Peace River Hydrobiological Monitoring Program
2016 HBMP Comprehensive Report

Required by
Southwest Florida Water Management District
Water Use Permit 20010420.008

Prepared for
Peace River Regional Water Supply Facility
Peace River Manasota Regional Water Supply Authority

PeACE RIver MANASOTA

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All of the extensive HBMP analyses completed to date have indicated that neither measured nor modeled changes resulting from Facility withdrawals have been of sufficient magnitude (relative to the far greater natural degree of variation in freshwater inflows) to have affected the long-term physical, chemical or biological characteristics of the lower Peace River/upper Charlotte Harbor estuarine system. Historically, the estimated changes due to Facility withdrawals have been such that they would have been difficult to physically measure given the far greater magnitudes of daily, seasonal and annual naturally occurring variation. The Facility, however, has undergone two major recent expansions (in 2002 and 2009), which substantially increased its ability to withdraw, store, and treat water from the river. In 2010 the District completed a review and adopted a final MFL for the lower Peace River, and the Authority’s withdrawal schedule was subsequently modified in 2011. This permit modification seasonally increased the maximum allowed withdrawal percentages, and when combined with the recent expanded Facility has increased the Facility’s overall reliability to meet public demand.

The results of statistical models presented in this report estimate increases in salinity changes and the movement of isohaline locations resulting from increased Facility withdrawals. However, these estimated changes due to actual Facility withdrawals continue to remain small in comparison to the relatively far greater magnitude of typical natural daily, seasonal and annual variations. The Facility’s modified withdrawal schedule by design directs the largest volumes of diverted river water to occur during the summer wet season, when salinities and isohaline locations are naturally experiencing greater temporal and spatial variation in response to increasing freshwater inflows and when expected impacts to the downstream estuary from greater withdrawals would be less.

The 2016 HBMP Comprehensive Summary Report follows and extends the summarization and interpretation of long-term HBMP data from previous Summary Reports. The report’s primary goals are to provide the District with sufficient analyses to:

- Assess the presence or absence of long-term trends for important HBMP variables;
- Evaluate key relationships between ecological characteristics and freshwater inflows, and determine whether the biological health and productivity of the estuary are showing signs of stress related to natural periods of low freshwater inflow or potential negative influences of Facility withdrawals;
- Assess the presence or absence of adverse ecological impacts and determine the influence Facility withdrawals may have contributed to such impacts;
- Assess the effectiveness of the withdrawal schedule for preventing adverse environmental impacts;
- Provide the District with sufficient analyses of the HBMP data to date to assure that the withdrawal schedule continues to provide adequate resource protection; and
• Evaluate the overall HBMP design and make recommendations regarding implementing modifications.

Chapter 1 - Introduction and HBMP monitoring program overview

This introductory chapter provides an overview for readers unfamiliar with the history of the Peace River Regional Water Supply Facility and the District’s associated series of issued Water Use Permits. The introduction reviews the history of the Facility and its permits, as well as the history of the major study elements that have been associated with the forty-one year record of the ongoing HBMP. An extensive HBMP was initially established in 1975, five years prior to completion of construction and actual Peace River Facility withdrawals, to assess the potential for harmful effects of freshwater withdrawals on the estuarine communities of the lower Peace River/upper Charlotte Harbor estuarine system. A number of statistical modeling efforts have been undertaken in conjunction with continuing efforts to refine the HBMP’s ability to quantitatively predict the magnitude of potential Facility withdrawal impacts on both the lower river’s salinity structure and movement of the freshwater/saltwater interface. The detected and estimated changes in salinity and/or spatial locations of isohalines resulting from Facility freshwater withdrawals have not resulted in pronounced or systematic changes in the salinity structure, water quality, or biological integrity of the estuarine communities of the lower Peace River/upper Charlotte Harbor estuarine system.

