



Water Budget Studies in the Mississippi-Rideau Source Protection Region Draft Study Findings – August 2009

The Clean Water Act

Water Budget studies were done under Ontario's *Clean Water Act* which requires municipalities and the local community to work together to protect local drinking water sources from becoming contaminated or depleted. The Act is primarily focused on minimizing threats to municipal drinking water sources (lakes, rivers and aquifers that supply municipal drinking water to residents). Where drinking water sources face significant threats, mandatory action could be required.

The key steps under this Act are:

2007 – Source Protection Committee Created

The Mississippi-Rideau Source Protection Committee is made up of 16 people representing a wide variety of local interests and sectors. This Committee is overseeing the development of science-based Source Protection Plans for the Mississippi River and Rideau River watersheds.

2009 – Complete Scientific Studies

Technical studies are focused on mapping local sources of drinking water, determining if they are vulnerable to contamination or depletion, and identifying potential threats. This science will show us where source protection policies are needed, and what threats they need to address.

2012 – Develop Policies to Protect Source Water

Source Protection Plans will contain a combination of voluntary and mandatory land use policies to protect drinking water sources. Under the Act, policies must moderate significant threats and prevent others from becoming significant

What is a Water Budget?

A water budget is a scientific method of accounting for the amount of water and how it moves through a watershed. Water budgets account for water added (or 'inputs', such as precipitation), water removed (or 'outputs', such as river flow out of the watershed) and changes in water stored (such as changes in lake levels and groundwater levels).

The water budget can identify the important processes in the water cycle that are occurring in a watershed. In this way, a water budget can help us to evaluate and manage the quantity of existing and future sources of drinking water.

Typically, the water cycle begins with water entering a watershed in the form of precipitation (rain or snow). The precipitation may return to the atmosphere by evaporation or transpiration (water used by plants). Water that does not evaporate or transpire may travel as overland runoff to rivers, lakes, streams, and wetlands or the water may seep into the ground to become part of the groundwater flow system. When surface water levels rise in lakes and wetlands, or the groundwater level rises in aquifers, the amount of water stored in a watershed increases. Groundwater may eventually discharge to surface water bodies, which is important for cold water fisheries and maintaining river and creek water levels in the winter.

Data gathering and analysis is required in order to complete water budget analysis. Climate information, as well as data on land use, vegetation, soils, and geology is used to build a conceptual understanding of how water moves through the watershed. Depending on the amount and reliability of this data, it is used in simple calculations or complex models to calculate water budget parameters (such as evaporation and groundwater recharge). Complex models require large amounts of data and are more labour intensive. The work done in these reports was carried out at a regional scale, where water budgeting required the use of simple calculations using Geographic Information System (GIS).

The Approach

The Province of Ontario requires the completion of water budgets and drinking water quantity stress assessments as part of its drinking water source protection program. They have prescribed a step-wise, or tiered, approach for the development of water budgets and drinking water quantity stress assessments. With each subsequent tier the scale is refined, model complexity increases, and certainty improves. Figure 1, below, shows an overview of this tiered approach.

Provincial Technical Rules stipulate that the Ottawa River is not to be considered in the water budget studies. Therefore, water budget studies in the Mississippi-Rideau region strictly account for water quantity in the Mississippi and Rideau watersheds which both drain into the Ottawa River.

