Exelon.
Generation

NP-10-0010
June 24, 2010

10 CFR 52, Subpart A

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Exelon Nuclear Texas Holdings, LLC
Victoria County Station
Early Site Permit Application
Environmental Report Revisions to Incorporate Additional Supporting Information
Docket No. 52-042

References: (1) Exelon Nuclear Texas Holdings, LLC letter to USNRC, Application for Early Site Permit for Victoria County Station, dated March 25, 2010

Exelon Nuclear Texas Holdings, LLC (Exelon) submitted an application for an early site permit (ESP) in Reference 1 for the Victoria County Station (VCS) site. That submittal consisted of six parts as described in the referenced letter.

In May 2010, Exelon completed an approximately year-long bio-statistical study evaluating the potential effects of proposed VCS water withdrawals from the Guadalupe River on the ecological health of the San Antonio Bay system. Exelon also reviewed additional information regarding the abnormal mortality reportedly experienced by the Aransas-Wood Buffalo population of whooping cranes during the 2008-2009 overwintering period at the Aransas National Wildlife Refuge.

Exelon is providing markups of three Environmental Report (ER) sections to reflect incorporation of the additional information described above into the ESPA. Specifically, ER Sections 5.2 and 5.11 have been revised to reflect the results of the VCS bio-statistical study, and ER Sections 2.4 and 5.11 have been revised to include additional information regarding the Aransas-Wood Buffalo population of whooping cranes.

The ER revisions indicated in Enclosure 1 will be included in the next periodic ESPA update. Regulatory commitments established in this submittal are identified in Enclosure 2.

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If additional information is needed, please contact Joshua Trembley at (610) 765-5345 or David Distel at (610) 765-5517.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 24th day of June, 2010.

Respectfully,

Marilyn C. Kray

Marilyn C. Kray
Vice President, Nuclear Project Development

Enclosure: (1) Markup Pages of Victoria County Station ESPA
(2) Summary of Regulatory Commitments

cc: USNRC, Director, Office of New Reactors/NRLPO (w/enclosures)
USNRC, Project Manager, VCS, Division of New Reactor Licensing (w/enclosures)
USNRC, Environmental Project Manager, VCS, Division of New Reactor Licensing (w/enclosures)
USNRC, Region IV, Regional Administrator (w/enclosures)

ENCLOSURE 1

MARKUP PAGES OF VICTORIA COUNTY STATION ESPA

(Exelon Letter to USNRC No. NP-10-0010, dated June 24, 2010)

The attached markup represents Exelon's good faith effort to show how the ESPA will be revised in a future ESPA submittal in response to the additional information described above. However, the same ESPA content may be impacted by revisions to the ESPA, responses to ESPA RAIs, other ESPA changes, editorial or typographical corrections, etc. As a result, the final ESPA content that appears in a future submittal may be somewhat different than as presented herein.

<u>ER Section 2.4 Pages</u>

2.4-11 to 2.4-13
2.4-43
2.4-45

<u>ER Section 5.2 Pages</u>

5.2-10 to 5.2-11
5.2-13 to 5.2-22
5.2-28
5.2-34 to 5.2-35

<u>ER Section 5.11 Pages</u>

5.11-5 to 5.11-8
5.11-10 to 5.11-13
5.11-18 to 5.11-19
5.11-23

Note that pages revised solely due to changes in section pagination have not been included in the above lists or in the enclosures.

ER Section 2.4, Rev.0

Pages Updated 6/24/10

were (1) the diet of cranes is varied and includes wolfberry fruit, blue crabs, clams, snails, insects, fiddler crabs, snakes, and fish; (2) that blue crabs were not always the primary prey item; (3) that wolfberry fruit production is strongly and negatively influenced by salinity levels during summer leaf production (i.e., high salinity = low production); (4) blue crab abundance was influenced by a combination of environmental factors including water levels, windspeeds, water temperature, and salinity; and (5) although salinity was statistically significant and positively correlated with crab abundance in the selected multivariate model, salinity level alone was not a determining factor in crab abundance. The results from these studies were incorporated into computer models. The following relationships were suggested based on computer simulations for the 11-year period from 1997 - 2007: (1) the food supply in the area does not seem limiting, even during lower freshwater inflow conditions within the 11-year period; (2) wolfberry abundance is lower when salinities are higher; (3) blue crab abundance was best explained by a suite of environmental factors that could not be simplified into single-factor predictive models; and (4) the relationship between salinity and whooping crane energetics and/or survival is still uncertain. Given that some of these findings were contrary to those from earlier studies (see comments in Slack *et al.*), additional studies have been proposed to more directly examine the relationship between freshwater inflows, blue crabs, and whooping crane energetics and survival.

The major cause of mortality of the current whooping crane population is collisions with transmission and distribution lines, especially lines within the migratory pathway (CWS & USFWS Mar 2007). Tower guy-wires are also a concern, although to a lesser degree. The USFWS required a transmission company to mark transmission lines with highly visible "aviation balls" within a Texas portion of the whooping crane migratory pathway (AEP 2007). "Spiral markers" are installed on some transmission lines to reduce avian collisions. Another threat to the wintering cranes includes impacts of disturbance (noise, human presence, etc.), a concern resulting from access to the wintering grounds (most areas are public domain) and the continued development along the Texas Coast.

High mortality rates for the Aransas-Wood Buffalo population of whooping cranes during 2008–2009 were documented by the Whooping Crane Eastern Partnership (WCEP), a group of government agencies and non-profit organizations that joined forces to reintroduce a migratory population of whooping cranes to eastern North America. According to WCEP, the majority of losses appear to have occurred during migration. Several possible factors for this mortality level have been identified such as extreme drought which affected food sources and fresh drinking water available in the wintering grounds and disease (e.g., infectious bursal disease (IBD)). Further, chick mortality at Wood Buffalo National Park in Canada was also high, potentially due to higher than average rainfall while the chicks were young. Data from specific analyses (e.g., necropsies, water quality and food source abundance data correlation) was not included in the WCEP assessment. (WCEP Nov 2009)

Due to the fact that only four crane carcasses were recovered, the reports of mortality during the 2008-2009 overwintering period were based primarily on the apparent absence of birds during USFWS aerial census events. These missing birds, which were documented as arriving at Aransas National Wildlife Refuge (ANWR) during earlier aerial censuses, accounted for up to 19 of the 23 suspected mortalities (USFWS 2009a and USFWS 2009b).

During the 2008-2009 overwintering season at ANWR, above-normal upland and water hole use was noted, scattering the cranes over a geographical area beyond their typical territory. As described in the January 2009 USFWS aerial census report, "This makes it very difficult to determine the identity of pairs and family groups and leads to much uncertainty during the census count" (USFWS 2009a). Limited visibility due to weather conditions and smoke from prescribed burns, as well as flight time limitations, were noted on multiple census flights, adding to the difficulty in spotting the widely dispersed cranes (USFWS 2009a). Considering these and other factors, it is possible that the extent of whooping crane mortality during the 2008-2009 overwintering period could be lower than reported.

Given the few carcasses recovered, questions also remain regarding the causes of the reported whooping crane deaths. USFWS reports from the first half of 2009 postulated that the birds absent during the later aerial census counts succumbed to injury, predation, and / or disease resulting primarily from food-related stress (particularly related to small amounts of wolfberries and blue crabs) believed to be brought on by the regional drought conditions (USFWS 2009b). Additionally, the need for the cranes to fly to upland areas to find fresh water to drink was cited as an energy burden that could have further weakened the birds (USFWS 2009b). However, as discussed previously, empirical research indicates that the crane diet is rich and varied, and even when blue crab and wolfberry numbers are low, cranes can meet their daily energy and protein requirements by efficiently foraging on foods such as insects, snails, and razor clams (Slack et al. Aug 2009). As an example, cranes were noted eating fiddler crabs immediately prior to their early departure from ANWR in spring 2009 (USFWS 2009b). Furthermore, the flock departed ANWR relatively early in 2009 (USFWS 2009b). Previous research has indicated that birds will generally migrate earlier than usual when food availability allows for rapid fattening and good physical condition (Studds and Marra 2007).

Additionally, other factors could have contributed to crane mortality. As noted in the USFWS report Whooping Crane Recovery Activities, October, 2008 – October, 2009, the National Wildlife Health Center in Madison, Wisconsin was able to isolate a virus very similar to IBD in a recovered juvenile carcass. One of the symptoms of IBD is emaciation, even when a bird is receiving adequate food. If it turns out the virus is a form of IBD, this would be the first case ever documented in a crane from the Central Flyway (USFWS 2009b). Taking into account the available information, there is uncertainty regarding the specific cause or causes of death for the whooping crane mortalities reported over the 2008-2009 overwintering period at ANWR.

