant parameters (a.k.a. local limits) are developed by a POTW as described above, such limits are deemed pretreatment standards.

Categorical Standards

National pretreatment standards specifying quantities or concentrations of pollutants or pollutant properties which may be discharged to a POTW by existing or new industrial users in specific industrial subcategories have been established as separate regulations [40CFR405 to 471]. These standards, unless otherwise excepted, are in addition to all applicable pretreatment standards and requirements set forth in this part.

Appendix B – Technologies for Sulfate Removal

Appendix B – Technologies for Sulfate Removal

B.1 Background

The Pueblo Wastewater Treatment Plant (WWTP) discharges into Segment 1 of the Lower Arkansas River Basin. The current stream standards for selenium and sulfate in Segment 1 are as follows ⁽¹⁾:

- Selenium - 0.017 mg/L (chronic) and 0.020 mg/L (acute)
- Sulfate - 310 mg/L

These standards have been adopted on a temporary basis through July 2008 in order to maintain existing water quality in Segment 1.

A special provision in the pretreatment section of the Pueblo WWTP current discharge permit (CO-0026645) requires that Pueblo not accept for treatment “any new sources of industrial wastewater with selenium concentrations that are anticipated to exceed a 30-day average of 17 µg/L nor sulfate concentrations that are anticipated to exceed a 30-day average of 310 mg/L.”⁽²⁾ One of the considerations in adopting both the stream standards and permit provision was the fact that much of the selenium and sulfate loading in Segment 1 of the Arkansas River comes from natural sources (primarily from Pierre shales located in certain areas of Pueblo), and the WWTP appears to reduce selenium loading by removing some of the selenium that would otherwise reach the river. One goal of the provision is to ensure that discharges of sulfate and selenium from the WWTP do not increase.

One of the options considered in this report is treatment of mustard (HD) hydrolysate at the Pueblo WWTP. One of the obstacles to treating the hydrolysate at the Pueblo WWTP is the fact that the hydrolysate contains relatively high concentrations of organo-sulfur compounds, which when biodegraded aerobically produce sulfate. The sulfur content of the HD hydrolysate (3.8 wt%) will be approximately 7,500 mg/L. During biotreatment, this sulfur has the potential to be converted to 22,500 mg/L of sulfate. When fully operational, the PCAPP will produce approximately 68,000 gallons per day of 3.8 wt% HD hydrolysate. The Pueblo WWTP has a design flow capacity of 19 million gallons per day (mgd), with current flows averaging about 12 mgd. Under average flow conditions, treatment of the HD hydrolysate at the Pueblo WWTP could increase the facility’s effluent sulfate concentration by as much as 128 mg/L (i.e., 22,500 mg/L x 0.068 mgd/12 mgd). The purpose of this paper is to review potential technologies and associated costs for removing this excess sulfate from the Pueblo WWTP effluent.

It should be noted that a 1998 study conducted for the City of Pueblo Department of Public Works assessed the feasibility of removing selenium from municipal wastewater at the Pueblo WWTP⁽³⁾. The study reviewed a variety of treatment methods, including precipitation, biological treatment, ion exchange, membrane filtration, adsorption, and chemical separations. Because selenium behaves similarly to sulfur in many ways, and participates in many of the same chemical bonds that sulfur does, some of the treatment technologies discussed in the report are directly applicable for sulfate removal. Many of these same technologies have also been evaluated recently by the Environmental Protection Agency (EPA) for the removal of arsenic ⁽⁴⁾,

which also behaves similarly to sulfur. Both the Pueblo and EPA reports served as primary sources of both technical and cost information for this report.

B.2 Sulfate Removal Alternatives

The treatment methods available for removing sulfate from wastewater include:

- Precipitation
- Biological treatment
- Ion exchange
- Membrane processes (reverse osmosis and nano filtration)

Each of these methods is discussed in subsequent sections of this appendix.

