Risk Analysis for Locating a Snow Disposal Site Adjacent to AWWU Well #13 PM&E Project No. 04-27

Executive Summary

The Project Management & Engineering Department has been tasked with designing and constructing a new snow disposal site near the intersection of Dowling Road and Spruce Street. The selected site was initially identified in a 1987 snow disposal site selection study that was reviewed and approved by the Planning and Zoning Commission. Well 13 was operational at the time the site selection study was completed and adopted. In anticipation that the selected site would be developed as a snow disposal facility, management authority for the site was transferred from the Heritage Land Bank to the Municipal Street Maintenance Department in 1993.

The selected site is near the Anchorage Water & Wastewater Utility's Well No. 13 and the anticipated snow disposal pad is approximately 320 feet from the Well 13 casing. In recognizing the proximity of the proposed snow disposal site to Well 13, PM&E met with AWWU Treatment and Engineering staff to ensure that AWWU questions and concerns would be fully addressed in the design process and that operation of the snow disposal site would not jeopardize the sanitary seal and continued long term operation of Well 13.

AWWU requested that PM&E evaluate and prepare a risk analysis to verify that the operation of the proposed snow disposal site would not threaten, interfere or impose a risk to the continued log term operation of Well 13. PM&E requested the assistance of Scott Wheaton at MOA's Watershed Management Services to provide hydro geological analysis of the snow disposal site proximity to Well #13 (Appendix B) and DOWL Engineers to address potential water quality impacts and design recommendations.

The design, operation and melt water characteristics from a modern snow disposal facility are well documented but not widely disseminated. AWWU's concerns are understandable and are largely based and summarized in a Source Water Assessment for Well #13, 2002.

The following risk analysis and appendices support the conclusion that the proposed snow disposal site will have no measurable impacts on the continued long term operation of Well 13 for the following reasons:

- The proposed location and horizontal separation distance between the snow disposal site and Well 13 will comply with and meet or exceed all provisions of the State of Alaska Drinking Water and Wastewater Disposal Regulations.

- Design and permitting of the snow disposal site will involve thorough review by the ADEC, the U.S. Army Corps of Engineers and the EPA.

- Design and operation of municipal snow disposal sites dilutes pollutant concentrations found in the meltwater and decreases potential for infiltration. The proposed snow disposal site design will incorporate BMP's that will ensure treatment of snow disposal site melt water prior to surface discharge to adjacent wetlands.

- Previous horizontal separation distance waivers between the Well 13 protective radius and adjacent sewer mains, storm drain facilities and on-site septic systems have been issued by ADEC predicated on the geology of the confined aquifer that serves Well 13 (Appendix B).

- Sediment and snow meltwater sampling indicate pollutant concentrations do not exceed drinking water standards. Example of collected data are included in this report.

- Using conservative values for the confining layer parameters yields a travel time for snow meltwater to reach the source waters of Well #13 of about 40 to 90 years (Appendix B).

Additional Project Background

As a winter city, snow removal and disposal is a key public service. It not only affects the quality of life for Anchorage residents, it affects the functioning of the transportation system which is essential to public safety and the local economy. Over the last few decades, the Municipality of Anchorage (MOA) has grown and expanded increasing snow removal in response to growing public expectations. In addition, snow disposal sites have been lost, resulting in higher costs and more time required for hauling snow to remote disposal sites. Finally, environmental regulations have resulted in a higher cost for developing new snow disposal sites.

The MOA Street Maintenance Department has done an admirable job of addressing these increased requirements, despite the total budget for snow removal remaining level for the last 10 years. However, without additional snow disposal capacity, there has been a decrease in the quality of snow removal services to the community and will continue into the future if additional snow disposal sites are not developed at key geographical locations throughout Anchorage. At this time technology has not advanced to the extent that reasonable alternatives to snow disposal sites have been feasible such as melting the snow for discharge.