The HBMP has incorporated a wide variety of study elements since its initial inception. The HBMP was not conceived to be a rigid monitoring program, but rather a flexible study design that could be periodically restructured based on updated findings and identified research needs. When the first discussion began in 1975 of what might be included within such an effort, very little was known about either salinity/flow relationships, or the spatial/temporal distributions of other physical/chemical water quality parameters in the lower Peace River/upper Charlotte Harbor Estuary. Even less was known about the biological communities that studies in other estuarine systems had indicated could potentially be negatively affected by freshwater diversions. As a result, much of the effort under the initial HBMP study design was directed toward developing sufficient data to statistically describe the spatial distribution and seasonal variability of physical and chemical indicators within this estuarine system, and to determine potential relationships with naturally occurring variation in freshwater inflows. Such HBMP investigations included the collection of monthly in situ water column profile characteristics, and surface and near-bottom water chemistry at a wide variety of sites located throughout the estuary.

In addition, initial attempts were begun to determine if key indicator species or biological communities could be identified to assess responses to natural variations in freshwater inflows. Determining the presence of such long-term relationships was thought to be especially important because, with only a small percentage of total flow being diverted, the direct effects of withdrawals were projected to be extremely small in comparison to natural variation. These HBMP elements included: 1) the initial long-term study of the seasonal pattern of juvenile fishes in the upper harbor; 2) studies of benthic indicator species; 3) the investigation of the seasonal distribution of sea stars in the harbor and lower river; and 4) the vegetation study of first and last occurrence of selected plant taxa along the lower Peace River.
In the 1980s, studies of phytoplankton and zooplankton community structure and production were added to the HBMP. These studies were again not intended to directly evaluate the influences of withdrawals, but rather were designed to address issues related to the “health of the estuary” and the influences of naturally occurring extended periods of drought and flood conditions. Two short-term HBMP program elements, the benthic invertebrate study by Mote Marine Laboratory and the fish nursery investigation by USF, were also not designed to directly measure the influences of withdrawals, but rather were designed to investigate the response of biological communities to natural variations in freshwater inflows.

Based on previous Summary HBMP Reports and additional analyses requested by District staff during the permit renewal process, an expanded HBMP was approved by the District in March 1996 as part of the Facility’s 1996 Water Use Permit renewal. Modifications have been made to the HBMP throughout its history, and study elements have been added and deleted in order to enhance the overall knowledge base of the lower Peace River/upper Charlotte Harbor estuarine system. Major monitoring elements, such as water quality, aimed at assessing direct relationships with variations in freshwater inflow have had the longest histories. Other program elements, primarily those focused on assessing indirect biological indicators, have extended over a number of years and then ended once a sufficient baseline level of information had been accumulated. Chapter 1 describes the current and previous HBMP study elements.

Chapter 2.0 - Summaries of recent relevant reports

This chapter provides brief overviews of each of the major studies and reports related to the Peace River watershed, lower Peace River and upper Charlotte Harbor that have been released since those previously summarized in the 2002, 2006 and 2011 Peace River Comprehensive Summary Reports. The primary focus of this chapter is to provide concise overviews of the purpose and major conclusions of each of the reviewed studies.

Chapter 3.0 - Status and trends in regional rainfall, flows, and facility withdrawals

The purpose of this chapter is to provide updated graphical and statistical analyses of rainfall and flows over multiple time scales. Recent and historical unusual occurrences (extended droughts and/or unusually wet intervals) are documented and compared to the long-term average statistical characteristics at each of the major tributary gaging locations in the Peace River watershed. When the long-term rainfall data for the Peace River watershed are analyzed as annual totals, the results clearly show both increased variations among the gages and greater indications of both historical wetter and drier intervals. Total annual average Peace River watershed rainfall levels were slightly higher from 1930 to the early 1960s when compared with the period since then.

Annual average wet-season (June-September) rainfall in the Peace River watershed was generally higher during the 1930s through the mid-1960s when compared with the interval from the late 1960s through the early 1990s. Since approximately 1994, there has been a notable increase in wet-season rainfall, contrasted with marked declines in dry-season rainfall throughout the Peace River watershed.
Base flows in the upper portions of the watershed have shown marked declines that can be directly linked to ground water withdrawals and historic reductions in ground water levels and spring flows. Conversely, in a number of the southern Peace River watershed subbasins, base flows in Peace River tributaries have been distinctly augmented by agricultural discharges.