The brown pelican (*Pelecanus occidentalis*) is a large gray-brown bird with a characteristic long bill and pouch, known to forage on fish in coastal areas (Campbell 2003). Historically present in large numbers along the Atlantic and Gulf Coasts, the brown pelican population dropped dramatically by the mid-1970s primarily owing to insecticide (DDT) impacts on egg quality, and it was classified as federally-endangered throughout its range. Around 1900, an estimated 5000 brown pelicans nested on the Texas Coast, but the population declined to less than 10 breeding pairs by 1970, partially as the result of disturbance at their nesting areas by fishermen. Control of insecticide use and other recovery activities (e.g., nesting site protection) have resulted in recovery of segments of the population. In 1985, pelicans along the Atlantic and Florida Coasts had recovered sufficiently to be de-listed, whereas brown pelicans in Louisiana, Texas, and California remain classified as endangered. Currently, the Texas population is at or near historical levels (USFWS 2007a). Primary threats to Texas pelicans are loss of their nesting habitat, typically dredge spoil islands, which are subject to loss during hurricanes, and pollution from either off-shore oil wells or shipping. The closest nesting locations to the VCS site are in Aransas, Calhoun, and Matagorda Counties (USFWS 2007b).

Piping plovers (*Charadrius melodus*) are small stocky shorebirds that nest on shoreline beaches in the northern Great Plains, Great Lakes, and Atlantic Coast areas. All populations are listed as either federally-threatened or endangered. Piping plovers are a migratory species, wintering along the Gulf Coast and other southern locations. Critical wintering habitat for the piping plover is designated along the Texas Gulf Coast, with the closest area to the VCS site located in Matagorda Island bayside habitats in Calhoun County, approximately 25 miles south of the VCS site (Figure 2.4-3).

Five species of sea turtles are federally listed for Calhoun County (Table 2.4-4) including: loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricata*), and the Kemp's Ridley sea turtle (*Lepidochelys kempii*). Three species are known to nest on Texas barrier island beaches (TSTNR 2007), and all five could possibly occur in San Antonio Bay.

Sightings and strandings of endangered West Indian manatees (*Trichechus manatus*) have been recorded over the last 100 years across the entire Texas Coast (Schmidly 2004). A live stranding of a manatee occurred near Galveston, Texas, as recently as 2007 (TMMSN 2007). However, there is no evidence that a breeding population ever existed along the Texas Coast; individuals sighted/stranded in Texas probably represent migrants from Mexico (Schmidly 2004), possibly as the result of cool northern Gulf waters.

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most likely alter the natural shallow groundwater flow direction and gradient; however, any hydrologic alterations to groundwater would be local.

5.2.2 Water-Use Impacts

This subsection describes the results of the analysis of operations that could affect water use, including water availability and the analysis of water quality changes that could affect water use.

5.2.2.1 Surface Water

The source of the plant's makeup water would be the Guadalupe River as described in Section 3.4. The RWMU system would deliver up to 75,000 acre-feet per year at a maximum rate of 217 cfs as makeup water to the cooling basin to replenish losses through evaporation, basin seepage, blowdown discharges, and cooling tower drift. The water would be diverted into an approximately 3150 feet long intake canal and an approximately 200-foot long intake basin located on the southwest side of the Guadalupe River.

The location, flow data, period of record, and drainage area for the U.S. Geological Survey (USGS) gaging stations on the Guadalupe and San Antonio Rivers near the VCS site are presented in Subsection 2.3.1.1.1. Long-term stream flow data is not available for the Guadalupe River at the location of the Exelon RWMU system, approximately 430 feet upstream of the saltwater barrier. The nearest upstream gaging stations with long-term records are the Victoria gage (USGS 08176500) on the Guadalupe River and the Goliad gage (USGS 08188500) on the San Antonio River. The drainage areas for the Victoria and Goliad gages are 5198 square miles and 3921 square miles, respectively. The drainage area for the abandoned gaging station on the Guadalupe River near Tivoli is 10,130 square miles. Based on these drainage areas, the Victoria and Goliad gages monitor flows from approximately 90 percent of the total drainage area that contributes to the flow in the Guadalupe River at the diversion to the RWMU system. Flows in the Guadalupe River at the point of diversion were estimated by summing the reported flows at the Victoria and Goliad gaging stations and multiplying that sum by the ratio of the drainage area of the Guadalupe River at Tivoli to the sum of the drainage areas of the Guadalupe River at Victoria and San Antonio River at Goliad (10,130 ÷ (5198 + 3921) = 1.11). Based on these estimates, the maximum VCS water use of 217 cfs represents 5 percent of the annual mean flow in the Guadalupe River (4341 cfs) based on 10 years (1997 through 2006) of flow data.

Water Use Evaluation

The potential water use impacts were evaluated as if the makeup water would be supplied to the VCS cooling basin under an assumed existing senior water right. This provides a conservative estimate of the potential impacts because under a senior water right, Exelon would have "first call" on diverting the water during periods when the Guadalupe River flows were low. The potential impact in terms of the volume of river flow being diverted would be higher than in the case of more junior water rights that would be restricted from using water during periods of low river flow.

Section 2.3.2.3.3 discusses the availability of water under the rights held either jointly or directly by the GBRA and Union Carbide Corporation (UCC). A surplus of more than 115,000 acre-feet per year is projected in 2060 under the GBRA/UCC water rights. Section 2.3.2.3.3 also discusses existing water rights in the Guadalupe and San Antonio river basins in addition to those held by GBRA/UCC. For the potentially available portions of these water rights, Exelon estimates a current surplus of approximately 39,000 acre-feet per year. The priority dates of these rights vary from 1895 to 1997. The largest portion of the unused water is associated with a senior right. Because the evaluation of VCS water use assumes a relatively senior water right, the impacts of obtaining water through any combination of the potentially available water rights or a new appropriation would be consistent with, and likely less than, those presented below. The regional water planning process described in Section 2.3.2.3.3 considers the use of water allocated under existing rights during a repeat of the 1950s drought of record and through the planning horizon, as well as projected demands, shortages, and potential water use conflicts.

Exelon could supply the makeup water demand at VCS via a new water right. The priority date assigned to a new water right would restrict diversions to the Exelon RWMU system to periods in which demands under the existing, more senior water rights could be met. Further, for a new water right the TCEQ may impose special conditions, including potential restrictions on withdrawals during periods of low river flow (e.g., environmental flow conditions). These considerations would constrain the VCS withdrawals during periods of low river flow. The diversion of water during periods of relatively high flow or low demand by other water users would reduce the impacts relative to acquisition of water under a more senior existing water right.

The daily makeup water withdrawals over the 60-year historical period (1947 through 2006) given the projected water availability under an existing senior water right were calculated based on the Guadalupe-San Antonio (GSA) River Basin Water Availability Model (WAM; TNRCC Dec 1999). To assess VCS surface water use impacts as a function of run-of-river flows, the estimated VCS daily makeup water withdrawal rates were compared with the range of daily river flow conditions estimated over the 60-year historical period. The frequency distribution of the daily VCS makeup water withdrawal as a percentage of the daily Guadalupe River flow for that 60-year period is shown in Table 5.2-1 and Figure 5.2-3. The estimated plant water withdrawal was less than 15 percent of the Guadalupe River flow 85 percent of the time. Approximately 17 percent of the time, the plant either needed no additional makeup water, or no water was available for plant use as the result of low flow conditions. The withdrawal rate exceeded 30 percent of the estimated river flow less than 3 percent of the time.

purposes subject to natural hydrology, prior appropriation, and hydrologic assumptions approved by the TWDB.

Although not specifically envisioned in the development of the 2006 Region L Water Plan, the proposed use of surface water by VCS under agreement with the GBRA is consistent with the plan assumptions. Legal use of existing surface water rights on a priority basis is a fundamental assumption in evaluating water supply. Hence, uses of all existing surface water rights are reflected in the water availability projections of the Region L Water Plan, which include consideration of the drought of record conditions. Additionally, the development of the 2011 South Central Texas Region (Region L) Water Plan has been ongoing since February 2006. The Initially Prepared Plan was approved during February 2010. The Initially Prepared Plan includes updated regional water demand projections for steam-electric power generation including those projected for the VCS Project. The Initially Prepared Plan also includes a recommended project to supply water to the VCS Project (i.e., the "GBRA-Exelon Project"). Analysis conducted for the Regional Water Planing Group using the state's surface water availability model, as modified for regional planning purposes, concludes that sufficient water is available for the VCS Project (TWDB Feb 2010).