Historical Snow Disposal Sites and Site Selection Studies

In 1987, the MOA had 12 sites for snow disposal. At that time, the loss of areas for snow disposal was identified as a significant problem and the importance of preservation of sites for snow disposal was deemed critical for efficient snow removal operations. Since 1987, the number of sites for snow disposal has been reduced by half to 6. Of those 6 sites, only 4 are owned by the Municipality. The remaining 2 sites are owned by the U.S. Air Force and the Ted Stevens International Airport. These non-MOA sites are currently run without long-term lease agreements – meaning that these sites could be lost at any time. In addition, only one of the MOA's 4 sites has been designed using the current criteria for melt water treatment. The other 3 MOA sites and the 2 non-MOA sites require improvements to meet current criteria.

A snow disposal site selection study in 1987 identified key areas to be preserved for snow disposal sites (MOA, Snow Disposal Site Selection Report 1987). The site at 64th Avenue and Spruce Street was identified as an important site in that study. The study was approved by the

MOA Planning & Zoning Commission in 1987 and maintenance authority was given to Street Maintenance for this site. Another site selection study was completed in 1993. This study also identified the need for this site and its importance related to overall operations and the development within this service area. If anything the need for this new disposal site continues to become more pronounced.

Current Purpose and Need

Most recently a 2008 site selection analysis was completed in an attempt to identify any reasonable alternative sites based on current conditions that would meet the needs of the MOA's snow disposal operations for a disposal site in this general area. This analysis found only three potential alternative sites, all of which have many of the same constraints as the proposed site (adjacent residential uses, etc.) but which also have very high acquisition costs (estimated at $3-5 million). A copy of this report can be provided if needed. This site can be developed without added property acquisition costs to the city.

Project Management & Engineering has been tasked with developing a new snow disposal site for this service area. In order to provide more cost efficient snow removal services to the local residents, the site at Spruce Street and 64th should be developed in an expeditious manner so that it is ready for use in 2010-2011.

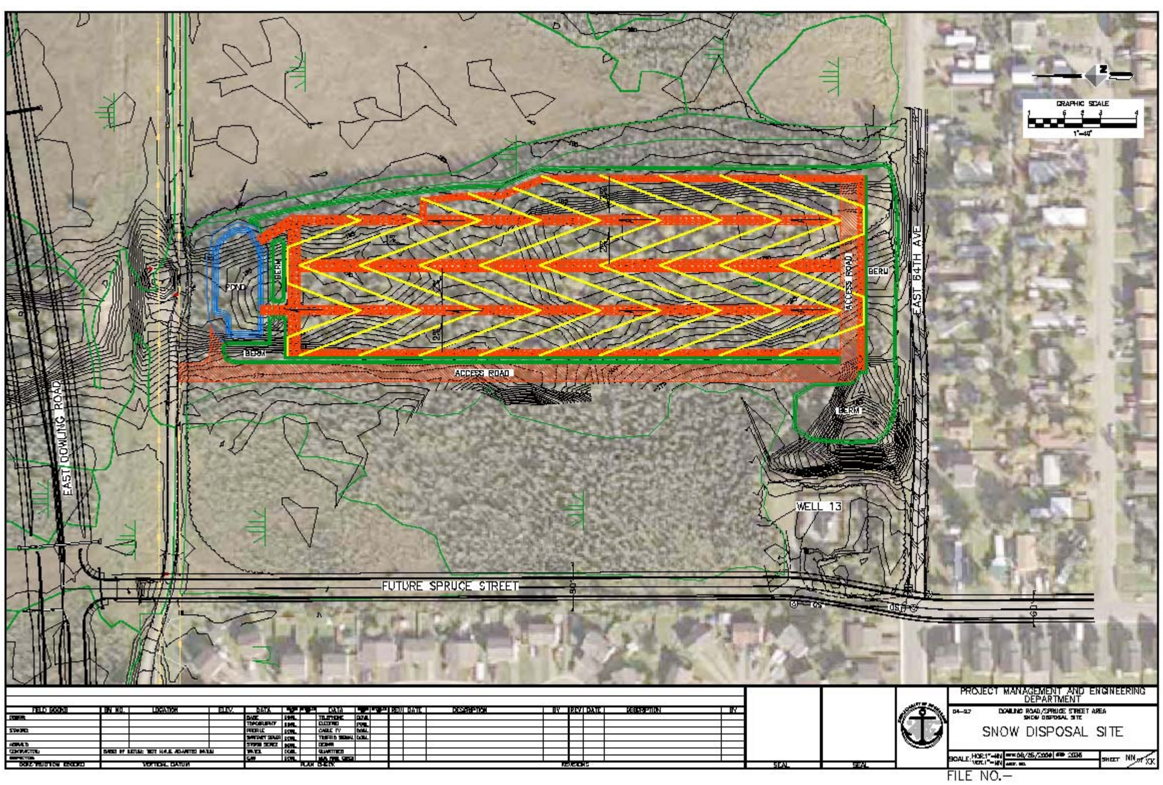
The following information is intended for use by AWWU regarding potential water quality impacts to Well#13 which is located in the vicinity of this proposed snow disposal site. This risk analysis was requested as a result of a meeting with representatives from AWWU on February 25, 2009 with PM&E and representatives from DOWL, HKM. The purpose of this analysis is to assess any risks that could be present if a snow disposal site were developed in the vicinity of Well 13. Both amenities are seen as crucial resources for the public and this risk analysis explores how development of this snow disposal site may impact water quality in Well #13.

