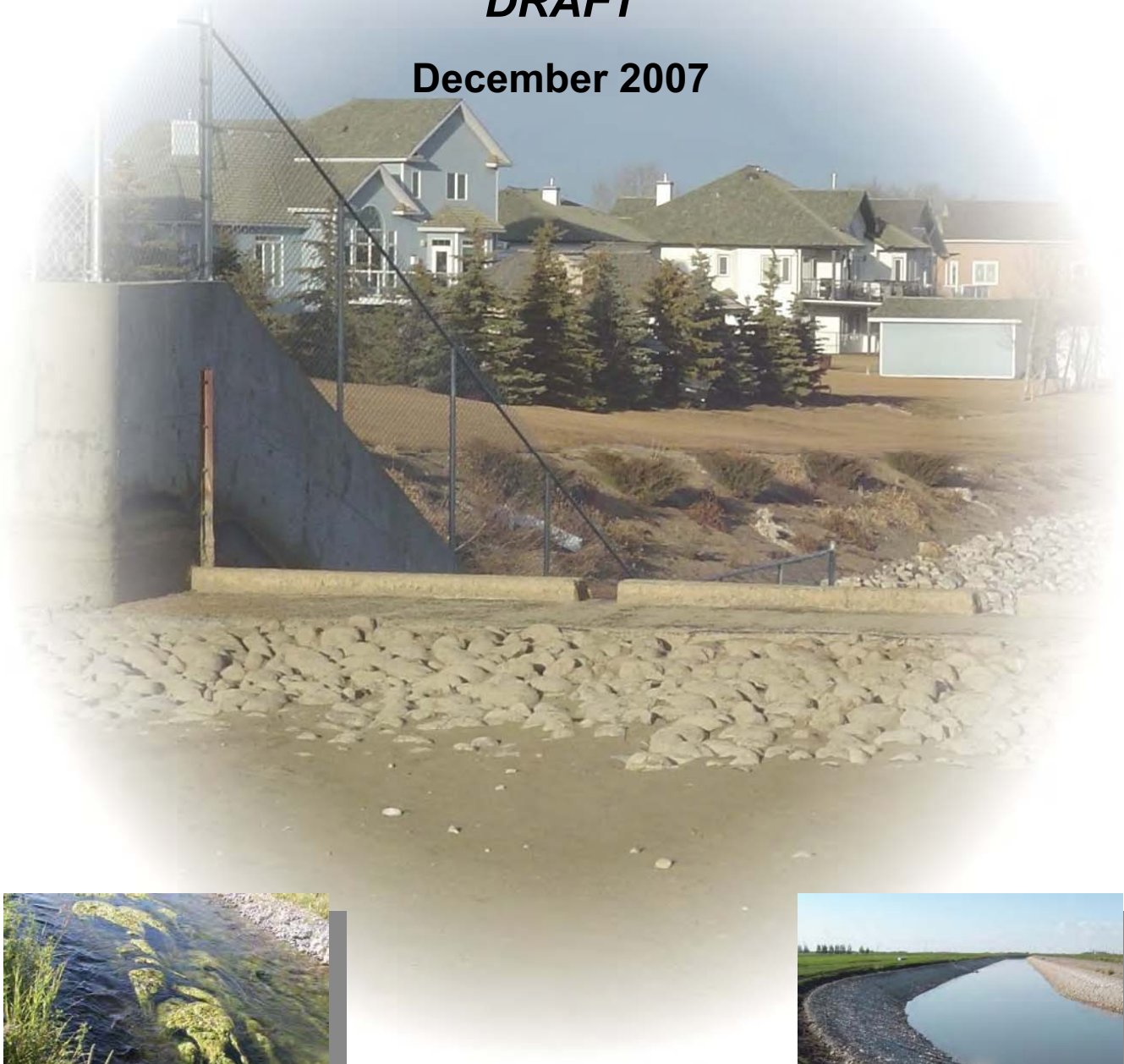
WESTERN IRRIGATION DISTRICT

STORMWATER GUIDELINES

DRAFT

December 2007



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1.0 SUMMARY

This document is meant for distribution to municipalities and developers to guide future development that may impact the Western Irrigation District (WID) irrigation canal system. It presents a framework for stormwater policies aimed at new urban developments that require stormwater access to the WID canal system. The policies complement other initiatives that the WID is undertaking to improve water quality from rural areas. AENV has deemed the WID the stormwater approving authority for developments draining into the canal system. As such, these guidelines are effective immediately.

These guidelines adopt a significantly higher stormwater treatment standard than is currently adopted in the Calgary region. This document presents a "first cut" at treatment targets and required facilities, pending further refinement as the performance of new techniques (i.e. BMPs) are locally proven, as feedback and innovative alternatives are presented from the development community, and as actual performance monitoring data from initial facilities is made available.

1.1 Canal System

The WID canal system is illustrated on Figure 1. The canal system is currently stressed from a water quality and quantity perspective. For the WID to accept any new inflows, stormwater must be treated to a higher standard than provided for by current Alberta Environment (AENV) guidelines.

This higher standard provides a superior degree of control and treatment reliability aimed at avoiding failures that could severely impact weed growth along the canal system, while promoting innovation in the development of stormwater alternatives for various sites. Even so, the WID anticipates that these guidelines may sterilize various land development options where the standards cannot be met and where access to the canal system cannot be avoided. As technologies improve, these situations may be remedied and the guidelines may be further refined.

As a private system, the WID must develop policies independent of Alberta Environment (AENV). These new guidelines will be applied by the WID when they are involved in approvals, excepting previously grandfathered agreements, where previously developed standards will be followed.

These guidelines are rooted in the fact that the canal system is uniquely sensitive. It is not designed as a traditional drainage system. Channels decrease in size moving downstream. Spills and drains at the bottom end of the system have limited capacity. Some parts of the system include natural channels. Most importantly, canals are more vulnerable than natural receiving streams:

- Canals are set for fixed irrigation flows, not for unpredictable runoff surges from urban areas.
- Little natural buffering capacity to cope with excessive nutrient and pollutant loads.
- High nutrient loads lead to rapid and excessive weed growth that choke canal capacity each year.
- Hydraulic design capacity drops downstream, opposite natural streams and drainage channels.
- More pollutants and nutrients enter the canals moving downstream, increasing concentrations.
- Cumulative effects lead to highest and most harmful concentrations near the end of the system.

Extensive monitoring already carried out along the canals and reservoirs confirms high loading concentrations and little to no capacity for more. Surging is accommodated in the canal freeboard, but there is a finite capacity to absorb these flows.

1.2 Water Quality Targets

Water quality information collected over the past number of years by Madawaska Consulting is used to specify quality targets as summarized in Table 1. The entire range of targets and limits are presented in Appendix A (Table 1).