As described previously, the frequency distribution of the daily VCS makeup water withdrawal as a percentage of the daily Guadalupe River flow for a 60-year historical period (which included the drought of record [1950-1957]) estimated that approximately 17 percent of the time either the plant needed no additional makeup water (i.e., the cooling basin water level was at or above the design pool elevation), or no water was available for plant use as the result of drought conditions. The VCS cooling basin is designed to sustain plant operation for several months during drought conditions.

Projected surface water demands, supplies, and needs for Victoria and Calhoun Counties, as presented in the 2006 Regional Water Plan, are summarized in Table 2.3.2-14. As shown in the table, after meeting the projected Calhoun County surface water demands and Victoria County surface water needs, a surplus of more than 115,000 acre-feet per year remains under the combined GBRA/UCC water rights in the time period during which the VCS units would be operating. Additionally, approximately 39,000 acre-feet per year of currently permitted water is estimated to potentially be available, and new water right applications are pending.

VCS Bio-statistical Study

Although VCS water withdrawals would generally represent a relatively small percentage of annual Guadalupe River flow, Exelon undertook an approximately year-long study to evaluate the potential effects of these water withdrawals on the ecological health of the San Antonio Bay system. The study reported in TPWD's 1998 document, Freshwater Inflow Recommendations for the Guadalupe Estuary of Texas (Pulich et al. 1998), sought to identify the hypothetical freshwater inflow patterns necessary to optimize fisheries harvests in the bay system. In contrast, the objective of the VCS analysis was to develop and utilize statistical relationships between freshwater inflows and surrogate representations of ecosystem health to identify potential effects associated with the proposed VCS water diversions.

In its guidance towards establishing relationships between freshwater inflows and estuarine health, the Science Advisory Committee (SAC, established through Senate Bill 3 of the 77th Texas Legislature) provided a brief summary discussion on estuarine ecosystems and their major physio-chemical and biological variables. Figure 5.2-5 is a highly simplified diagram prepared by the SAC to represent causal relations among such estuarine processes. Despite the simplifications made in such a depiction, the diagram demonstrates that the estuarine ecosystem is highly dynamic and complex, being comprised of many variables and their interactions. The SAC has noted that it is not feasible to quantify each of the cause-and-effect relations diagrammed in Figure 5.2-5. Instead, the complexity of Figure 5.2-5 has been further distilled by the SAC to represent the most fundamental relations of inflow to the ecosystem in a form that may be feasible for determining inflow requirements. Figure 5.2-6 presents a conceptual schematic of the causal connection(s) between “inflow” and “biology.” (SAC 2009)

Inflows are one of the principal components contributing to estuarine ecology for which man exhibits some influence, and were hence of primary interest to the VCS bio-statistical study. Flow and salinity are known to exhibit strong correlations, a relationship that is strengthened in San Antonio Bay by the rather enclosed geomorphology of the bay system (Figure 5.2-7). Because the bay is somewhat sheltered from direct salinity intrusion from the Gulf of Mexico, Gulf salinities take a relatively long time to intrude into the system via the natural passes (e.g., Aransas Pass and Pass Cavallo). Accordingly, freshwater inflows typically have a longer-lasting influence on San Antonio Bay salinities relative to other Texas Bays (e.g. Galveston Bay and Matagorda Bay), with salinities generally higher, and the influences of tides and wind on water quality more noticeable, during periods of low freshwater inflow (Slack et al. 2009).

Rather than develop relationships between salinity and the biology of the system, the VCS bio-statistical study focused upon the more direct relationship between representations of San Antonio Bay biology and freshwater inflow. Both organism abundance and salinity are affected by factors other than inflow. Such a fact makes it difficult to extract a simple relation of either purely on inflow. As noted in Figure 5.2-6, the ultimate target is a relation to the “biology”. Studies typically focus upon salinity rather than abundance for the simple reason that salinity data are typically readily available, whereas biological data are not. In San Antonio Bay, however, there are ample biological data available to study biology directly. Secondly, inferring biological reactions through salinity can be misleading, as estuarine organisms generally function over a wide range of salinities. While these organisms exhibit preferences, they can exist outside of their preferred salinity conditions, complicating the relationship between salinity and biology and hampering the characterization of the organisms' dependence upon inflow. Lastly, salinity is but one of several pathways by which inflow can exert an influence on abundance (see Figure 5.2-5). Focusing entirely upon salinity may result in overlooking other flow-modulated responses or wholly misinterpreting a non-salinity response to inflow. By analyzing directly the relation of organism abundance to freshwater inflows, there is a better chance of capturing all of the flow-modulated effects.

Thus, the primary interest in the VCS study was the bio-statistical analysis of organism density (abundance) and its relation to freshwater inflows. The methodology utilized in the VCS bio-statistical study is consistent with the present knowledge on developing relationships in highly dynamic systems described in the SAC's document to the Basin and Bay Expert Science Teams, Methodologies for Establishing a Freshwater Inflow Regime for Texas Estuaries (SAC 2009). As described in greater detail in the subsequent discussion, the VCS bio-statistical study was completed in the following major steps:

1. Identification of key estuarine species to evaluate (via average annual abundance) as a proxy for bay health;

2. Data retrieval from the Texas Parks and Wildlife Department (TPWD) Coastal Fisheries Database and preparation for use with statistical analysis tools;

3. Quantification of historical freshwater inflows to the San Antonio Bay system and characterization of these flows using annual and seasonal representations;

4. Identification and culling of statistical relationships between the average annual abundances of the selected species and freshwater inflows, including the assessment of the potential effects of other independent variables (namely fisheries harvest data and water temperature) on organism abundance;

5. Utilization of the TCEQ Water Availability Model (WAM) to simulate "without-project" (i.e., baseline) and "with-project" hydrological scenarios, such that the best-fit statistical relationships could be used to assess potential effects on the abundances of the selected organisms.

As noted above, the first study task was to select the estuarine species to be evaluated as a measure of present and potential future bay health. Brown shrimp (*Penaeus aztecus*), white shrimp (*Penaeus setiferus*), blue crab (*Callinectes sapidus*), and eastern oyster (*Crassostrea virginica*) were chosen as important San Antonio bay species. These are four of the key organisms utilized during the application of the Texas Water Development Board (TWDB) and TPWD's "State Methodology for San Antonio Bay" (Longley, W.L., ed. 1994). As described in TPWD's 1998 report, Freshwater Inflow

Recommendations for the Guadalupe Estuary of Texas, the selected species "are representative dominant fisheries organisms or ecologically important prey species common in the Guadalupe Estuary based on TPWD Coastal Fisheries Program surveys" (Pulich et al. 1998). Thus, the abundances of these organisms provide a measure of the ecological productivity of the San Antonio Bay system, including a partial measure of the availability of food for certain predatory species. Notably, as discussed in Subsection 2.4.1.5, blue crabs are one important food source for the federally endangered whooping crane (*Grus americana*). Accordingly, the average annual abundances of the four species listed above were chosen as the proxy for the ecological health of the San Antonio Bay system in the VCS bio-statistical study.

The next step was to retrieve San Antonio Bay abundance data for the selected species. The source of such biological data used in the VCS study, the TPWD Coastal Fisheries Database, is a compilation of data collected by the TPWD utilizing various sample methodologies. This dataset contains data from 1976 to 2008, varying by the sample gear utilized. In contrast to San Antonio Bay fisheries harvest data, which were used by some previous efforts such as the above-referenced 1998 TPWD inflow recommendations study, the Coastal Fisheries Database information is obtained via random sampling; thus, the sampling schedule and locations are not subject to external factors like fuel and market seafood prices. Approximately 787,000 records (with up to 40 separate entries per record) were obtained from the TPWD database, representing all of the readily available data of this nature historically collected by the TPWD for the selected species. Once retrieved, abundance data for each organism were normalized by volume of water, area of sample, and sampling time, depending upon the geartype in which the organism was caught, to prepare for statistical analysis. Ultimately, the development of biological parameters consisted of four phases: the initial development of database tools to process the Coastal Fisheries data; the analysis of the geographic distribution of sampling events; the detailed analysis of sampling data; and, finally, specific analyses of organism densities.

The task of quantifying freshwater inflows for use in the statistical analyses began with the development of the hydrologic data for the San Antonio Bay system watershed. These data were developed from a variety of sources, including the USGS and TWDB. Daily mean flow data were obtained for five USGS stream flow gages on the Guadalupe and San Antonio Rivers and Coleto Creek (a tributary to the Guadalupe River) for their entire periods of record. The TWDB provided modeled daily runoff values for 13 ungaged watersheds within the San Antonio Bay watershed for the period 1977 – 2008, as well as estimates of the diversions from and return flows to these ungaged watercourses. The TWDB and USGS data were compiled to develop a daily representation of total freshwater inflows to San Antonio Bay for the period 1977 through 2008 (i.e., the period of record for the historical biological data obtained for use in the study).