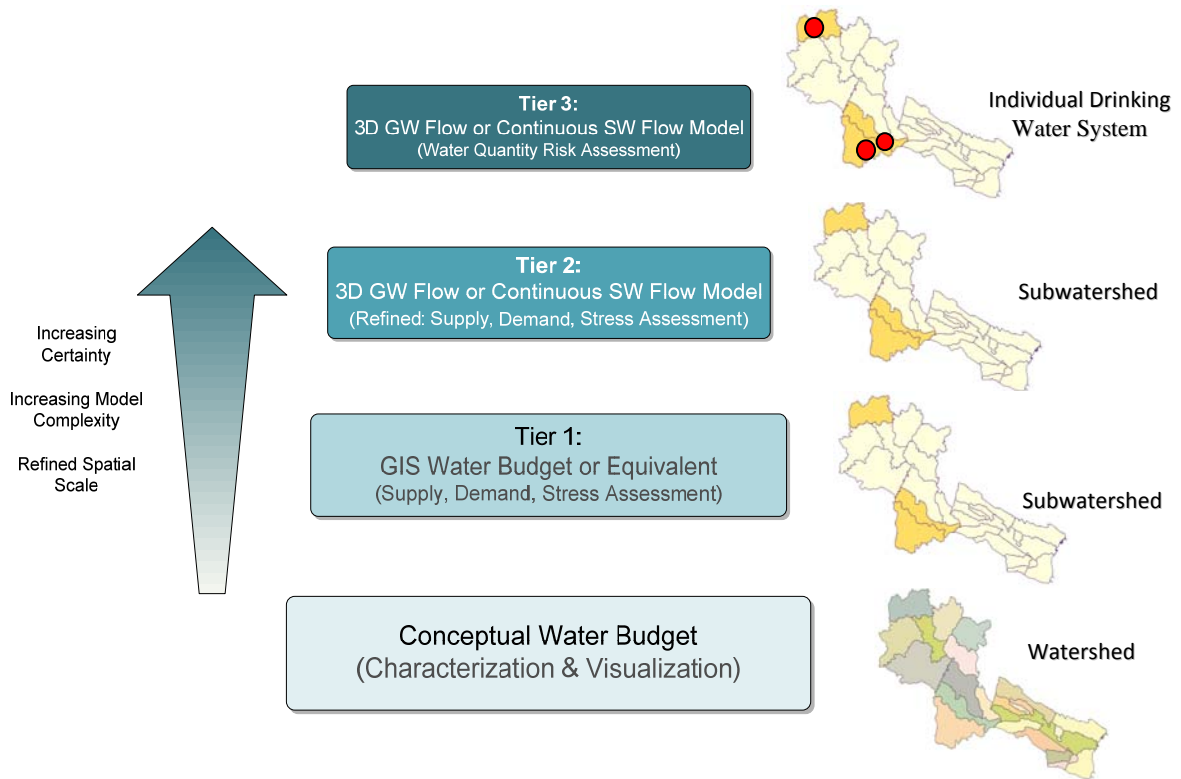


Figure 1: Overview of the Water Budget Process

The Mississippi-Rideau Source Protection Region completed the first two stages of the tiered approach: a “Conceptual Understanding of the Water Budget (2007)” (referred to herein as Conceptual Water Budget) and a “Tier 1 Water Budget and Stress Assessment (2009)” (referred to herein as Tier 1). Both stages used existing data and a simple Geographic Information System (GIS) model to characterize the hydrologic processes and complete the water budget analysis.

The Conceptual Water Budget builds on the Watershed Characterization Report. It characterizes the hydrologic processes in the Mississippi-Rideau, and provides annual estimates of water budget parameters at the regional and watershed level. This means that we’ll know how much water there is for the watershed and the region for the major water cycle components for the year.

The Tier 1 builds on data and information gathered for the Conceptual Water Budget. Tier 1 water budgets are completed for smaller areas (subwatershed versus watershed levels) and shorter time scales (monthly versus annual). Furthermore, the Tier 1 uses the water budget results to complete water quantity stress assessments in each subwatershed. This stress assessment compares consumptive water demand to the available water supply for surface water and groundwater in each subwatershed. They are designed to identify subwatersheds with municipal drinking water systems that have water quantity stresses. Subwatersheds that result in a LOW stress do not move forward in the process. Any subwatershed with a MODERATE or SIGNIFICANT stress and containing a municipal drinking water system moves on to a Tier 2 assessment.

Water Budget Study Components

As per the Provincial requirements, there are three major components to the water budget analysis. They are the Conceptual Water Budget, Tier I Water Budget and Stress Assessment, and Climate Change Review. Specific steps for the Conceptual and Tier I studies are outlined below:

Conceptual Understanding of Water Budget

- Step 1 Characterize the physical system
- Step 2 Collect and analyze data
- Step 3 Determine annual water budget for the watershed

Tier 1 Water Budget and Stress Assessment

- Step 1 Refine the analysis area and time periods
- Step 2 Refine the data from the conceptual water budget
- Step 3 Determine the annual and monthly subwatershed water budgets
- Step 4 Calculate the percent water demand for each subwatershed
- Step 5 Assign a stress level to each subwatershed

Climate Change Review

Climate change may impact the amount of water available to us in the future. The impact that climate change will have on the quantity of water supplies in the Mississippi-Rideau is generally unknown at this time. The Province therefore requires the use of historical climate and stream flow data to calculate the amount of water supply for the Conceptual Water Budget and the Tier 1 Water Budget and Stress Assessment. The Province also requires a summary of the existing climate change knowledge and climate data, and an interpretation of how climate change can impact the conclusions in the Assessment Report. Please refer to the Mississippi-Rideau 'Climate Change Review' study and summary for this information. Future updates of water budget studies may incorporate historical climate and stream flow data as well as climate change information.

The Experts

The Conceptual Water Budget study was completed in 2007 by Mississippi-Rideau Source Protection Region staff (water resources engineers and GIS/database specialists) and water resource engineers, hydrogeologists and GIS/database specialists at Intera Engineering, Ltd. (Intera).

The Tier 1 Water Budget and Stress Assessment study was completed in 2009 by Mississippi-Rideau Source Protection Region staff (water resources engineers and GIS/database specialists) and water resource engineers, hydrogeologists and GIS/database specialists at Intera Engineering, Ltd. (Intera). Delcan also provided some early assistance in the preparation of the Tier 1 study.

All components of the water budget studies conform to the Assessment Report Technical Rules (dated December 12, 2008) issued under the *Clean Water Act*.