B.2.1 Precipitation

Sulfate can be precipitated with calcium, barium, or lead. Lime, both quick lime (CaO) and hydrated lime (CaOH), and calcium carbonate (CaCO₃), when added to wastewater high in sulfate, can form calcium sulfate (CaSO₄), also called anhydrous gypsum. Lime can also precipitate some forms of selenium, primarily selenite (SeO₃²⁻), at high pH⁽³⁾. However, because of calcium sulfate's moderate solubility in water (~410 mg/L at 25°C from solubility product calculations), precipitation with calcium alone will not be effective for the Pueblo WWTP effluent, which is expected to have a sulfate concentration in the range of 700-750 mg/L after hydrolysate addition. Precipitation with lead or barium is potentially a more effective method for removing sulfate from the wastewater due to the very low solubility of PbSO₄ (~ 40 mg/L) and BaSO₄ (~ 2 mg/L) in pure water at ambient temperature.

In laboratory-scale tests, barium and lead salts were shown to be effective for precipitating sulfate from textile wastewater.⁽⁵⁾ Sulfate concentrations were reduced from 6,870 mg/L to 480 mg/L using barium chloride (BaCl) and down to <10 mg/L using Pb(NO₃)₂. Other forms of barium, such as barium hydroxide [Ba(OH₂)], barium carbonate (BaCO₃) and barium sulfide (BaS) have been used in bench- and pilot scale tests on mine wastes.⁽⁶⁾ Of the three forms tested, Ba(OH)₂ and BaS gave the best results with reported sulfate removal efficiencies ranging from 95% to 98% under both acidic (pH 2.9) and alkaline (pH 7.9 – 12) conditions. BaCO₃, which achieved fairly good sulfate removal at high pH (reported removal efficiencies of 82% to 90%), was not effective at low pH, achieving only 24% sulfate removal. Both the Ba(OH)₂ and BaS processes also remove heavy metals.

A few companies advertise systems for removing sulfate from mining wastewater using barium salt precipitation, but none have commercial-scale experience. Most of the processes advertised consist of two steps:

- Water treatment where barium sulfide, oxide, or carbonate is dosed to sulfate containing water resulting in barium sulfate precipitate; and
- Thermal reduction where the barium sulfate is reduced at 1,200°C to BaS or BaO, which can be reused in the process.

Some process flow sheets include a lime addition step after sulfate precipitation with BaS for additional metals removal.

The hydrogen sulfide (H₂S) rich off-gas produced in the barium sulfide based process can be treated in a sulfide oxidizer unit to produce elemental sulfur. The LO-CAT process, which is recommended for H₂S loads of 400 to 40,000 pounds /day, uses a regenerable, water based chelated iron catalyst to convert the H₂S to elemental sulfur. The catalyst is continuously regenerated in the process.

The major disadvantage of precipitation with either barium or lead is that both compounds are relatively toxic and sludge produced in the process would likely be hazardous. The process requires careful control to prevent over or under-dosing of feed chemicals, and coagulation-enhanced filtration may be required to remove colloids. Additional treatment of liquid effluent may be required to meet the Universal Treatment Standards (UTS) of 1.2 mg/L for barium and 0.69 mg/L for lead. Extensive laboratory and small pilot-scale testing would be required to develop design bases and performance specifications for the individual unit processes.

B.2.2 Biological Treatment

Under anaerobic conditions, sulfate may be reduced biologically to sulfide by sulfate reducing bacteria (SRB) such as those of the genus *Desulfovibrio* and *Desulfotomaculum*. These organisms have a respiratory metabolism in which sulfates, sulfites, elemental sulfur, and/or other reducible sulfur compounds serve as the final electron acceptors. The biological reduction of sulfate to sulfide generally requires a suitable energy and carbon source such as organic acids, alcohols, and other fermentation products as might be found in sewage sludge and other wastes. Hydrogen, carbon dioxide and carbon monoxide can also serve as energy sources for several species of SRBs. SRBs compete for some of the same carbon and energy sources used by methanogenic (methane forming) bacteria in anaerobic digesters.