Comparisons indicate that, other than during the warm/dry spring months when the Facility is often not withdrawing water from the Peace River due to the 130 cfs low flow threshold, Facility withdrawals had historically been fairly uniform throughout most of the year, differing primarily between changes in the permits and differences in Facility capacities. Following the 2002 and 2009 major expansions, the annual pattern of withdrawals has begun to more closely follow a seasonal cycle that follows the natural variability in flow. Low river flows have often resulted in extended periods when the Facility is unable to withdraw water from the river. During both the extended droughts of 1999-2001 and 2006-2011 intervals, the Facility did not withdraw water from the lower Peace River for up to 200 days or more, and had to rely solely on stored reserves to meet regional demands. Comparisons of the annual average hydrographs of total gaged flows upstream of the Facility with and without withdrawals indicate very small seasonal differences regardless of the time period tested. The magnitude of these differences is especially small given the fairly large degree of natural variability in flow inherent both among years and over longer decadal periods.

**Chapter 4.0 - Salinity in the lower Peace River/upper Charlotte Harbor estuarine system**

This chapter provides overview and analyses of the spatial and temporal patterns and trends in salinity in the lower Peace River/upper Charlotte Harbor estuarine system over the 1976-2016 interval of HBMP monitoring. The relationship between freshwater flows and salinity is examined and statistical salinity models are developed for multiple locations along the HBMP monitoring transect. These models are then used to assess the potential influence of withdrawals on the Lower Peace River/Upper Charlotte Harbor estuarine system.

A strong, distinct spatial salinity gradient exists along the lower Peace River monitoring transect with salinity levels much higher in the vicinity of the river mouth and typically near freshwater levels just upstream of the Facility. The greatest inter-annual variability in salinity generally occurs in the surface waters at the most downstream monitoring sites where seasonal differences may reach 35 psu between extended periods of low and high freshwater inflow. However, even bottom salinity levels in the area of the US 41 Bridge (RK 6.6) exhibit similar large inter-annual variation. Statistical trend tests indicated statistically significant progressive increasing upstream movements in the relative spatial distributions of isohaline locations along the HBMP monitoring transect. Periods of extended drought since 1999, affecting rainfalls and river flows throughout southwest Florida, as well as small changes in sea level that have occurred over the monitoring period, may be reflected in these changes.

The relative locations of each of the four HBMP isohalines along the monitoring transect show strong inverse relationships with freshwater inflows. The graphical and statistical analyses indicate that the relative spatial locations of each of the isohalines initially move rapidly downstream with increasing flows. However, over higher ranges of flows the relative slope of
change becomes less as do the relationships between flow and isohaline location along the monitoring transect. The observed relationships are confounded due to the importance of both short and long-term preceding conditions, as well as the often increasing physical stratification of the water column under conditions of higher flows.

There is a distinct inverse relationship between measured surface salinities and increases in gaged flow up to 3000 cfs at the most downstream fixed sampling site, located near the river's mouth. However, similar relationships increasingly break down further upstream with increasing flows as surface salinities along the HBMP lower river monitoring transect change from being tidally brackish to always being characteristically freshwater under conditions of increasing freshwater flows. Bottom salinities at the two most downstream monitoring sites show relationships with flows up to about 1000 cfs after which the water column becomes highly stratified and influences of further increases are highly reduced. Moving further upstream both surface and bottom salinities show similar relationships with increasing flows.

A series of site-specific empirical models were developed using average hourly surface conductivity, stage, and gaged freshwater inflow data gathered during the periods-of-record for selected continuous recording locations. Overall, comparative plots of observed salinities with those estimated by the empirical models indicate that the models slightly over-estimate salinities at low observed salinity levels and correspondingly somewhat under-estimate at higher observed salinity levels. However, over the typical range of salinities observed at each of the recorder sites, the models provide a relatively good fit between observed and estimated values. The models provide a fairly simple and straightforward method to analyze and estimate the potential range and magnitude of potential salinity impacts of withdrawals along the lower river downstream of the Facility over the wide range of observed natural temporal and spatial fluctuations due to the combined influences of variations in upstream flows, tides and seasonal wind patterns.