Using the daily data, parameters of freshwater inflow were developed to serve as independent variables in the statistical comparisons to average organism abundance. The most important aspect of the year-to-year variation in annual discharge is how it is manifested in the annual seasonal floods and the summer low-flow period (SAC 2009). Some years exhibit a pronounced and extended seasonal pulse (also known as a "freshet"), while in other years the spring freshet may be totally absent. Correspondingly, in some years the summer low-flow period may be shortened or even eliminated by unusual runoff, and in other years may be prolonged while the flows dwindle. The SAC indicates that preliminary statistical analyses (based on work performed in Matagorda Bay) using seasonal freshets as an independent variable have better explained the variation of abundance for several major species than similar analyses using calendar-period flows (i.e., bi-monthly or annual periods). The SAC recommends that, "If available, a freshet analysis may prove a useful characterization of estuarine inflows for purposes of assessing the response of biology (SAC 2009)." This representation of flow, and its suggested use by the SAC, represents the evolving thinking of the scientific community with respect to the relation of freshwater inflow to estuarine health.

Thus, while earlier efforts, such as the those reported for the TPWD's 1998 inflow recommendations study (Pulich et al. 1998), focused on gaged flow averaged temporally, either as annual means or as "seasonal" (i.e., bimonthly volumes), the flow component of the VCS bio-statistical analysis was based on the premise that substantial explanation of ecological response depends upon the space-time variation of inflows. Accordingly, in addition to evaluating the relationships between annual freshwater inflow volumes and organism abundance, more refined representations of inflow were developed to recognize the importance of seasonal pulses (i.e., "freshets") and the intervening drier periods. Furthermore, the seasonal freshets (and the associated low-flow periods between them) were characterized by two methods, one assigning a 3-month timeframe after the onset of the freshet in the hydrological record, and the other with a varying freshet duration dictated by identifying both the freshet onset and ending in the hydrologic data via the application of a mathematical algorithm (termed the "FRESHET Methodology"). In all, eleven seasonal characterizations of freshwater inflow were used to develop the inflow-related independent variables for statistical analysis:

- Annual freshwater inflow
- 3-month spring freshet (3 calendar months starting with freshet onset)
- Summer dry period between 3-month freshets
- 3-month fall freshet (3 calendar months starting with freshet onset)
- Winter dry period between 3-month freshets
- Summer lowest 3-month flow (3 calendar months starting with low-flow onset)

- Winter lowest 3-month flow (3 calendar months starting with low-flow onset)
- Spring freshet using "FRESHET Methodology" (mathematically identified pulses of flow in the hydrologic record)
- Summer dry period between freshets identified with the FRESHET Methodology
- Fall freshet using FRESHET Methodology (mathematically identified pulses of flow in the hydrologic record)
- Winter dry period between freshets identified with the FRESHET Methodology

It should be noted that hydrologic data were temporally related to the biological data through the development of a relative timeframe referred to as an "effective hydrologic period." For each organism, the effective hydrologic period is that 12-month period in which the hydrology is considered to influence the given organism, considering its life cycle traits (e.g., moving in or out of the bay at a given time of year). In addition to the freshwater inflow-related parameters developed from the annual and seasonal inflow volume representations described above, parameters of water temperature and commercial fishing harvest data were developed for use in the statistical analyses.

With the dependent (i.e., average annual organism abundance for the selected key species) and independent (i.e., based on freshwater inflow representations, fisheries harvest data, and water temperature data) variables prepared, statistical regressions were developed to assess which, if any, relationships of organism abundance to freshwater inflow yielded statistically valid and meaningful tools for the subsequent analysis of potential effects on the ecological health of San Antonio Bay. Approximately 60,000 multi-variate linear regression analyses were performed and subsequently analyzed (facilitated by statistical analysis tools developed for the project) to identify their capability in predicting average annual abundance. The regressions ultimately identified to relate organism abundance to fresh water inflow are presented below, wherein "Adj. R^2" represents the percent of variance explained by a regression and "A" represents the relative annual organism abundance in the bay. It should be noted that the descriptor "Whole Bay" indicates that organism abundance was aggregated across the San Antonio Bay system, rather than for a specific sampling location(s). This methodology was selected because the TPWD's program of random sampling leads to variation in the total number and frequency of sampling events at individual sampling locations that hinders the development of statistical relationships at a specific point(s) in the bay system. The identified regressions are as follows:

White Shrimp:

Whole Bay Otter Trawl White Shrimp related to Total San Antonio Bay 3-Month Summer Low-Flows

Adj. R^2 = 0.586

A = 0.433 + 1.97×10^{-5} DQ3

This equation relates average annual white shrimp abundance, as represented by sampling in San Antonio Bay using an otter trawl, to the magnitude of the lowest 3-month cumulative flow occurring between March and August (as represented in the above equation by DQ3). This equation explains approximately 59 percent of the variance of the data.

Eastern Oyster:

Whole Bay Oyster Dredge Eastern Oyster related to Total San Antonio Bay 3-Month Spring Freshet Flows

Adj. R^2 = 0.218

A = 2285.44 – 5.59×10^{-4} SQ3

This equation relates average annual eastern oyster abundance, as represented by samples collected in San Antonio Bay using an oyster dredge, to the magnitude of the 3-month cumulative high flow occurring between January and June (as represented in the above equation by SQ3). This equation explains about 22 percent of the variance of the data.

Blue Crab:

Whole Bay Otter Trawl Blue Crab related to Colorado Total San Antonio Bay 3-Month Summer Intervening Flows:

Adj. R^2 = 0.280

A = 3.843 + 1.52×10^{-5} SINTQ

This equation relates average annual blue crab abundance, as represented by sampling in San Antonio Bay using an otter trawl, to the average monthly magnitude of intervening flows occurring between the spring and fall 3-month freshets (as represented in the above equation by SINTQ). This equation explains approximately 28 percent of the variance of the data.

No discernable statistical relationship between average annual brown shrimp abundance and freshwater inflow variables resulted from the analysis.

To use the identified linear regressions to evaluate the potential effects on San Antonio Bay health resulting from the proposed VCS water withdrawals, the TCEQ GSA WAM (see Subsection 2.3.2.3.3) was chosen as an available and accepted means of modeling baseline and with-project hydrological scenarios. The following WAM simulations were used in the VCS bio-statistical study:

Current Conditions Scenario – The Current Conditions Scenario uses results from a WAM simulation that represents current conditions with respect to water availability for individual water rights. The version of the WAM used in the VCS bio-statistical study includes the following assumptions:

- The maximum diversion amount being sought by each individual water right is established as the actual maximum annual use in the 10 years prior to when the WAM was originally developed (mid-1980s to mid-1990s) as reported by the individual water rights owners;

- The maximum storage capacity of all reservoirs specified as the actual year-2000 storage capacity (rather than the authorized maximum storage amount); and

- Return flows associated with individual water rights and within the basin are accounted for in accordance with actual operations.

Comparative Scenario One – Comparative Scenario One incorporates the data sets and assumptions from the Current Conditions Scenario, except that up to 75,000 acre-feet is annually diverted from the river under Certificate of Adjudication 18-5178 (proxy used to represent potential water supply for the proposed VCS). The representative water use is incorporated into the model run using an assumed monthly diversion pattern for a potential onsite cooling water impoundment. No discharges to the river from blowdown from the proposed onsite cooling reservoir were included in the scenario input data. That is, Comparative Scenario One uses conservative assumptions and is intended to represent the incremental effect on fresh water inflows to the bay resulting from surface water diversions associated with VCS operation.

A second comparative scenario ("Comparative Scenario Two") that was developed to conservatively model potential future conditions in the basin is discussed in the cumulative impacts analysis presented in Section 5.11.

The hydrologic scenarios (i.e., current conditions and with the VCS project) were then used in conjunction with the previously described linear regressions relating average annual organism abundance to freshwater inflows to evaluate the potential effects on the health of the San Antonio Bay system (i.e., compared to the current health of the bay) associated with proposed VCS water withdrawals from the Guadalupe River. Based on the analysis of the potential impacts to the key species assessed in this study, the following conclusions were drawn:

- No statistically significant relationships between key species abundance and *annual* freshwater inflows to San Antonio Bay were identified. However, a small number of statistical relationships associated with seasonal inflows were developed using the FRESHET and the 3-Month Freshet methodologies. Thus, the original hypothesis that pulses of flow, or the period between these pulses, are more significant to estuarine health than annual flows appears to be valid. Further, the 3-Month Freshet methodology provides a readily implementable means of evaluating flows utilizing the State of Texas' current tool for such an assessment, the TCEQ's WAM.

- The identified statistical relationships between eastern oyster and blue crab abundances and freshwater inflow parameters are weak (i.e., there are small amounts of explained variance for these relationships). The results of the analyses conducted during this study indicate that other external factors unrelated to freshwater inflows (as represented within the VCS study) contribute to variations in oyster and blue crab abundances.