Table 1: District Wide Water Quality Targets

Parameter	District-Wide Target
Total Phosphorus (TP)	0.03 mg/L
Total Suspended Solids (TSS)	10 mg/L
Bacteria	100 per 100 mL Fecal Coliforms
Salinity	0.6 mS/cm Electrical Conductivity (EC)

These targets have been developed to protect the canals from excessive weed growth, to maintain irrigation quality water, and to preserve the quality of return flows back to natural streams, including the Bow River. On-site stormwater management practices in Alberta have typically focussed only upon removal of Total Suspended Solids (TSS), hence the need to create guidelines over-and-above those of AENV to include phosphorus, bacteria, and salinity.

This document assumes the City of Calgary Shepard Stormwater Diversion Project is operational and meeting the water quality and flow diversion targets. These works will not be operational until March 31, 2008.

1.3 Policy Implementation

The broader implementation of these stormwater guidelines varies across the District, though the goal will be to eventually apply the fundamental principles system-wide.

The guidelines provide actual performance targets which can invariably lead to a wide variety of facility designs, and significant variability in facility performance. Although the WID desires innovation in such designs, some practical basis for review and implementation of project proposals is needed. As such, these guidelines provide basic facility design parameters that must be incorporated into each proposal, unless the proponent can provide strong technical back-up and proven local performance data to justify some variance.

1.4 Approval Jurisdiction

The involvement of the WID in the approval process, and hence the application of these guidelines, will vary geographically. The WID is the *sole* approving authority for stormwater systems that access the canal system. In some catchment areas where natural drainage courses and the canal system intermingle, approving authority is a *shared* responsibility between both the WID and AENV. Where Towns and catchment areas have pre-existing agreements or guidelines, these will continue to govern approvals or remain in force until those agreements are renegotiated. Within WID catchment areas where no access to the canal system is required, the approving authority remains with AENV. In these instances, the WID may still provide comment.

The stormwater policies on a catchment area basis are summarized in Table 2, provided canal system access is required. The catchment areas between Calgary and Strathmore are illustrated on Figure 2. This is where most development pressure currently exists, though the policies are deemed to extend further east across the entire District.

Table 2: Stormwater Policy by Catchment Area (If Canal System Access Required)

WID Is Sole Approving Authority	Approval Required by both AENV & WID	WID Approval Governed by Pre-Existing Agreement or Guideline	No Access to WID System Permitted (Underdrain WH Canal)
'A' Canal	Hartell Coulee	Town of Chestermere (within 2004 Town Boundary)	Town of Chestermere West (outside 2004 Town Boundary)
'B' Canal	Serviceberry Creek	Town of Strathmore (within Agreement Boundary)	West Creek (outside 2004 Chestermere Town Boundary)
'B/C' Canal / McElroy Slough	Town of Chestermere East (outside 2004 Town Boundary)	Weed Lake (including Langdon)	
Chestermere Lake (outside 2003 Town Boundary)	Other Catchments to East (Site by Site Basis)		
Strathmead			
Cairn Hill			
Other Catchments to East (Site by Site Basis)			

1.5 Stormwater Facilities

These guidelines will require the following facility components on new development sites:

a. Component #1 – On-Site Source Control BMPs.

b. Component #2 – Primary On-Site Stormwater Treatment Facility (Wet Pond).

c. Component #3 – Secondary Off-Site Final Treatment Facility (Multi-Cell Wet Pond).

d. Component #4 – Mechanical Treatment Facility *only* for canal reaches that flow into or through a reservoir.

These are illustrated on Figure 3 and are discussed in more detail later in this document. The first *three* components are required for *all* developments. The *fourth* component is *only* required on canal reaches that feed into a downstream reservoir or lake. Should the *fourth* component be proposed or required, the size of the *third* component may be reduced at the discretion of the District.

The first two components are "On-Site" within the actual subdivision development, and as such will be owned and operated by the respective municipality, or equivalent (i.e. condominium association). The final two components are "Off-Site", and as such may be owned and operated by the WID. Developers will construct all required components, and transfer them accordingly after a three-year maintenance and performance monitoring period.

1.6 Document Format

This document has been prepared for the Western Irrigation District by MPE Engineering Ltd. in collaboration with Madawaska Consulting and from discussions with various stakeholders. It has three major components:

- Policy Framework
- Appendix A – Summary of Background Information
- Appendix B – Technical Section: WID Stormwater Guidelines

The *Policy Framework* outlines the guiding principles and understanding, identifies the key participants and stakeholders, summarizes the process, establishes timelines for feedback and review, outlines the fundamental stormwater management principles, and overviews the future implementation requirements.

The *Summary of Background Information* includes water quality information collected by Madawaska Consulting. This is included in Appendix A.

The Technical Standards – WID Stormwater Guidelines includes the more detailed stormwater management guidelines for design and review of future development facilities within the WID catchment area. The technical document builds upon existing local guidelines (i.e. City of Calgary, AENV), and outlines the different or additional requirements of the WID. This is included in Appendix B.

2.0 POLICY FRAMEWORK

2.1 Guiding Principles and Understanding

This document has been prepared following a number of basic principles and assumptions:

1. The WID is a private system consisting of a number of private canals, reservoirs, and spillways.
2. The WID desires to support sustainable economic growth and development within the local municipalities provided that the District meets its first mandate, which is efficient delivery of irrigation quality water to its members.
3. The WID mandate and primary business is delivery of irrigation quality water, or better, in their canals, rather than operation of extensive stormwater management systems.
4. The WID is under no obligation to accept stormwater runoff from new developments, particularly if the water does not meet WID quality and quantity requirements, which in turn could compromise the District's works.
5. The WID is willing to accept a limited volume of stormwater runoff at a sufficient quality and rate of flow from new developments provided the District's works are not compromised.
6. The WID canals are currently stressed, based upon water quality testing along the system, and cannot accept degraded runoff inflows. There is a finite limit to the loadings that can be deposited and in turn the number of developments that can be accepted.
7. The WID requires a set of guidelines to protect the canal system and to promote other stormwater alternatives (i.e. recycling, reuse, volume reduction, avoidance of the canal system).
8. The WID will accept stormwater from new developments provided the proposed facilities meet the guidelines presented herein, and proper maintenance of facilities is carried out.
9. The WID is not considering any other inputs to the canal system other than treated stormwater.
10. The WID assumes the City of Calgary Shepard Stormwater Diversion Project will soon be operational and will meet performance targets to provide some capacity in the WID system.
11. The WID is only involved in the review and approval of stormwater systems that require direct access to the canal system, otherwise approval remains with Alberta Environment.

2.2 Administrative Framework

In developing the policies for developments that require access to the canal system, the roles and responsibilities of the various stakeholders are summarized:

1. The WID's primary role is to protect the quality of water entering the canals from proposed urban developments, which includes setting minimum standards for on-site facilities, off-site

facilities, and treatment targets for proposed urban developments. The WID will review facility designs and constructed installations. The WID will operate, maintain, and monitor any *off-site* facility, and directly control release into the canals.

2. The Municipality's role is to approve developments including the design and construction of all stormwater management facilities, and to operate, maintain, and monitor water quality of *on-site* facilities.