The empirical models developed for surface salinities for the selected recorder locations were used to estimate salinities over the period 1998 through 2016 under two modeling alternatives: "No Withdrawal" Scenario and "Actual Withdrawal" Scenario. Additionally, empirical models were developed to estimate the relative spatial location of each of the four monthly monitored HBMP isohaline locations along the HBMP monitoring transect using methodology similar to that used to estimate salinity at the continuous recorder sites. The results emphasize the very high degrees of long-term, annual, seasonal, and daily salinity variability naturally occurring temporally and spatially along the lower river. These differences are especially notable when comparing wetter intervals with extended periods characterized by lower flows. The modeled results indicate that salinity changes (and movements of the isohalines) due to Facility withdrawals have increased since the most recent expansion and change in the withdrawal schedule. These increases remain relatively small when compared to the range of naturally occurring daily, seasonal and longer term flow/tide related variation along the lower Peace River. The results further indicate that, by design, the largest increases in salinity resulting from the withdrawal schedule are focused into wetter periods, and occur in regions of the lower river that naturally experience relatively large salinity fluctuations. The components of the withdrawal schedule thus effectively reduce the relative potential influences of Facility withdrawals.
Prior reports (PBS&J 2007, Atkins 2013) have identified anthropogenically related trends of increasing specific conductance within a number of the major upstream watershed tributaries to the lower Peace River. The observed changes in the lower portions of the Peace River watershed over recent decades have been primarily associated with increasing land conversions from less to more intense forms of agriculture, which increasingly relies on irrigation using higher conductivity ground water pumped from the upper Floridan aquifer. Additional increases may have occurred as a result of mining activities in the watershed. This chapter presents updates of earlier evaluations of patterns and historical trends in specific conductance and associated water quality characteristics measured at the Peace River at Arcadia gage, both the upstream Joshua and Horse Creek tributaries, and at the fixed HBMP long-term monitoring site located at River Kilometer (RK) 30.7 located immediately upstream of the Peace River Facility’s intake. These updated analyses indicate qualitatively that increased specific conductance (and related parameters) are still evident at the sites evaluated upstream of the Facility.

**Chapter 5.0 - Patterns and trends of hydrobiological water quality indicators in the lower Peace River/upper Charlotte Harbor estuarine system**

This chapter provides overviews and analyses relative to both the patterns and trends of key lower Peace River/upper Charlotte Harbor estuarine system water quality characteristics (other than salinity/specific conductance) over the 1976-2016 interval of HBMP monitoring. Additionally, the chapter evaluates the effects of flow on the identified water quality parameters. It is important to note that concentrations of water quality constituents (such as nutrients) are not affected by freshwater withdrawals. However, the loads of such constituents decrease with increasing freshwater withdrawals. Other factors, such as changes in land use patterns, are also likely to affect changes in water quality. Analyses of period of record HBMP data have illustrated key findings relevant to water quality parameters, other than salinity, in the lower Peace River/upper Charlotte Harbor, and these are summarized below.

Dissolved oxygen levels in the lower Peace River estuarine system show distinct seasonal patterns, with the lowest levels typically occurring during the summer wet-season. Measured levels are generally higher during cooler months, due to lower water temperatures (that increase the ability of the water to hold more dissolved gases) and seasonally increasing wind stress and mixing. Surface dissolved oxygen concentrations along the monitoring transect initially increase slightly under increasing low to moderate levels of flow. However, above some level, further increases in flow tend to progressively depress ambient surface dissolved oxygen levels at each of the fixed locations along the HBMP monitoring transect. The relationship between surface dissolved oxygen concentrations and flow is confounded by the combined influences of seasonal changes in water temperature and salinity. Bottom dissolved oxygen levels at the more downstream sites decline with increasing flow in response to progressive density stratification of the water column. At the more upstream locations, the responses of both surface and bottom dissolved oxygen concentrations are similar to increasing seasonal flows.

Phytoplankton levels (as measured by chlorophyll a) in the Peace River and Charlotte Harbor during periods of low to moderate freshwater flow are limited by the availability of inorganic nitrogen. However, as flows increase, water color levels correspondingly increase and phytoplankton production becomes increasingly limited by the ability of light to penetrate the
water column. Spatially, the highest chlorophyll a levels occur within the two intermediate salinity zones. The statistical trend procedures suggest chlorophyll a phytoplankton levels increased within the 20 psu isohaline over the examined time interval. Higher chlorophyll a levels are a reflection of the corresponding observed significant higher color levels (that can serve as a proxy for nutrient loadings), and summer wet-season flows that have, on average, characterized portions of proposed warmer AMO phase since 1995.