Because of the problems they can cause in sewage treatment systems, SRBs have been studied extensively. Past research has focused on ways of controlling the growth of SRBs in sewer systems and anaerobic digesters. The potential use of SRBs to treat wastewaters high in sulfate has been the subject of recent research. Much of the research has focused on the treatment of wastewater from the mining industry, which is high in both sulfate and heavy metals. Laboratory scale experiments on acid mine effluent demonstrated the conversion of high levels of sulfate to sulfide in a single-stage anaerobic reactor fed ethanol as a carbon and energy source.⁽⁷⁾ Sulfate concentrations were reduced from 3,000 mg/L to less than 200 mg/L with hydraulic residence times (HRTs) varying between 4 to 18 hours and volumetric removal rates ranging from 2.5 to 8.4 g SO₄²⁻/L/day. Biomass concentrations, measured as volatile suspended solids (VSS), typically ranged from 3 to 4 g VSS/L resulting in specific sulfate removal rates of 0.47 to 2.47 g SO₄²⁻/g VSS/day. The experimental COD to sulfate ratio was between 0.55 and 0.84.

The use of producer gas (gas mixture containing H₂, CO, and CO₂) as a carbon and energy source for biological sulfate reduction was demonstrated in bench-scale studies using a packed bed anaerobic reactor operated at 35°C⁽⁸⁾. Sulfate was reduced to sulfide at a rate of 1.2 g SO₄/L/day with H₂/CO as substrate, and 2.4 g SO₄/L/day with only CO as substrate. Effluent from the biological reactor was passed through a stripper to remove H₂S. The stripped H₂S was passed through a liquid scrubber containing ferric iron (Fe⁺³) where it was converted to

elemental sulfur. The ferrous iron (Fe^{+2}) produced from the oxidation of hydrogen sulfide is oxidized biologically back to Fe^{+3} and re-used in the process. Overall, sulfate was reduced from 2,000 mg/L to less than 90 mg/L.

A commercial scale integrated biological and chemical process for sulfate and metals removal from wastewater has been developed by Paques, a Dutch company. The technology is marketed in North America under the name BioSulphide/Thiopaq Process™ by BIOTEQ Environmental Technologies Inc., a Canadian company based in Vancouver, British Columbia⁽⁹⁾. The two-step process, which was developed primarily for the mining industry to treat acid mine waste, involves reduction of sulfate or elemental sulfur to hydrogen sulfide in an anaerobic bioreactor followed by reaction of hydrogen sulfide with metals to produce insoluble metal sulfides. The bioreactor is fed either hydrogen or an organic substrate to serve as an electron donor. Two pilot-scale demonstration plants have been operated in North America since 1997, while over 24 commercial plants using biological desulfurization technology have been built in Europe.

A biological process to remove sulfate from wastewater at the Pueblo WWTP could involve the following steps:

- Biological reduction of sulfate to hydrogen sulfide
- Hydrogen sulfide stripping, and
- Treatment of hydrogen sulfide off-gas in a scrubber, catalytic oxidizer, or biofilter system.

Either dispersed growth systems (e.g., anaerobic contact process, sludge blanket type systems) or fixed film systems (anaerobic filters, fluidized or expanded bed processes) might be appropriate for this application. However, because the Pueblo WWTP already has an aerobic trickling filter, consideration should be given to using an anaerobic filter system that could be readily converted to a second aerobic trickling filter upon completion of the PCAPP project.

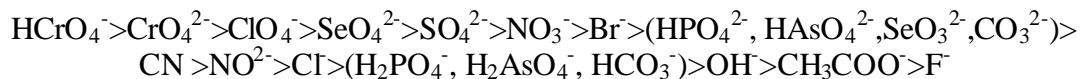
The main advantages of biological sulfate removal compared to other competing technologies are simplicity and overall lower costs. The main disadvantages are larger space requirements, longer start-up times, potential for process upsets, and potential for odors. Extensive laboratory and small pilot-scale testing would be required to develop design bases and performance specifications for the individual unit processes.

B.2.3 Ion Exchange

Ion exchange is a unit process in which ions of a given species are displaced from an insoluble exchange material by ions of a different species in solution. The ions removed from solution become attached to the solid structure of the exchange material, thus rendering them immobile. As an anion (i.e., negatively charge ion), sulfate (SO_4^{-2}) is typically exchanged for hydroxyl (OH) groups on an anionic resin. Cations or positively charged ions such as calcium and magnesium are typically exchanged for hydrogen ions (H^+) on a cationic resin.