The Technical Rules can be found at
<http://www.ene.gov.on.ca/en/water/cleanwater/cwa-technicalstudies.php>

Peer Review and Provincial Approval

Under provincial direction, the Conceptual Water Budget and Tier 1 studies were peer-reviewed by a team of independent experts. The peer review team was created in 2005 for the Mississippi-Rideau Source Protection Region, the Cataraqui Source Protection Area, and the Quinte Source Protection Region.

The Ministry of Natural Resources provided key directions and draft acceptance of the Conceptual Water Budget and Tier 1 Water Budget and Stress Assessment studies for the Mississippi-Rideau Source Protection Region. The Ministry of the Environment (MOE) provides final approval of these studies as part of the Assessment Report.

Conceptual Understanding of Water Budget

Step 1 – Characterize the Physical System

The first step in the preparation of the Conceptual Water Budget is to gain a comprehensive understanding of the physical environment of the watershed region, and how surface water and groundwater moves through it.

Overview

The Mississippi-Rideau Source Protection Region (Mississippi-Rideau) is located in eastern Ontario. It includes the boundaries of Mississippi Valley Conservation and Rideau Valley Conservation Authority (Figure 2).

Mississippi Valley Conservation includes the Mississippi River watershed (3,765 km²), the Carp River subwatershed (303 km²), and an area that drains directly to the Ottawa River named Ottawa MVC (283 km²). The Mississippi River flows over 212 km from Mazinaw Lake to the Ottawa River near Galetta. The main tributaries on the Mississippi River include the Clyde River, Fall River, and Indian River. There are 11 municipalities in the Mississippi Valley and a population of approximately 250,000.

Rideau Valley Conservation Authority includes the Rideau River watershed (3,851 km²) and two subwatersheds that drain directly to the Ottawa River named Ottawa RVCA West (263 km²) and Ottawa RVCA East (120 km²). The Rideau River flows 160 km from Burrige Lake near Newboro to the City of Ottawa where it discharges into the Ottawa River. The main tributaries on the Rideau River include the Tay River, Jock River, and Kemptville Creek. There are 18 municipalities in Rideau Valley and approximately 420,000 people.

The topography in the Mississippi-Rideau generally slopes from west to east with a total relief of approximately 420 m. The shore of the Ottawa River is near 40 metres above sea level.

Land Cover

The majority of the land in the Mississippi-Rideau is not developed. More than 50% of the Mississippi-Rideau is classified as forest and plantations. Agricultural

land represents almost 25% of the Mississippi-Rideau. Water and wetlands cover 16% of the Mississippi-Rideau. Only 2% of the Mississippi-Rideau is developed.

Surface Water

Surface water in the Mississippi-Rideau flows in lakes, river and wetlands. Most of the surface water storage occurs in large reservoir lakes in the upper portion of the Mississippi-Rideau. The lower portion is dominated by large riverine systems with significantly less surface water storage. Flows and levels on many of these surface water systems are controlled by hydraulic structures including dams, lock gates, and generating stations. Drinking water supply from surface water is obtained from the Ottawa River, Mississippi River (Mississippi Lake), Rideau River and Tay River.

Geology

The Mississippi-Rideau can be divided into two geological areas: 1) the western half of the Mississippi Valley, where the Precambrian Canadian Shield is exposed at surface, and 2) the eastern half of the Mississippi-Rideau that is a part of the Central St. Lawrence Lowland basin where the Precambrian Canadian Shield is overlaid by sedimentary bedrock and overburden deposits. The bedrock in the region has extensive faults through the sedimentary bedrock that impact the surface topography and groundwater resources in the Mississippi-Rideau.

With the exception of the northern and eastern areas of the Mississippi-Rideau, bedrock outcrops are frequent throughout the Mississippi-Rideau and the overburden is discontinuous. Where overburden is present the overburden coverage is minimal (<1 m), except for the northern portion of the Mississippi-Rideau where sands and clays reach thicknesses of 30 m.

Groundwater

There are both unconfined and confined aquifers in the Mississippi-Rideau. Unconfined aquifers are shallow aquifers (i.e. a water-table aquifer). Confined aquifers are deeper aquifers that are typically buried beneath a layer of clay, till, or impermeable bedrock; these layers help protect confined aquifers from contamination. The aquifers in the Mississippi-Rideau are comprised of unconsolidated material (i.e. sand and gravel) and bedrock.

Generally, drinking water supply from groundwater is obtained from the following aquifers: 1) the upper, unconfined, portion of the Precambrian is used in the western portion of the Mississippi-Rideau. 2) The unconfined and confined Nepean Formation sandstone and the unconfined March-Oxford dolostone aquifer are used in the central part of the Mississippi-Rideau. 3) The unconfined and confined sand and gravel aquifers as well as other limestone bedrock aquifers are used in the northern and extreme eastern portions of the Mississippi-Rideau.