3. The Developer's role is to construct, maintain, and monitor the *on-site* and *off-site* facilities until the end of a 3-year maintenance and water quality "proving period", provided the performance of the facilities is adequate.

This is addressed in more detail within Section 2.7.

2.3 Stormwater Management Principles

The primary stormwater management principles are:

1. Stormwater management policies have been developed:

   a. To protect the integrity of the WID canal system.

   b. To apply to lands not covered by AENV standards (i.e. accessing canals).

   c. To exceed AENV standards, given the sensitive nature of the canals.

   d. To guide the municipal approving authority in the development approval process.

   e. To provide a consistent set of standards to the development community.

   f. To allow development review by the municipal subdivision approving authority and the WID.

   g. To allow the development industry to evaluate the cost of alternates to connecting to the WID system.

   h. To be flexible over time given improved technology, knowledge, and ongoing water quality and volume monitoring.

2. The components of any proposed development shall include:

   a. Stormwater Quality Controls,

   b. Stormwater Quantity Controls, and

   c. Construction Management Plans that include Erosion and Sediment Controls.

3. In the Calgary region, both the City of Calgary and Alberta Environment have developed detailed documents for Stormwater Management and Design. These are generally complimentary documents familiar to the development community in the region, and will be used as the base for Stormwater Management Policies associated within the WID. The WID

will have some requirements that differ from or are over-and-above these documents, based upon the unique nature of the canals (i.e. reduced capacity downstream, weed growth very sensitive to nutrient load, loads accumulate downstream, greatest nutrient concentrations measured at ends of canals).

4. The fundamental philosophy of the WID Stormwater Policies will be to:

   a. Monitor and limit, in order of priority, Total Phosphorus (TP), Total Suspended Solids (TSS), Bacteria (Fecal Coliforms), and Salinity (EC) in the canals to targets as outlined in Table 1 of Section 1.2.

   b. Gauge treatment performance using TP as the primary indicator.

   c. Reduce runoff volume from development sites.

   d. Build upon already developed principles in the City of Calgary and AENV documents.

   e. Adopt additional stormwater management policies specific to the WID in order to protect the integrity of the canal system.

   f. Allow for future review and updating of the guidelines based upon actual monitoring of the performance of facilities and the state of the canal system.

   g. Recognize that proper erosion and sediment controls during construction activities are essential.

5. The following facility components will be required on new development sites (see Figure 3):

   a. Component #1 – Source Control BMPs to reduce runoff volume to a set amount annually and to reduce nutrient loads, including TP. These will be operated and maintained by the municipality, or equivalent authority (i.e. condominium association).

   b. Component #2 – Primary On-Site Stormwater Treatment Facility (Wet Pond) complete with forebay to trap sediment and debris, to provide stormwater quality enhancement via a permanent pond, to provide sufficient active storage to accommodate a 100-year event, and to limit release flows to a preset rate. This will be operated and maintained by the municipality, or equivalent authority.

   c. Component #3 – Secondary Off-Site Final Treatment Facility (Multi-Cell Wet Pond), to provide further water quality enhancement and sized to contain the runoff volume over the irrigation season, accommodating the volume from a 100-year storm event, thereby allowing discretionary release by the WID. This will be operated and maintained by the WID.

   d. Component #4 (Special Circumstances) – Mechanical Treatment Facility, along canal reaches which flow into or through reservoirs to ensure nutrient loads (primarily TP) are below the targets needed to ensure the health of the canal and reservoir systems (e.g. Secondary A Canal upstream of the Langdon Reservoir). This component will be operated and maintained by the WID. This component may be incorporated at the request of the developer, and at discretion of the WID, to reduce the volume and land base required for Component #3.

Components #1 to #3 are mandatory. Component #4 is required in special cases as discusses. Each component is further detailed in Section 2.5.

6. The main rationale for ownership of these various components is as follows:

   a. The WID's primary responsibility is to ensure that the quality of water in their canal system is acceptable.

   b. The WID will not knowingly accept a pollutant that does not meet the desired water quality targets set for the canals.

   c. The WID is not in the business of owning and operating *on-site* stormwater facilities (i.e. Components #1 and #2; see Figure 3). This role will remain with the municipality.

   d. The WID is willing to accept recycled stormwater runoff of desired quality from developments, provided that the District maintains control of the timing and quality of water released into the canals. Upon this basis, the WID requires ownership and full operational control of the Component #3 and #4 storage and treatment facilities.

   e. The WID requires that the water they receive into the Component #3 storage and treatment facility be pre-treated and both the volume and the hydraulic flow be properly controlled by appropriately designed and constructed on-site facilities.

2.4 Stormwater Guidelines Overview

1. For the WID to accept stormwater from a development, these stormwater guidelines are effective immediately.

2. This document is applicable across the entire WID drainage basin, where canal access is required.

3. A conservative set of guidelines are developed that provide a reasonable level of treatment surety, allowing time for multi-year water quality monitoring and feedback, while also providing a sufficient land base to allow retrofit modifications and/or enhanced treatment in future if necessary.

4. These guidelines are based upon a combination of current Best Management Practises (BMPs), Best Practical Technologies (BPTs), and good engineering judgement that recognize that the loading the canal system can accept is, at best, an estimate based upon available information and current understanding.

5. Developments shall construct facilities to treat stormwater to meet the WID guidelines. The WID will review the proposed designs.

6. These guidelines and development policies must remain flexible to change given improved technology and better understanding gained from ongoing monitoring of the canal system. After facilities are constructed and monitored, the targets and policies presented in this document will undoubtedly be updated and further refined. To realize this, an ongoing water quality-monitoring program is essential.

7. The fundamental goals of the stormwater guidelines are to preserve irrigation-quality water within the WID system and to maintain the hydraulic capacity within the canals. The primary techniques include the control of nutrient loads to preserve irrigation-quality and limiting the volume and release of runoff from developments.

8. These water quality objectives require measurement and aim at protecting the quality of water in the canal system, recognizing average and acute storm values as realities.

9. The Bow River, as the WID's water source, is itself undergoing changes in water quality. Both the City of Calgary and Alberta Environment are reviewing policies and addressing the issues.

2.5 Land Use Factors

1. Existing land uses within the wider drainage basin primarily include urban (Towns of Chestermere and Strathmore, Villages, and Hamlets), quasi-urban (country residential), rural (agricultural), transportation (roads and highways), and other (non-residential, non-agricultural).

2. These guidelines are primarily aimed at residential developments that contribute concentrated runoff (i.e. high volume, high intensity, high pollutant concentrations) directly to the canal system, rather than a lake or reservoir. Proposed commercial and industrial developments will be considered on a site by site basis following similar principles.

3. A number of development areas (i.e. Town of Chestermere within 2004 boundaries; Town of Strathmore; Weed Lake basin) are subject to private agreements that precede these guidelines. These will continue to be in force until or unless they are renegotiated. Other development areas that do not require access to the canal system will continue to be subject to AENV guidelines and approvals.