Ion exchange has been used extensively in water and waste treatment to soften water, selectively remove impurities, and recover valuable chemicals otherwise lost in industrial waste discharges. A strong base anion exchanger is most effective for removing sulfates, phosphates and nitrates from municipal wastewater. Strong acid cation exchangers are effective for removing calcium and metals such as magnesium, iron, copper, zinc, nickel, and trivalent chromium. Strong base

anion resins also work well for removal of some forms of selenium and arsenic, but removal efficiency may be reduced in the presence of competing anions such as sulfate^(3,4). The order of exchange for most strong base resins is given below, with the adsorption preference being greatest for the constituents on the far left⁽⁴⁾.



When exhausted, the resin can be regenerated by the reverse reaction. Highly basic anion resins are usually regenerated with sodium hydroxide, while strong cationic resins are typically regenerated with a solution of strong acid such as sulfuric acid.

Like membrane processes, ion exchangers are subject to scaling, clogging and fouling. Wastewater high in calcium and sulfate are of particular concern because of the potential to form insoluble calcium sulfate. A modified form of ion exchange has been developed for these wastewaters. The GYP-CIX ion exchange process supplied by BIOTEQ is a sulfate removal technology that can handle feeds high in both sulfate and calcium⁽¹⁰⁾. According to the supplier, the GYP-CIX process can reduce sulfate concentrations down to any desirable level, but the economics of the process become most favorable compared to other physical/chemical technologies at feed sulfate concentration <2,000 mg/L. Above 2,000 mg/L sulfate, precipitation with lime is considered the least expensive method for reducing sulfate concentrations to 1,500 to 2,000 mg/L. As previously mentioned, the ineffectiveness of direct liming in reducing the concentration of sulfate below 1500 mg/L derives from the limitation imposed by the solubility of gypsum. A potential advantage of the GYP-CIX process is that it does not use a membrane or fixed bed and therefore does not require pretreatment to remove TSS. The GYP-CIX process has been pilot tested at a 50-gpm scale to treat mine effluents⁽¹⁰⁾.

B.2.4 Membrane Processes

Two membrane processes, namely reverse osmosis and nanofiltration, are discussed herein as being potentially applicable for removing sulfate from municipal wastewater at the Pueblo WWTP.

Reverse Osmosis

Reverse Osmosis (RO), also called hyperfiltration, is a process in which water is separated from dissolved salts in solution by filtering through a semi-permeable membrane at a pressure greater than the osmotic pressure caused by the dissolved salts in the wastewater⁽¹¹⁾. Operating pressures can vary from atmospheric to 1000 psi, depending on the characteristics of the feed water and required production rates. Discharge concentrate can be substantial, between 10 and 50 percent of the influent flow depending on influent water quality and membrane properties⁽⁴⁾. A modified RO process developed specifically for mining wastes high in sulfate, calcium, and heavy metals has demonstrated water recoveries of over 95%⁽⁶⁾.

The basic components of a reverse osmosis unit are the membrane, a membrane support structure, a containing vessel, and a high-pressure pump. Cellulose acetate and nylon have been used in three different membrane support configurations: spiral wound, tubular, and hollow fiber configurations⁽¹¹⁾. RO units can be arranged either in parallel to provide adequate hydraulic capacity or in series to obtain the desired degree of demineralization.

RO units are subject to fouling, scaling, and clogging. Waters high in sulfate have a high scaling potential. Typically, only water in which sulfate (<700 mg/L) and calcium (<100 mg/L) are relatively low can use RO directly ⁽⁶⁾. Even then, membrane elements can still become fouled with colloids and bacterial growth. Pretreatment by chlorination and/or filtration may be necessary to prevent fouling. Also, the removal of iron and manganese or pH adjustment is sometimes necessary to decrease scaling potential.