Ambient inorganic nitrogen concentrations are typically at or near detection limits in the highest salinity reaches of the estuary throughout most of the spring and summer when light levels are high and phytoplankton production is greatest. Concentrations are conversely greater during the fall and winter months. Overall, ambient inorganic nitrogen levels progressively increase moving upstream from high to low salinities. The relationships between dissolved inorganic nitrogen concentration and rates of freshwater inflow are complex. As flows gradually increase following the typical spring dry-season, increasing nitrogen loadings stimulate estuarine phytoplankton production and ambient inorganic nitrogen levels often remain near or at detection limits throughout much of the lower Peace River estuarine system. However, as flows increase further, upstream phytoplankton primary production become color-, rather than nitrogen-, limited and inorganic nitrogen levels rapidly rise with increasing flows. A third condition then occurs at the upstream HBMP sampling locations as both water color and nutrient levels start to decline with further increases in flow. Such changes again reflect seasonal changes in the water quality characteristic of sheet flow to the watershed’s major tributaries following longer (and/or higher) amounts of rainfall.

Like inorganic nitrogen, total Kjeldahl nitrogen (TKN) shows distinct seasonal and spatial patterns along the HBMP monitoring transect. Concentrations are typically lower in the more saline waters of the downstream stations, and are also more elevated during the summer wet-season than during the dry-season. The applied statistical trend procedures did not indicate that TKN levels have systematically increased or decreased over the monitoring interval. Large degrees of variation often occur at a given flow depending on the history of flows over both the immediate and longer-term preceding periods. TKN concentrations within the lower Peace River/upper Charlotte Harbor Estuary generally show spatial increases moving upstream, as well as increasing levels under higher freshwater inflows. Several stations exhibited statistically significant, positive correlations of TKN with 7-day average flow.

The lower Peace River/upper Charlotte Harbor estuarine system is naturally high in phosphorus due to the extensive natural phosphate deposits in a number of the major upstream watershed basins. However, a longitudinal gradient, with lower values in more saline waters is observed in the HBMP data. Measured phosphorus levels in the estuary have declined by as much as an order of magnitude since the early 1980s due to changes in upstream mining practices. Phosphorus concentrations generally reflect both the spatial and temporal variation in Peace River freshwater inputs. The highest phosphorus concentrations are typically associated with seasonal lower river flow, when the influences of ground water are more pronounced. Large degrees of variation often occur at a given flow depending on the history of flows over both the immediate and longer-term preceding periods. Concentrations progressively increase upstream towards the freshwater source, and initially rise in response to higher levels of freshwater inflow. However, as freshwater flows increase further and surface water runoff begins to provide an ever greater
percentage of total river flow, the actual concentration of ortho-phosphorus (which is usually more than ninety percent total phosphorus) declines.

Silica concentrations exhibit a longitudinal gradient in the lower Peace River, with typically higher levels farther upstream than near the mouth of the river. Seasonally, as freshwater inflows become greater, ambient reactive silica concentrations are shown to both increase and move further downstream into the upper Harbor. Ambient concentrations initially rapidly rise throughout the lower river/upper harbor estuarine system as freshwater inflows increase. Following this marked initial rise however, silica concentrations then remain relatively similar as flows further increase. Silica concentrations have and continue to dramatically increase along the entire length of the lower Peace River monitoring transect. As with the observed increase in phosphorus levels, upstream data collected by the Authority showed very high silica concentrations in discharge waters associated with the Ft. Meade phosphogypsum stack system closure in the Whidden Creek subbasin. However, while phosphorus levels in the lower river/upper harbor appear to have again declined to more normal levels, silica levels continue to remain high.

Water color exhibits a longitudinal gradient in the lower Peace River, with typically higher levels farther upstream than near the mouth of the river. However, very high water levels can extend well into the harbor during extended periods of high flows such as was observed following Hurricane Charlie. Under low Peace River flows, much of the water coming from the watershed originates from sources having low color levels, such as surficial base flows and discharges of deeper aquifer waters associated with agricultural pumping. As flows increase, typical southwest Florida “blackwater” river inflows are a major influence on the lower Peace River/upper Charlotte Harbor estuarine system. Levels of water color at the downstream fixed monitoring sites show steady increases in color levels under ever higher rates of freshwater inflow. Although a number of extensive droughts have characterized much of the more recent historical period, the data also suggest a number of wetter than usual summer wet-seasons have also occurred. The applied statistical trend test procedures indicate that these increases in wet-season flows have resulted in statistically significant increases in average annual ambient water color within estuary.