Research performed as a result has shown that the proposed snow disposal site location at Dowling and Spruce has no identifiable or measurable risks to Well 13. Details of the research performed are included in this report.

Snow Disposal Site Characteristics:

The Dowling and Spruce snow disposal site is located at the west end of HLB parcel 3-064. The site consist of approximately 23 acres of which 6 are wetland, 16.5 are uplands with approximately 0.5 acres of the 16.5 dedicated to AWWU Well #13. The Municipality of Anchorage is proposing to use approximately 10 acres of the uplands for their snow disposal site. See figure 1.

Figure 1: Proposed Snow Disposal Site Layout



The Alaska Department of Environmental Conservation (ADEC) and MOA have developed snow disposal site selection and design criteria in order to protect surface water and groundwater from contaminants that may exist in snow melt waters. The design will be reviewed and require approval by the MOA Watershed Management Services (WMS) Division and the ADEC. WMS oversees the National Pollution Discharge Elimination System (NPDES) permit for the MOA which is the permit that allows the MOA to discharge stormwater to the municipal storm sewer system and consequently to surface waters throughout the MOA. The MOA also has written criteria for discharging stormwater into wetlands.

Well #13 is a Class A community drinking water source with an overall vulnerability rating of Medium for bacteria and viruses, nitrates or nitrites, volatile organic compounds, and heavy metals and Low for synthetic organic chemicals (Crotteau, 2002). Identified potential sources are currently listed by the Source Water Assessment indicate the following sources of contaminants which currently exist for the well:

- Domestic Wastewater Sewer Lines
- Residential Septic Systems
- Gasoline Stations
- Lubrication Shop
- Motor Vehicle Supply Stores
- Motor Vehicle Repair Shops
- Open and Closed Leaking Underground Storage Tank Sites
- A Class V Shallow Injection Well
- Motor Vehicle Waste Disposal Well
- Underground Fuel Storage Tanks
- Storage Yards
- Paved Roads
- Parks
- Commercial Greenhouse
- Heavy Equipment Storage
- Construction Trade Area
- 232 Acres of Residential Land

The assessment indicates that the potential for contaminants to reach Well #13 from these sources would mainly be from drawdown effects of pulling water which is greatly reduced as you move away from the well. Pumping from Well #13 is sporadic during the winter and spring so that the potentiometric surface in the vicinity of the well is relatively undisturbed from its average position during seasonal snow melt (Appendix B). The proximity to several of these sources is closer than the surface location of the proposed snow disposal site. See Appendix B for an additional analysis regarding hydraulic properties near the proposed snow disposal site and transport of meltwaters to Well #13 aquifer.

The ADEC recommends that snow disposal sites be located at least 150 feet upgradient of private and Class C wells and 200 feet from Class A or B public water systems. The current snow disposal site pad is at a minimum 320 horizontal feet from the well location at the surface which meets this and other recommendations outlined by the ADEC and MOA.