4. Land uses within the drainage basin are anticipated to intensify over time.

5. Both construction activities and the ultimate land use impact the loadings in the drainage basin.

6. Appropriate land use and development policies should be adopted by the primary approving authorities in the WID basin, namely the M.D. of Rocky View No. 44 and Wheatland County.

7. The WID anticipates that these guidelines will sterilize various land development options where the standards cannot be met and where access to the canal system cannot be avoided.

2.6 Significant Stormwater Policy Highlights

1. As promoted by the USEPA (USEPA 2004; Vol.1, Pg. E-3) a "*treatment train approach*", with source controls to limit both influent concentrations and runoff volume, is adopted to increase pollutant removal from the drainage area and to benefit the receiving stream (i.e. the canal system).

2. The *"treatment train approach"* illustrated on Figure 3 includes the minimum three components required of any development in the applicable catchments (Figure 2):

   a. Component #1: Source Control BMPs within the development capable of limiting post-development runoff volumes to a maximum of 120 mm runoff over the contributing area on an average annual basis;

   b. Component #2: Primary On-Site Stormwater Treatment Facility; typically a wet pond with a forebay, a permanent storage volume (minimum 25 mm volume over catchment), active storage for a 100-year return period event as determined from the greater of the active storage volume derived from a discrete storm event or a continuous simulation model utilizing a maximum pond release rate of 2.0 L/s/ha; the pond will also include an emergent vegetation bench and an outlet control structure; and,

   c. Component #3: Secondary Off-Site Final Treatment Facility; typically a three (3) cell wet pond with an upstream and downstream sampling/dosing/metering vault, forebay, permanent storage volume with a minimum depth of 2.0 to 3.0 meters, minimum 1.0 meter active storage depth, minimum 1.0 m freeboard, emergent vegetation bench (where required by WID), and a downstream outlet structure capable of variable flow control, allowing complete closure to full release into the canal and allowing late or out of season releases. This secondary off-site stormwater treatment facility must provide sufficient active storage to accommodate runoff during the entire irrigation season (May 1 to October 30, i.e. minimum of 120 mm volume over the catchment area) and preceding melt period (April) effectively allowing the WID to release into the canal during the off-season. To minimize the area requirements, the facility can be more functional in nature, being fenced with no public access and having steeper side slopes and larger operational depths than normally allowed for compared to an on-site facility.

   For canal reaches or catchments that empty into a reservoir (i.e. A Canal upstream of Landgon Reservoir), a fourth component is required to offset nutrient accumulation.

   d. Component #4 (Special Circumstances): Any development proposed on A Canal upstream of Langdon Reservoir must provide the three components as specified above plus an off-site mechanical treatment facility with chemical addition to ensure the total phosphorus release into the canal is consistently at or below 0.03 mg/L.

3. At the discretion of the developer and with the approval of the WID where Component #4 (mechanical treatment) is proposed, the volume and land base required for Component #3 (storage) may be reduced. Component #3 must still be of sufficient size to accommodate a 100-year storm event and a potential mechanical treatment plant upset, subject to the flow-through capacity of the Component #4 treatment plant.

4. The Component #4 mechanical treatment system adopts a design flow not exceeding the maximum accepted flow for the technology, as approved by the WID. Passive filter systems and bio-filters cannot generally achieve the removal requirements needed for Component #4 and will not be accepted.

5. Engineering analysis including continuous simulation, discrete event simulation, and water balance must be provided to verify:

    a. The source control volume target is met.

    b. 85% of total suspended solids (TSS) larger than 75 μm particles in the primary on-site facility can be achieved even without the source controls present.

    c. Facility performance based upon 100-year return period storm events with more frequent events (i.e. 5-year return periods) modelled to ensure adequate performance in more frequent events.

    d. Proposed storage volumes are adequate as supported by a return-period analysis of overflow conditions to the canal.

    e. Potential impacts of local groundwater conditions.

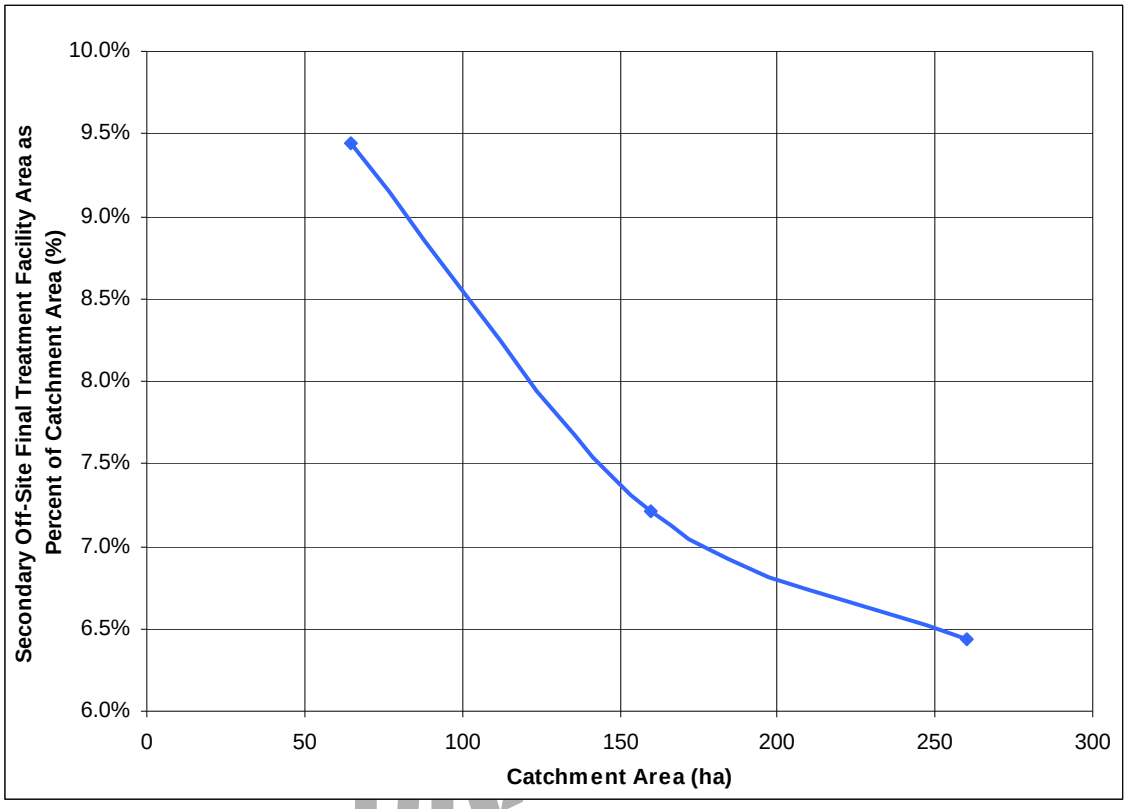
6. For smaller or infill developments, where large pond facilities cannot be practically constructed, sediment control devices (i.e. Vortechnics, Stormceptors, or approved equals) may be considered at the discretion of the WID, but only in conjunction with other appropriate BMPs. The WID supports larger regional stormwater master plans being developed to minimize the number of facilities. Small or infill subdivisions that cannot meet these guidelines must maintain their water on-site or discharge by methods other than to the canal system. Periodic releases to the canal system shall only be by special agreement with the WID on a site by site basis.