The groundwater flow direction in the Mississippi-Rideau generally follows the same pattern as topography. The regional groundwater flow direction in the Mississippi-Rideau is from the south-west to north-east. Local groundwater flow directions are influenced by topography and generally flow from higher elevations towards lower lying surface water bodies.

Climate

The climate of the Mississippi-Rideau can be described as humid continental. The Great Lakes cause milder winters and cooler summers. The climate is also affected by the intersection of cold polar air from the north and warm moist air from the United States. Approximately 77% of precipitation in the Mississippi-Rideau is from rainfall and 23% is from snowfall. The driest month is February. The wettest month is September. The greatest amount of snowfall occurs in December.

Step 2 – Collect and Analyze Data

The next step is to collect and analyze data relating to surface water and groundwater in the Mississippi-Rideau region. Data was collected at both the regional and watershed level (Mississippi River and Rideau River). Only existing data and information was collected. No field data collection was performed.

Specifically, data was collected for:

- Precipitation, temperature
- Surface water flow
- Groundwater levels
- Soils, geology, land use
- Water use

Precipitation and Temperature

Long-term, high quality precipitation and temperature data was obtained from the Canadian Forest Service for the time period 1971-2000. Average precipitation is lowest in the central part of the Mississippi Valley at <900 mm per year, and greatest near the eastern edge of the Rideau Valley at >1000 mm per year. Average annual temperature increases from near 4° C in the western tip of the Mississippi-Rideau to 7° C in the southern and eastern areas of Rideau Valley.

Evapotranspiration

Evapotranspiration is the rate at which water evaporates from lakes and rivers or is consumed by plants. Evapotranspiration is not measured, it is calculated. Evapotranspiration was calculated in a GIS on a 25 m x 25 m scale using precipitation, temperature, land cover and soils data. The land cover data was obtained from the Ministry of Natural Resources (1991-1998). The soils data was obtained from Agriculture Canada. The pattern of calculated evapotranspiration was similar to temperature. This was expected because temperature is an important factor affecting evapotranspiration. Evapotranspiration increases from the western edge of the Mississippi Valley to the south and east area in the Rideau Valley.

Surface Water Flow

Surface water flow data for the Mississippi and Rideau Rivers was obtained from the Government of Canada HYDAT database. Surface water flows in the Mississippi-Rideau peak in April due to snowmelt. The lowest flows are observed in July, August and September due to high evapotranspiration.

Groundwater Recharge

Groundwater recharge was calculated using a method developed by Ontario's Ministry of Environment and Energy (MOEE) at a 25 m x 25 m scale. The MOEE method uses precipitation, evapotranspiration, soils, topography and land cover data to calculate groundwater recharge. Groundwater recharge is a complex process that changes with time (snow melt, thawed and frozen soil) as well as by location (clay, bedrock, sand). Therefore, calculated groundwater recharge represents the best possible estimate considering the regional scale of the calculations.

Step 3 – Determine Annual Water Budgets for the Watersheds and Region

Methodology

Water budgets were completed on an annual scale for the Mississippi-Rideau region and individually for the Mississippi and Rideau watersheds. To account for the major hydrological processes, long-term (30 years) hydrologic data was used and 10 different components were analyzed: precipitation, evapotranspiration, groundwater recharge, groundwater discharge, surface water flow in, surface water flow out, anthropogenic takings (e.g. water supply), anthropogenic returns (e.g. waste water return), water diversions and change in storage (e.g. lake levels and groundwater levels). This analysis revealed that the most important processes in the Mississippi-Rideau are **precipitation, evapotranspiration, and surface water flow.**

Results

Table 1 shows the average annual water budgets for the study area(s). The result of the calculations shows that precipitation is the primary way that water enters the watershed region. Evapotranspiration (the combination of evaporation and transpiration) is the primary way that water is removed from the watershed region. Surface water flow out through the Mississippi and Rideau Rivers also removes water from the region.

Since the Mississippi and Rideau watersheds are large neighbouring basins with similar weather and geologic conditions, when averaged over a long-term period they show similar surface water flow (although local conditions will vary). Approximately 60% of the water is removed from each watershed by evapotranspiration, with the remainder leaving by surface water flow in the Mississippi or Rideau rivers.

Table 1 Annual water budget – watershed and regional scale (in millimeters)

| Study Area | Annual Precipitation | Annual Surface Water Flow | Annual Evapotranspiration |
|---|----------------------|---------------------------|---------------------------|
| Mississippi Watershed | 898 | 367 | 555 |
| Rideau Watershed | 926 | 365 | 576 |
| Mississippi-Rideau Region (area-weighted average) | 912 | 366 | 565 |

Anthropogenic water takings included the following uses: domestic (municipal and private), agricultural, commercial and institutional. On average, annual basis, anthropogenic water uses are small compared to the amount of water available in precipitation after losses to evapotranspiration. The effects of water takings,

however, may be more significant on a shorter time scale (e.g. monthly) or on a smaller area (e.g. subwatershed).

Water reserved for in-stream needs (e.g. ecological) is not accounted for until the Tier 1 analysis.