The Design Criteria Manual has specific criteria for the design of melt water transport, detention and discharge. These criteria are mostly designed for early season melt water to mitigate for chloride peaks and late season sedimentation (MOA Design Criteria Manual, 2007). The detention basin design has two treatment goals 1) 95% removal of sediments ≥ 100 μm in diameter and 2) 7-day average concentration of 3,000 ppm chloride in 1 cfs of melt water and 30-day average concentration of 1,000 ppm in 0.5 cfs of melt water. The design will proceed with these goals in mind. However, we will be analyzing the effectiveness in the design approach further with respect to those pollutants that were stated as a concern to AWWU; hydrocarbons and heavy metals.

Maintenance procedures will greatly impact the aesthetic value of the snow disposal site. Routine maintenance will be required to accomplish the performance standards currently required and reduce the transfer of trash to the surrounding area. In general plastic bags and lighter trash is weighted down by sediments accumulated on the surface of the melting snow pack and can later easily be cleaned up by street maintenance crews. Sediment accumulation will also need to be cleared and disposed of on an annual basis. Maintenance and procedural standards will be defined and documented as part of the application for the Conditional Use Permit required for development of this site.

Additional potential impacts to water quality will be discussed further in the sections following. The design team will be implementing limiting layers to the design to discourage infiltration. This can be done by incorporating a bentonite liner or other impermeable layer into the detention basin design. The transport of water will be directed away from the well site to discourage any ponding or infiltration potential near the well.

This analysis is by no means exhaustive of the information available. If more detailed information is required, the PM&E project team could meet to discuss additional concerns and questions if they are not addressed to the satisfaction of AWWU in this risk analysis.

Water Quality Impacts and Recommendations

The Municipality of Anchorage PM&E has proposed to construct a snow disposal site near the intersection of Spruce Street and Dowling Road within the immediate vicinity of an Anchorage Water and Wastewater Utility's, Well 13. DOWL HKM was asked to compile and analyze potential water quality treatments options and potential water quality impacts for the proposed snow disposal site. Our review and analysis is summarized below:

- Impacts from the proposed site depend predominately on meltwater characteristics.

- Collection and control of meltwater should be accomplished by shaping and storing snow on a v-swale pad to allow sediment to settle before outfalling.

- Preventing the first meltwater from flowing offsite ("detaining" it) right away should provide an opportunity for early, pollutant-rich meltwater to be diluted by later meltwater that has progressively lower pollutant concentrations.

- Overall the most effective system in terms of retaining pollutants appears to be dry retention ponds. A dry retention pond is recommended over a wet pond.

- Detention ponds are the most highly recommended BMP in cold regions. For snow disposal areas, ponds have been used for sediment removal and dilution. Detention of early meltwater is important for reducing the meltwater chloride concentrations through dilution with later meltwaters.

- The designed detention basin should allow for the removal of 95 percent of the sediments greater than 100 µm in diameter and a 7 day average concentration of 3,000ppm of chloride in 1 cfs of meltwater and a 30 day average concentration of 1,000 ppm of chloride in 0.5 cfs of meltwater. The target concentration for chloride is 100-200 mg/L the drinking water standards.

- The potential for the groundwater to be impacted by the pollutants released in the snow disposal meltwater is expected to be minimal provided meltwater is treated to allow sedimentation to occur in a retention pond prior to being released in the surrounding wetlands. Any trace pollutants remaining in the water prior to being released into the nearby wetland are likely to be absorbed by the vegetation and or biological processes before leaching into groundwater. Dissolved pollutants measured from snow disposal sites were found to meet current drinking water criteria.

- By retaining the water from runoff and allowing the pollutants to settle out and /or be absorbed and diluted, the water that is then returned to the ground or to neighboring streams, wetlands will contain contaminants at lower concentrations than those that may exist in the meltwater flows at the snow pad site.