Nanofiltration

Nanofiltration (NF) membranes have slightly larger average pore sizes than RO membranes and operate at much lower pressures (typically 50 to 150 psi) ⁽⁴⁾. NF will primarily remove divalent ions (Ca^{2+} , Mg^{2+} , SO_4^{2-}). Through size exclusion, NF can also remove oxidized forms of arsenic and selenium ^(3,4). Water recovery for NF membranes may be as high as 85% ⁽⁴⁾.

In 1987, Dow Chemical Company and Marathon Oil Corp. jointly developed a NF membrane that selectively removes sulfate ions from seawater while allowing sodium and chloride to remain behind ⁽¹²⁾. Sulfate concentrations are typically reduced from 3,000 mg/L in feed water to < 50 mg/L in recovered water. The technology was developed for the oil and gas industry to remove sulfate from injection seawater thereby preventing the formation of harmful barium sulfate and strontium sulfate scales. The technology has been licensed to several equipment manufactures and suppliers, such as US Filter and Kvaerner, who have developed full-scale, package treatment systems. The largest of these has a capacity of 5.67 mgd ⁽¹²⁾.

Like RO membranes, NF membranes are also prone to fouling and therefore pretreatment may be necessary to remove suspended solids and prevent bacterial growth.

B.3 Residuals Considerations

The residual waste estimates and costs presented here and in the next section of this appendix were based on the assumption that the Pueblo WWTP would remove only the sulfur contained in the PCAPP hydrolysate (13,200 lb/day as sulfate), plus an additional 20%, or a total 15,850 lb/day as sulfate. This mass flow is based on removing 100 mg/L of sulfate from an influent stream that contains approximately 700 mg/L sulfate at a flow of 19 mgd.

Each of the sulfate removal technologies will produce residual waste (solid and/or liquid) requiring additional treatment and/or disposal. Table 1 presents order-of-magnitude estimates of waste quantities and annual disposal costs. The brine volumes presented in the table represent the quantity of brine that could be produced by the process without volume reduction. It is clear from the table that some form of volume reduction must be considered for most of the alternatives in order to lower disposal costs. One alternative for the biological system would be to use a catalytic oxidizer, such as the LO-CAT process, for the off-gas treatment instead of a conventional wet scrubber. That would substantially reduce or even eliminate the brine waste. Since the off-gas from the biotreatment unit will also contain high concentrations of CO_2 and traces of methane, it remains to be determined if such a process is applicable.

Table 1. Estimated Residuals Production and Disposal Costs for Sulfate Removal Alternative for the Pueblo WWTP

Treatment Alternative	Daily Solids/Sludge/Brine Production ⁽¹⁾	Annual Sludge/Brine Production ⁽¹⁾	Annual Disposal Cost
Precipitation with BaS	2.6 tons of elemental sulfur ⁽²⁾	949 tons ⁽²⁾	⁽³⁾
Anaerobic biological treatment	4,700 gallons of thickened sludge plus 28,000 gallons of scrubber brine ⁽⁴⁾	1.7 million gallons sludge plus 10.2 million gallons scrubber brine ⁽⁴⁾	\$5,100,000 ⁽⁵⁾
Ion exchange	140,000 gallons ⁽⁶⁾	51.1 million gallons ⁽⁶⁾	\$25,550,000 ⁽⁸⁾
Membrane processes	1.9 million gallons ⁽⁷⁾	694 million gallons ⁽⁷⁾	\$347,000,000 ⁽⁸⁾

- (1) Quantities based on removing 15,850 lb of sulfate per day or 100 mg sulfate/L/day from 19 mgd.
- (2) Quantity based on dry weight of sulfur produced in H₂S catalytic oxidizer. Catalyst and BaS are assumed to be regenerated.
- (3) Depending on quality, recovered elemental sulfur may have value.
- (4) Assumes sludge is thickened to 5 wt% solids in existing sludge thickener and scrubber brine is 10-wt% sodium sulfate.
- (5) Disposal cost for brine only at \$0.5/gallon including transport and deep well injection. Thickened sludge can be digested in existing anaerobic digesters. Digested sludge is dried in existing drying beds.
- (6) Brine production is based on assumed sodium sulfate concentration in waste brine of 2 wt%.
- (7) Brine production estimated as 10% of total influent volume of 19 mgd.
- (8) Assumes \$0.5/gallon disposal cost; includes transport and deep well injection.