Chapter 6.0 - Regulatory influences on water withdrawals from the lower Peace River

This chapter provides a summary of the history of the Lower Peace River Minimum Flow and Level (MFL), its relevancy to Authority operations, and its current status. Additionally, the chapter provides a summary of the history of the Facility and the Authority’s water use permit. Finally, the chapter identifies water quality impairments in the Peace River watershed and any associated management responses to such impairments.

The capability of the Peace River Manasota Regional Water Supply Authority to withdraw and utilize water from the Lower Peace River is controlled by many factors. Primarily, the limits of its capabilities are controlled by the water use permit granted by the District to the Authority. However, such limits in the water use permit are made in accordance with Minimum Flows and Levels also established by the District. A revised withdrawal schedule based on the District’s
adopted MFL was issued by the District to the Authority on April 26, 2011, and was implemented the following day. While the District’s adopted MFL allows seasonal maximum withdrawals of 16% (Block 1), 29% (Block 2) and 38% (Block 3), the Authority requested and received maximum withdrawals of 16% (Block 1) and 28% (Blocks 2 and 3) in the permitted diversion schedule. Daily Facility withdrawals had previously been based on the preceding daily average flow measured at only the USGS Arcadia gage. The new District permitted withdrawal schedule instead utilizes the previous days’ combined flow based on the readings from three gages upstream of the Facility located on the Peace River at Arcadia (USGS 02297310), Horse Creek (USGS 02297310), and Joshua Creek (USGS 02297100). The low flow cutoff for Facility withdrawals is 130 cfs as measured as the combined flow of the three upstream gages.

**April 2011 Revised Authority Lower Peace River Withdrawal Schedule**
(based on combined USGS gaged flow at three upstream gages)

<table>
<thead>
<tr>
<th>Block</th>
<th>Allowable Percent Reduction in Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1 (April 20th – June 25th)</td>
<td>16% if flow is above 130 cfs</td>
</tr>
<tr>
<td>Block 2 (October 27th – April 19th)</td>
<td>16% if flow is &gt; 130 cfs  26% if flow &gt; 625 cfs</td>
</tr>
<tr>
<td>Block 3 (June 26th – October 26th)</td>
<td>16% if flow is &gt; 130 cfs  28% if flow &gt; 625 cfs</td>
</tr>
</tbody>
</table>

In addition to MFL and water use permit allowance, the ability of the Authority to withdraw and treat water from the Lower Peace River can be affected by the temporary changes in quality of the water in the vicinity of the withdrawal point, availability of off-stream storage capacity and routine maintenance.

**Chapter 7.0 - Water demand and supply**

This chapter provides a synopsis of demand (historical and projected) in the region receiving water from the Peace River, and the related withdrawals from the Peace River. Additionally, this chapter includes a summary of major Facility expansions and capabilities, as well as the Authority’s Master Water Supply Plan and identified alternative sources.

In order to meet future projected increases in regional demands, the Peace River Facility has undergone several expansions to enhance its potential ability to meet those projected future needs. These include 6.625 billion gallon off-stream surface reservoirs, as well as a system of 21 aquifer storage/recovery (ASR) wells.

Total supply capacity available from the Authority and its five Customers (Charlotte, DeSoto, Manatee and Sarasota, Counties and the City of North Port) is 102 mgd. This capacity is expected to increase to nearly 107 mgd in 2024 with the development of two wellfields in Manatee County and the City of North Port (Atkins et al 2015). The Authority supplies a significant portion of this capacity. While currently supply exceeds demand, regional water demand is projected to grow resulting in a need for new supply development. The 2015 Regional Water Supply Plan (Atkins et al 2015) projects that an additional 25 mgd of average annual permitted finished water capacity will need to be developed by the Authority and/or its Customers within the region by 2035. Multiple potential sources of supply were evaluated in the
2015 Regional Water Supply Plan and include brackish wellfields, Peace River Facility surface water system expansion, and Cow Pen Slough surface water facility and expansion.