- Wetland degradation is unlikely provided water quality remains at or below existing water quality standards. The current NPDES permit will most likely require routine water quality testing. If water quality test results exceed the drinking water standard then further treatment in on-site sedimentation basins or oil/grit separators may be required.

- Water quality sampling in existing snow disposal sites found no potential pollutants above the drinking water standards; therefore, it is unlikely that releasing snow into the surrounding wetland will have an adverse impact on the wetland or the groundwater

- Develop a Best Management Practice Guidance for the Dowling and Spruce Snow Disposal location which should address minimizing the anticipated environmental impacts to water resources as a result of the snow disposal site meltwater.

- Based on the fact that no contaminants exceeded the drinking water standard level for surface water and given the estimated time of travel of 0.001 foot / day for an estimated thickness of 75 to 100 feet (See Appendix B) it would take for any trace contaminates to reach the aquifer AWWU is drawing from, it is highly unlikely a contaminate would reach the aquifer at a concentrations higher than drinking water standards.

Based on the proposed water treatment recommendations and the existing water quality test results, we do not believe there will be any water quality impacts as a result of the proposed Dowling and Spruce snow disposal site on AWWU's Well #13.

Water Quality of Snow Disposal Site Meltwater

Potential Pollutants:
Snow in urban areas, similar to stormwater, may contain pollutants from different sources such as atmospheric precipitation, traffic emission and de-icing chemical (Obert, 1986). The amount of pollutants in urban snow is affected by a number of factors – land use, traffic load, type of traffic in the time between snowfall and removal, the type of deicers used and the time of year. The pollutant pathway is also affected by snow handling activities and winter climate conditions. Average annual snowfall for the Anchorage area is 70 inches. The Municipality of Anchorage (MOA) attempts to remove snow from its roadways within 72 hours.

De-icing chemicals and antiskid materials are used to maintain the safety on roads during wintertime. Magnesium chloride ($MgCl_2$) is sometimes used but on a limited basis when temperatures fall below -25°C (Reinosdotter 2007). The deicer primarily used by the MOA is potassium acetate, diluted to 25 percent before application (MOA Maintenance, 2009).

Analysis of snow contamination in Alaska has developed over several decades. From the multiple studies performed in Anchorage, pollutants of concern in snowpacks were found to be Copper, Lead, Zinc Cadmium, Total Suspended Solids (TSS) metals, chloride and oil/grease.

Potential pollutant found in tested snow, meltwater and soil from Anchorage disposal sites:

- Sodium Chloride (NaCl)
- Magnesium Chloride ($MgCl_2$)
- Potassium Acetate
- Sand
- Corrosion inhibitor – trace metals
- Copper (Cu)
- Iron (Fe)
- Cadmium (Ca)
- Lead (Pd)
- Zinc (Zn)
- Oil and grease

The gross amounts of materials and contaminants delivered to disposal sites are generally unknown. Pollutant discharge from snow disposal sites varies spatially and temporally. The MOA Watershed Management Section (WMS) as part of the Municipality's NPDES permit has conducted multiyear studies of snow disposal sites in Anchorage. From these studies, the MOA has found TSS, metals (Pd and Cu) and chloride to be contaminants of concern in snowmelt.

Water Quality

The MOA performed water quality testing on meltwater from two snow disposal sites over one melting season. The water sampling results in relation with the ADEC Drinking Water Standards are listed below.

Table of results of water quality testing at two snow disposal sites

Contaminant	MCL (mg/L)/Drinking	ADEC Water Quality	Median From

	Water Standard	Standard (mg/L)	Measured Data (mg/L)
Acenaphthene	N/A	1.2	0.00002
Anthracene	N/A	9.6	0.000004
Benzo(a)pyrene	N/A	0.0002	0.00001
Fluoranthene	N/A	0.3	0.00003
Fluoranthene-d10	N/A	N/A	N/A
Fluorene	N/A	1.3	0.000006
Pyrene	N/A	0.96	0.00007
Chromium, Dissolved	0.1	0.1	0.0021
Copper, Dissolved	1.3	0.2	0.0065
Lead, Dissolved	0.015	0.05	0.00054
Magnesium, Dissolved	N/A	N/A	3.71
Zinc, Dissolved	N/A	9.1	0.0145
**Chloride	100	N/A	

Drinking water standards found for chloride on EPA site was 250mg/L, ADEC

The data used to find the average concentrations were calculated from data collected in 2000 at the Sitka Snow Disposal Site at 15th and Sitka Street and the Tudor Snow Disposal Site at Campbell Airstrip Road and Tudor Road. This data was collected at various locations at these two sites and a median of all the data collected was used for the values shown in the table.