B.4 Cost Estimates

Table 2 summarizes the advantages and disadvantages for each alternative and provides rough estimates for capital and operating and maintenance (O&M) costs. As previously mentioned, the estimates are extrapolated from cost data found in References 3 and 4 and should be considered order-of-magnitude type estimates.

In general, the capital cost estimates derived from the EPA cost curves in Reference 4 yielded lower estimates than the data extrapolated from Reference 3. Cost data obtained from other sources suggest that the estimates derived from the EPA cost curves may be low. Using cost data in Reference 13, the estimated capital cost of a 19 mgd RO system (in 2003 dollars) is \$36.5 million dollars, which is closer to the estimate obtained using data from Reference 3.

Table 2. Comparison of Sulfate Removal Alternatives

Alternative	Advantages	Disadvantages	Capital (\$M)	O&M (\$M/yr)
Precipitation with BaS	<ul style="list-style-type: none"> ▪ Selective removal ▪ BaS can be recycled ▪ Low waste generation ▪ Produces elemental sulfur, a potentially valuable product 	<ul style="list-style-type: none"> ▪ Uses Ba, a toxic element ▪ Effluent may not meet UTS for Ba without additional treatment ▪ Produces H₂S ▪ Requires thermal process to regenerate BaS and recover elemental sulfur from off-gas ▪ Relatively new process configuration ▪ No full-scale experience 	Not available ⁽¹⁾	Not available ⁽¹⁾
Anaerobic biological treatment	<ul style="list-style-type: none"> ▪ Selective removal ▪ Mature technology ▪ System can be retrofitted for use by WWTP after PCAPP project ▪ Low sludge yields 	<ul style="list-style-type: none"> ▪ Requires large foot-print and longer start-up times ▪ Produces H₂S ▪ Requires off-gas treatment to remove and/or recover sulfur 	17.9 ⁽²⁾	6.7 ⁽³⁾
Ion exchange	<ul style="list-style-type: none"> ▪ Effective removal ▪ Mature technology 	<ul style="list-style-type: none"> ▪ May produce relatively large volume of waste ▪ Susceptible to clogging ▪ May require pre-treatment 	24.1 ⁽⁴⁾ 46.89 ⁽⁵⁾	29 ⁽³⁾
Membrane processes	<ul style="list-style-type: none"> ▪ Effective removal ▪ Mature technology ▪ Nanofilters provide some selectivity 	<ul style="list-style-type: none"> ▪ High maintenance requirements ▪ Prone to fouling and scaling ▪ Requires pre-treatment ▪ Produces large volume of brine ▪ RO is not sulfate specific 	17.3 ⁽⁴⁾ 39.8 ⁽⁶⁾	352 ⁽³⁾

- (1) Capital and O&M costs for complete system were not available. Based on data in Reference 3, the estimated capital and O&M costs (excluding sludge disposal) of a system using lime precipitation are \$17.8 million and \$0.73 million, respectively, in 2003 dollars. Costs for a BaS system are likely to be substantially higher.
- (2) Capital cost is based on 1998 cost of facultative system found in Reference 3. Cost was updated to 2003 dollars by escalating at a 4%/year rate. Cost includes 20% contingency, 10% allowance for testing, and 30% allowance for engineering and administration.
- (3) O&M costs include brine disposal cost shown in Table 1.
- (4) Capital cost is derived from cost data in Ref. 4 for year 2000, updated to 2003 dollars by escalating at a 4%/year rate. Capital cost does not include pretreatment. Cost includes 20% contingency, 10% allowance for testing, and 30% allowance for engineering and administration.
- (5) Capital cost based on 1998 cost of ion exchange system in Reference 3. Cost was updated to 2003 dollars by escalating at a 4%/year rate and includes 20% contingency, 10% allowance for testing, and 30% allowance for engineering and administration.
- (6) Capital cost based on 1998 cost of RO or nanofiltration system in Reference 3. Cost was updated to 2003 dollars by escalating at a 4%/year rate and includes 20% contingency, 10% allowance for testing, and 30% allowance for engineering and administration.