7. The source controls and the primary on-site treatment facility would remain within the subdivision proper (i.e. Components #1 and #2 "on-site"). In most cases, ownership of both facilities would be transferred from the developer to the approving municipality (i.e. M.D. of Rocky View or Wheatland County) or would remain within the control of a condominium association. In either case, the works would have to be satisfactorily maintained and policies implemented to allow for the eventual replacement of necessary elements of the facilities (i.e. cleaning of forebay, replacement of biofilters, etc.). Proof of maintenance and operations scheduling for both source controls and the primary on-site treatment facility must be forwarded to the WID for approval.

8. Ownership of the secondary off-site treatment facility (Component #3) and any mechanical treatment facility (Component #4) would be transferred to the WID after a three (3) year maintenance and performance monitoring period. After acceptance by the WID, the District would own, operate, and maintain the off-site facility.

9. Common "regional" facilities should be developed where a larger development area is proposed. The typical parcel required for the off-site Component #3 facility would be approximately 9.5% of the developed catchment area, or approximately 15.1 acres (6.1 ha) of each developed quarter section. Larger regional systems that service multiple developments are preferred given the land base percentage decreases with increasing contributing area. Chart 1 illustrates the estimated secondary treatment facility area as a percentage of the catchment area. Staging of such facilities may be considered. Should wetlands be considered at the discretion of the WID, this area may have to be increased.

Chart 1: Approximate Secondary Off-Site Final Treatment Facility Area as a Percentage of the Catchment Area



10. The WID owned and operated secondary off-site final treatment facility should, where possible, service more than one development, or service a minimum development size of 50 to 100 ha.

11. Runoff from undeveloped off-site areas that are unlikely to develop in the foreseeable future should be routed around the development and treatment facilities.

12. The primary on-site treatment facility (i.e. wet pond) and source control BMPs shall be designed to meet current AENV and City of Calgary guidelines, plus any additional requirements as deemed necessary by the WID.

13. The secondary off-site treatment (Components #3 and #4) shall be designed to meet the WID Stormwater Guidelines.

14. Other facility options and innovations (i.e. irrigation, reuse) may be considered on a discretionary basis by the WID. Long-term performance must be verified by continuous modelling and proven examples of successful local applications.

15. Erosion and Sediment controls that meet current local requirements (i.e. City of Calgary) shall be implemented on each project. Such facilities must be in place prior to major stripping or grading operations. They shall be monitored and maintained on an ongoing basis to protect the canals.

2.7 Fees and Levies

1. Annual and up front fees will be set and collected by the WID on a per development acre basis for:

    a. Administration associated with stormwater agreements;

    b. Use of the WID canals, including additional operation and maintenance requirements; a separate surcharge fee may be levied when water quality from a development is above desired target levels or damage to the canal system is incurred, thereby resulting in additional repair or maintenance operations (i.e. additional weed control, etc.);

    c. Operation and maintenance of the secondary off-site final treatment facilities (Components #3 and #4);

    d. Ongoing water quality monitoring program; and

    e. Review and analysis of the water quality monitoring program, plus assessing advancements in nutrient, bacteria, and salinity removal methods to update the WID Stormwater Guidelines when required.

2. Cash in lieu payments for land and construction of the secondary off-site final treatment facility will not be considered. Actual construction of facilities is required.

3. Fees and levies will be assessed to the respective municipal approving authority for each contributing development specific to their requirement to mitigate pollutant loading.

2.8 Key Participants and Stakeholders

1. The key participants in the development and implementation of stormwater facilities:

    a. Western Irrigation District (WID), in its role as owner and operator of the irrigation system, and

    b. The Municipal District of Rocky View No. 44 (MD) and the County of Wheatland (County), each with its respective role acting as *approving authority* responsible for new developments within the drainage basin contributing to the WID canal system. Each municipality adopts policies and technical standards that new developments must adhere to, including land use, development density, stormwater management, erosion and sediment control, sanitary treatment, road standards, building siting, building permits, and general construction requirements. Each remains responsible for the long-term operations and maintenance of stormwater facilities on public lands and for meeting the approval requirements of the WID and Alberta Environment (AENV).

2. The other major stakeholders capable of impacting the canal system include:

    a. Alberta Environment (AENV), although not directly involved in the approval of storm facilities accessing the WID system, maintains its jurisdiction upstream and downstream of the District under the *Water Act* and the *Environmental Protection and Enhancement Act (EPEA)*. Under the *EPEA*, AENV requires that approval be sought from the WID to allow construction of any works that access the canal system.

b. Local municipalities adjacent to the canal system.

c. Local landowners adjacent to the canal system, including developers with plans to intensify use of the adjacent lands.

d. Residents and industry within the drainage basin.

2.9 Process, Roles, and Timelines

1. The WID shall remain the final approving authority for stormwater facilities that require access to the WID canal system. Generally the WID will:

   a. Develop the *WID Stormwater Guidelines* that can be adopted by the MD and the County for future developments in the basin.

   b. Review and approve stormwater facilities where canal access is required within development proposals, following initial review by MD or County staff.

   c. Where canal impacts are suspected, seek referrals from the municipal approving authorities (i.e. the MD and the County).

   d. Review water quality monitoring data and update criteria to determine whether additional amendments to the stormwater guidelines and development policies are required to protect the integrity of the WID system.

   e. Update the stormwater guidelines based upon feedback from the approving authorities, upgrades to and/or new technology or standards, and ongoing monitoring data.

2. For development to proceed where access is required to the canal system, the *WID Stormwater Guidelines* shall be adhered to by the respective approving authority in the design and approval of stormwater facilities.

3. Staff of the respective municipal approving authority will carry out the initial review of developments and design drawings in accordance with the *WID Stormwater Guidelines.* Final review and approval of applicable drawings is to be carried out by the WID prior to any construction. The WID will share with the development community the criteria that would permit access to the canal system.

4. The WID canals will continue to be monitored over time by the WID. All monitoring results will be public information and available on request. Nutrient and other loadings will be monitored by sampling and compared to the criteria developed for the canals.

5. Parameters and sample locations that are important to determine the performance of the overall stormwater facilities will be included in the overall monitoring program and modified from time to time as required.

6. Based upon the results of the ongoing monitoring program, the stormwater guidelines governing development within the WID drainage basin may be amended.

7. The WID Stormwater Guidelines and overall development policy will be reviewed and updated within approximately five (5) years.