The table shows that no contaminant exceeded the drinking water standards level. Fecal Coliform was analyzed from snow disposal sites but was not included in this table due to very low measurements or “non-detect” levels of the non-adsorbed fecal bacteria (WMS, 2000). In addition, further source assessment studies indicate that fecal coliform bacteria concentrations are generally very low when collected strictly from streets and higher concentrations are found when collected from landscaped surfaces (WMS, 2002).

Water Quality Impacts from the snow meltwaters depend predominately upon

- Rate of meltwater flow
- Character of the meltwater that will be discharged from the site
    - Shape of snow pack
    - Size of detention pond

Treatment Methods:

The design objective for the MOA for the Spruce and Dowling snow disposal site should address water quality parameters related to the drinking water standards. To achieve water quality objectives the following treatment objectives are proposed:

- Collection, detention and routing snow
- Improvement of water quality / sediment retention and
- Treat for petroleum hydrocarbon contaminants and other sediment adsorbed pollutants.

Fine sediments are common contaminants in plowed snow and can be easily mobilized during the melting season. However, seasonal on-site snow melt in Anchorage is by nature a slow and a hydraulically 'low-energy' process and there are many opportunities for practicable on-site treatment for this pollutant (Reinosodotter 2007). The following are the basic elements of a best management practices plan for this pollutant

- Place the first plowed snow of the year at the lowest point on the site, filling upslope from the initial fill point throughout the rest of the winter season.
- Stack hauled snow in a compact mass to a uniform thickness; maintaining steep sides and a relatively broad base (do not pile snow to depths greater than 20 feet).
- Maintain a vegetated site surface where possible.
- Armor and protect all drainage channels crossing the site and treat meltwater, particularly for turbidity and salt, prior to its exit off-site.
- Placement of hauled snow at the low point should encourage ponding around the melting snow mass and minimize the length of flow paths for meltwater draining across the site.

Because much of the sediment in meltwater is generated by the collapsing snow mass, stacking the snow with very steep sides minimizes the amount of snow surface area that is most subject to this type of erosion. Piling the snow in a compact mass to uniform depths across a broad base (low stored snow heights) can significantly help reduce leached chloride concentrations in the early meltwater released from the stored snow (Wheaten and Rice 2003).

Vegetated site surfaces help trap fine sediments, metals, and petroleum pollutants. For this reason it is important to promote spring re-vegetation by limiting site access and otherwise preventing trafficking and disturbance of the wet ground surface. Where snow disposal must occur, placing snow across as broad a footprint as possible, at uniform depths and at the low point on the site remains important. It is important to minimize the drainage path from the melting snow mass to the nearest storm drain inlet or ground surface discharge point. Where meltwater flow exits a paved surface onto ground, dissipate flow energy by directing flow across a rock or grass apron to protect against erosion. It is important to provide unobstructed, armored meltwater channels to minimize erosion. Delineating dedicated site drainage channels so that hauled snow is not accidentally placed in them reduces the potential for diverting flow to more erodible surfaces. Armor the main channels: depending on site grade and the volume of meltwater, grass or very small aggregate may provide adequate armor. Where meltwater is not adequately treated through detention, site layout and operational practices, further treatment in on-site sedimentation basins or oil/grit separators may be required. Limiting layers, such as bentonite or other impermeable layer can also be incorporated into the design to discourage infiltration at the snow pad site and in the detention basins.

Studies performed by the Municipality of Anchorage (MOA) over the last several years have shown that the manner in which pollutants are released strongly reflects the initial source of hauled snow, the melt processes of stored snow fill and the geometry of disposal areas and the snow fills themselves (WMS 1998).