Chapter 8.0 - Assessing environmental change

This chapter directs the reader to prior Comprehensive Summary Reports that have detailed the regulatory basis of review, the rationale for defining significant environmental change, and the hierarchy of management actions proposed under the HBMP to be implemented in response to detected changes that could forewarn of potential future adverse environmental impacts of sufficient magnitude that they would constitute an “adverse change”. Such management actions include data QA/QC audits, comparison of data correlates, redirected sampling efforts, District Governing Board hearings, and remediation. Additionally, the District may, at its discretion, convene a meeting of the HBMP Scientific Review Panel to evaluate detected changes or determine the appropriate regulatory course of action.

Chapter 9.0 - Monitoring program design and modifications to the existing long-term HBMP elements

Based on the overall findings and conclusions presented in this report, the final chapter extends the discussions in previous Summary Reports relative to the potential need for future changes to existing HBMP study elements. The combined elements of the program’s design need to meet the specific expectations and objectives set forth in the permit as well as provide sufficient long-term information on which to base the development of answers to potential future questions that might be expected to arise. In order to effectively meet these goals and objectives, the integrated design of HBMP elements should incorporate the following criteria.

- The program needs to identify appropriate physical and biological indicators, and specific mechanisms of action, potentially subject to significant changes resulting from permitted freshwater withdrawals from the lower Peace River/upper Charlotte Harbor estuarine system.

- The program should determine and predominantly focus its efforts in those geographical regions of the lower river where naturally occurring and Facility induced changes in river flow would be expected to result in the greatest potential for observed changes in identified key estuarine characteristics.

- The design of the HBMP monitoring element should include sufficient spatial and temporal intensity to assure detection of measurable changes in selected physical/chemical/biological parameters resulting from changes in freshwater inflows.

It is important that each HBMP study element, as well as the overall program, have specific clearly stated goals and objectives to effectively meet the design criteria needed to accomplish the monitoring program’s multiple expectations. These goals and objectives need to clearly establish the scientific basis needed to provide sufficient information to meet the District’s criteria for required reasonable assurance, as well as provide meaningful information to both the public and the members of the HBMP Scientific Review Panel. The HBMP design elements
further need to be sufficiently flexible to allow incorporation of modifications when and where changes in conditions, or new gathered information, suggest the need for specific monitoring program changes.

The HBMP monitoring design needs to be primarily focused on identifying and incorporating those critical indicators known to exhibit marked direct responses to variations in freshwater inflow, since it is these parameter measurements that present the greatest probability of both detecting and assessing the principle underlying causative factor(s) to observed environmental changes.

Since the initiation of HBMP monitoring in 1976, the program has incorporated a number of differing physical, chemical, and biological study elements. Modifications have been made to the elements of the HBMP throughout its history. Historically, those major monitoring elements aimed at assessing direct relationships with variations in freshwater inflow have had the longest histories. Other program elements, primarily those focused on assessing indirect biological indicators, have extended over a number of years and then ended once a sufficient baseline basis of information had been accumulated.

Results from both the “fixed” and “moving” HBMP study elements have indicated the presence of a distinct, seasonally-variable chlorophyll a maxima along the lower Peace River/upper Charlotte Harbor monitoring transect. Inclusion of a new HBMP study element employing in situ fluorometric methodology to measure chlorophyll a was expected to provide the fine-grained spatial information needed to accurately define on a monthly basis both the magnitude and spatial extent of variations in chlorophyll a patterns within the lower Peace River/upper Charlotte Harbor Estuaries. Accurate spatial determinations of the relative intensity and location of monthly chlorophyll a maxima patterns would provide additional information regarding the known seasonal interactions between changes in freshwater flow (relative to additions of both nutrients and color) and the seasonal movement of important estuarine zones of primary (and secondary) production. Based on previous discussions and Scientific Review Panel recommendations, such a monitoring element was added to the HBMP during 2013. Now that several years of data have been collected, it is recommended that an analysis of the utility of this HBMP study element, and recommendations for its future continuance, be made. Should the assessment indicate this HBMP element be continued, then continued assessment and reporting should be done at specific intervals as part of future major summary monitoring program reports.