- The statistical relationships identified between freshwater inflow parameters and species abundance were used in conjunction with Comparative Scenario One (Current Conditions Scenario modified to include VCS project water withdrawals) to evaluate the potential effects of water use by VCS. This evaluation determined that implementation of the VCS project would yield no discernible change in the predicted abundance of white shrimp. Similarly, no discernable change can be seen in predicted blue crab and eastern oyster abundances utilizing the relatively weaker statistical relationships in conjunction with Comparative Scenario One.

Thus, with respect to freshwater inflows to San Antonio Bay, the project-specific scenario analyzed, and the methodologies employed therein, the study did not indicate that the VCS project would impact the future health (i.e., as compared to the current health) of the key San Antonio Bay organisms evaluated. The study results are consistent with the conclusion that VCS water use impacts on the ecological health of San Antonio Bay would be small.

Summary

Surface water use impacts as a result of the VCS surface water withdrawals from the Guadalupe River would be SMALL based on the following findings:

- The maximum instantaneous diversion for VCS water use of 217 cfs represents 5 percent of the annual mean flow of the Guadalupe River at the proposed point of diversion, based on 10 years (1997-2006) of flow data.

- The cooling basin would be designed to contain enough water to support the operation of the plant for several months during low river flow periods. Variations in makeup water availability would be accommodated by allowing the cooling basin water level and quality to fluctuate within acceptable ranges. Additionally, as discussed in Hydrologic Alterations and Plant Water Supply, the site groundwater model predicts that cooling basin seepage would create a small base flow in tributaries within the Guadalupe-San Antonio River System.

- The daily makeup water withdrawals over the 60-year historical period (1947 through 2006) assuming a senior priority date were calculated based on the Guadalupe-San Antonio River Basin Water Availability Model (TNRCC Dec 1999). To assess VCS surface water use impacts as a function of run-of-river flows, the estimated VCS daily makeup water withdrawal rates were compared to the range of daily river flow conditions estimated over the 60-year historical period. The frequency distribution of the daily VCS makeup water withdrawal as a percentage of the daily Guadalupe River flow for the 60-year period estimates that VCS water withdrawal would be less than 15 percent of the Guadalupe River flow 85 percent of the time; and the withdrawal rate would exceed 30 percent of the estimated river flow less than 3 percent of the time. Based on this evaluation, freshwater inflows to the San Antonio Bay system for the period of record would be relatively unaffected by VCS water use.

- The VCS water withdrawals would be obtained from one or more water rights. The surplus available under senior (priority) GBRA/UCC unallocated water rights or other existing water rights in the Guadalupe-San Antonio River Basin is sufficient to meet the VCS site demand.

- A bio-statistical study was conducted to evaluate the potential effects of VCS water withdrawals on the ecological health of the San Antonio Bay system, using the average annual abundances of four key estuarine species (brown shrimp, white shrimp, blue crab, and eastern oyster) as a representation of bay health. The TPWD Coastal Fisheries Database provided approximately 787,000 records for the selected species for the period 1977-2008. Freshwater inflow data were obtained from the TWDB and the USGS and aggregated to estimate daily inflows to the bay system over the same period, from which seasonal (i.e., "freshet") and annual representations of inflow were characterized. Roughly 60,000 multi-variate linear regression analyses were performed and evaluated to identify their ability to relate freshwater inflows to the average annual abundances of the selected species, ultimately yielding a relationship for white shrimp and relatively weaker relationships for blue crab and eastern oyster. No relationship was identified for brown shrimp. The identified regressions were utilized in conjunction with hydrological scenarios developed using the TCEQ WAM to assess current San Antonio Bay conditions and potential effects on the selected organisms' abundances associated with the proposed VCS water withdrawals from the Guadalupe River. With respect to the freshwater inflows to San Antonio Bay, the project-specific scenario analyzed, and the methodologies employed therein, the VCS bio-statistical study did not indicate that the VCS project would impact the future health (i.e., as compared to the current health) of the key San Antonio Bay organisms evaluated. The study results are consistent with the conclusion that VCS water use impacts on the ecological health of San Antonio Bay would be small.

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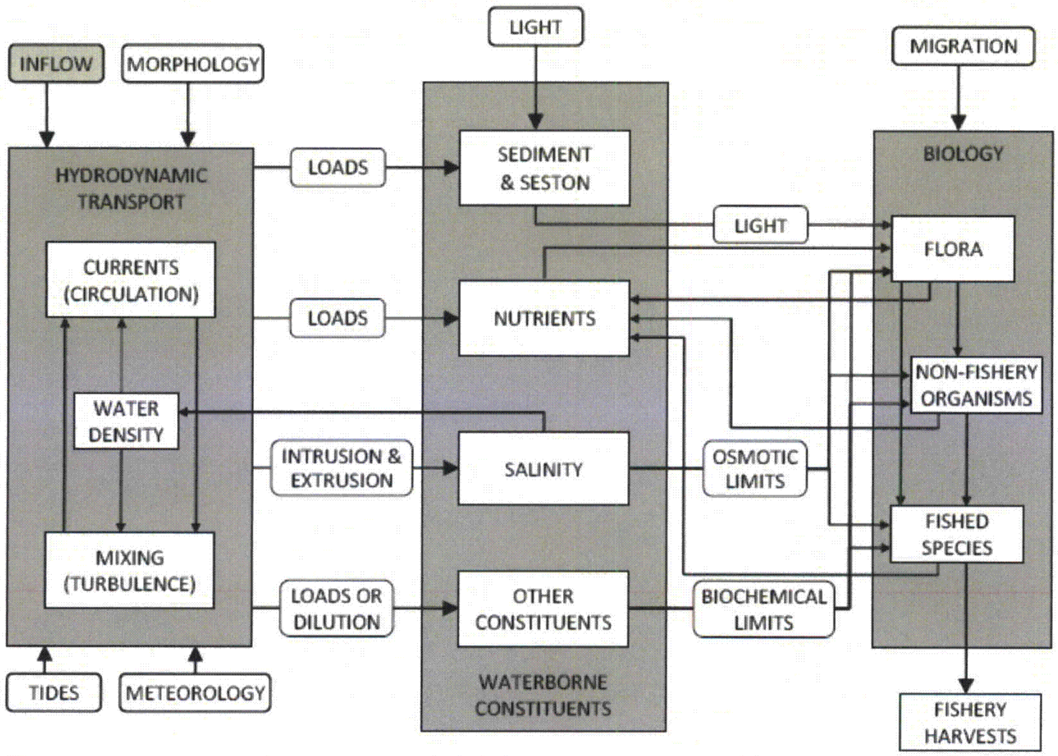

Figure 5.2-5 Schematic of Estuarine Ecosystem (SAC 2009)

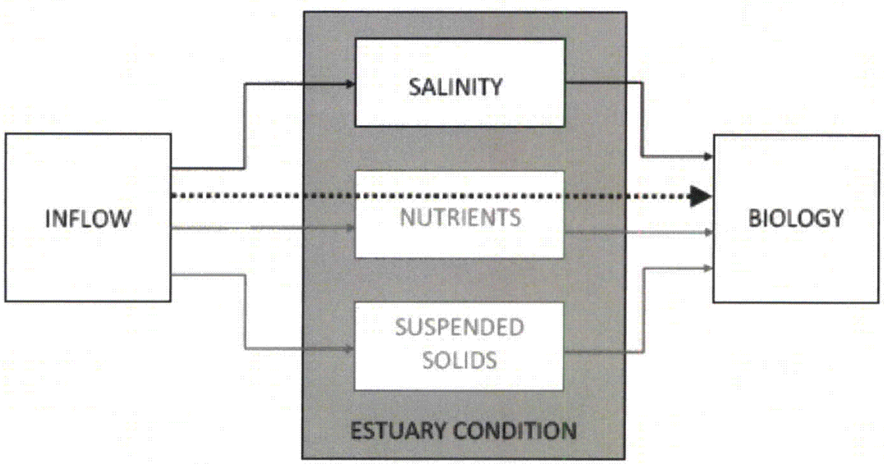

Figure 5.2-6 Schematic of Estuarine Ecosystem Simplified to Show Relation of Freshwater Inflow to Estuary Biology (SAC 2009)