Effective control measures of pollutants released from snow disposal sites are essential for maintaining healthy waterways. Practicable control methods can be used to economically control pollutants released from snow disposal sites. The following design options were analyzed as part of the hydrologic analysis for Dowling Road and Spruce Road Snow Disposal site and their potential impact.

- V-Swale – shaping the basal ice
- Dry - Detention Pond
- Wet - Detention Pond
- Wetlands

The water treatment methods being considered for the site are detention pond and wetland. Both treatments have been endorsed by state and federal government as affected BMP for treating wastewater.

V-swales snow disposal pad:

Snow placement within Anchorage suggests turbidity in meltwater flows from snow packs may be reduced by proper placement of snow within a disposal site. As snow melts, sediment collects on the surface of the pack, forming a sediment "crust" (Wheaton and Rice, 2003). On sloped pads, meltwater flows should travel through existing snowpack, which requires snow placement begin at the down slope portion of the site and progress uphill. Incorporation of V-swales in the pad design can provide more defined storage areas and further direct meltwater flows and increase sediment removal from the meltwater (Wheaton and Rice 2003).

Pollutant loading in meltwater relates to the shape of the snow fill and the pad on which it is situated and can be controlled by manipulation of these elements. Turbidity of meltwater is a function of meltwater exposure to fine sediment: Turbidity in snow disposal site flows is generated as meltwater exits and cascades off a snow fill, gathering sediment from the surface of the deflating mass. Turbidity may be further increased as meltwater crosses a pad surface, particularly if pad surface soils are unprotected, waste soils are exposed, or flow velocities are increased.

The Municipality of Anchorage and the Alaska Department of Transportation and Public Facilities have snow disposal guidelines that include the base with "V" ditches under the pile to channel meltwater to a collection pond to take advantage of the melting process and inherently low-energy environment of a melting snowfall. The detention pond will be located on the north side of the property with berms located on the south to direct meltwater away from the AWWU Well #13 and towards the north where it will flow into the detention pond.

A V-swale snow disposal pad configuration promotes meltwater movement as saturated flows within the snow fill so that particulates are not mobilized during the early and middle stages of melt. Flow direction along the trough of the v-swale pads endures a single predictable discharge point so that flow can be further managed and directed to minimize erosion of pad and waste soils.

For a complete detailed description of a V-swale concept see Appendix A.

Detainment options:

The use of detainment facilities for stormwater management has increased dramatically in the recent years. The benefits of detainment facilities can be divided into 2 major control categories of quality and quantity. Controlling the quantity of stormwater can provide the following potential benefits.

- Prevent or reduce peak runoff rate increases
- Mitigate downstream drainage capacity problems
- Recharge groundwater resources

Detention and retention ponds are the most common snow meltwater treatment practices used for flood mitigation and water quality improvement. Detention ponds collect and provide temporary disposal for meltwater with subsequent gradual discharge. Retention ponds subsequently dispose of stormwater by promoting infiltration into the ground or evaporation without any release to downstream receiving waters (Harper, 1993). Detention ponds are also classified into various types such as, dry detention, and wet detention ponds.

When the pollutants enter the pond during a rain event, the pond slows the water movement, allowing the heavier pollutants such as suspended solids, sediments, and metals to settle out of the water column and come to rest in the bottom sediments. This greatly improves the overall clarity or turbidity of the water. Other pollutants are reduced through aquatic plant growth. Many of these nutrients are taken out of the water and used in plant growth. Bacteria can also be reduced within the ponds through natural biological treatment processes which utilize indigenous micro-organisms which reduce bacteria concentrations in the water. By retaining the water from runoff and allowing the pollutants to settle out and /or be adsorbed, the water that is then returned to the ground water system, neighboring streams, and or wetlands is of much better quality (Driscoll et al. 1989).

Detention pond – for storm water applications are the most highly recommended BMP in cold regions (Caraco and Claytor, 1997). For snow disposal areas, ponds have been used for sediment removal and dilution.