2.10 Implementation and Review

The WID will define its ongoing role, and consider the following:

1. Forward copies of the guidelines for comment and feedback to:
   a. Alberta Environment.
   b. Municipalities.
   c. Active Developers in the Area.
2. Oversee the development of stormwater and other water quality guidelines.
3. Participate in the final design review and approval process.
4. Retain engineering expertise to assist in the review and approval process.
5. Review the ongoing water quality-monitoring program.
6. Liaison with the municipal approving authorities.
7. Develop and assess fees and levies.
8. Review and consider new technologies that may reduce the burden on development.
9. Update the stormwater guidelines based upon on-going monitoring data, feedback from the stakeholders, plus improvements in technology and/or stormwater standards.

To implement these guidelines, the WID will seek consideration of a number of items by the municipal approving authorities:

1. Adoption of these guidelines into current development standards, or supplementary WID section(s) of development standards, by the MD and County.
2. Consider, where practical, adoption of future land use policies that support dedicating Municipal Reserves (MRs) adjacent to Public Utility Lots (PULs) that contain stormwater management facilities, allowing a ready land-base for future expansion of the stormwater facilities if required.
3. Develop maintenance, monitoring, and cleaning programs for the various stormwater quality facilities.
4. Consider including associated O&M costs in a stormwater utility charge to benefiting ratepayers.
5. Promote responsible homeowner activities and a broader understanding of the WID system through education and information packages.

Co-operation on these items will help to avoid refusal of all future access where the water quality targets are not met, which for most locations is currently the case.

FIGURES

APPENDIX A

SUMMARY OF BACKGROUND INFORMATION

APPENDIX A - SUMMARY OF BACKGROUND INFORMATION

A.1 Development Potential in Catchment Areas

The various catchment areas between the City of Calgary and Strathmore within the WID Drainage Area are illustrated on Figure 2. Drainage boundaries are approximate and should be field verified on a development-by-development basis.

Potential new urban development within the M.D. of Rocky View as of May 2006 was over 4,400 ha, which could result in the equivalent of 44,000 homes or an estimated population of 130,000. Of this, most was planned within the WH Canal (26%), West Creek (28%), and Weed Lake (25%) catchments, which represents over 3,500 ha. The large areas within the WH Canal and West Creek catchments will be too much for the canal systems to handle, so the WID requires a planned underdrain system beneath the AENV WH Canal to the Shepard Stormwater Diversion Project to eventually remove these areas from the WID drainage basin altogether.

The Weed Lake drainage area already has specific *Weed Lake Stormwater Guidelines* in place. The WID only occasionally receives water from Weed Lake if the B-Canal gate is opened and water is directed to Hartell Coulee and Serviceberry Creek. Future consideration will be given to adopting the new policies outlined herein within the *WID Stormwater Guidelines.* Significant development and regional sanitary treatment facilities are proposed for Langdon, which will require a new outfall to the river once the loading on Weed Lake increases above the 12,000 population equivalent assumed in analyses to date.

Of the remaining catchments, urban development is planned within the B/C Split (10%), C Canal at Dalroy (6%), and Chestermere Lake (5%) catchments as of May 2006. No urban development (town site) was proposed along A Canal, B Canal, Bruce Lake, Serviceberry Creek or the Bow River catchments, however, more recent development proposals are imminent. Development around the Chestermere High School, for instance, may contribute to A Canal and should be confirmed.

A summary of the various policies by catchment area between Calgary and Strathmore (Figure 2) is provided in Table A.1. These areas are experiencing the most development pressure. The eastern portion of Wheatland County is not illustrated, but is also experiencing development pressure, particularly in the vicinity of Strathmore. It should be noted that the Town of Strathmore is under a separate agreement with the WID and is not included in Table A.1.

It is important to note that water quality modelling to date on Chestermere Lake has assumed the rural areas remain "rural." Once the Shepard Stormwater Division Project is fully operational, directing stormwater flows away from the WH Canal and Chestermere Lake system, total loadings to the canal system and Chestermere Lake will reduce, with the intent to progress towards a sustainable water quality balance in Chestermere Lake and the downstream canal system. With this is mind, water quality on the WID system will remain a priority.

Table A.1: WID Catchment Areas and Potential Stormwater Policy within the M.D. of Rocky View

Catchment	WID Catchment Area (ha)	Policy Comments
WH Canal AENV	To AENV	Large urban area planned subject to other policies; underdrain WH Canal
West Creek	6,653	Outside the Town of Chestermere 2004 boundaries, large urban area planned subject to other policies; underdrain WH Canal
Chestermere Lake	1,450	Current inflow & water quality limited to that allowed by WID agreement with Town (Town of Chestermere 2004 boundaries); follow current Town & AENV standards with WID review; consider adopting new WID Guidelines
Weed Lake	13,156	Already water quality guidelines in place; WID only sees water if B-canal gate opened; goes to Hartell Coulee & Serviceberry Ck.; consider adopting new WID Guidelines once approval jurisdiction is confirmed.
B/C Split	450	Improve McElroy slough; Adopt new WID Guidelines.
A - Canal	2,007	Little room for more TP; Adopt new WID Guidelines. Require mechanical treatment upstream of Langdon Reservoir.
B - Canal	7,043	Little room for more TP; Adopt new WID Guidelines.
C - Canal	33,300	Little room for more TP; consider piping Dalroy stormwater further east into Serviceberry Ck.; Adopt new WID Guidelines.
Serviceberry Creek.	10,028	Shared WID and AENV approval authority; consider adopting new WID Guidelines.
Strathmead	6,802	Little room for more TP; Drains to Bow River; Adopt new WID Guidelines.
TOTAL	**83,931**	

A.2 Stormwater Criteria Rationale

A recent literature review has revealed a high variability in the performance of stormwater management facilities. In general, the guidelines presented herein recognize that the actual treatment performance of current stormwater treatment facilities is not well documented. New technologies, while promising, have yet to be implemented on a wide-scale basis. Local, long term performance data is lacking. Source controls and other BMPs have been utilized in many parts of the world, but performance cannot be readily transferred to the Calgary region, especially given the colder climate and the rapid snowmelts caused by Chinooks. This does not mean such technologies should not be promoted, adopted, and monitored. As such, the guidelines reflect a pragmatic approach to incorporating new BMPs alongside more traditional stormwater facilities (i.e. wet ponds).