Tier 1 Water Budget and Stress Assessment

Step 1 – Refine the Area and Time Scales

Analysis for the Conceptual Water Budget was completed on an annual basis, at the watershed scale. The Tier I study required that the water budget and stress assessment calculations were completed for smaller areas. Subwatersheds were selected as appropriate areas for this work.

The Mississippi and Rideau watersheds were divided into subwatersheds based on the location of surface water flow gauges (Figure 3). The gauges produce high-quality data that forms the backbone of the water budget and surface water stress assessment calculations. As per the Technical Rules, groundwater stress assessments were carried out at the same spatial scale as the surface water assessments.

The time scale for the Tier 1 calculations was also refined from that used in the Conceptual Water Budget Study. For the Tier I study, calculations were completed on both an annual and monthly scale for each subwatershed, rather than just on an annual scale.

Step 2 – Refine the Data from the Conceptual Water Budget

The data sources for the Tier 1 are the same as those used in the Conceptual Water Budget, and are described above. These data were refined to the subwatershed scale and the monthly scale for use in the Tier 1 analyses. Some data was updated.

Surface water flow data was obtained for the gauges shown in Figure 3. Where flow data was not available (e.g. Ottawa RVCA West) and for gauged subwatersheds with some missing data (e.g. Tay River at Perth), the surface water flows were estimated from gauge data for subwatersheds with similar hydrologic properties.

Step 3 – Determine the Annual and Monthly Subwatershed Water Budgets

For the Tier I study, the annual water budgets completed in the Conceptual Water Budget were refined to the subwatershed scale, and calculated on monthly and annual time scales. As for the Conceptual Water Budget, the most important hydrological processes were determined to be precipitation, evapotranspiration, and surface water flow. To account for data errors and uncertainty, a 'residual term' was also calculated. This is expressed as precipitation minus evapotranspiration minus surface water flow.

Table 2 (below) shows the annual water budgets, as calculated for each subwatershed. Precipitation is the only way that water enters into each subwatershed. Water is removed from each subwatershed primarily by evapotranspiration, and then by surface water flow out.

The residual term is less than 5% of precipitation for each subwatershed, with the exception of Ottawa RVCA West, which was 11%. This higher percentage is due to uncertainty. Because no data was available for surface water flow in the Ottawa RVCA West subwatershed, it had to be estimated.