The base criteria for the Spruce Street and Dowling Road snow disposal site pond will be addressed in the design process. BMPs will be implemented once the sizing criterion for adequate disposal has been completed. The many variations that could be part of pond sizing will be sorted and applied as design recommendations are agreed upon.

Dry Detention Ponds:

Dry detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, and extended detention ponds) are basins whose outlets have been designed to detain stormwater runoff for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool of water. This process reduces the velocity of the water and provides sufficient time for settling and filtration of the particulate matter present in the meltwater. It has been found that about 50 % of the particulate matter settles within the first 1 to 2 hours of detention (Driscoll, 1989). Dry detention ponds are more flexible in maintenance and inspection. The characteristic of dry detention ponds have made them an attractive option for designers and users as continuous ponding of water can lead to problems like algal growth, mosquito breeding, drowning, difficult access for cleaning, bad odors, etc.

In Anchorage, some additional design features may treat the spring snowmelt that can be minimally engineered with native plant materials and utilize natural biological processes as stated earlier. Increasing the volume available for detention to help treat the relatively large spring runoff events, and landscaping should incorporate salt-tolerant species.

Dry detention basins provide moderate pollutant removal, provided that the design features are incorporated as specified per EPA's siting and design criteria. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. A few studies are available on the effectiveness of dry detention ponds. Typical removal rates, as reported by Schueler (1997), are as follows:

- Total suspended solids: 61%
- Total phosphorus: 19%
- Total nitrogen: 31%
- Nitrate nitrogen: 9%
- Metals: 26%-54%

There is considerable variability in the effectiveness of ponds, and it is believed that properly designing and maintaining ponds may help to improve their performance. In many of the studies on the ability of a detention pond to remove total nitrogen is heavily dependent upon the fraction of total nitrogen present as organic nitrogen. Organic nitrogen is not readily available through biological or chemical processes, and there are relatively few mechanisms for removal of this species in a detention pond system. In contrast, both NO and ammonia are readily taken up in biological processes which account for the relatively good removal efficiencies achieved for these species (Bartone, D.M. and Uchrin, 1999).

Wet Retention Pond:

Wet ponds are ponds specially designed for the disposal and treatment of stormwater runoff. Unlike, dry ponds, these ponds continually hold a certain volume of water, even during dry weather. As stormwater is held in the pond particles settle to the bottom and nutrients are taken up by pond vegetation. When stormwater enters the pond, it displaces a portion of the existing water, which flows out to a stormwater drainage system or receiving waterway. Wet ponds are typically lined or sited in areas with impermeable soils and therefore do not infiltrate stormwater into the ground as groundwater.

Wet ponds retain a permanent pool which is displaced by incoming flows. Wet ponds are generally not recommended for snow applications because the pond level must be maintained periodic (spring / summer) (Obert, G.L. 1994). Discharge from disposal sites cannot solely maintain the required water volume in a conventional wet pond design. Pools interfacing with shallow groundwater could maintain water levels; however this practice would encourage direct interaction between the meltwater and groundwater. Rather than attempting to seasonally vary the pond between wet and dry, dry ponds are recommended (Harper, Harvey 1993).

Wetlands:

Wetland functions are considered valuable because they provide ecological, hydrologic, and social benefits (Sather, 1984). By virtue of their sheer numbers within the Anchorage area wetlands are often used as modified detention facilities (WMS 2000). Wetlands can trap, precipitate, transform, recycle, and export many waterborne pollutants, and water leaving the wetland can differ markedly from that entering (Mitsch and Gosselink, 1993; Elder, 1987). Wetlands can maintain good quality water and improve degraded water.

The proposed snow disposal site is located near an extensive wetland that drains into the Campbell Creek. Wetland creation for water quality treatment is a common and sometimes a recommended practice for snow disposal facilities (Carlson, Robert 2003). Meltwater from a snow disposal facility can help maintain wetland hydration.

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Appendix A.

Siting, Design and Operational Controls For Snow Disposal Sites

Appendix B

Snow Disposal Site Impacts on Well 13, Anchorage, AK

Scott Wheaton