B.5 Conclusion

The technologies reviewed in this appendix have been proven effective at removing sulfate from water and wastewater. However, their application to Pueblo's wastewater poses some significant technical and financial obstacles that arise largely from the relatively high flow of the Pueblo WWTP. Regardless of the technology, estimated costs for sulfate removal are prohibitively high and therefore the option is deemed unfeasible for application at the Pueblo WWTP.

B.6 References

1. Colorado Department of Public Health and Environment, Water Quality Control Commission. Classifications and Numeric Standards for Arkansas River Basin (5 CCR 1002-32). The Public Record Corp., Denver, Colorado. August 1997.
2. Colorado Department of Public Health and Environment, Water Quality Control Division, Colorado Discharge Permit System (CDSP) Permit Number CO-0026646, Pueblo County, issued to City of Pueblo, June 2002.
3. City of Pueblo Department of Public Works. Feasibility Analysis on Selenium Removal at the Pueblo Wastewater Treatment Facility. January, 1998.
4. U.S. Environmental Protection Agency, Office of Water. Technologies and Costs for Removal of Arsenic from Drinking Water. Prepared by International Consultants, Inc., Malcolm Pirnie, and the Cadmus Group Inc. December 2000.
5. Kabdasli, I., Tunay, O., and Orhon, D. "Sulfate removal from indigo dyeing textile wastewaters," Water Science and Technology, Vol. 32, No. 12, pp. 21-27, 1995.
6. Bowell, R.J. "Sulfate and salt minerals: the problem of treating mine waste," Mining Environmental Management, May 2000.
7. Greben, H.A., Maree, J.P., Singmin, Y., and Mnqanqeni, S. "Biological sulphate removal from acid mine effluent using ethanol as carbon and energy source," Water Science and Technology, Vol. 42, No. 3-4, pp. 339-344, 2000.
8. Preez, L.A., and Maree, J.P., "Pilot-scale sulfate and nitrate removal utilizing producer gas as energy source," Water Science and Technology, Vol. 30, No. 12, pp 275-285, 1994.
9. BIOTEQ Environmental Technologies, Inc., The Biosulphide/Thiopaq Process, product brochure, 2002.
10. BIOTEQ Environmental Technologies, Inc., The GYP-CIX Process- Water Treatment for Sulfate Removal and Desalination, product brochure, 2002
11. Metcalf and Eddy, Inc. Wastewater Engineering: Treatment, Disposal & Reuse. McGraw Hill Publishing Company. 1991.
12. Kvaerner Process Systems, Water Treatment – Injection Water: Seawater Sulfate Reduction Systems, product brochure, 2002.
13. Texas Water Development Board, Region H Water Planning Group, Task 5 Report: Identification, Evaluation and Selection of Water Management Strategies. Prepared by Brown and Root Inc., and Turner Collies and Braden, Inc. January 2001.

Appendix C – Acceleration Options Working Group 21 January 2003 Meeting Minutes



**Colorado Chemical Demilitarization Citizens' Advisory Commission
Acceleration Options Work Group Meeting
January 21, 2003**

DRAFT Meeting Notes

This document provides a summary of the actions and next steps from the January 21, 2003 Pueblo Acceleration Options Work Group (AOWG). This summary is intended for those who were present at the meeting and are familiar with the issues discussed. Any questions, or for additional context, please contact Rebecca Turner of The Keystone Center at 970-513-5839 or rturner@keystone.org.

In attendance

Ross Vincent, Scott Susman, Irene Kornelly, Michael Lewis, Ken Biernacki, Phil Burns, Garry Brewer, Anne Cain, Chuck Finley, Dennis Grant, Neal Hall, Terry Hart, Larry Howe-Kerr, Doug Knappe, David Krentzer, Brian Miller, Ruben Pena, Loren Sharp, Brad Still, Brian Summers, Lisa Woodward, Rebecca Turner, Lloyd Covens, Jim Early, Ruth Flanders, Joel Hoffman, Bob Kennemer, Andy King, Mike Lazaro, Stephen Lewis, John McArthur, Joe Mashinski, Vera Moritz, Dan Oburn, Janet Scanlon, John Slater, Peter Spaeth, Bill Knapp, Pete Offringa, Jim Richmond, Bill Pehlivanian, Bill Scarpinato, Gerald Starnes, Joan Sowinski, Bobby Templin, Jon Ware.