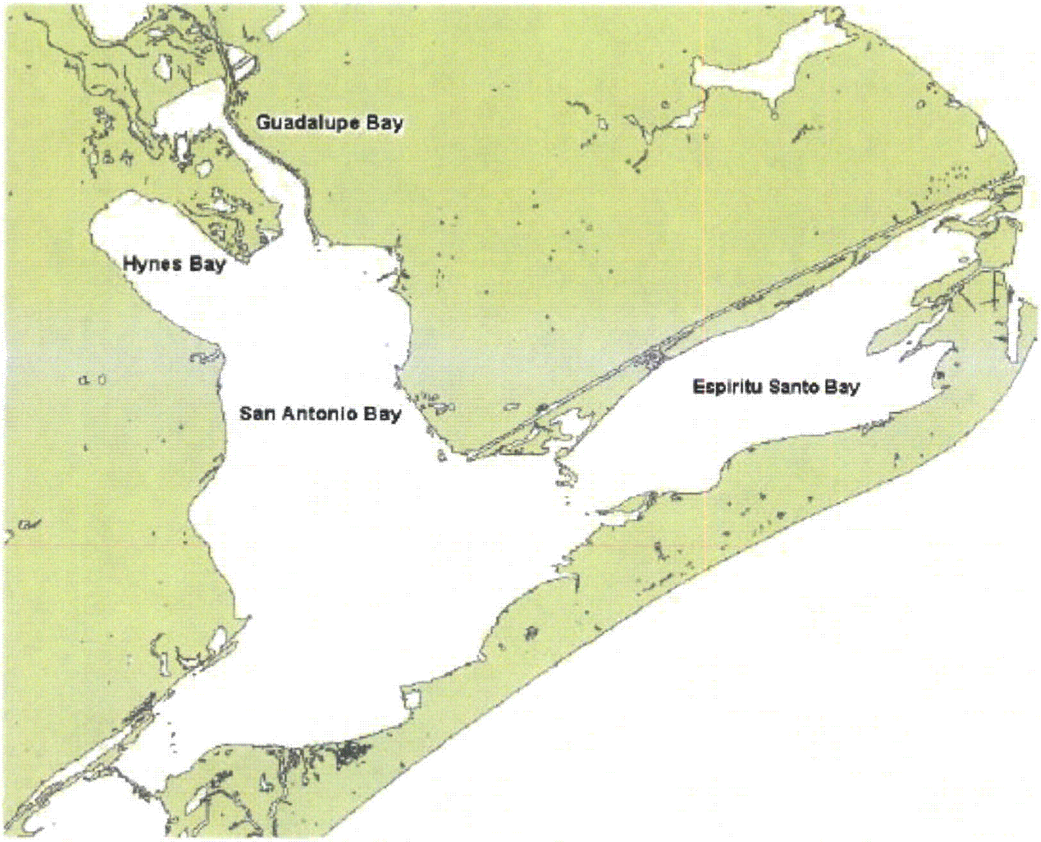

Figure 5.2-7 San Antonio Bay System

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The new water right for withdrawal of up to 189,484 acre-feet per year from the Guadalupe River that GBRA is seeking would be junior to all existing water rights, and therefore, withdrawals under this junior right would occur during periods of average to relatively high flow. The new water right may include conditions to protect the San Antonio Bay and estuary system. Under this new water right, GBRA would be able to supply water from off-channel storage to areas of need during times of drought. TCEQ would consider freshwater inflow requirements prior to issuance of the water right. The execution of this proposed water right would be beneficial in producing firm supply to satisfy projected demands in the region. Its junior status as well as any conditions stipulated to ensure adequate freshwater inflows for the Guadalupe Estuary would prevent adverse water use impacts. Therefore, cumulative impacts related to the proposed withdrawals for the VCS cooling basin and LGWSP and the execution of the proposed GBRA water right of up to 189,484 acre-feet per year from the Guadalupe River, are expected to be SMALL.

5.11.2.1 Groundwater

As discussed in Section 5.2, it is unlikely that the proposed VCS production wells would impact the offsite well users because of the estimated groundwater demand of 1200 gpm (maximum), depth of withdrawal, and distance to offsite wells. Of the projects considered in this cumulative analysis, only Coleto Creek Unit 2 would potentially use groundwater with withdrawals being from the Evangeline Aquifer. However, because of the distance (approximately 11 miles) separating the two facilities, their zones of influence would not overlap, and any Coleto Creek Unit 2 impacts would not be considered cumulative with VCS groundwater use impacts. The Goliad project overlies the Gulf Coast aquifer but is at an even greater distance from VCS, and their zones of influence would not overlap. Neither the operation of Coleto Creek Unit 2 nor VCS is expected to adversely affect groundwater quality. Therefore, cumulative impacts to groundwater are expected to be SMALL.

5.11.3 Ecology (Terrestrial and Aquatic)

5.11.3.1 ~~Terrestrial~~Ecological Impacts of Land Use (Terrestrial and Aquatic)

Approximately 6354 acres of the VCS site would be permanently disturbed and unavailable as habitat for terrestrial wildlife. However, this acreage includes the cooling basin that would provide large, open water habitat of benefit to multiple species of water birds. There are no other projects within close enough proximity to the VCS site to be considered cumulative. With regard to impacts to resident waterfowl and migratory birds, the cumulative impacts analysis considers projects in the lower Guadalupe River basin.

5.11.3.2 Ecological Impacts of Water Use (Terrestrial and Aquatic)

Water Use Evaluation

As stated in Section 5.11.2, the net result of the LGWSP and VCS cooling basin makeup water withdrawals and the VCS blowdown discharge would be a small reduction in the Guadalupe River flow compared to current conditions. Despite the small reduction in flow, the combination of the GBRA and VCS consumptive use of water from the lower Guadalupe River basin would result in reduced freshwater inflows into the Guadalupe estuary and San Antonio Bay, which support aquatic species and migratory birds. The potential of reduced freshwater inflows into the Guadalupe River estuary and San Antonio Bay is a possible concern for the whooping crane (*Grus americana*). The whooping crane is an endangered species that overwinters and forages in habitats on the periphery of the Guadalupe River estuary and San Antonio Bay (see Subsection 2.4.1). There are differing professional and scientific opinions regarding the impacts of freshwater inflows on the whooping cranes and their habitat.

For example, the U.S. Fish and Wildlife Service (USFWS) Whooping Crane Coordinator has observed the whooping crane population at the Aransas National Wildlife Refuge (ANWR) for approximately 30 years. Based upon his observations, he has expressed the opinion that there is a relationship between marsh salinities, blue crab populations, and whooping crane mortality rates. He has stated that with reduced freshwater inflows and high marsh and bay salinities, blue crabs do poorly and whooping crane mortality rises (comments dated June 5, 2009, included in Slack et al. Aug 2009).

In contrast, as~~As~~ discussed in Section 2.4, Texas A&M University recently conducted a multi-year study evaluating the relationships among freshwater inflows, whooping cranes and their prey, Linking Freshwater Inflows and Marsh Community Dynamics in San Antonio Bay to Whooping Cranes (Slack et al. Aug 2009). Among the many results of this project, field and laboratory studies documented that the diet of wintering cranes can vary annually (including wolfberry fruit, blue crabs, clams, snails and other items); blue crabs are not always the dominant food item; blue crab abundance and distribution are influenced by a combination of environmental factors (water levels, wind speed, temperature and salinity); salinity levels alone do not determine crab abundance and distribution; and wolfberry production is strongly influenced by salinity levels during summer leaf production. Many of these findings were incorporated into computer models examining impacts of freshwater inflows on whooping cranes and their food over an 11-year period (1997–2007). These models suggested that food supply within the bay area does not appear to be limiting, even during the lower inflow years, but also that the relationship between salinity and whooping crane energetics and/or survival remains unclear.

As discussed in Section 2.4.1.5, the Whooping Crane Eastern Partnership (WCEP) reported high mortality rates for the Aransas-Wood Buffalo population of whooping cranes during 2008–2009. According to WCEP, the majority of losses appear to have occurred during migration. Several possible factors for this mortality level have been identified such as extreme drought which affected food sources and fresh drinking water available in the wintering grounds and disease (e.g., infectious bursal disease (IBD)). Further, chick mortality at Wood Buffalo National Park in Canada was also high, potentially due to higher than average rainfall while the chicks were young. Data from specific analyses (e.g., necropsies, water quality and food source abundance data correlation) was not included in the WCEP assessment. (WCEP Nov 2009)

Due to the fact that only four crane carcasses were recovered, the reports of mortality during the 2008-2009 overwintering period were based primarily on the apparent absence of birds during USFWS aerial census events. These missing birds, which were documented as arriving at ANWR during earlier aerial censuses, accounted for up to 19 of the 23 suspected mortalities (USFWS 2009a and USFWS 2009b).