Table 2 Annual Water Budgets for All Subwatersheds

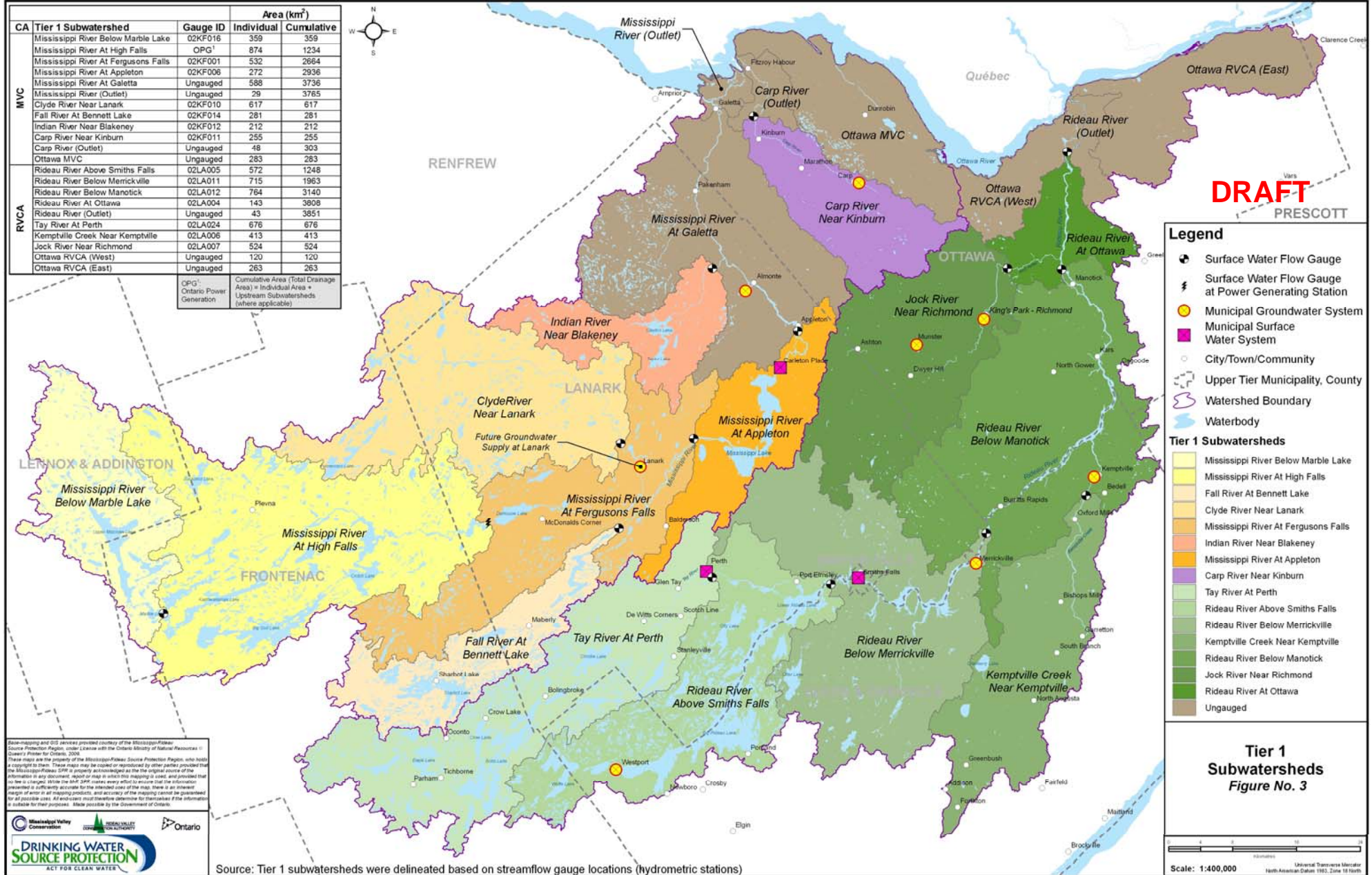
| Subwatershed (from upstream to downstream) | Water Budget Component | | | | |
|---|------------------------|----------------|-----------------|--------------------------------|----------|
| | Gauge ID | P ¹ | ET ² | SW _{OUT} ³ | Residual |
| MISSISSIPPI VALLEY CONSERVATION | | | | | |
| Mississippi River Below Marble Lake | 02KF016 | 919 | 540 | 420 | -41 |
| Mississippi River At High Falls | Generating Station | 925 | 543 | 359 | 23 |
| Clyde River Near Lanark | 02KF010 | 889 | 549 | 357 | -17 |
| Fall River At Bennett Lake | 02KF014/18 | 900 | 561 | 383 | -44 |
| Mississippi River At Fergusons Falls | 02KF001 | 905 | 550 | 375 | -20 |
| Mississippi River At Appleton | 02KF006 | 904 | 552 | 358 | -6 |
| Indian River At Blakeney | 02KF012 | 876 | 560 | 330 | -15 |
| Mississippi River At Galetta | ungauged | 898 | 555 | 331 | 12 |
| Mississippi River (Outlet) | ungauged | 898 | 555 | 331 | 12 |
| Carp River At Kinburn | 02KF011 | 902 | 571 | 326 | 5 |
| Carp River (Outlet) | ungauged | 896 | 571 | 344 | -19 |
| Ottawa MVC | ungauged | 884 | 573 | 344 | -33 |
| RIDEAU VALLEY CONSERVATION AUTHORITY | | | | | |
| Tay River at Perth | 02LA024 | 906 | 567 | 355 | -16 |
| Rideau River Above Smiths Falls | 02LA005 | 909 | 570 | 383 | -44 |
| Rideau River Below Merrickville | 02LA011 | 914 | 574 | 375 | -35 |
| Kemptville Creek At Kemptville | 02LA006 | 949 | 586 | 383 | -20 |
| Rideau River Below Manotick | 02LA012 | 925 | 576 | 368 | -19 |
| Jock River Near Richmond | 02LA007 | 917 | 575 | 386 | -44 |
| Rideau River At Ottawa | 02LA004 | 924 | 576 | 367 | -19 |
| Rideau River (Outlet) | ungauged | 924 | 575 | 367 | -18 |
| Ottawa RVCA (West) | ungauged | 916 | 544 | 477 | -105 |
| Ottawa RVCA (East) | ungauged | 941 | 560 | 409 | -28 |

¹ Precipitation

² Evapotranspiration

³ Surface water out

Figure 3 – Tier I Water Budget Subwatersheds



Step 4 – Calculate the Percent Water Demand for Each Subwatershed

The percent water demand equation is the primary tool used in the Tier 1 to evaluate the level of water quantity stress. As provided in the Technical Rules:

$$\% \text{ Water Demand} = \frac{Q_{\text{Demand}}}{Q_{\text{Supply}} - Q_{\text{Reserve}}} \times 100$$

where,

Q_{Demand} is the anthropogenic water takings that are described below,

Q_{Supply} is the water supply to the surface water system (surface water flow data) or groundwater system (groundwater recharge calculations),

Q_{Reserve} is the water reserve set aside for other uses (e.g. ecological).

Stress assessments were completed for the following time scales:

- Surface water stress assessments were completed on a monthly scale.
- Groundwater stress assessments were completed on monthly and annual scales.

Percent water demand is calculated using current water supply and water demand data. The Technical Rules also require the calculation to be carried out for anticipated conditions 25 years into the future. The difference between current and future water demand was assumed to be due to population growth, since it is difficult to estimate any other future changes in the hydrologic system.