From the literature a number of points can be made:

- Multiple Practices or "Treatment Trains" (USEPA 2004) are most effective to achieve water quality targets.
    - Better Site Design (BSD) – reducing imperviousness reduces loading (i.e. reduce or disconnect impervious cover, minimize turf area in favour of conserving natural areas).
    - Stormwater Treatment Practices (STPs) include:

- Source Control BMPs
- End of Pipe BMPs

- *Irreducible Phosphorus Concentrations* (Caraco, 2001) represent minimum achievable concentrations discharged by a STP. For wetlands and wet ponds this value is typically 0.03 – 0.15 mg/L. Practically speaking, it will be difficult to reliably reduce total phosphorus in stormwater runoff below 0.1 mg/L without some form of chemical treatment process in addition to traditional storm wet ponds and wetlands.
- Caraco (2001) notes that *"even if stormwater practices are widely spread across a watershed, the treated stormwater runoff may still exceed background concentrations."* Regulations that require *no net increase* in TP load from pre-development conditions may be extremely difficult to meet. This means that if development is allowed into the canal system, there is a good chance there will be an increase in TP loads. To minimize the TP load, multiple facilities will be implemented.
- Wetlands are found to be highly variable in terms of phosphorus removal due to internal phosphorus cycling, sediment release, and vegetative die back (Caraco 2001). Careful consideration to wetland design and hydraulic retention times is critical.
- Natural wetlands are less predictable and less effective than constructed wetlands (SWCSMH 2006).
- Wet ponds with wetland fringe (Caraco 2001 refers to as "Pond / Wetland System") appear promising from a TP removal perspective, however, bypassing and short-circuiting of the fringe areas must be addressed.
- Multiple, smaller pond systems are more effective than larger single facilities in TSS and TP removal. Single pond facilities can be developed with multiple cells to achieve improved performance (i.e. longer flow paths; submerged berms; extended detention).
- BMPs will have to be implemented in series in order to achieve targets.
- Alum dosing can have some effectiveness but literature is sparse. Consider use as a supplement when storage is taken up – particularly during construction or if performance values are lower than anticipated.
- Ongoing monitoring of the initial facilities to confirm performance will be the key.
- In order to achieve total phosphorus concentrations in the order of 0.03 mg/L, mechanical treatment plants and chemical addition will likely be required.

The stormwater criteria used as the basis for development of these guidelines is summarized in Table A.2.

References:

Caraco 2001; Managing Phosphorus Inputs into Lakes, III. Evaluating the Impact of Watershed Treatment; Watershed Protection Techniques 3(4) 791-796; Center for Watershed Protection, Ellicott City, MD; December 2001.

SWCSMH 2006; Treatment of Stormwater Runoff. Soil and Water Conservation Society of Metro Halifax, Retrieved March 1, 2007 from http://lakes.chebucto.org/SWT/treatment.html.

USEPA 2004; Stormwater Best Management Practice – Design Guide; Volumes 1, 2, 3; National Risk Management Research Laboratory; Office of Research and Development; U.S. Environmental Protection Agency, Cincinnati, OH; 2004.

Table A.2: Stormwater Criteria

LONG-TERM GOAL	TECHNIQUE	REALITY	SHORT-TERM POLICY
Runoff Volume: Limit runoff volume to pre-development levels (often range from 5% to 20% of 335 mm April to October precipitation; or 20 mm to 80 mm runoff)	Source control BMPs, End of Pipe BMPs and other Low Impact Development Techniques (evaporation, evapo-transpiration, infiltration, Better Site Design - reduce and disconnect impervious area; conserve natural areas)	Source controls are promising in Calgary region and Alberta but are unproven; some local installations have failed; performance must be monitored and local performance / improved design established over next decade and beyond. Reducing impervious from 40% to 20% is close to applying one BMP Practice.	Typical urban residential development can result in runoff rates of 50% to 75% (170 to 250 mm). Aim for an achievable runoff limit of 120 mm. Decrease in future as performance and design techniques improve.
Total Phosphorus: Limit total phosphorus (TP) loadings to pre-development levels, or maximum of 0.03 mg/L average. Canal average target of 0.03 mg/L adopted to reduce weed growth and maintain irrigation quality. Recent local models adopt export coefficients of 0.19 kg/ha for rural (pre-development) that increase to 0.75 kg/ha (urban), an increase of nearly four fold.	Source control BMPs, other Low Impact Development Techniques (see above), Wet Ponds, Wetlands, Chemical Addition and Mechanical Treatment.	See source control comments as above. *Irreducible Phosphorus Concentrations* out of wetlands and wet ponds is typically 0.03 to 0.15 mg/L, so challenging to reduce much below 0.1 mg/L. Allowance for more active mechanical/chemical treatment, or future limitation on urban development area may be required. Off-irrigation system release avoids issues in canals but can still be an issue in reservoirs.	Adopt a multi-train treatment approach to improve likelihood of reducing post-development TP loads to 0.1 mg/L or less. WID requires secondary wet pond facility to allow further treatment prior to canal and storage to facilitate timed release, including off-season release. Compensation for O & M for treatment facility and a fee for any stormwater released with water quality not meeting WID Stormwater Guidelines.
Total Suspended Solids: Target 10 mg/L. Urban untreated typical 300 to 400 mg/L.	Similar to above.	Traditional designs call for 85% removal above 75 µm.	Target 20 to 40 mg/L (90% to 95% removal) on annual basis.
Other Parameters: Limit other parameters (Bacteria as Fecal Coliforms to 100 / 100 mL; Salinity as Conductivity to 0.6 mS/cm).	Similar to above.	Bacteria likely more easily addressed than TP at this point in time. Salinity to be addressed on site-by-site basis.	Continue monitoring these and other parameters.
Peak Flows: Limit to 2.0 L/s/ha or less if required.	Active storage on-site, reduced runoff volume.	Hydraulic Capacity varies along canals, so may refine in future. Newer rehabilitated canals include some "surge" capacity in freeboard in the order of 2 to 3 L/s/ha.	Limit to 2.0 L/s/ha from primary facility into WID facility to provide consistent hydraulic loading.

A.3 Water Quality Objective Development

This section has been prepared by Madawaska Consulting and overviews the water quality work associated with the WID canal system, and development of the water quality objectives.

Stormwater contributes significantly to the deterioration of water quality entering the Western Irrigation District (WID), affecting Chestermere Lake and downstream along the canal distribution system. The development of the Shepard Stormwater Diversion Project provides an opportunity to reduce the ongoing impacts on the WID system, but any improvements in water quality need to be protected from the effects of increasing urbanization in the watersheds of the WID system. To help provide this protection, water quality objectives were developed for the canal system.

The water quality issues related to stormwater inputs identified for the WID canals are nutrients and suspended sediments contributing to weed growth and affecting hydraulic capacity; bacteria, salinity, pesticides and hazardous substances limiting the application of the irrigation water. Development of numerical water quality objectives along the canals was narrowed to include total phosphorus (nutrient), fecal coliforms (bacteria) and conductivity (salinity). The issues of suspended solids, pesticides and hazardous substances were given a narrative objective (reduce or limit input).

Existing water quality guidelines were used as a base for setting water quality objectives with historical water quality data and longitudinal changes along the canals taken into consideration.

Water Quality Guidelines

Total phosphorus concentration guidelines for rivers (Environment Canada 2004) range from 0.025 to 0.050 mg/L, with Alberta and Manitoba at 0.050 mg/L, Ontario and Quebec at 0.030 mg/L (also a target for a stream in Texas), and Australia and New Zealand at 0.035 to 0.037 mg/L. These are typically for the protection of aquatic life. The Bow River Task Force (1991) set the guideline for irrigation waters at 0.025 mg/L.