During the 2008-2009 overwintering season at ANWR, above-normal upland and water hole use was noted, scattering the cranes over a geographical area beyond their typical territory (USFWS 2009a). As described in the January 2009 USFWS aerial census report, "This makes it very difficult to determine the identity of pairs and family groups and leads to much uncertainty during the census count" (USFWS 2009a). Limited visibility due to weather conditions and smoke from prescribed burns, as well as flight time limitations, were noted on multiple census flights, adding to the difficulty in spotting the widely dispersed cranes (USFWS 2009a). Considering these and other factors, it is possible that the extent of whooping crane mortality during the 2008-2009 overwintering period could be lower than reported.

Given the few carcasses recovered, questions also remain regarding the causes of the reported whooping crane deaths. USFWS reports from the first half of 2009 postulated that the birds absent during the later aerial census counts succumbed to injury, predation, and / or disease resulting primarily from food-related stress (particularly related to small amounts of wolfberries and blue crabs) believed to be brought on by the regional drought conditions (USFWS 2009b). Additionally, the need for the cranes to fly to upland areas to find fresh water to drink was cited as an energy burden that could have further weakened the birds (USFWS 2009b). However, as discussed previously, empirical research indicates that the crane diet is rich and varied, and even when blue crab and wolfberry numbers are low, cranes can meet their daily energy and protein requirements by efficiently foraging on foods such as insects, snails, and razor clams (Slack et al. Aug 2009). As an example, cranes were noted eating fiddler crabs immediately prior to their early departure from ANWR in spring 2009 (USFWS 2009b). Furthermore, the flock departed ANWR relatively early in 2009 (USFWS 2009b). Previous research has indicated that birds will generally migrate earlier than usual when food availability allows for rapid fattening and good physical condition (Studds and Marra 2007).

Additionally, other factors could have contributed to crane mortality. As noted in the USFWS report Whooping Crane Recovery Activities, October, 2008 – October, 2009, the National Wildlife Health Center in Madison, Wisconsin was able to isolate a virus very similar to IBD in a recovered juvenile carcass. One of the symptoms of IBD is emaciation, even when a bird is receiving adequate food. If it turns out the virus is a form of IBD, this would be the first case ever documented in a crane from the Central Flyway (USFWS 2009b). Taking into account the available information, there is uncertainty regarding the specific cause or causes of death for the whooping crane mortalities reported over the 2008-2009 overwintering period at ANWR.

Additional studies have been proposed to further clarify the relationship among freshwater inflows, salinity, and whooping cranes. Freshwater inflows provide nutrient and sediment loading to the estuary, and they are one factor affecting salinity gradients in the bay system.

As discussed in Section 5.11.2, preparation of the 2011 Initially Prepared Plan included use of hydrologic models to quantify the cumulative effects of implementation of the South Central Texas Regional Water Plan through the year 2060. The TCEQ water availability model, modified for regional water planning purposes, was used to simulate freshwater inflows to the Guadalupe Estuary given full implementation of the recommended water management strategies (the Regional Water Plan case). Three additional simulations were performed for comparison with the Regional Water Plan case:

- The first comparison scenario, the Baseline (Full Permits) case, included the assumptions used elsewhere in the 2011 Initially Prepared Plan to determine surface water supply reliability and perform technical evaluations of surface water management strategies. These assumptions included full utilization of existing surface water rights and treated effluent discharges representative of current conditions.

- The second comparison simulation, the Present Conditions case, was intended to be a realistic, but somewhat conservative, portrayal of current basin conditions with respect to springflows, surface water rights use, and effluent discharges.

- The third comparison scenario, the Natural Conditions case, is a historical set of theoretical streamflows and estuarine inflows, in which the effects of mankind on water resources have been removed.

Two ecologically based assessments, based on spring / early summer freshwater pulse criteria and low-flow inflow criteria, were used to compare simulated inflows to the Guadalupe Estuary under the four estuarine inflow scenarios described above (i.e., the Regional Water Plan, Baseline (Full Permits), Present Conditions, and Natural Conditions cases). The freshwater pulse evaluation was used to compare Guadalupe Estuary inflow conditions based on occurrences below a target inflow of 526,000 acre-feet over the critical four month period from April–July. The low-flow inflow evaluation was focused on whether enough freshwater would be available to maintain salinity conditions within reasonable tolerance ranges and enable sufficient populations of organisms such rights. During normal and high inflow periods, additional inflow reductions beyond the Baseline (Full Permits) case as a result of fully implementing the 2011 Region L Water Plan were predicted to be relatively small. Additionally, as discussed in Hydrology and Water Use, implementation of the 2011 Region L Water Plan is expected to slightly increase inflows to the Guadalupe Estuary relative to the Baseline (Full Permits) case during dry or drought periods.

VCS Bio-Statistical Study

As discussed in Subsection 5.2.2.1, a bio-statistical study was conducted to evaluate the potential effects of VCS water withdrawals on the ecological health of the San Antonio Bay system, using the average annual abundances of four key estuarine species (brown shrimp, white shrimp, blue crab, and eastern oyster) as a representation of bay health. The TPWD Coastal Fisheries database provided approximately 787,000 records for the selected species for the period 1977-2008. Freshwater inflow data were obtained from the TWDB and the USGS and aggregated to estimate daily inflows to the bay system over the same period, from which seasonal (i.e., "freshet") and annual representations of freshwater inflow were characterized. Roughly 60,000 multi-variate linear regression analyses were performed and evaluated for their ability to relate freshwater inflows to the average annual abundances of the selected species, ultimately yielding a relationship for white shrimp and relatively weaker relationships for blue crab and eastern oyster. No relationship was identified for brown shrimp.

To use the identified linear regressions to evaluate the potential effects on San Antonio Bay health resulting from the proposed VCS water withdrawals, the TCEQ Water Availability Model (see Subsection 2.3.2.3.3) was chosen as an available and accepted means of modeling baseline and potential future hydrological scenarios, as follows:

Current Conditions Scenario – The Current Conditions Scenario is a WAM simulation that represents current conditions with respect to water availability for individual water rights. The version of the WAM used to represent current conditions in the VCS bio-statistical study includes the following assumptions:

- The maximum diversion amount being sought by each individual water right is established as the actual maximum annual use in the 10 years prior to when the WAM was originally developed (mid-1980s to mid-1990s) as reported by the individual water rights owners;
- The maximum storage capacity of all reservoirs specified as the actual year-2000 storage capacity (rather than the authorized maximum storage amount); and
- Return flows associated with individual water rights and other discharges in the basin are accounted for in accordance with actual operations.

Comparative Scenario One – This project-specific scenario simulates basin conditions with the VCS project in operation and no other changes from the Current Conditions Scenario. The use of Comparative Scenario One in evaluating the potential effects on the ecological health of San Antonio Bay associated specifically with the proposed VCS water withdrawals is discussed in Subsection 5.2.2.1.

Comparative Scenario Two (Full Authorization Scenario) – This scenario assumes that all currently authorized water rights are used up to their full authorization. The Full Authorization Scenario is a conservative representation of water rights utilization and discharges in a possible future condition. The model run is used by the TCEQ to assess water availability and possible impacts of new water rights applications and assess incremental effects of new diversions. For the VCS bio-statistical analysis, it was used to present results of a possible future condition that could result with or without the VCS project in operation if all existing surface water rights are fully utilized. That is, assuming VCS water withdrawals via an existing water right, the resulting modeled future conditions would be the same with or without the VCS project, with the exception that the annual diversion pattern in the model was not modified to recognize the use pattern of the proposed VCS project with off-channel storage. This WAM simulation incorporates several assumptions, including:

- All existing surface water rights in the Guadalupe-San Antonio basin model are fully exercised (that is, used 100 percent) at their authorized annual diversion and impoundment amounts;
- No return flows or effluent discharges throughout the basin; and
- Springflow discharges from the Edwards Aquifer consistent with aquifer management rules in effect at the time the WAM was developed (1999).

The Full Authorization Scenario accounts for the annual volume of water that would be used by VCS assuming diversion of an existing water right and, therefore, represents a possible, although conservative, representation of future hydrologic conditions with or without the project (noting that no modification was made to the diversion pattern authorized under Certificate of Adjudication 18-5178 as a proxy for water diverted for VCS in this scenario).