Contractor Status and Next Meeting

Mike Lewis, the Point of Contact for the Bechtel Pueblo project, addressed the group as to Bechtel's commitment to teamwork, and their focus on the mission of removal of the material in a safe, efficient way. A more formal presentation will occur at the next AOWG meeting.

Work Group's Protocols

Consistency edits were made to the protocols after the meeting. Attached is the final version.

POTW/ FOTW Study Update

(For copies of this and other presentations please contact Rebecca Turner at rturner@keystone.org.)

Scott Susman of PMACWA presented the most up-to-date version of the Publicly/ Privately or Federally Owned Treatment Works (POTW/FOTW) Study. The study was conducted to examine the possibilities of using an existing POTW or building an FOTW to treat the hydrolysates coming out of the clean-up process. The final version will be circulated to the group prior to the next AOWG meeting.

The original process was to include an all-encompassing biotreatment at the PCAPP. The POTW/FOTW study was conducted to determine the practicality of this as an accelerated option by using an existing (or building a) treatment plant. Sites around Pueblo were examined and it was determined that they could not support the capacity of the PCAPP waste. One of the limiting factors to their capacity is that the discharge of the

FOTW/POTWs would go to the Arkansas River, which is at the allowable limits for sulfate and selenium concentrations. The tasks put forth for the group are to review and finalize the feasibility report for the next meeting, and decide if any additional information is needed prior to decision-making. After group questions and discussion about water use and quality, AOWG decided that the acceleration option of using a POTW/FOTW for the PCAPP waste was not feasible and other options should be examined.

Briefing of the Transportation Risk Assessment Report

Bob Templin and Mike Lazaro of Argonne National Laboratories presented the risk analysis of transporting PCAPP waste to another facility. The purpose of this briefing was to outline some considerations for the group as it examines the accelerated option of shipping energetics and hydrolysates off-site. A copy of the presentation is attached.

The objective of the assessment was to evaluate the transportation risk associated with shipment of residual PCD waste streams under three proposed ACWA disposal options. Under each option all solid hazardous waste would be shipped to a Treatment, Storage, and Disposal Facility (TSDF) in Last Chance, CO. Option A assumptions are that all waste is treated on site. Option B assumed that liquid agent and energetic hydrolysate would be shipped to one of five TSDFs. Option C assumed that energetics would be shipped to one of four TSDFs, including the assumptions in Option B (minus the energetics hydrolysate portion).

The assessment studied two types of risk, cargo and non-cargo. Non-Cargo, or vehicle, is risk associated with highway or railway accidents. Cargo is risk associated with accident involving the shipped material. The risk assessment methodology included two models and a database on munitions shipment/accident frequency and a vehicle risk spreadsheet.

The conclusions reached from the analysis were that the transportation risk in each of the three options for disposal of ACWA residual waste streams from PCD is small (no expected serious injuries or fatalities.) The risk for final disposal under Option B (hydrolysates and solids) or Option C are about the same and are approximately four times greater than Option A (intrastate dunnage disposal.) Compared on a normalized basis, the risk of an accident with fire during off-site shipment of the energetic PDC components under Option C poses a smaller fatality risk than the national risk from commercial explosive shipments. The risk of serious injury involving energetic components is less than one half the risk of serious injury compared to the same risk from national shipments of hazardous chemicals (TIH) or liquefied petroleum gas.

Options for Acceleration Matrix Review

Scott Susman of PMACWA presented the options for acceleration matrix. This tool is intended to track the acceleration options the group has reviewed, the status of each option, and the final decision of the group. A copy of the matrix is attached.

Next Steps

The next AOWG meeting will be determined once the CAC schedule is set.