Water Demand (Q_{Demand})

Water demand was calculated based on four data sources:

1. Permits to Take Water –The MOE maintains a database of permits to take water for large water users (>50,000 L/day). Temporary (e.g. short term construction) and permits expired for more than 5 years were not included in the calculations.
2. Municipal Systems - The actual water taking data from each municipal surface water and groundwater system was obtained.
3. Agricultural - Water takings data was obtained from the Census of Agriculture.
4. Private – The number of private wells in each subwatershed was determined using the MOE Water Well Information System. Based on information in the Conceptual Water Budget, each private well was estimate to use 570 L per day.

Consumptive Demand

The approach to consumptive demand as prescribed in the Provincial guidance is for a portion of the surface water or groundwater used by permits to take water, municipal systems, agriculture or private wells to be returned to surface water or groundwater systems. The ratio of water used to water returned for each

type of taking is prescribed by the Guidance. Water not returned to groundwater or surface water systems is 'consumed'; this amount is the consumptive demand.

For example, 20% of water used by households (either by municipal systems or private wells) is consumed, which allows 80% to be returned to groundwater or surface water systems. The consumptive demand was calculated for each water taking, and was used to calculate the total water demand for each subwatershed.

Water Supply and Reserve (Q_{Supply} and $Q_{Reserve}$)

Surface water supply was calculated for each of the subwatersheds as median monthly stream flow. The surface water reserve was calculated as the tenth percentile of stream flow, or the rate of discharge that is exceeded 90% of the time.

Groundwater supply is equal to the groundwater recharge values. Annual groundwater supply was calculated using the MOEE method as described in Step 2 of the Conceptual Water Budget. The annual groundwater supply was divided evenly across the months to produce a constant monthly groundwater recharge rate. The groundwater reserve was calculated as 10% of the groundwater supply for annual and monthly time scales, as outlined by the Guidance.

Step 5 – Assign a Stress Level to Each Subwatershed

The Technical Rules require a stress level to be assigned to each subwatershed for both surface water and groundwater quantity. Subwatersheds that contain municipal drinking water systems and have MODERATE or SIGNIFICANT water quantity stresses for surface water or groundwater must move on to Tier 2 analysis.

There are five municipal drinking water systems in the Mississippi-Rideau that draw from surface water. Of the five systems, two (Britannia and Lemieux) draw from the Ottawa River. The Technical Rules mandate that water systems that obtain water from the Ottawa River must not be considered in the Tier 1 study.

The three remaining surface water systems are Carleton Place (Mississippi River), Perth (Tay River) and Smiths Falls (Rideau River) (Figure 3).

There are seven subwatersheds that contain municipal groundwater systems (Figure 3). The Carp municipal water system draws groundwater from a shallow sand and gravel aquifer that is partially confined by surficial clay. Six systems (Almonte, Kings Park, Munster, Merrickville, Kemptville, and Westport) draw water primarily from the deep Nepean sandstone aquifer and to a lesser degree from the shallow Oxford-March aquifer. The Village of Lanark proposed groundwater system was also included in the Tier 1 analyses, using anticipated water takings in the future demand calculations.

The percent water demand calculations for surface water were calculated on a monthly basis for each subwatershed. For groundwater, they were calculated both a monthly and annual basis for each subwatershed. The same calculations were performed for the current and future demand scenario. The calculated results for groundwater and surface water were compared to the table below to assign a water quantity stress level. The stress levels are mandated by the Technical Rules.

| Water Quantity Stress Level | SURFACE WATER Monthly % Demand | GROUNDWATER | |
|-----------------------------|--------------------------------|------------------|-----------------|
| | | Monthly % Demand | Annual % Demand |
| Significant | >50% | >50% | >25% |
| Moderate | 20% - 50% | >25% | >10% |
| Low | <20% | 0 – 25% | 0 – 10% |

Table 3 Provincial Criteria for Subwatershed Stress Levels

The results for the groundwater and surface water stress assessments are combined in Figure 4. Three subwatersheds showed a **surface water stress** of MODERATE for current and future scenarios. The stressed surface water subwatersheds include Fall River at Bennett Lake, Carp River near Kinburn, and Ottawa MVC. These subwatersheds do not contain a municipal surface water drinking system; therefore, they are not required to move on to Tier 2 analyses.

The surface water percent water demand for the Mississippi River At Galetta subwatershed originally resulted in a SIGNIFICANT stress however this was reduced to LOW after receiving new direction from the Province regarding the amount of water actually consumed by power generating stations – a major factor in that subwatershed.

Only one subwatershed, Rideau River at Ottawa, showed a **groundwater stress**. It was assigned a MODERATE stress for both the current and future scenarios. Since this subwatershed does not contain a municipal drinking water system, however, it is not required to move on to Tier 2 analyses.