The developed hydrologic scenarios (i.e., Current Conditions and Full Authorization) were used in conjunction with the previously described linear regressions (see Subsection 5.2.2.1) relating average annual organism abundance to freshwater inflow parameters to evaluate the potential effects on the health of the San Antonio Bay system (i.e., compared to the current health of the bay through the use of key organism abundances as a surrogate for bay "health") associated with the full use of currently authorized water rights and no return flows (i.e., the Full Authorization Scenario). Based on this highly conservative analysis of the potential impacts to the key species abundances assessed, it was determined that potential decreases in the frequencies of occurrence of white shrimp abundances (relative to the frequencies modeled using the Current Conditions Scenario) are possible over a range of organism abundances (measured in organisms per acre-foot of water sampled). Because the frequencies of occurrence of organism abundance modeled using the Full Authorization Scenario approach but do not fall beyond the lower statistical confidence bound (95 percent) derived from the methodologies employed in the study, a quantified magnitude of the potential decreases is not proffered. That is, although the Current Conditions and Full Authorization Scenario modeling results diverge enough to discern the *potential* for changes in how often given organism abundances occur, the results of the two scenarios remain statistically indistinguishable given the inherent uncertainty in the relationship between abundance and freshwater inflow. It should be noted that the potential for decreases would be evident when considering the full use of currently authorized water rights and no return flows, with or without implementation of the VCS project. No changes in abundances of blue crab or eastern oyster were discernable utilizing the relatively weaker relationships for those organisms, and no statistically meaningful linear regression was identified for brown shrimp (see Subsection 5.2.2.1).

Recognize that the Full Authorization Scenario utilized in the VCS bio-statistical study is similar to the "Baseline (Full Permits)" WAM run used in the previously described Region L planning process. One significant difference between these model runs is that the VCS study's Full Authorization Scenario assumes no return flows, whereas the Region L Full Permits scenario assumes effluent discharges representative of current conditions. For the reasons discussed previously, the Region L Full Permits scenario is very conservative for evaluating the cumulative impacts of the considered projects. The additional conservatism associated with the Full Authorization Scenario relative to the Full Permits scenario dictates that any cumulative impacts analysis based on the Full Authorization Scenario will be similarly (i.e., highly) conservative. Thus, although the VCS bio-statistical study report identified (based on the methodologies employed therein) the potential for changes in white shrimp abundance modeled using the Full Authorization Scenario, the hydrological inputs yielding the results are highly conservative. Given this degree of conservatism, the VCS bio-statistical study results are consistent with the conclusion that the cumulative impacts of VCS water use on the ecological health of San Antonio Bay would be small.

Summary

Based on the information provided in the cumulative effects assessment prepared as part of the Region L 2011 Initially Prepared Plan, ~~and~~ the discussion of cumulative hydrologic impacts presented in Hydrology and Water Use, and the results of the VCS bio-statistical study, it is concluded that the cumulative impacts on freshwater inflows to the Guadalupe Estuary would be small. Accordingly, although the relationship of freshwater inflows, salinity, and other factors to whooping crane health and energetics remains unclear, the cumulative impacts on aquatic and terrestrial wildlife relying on the Guadalupe Estuary and San Antonio Bay system, including whooping cranes and their habitat, would be SMALL.

~~5.11.3.2~~5.11.3.3 ~~Aquatic~~Impingement and Entrainment

Additional pumping capacity of 50 cfs would be available at the RWMU intake structure beyond the maximum of 217 cfs needed to provide makeup water to the VCS cooling basin. This additional pumping capacity would not be used by VCS but would be held in reserve to support increasing demand for other non-VCS water users. Should another water user(s) take advantage of the full capacity of the RWMU intake structure, the increase in the pumping rate would increase the number of fish impinged and entrained. Even if the full 267 cfs pump capacity is used, Exelon is committed to limiting the through-screen velocity to 0.5 feet per second or less in accordance with "technology-based performance standards" for cooling water intake structures established in EPA's Track 1 requirements for compliance with Section 316(b) of the Clean Water Act.~~This is the only cumulative impact that has been identified relative to aquatic ecological resources.~~

As described in Subsection 5.3.1.2.2, Exelon surveyed fish, including ichthyoplankton (eggs and larvae), in the Guadalupe River immediately upstream of the salt water barrier, in Goff Bayou, and in the GBRA main canal in 2008. Ichthyoplankton collections from the lower Guadalupe River were dominated by three species (common carp (*Cyprinus carpio*, 60 percent of total), inland silverside (*Minidia beryllina*, 15.6 percent) and red shiner (*Cyprinella lutrensis*, 14.6 percent). Exelon's analysis of entrainment assumed 100 percent mortality of eggs and larvae entrained in pumping systems. Table 5.11-2 shows the estimated number of larvae that would have been entrained at the RWMU system intake at a maximum pumping rate of 267 cfs (217 cfs + 50 cfs) based on the larval densities observed in the Guadalupe River in 2008.

Most larvae collected were common carp, a nonnative nuisance species. Carp were only collected in one month, March 2008, but spawning almost certainly continued, at a lower intensity, into early summer. Based on larval densities in the river in 2008, an estimated 301,305 carp larvae would have been entrained (see Table 5.11-2) at a pumping rate of 267 cfs. A single large female carp can produce several million eggs per season, but the more typical range is 100,000 to 500,000 eggs. These eggs would develop into 10,000–50,000 larvae, according to the species- and age-specific mortality table in the case study analysis for the Phase II Cooling Water Intake Structures [Section 316(b)] rule (U.S. EPA Feb 2002). Thus, the number of larvae that would have been entrained represents the production of approximately 6–30 female carp. Losing the production of 6–30 fish could have a small impact on carp in the immediate vicinity of the intake canal, but would have negligible impact on the lower Guadalupe River carp population.

This evaluation assumes that carp have some intrinsic value, and their losses would adversely affect the fish community of the Guadalupe River. Many fisheries managers regard the common carp, a nonnative species introduced to the United States in the middle of the 19th century, as a nuisance. The common carp is considered a pest in the Gulf states and much of the United States because it roots along the bottom searching for food and stirs up bottom sediments. These suspended

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Table 5.11-3
Summary of Adverse Cumulative Impacts

Category	Description of Cumulative Impact	Potential Cumulative Impacts Significance
Land Use	• VCS: Permanent use of 6354 acres land. • GBRA Water Supply Projects: Operation and maintenance of the water supply infrastructure would have small impacts to land use. • Operation and maintenance of transmission lines would have small impacts to land use.	Small
Hydrology & Water Use	• VCS: Withdraw up to 75,000 acre-feet per year. Permitted discharge of water and water return to lower Guadalupe River basin through reservoir seepage. The consumptive use of surface water by VCS would range from approximately 46,000 gpm under normal use conditions to approximately 68,300 gpm for maximum use conditions. Withdrawal of groundwater for consumption with minimal impact to offsite users. • GBRA Water Supply Projects: GBRA would withdraw up to 60,000 acre-feet per year water under existing water rights and up to 189,484 acre-feet per year under a new junior water right for storage and use by its customers including Coleto Creek Power Station. • Coleto Creek Unit 2: Potential groundwater use and makeup water received as a portion of the GBRA withdrawals. Consumptive Guadalupe River water use by Coleto Creek Power Station of up to 12,500 acre-feet per year.	Small
Terrestrial Ecology (Terrestrial and Aquatic)	• VCS: VCS operation on approximately 6354 acres including basins that provide large, open water habitat of benefit to multiple species of water birds. Water withdrawals and returns to the lower Guadalupe River basin resulting in reduced freshwater inflows into the Guadalupe estuary and San Antonio Bay, which supports aquatic species and migratory birds. • GBRA water transfer GBRA Water Supply Projects: Water withdrawals would result in some water loss resulting in reduced freshwater inflows into the Guadalupe estuary and San Antonio Bay, which support aquatic species and migratory birds. • VCS and GBRA Water Withdrawals: Proportional increase in amounts of fish, larvae, and eggs impinged or entrained in the RWMU Intake Structure. The species most likely to be affected are common to ubiquitous in the river, are of no value as food or sport fish, and have high reproductive potential, thus, can easily replace any losses.	Small
Aquatic Ecology	• VCS and GBRA Water Withdrawals: Proportional increase in amounts of fish, larvae, and eggs impinged or entrained in the RWMU Intake Structure. The species most likely to be affected are common to ubiquitous in the river, are of no value as food or sport fish, and have high reproductive potential, thus, can easily replace any losses.	Small

ENCLOSURE 2

SUMMARY OF REGULATORY COMMITMENTS

(Exelon Letter to USNRC No. NP-10-0010, dated June 24, 2010)

The following table identifies commitments made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	Programmatic (Yes/No)
Exelon will update ESPA Environmental Report (ER) Sections 2.4, 5.2, and 5.11 to incorporate the changes shown in Enclosure 1. Specifically, ER Sections 5.2 and 5.11 have been revised to reflect the results of an approximately year-long bio-statistical study undertaken by Exelon to evaluate the potential effects of proposed VCS water withdrawals from the Guadalupe River on the ecological health of the San Antonio Bay system. Additionally, ER Sections 2.4 and 5.11 have been revised to present additional information regarding the Aransas-Wood Buffalo population of whooping cranes and the abnormal mortality reportedly experienced by the flock during the 2008-2009 overwintering period at the Aransas National Wildlife Refuge.	Revision 1 of the ESPA Environmental Report planned for March 25, 2011	Yes	No