The irrigation guideline for fecal coliform bacteria is 100 colony forming units per 100mL (Alberta Environment 1999).

The irrigation guideline for electrical conductivity is 1 mS/cm (Alberta Agriculture 1983), however this does not provide adequate protection for very sensitive crops such as strawberries, raspberries, beans and carrots. To protect these crops a guideline limit of less than 0.7 mS/cm is required (CCREM 1987).

Historical Data Analysis

The historical water quality database collected at sites along the WID canals from 1996 to 2005 was reviewed to determine the characteristics of the water quality (see Figure A.1). In general the data at each site followed a pattern of relatively similar concentrations, with higher concentrations in May (canal filling) or sporadically higher concentrations (possibly related to storm events). Statistics were used to divide the data into two subsets at the 75th percentile. The water quality objectives were set to fit this natural pattern of the data and to fit the historical water quality concentrations. A more complete description of this analysis is available in Madawaska Consulting 2006a.

Water Quality Objectives

The historical data were reviewed to determine what was feasible in terms of existing conditions. The division of data at the 75th percentile led to the development of three possible water quality objectives for each water quality parameter.

The water quality objectives have the following characteristics:

1) District wide objectives were based to a large degree on water quality guidelines. These values should not be exceeded anywhere in the District secondary canals.

2) Site specific objectives along the canals were set to ensure that the downstream ends of the canals did not exceed the District wide objectives, considering the changes in concentration along the canals as determined from the historical database.

3) Data < 75th percentile were assigned a target and a limit. Targets (chronic objectives) are concentrations not to be exceeded by the average of the data in each year. Limits (acute objectives) are concentrations not to be exceeded by any individual sample.

4) Data > 75th percentile were assigned a limit (acute objective). No individual sample should exceed this concentration.

Assigned water quality objectives are summarized in Table A.3. Examples of historical data graphed against site specific water quality objectives are given in Figure A.2. The first 50 km on these graphs are upstream of the secondary canals for which the water quality objectives were primarily developed. The graphs show the historical data collected in the Bow River and along the Western Headworks (WH) Canal and the deterioration in water quality passing through Calgary. The data are prior to the Shepard Stormwater Diversion Project and the expectation is that there will be a significant improvement once the diversion to the wetland is operational.

In addition to the numerical objectives, there were several descriptive objectives. Total suspended solids in the canals should be reduced as much as possible by using beneficial management practices to reduce erosion. Pesticides in the canals should be reduced as much as possible by using beneficial management practices to reduce movement away from the target location. Hazardous substance should not enter the canals.

Monitoring and Compliance

The current monitoring program measures the water quality along the canals eight times per irrigation season to determine compliance with water quality objectives (Figure A.1). Each sample is compared with the appropriate limit for compliance. At the end of the season the average concentration (data < 75th percentile) is compared with the target to determine compliance. Non-compliance of any of the objectives should be investigated to determine the cause and develop a strategy for achieving the target objective.

The monitoring program to determine compliance as well as the achievability of the target water quality objectives may require some adjustment during initial implementation. Two years of compliance monitoring data have been collected (Madawaska Consulting 2006b, 2007).

Implications for Stormwater Treatment Guidelines

The water quality objectives as currently defined are based on historical data which includes the water quality of the source Bow River water, historical operation of diversions from the Bow River, inputs from stormwater along WH canal and inputs along the secondary canals. The impacts of the existing water quality on the operations of the WID and water user are of concern. Therefore development within the District watershed can proceed only with a strong regard for water quality impacts.

But several things are changing at the upstream end of the system. Some urban stormwater will be diverted to the Wetland Complex which is part of the Shepard Stormwater Diversion Project. Stormwater from development along WH canal should not be allowed to enter the canal. Bow River water quality at the diversion may change due to management practices in Calgary and upstream. Operations within the District may change related to water conservation and efficiency strategies.

The full impact of the changes in the quality of the source water before it enters the secondary canals is not know, with potential for improvement and for deterioration. Ongoing monitoring will help to define this, but in the meantime, stormwater treatment within the WID watershed needs to be strongly protective.

While the historical database is generally in compliance with the site specific objectives, there is essentially no "room" for more total phosphorus along A canal, and a small capacity along B and C canals. It is hoped that when the Shepard Stormwater Diversion Project is operational, the targets and limits downstream of Chestermere Lake will be more readily achieved.

The historical data to date, while very good as a general indicator of the canals health along various reaches, is not sufficient to formulate an accurate predictive model that can be used to determine policy (i.e. can't answer how many acres of new urbanization can discharge into the canals?). More research into the cumulative affects of increased loadings from urban development are also needed.

However, development pressure is building, and some type of policy needs to be formulated in light of the lack of data. A pragmatic approach is considered, based on the data available combined with model information used to date (i.e. export coefficients) and good judgement.

Export coefficients adopted to date imply that urban development contributes 4 times more TP than rural (i.e. Urban Export Coefficient = 0.75 kg/ha versus Rural = 0.19 kg/ha giving a 4:1 ratio). Much of the TP increase may be attributed to the 3 to 10-fold increase in runoff volume in urban versus rural conditions. In this regard, source control BMPs to reduce runoff volume should be promoted.

Since TP is often attached to solids, if TSS can be reduced then so will TP. As such, both TSS and TP reductions are desired. In most cases, TSS from urban areas is typically highest during construction operations, so Erosion and Sediment Controls must be implemented.

These considerations form the basis of the stormwater guidelines presented in this document.

References

Alberta Agriculture. 1983. Guidelines for Irrigation Water Quality. Agdex 562-1.

Alberta Environment. 1999. Surface Water Quality Guidelines for Use in Alberta. Environmental Service and Natural Resource Service. 20 p.

Bow River Water Quality Task Force. 1991. The Bow River. Preserving Our Lifeline. 58 p + 6 Appendices.

Canadian Council of Resource and Environment Ministers. 1987 (and updates). Canadian Water Quality Guidelines. Environmental Quality Guidelines Division, Water Quality Branch, Ottawa, Ontario.

Environment Canada. 2004. Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems. Report No 1-8. Ecosystem Health Science-Based Solutions. National Guidelines and Standards Office Water Policy and Coordination Directorate. Environment Canada 114 p.

Madawaska Consulting 2006a. Developing Water Quality Objectives for WID Canals. 15 p.

Madawaska Consulting 2006b. Western Irrigation District Water Quality Program 2006. 21 p.

Madawaska Consulting 2007. Western Irrigation District Water Quality Program 2007. 21 p.

APPENDIX B

TECHNICAL STANDARDS

TAB B1

Primary On-Site Treatment Facility
Summary of Wet Pond and Wetland City of Calgary Design Criteria

TAB B2

Secondary Off-Site Treatment Facility
Summary of Design Criteria

TAB B3

Table 6-4 Obtained from Alberta Environmental Protection, Stormwater Management Guidelines for the Province of Alberta, 1999.

FOR REFERENCE ONLY