Historical Performance of Municipal Systems

According to the Technical Rules, a surface water intake or groundwater well that has reported either of the following criteria since January 1, 1990, must be assigned, as a minimum, a MODERATE stress level:

Surface Water Intakes:

- I. any part of a surface water intake was not below the water's surface during normal operation of the intake; or
- II. the operation of a surface water intake pump was terminated because of an insufficient quantity of water being supplied to the intake.

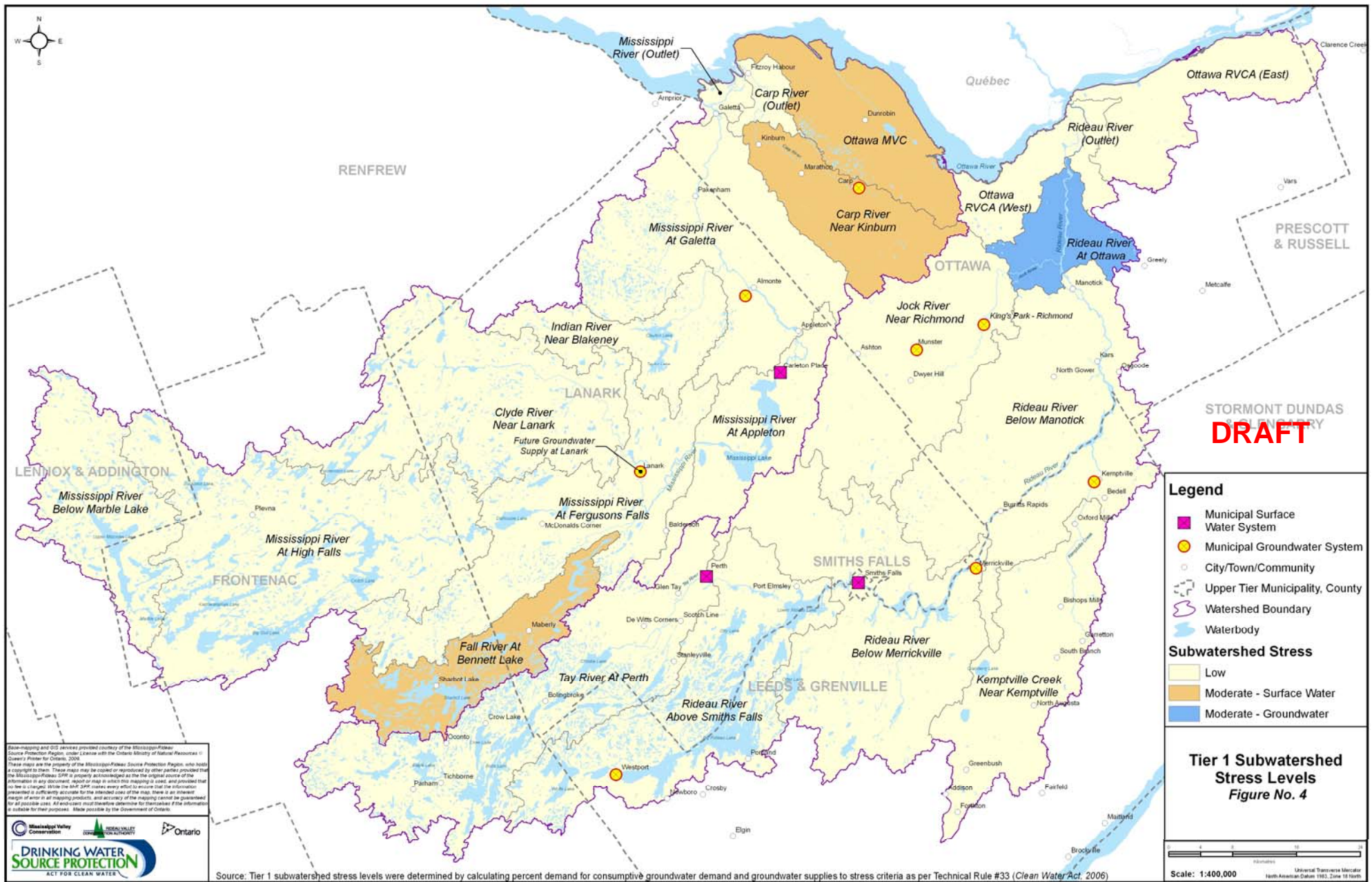
Groundwater Wells:

- I. (i) the groundwater level in the vicinity of the well was not at a level sufficient for the normal operation of the well; or
- II. (ii) the operation of a well pump was terminated because of an insufficient quantity of water being supplied to the well.

The above Tier 1 stress assessment step is done in addition to the percent water demand calculations. It is intended as an independent verification that the percent demand calculations at the subwatershed scale are consistent with

observations at municipal systems. When surveyed during the Tier 1 study, no municipality with a surface water or groundwater system reported either of the criteria listed above. Therefore, no additional stress assignments were required.

Figure 4 – Tier I Subwatershed Stress Levels



DRAFT for Public Review – September 16, 2009

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